Part III
Attachment III-C
Appendix III-C.5

EROSION CONTROL PLAN

Pescadito Environmental Resource Center
MSW No. 2374
Webb County, Texas

PESCADITO
ENVIRONMENTAL RESOURCE CENTER

March 2015

Prepared for:
Rancho Viejo Waste Management, LLC
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Laredo, TX 78041

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STATE OF TEXAS
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Table of Contents

Attachments

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1.0 INTRODUCTION

This Erosion Control Plan has been developed to minimize the potential for erosion and sedimentation during landfill development. Landfill development is a general term intended to capture the multitude of steps necessary to construct the fully-developed landfill that is described and analyzed in the Site Development Plan (Part III) of this application. It is noted that all final landform stormwater management features, including terrace benches, downchutes, and perimeter channels, have been shown to prevent erosion in the Facility Surface Water Drainage Report and Analysis in Appendices III-C.1 and III-C.3, respectively.

Erosion control measures described within this plan may be utilized at all stages of landfill development, from the excavation of soil necessary to construct a base liner, during interim conditions when surface water controls may be necessary over soil-covered areas, on intermediate and final cover surfaces that direct stormwater to perimeter ditches, and during closure and post-closure care of the facility. This Erosion Control Plan has been developed to build the framework for erosion control. However, due to the multiple scenarios that may be encountered during landfill construction, it is stressed that each construction or development project should be evaluated to ensure that erosion control measures are appropriate.

Erosion control is to be handled through adherence to best management practices (BMPs), physical erosion control measures, temporary swales and ditches to be used during the development of the landfill, and the erosion and sediment control safeguards that have been incorporated into the final landform design for long-term conditions.

2.0 BEST MANAGEMENT PRACTICES

Best management practices will be utilized at the landfill to minimize the potential for erosion and sediment migration, including:

- Natural drainage features and vegetation will be maintained to the extent possible to allow natural stormwater controls to function.
- Development will be phased to minimize the area of bare soils exposed at any given time.
- Stormwater that comes into contact with construction activities will be managed within the construction area, if possible.
- Exposed surfaces will be stabilized, as necessary, in a timely manner.

3.0 PHYSICAL EROSION CONTROL METHODS

Physical erosion control methods will be used to minimize the generation of sediment in the runoff from disturbed areas. These methods will not only minimize sediment erosion but will improve the water quality of the stormwater runoff. These may include, but not be limited to:

1. *Barrier Filters.* Barrier filters (e.g. silt fences, waddles, rock checks, etc.) are intended to filter sediment from runoff in areas where runoff is not routed into a detention basin or sediment trap. Barrier filters will be used for both sheet flow and channel flow. Barrier filters will be used at a minimum along the entire length of all disturbed slopes that are being directly discharged off-site until permanent vegetation has been established and sediment control is no longer necessary.

   Barrier filters placed on slopes shall be installed parallel to the contours. When used around inlets, as much filter area as possible will be provided. For channel flow application, the barrier shall be extended to such a length that the ends of the barrier are higher in elevation than the top of the expected flows. Barrier filters will be routinely inspected in accordance with the stormwater pollution prevention plan and best management practices.

2. *Vegetative Filter.* Vegetative filters provide biological filtration to improve water quality where concentrations of sediment are high and flow velocities are relatively low. Vegetative filters may be used along drainageways. Vegetative filters may also be used on the side slopes of the detention basin to filter sediment from overland flow.

3. *Terrace Benching.* Terrace benches will be constructed along the landfill side slopes and perimeter fill slopes to intercept sheet runoff and direct it into downchutes.

4. *Sedimentation Basin.* Stormwater runoff from disturbed areas typically contains sediment. The sediment includes soil that erodes off of earth surfaces and aggregates that accumulate on paved surfaces. Stormwater runoff from the landfill will be

directed to a 46 acre stormwater detention basin at the southern end of the facility to improve stormwater discharge quality.

5. *Energy Dissipators*. Energy dissipators may be used along steep downchutes and at culvert outlets as required to prevent erosion and scouring. Energy dissipators routinely include baffles, concrete blocks, and/or large riprap.

4.0 EROSION CONTROL DURING CONSTRUCTION

Landfill construction is an on-going process that will require multiple stormwater management controls and best management practices based on the observed conditions. No landfill areas will be developed without appropriate/adequate stormwater management controls. The development of the perimeter ditches and detention basin will be phased to correspond with development of the landfill. It is noted that the final-landform stormwater management controls have been designed to convey the 100-year storm without erosion or scour, as demonstrated in Appendix III-C.3. Therefore, once these features have been developed, they can be utilized with the knowledge that because they have been designed to accommodate the entire fully developed landfill, they are also sufficiently sized to handle interim conditions.

However, multiple conditions will exist when these controls cannot be used for stormwater management. Examples include:

1. Run-on control to prevent surface water from entering the approved waste placement areas.
2. Intermediate cover construction when placed in an area that requires stormwater conveyance prior to entering the perimeter ditch system or other controlled areas.

Based on the multiple potential development conditions that may be encountered during construction, general temporary ditch and swale designs have been evaluated based on various drainage areas and slope areas. In general, ditches are intended to be used during cell development and in intermediate cover areas that are located in internal areas of the landfill (e.g. in areas where final waste grades have not yet been achieved). Ditches will have 3H:1V sideslopes and 2-foot minimum depth. Swales will be used on intermediate cover areas on external slopes where final waste grades have been achieved but final cover has not yet been constructed. Swales will also be 2-feet in depth and will have both 2H:1V and 4H:1V slopes with a V-notch configuration. It is assumed that both ditches or swales will be placed every 50 vertical feet in order to manage stormwater drainage.

Drainage areas of 1-acre, 5-acre, and 10-acre size have been contemplated for temporary ditches assuming grades that vary between 6% and 40% (2.5H:1V). The 2.5H:1V is considered based on the maximum slopes that may be anticipated either on soil faces during cell excavation of interim intermediate cover slopes that are not on exterior 4H:1V slopes. The 6% grade is considered as a minimum slope requiring a temporary drainage ditch feature and was selected due to the fact that it represents the minimum top-slopes that may be constructed with intermediate cover. Drainage areas of 1-acre, 5-acre, and 10-acre size have also been contemplated for temporary swales, although all calculations are based only on 4H:1V contributing areas.

A summary of acceptable temporary swale and ditch slopes and base widths to convey with 25-year, 24-hour storm without erosion or scour is presented in the table below. It is noted that the attached calculations provide information on how these configurations were evaluated.

Acceptable Swale Slopes for Various Drainage Areas (V-Notch)					
Channel Grade	**Peak Flow Velocity**	**Maximum Capacity of Swale**	**Acceptable for 1-acre Area?**	**Acceptable for 5-acre Area?**	**Acceptable for 10-acre Area?**
(percent)	**(ft/sec)**	**(cfs)**	**Yes/No**	**Yes/No**	**Yes/No**
0.3	*2.61*	*31.32*	Yes	Yes	No
0.5	*3.37*	*40.43*	Yes	Yes	No
0.75	*4.13*	*49.52*	Yes	Yes	No
1.0	*4.76*	*57.18*	Yes	Yes	Yes

Acceptable Ditch Slopes for Various Drainage Areas						
Channel Grade	**Channel Width**	**Peak Flow Velocity**	**Maximum Capacity of Swale**	**Acceptable for 1-acre Area?**	**Acceptable for 5-acre Area?**	**Acceptable for 10-acre Area?**
(percent)	**(feet)**	**(ft/sec)**	**(cfs)**	**Yes/No**	**Yes/No**	**Yes/No**
0.3	*0*	*2.62*	*31.43*	Yes	Yes	No
0.3	*2*	*2.88*	*46.04*	Yes	Yes	No
0.3	*4*	*3.07*	*61.3*	Yes	Yes	Yes
0.5	*0*	*3.38*	*40.58*	Yes	Yes	No
0.5	*2*	*3.71*	*59.43*	Yes	Yes	Yes
0.5	*4*	*3.96*	*79.16*	Yes	Yes	Yes
0.75	*0*	*4.14*	*49.70*	Yes	Yes	No
0.75	*2*	*4.55*	*72.79*	Yes	Yes	Yes
0.75	*4*	*4.85*	*96.95*	Yes	Yes	Yes
1.0	*0*	*4.78*	*57.39*	Yes	Yes	Yes

Additional erosion control features, such as rock check dams, hay bales, or other items described earlier in this Plan, may be used in conjunction with the temporary ditches and swales to enhance water quality and minimize the potential for erosion or soil transport.

Any stormwater that collects within the landfill excavation will be routed to temporary stormwater collection sumps. Rainfall which ponds on the liner and leachate collection system prior to the placement of waste will be pumped into the stormwater management system. Once landfilling begins within a new cell, stormwater which contacts waste or collects within the leachate collection system will be treated as leachate per 30 TAC 330.207.

Access roads leading to the active waste disposal area and other frequently traveled onsite roads will be surfaced with a suitable thickness of aggregate to minimize the tracking of mud from the active face in order to improve stormwater quality and to control dust. Water trucks will be used as necessary to moisten roads and bare-soil covered areas to minimize the potential for wind-borne erosion (dust).

