# CALCULATION SUMMARY SHEET



PROJECT NUMBER: 143418

PROJECT NAME: USEN – Trench 13 Design

DATE: September 15, 2014

CALCULATION NUMBER: C.13 Revision: 1 (March 11, 2016)

**CALCULATION TITLE: Final Cover Erosion by Wind using WEPS**

**DESCRIPTION OF CALCULATION:**

This calculation determines the rate of Trench 13 soil cover erosion using the NRCS Wind Erosion Prediction System (WEPS) Version 1.3.9.

**REFERENCES USED:**

1. USEPA. Design and Construction of RCRA/CERCLA Final Covers, EPA/625/4-91/025. 1991.
2. Bechtel SAIC Company, LLC, September 2006. Soil-Related Input Parameters for the Biosphere Model.
3. WEPS User Guide March 2010
4. USDA Web Soil Survey – USEN Beatty Facility and Vicinity
5. Soil Properties/Gradation of USEN Trench 11 Cover Materials – 2013
6. Soil Properties/Gradation of USEN Trench 11 Cover Materials - 2016
7. Soil Properties/Gradation of 2053 Yermo-Greyeagle-Arizo
8. Construction Management WEPS Input
9. WEPS Inputs and Model Outputs

**REVIEW COMMENTS:**

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|---|---|---|---|
| CALCULATION MADE BY: | CWK | DATE: | 09/15/14 |
| CALCULATION CHECKED BY: | CAB | DATE: | 04/18/15 |
| CALCULATION REVISED BY: | CWK | DATE: | 05/22/15 |
| CALCULATION REVIEWED BY: | PAZ | DATE: | 06/17/15 |

# CALCULATION

# RATE OF SOIL COVER EROSION BY WIND

## PURPOSE

This calculation estimates soil loss by wind erosion from the proposed final cover for Trench 13 at the US Ecology Beatty Facility.

## APPROACH

Calculated soil loss is compared to the USEPA recommendations for maximum erosion rate (of two tons per acre per year)[1] for a landfill cover. The soil loss tolerance value assigned by U.S. Natural Resource Conservation Service (NRCS) as a standard for protecting soil as natural resource is five tons per acre per year for the 2053 Yermo-Greyeagle-Arizo association (soil type associated with materials to be used as the final Trench 13 cover at US Ecology Nevada (USEN) facility) in its natural desert setting. Tolerable soil loss from desert soil types present in the Amargosa Valley is four to five tons per acre per year.[2]

The NRCS Wind Erosion Prediction System (WEPS) model is used for this analysis. WEPS is used to estimate expected soil loss (as soil weight per surface area unit) based on soil properties, wind and climate history for a local weather station, and site geography (**Reference 3**). The Wind Erosion Equation (WEQ), upon which WEPS is based, is widely used for estimating soil loss by wind from agricultural fields. The functional form of WEQ is:

$$E = f\,(I, C, K, L, V)$$

Where, E is the average soil loss (tons/acre/year), I is the soil erodibility, K is the soil ridge roughness, C is the climatic factor, L is the field length along the prevailing wind erosion direction, and V is the vegetative factor.

WEPS is a process-based, daily time-step model that simulates weather, field conditions, and erosion to predict wind erosion. The WEPS model allows the use of uploaded region-specific database information to determine the WEQ soil loss factors. For Trench 13 wind erosion estimates, the following three databases were uploaded:

1. Climate Data (Amargosa Valley 4s);

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[1] USEPA. Design and Construction of RCRA/CERCLA Final Covers, EPA/625/4-91/025. 1991 (**Reference 1**).

[2] Bechtel SAIC Company, LLC, September 2006. Soil-Related Input Parameters for the Biosphere Model (**Reference 2**)

2. Soil Data (Nye SW, NV785\2053 Yermo-Greyeagle-Arizo Association)
3. Wind Data (Mercury/Desert Rock); and
4. Crop Management Template (CMZ-31)

Climate: For the US Ecology Beatty facility, the location chosen as representative was the "Amargosa Valley 4s."

Soil: The USDA Web Soil Survey (**Reference 4**) was used to determine the prevalent surface soil type in the vicinity of the US Ecology facility and the soil type most closely matching the grain size analysis for soils used as cover material on Trench 11 (**References 5 and 6**). As acknowledged in **Calculation C.12**, soils used to form the Trench 13 cover likely will come from a mixture of surface soils present at the facility and subsurface soils generated during the excavation of Trench 13. Subsurface soils have been shown to be coarser than those observed at the surface. The soil properties of 2053 Yermo-Greyeagle-Arizo (**Reference 7**) were compared with soil samples taken from the cover of Trench 11 (**References 5 and 6**). The soil properties of 2053 Yermo-Greyeagle-Arizo, specifically grain distribution and rock fragments, were found to be very similar to properties of cover soil for Trench 11. Therefore this soil type was selected for the wind erosion estimation. The 2053 Yermo-Greyeagle-Arizo also is used in the water erosion evaluation in **Calculation C.12.**

Wind: The weather station selected as representative for wind speed and direction was the Mercury/Desert Rock Station.

Crop Management: A Construction Management Template was developed, based on activities necessary to build the Trench 13 final cover. The Construction Management Template assumes non-vegetated disturbed soil that has been modified using certain combinations of construction or agricultural equipment. In this instance, the soil surface modifications assumed included 1) clearing-cutting by bulldozer, 2) filling and leveling by bulldozer, 3) heavy disking (simulating ripping), 4) rolling smooth (representing slope backdrag with a bulldozer blade) and 5) beginning weed growth (**Reference 8**).

## SOIL LOSS ESTIMATE

The WEPS model simulation uses a basic area shape (e.g., rectangle, square, circle, or quarter circle), site-specific dimensions, and the orientation (relative to wind direction) as input for the model run. The US Ecology Trench 13 area was modeled as:

- North Slope (2,190 ft x 300 ft) with regional slope of 33%;
- Upper Deck (1,835 ft x 516 ft) with a regional slope of 5%;
- South Slope (2,190 x 225 ft) with a regional slope of 33%; and
- East and West Slopes (300 ft x 940 ft) with a regional slope of 33%.

The inputs and results of the WEPS calculation are included as **Reference 9**. The findings of the modeling are summarized in the Table below. Since the WEPs program was designed to evaluate agricultural fields, it assumes a crop rotation frequency and repeatedly disturbed conditions. Since no active farming will occur on the Trench 13 final cover, soil disturbance will be less than the WEPS model would predict because of the natural armoring process where the fine sediments at the surface tend to be blown or washed away and the coarser, more resistant fraction of aggregates (coarse sand and gravel particles) remain.

| Model Run | Soil Type: 2053 (tons/acre/year) |
|---|---|
| North Slope at 3H:1V | 3.96 |
| Upper Deck at 20H:1V | 4.86 |
| South Slope at 3H:1V | 3.99 |
| East and West Slope at 3H:1V | 4.19 |
| Average | 4.25 |

Wind erosion is assumed to result in uniform soil removal over a broad area and not in a manner than tends to concentrate soil removal (such as rill erosion by water). Accordingly, consideration of the significance of surface soil removal (or thinning) is pertinent. The soil loss caused by wind erosion was analyzed for the potential of thinning the cover to the point of exposing waste. Using the erosion rate estimated for Trench 13, and assuming that cover soil is placed with a density of 100 lbs per cubic foot or approximately 1.35 tons per cubic yard, the following soil loss is estimated.

<u>Soil Type 2053 Yermo-Greyeagle Arizo at a maximum erosion rate of 4.25 tons/acre/year</u>

For one year: $4.25\frac{tons}{acre} * \frac{1}{1.35}\frac{yd^3}{tons} * \frac{1}{43{,}560}\frac{acre}{ft^2} * \frac{27}{1}\frac{ft^3}{yd^3} = 0.0020\,ft$ of soil loss per year

= 0.023 inches of soil loss per year

For 30 years = 0.70 inches of soil loss.

**LIMITATIONS**

WEPS is intended to estimate erosion from uniformly sloped agricultural fields that are managed for production of various crop types. The model allows for consideration of certain adjoining topographic features (such as wind breaks) that modify wind direction and velocity, but does not estimate erosion from complex geometric shapes, such as a landfill cover. Also, surface preparation and crop management inputs to the model probably do not accurately reflect the management of a closed landfill. As a result, the accuracy of the wind erosion estimate is uncertain. However, since soil disturbance on the final soil cover is anticipated to be less than that caused by active farming, the WEPS results likely are conservative.

## CONCLUSION

The soil loss tolerance value assigned by NRCS as a standard for protecting soil as natural resources is five tons per acre per year for the 2053 Yermo-Greyeagle-Arizo Association in this natural desert setting. The calculated value for the 2053 Yermo-Greyeagle-Arizo Association is just below the NRCS soil loss tolerance values, suggesting that excessive soil loss from wind erosion is not expected to occur. This values are greater than the USEPA-recommended maximum erosion rate of two tons per acre per year for hazardous waste disposal sites but within the five tons per acre per year, common for desert soils.

The soil cover thinning calculation indicated a potential soil cover loss of 0.023 inches per year. For a 30 year post closure time period, the soil loss is estimated at about 0.70 inches. These initial construction conditions are likely to occur prior to the natural armoring process that occurs as fine particles are removed by wind and water leaving coarser materials that resist such erosional forces. This armoring process has been observed in final cover materials on Trench 11 at the USEN Facility where in 2013, following construction of the cover, average materials had a soil particle distribution with an average $D_{50}$ of 0.08 inches (**Reference 5**). Samples collected and analyzed in 2016 (**Reference 6**) show an average $D_{50}$ of 0.13 inches. Samples were obtained by gathering aggregates located in the upper 2 inches of the cover and consequently still included a significant fraction of the underlying fines.

REFERENCE 1

United States
Environmental Protection
Agency

Office of Emergency and
Remedial Response
Washington DC 20460

Office of Research and
Development
Hazardous Waste Engineering
Research Laboratory
Cincinnati OH 45268

Technology Transfer

EPA/625/6-85/006

c.3

EPA

# Handbook

# Remedial Action at Waste Disposal Sites

# (Revised)

REFERENCE 1

EPA/625/6-85/006

# HANDBOOK
# REMEDIAL ACTION AT WASTE DISPOSAL SITES (REVISED)

OCTOBER 1985

HAZARDOUS WASTE ENGINEERING RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

OFFICE OF EMERGENCY AND REMEDIAL RESPONSE
OFFICE OF SOLID WASTE AND EMERGENCY RESPONSE
U.S. ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

U.S. Environmental Protection Agency
Region V, Library
230 South Dearborn Street
Chicago, Illinois 60604

support the weight of the entire cap and not abrade the liner. If a clay or similarly fine grained soil liner is to be used, the underlying base must be sufficiently fine to preclude piping of the liner. Piping occurs when sections of an overlying fine-grained soil layer erode and fall into an underlying coarser grained soil layer (Matrecon, Inc., 1983). Piping may be prevented by placement of a suitably fine-meshed filter fabric between the two layers.

The drainage layer of the multi-layered cap is placed directly above the low permeability layer. The permeability of the drainage layer should be sufficiently high that it minimizes contact of infiltrating rainwater with the low permeability layer (Lutton, 1982). Current designs generally specify a material with greater than or equal to $10^{-3}$ cm/sec permeability (Cope et al., 1984). This layer can be composed of a sand in the SW or SP range of USCS (less than 5 percent passing through a number 100 sieve) or a coarser material. The thickness of the drainage layer depends on the amount of settling expected and the maximum volume of water that could enter it. The vegetative layer of the multi-layer cap is placed above the drainage layer, usually with a layer of filter fabric in between to prevent piping. The vegetative layer usually exceeds 2 feet in thickness, but may be greater depending on the frost depth, the maximum depth of root penetration, and the rate of anticipated soil loss. The frost depth must not be allowed to reach the low permeability layer because freezing and thawing cycles could greatly increase its permeability. The selection of a vegetative cover should include consideration of root penetration, erosion potential, and competitive advantage over other plant species in the area. These factors can be determined by consulting with local botany professors. Erosion potential of the soil, however can occur even when the vegetative cover has good soil retaining capabilities. Therefore, it is recommended that the soil in the vegetative layer have an erosion rate of less than 2 tons per acre, per year, using the U.S. Department of Agriculture Universal Soil Loss Equation (USLE). This equation is written:

$$A = R \times K \times L \times S \times C \times P$$

| | |
|---|---|
| Where: | A = average spoil loss in tons/acre for time period used for R |
| quantitative: | R = rainfall and run-off erosivity index<br>K = soil erodibility factor<br>L = slope length factor<br>S = slope steepness factor |
| qualitative: | C = cover/management factor<br>P = supporting practices factor |

Directions for determining variables are given in Lutton, Regan, and Jones (1979) pp. 127-133. For information regarding soil sampling and testing, for local data on soils and climate, or for any form of technical assistance regarding selection of cover materials, regional and county Soil Conservation Services (SCS) offices should be consulted.

REFERENCE 2

DOC.20070927.0004

QA: QA

ANL-NBS-MD-000009 REV 03

September 2006

# Soil-Related Input Parameters for the Biosphere Model

**THIS DOCUMENT CONTAINS THE FOLLOWING, LOCATED AT THE BACK OF THE DOCUMENT:**
**1) ADDENDUM 001, DATED 09/20/2007**

Prepared for:
U.S. Department of Energy
Office of Civilian Radioactive Waste Management
Office of Repository Development
1551 Hillshire Drive
Las Vegas, Nevada 89134-6321

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1180 Town Center Drive
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Under Contract Number
DE-AC28-01RW12101

The textbook *Soil and Water Conservation for Productivity and Environmental Protection* (Troeh et al. 1980 [DIRS 110012], Section 6-1) states that erosion cannot be prevented but that it is possible and necessary to reduce erosion losses to tolerable rates. The book then presents the concept of the tolerable soil loss, T. This factor is an estimate of the maximum average annual rate of soil erosion (by wind, water, or both) that can occur without affecting crop productivity over a sustained period. Tolerable soil loss for the soil series occurring in Amargosa Valley is given in Table 6.2-2 in units of ton acre$^{-1}$ yr$^{-1}$ (USDA 2004 [DIRS 173916], Part II, Table 12). With the exception of the Shamock soil (T factor of 2 ton acre$^{-1}$ yr$^{-1}$), it is reasonable to say that the typical soils in the Amargosa Valley area could tolerate annual erosion losses of about four to five tons per acre before production would be affected. It is conceivable that some future users, using poor conservation practices, would accept losses at a higher rate for many years before production is impacted. Such use is considered non-representative of a farmer who has to work in an arid (or in the future semi-arid) climate where irrigation presents a significant expense and requires attention to watering needs. In the absence of an alternative upper limit for soil removal, the highest T value of 5 ton acre$^{-1}$ yr$^{-1}$ is taken as the limit.

Both fluvial and eolian soil erosion mechanisms are complex and are dependent on soil characteristics, crop type, slope, vegetation cover, and erosion control practices in addition to the prevailing meteorological conditions. Troeh (1980 [DIRS 110012], Section 1-2.1) indicates that erosion from either process is generally intermittent with the possibility of months or years passing without much soil being lost. During unfavorable meteorological conditions, especially when the soil is in a vulnerable condition such as when plant cover is at a minimum, a significant fraction of the annual loss can be removed in only a few days.

Inspection of the values given in Tables 6.4-2 and 6.4-3 indicates that wind erosion dominates the soil removal process.

### 6.4.3 Estimate of Lower Loss Limit for Erosion

The lower limit of soil loss due to erosion was based on the average soil loss by erosion on non-cultivated cropland in Nevada. The sheet and rill erosion on non-cultivated cropland in Nevada is listed as zero (USDA 2000 [DIRS 160548], Table 10), so effectively the erosion of non-cultivated cropland is caused by wind. From Table 6.4-3, the average value of wind erosion for non-cultivated cropland in Nevada is 1 ton acre$^{-1}$ yr$^{-1}$. Using the conversion factor introduced in Section 6.3.1, this is equivalent to the surface soil loss rate of $2.24 \times 10^{-1}$ kg m$^{-2}$ yr$^{-1}$.

### 6.4.4 Estimate of Upper Loss Limit for Erosion

The upper limit of soil erosion rate was calculated based on the average values of sheet, rill, and wind erosion for different types of cropland and for pastureland for Nevada (Tables 6.4-2 and 6.4-3) as well as the consideration of tolerance factor for the Amargosa Valley soils. The upper limit of the erosion rate is a limiting factor for radionuclide buildup in soil only for elements that have high partition coefficients and, therefore, for which leaching is not a very effective removal mechanism. Using an average soil erosion rate based on statewide data to estimate an upper limit value for Amargosa Valley provides a degree of conservatism in predicting the receptor doses from the pathways that include radionuclides in surface soil. Even as an upper limit, the rate of erosion is sufficiently low that the mean residence time of a

REFERENCE 3

# The Wind Erosion Prediction System

# WEPS 1.0 User Manual

USDA-ARS
Wind Erosion Research Unit
Manhattan, Kansas, USA

March 2010

REFERENCE 3



# An Overview of the Wind Erosion Prediction System

## Introduction

Soil erosion by wind is a serious problem in the United States and the world. Wind erosion is a threat to agriculture and the earth's natural resources. It renders soil less productive by removing the most fertile part of the soil, namely, the clays and organic matter. This removal of clays and organic matter also damages soil structure. In addition to the soil, wind erosion can damage plants, primarily by the abrasive action of saltating particles on seedlings and fruits. Eroded soil can also be deposited into waterways where it impacts water quality and emitted into the air where it degrades the air resources. By affecting these resources, wind erosion can also become a health hazard to humans and other animals. The ability to accurately simulate soil loss by wind is essential for, among other things, environmental and conservation planning, natural resource inventories, and reducing air and water pollution from wind blown sources.

The Wind Erosion Equation (WEQ) was published in 1965 by Woodruff and Siddoway (1965). For years, WEQ has represented the most comprehensive and widely used model in the world for estimating soil loss by wind from agricultural fields. The functional form of WEQ is:

$$E = f(I, C, K, L, V)$$

where, E is the average soil loss (tons/acre/year), I is the soil erodibility, K is the soil ridge roughness, C is the climatic factor, L is the field length along the prevailing wind erosion direction, and V is the vegetative factor. WEQ is largely empirical in nature and was derived from nearly 20 years of field and laboratory studies by scientists at the USDA-Agricultural Research Service (ARS), Wind Erosion Research Unit (Chepil, 1958, 1959, 1960; Chepil and Woodruff, 1959). Many improvements were made to WEQ over the next 30 years. Because of the limitations of adapting WEQ to many problems and environments, as well as advancements in wind erosion science and computer technology, the USDA Natural Resources Conservation Service requested that ARS develop a replacement for WEQ (Hagen,1991).