5.0 INTERMEDIATE COVER CONSIDERATIONS

For the purpose of compliance with 30 TAC Section 330.305(d), intermediate cover areas are those that that meet the following criteria:

1. Drain directly to the site perimeter stormwater management system;
2. Have received intermediate or final cover; and
3. Have either reached the landfill permitted elevation, or will remain inactive for longer than 180 days.

As previously noted, stormwater will be managed through the use of temporary swales and ditches once intermediate cover is installed. It is assumed that temporary swales and diversion channels will be lined with vegetation. Temporary swales shall be placed at a maximum spacing of 50 vertical feet with appropriate dimensions and slope to safely convey the drainage area (previously presented). It is anticipated that swales may discharge to downchutes. Downchutes must be sized to convey the total stormwater discharge rate associated will all contributing stormwater management features. Downchutes must be constructed of riprap, geomembrane, concrete, turf reinforced mat, or other material that will eliminate the potential for erosion. Temporary erosion control features will be installed within 180 days of intermediate cover placement.

5.1 Stormwater Velocities along Intermediate Cover Surface

The sheet flow velocity along both the topslopes and sideslopes has been evaluated for the 25-year storm using the Rational Method (see attached calculations). Stormwater velocities have been found to be non-erodible (less than five ft/sec). Therefore, the expected sheet flow velocities are deemed acceptable.

5.2 Intermediate Cover Erosion Loss Evaluation

The topslopes and sideslopes have been reviewed to ensure that erosion and soil erosion loss, in tons/acre, will not exceed the permissible soil loss of 50 tons/year based on a maximum vertical spacing of 50 feet between temporary stormwater management features. A soil erosion loss has been estimated as 0.45 tons/year for the topslopes and 4.32 tons/year for the sideslopes.

Therefore, the maximum vertical spacing is acceptable based on intended intermediate cover design. Please refer to the attached calculations for the evaluation.

5.3 Intermediate Cover Soil Stabilization and Vegetation Schedule

The soil stabilization and vegetation schedule is as follows:

- Areas that will remain inactive for periods greater than 180 days will receive intermediate cover.
- Intermediate cover on slopes will be stabilized by tracking into the slope. Soil stabilization can be enhanced by mulching, the addition of soil tackifiers, soil treatment, or any combination of these measures. The intermediate cover will be graded to provide positive drainage.
- Temporary erosion control structures will be installed within 180 days from when intermediate cover is constructed.
- The intermediate cover area will be seeded or sodded as soon as practical, following placement of intermediate cover and will be documented in the site operating record. All intermediate cover areas will be managed to control erosion and achieve a predicted soil loss of less than 50 tons per acre per year. A 60 percent vegetative cover will be established over the intermediate cover areas within 180 days from intermediate cover construction unless prevented by climatic events (e.g., drought, rainfall, etc.). Additional temporary erosion control measures will be implemented during these events to promote establishment of vegetative cover.
- Although not required for the establishment of vegetation, mulch, woodchips, or compost may be used as a layer placed over the intermediate cover to protect the exposed soil surface from erosive forces and conserve soil moisture until vegetation can be established. The mulch, woodchips, or compost may be used to stabilize recently graded or seeded areas.
- Final cover will be constructed as the site develops. Temporary erosion control features will be removed as permanent erosion control structures are constructed.

5.4 Intermediate Cover Inspection and Maintenance

Interim construction, erosion, and sediment controls will be installed prior to disturbing one acre or more, and will be maintained until the disturbed areas are stabilized or runoff is routed to a detention basin. All temporary and permanent erosion and sediment control measures will be maintained and repaired as needed to assure continued performance of their intended function. This program will include performance checks of facilities and grades, remedial grading, sediment removal, vegetative care and maintenance. Inspections will address points of scour, slope failure, breaching or settling. Inspections will be performed once every 3 months and after significant storm events. Maintenance will include clearing of sediment from culverts, discharge pipes, the basin, and other observed points of collection. Sediments will be removed from the detention basin when the sedimentation level is within one foot from the invert of the outlet structure. Sediment removed from the barriers and the detention basin will not be placed in floodplain areas or in areas without adequate BMPs in-place. As necessary, runoff collection features will be cleaned, re-graded, relined, rip-rapped, etc., to restore design capacities and correct problem areas. A written record of all inspections and maintenance will be prepared and placed in the facility Stormwater Pollution Prevention Plan (SWPPP), which will be kept at the site. Site inspections by landfill personnel will be performed weekly or within 48 hours of a rainfall event of 0.5 inches or more.

6.0 EROSION CONTROL DURING FINAL LANDFORM CONDITIONS

Stormwater modeling of the final landform stormwater management features (terrace benches, downchutes, perimeter channels, detention basin, and culverts) have demonstrated that the features are appropriately sized and function with non-erodible stormwater velocities or provide adequate protection to prevent erosion or scour. Please refer to the calculations provided in **Attachment B** of this Appendix (III-C.5-B).

The final slopes are designed at a grade capable of supporting vegetation to minimize erosion. These slopes will drain runoff from the cover and prevent ponding. Vegetation will be established on reconstructed surfaces to minimize wind and water erosion of the final cover. In addition, terrace benches will be constructed on the final landform to collect runoff and control erosion along the slopes of the landfill.

A grass seed mixture will be incorporated into the upper surface of the protective soil layer. The mixture selected will be amenable to the soil quality/thickness, slopes and moisture/climatological conditions that exist to minimize the need for maintenance.

Landscaping or seeding professionals knowledgeable of local soil and climatological conditions will be consulted in determining the specific seed mixtures, necessary soil amendments and application rates based upon specific seasonal conditions at the time of closure. Application rates for lime, fertilizer and any other necessary soil amendments shall be determined from composite soil tests from the area to be seeded or by experienced professional judgment. Mulch consisting of straw, jute, wood excelsior, etc. shall be used as necessary to hold the seed in place and conserve moisture. All finalized areas of the landfill will be seeded as soon as practical, with seeding usually conducted in the spring or fall.

Erosion will be controlled by vegetation on topslopes, sideslopes, and in drainage conveyance structures with flow velocities less than or equal to 5 fps. For drainage conveyance structures with flow velocities greater than 5 fps, turf reinforcement, rock riprap, concrete, gabions, or other appropriate materials will be used for surface reinforcement.

6.1 Stormwater Velocities along Final Cover Surface

The sheet flow velocity along the both the topslopes and sideslopes was evaluated for the 25-year storm using the HydroCAD, as shown in **Attachment III.C.3** of this Appendix. However, it was also calculated using Rational Method to ensure that consistency with HydroCAD (which is to be used for modeling areas greater than 200 acres). As shown in the attached calculations, stormwater velocities have been found to be non-erodible (less than five ft/sec) over the final cover surface. Therefore, the expected sheet flow velocities are deemed acceptable.

6.2 Final Cover Erosion Loss Evaluation

As demonstrated in the attached calculations, the soil loss for the final cover is approximately 2.88 tons/acre/year for the sideslopes and 0.54 tons/acre/year for the topslopes. The calculated minimum thickness for the erosion layer is 6.76 inches (regulatory minimum thickness of 6 inches plus 0.76 inches of soil thickness loss due to erosion). For ease of construction, the erosion layer of the final cover will be constructed with a minimum thickness of 7 inches.

6.3 Final Cover Inspection and Maintenance

All permanent erosion and sediment control measures will be maintained and repaired as needed to assure continued performance of their intended function. The final cover system and the erosion sediment control structures will be maintained throughout the site life and postclosure care period. Inspections will be performed once every 3 months and after significant storm events. Maintenance will include clearing of sediment from culverts, discharge pipes, the basin, and other observed points of collection. Sediments will be dredged from the detention basin when the sedimentation level is within one foot from the invert of the outlet structure. Sediment removed from the barriers and the detention basin will not be placed in floodplain areas or in areas without adequate BMPs in-place. As necessary, runoff collection features will be cleaned, regraded, relined, rip-rapped, etc., to restore design capacities and correct problem areas.

ATTACHMENT III-C

APPENDIX III-C.5

EROSION CONTROL PLAN

A. FLOW RATE PER UNIT AREA INTO TEMPORARY DITCHES AND SWALES
B. TEMPORARY DITCH GEOMETRY
C. TEMPORARY SWALE GEOMETRY
D. SHEET FLOW VELOCITY ON INTERMEDIATE COVER SLOPES
E. SOIL LOSS FROM INTERMEDIATE COVER SLOPES
F. FLOW RATE PER UNIT AREA FROM FINAL COVER SLOPES
G. SHEET FLOW VELOCITY ON FINAL COVER SLOPES
H. SOIL LOSS FROM FINAL COVER SLOPES

ATTACHMENT III-C

APPENDIX III-C.5

EROSION CONTROL PLAN

A. FLOW RATE PER UNIT AREA INTO TEMPORARY DITCHES AND SWALES (ATTACHMENT A TO APPENDIX III-C.5)

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Client:	Rancho Viejo Waste Managment, LLC
Project:	Pescadito Environmental Resource Center
Project #:	148866
Calculated By:	MTE — Date: 1/27/15
Checked By:	RDS — Date: 1/27/15

TITLE: FLOW RATE PER UNIT AREA INTO TEMPORARY DITCHES AND SWALES

Problem Statement

Determine the peak discharge per unit width of flow into temporary ditches and swales used during intermediate landfill development conditions. Temporary ditches and swales may be utilized in either waste areas covered with intermediate cover or in future landfilling construction areas that require temporary stormwater conveyance.

This value is used to determine sheet flow velocity and discharge rates of temporary ditches and swales (see subsequent sheets within this Attachment).

Given

- ❑ Texas Department of Transportation, *Hydraulic Design Manual*, Revised October 2011.
- ❑ United States Geologic Survey, *Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas*, 2004.

Assumptions

- ❑ The 25 year, 15 minute rainfall depth is 1.7 inches, per the USGS *Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas*. A depth of 1.3 inches has been extrapolated for 10 minutes.
- ❑ Time of concentration (Tc) is conservatively assumed to be 10 minutes, per *Hydraulic Design Manual* guidance.
- ❑ The runoff coefficient (C) is 0.70, a typical value for intermediate cover.
- ❑ The Rainfall Intensity (I) is 7.8 in/hr, based on Pd/tc, per the *Hydraulic Design Manual*
- ❑ Manning's Number of 0.03, typical for intermediate cover
- ❑ The maximum slope of a contributing area to a ditch is assumed to be 2.5H:1V (0.4 ft/ft).
- ❑ The minimum slope of a contributing area to a ditch is assumed to be six percent (0.06 ft/ft).
- ❑ The slope of contributing areas to a swale will be 4H:1V (0.25 ft/ft).

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TITLE: FLOW RATE PER UNIT AREA INTO TEMPORARY DITCHES AND SWALES

- The unit width for any contributing flow is 1 foot (to allow the determination of total inflow per linear foot of depth analysis).
- Temporary channels and swales will be placed every 50 vertical feet. For a 2.5H:1V slope, this produces a 134.6 ft maximum flow length. For a 4H:1V slope, this produces a 206 ft maximum flow length. For a six percent slope, this produces a 833 ft maximum flow length.

Calculations

25-year Peak Flow Rate (Rational Method)

$$Q = CIA$$

Where:

Q = Peak Flow Rate per Unit Width (ft^3/sec/ft)
C = Runoff Coefficient
I = Rainfall Intensity (in/hr)
A = Area (acres) (Flow Length x Unit Width)

Results

The peak discharge rate per unit width of flow into a temporary drainage system for 6%, 2.5H:1V and 4H:1V slopes are shown below. The 6% slopes produce a slightly higher result due to the longer flow length to the channel.

Slope (H:V)	Flow Length (feet)	Peak Discharge Rate Per Unit Width (ft^3/sec/ft)
4H:1	206	0.026
2.5H:1	134.6	0.017
6 %	833	0.105

USGS

science for a changing world

In cooperation with the Texas Department of Transportation

Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas

Scientific Investigations Report 2004–5041
(TxDOT Implementation Report 5–1301–01–1)

U.S. Department of the Interior
U.S. Geological Survey

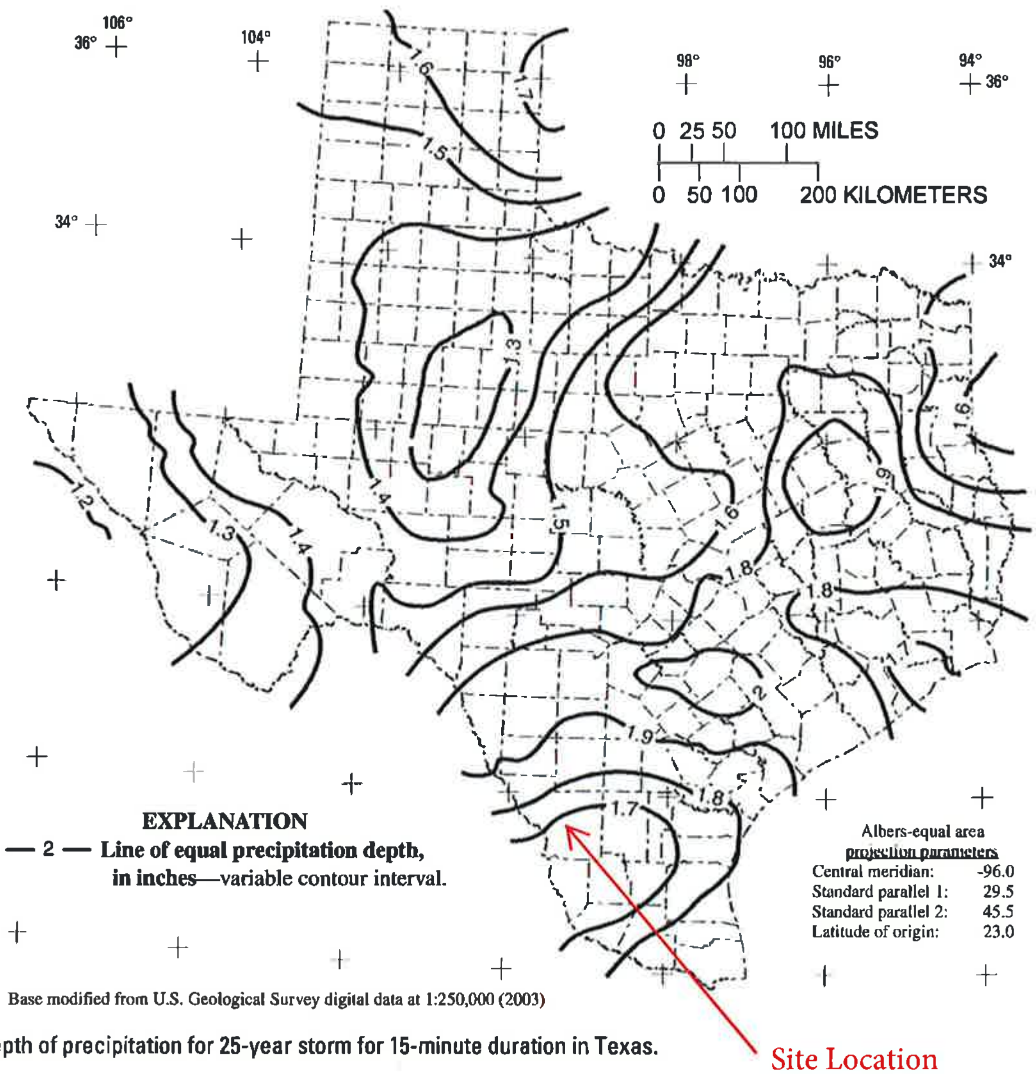

Figure 40. Depth of precipitation for 25-year storm for 15-minute duration in Texas.

ATTACHMENT III-C

APPENDIX III-C.5

EROSION CONTROL PLAN

B. TEMPORARY DITCH GEOMETRY (ATTACHMENT B TO APPENDIX III-C.5)

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TITLE: TEMPORARY DITCH GEOMETRY

Problem Statement

Determine the peak flow rate within temporary ditches to be used during landfill construction.

Given

- ❑ Ditches will be placed as necessary during operations to manage stormwater. Ditches are assumed to be constructed with 3H:1V sideslopes and a depth of 2 feet.
- ❑ Ditches will have variable widths depending on the area that they serve, as determined in this calculation.
- ❑ The peak discharge rates per unit width of flow into the ditches for various slopes are provided in Attachment A of Appendix III-C.5.

Assumptions

- ❑ Temporary ditches will be constructed based on phasing and development needs. Ditches may serve areas ranging from small (1 acre) to large (10 acres).
- ❑ A Manning's Coefficient of 0.03 is representative of the temporary ditch.

Calculations

Determine the length of ditch required to serve 1 acre, 5 acre and 10 acre drainage areas as well as peak flow volume of the ditch based on peak discharge rate per unit width:

Drainage Area (acres)	Slope	Maximum Flow Length (ft)	Required Ditch Length to Serve Drainage Area (ft)	Discharge Rate per Unit Width (cfs)	Peak Flow Volume of Ditch (cfs)
1	6%	833	52	0.105	5.5
	4H:1V	206	211	0.026	
	2.5H:1V	134.6	324	0.017	
5	6%	833	261	0.105	27.5
	4H:1V	206	1,057	0.026	
	2.5H:1V	134.6	1,619	0.017	
10	6%	833	523	0.105	55.0
	4H:1V	206	2,114	0.026	
	2.5H:1V	134.6	3,236	0.017	

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TITLE: TEMPORARY DITCH GEOMETRY

Based on the information determined above, all temporary ditches must be designed to convey a minimum of 5.5 cfs, 27.5 cfs, and 55.0 cfs for 1-acre, 5-acre, and 10-acre drainage areas, respectively.

Results

Acceptable ditch grades and geometries for the various drainage areas are identified below. An acceptable grade is one that is able to pass the peak discharge rates identified above while maintaining a flow velocity lower than 5 ft/sec (non-erodible velocity). The peak flow velocities and capacities of various slopes are determined using FlowMaster. A sample FlowMaster output file is included; however, all output files are available upon request.