## Development of WEPS

Research in the 1980's (Cole et. al., 1983; Cole, 1984; and Lyles, et. al., 1985) provided the initial attempt to outline a processed based approach to simulating wind erosion that would replace WEQ. Following this initial work, the modular structure used in the current WEPS model was developed (Hagen, 1991) and the experimental research needed to support that

structure was outlined. Numerous field and laboratory studies were conducted to develop relationships for surface conditions and erosion. Experimental data were collected for weather (Skidmore and Tatarko, 1990), hydrology (Durar and Skidmore, 1995), crop growth (Retta and Armbrust, 1995), residue decomposition (Steiner et. al., 1995), soil (Hagen, et. al., 1995; Potter, 1990, Zobeck and Popham, 1990, 1992), management (Wagner and Ding, 1995), and erosion (Hagen, 1995). Experiments were also conducted to validate that the erosion routines were producing accurate and precise erosion estimates (Fryrear, et. al, 1991).

A multi-disciplinary team was assembled to develop WEPS that included climate modelers, agronomists, agricultural engineers, soil scientists, and crop modelers. The WEPS development project had a multi-agency commitment consisting of the Agricultural Research Service, Natural Resources Conservation Service, and the Forest Service from the U.S. Department of Agriculture, along with the Environmental Protection Agency, the Army Corps of Engineers, and the Bureau of Land Management. In 2005, WEPS was released to the NRCS for testing and further development for field office conservation planning. In 2008, WEPS was released to NRCS for field office implementation.

**WEPS User Requirements**

Early in the WEPS development process, input was requested from potential users on the needed capabilities of a new wind erosion simulation model. These user requirements were summarized by Hagen (1991). Based on these requirements, WEPS was designed to:

**1. Provide more accurate and detailed estimates of soil loss by wind from agricultural fields.** Results for WEQ were an annual average soil loss based essentially on average weather and field conditions. Since erosion is often the result of extreme weather events (e.g., high wind or dry soil conditions), an approach that accounts for such extreme conditions was needed to simulate the extreme soil loss for these situations. In addition, WEPS is capable of outputting erosion loss and surface conditions on a relatively fine temporal scale (e.g., hourly). However, for practical purposes, the default time step for WEPS output is two weeks. Such detail allows the user to observe the periods when excessive erosion occurs and the wind or surface conditions which caused the soil loss (e.g., low vegetative cover, etc.). These conditions can then be addressed by altering management or other control measures.

**2. Develop more cost-effective erosion control methods.** Because of the detail in the soil loss and field conditions provided by WEPS, it is a valuable tool for testing various management scenarios or control methods through simulation. Each scenario can be evaluated before a change in farming practices is made in the field. Surface conditions and management can be observed during periods of excessive loss and adjusted to minimize erosion.

**3. Simulate the amount of soil loss by direction.** With increasing concern of the offsite impacts of wind erosion on soil, water, and air quality, the capability of WEPS to provide the direction of soil loss is useful. For example, creep and saltation loss to a roadside ditch or waterway will impact water quality, so attention can be focused in these scenarios to controlling loss in that direction. Similarly, suspension loss in the direction of highly populated areas or nearby heavily trafficked roadways can be simulated with WEPS and specific control strategies simulated.

**4. Separate soil loss into creep/saltation, suspension, and PM10 components.** Each of these components have specific characteristics and effects. Creep/saltation are typically deposited locally where they can affect soil and water quality, bury crops, roads, and irrigation ditches, or be deposited as dunes in fences or windbreaks. Suspension, by definition, can be lifted into the air and carried great distances. As such, it can be a detriment to air quality, become a health hazard, and reduce visibility along transportation systems. PM10 has been determined by the U.S. Environmental Protection Agency to be a hazard to air quality and a respiratory hazard in particular (U.S. EPA, 1996). Estimating soil loss of each of these components can aid in environmental assessments.

Taking all user requirements into consideration, WEPS is designed to be an aid in: 1) soil conservation planning, 2) environmental assessment and planning; and 3) determining off-site impacts of wind erosion.

## WEPS Modeling Approach

WEPS is a process-based, daily time-step model that simulates weather, field conditions, and erosion. As such, it simulates not only the basic wind erosion processes, but also the field management and weathering processes that modify a soil's susceptibility to wind erosion. The initial model release is WEPS 1.0 and is designed to provide the user with a simple tool for inputting initial field conditions, calculating soil loss, and displaying either simple or detailed outputs for conservation planning and design of erosion control systems.

*WEPS 1.0 Geometries*

To simplify inputs, WEPS 1.0 is designed with specific geometric constraints when specifying the simulation region or field (Figure 1.2). The simulation region is limited to a rectangular area. However other field shapes such as circles or half circles can also be simulated by defining a rectangle of the same length, width, or area of the desired field shape. The simulation area may be rotated to orient the field correctly on the landscape to account for the effects of varying tillage, planting, and wind directions.

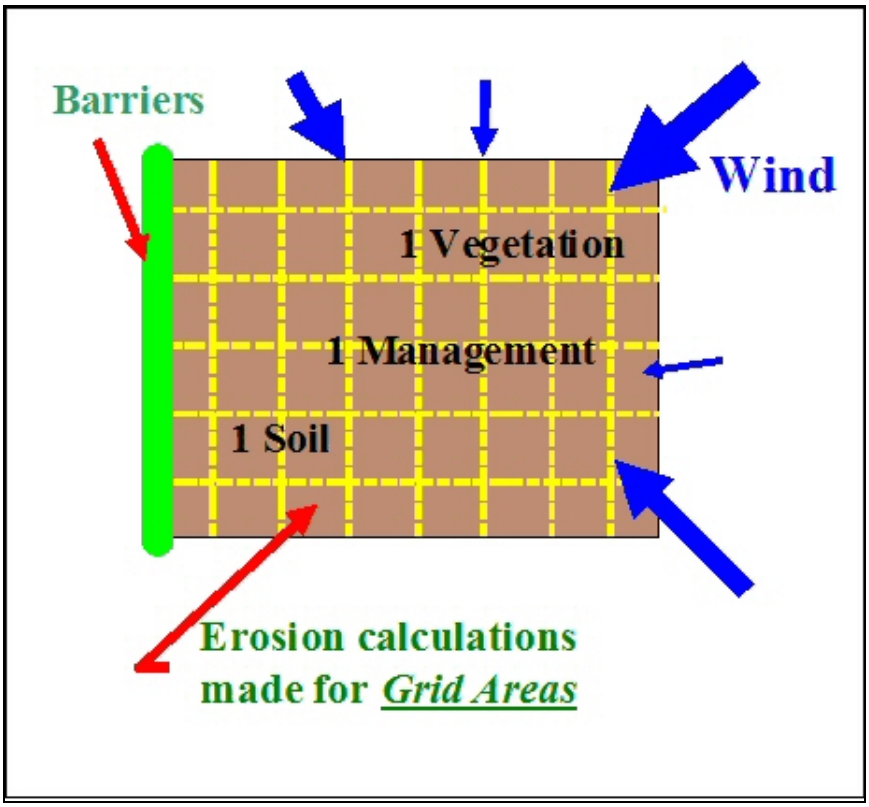


**Figure 1.1.** WEPS simulation geometries.

A uniform simulation region surface is assumed in that only one soil type (uniform soil properties), crop type (biomass properties), and management are uniformly distributed over the field. In reality, fields are often not uniform so the user may select the dominant-critical (i.e., most erodible) soil or crop condition for a simulation. Barriers may be placed on any or all field boundaries. When barriers are present, the wind speed is reduced in the sheltered area on both the upwind and downwind sides of the barriers. Thus, WEPS can simulate deposition in front of downwind barriers. The erosion submodel determines the threshold friction velocity at which erosion can begin for each day's surface condition. When wind speeds exceed the threshold, the submodel calculates the loss/deposition over a series of individual grid cells representing the field. The soil loss and deposition is divided into components of saltation/creep and suspension, because each has unique transport modes, as well as off-site impacts. The field surface is periodically updated during erosion events to simulate the surface changes caused by erosion. Surface updating during an erosion event includes changes to aggregate size distribution of the surface as fine particles are removed and surface aggregates breakdown into smaller sizes due to impacts from moving particles, smoothing of ridge roughness as ridges are eroded and furrows fill with eroded materials, etc.

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*WEPS 1.0 Model Implementation*

The structure of WEPS 1.0 is modular and consists of the science model, coded in FORTRAN 95 coupled with a graphical user interface, which is coded in JAVA. The model also includes five databases, two weather simulation generators, and six submodels (Figure