Acceptable Swale Slopes for Various Drainage Areas						
Channel Grade	Channel Width	Peak Flow Velocity	Maximum Capacity of Swale	Acceptable for 1-acre Area?	Acceptable for 5-acre Area?	Acceptable for 10-acre Area?
(percent)	(ft)	(ft/sec)	(cfs)	Yes/No	Yes/No	Yes/No
0.3	0	2.62	31.43	Yes	Yes	No
0.3	2	2.88	46.04	Yes	Yes	No
0.3	4	3.07	61.3	Yes	Yes	Yes
0.5	0	3.38	40.58	Yes	Yes	No
0.5	2	3.71	59.43	Yes	Yes	Yes
0.5	4	3.96	79.16	Yes	Yes	Yes
0.75	0	4.14	49.70	Yes	Yes	No
0.75	2	4.55	72.79	Yes	Yes	Yes
0.75	4	4.85	96.95	Yes	Yes	Yes
1.0	0	4.78	57.39	Yes	Yes	Yes
1.0	2	5.25	84.05	No	No	No
1.25	0	5.35	64.16	No	No	No

Ditch: 1.0% Slope, 2-ft Bottom Width

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.030	
Channel Slope	0.01000	ft/ft
Normal Depth	2.00	ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	2.00	ft

Results

Discharge	84.05	ft^3/s
Flow Area	16.00	ft^2
Wetted Perimeter	14.65	ft
Hydraulic Radius	1.09	ft
Top Width	14.00	ft
Critical Depth	1.87	ft
Critical Slope	0.01358	ft/ft
Velocity	5.25	ft/s
Velocity Head	0.43	ft
Specific Energy	2.43	ft
Froude Number	0.87	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.87	ft
Channel Slope	0.01000	ft/ft

Ditch: 1.0% Slope, 2-ft Bottom Width

GVF Output Data

Critical Slope	0.01358	ft/ft

ATTACHMENT III-C

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EROSION CONTROL PLAN

C. TEMPORARY SWALE GEOMETRY (ATTACHMENT C TO APPENDIX III-C.5)

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Calculated By:	**MTE**	**Date:**	**1/27/15**
Checked By:	**RDS**	**Date:**	**1/27/15**

TITLE: TEMPORARY SWALE GEOMETRY

Problem Statement

Determine the peak flow rate within a temporary (intermediate conditions) swale placed on exterior 4H:1V sideslopes.

Given

- Swales will be constructed on 4H:1V sideslopes. Swales will be constructed as V-notch trenches with a depth of two feet and sideslopes of 4H:1V and 2H:1V.
- The peak discharge rate per unit width of flow into the swale is 0.026 cfs (see Attachment A of this Appendix III-C.5 (III-C.5-A)).
- Temporary swales will be placed at a maximum spacing of 50 vertical feet. This results in a total flow length of 206 feet along the slope to the swale.

Assumptions

- Temporary swales will be constructed based on phasing and development needs. Swales may serve areas ranging from small (1 acre) to large (10 acres).
- A Manning's Coefficient of 0.03 is representative of the temporary swale.

Calculations

Determine the length of swale required to serve various drainage areas:

1 acre:	1 acre = 43,560 square feet. 43,560 square feet / 206 feet (maximum flow length) = 211 feet
5 acres:	5 acres = 217,800 square feet. 217,800 square feet / 206 feet (maximum flow length) = 1,057 feet
10 acres:	10 acres = 435,600 square feet. 435,600 square feet / 206 feet (maximum flow length) = 2,114 feet

Client: Rancho Viejo Waste Management, LLC
Project: Pescadito Environmental Resource Center
Project #: 148866
Calculated By: MTE Date: 1/27/15
Checked By: RDS Date: 1/27/15

TITLE: TEMPORARY SWALE GEOMETRY

Determine the peak flow volume of the swale based on maximum swale length and peak discharge rate per unit width:

1 acre: (211 feet) x 0.026 cfs = 5.5 cfs

5 acres: (1,057 feet) x 0.026 cfs = 27.5 cfs

10 acres: (2,114 feet) x 0.026 cfs = 55.0 cfs

Determine acceptable swale grades for the various drainage areas identified above. An acceptable grade is one that is able to pass the peak discharge rates identified above while maintaining a flow velocity lower than 5 ft/sec (non-erodible velocity). The peak flow velocities and capacities of various slopes are determined using FlowMaster. Output files are attached.

Results

The table below identifies acceptable channel slopes for various drainage areas.

Acceptable Swale Slopes for Various Drainage Areas					
Channel Grade	*Peak Flow Velocity*	*Maximum Capacity of Swale*	Acceptable for 1-acre Area?	Acceptable for 5-acre Area?	Acceptable for 10-acre Area?
(percent)	*(ft/sec)*	(cfs)	Yes/No	Yes/No	Yes/No
0.3	*2.61*	*31.32*	Yes	Yes	No
0.5	*3.37*	*40.43*	Yes	Yes	No
0.75	*4.13*	*49.52*	Yes	Yes	No
1.0	*4.76*	*57.18*	Yes	Yes	Yes
1.25	*5.33*	*63.93*	No	No	No

ATTACHMENT III-C

APPENDIX III-C.5

EROSION CONTROL PLAN

D. SHEET FLOW VELOCITY ON INTERMEDIATE COVER SLOPES (ATTACHMENT D TO APPENDIX III-C.5)

STATE OF TEXAS
MICHAEL W. ODEN
67165
REGISTERED PROFESSIONAL ENGINEER

3-2-2015

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Client:	Rancho Viejo Waste Management, LLC
Project:	Pescadito Environmental Resource Center
Project #:	148866
Calculated By: MTE	Date: 1/27/15
Checked By: RDS	Date: 1/27/15

TITLE: SHEET FLOW VELOCITY ON INTERMEDIATE COVER SLOPES

Problem Statement

Determine the peak sheet flow velocity for intermediate cover design and compare to the permissible non-erodible flow velocity.

Given

- ❑ Texas Department of Transportation, *Hydraulic Design Manual*, Revised October 2011.

Assumptions

- ❑ The peak discharge rate per unit width of flow into a ditch is 0.026 cfs/ft for 4H:1V slopes and 0.017 cfs/ft for 2.5H:1V slopes (see Attachment A of Appendix III-C.5).
- ❑ Temporary ditches and swales will be placed every 50 vertical feet. For a 2.5H:1V slope, this produces a 134.6 foot maximum flow length. For a 4H:1V slope, this produces a 206 foot maximum flow length.
- ❑ A Manning's Coefficient of 0.03 is representative of intermediate cover conditions.

Calculations

The sheet flow velocity is a function of flow rate and depth. Therefore, flow depth is first calculated based on a re-arranged format of Manning's Equation.

Flow Depth (re-arranged Manning's Equation)

$$y = \left(\frac{Qn}{1.49S^{0.5}}\right)^{0.6}$$

Where:

y = Peak flow depth (ft)
Q = Peak flow rate per unit width (cfs/ft)
S = Slope (ft/ft)
n = Manning's Coefficient

Client:	**Rancho Viejo Waste Management, LLC**		
Project:	**Pescadito Environmental Resource Center**		
Project #:	**148866**		
Calculated By:	**MTE**	**Date:**	**1/27/15**
Checked By:	**RDS**	**Date:**	**1/27/15**

TITLE: SHEET FLOW VELOCITY ON INTERMEDIATE COVER SLOPES

Slope (H:V)	Peak Flow Rate (cfs/ft)	Manning's Coefficient	Peak Flow Depth (ft)
4H:1V	0.026	0.03	0.016
2.5H:1V	0.017	0.03	0.011

Sheet Flow Velocity

$$V = \frac{Q}{y * w}$$

Where:

V = Sheet flow velocity (ft/sec)
Q = Peak flow rate per unit width (cfs/ft)
y = Peak flow depth (ft)
w = Unit width (ft)

Slope (H:V)	Peak Flow Rate (cfs/ft)	Peak Flow Depth (ft)	Unit Width (ft)	Sheet Flow Velocity (ft/sec)
4H:1V	0.026	0.016	1.0	1.63
2.5H:1V	0.017	0.011	1.0	1.55

Results

A sheet flow velocity of 1.55 ft/sec will result from 2.5H:1V slopes with a flow length of 134.6 feet. A sheet flow velocity of 1.63 ft/sec will result from 4H:1V slopes with a flow length of 206 feet. Both velocities are lower than 5 ft/sec, and are therefore considered non-erodible.

ATTACHMENT III-C

APPENDIX III-C.5

EROSION CONTROL PLAN

E. SOIL LOSS FROM INTERMEDIATE COVER SLOPES (ATTACHMENT E TO APPENDIX III-C.5)

3-2-2015

STATE OF TEXAS

MICHAEL W. ODEN

67165

REGISTERED PROFESSIONAL ENGINEER

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Client:	Rancho Viejo Waste Management, LLC
Project:	Pescadito Environmental Resource Center
Project #:	148866
Calculated By:	MTE	Date: 1/28/15
Checked By:	RDS	Date: 1/28/15

TITLE: SOIL LOSS FOR INTERMEDIATE COVER CONDITIONS

Problem Statement

Determine the erosion loss for the intermediate cover to ensure that it remains less than 50 tons/acre/year.

Given

- *Predicting Rainfall Erosion Losses : A Guide to Conservation Planning,* United States Department of Agriculture, Agriculture Handbook Number 537, prepared by Science and Education Administration
- AutoCAD Civil 3D 2014
- NRCS Soil Survey data for Webb County
- The Universal Soil Loss Equation (USLE) was used to determine the annual erosion rate.

$$A = R * K * LS * C * P$$

Where,

A = Annual soil loss in tons/acre per year
R = Rainfall Erosion Index
K = Soil erodibility factor
LS = Topographic factor
C = Cover factor
P = Management practice factor

Assumptions

- Two external slope cover scenarios are assumed during intermediate conditions; 4H:1V and 6% slopes.

Client:	**Rancho Viejo Waste Management, LLC**		
Project:	**Pescadito Environmental Resource Center**		
Project #:	**148866**		
Calculated By:	**MTE**	**Date:**	**1/28/15**
Checked By:	**RDS**	**Date:**	**1/28/15**

TITLE: SOIL LOSS FOR INTERMEDIATE COVER CONDITIONS

Calculations

Determine the appropriate values for the USLE equation:

R (Rainfall Erosion Index)
Based on Figure 1 "Average annual values of the rainfall erosion index" a factor of 220 was determined.

K (Soil Erodibility Factor)
Using NRCS Soil data for the facility, a soil erodibility factor of 0.32 is assumed (see attached).

LS (Slope Length/Steepness Factor)
Based on a 50 foot vertical spacing of temporary swales, the slope lengths of 206 ft and 532 ft represent 4H:1V and 6% slopes, respectively. Based on Figure 4 "Slope-effect chart", the LS values were determined to be 8.5 and 1.6.

C Factor
Based on Table 10 "Factor C for permanent pasture, range, and idle land", and assuming a 60% ground cover and no appreciable canopy, a C factor of 0.042 was selected. This is a conservative assumption; the C factor will likely be lower for actual intermediate cover conditions.

P Factor
Based on Table 15, a P factor value of 0.18 is used for terraced slopes from 21 to 25% and 0.10 for terraced slopes from 3% to 8%, where sediment loss is being calculated for overall "watershed gross erosion".

Calculate the sediment loss per acre using the USLE equation for 4H:1V slopes:

$$A = R * K * LS * C * P$$

$$A = 220 * 0.32 * 8.5 * 0.042 * 0.18$$

$$A = 4.52 \ tons/acre/year$$

Client:	**Rancho Viejo Waste Management, LLC**
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Calculated By:	**MTE** — **Date:** **1/28/15**
Checked By:	**RDS** — **Date:** **1/28/15**

TITLE: SOIL LOSS FOR INTERMEDIATE COVER CONDITIONS

Calculate the sediment loss per acre using the USLE equation for 6% slopes:

$$A = R * K * LS * C * P$$

$$A = 220 * 0.32 * 1.6 * 0.042 * 0.10$$

$$A = 0.47\ tons/acre/year$$

Results

The calculated maximum soil loss for intermediate cover conditions is 4.52 tons/acre/year, which is less than the maximum allowable soil loss of 50 tons/acre/year.