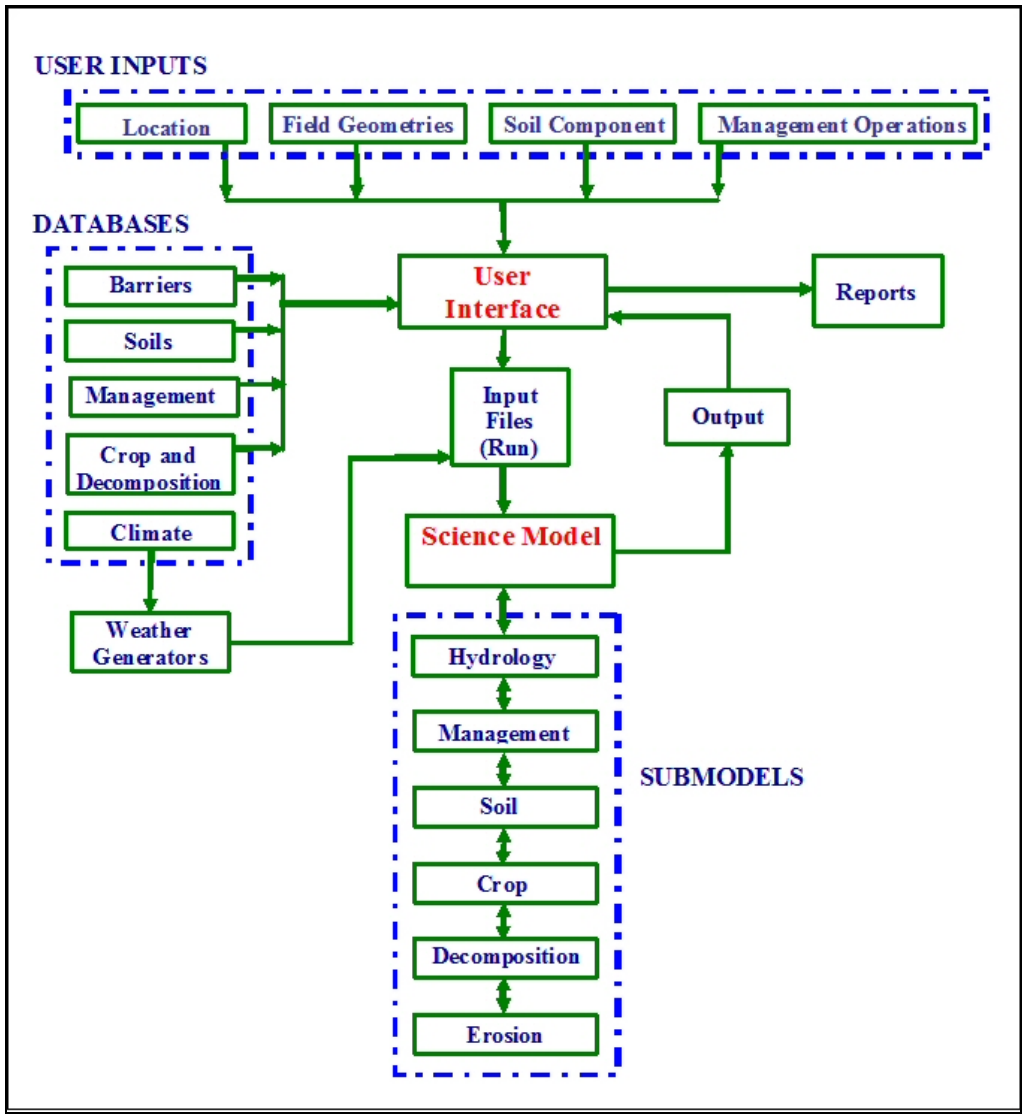



**Figure 1.2.** Structure of the WEPS model.

1.2). The user interface provides a means for the user to enter initial conditions such as the field dimensions, orientation, barriers, location, management operations, and soil component

desired for the simulation region. Field dimensions are entered as a length and width and orientation as an angle deviation from north. The user selects the barrier type from a list accessed through the interface. For location, the user can either select the country (if configured for non-U.S. usage), state and county or enter a latitude and longitude directly for simulation. The interface then selects the weather stations for which statistical weather parameters based upon historical measured meteorological data are used to simulate daily (and hourly for wind) weather parameters. The soil component is selected from a list of soils supplied by the NRCS Soil Survey Geographic (SSURGO) database for the Soil Survey Area of the simulation region or, when online, directly from the NRCS Soil Data Mart website (http://soildatamart.nrcs.usda.gov). Management operation and dates are compiled in the Management/Crop Rotation Editor for WEPS (MCREW) in a spreadsheet style table editor.

Given the user supplied inputs, the interface accesses five databases for climate, soils, management, barriers, and crop growth and residue decomposition for the simulation. These databases provide needed parameters for location and conditions simulated as specified by the user. The interface writes the information needed for a WEPS simulation, obtained from the user and the databases, to WEPS input files. The interface also calls the weather generators which create weather files containing daily precipitation, maximum and minimum temperatures, solar radiation, and dew-point temperature as well as daily wind direction and subdaily (e.g., hourly) wind speeds. These input files for a given simulation are collectively known in WEPS as a "Run". To reduce computation time, a daily time step is used in WEPS, except for selected subroutines in the Hydrology and Erosion submodels, which may use hourly or sub-hourly time steps (e.g., 15 minutes). The science model reads the input run files and calls the Hydrology, Soil, Crop, and Decomposition submodels daily which account for changes in the soil surface erodibility as influenced by management and weather. If surface conditions for a given day are such that erosion can occur for the maximum wind speed for that day, Erosion submodel routines are called to calculate soil loss and deposition. Soil erosion by wind is initiated when the wind speed exceeds the saltation threshold speed for a given soil and biomass condition. After initiation, the duration and severity of an erosion event depend on the wind speeds and the evolution of the surface conditions.

**WEPS Model Use**

WEPS is a comprehensive wind erosion model with many options for inputs and outputs. For basic simulations however, WEPS 1.0 is simple to operate. Only four types of information are entered on the main screen: 1) description of the simulation region geometry by defining the field dimensions and field orientation; 2) select the field location for which to generate simulated weather; 3) select the soil; and 4) select a management scenario. For U.S. simulations, the last three may be selected from lists provided with the WEPS model or from NRCS. New input files will usually be created using previous input files as templates modified within the user-interface. By varying inputs, particularly the field management, the user can compare various alternatives to control soil loss by wind. Interpreting the outputs

REFERENCE 3



of WEPS is an integral part of using WEPS as a tool to develop conservation plans for controlling wind erosion. WEPS provides options for viewing very detailed outputs by periods (default is two weeks) including soil loss as saltation/creep, suspension, and PM10. Period output is also available for weather parameters such as wind energy, as well as surface conditions such as soil erodibility and biomass amounts. Such information is useful in determining which period is resulting in severe erosion and the conditions that are contributing to the loss. WEPS outputs also include amount of loss for each direction which aid the user in the placement of barriers, strip cropping, or other directional erosion control methods. More detailed features of WEPS and information on use of WEPS outside the U.S. are covered later in this manual. WEPS also has a Multiple Run Management View option to allow easier comparisons of alternative outputs.

## Conclusion

The Wind Erosion Prediction System is a process-based, daily time-step model that simulates weather, field conditions, and erosion. WEPS development was in response to customer requests for improved wind erosion technology. It is intended to replace the predominately empirical Wind Erosion Equation as a prediction tool for those who plan soil conservation systems, conduct environmental planning, or assess offsite impacts caused by wind erosion. The WEPS model is continually being improved with periodic updates. Plans are in place to develop the following enhancements to WEPS for future upgrades: i) provide plant damage estimates, ii) integration with the Water Erosion Prediction Project (WEPP) model, iii) add capabilities for other, non-cropped lands, iv) predict visibility effects of dust storms, v) dust prediction via weather forecasting, vi) prediction of PM2.5 and PM-coarse (PM10 minus PM2.5), and vii) include capabilities for complex fields in terms of relief, multiple soils, crops, and management on one simulated field.

## References

Chepil, W.S. 1958. Soil conditions that influence wind erosion. USDA Tech. Bul. No. 1185.

Chepil, W.S. 1959. Wind erodibility of farm fields. J. Soil and Water Conserv. 14(5):214-219.

Chepil, W.S. 1960. Conversion of relative field erodibility to annual soil loss by wind. Soil Sci. Soc. Am. Proc. 24(2):143-145.

Chepil, W.S. and N.P. Woodruff. 1959. Estimations of wind erodibility of farm fields. USDA, ARS Prod. Res. Rpt. No. 25.

# REFERENCE 4

Soil Map—Nye County, Nevada, Southwest Part
(USEN and Vicinity)

Map Scale: 1:14,900 if printed on B landscape (17" x 11") sheet.

Meters: 0 200 400 800 1200

Feet: 0 500 1000 2000 3000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 11N WGS84

# REFERENCE 4

Soil Map—Nye County, Nevada, Southwest Part
(USEN and Vicinity)

## MAP LEGEND

**Area of Interest (AOI)**

- Area of Interest (AOI)

**Soils**

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

**Special Point Features**

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

**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 1:24,000.

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: Nye County, Nevada, Southwest Part
Survey Area Data: Version 7, Aug 22, 2014

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

Date(s) aerial images were photographed: Jul 3, 2010—Oct 30, 2011

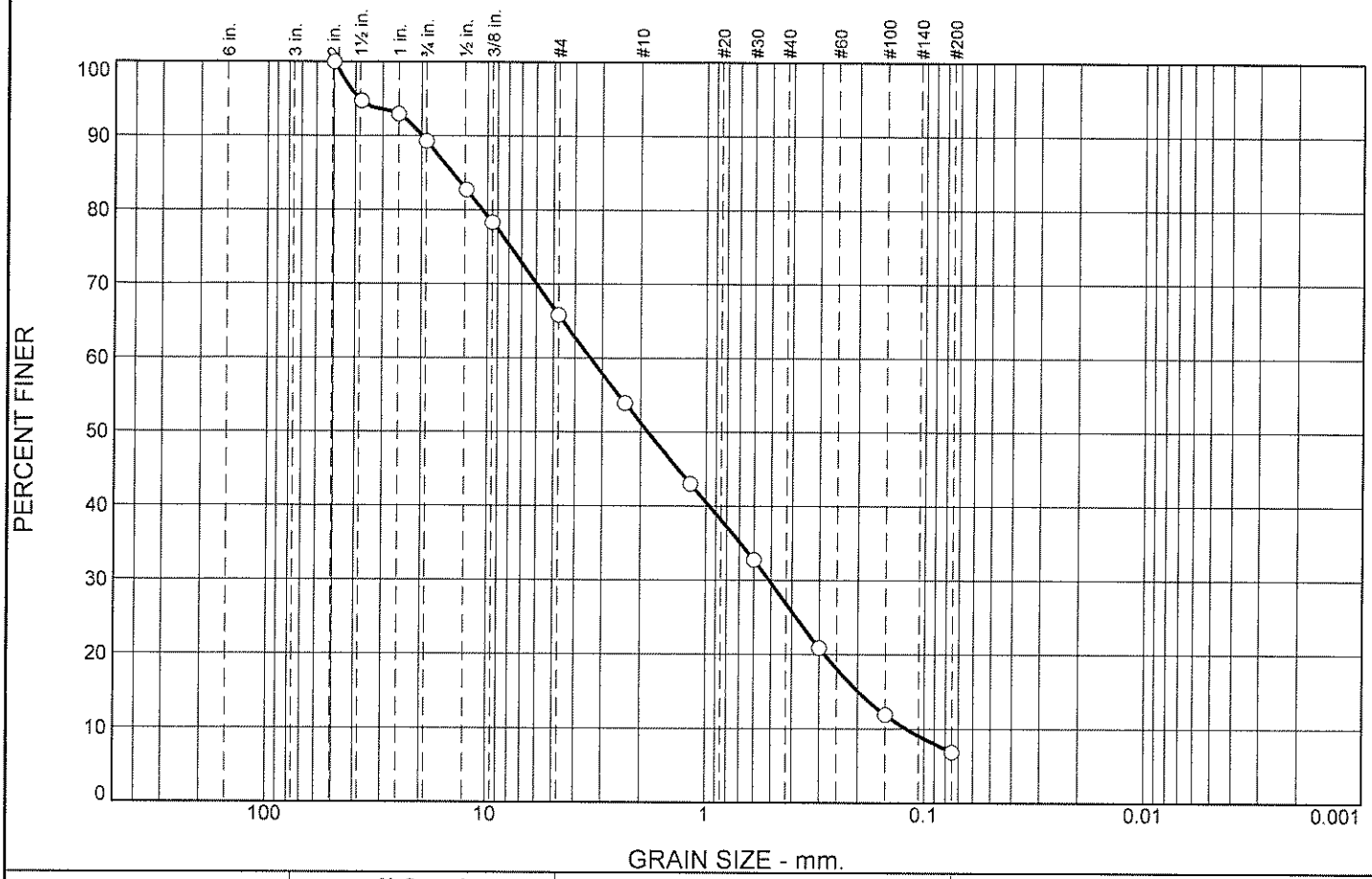
The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

# Map Unit Legend

| Nye County, Nevada, Southwest Part (NV785) | | | |
|---|---|---|---|
| **Map Unit Symbol** | **Map Unit Name** | **Acres in AOI** | **Percent of AOI** |
| 2020 | Weiser-Canoto association | 10.6 | 0.6% |
| 2053 | Yermo-Greyeagle-Arizo association | 286.6 | 16.0% |
| 2054 | Yermo, hot-Yermo-Arizo association | 1,221.7 | 68.2% |
| 2393 | Commski-Yermo association | 271.5 | 15.2% |
| **Totals for Area of Interest** | | **1,790.3** | **100.0%** |

# Particle Size Distribution Report

**REFERENCE 5**




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0 | 11 | 23 | 15 | 24 | 20 | 7 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 2 | 100 | | |
| 1-1/2 | 95 | | |
| 1" | 93 | | |
| 3/4 | 89 | | |
| 1/2 | 83 | | |
| 3/8 | 78 | | |
| #4 | 66 | | |
| #8 | 54 | | |
| #16 | 43 | | |
| #30 | 33 | | |
| #50 | 21 | | |
| #100 | 12 | | |
| #200 | 6.9 | | |

* (no specification provided)

**Soil Description**

poorly graded sand with silt and gravel

**Atterberg Limits**

PL= NP LL= NV PI= NP

**Coefficients**

$D_{90}$= 19.8890 $D_{85}$= 14.4412 $D_{60}$= 3.4032
$D_{50}$= 1.8508 $D_{30}$= 0.5102 $D_{15}$= 0.1986
$D_{10}$= 0.1204 $C_u$= 28.27 $C_c$= 0.64

**Classification**

USCS= SP-SM AASHTO= A-1-b

**Remarks**

**Location:** 50' West of Lysimeter #1
**Sample Number:** 13-0335A

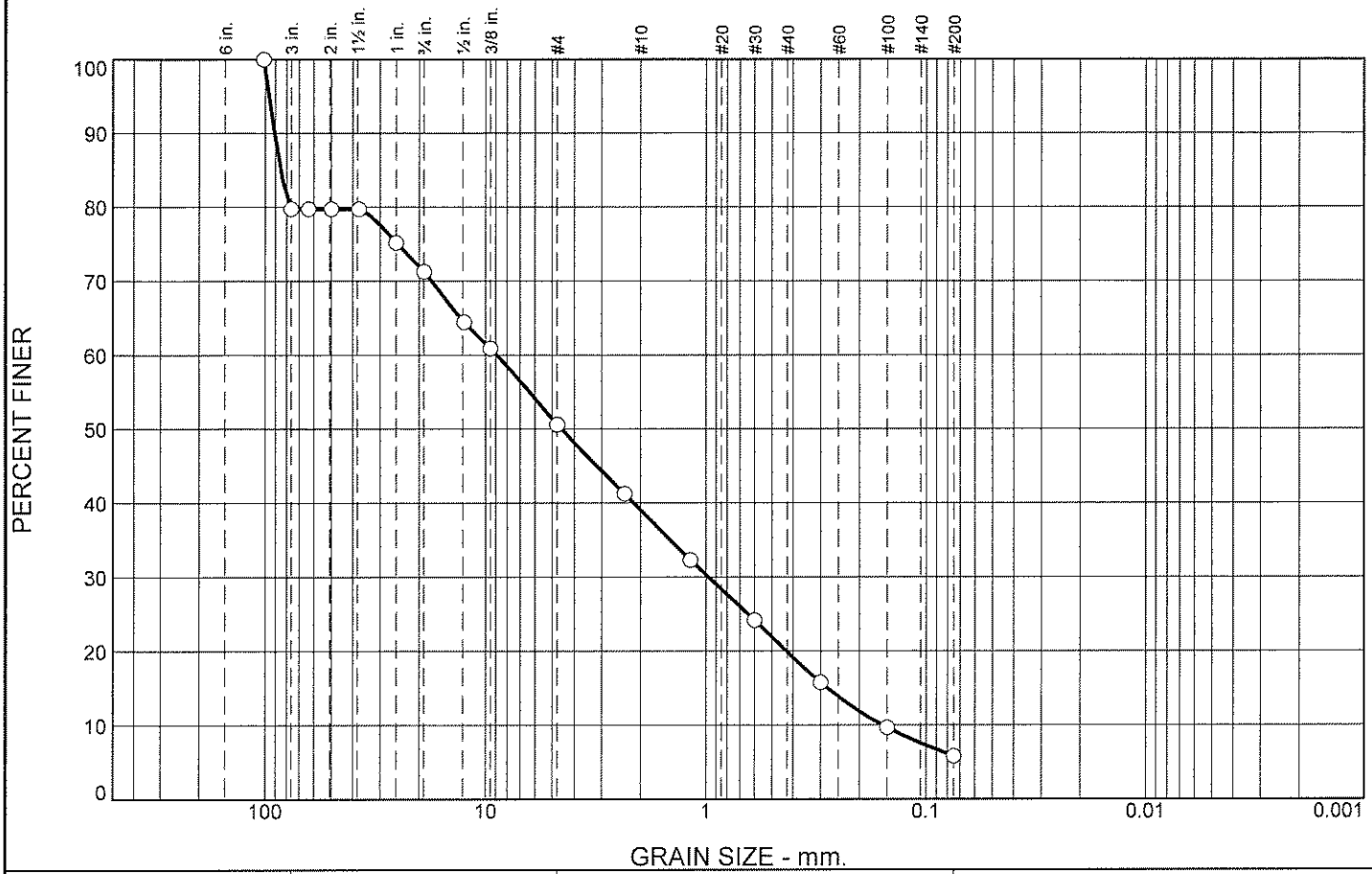
**Date:** 10/09/2013

CESARE, INC.
Geotechnical Engineers & Construction Materials Consultants

**Client:** AquAeter, Inc.
**Project:** US Ecology Disposal Cell Construction
US Ecology - Beatty, NV
**Project No:** 13.1048E **Figure** 13-0335A

# Particle Size Distribution Report

**REFERENCE 5**




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 20 | 9 | 20 | 12 | 19 | 14 | 6 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 4 | 100 | | |
| 3 | 80 | | |
| 2-1/2 | 80 | | |
| 2 | 80 | | |
| 1-1/2 | 80 | | |
| 1" | 75 | | |
| 3/4 | 71 | | |
| 1/2 | 64 | | |
| 3/8 | 61 | | |
| #4 | 51 | | |
| #8 | 41 | | |
| #16 | 32 | | |
| #30 | 24 | | |
| #50 | 16 | | |
| #100 | 10 | | |
| #200 | 5.8 | | |

* (no specification provided)

**Soil Description**

poorly graded sand with silt and gravel

**Atterberg Limits**

PL= NP LL= NV PI= NP

**Coefficients**

$D_{90}$= 90.8992 $D_{85}$= 85.1004 $D_{60}$= 8.8897
$D_{50}$= 4.5568 $D_{30}$= 0.9756 $D_{15}$= 0.2792
$D_{10}$= 0.1572 $C_u$= 56.55 $C_c$= 0.68