AH537/12/78

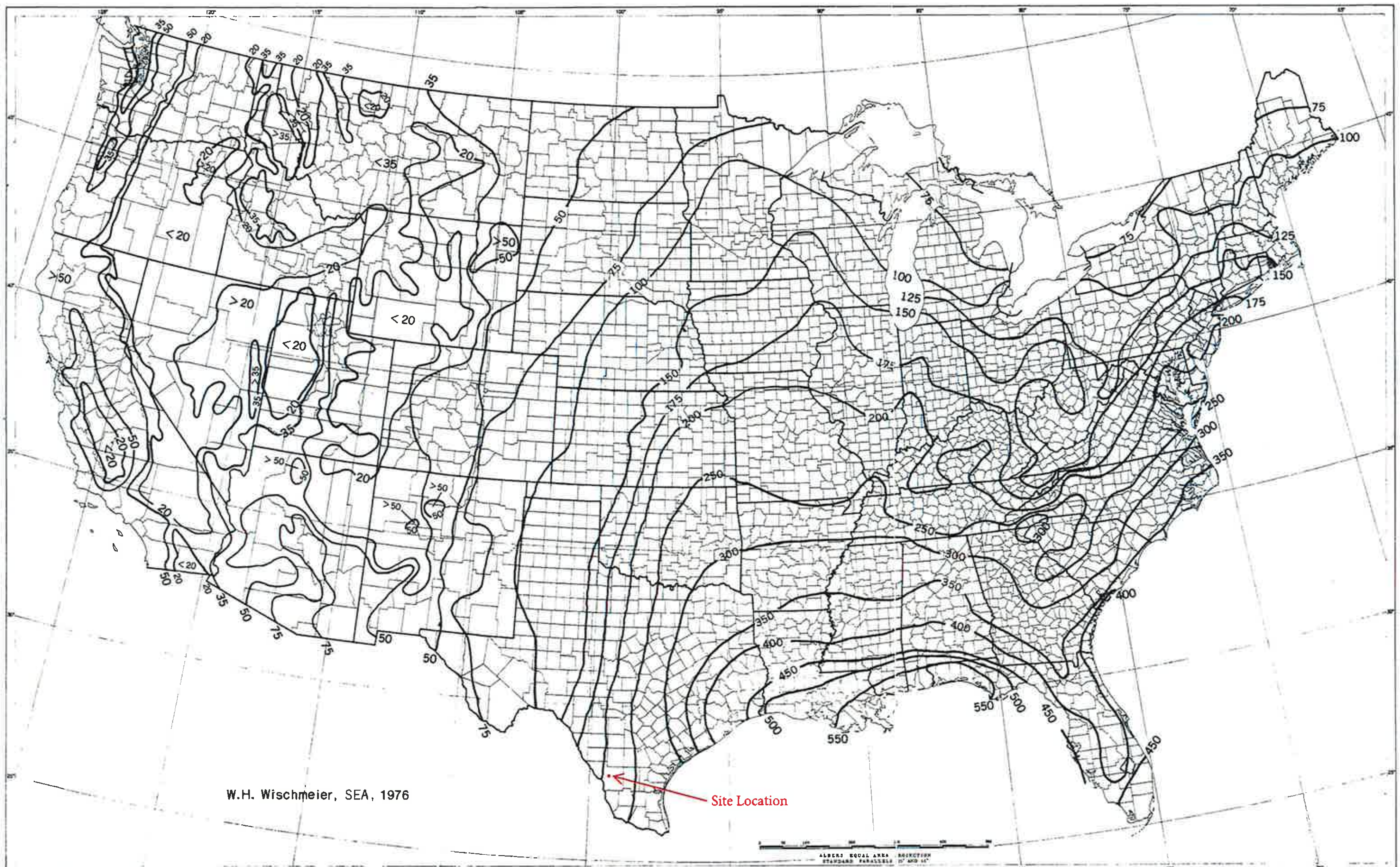
PREDICTING RAINFALL EROSION LOSSES

A GUIDE TO CONSERVATION PLANNING

UNITED STATES DEPARTMENT OF AGRICULTURE

AGRICULTURE HANDBOOK NUMBER 537

PREPARED BY SCIENCE AND EDUCATION ADMINISTRATION



W.H. Wischmeier, SEA, 1976
Site Location

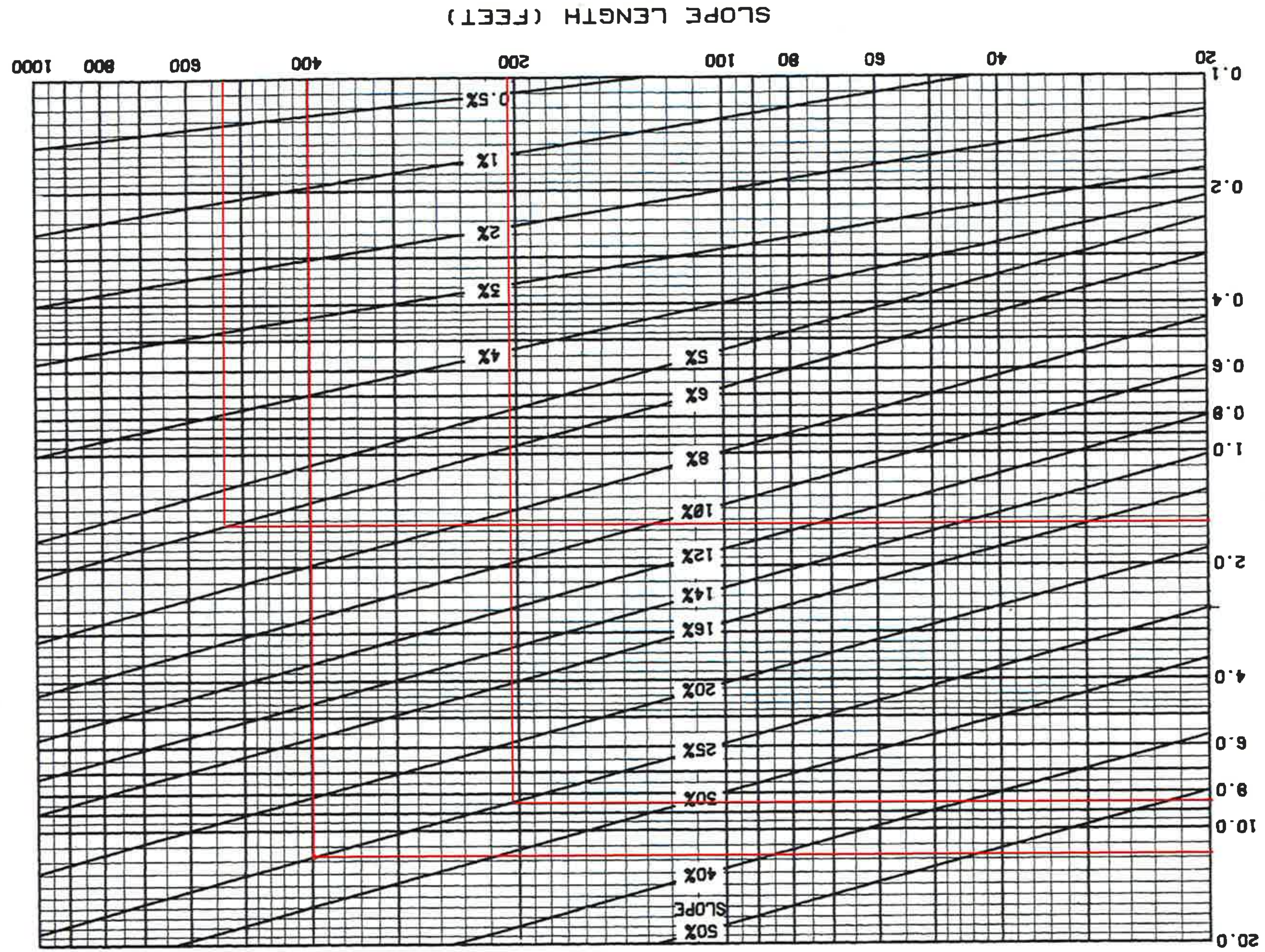


FIGURE 4.—Slope-effect chart (topographic factor, LS). $LS = (\lambda/72.6)^m (65.41 \sin^2\theta + 4.56 \sin\theta + 0.065)$ where λ = slope length in feet; θ = angle of slope; and $m = 0.2$ for gradients < 1 percent, 0.3 for 1 to 3 percent slopes, 0.4 for 3.5 to 4.5 percent slopes, and 0.5 for slopes of 5 percent or steeper.

tion and developmental areas can be obtained from table 5 if good judgment is exercised in comparing the surface conditions with those of agricultural conditions specified in lines of the table. Time intervals analogous to cropstage periods will be defined to begin and end with successive construction or management activities that appreciably change the surface conditions. The procedure is then similar to that described for cropland.

Establishing vegetation on the denuded areas as quickly as possible is highly important. A good sod has a **C** value of 0.01 or less (table 5-B), but such a low **C** value can be obtained quickly only by laying sod on the area, at a substantial cost. When grass or small grain is started from seed, the probable soil loss for the period while cover is developing can be computed by the procedure outlined for estimating cropstage-period soil losses. If the seeding is on topsoil, without a mulch, the soil loss ratios given in line 141 of table 5 are appropriate for cropstage **C** values. If the seeding is on a desurfaced area, where residual effects of prior vegetation are no longer significant, the ratios for periods SB, 1 and 2 are 1.0, 0.75 and 0.50, respectively, and line 141 applies for cropstage 3. When the seedbed is protected by a mulch, the pertinent mulch factor from the upper curve of figure 6 or table 9 is applicable until good canopy cover is attained. The combined effects of vegetative mulch and low-growing canopy are given in figure 7. When grass is established in small grain, it can usually be evaluated as established meadow about 2 mo after the grain is cut.

C Values for Pasture, Range, and Idle Land

Factor **C** for a specific combination of cover conditions on these types of land may be obtained from table 10 (*57*). The cover characteristics that must be appraised before consulting this table are defined in the table and its footnotes. Cropstage periods and **EI** monthly distribution data are generally not necessary where perennial vegetation has become established and there is no mechanical disturbance of the soil.

Available soil loss data from undisturbed land were not sufficient to derive table 10 by direct comparison of measured soil loss rates, as was done for development of table 5. However, analyses of the assembled erosion data showed that the research information on values of **C** can be extended to completely different situations by combining subfactors that evaluate three separate and distinct, but interrelated, zones of influence: (a) vegetative cover in direct contact with the soil surface, (b) canopy cover, and (c) residual and tillage effects.

Subfactors for various percentages of surface cover by mulch are given by the upper curve of

TABLE 10.—*Factor* **C** *for permanent pasture, range, and idle land*[1]

Vegetative canopy		Cover that contacts the soil surface						
			Percent ground cover					
Type and height[2]	Percent cover[3]	Type[4]	0	20	40	60	80	95+
No appreciable canopy		G	0.45	0.20	0.10	0.042	0.013	0.003
		W	.45	.24	.15	.091	.043	.011
Tall weeds or short brush with average drop fall height of 20 in	25	G	.36	.17	.09	.038	.013	.003
		W	.36	.20	.13	.083	.041	.011
	50	G	.26	.13	.07	.035	.012	.003
		W	.26	.16	.11	.076	.039	.011
	75	G	.17	.10	.06	.032	.011	.003
		W	.17	.12	.09	.068	.038	.011
Appreciable brush or bushes, with average drop fall height of 6½ ft	25	G	.40	.18	.09	.040	.013	.003
		W	.40	.22	.14	.087	.042	.011
	50	G	.34	.16	.08	.038	.012	.003
		W	.34	.19	.13	.082	.041	.011
	75	G	.28	.14	.08	.036	.012	.003
		W	.28	.17	.12	.078	.040	.011
Trees, but no appreciable low brush. Average drop fall height of 13 ft	25	G	.42	.19	.10	.041	.013	.003
		W	.42	.23	.14	.089	.042	.011
	50	G	.39	.18	.09	.040	.013	.003
		W	.39	.21	.14	.087	.042	.011
	75	G	.36	.17	.09	.039	.012	.003
		W	.36	.20	.13	.084	.041	.011

[1] The listed **C** values assume that the vegetation and mulch are randomly distributed over the entire area.

[2] Canopy height is measured as the average fall height of water drops falling from the canopy to the ground. Canopy effect is inversely proportional to drop fall height and is negligible if fall height exceeds 33 ft.

[3] Portion of total-area surface that would be hidden from view by canopy in a vertical projection (a bird's-eye view).

[4] G: cover at surface is grass, grasslike plants, decaying compacted duff, or litter at least 2 in deep.

W: cover at surface is mostly broadleaf herbaceous plants (as weeds with little lateral-root network near the surface) or undecayed residues or both.

Terracing

The most common type of terrace on gently sloping land is the broadbase, with the channel and ridge cropped the same as the interterrace area. The steep backslope terrace is most common on steeper land. Difficulty in farming point rows associated with contoured terraces led to developing parallel terracing techniques (*16*). Underground outlets, landforming, and variable channel grades help establish parallel terraces. The underground outlets are in the low areas along the terrace line. The ridge is constructed across these areas. Another type of terrace, using a level and broad channel with either open or closed ends, was developed to conserve moisture in dryland farming areas.

Terraces with underground outlets, frequently called impoundment terraces, are highly effective for erosion control. Four-year losses from four such terrace systems in Iowa (*17*) averaged less than 0.4 t/A/year, which was less than 5 percent of the calculated soil movement to the channel. Comparable losses were measured from installations in Nebraska.

Terracing combined with contour farming and other conservation practices is more effective than those practices without the terraces because it positively divides the slope into segments equal to the horizontal terrace interval. The horizontal terrace interval for broadbase terraces is the distance from the center of the ridge to the center of the channel for the terrace below. For steep backslope terraces with the backslope in sod, it is the distance from the point where cultivation begins at the base of the ridge to the base of the frontslope of the terrace below (*44*). With terracing, the slope length is this terrace interval; with stripcropping or contouring alone, it is the entire field slope length.

P Values

Values of **P** for contour farming terraced fields are given in table 15. These values apply to contour farmed broadbase, steep backslope, and level terraces. However, recognize that the erosion control benefits of terraces are much greater than indicated by the **P** values. As pointed out earlier, soil loss per unit area on slopes of 5 percent or steeper is approximately proportional to the square root of slope length. Therefore, dividing a field slope into **n** approximately equal horizontal terrace intervals divides the average soil loss per unit area by the square root of **n**. This important erosion control benefit of terracing is not included in **P** because it is brought into the USLE computation through a reduced **LS** factor obtained by using the horizontal terrace interval as the slope length when entering figure 4 or table 3.