**Classification**

USCS= SP-SM AASHTO= A-1-a

**Remarks**

**Location:** 30' South of Lysimeter #2
**Sample Number:** 13-0335B

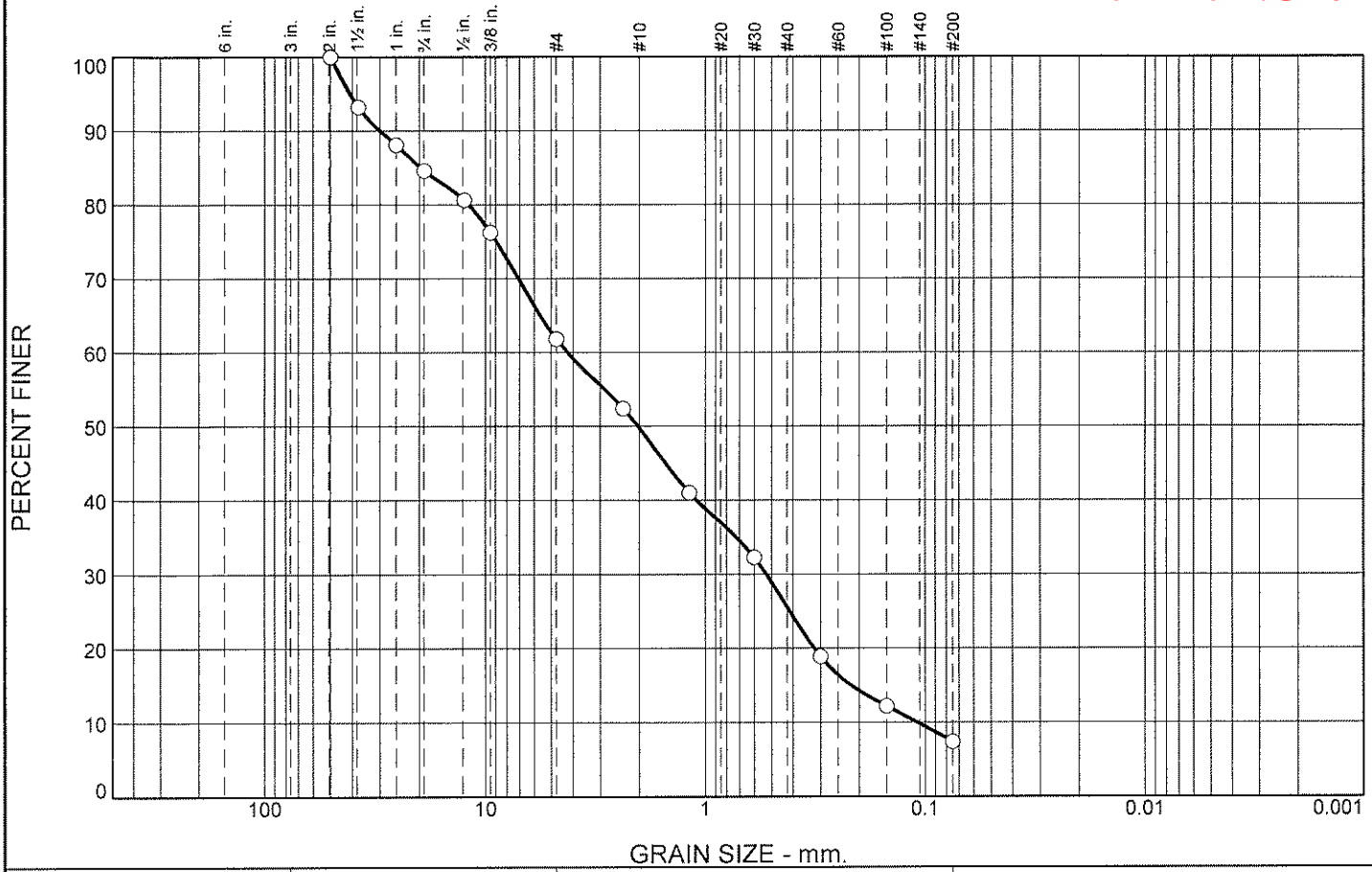
**Date:** 10/09/2013

CESARE, INC.
*Geotechnical Engineers & Construction Materials Consultants*

**Client:** AquAeter, Inc.
**Project:** US Ecology Disposal Cell Construction
US Ecology - Beatty, NV
**Project No:** 13.1048E **Figure** 13-0335B

# Particle Size Distribution Report

**REFERENCE 5**




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0 | 15 | 23 | 12 | 24 | 19 | 7 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 2 | 100 | | |
| 1-1/2 | 93 | | |
| 1" | 88 | | |
| 3/4 | 85 | | |
| 1/2 | 81 | | |
| 3/8 | 76 | | |
| #4 | 62 | | |
| #8 | 52 | | |
| #16 | 41 | | |
| #30 | 32 | | |
| #50 | 19 | | |
| #100 | 12 | | |
| #200 | 7.4 | | |

* (no specification provided)

**Soil Description**

poorly graded sand with silt and gravel

**Atterberg Limits**

PL= NP LL= NV PI= NP

**Coefficients**

$D_{90}$= 30.0678 $D_{85}$= 19.7079 $D_{60}$= 4.2428
$D_{50}$= 2.0255 $D_{30}$= 0.5280 $D_{15}$= 0.2181
$D_{10}$= 0.1087 $C_u$= 39.03 $C_c$= 0.60

**Classification**

USCS= SP-SM AASHTO= A-1-a

**Remarks**

**Location:** 20' East of Lysimeter #3
**Sample Number:** 13-0335C

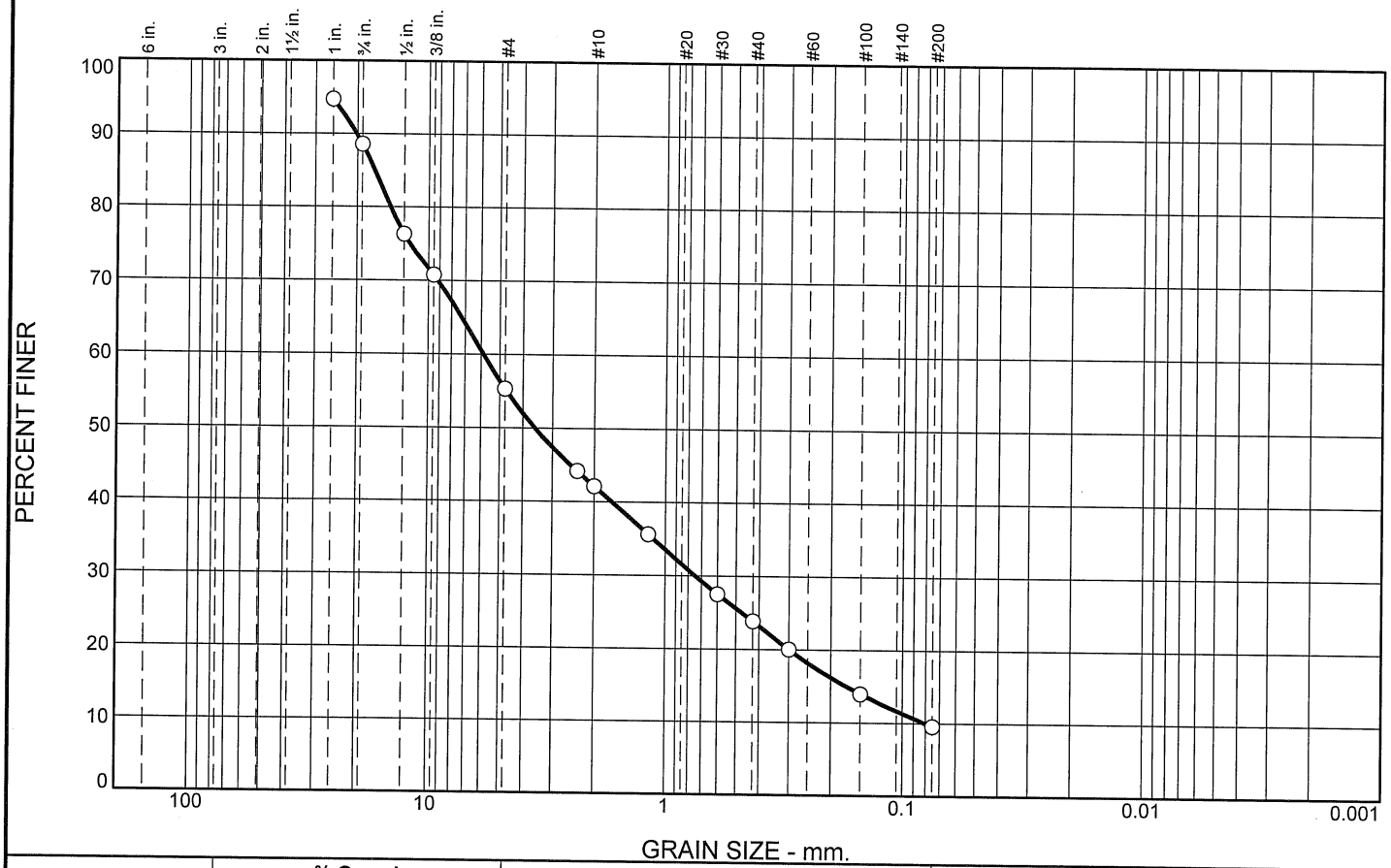
**Date:** 10/09/2013

CESARE, INC.
*Geotechnical Engineers & Construction Materials Consultants*

**Client:** AquAeter, Inc.
**Project:** US Ecology Disposal Cell Construction
US Ecology - Beatty, NV
**Project No:** 13.1048E **Figure** 13-0335C

REFERENCE 6

# Particle Size Distribution Report




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| | | 34 | 13 | 18 | 14 | 10 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 1 | 95 | | |
| .75 | 89 | | |
| .5 | 76 | | |
| .375 | 71 | | |
| #4 | 55 | | |
| #8 | 44 | | |
| #10 | 42 | | |
| #16 | 36 | | |
| #30 | 28 | | |
| #40 | 24 | | |
| #50 | 20 | | |
| #100 | 14 | | |
| #200 | 9.6 | | |

* (no specification provided)