Erosion control between terraces depends on the crop system and other management practices evaluated by **C**. The total soil movement within a contour-farmed terrace interval may be assumed equal to that from the same length of an identical slope that is contoured only. Therefore, if a control level is desired that will maintain soil movement between the terraces within the soil loss tolerance limit, the **P** value for a contour-farmed terraced field should equal the contour factor (col. 2, table 15), and use of these values for farm planning purposes is generally recommended.

With contour stripcropping, the soil deposited in the grass strips is not considered lost because it remains on the field slope. With terraces, most of the deposition occurs in the terrace channels, but research measurements have shown that this deposition may equal 80 percent of the soil moved from the contour-farmed slopes between the terraces (*67*). Use of the contour factor as the **P** value for terracing assumes that all of the eroded soil deposited in the terrace channels is lost from the productive areas of the field. With broadbase terraces, the channels and ridges are cropped the same as

TABLE 15.—**P** *values for contour-farmed terraced fields*[1]

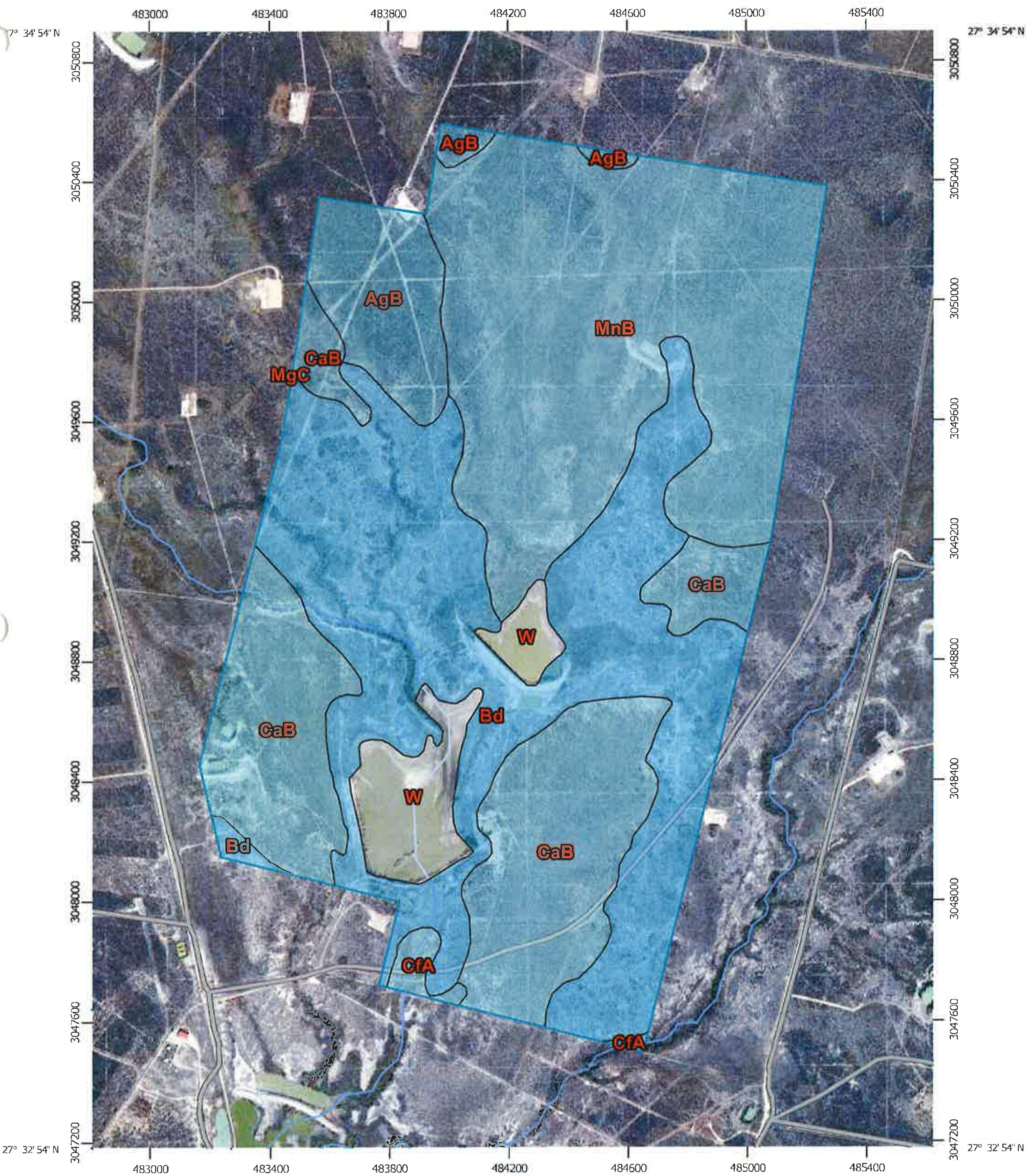
Land slope (percent)	Farm planning		Computing sediment yield[3]	
	Contour factor[2]	Stripcrop factor	Graded channels sod outlets	Steep backslope underground outlets
1 to 2	0.60	0.30	0.12	0.05
3 to 8	.50	.25	.10	.05
9 to 12	.60	.30	.12	.05
13 to 16	.70	.35	.14	.05
17 to 20	.80	.40	.16	.06
21 to 25	.90	.45	.18	.06

[1] Slope length is the horizontal terrace interval. The listed values are for contour farming. No additional contouring factor is used in the computation.

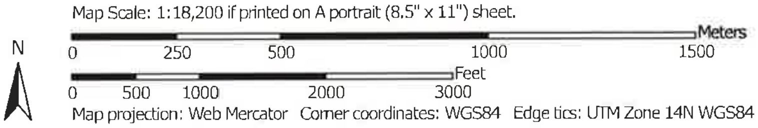
[2] Use these values for control of interterrace erosion within specified soil loss tolerances.

[3] These values include entrapment efficiency and are used for control of offsite sediment within limits and for estimating the field's contribution to watershed sediment yield.

K Factor, Whole Soil—Webb County, Texas
(Facility Boundary)



Map Scale: 1:18,200 if printed on A portrait (8.5" x 11") sheet.



Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 14N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
Not rated or not available

Soil Rating Lines

.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
Not rated or not available

Soil Rating Points

.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
Not rated or not available

Water Features

Streams and Canals

Transportation

Rails
Interstate Highways
US Routes
Major Roads
Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:31,700.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

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

Soil Survey Area: Webb County, Texas
Survey Area Data: Version 10, Dec 12, 2013

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 12, 2010—Jan 22, 2011

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 — Webb County, Texas (TX479)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
AgB	Aguilares sandy clay loam, 0 to 3 percent slopes	.32	68.2	6.1%
Bd	Brundage fine sandy loam, occasionally flooded	.37	382.6	34.5%
CaB	Catarina clay, 0 to 2 percent slopes	.32	243.1	21.9%
CfA	Catarina clay, occasionally flooded	.32	8.8	0.8%
MgC	Moglia clay loam, 1 to 5 percent slopes	.32	0.0	0.0%
MnB	Montell clay, 0 to 2 percent slopes, saline	.32	353.2	31.8%
W	Water		53.9	4.9%
Totals for Area of Interest			**1,109.8**	**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 (Horizon Aggregation Method): Surface Layer (Not applicable)

ATTACHMENT III-C

APPENDIX III-C.5

EROSION CONTROL PLAN

F. FLOW RATE PER UNIT AREA FROM FINAL COVER SLOPES (ATTACHMENT F TO APPENDIX III-C.5)

STATE OF TEXAS
MICHAEL W. ODEN
67165
REGISTERED
PROFESSIONAL ENGINEER

3-2-2015

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Client:	Rancho Viejo Waste Management, LLC		
Project:	Pescadito Environmental Resource Center		
Project #:	148866		
Calculated By:	MTE	Date:	1/27/15
Checked By:	RDS	Date:	1/27/15

TITLE: FLOW RATE PER UNIT WIDTH FOR FINAL COVER SLOPES

Problem Statement

Determine the peak discharge per unit width of flow along the final cover. This value is used to determine sheet flow velocity along the final cover in a subsequent calculation.

Given

- Texas Department of Transportation, *Hydraulic Design Manual*, Revised October 2011.
- United States Geologic Survey, *Atlas of Depth-Duration Frequency of Precipitation Annual Maxima for Texas*, 2004. (See Attachment A to Appendix III-C.5)

Assumptions

- Time of concentration (Tc) is conservatively assumed to be the minimum of 10 minutes, per *Hydraulic Design Manual* guidance.
- The runoff coefficient (C) is 0.70, a typical value for final cover systems.
- The Rainfall Intensity (I) is 7.8 in/hr, based on Pd/tc, per the *Hydraulic Design Manual.*
- Final cover side slopes will be 4H:1V (0.25 ft/ft). Final cover top slopes will be 6% (0.06 ft/ft).
- The unit width is 1 foot.
- Terrace berms will be placed every 50 vertical feet along the 4H:1V side slopes, producing a 206 foot maximum flow length. However, at the base of the side slopes where subcatchment areas flow directly to the perimeter ditch, maximum flow lengths reach approach 400 feet. For the 6% top slopes, a maximum flow length of 600 feet is used.

Client:	**Rancho Viejo Waste Management, LLC**
Project:	**Pescadito Environmental Resource Center**
Project #:	**148866**
Calculated By:	**MTE** — **Date:** **1/27/15**
Checked By:	**RDS** — **Date:** **1/27/15**

TITLE: FLOW RATE PER UNIT WIDTH FOR FINAL COVER SLOPES

Calculations

25-year Peak Flow Rate (Rational Method)

$$Q = CIA$$

Where:

Q = Peak Flow Rate per Unit Width (ft^3/sec/ft)
C = Runoff Coefficient
I = Rainfall Intensity (in/hr)
A = Area (acres) (Flow Length x Unit Width)

Results

The peak discharge rate per unit width of flow into stormwater features during final cover conditions are provided in the table below.

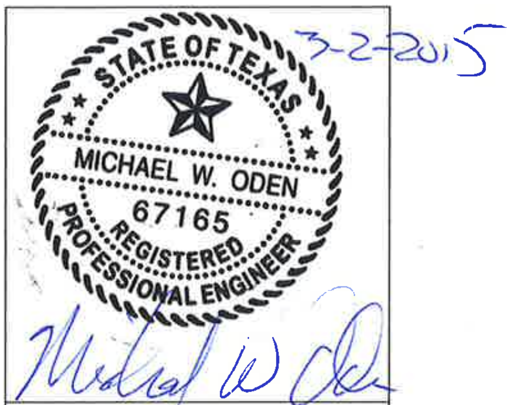
Slope (ft/ft)	Flow Length (feet)	Peak Discharge Rate Per Unit Width (ft^3/sec/ft)
0.25	400	0.050
0.06	600	0.075

ATTACHMENT III-C

APPENDIX III-C.5

EROSION CONTROL PLAN

G. SHEET FLOW VELOCITY ON FINAL COVER SLOPES (ATTACHMENT G TO APPENDIX III-C.5)



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CB&I

Client:	Rancho Viejo Waste Management, LLC
Project:	Pescadito Environmental Resource Center
Project #:	148866
Calculated By:	MTE Date: 1/27/15
Checked By:	RDS Date: 1/27/15

TITLE: SHEET FLOW VELOCITY ON FINAL COVER SLOPES

Problem Statement

Determine the peak sheet flow velocity for the final cover design and compare to the permissible non-erodible flow velocity.

Given

- ❑ Texas Department of Transportation, *Hydraulic Design Manual*, Revised October 2011.

Assumptions

- ❑ The peak discharge rate per unit width of flow into a channel is 0.050 cfs/ft for 4H:1V slopes and 0.075 cfs/ft for 6% slopes (see previous calculation in this Attachment).

- ❑ Terrace berms will be placed every 50 vertical feet along the 4H:1V side slopes, producing a 206 foot maximum flow length. However, at the base of the side slopes where subcatchment areas flow directly to the perimeter ditch, maximum flow lengths may exceed 206 feet. As a result, 400 feet has been used as a conservative maximum flow length for 4H:1V side slopes. For the 6% top slopes, a maximum flow length of 600 feet has been assumed.

- ❑ A Manning's Coefficient of 0.03 is representative of final cover conditions.

Calculations

The sheet flow velocity is a function of flow rate and depth. Therefore, flow depth is first calculated based on a re-arranged format of Manning's Equation.

Flow Depth (re-arranged Manning's Equation)

$$y = \left(\frac{Qn}{1.49S^{0.5}}\right)^{0.6}$$

Where:

y = Peak flow depth (ft)
Q = Peak flow rate per unit width (cfs/ft)
S = Slope (ft/ft)
n = Manning's Coefficient

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Slope (ft/ft)	Peak Flow Rate (cfs/ft)	Manning's Coefficient	Peak Flow Depth (ft)
0.25	0.050	0.03	0.0242
0.06	0.075	0.03	0.0473

Sheet Flow Velocity

$$V = \frac{Q}{y * w}$$

Where:

V = Sheet flow velocity (ft/sec)
Q = Peak flow rate per unit width (cfs/ft)
y = Peak flow depth (ft)
w = Unit width (ft)

Slope (ft/ft)	Peak Flow Rate (cfs/ft)	Peak Flow Depth (ft)	Unit Width (ft)	Sheet Flow Velocity (ft/sec)
0.25	0.050	0.0242	1.0	2.07
0.06	0.075	0.0473	1.0	1.59

Results

A sheet flow velocity of 2.07 ft/sec will result from 4H:1V slopes with a flow length of 400 feet. A sheet flow velocity of 1.59 ft/sec will result from 6% slopes with a flow length of 600 feet. Both velocities are lower than 5 ft/sec, and are therefore considered non-erodible.

Attachment III-C

Appendix III-C.5

Erosion Control Plan

H. SOIL LOSS FROM FINAL COVER SLOPES (ATTACHMENT H TO APPENDIX III-C.5)

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3-2-2015

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Project:	Pescadito Environmental Resource Center
Project #:	148866
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TITLE: EROSION LAYER THICKNESS EVALUATION

Problem Statement

Determine the erosion loss for the final cover to ensure that it remains less than 3 tons/acre/year. Additionally, determine the minimum acceptable erosion control layer thickness to ensure that 6-inches of protection is provided after calculated soil loss.

Given

- *Predicting Rainfall Erosion Losses : A Guide to Conservation Planning,* United States Department of Agriculture, Agriculture Handbook Number 537, prepared by Science and Education Administration (See Attachment E to Appendix III-C.5)
- AutoCAD Civil 3D 2014
- NRCS Soil Survey data for Webb County
- The Universal Soil Loss Equation (USLE) was used to determine the annual erosion rate.

$$A = R * K * LS * C * P$$

Where,

A = Annual soil loss in tons/acre per year
R = Rainfall Erosion Index
K = Soil erodibility factor
LS = Topographic factor
C = Cover factor
P = Management practice factor

- The required soil thickness is calculated using the following equation:

$$T = 6\,in + \frac{(A * Y * F)}{D}$$

Where,

T= Required soil thickness in inches
A = Annual soil loss in tons/acre per year
Y = Postclosure period in years
F = Factor of Safety
D = Soil Density in pcf

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Checked By:	**RDS**	**Date:**	**1/28/15**

TITLE: EROSION LAYER THICKNESS EVALUATION

Assumptions

- A soil density of 125 pcf.
- Post-closure period is 30 years.
- Two slope scenarios are assumed during final cover conditions; 4H:1V side slopes and 6% top slopes.

Calculations

Determine the appropriate values for the USLE equation:

R (Rainfall Erosion Index)
Based on Figure 1 "Average annual values of the rainfall erosion index" a factor of 220 was determined.

K (Soil Erodibility Factor)
Using NRCS Soil data for the facility, a soil erodibility factor of 0.32 is assumed.

LS (Slope Length/Steepness Factor)
A slope length of 400 ft is assumed for 4H:1V side-slopes. The slope length for the 6% top slopes is assumed for 600 ft. Based on Figure 4 "Slope-effect chart", the LS values were determined to be 10.2 and 1.6.

C Factor
Based on Table 10 "Factor C for permanent pasture, range, and idle land", and assuming a 70% ground cover, a C factor of 0.028 was selected. This is a conservative assumption; the C factor will likely be lower for actual final cover conditions.

P Factor
Based on Table 15, a P factor value of 0.12 is used for terraced slopes from 21 to 25% and 0.10 for terraced slopes from 3% to 8%, where sediment loss is being calculated for overall "watershed gross erosion". The value of 0.12 was calculated as the average of the values presented in Table 15 for the different terrace outlet conditions, since the proposed check dams and outlet pipes will provide a greater sediment retention effect than sod outlets but a lesser sediment retention effect than underground outlets.

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TITLE: EROSION LAYER THICKNESS EVALUATION

Calculate the sediment loss per acre using the USLE equation for 4H:1V slopes:

$$A = R * K * LS * C * P$$

$$A = 220 * 0.32 * 10.2 * 0.028 * 0.12$$

$$A = 2.41\ tons/acre/year$$

Calculate the sediment loss per acre using the USLE equation for 6% slopes:

$$A = R * K * LS * C * P$$

$$A = 220 * 0.32 * 1.6 * 0.042 * 0.10$$

$$A = 0.31\ tons/acre/year$$

Calculate the required mimimum thickness for the erosion layer:

$$T = 6\ in + \frac{(A * Y * F)}{D}$$

$$T = 6\ in + \frac{2.41\ tons/acre/year\ * 30 years * 2}{125\ lbs/ft^3 * \frac{1acre}{43560ft} * \frac{1ton}{2000lbs} * \frac{1ft}{12in}}$$

$$T = 6\ .63\ inches$$

Results

The soil loss for the final cover is approximately 2.41 tons/acre/year for the sideslopes and 0.31 tons/acre/year for the topslopes.

The calculated minimum thickness for the erosion layer is 6.63 inches (regulatory minimum thickness of 6 inches plus 0.63 inches of soil thickness loss due to erosion). For ease of construction, the erosion layer of the final cover will be constructed with a minimum thickness of 7 inches.