**Material Description**

N/A

**Atterberg Limits**

PL= N/A LL= N/A PI= N/A

**Coefficients**

$D_{90}$= 20.1470 $D_{85}$= 16.8954 $D_{60}$= 5.8559
$D_{50}$= 3.5602 $D_{30}$= 0.7463 $D_{15}$= 0.1719
$D_{10}$= 0.0801 $C_u$= 73.08 $C_c$= 1.19

**Classification**

USCS= N/A AASHTO= N/A

**Remarks**

SAMPLED BY: CLIENT
ASTM C136

**Location:** T11 ARMORED SOIL #1
**Sample Number:** 16-075-1

**Date:** 2/23/16

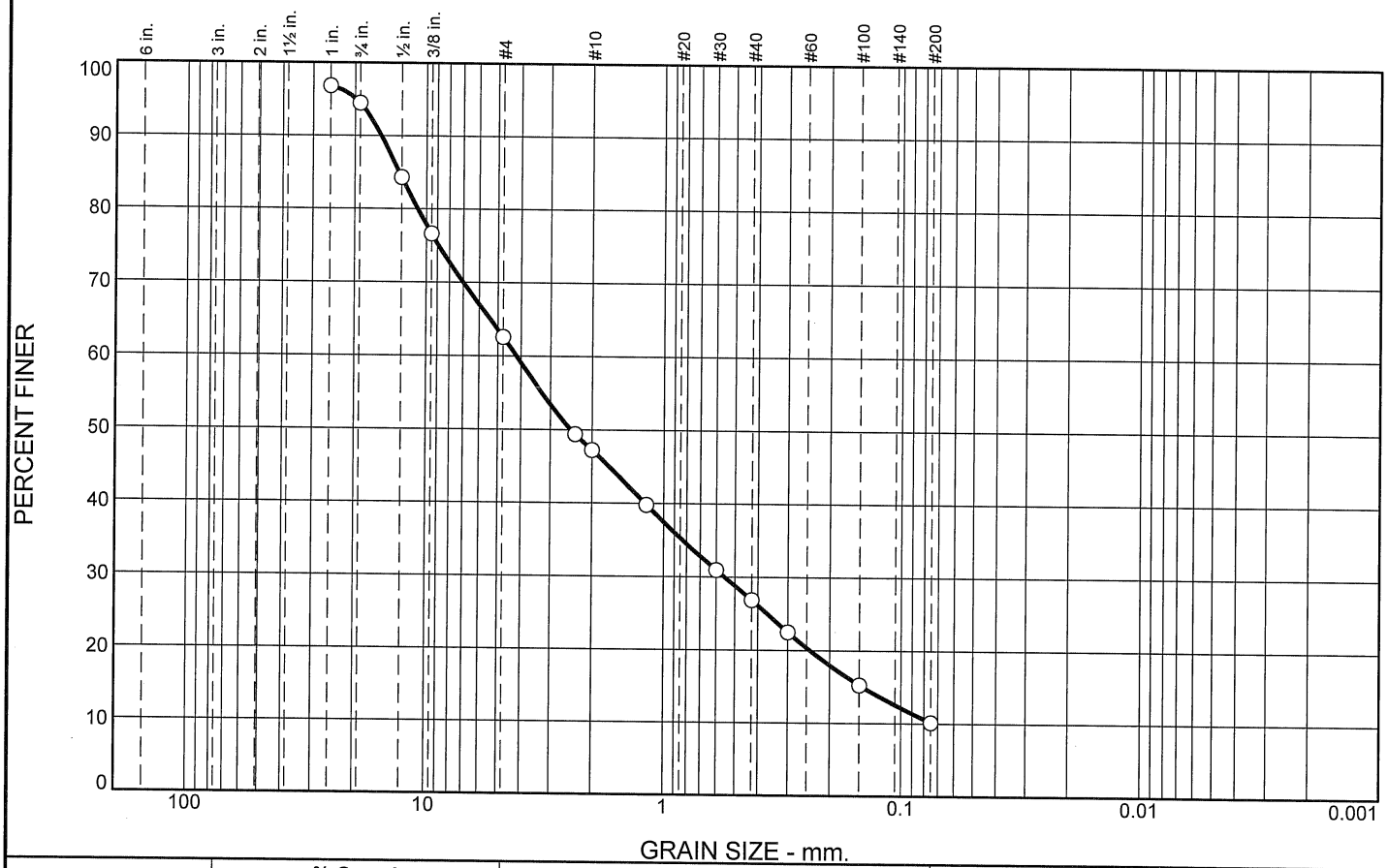
GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.
GES

**Client:** US ECOLOGY
**Project:** TRENCH 11 ARMORED SOIL
**Project No:** 2016 MISC
**Figure** 16-075-1

**Tested By:** T. RAMOS

REFERENCE 6

# Particle Size Distribution Report




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| | | 31 | 16 | 20 | 17 | 10 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 1 | 97 | | |
| .75 | 94 | | |
| .5 | 84 | | |
| .375 | 77 | | |
| #4 | 63 | | |
| #8 | 49 | | |
| #10 | 47 | | |
| #16 | 40 | | |
| #30 | 31 | | |
| #40 | 27 | | |
| #50 | 22 | | |
| #100 | 15 | | |
| #200 | 10 | | |

* (no specification provided)

**Material Description**

N/A

**Atterberg Limits**

PL= N/A LL= N/A PI= N/A

**Coefficients**

$D_{90}$= 15.5147 $D_{85}$= 13.0000 $D_{60}$= 4.1799
$D_{50}$= 2.4608 $D_{30}$= 0.5538 $D_{15}$= 0.1453
$D_{10}$= $C_u$= $C_c$=

**Classification**

USCS= N/A AASHTO= N/A

**Remarks**

SAMPLED BY: CLIENT
ASTM C136

**Location:** T11 ARMORED SOIL #2
**Sample Number:** 16-075-2

**Date:** 2/23/16

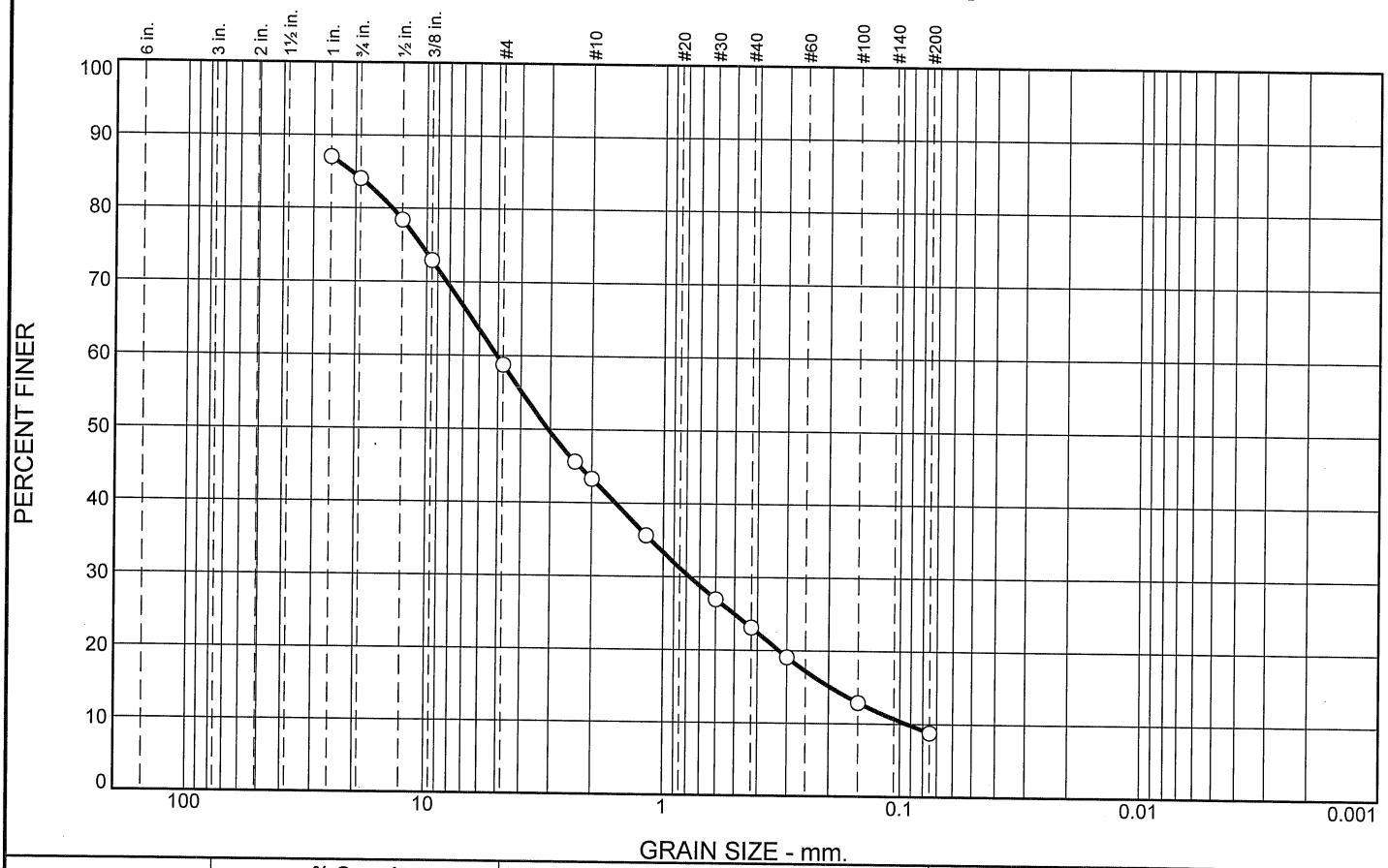
GES GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

**Client:** US ECOLOGY
**Project:** TRENCH 11 ARMORED SOIL
**Project No:** 2016 MISC
**Figure** 16-075-2

**Tested By:** T. RAMOS

REFERENCE 6

# Particle Size Distribution Report




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| | | 25 | 16 | 20 | 14 | 9 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 1 | 87 | | |
| .75 | 84 | | |
| .5 | 78 | | |
| .375 | 73 | | |
| #4 | 59 | | |
| #8 | 46 | | |
| #10 | 43 | | |
| #16 | 36 | | |
| #30 | 27 | | |
| #40 | 23 | | |
| #50 | 19 | | |
| #100 | 13 | | |
| #200 | 8.8 | | |

* (no specification provided)

**Material Description**

N/A

**Atterberg Limits**

PL= N/A LL= N/A PI= N/A

**Coefficients**

$D_{90}$= $D_{85}$= 20.7701 $D_{60}$= 5.0491
$D_{50}$= 3.0697 $D_{30}$= 0.7741 $D_{15}$= 0.1968
$D_{10}$= 0.0932 $C_u$= 54.18 $C_c$= 1.27

**Classification**

USCS= N/A AASHTO= N/A

**Remarks**

SAMPLED BY: CLIENT
ASTM C136

**Location:** T11 ARMORED SOIL #3
**Sample Number:** 16-075-3

**Date:** 2/23/16

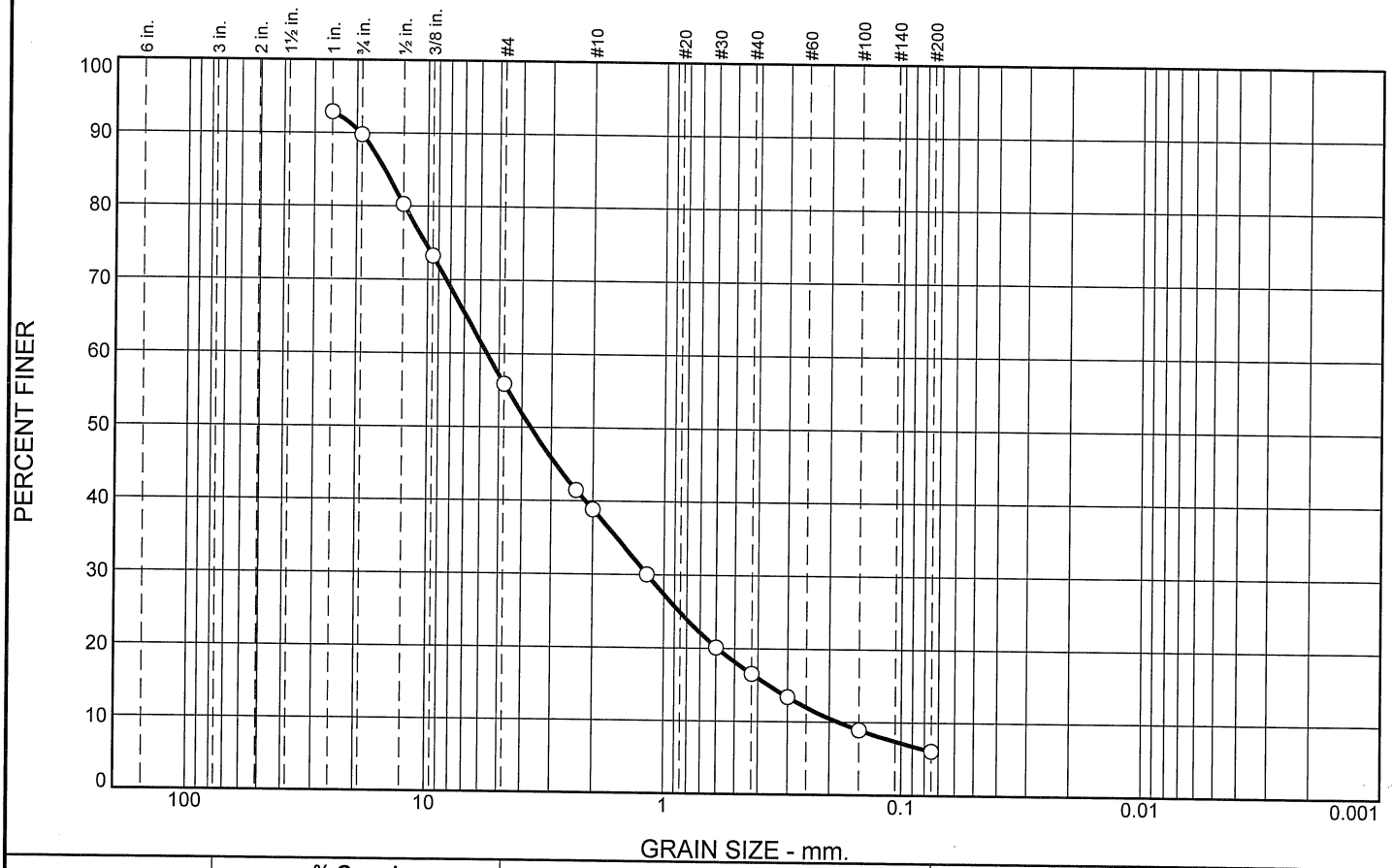
GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.
GES

**Client:** US ECOLOGY
**Project:** TRENCH 11 ARMORED SOIL
**Project No:** 2016 MISC
**Figure** 16-075-3

**Tested By:** T. RAMOS

REFERENCE 6

# Particle Size Distribution Report




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| | | 34 | 17 | 22 | 11 | 6 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 1 | 93 | | |
| .75 | 90 | | |
| .5 | 80 | | |
| .375 | 73 | | |
| #4 | 56 | | |
| #8 | 41 | | |
| #10 | 39 | | |
| #16 | 30 | | |
| #30 | 20 | | |
| #40 | 17 | | |
| #50 | 13 | | |
| #100 | 9 | | |
| #200 | 6.1 | | |

* (no specification provided)

**Material Description**

N/A

**Atterberg Limits**

PL= N/A LL= N/A PI= N/A

**Coefficients**

$D_{90}$= 19.3104 $D_{85}$= 15.2466 $D_{60}$= 5.6196
$D_{50}$= 3.6774 $D_{30}$= 1.1760 $D_{15}$= 0.3607
$D_{10}$= 0.1831 $C_u$= 30.69 $C_c$= 1.34

**Classification**

USCS= N/A AASHTO= N/A

**Remarks**

SAMPLED BY: CLIENT
ASTM C136

**Location:** T11 ARMORED SOIL #4
**Sample Number:** 16-075-4

**Date:** 2/23/16

GES GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

**Client:** US ECOLOGY
**Project:** TRENCH 11 ARMORED SOIL
**Project No:** 2016 MISC
**Figure** 16-075-4

**Tested By:** T. RAMOS

# Initial Field Conditions Data

REFERENCE 7

Soil ID NV785-2053-Arizo-15-STV_SL-Nevada-Nye County-Nye County, Nevada, Southwest Part
Taxorder Entisols
Number of soil layers 2
Layer thickness (mm) 200  1320
Organic matter (kg/kg) 0.002  0.002
Sand fraction 0.666  0.960
Silt fraction 0.234  0.015
Clay fraction 0.100  0.025
Rock fragments 0.580  0.570
Sand fraction very coarse 0.045  0.007
Sand fraction coarse 0.137  0.131
Sand fraction medium 0.167  0.372
Sand fraction fine 0.200  0.378
Sand fraction very fine 0.117  0.072
Bulk Density (1/3 bar)(Mg/m^3) 1.550  1.550
Initial Bulk Density (1/3 bar)(Mg/m^3) 1.550  1.550
Aggregate geometric mean diameter (mm) 1.628  3.852
Aggregate geometric standard deviation 11.146  14.376
Maximum aggregate size (mm) 30.938  35.162
Minimum aggregate size (mm) 0.010  0.010
Aggregate density (Mg/m^3) 1.800  1.800
Aggregate stability (ln(J/m^2)) 2.162  1.208
Dummy 0.010
Crust thickness (mm) 1.800
Crust density (Mg/m^3) 2.16
Crust stability (ln(J/m^2)) 0.00
Crust surface fraction (m^2/m^2) 0.00
Mass of loose material on crust (kg/m^2) 0.00
Fraction of loose material on crust (m^2/m^2) 4.00
Random roughness (mm) 0.00
Ridge orientation (deg) 0.00
Ridge height (mm) 10.00
Spacing between ridge tops (mm) 10.00
Initial soil water content (m^3/m^3) 0.039  0.018
Saturation soil water content (m^3/m^3) 0.411  0.313
Field capacity water content (m^3/m^3) 0.055  0.030
Wilting point water content (m^3/m^3) 0.023  0.007
Soil CB value (exponent to Campbell's SWRC) 4.907  3.957
Air entry potential (J/kg) -0.810  -0.423
Saturated hydraulic conductivity (m/s) 2.8E-5  4.23E-4
Ridge width (mm) 0.340
Dry soil albedo (fraction) 0.100
Soil PH (0-14) 8.20  8.20
Calcium carbonate equivalent (CaCO3) 0.03  0.10
Cation exchange capacity (CEC) (meq/100g) 6.50  1.50
Linear extensibility 1.500  1.500

REFERENCE 8

MCREW(Management Crop Rotation Editor for WEPS)

File Edit View Configure Tools Help

Years in Rotation: 1

Rotation : C:\Users\CBolin\Documents\WEPS Files\USEN East West 2053.wpj\USEN Construction Management.man

| Date | Operation Name | Crop or Residue | Row/Ridge Dir. (Deg.) |
|---|---|---|---|
| Jan 01, 01 | Bulldozer, clearing-cutting | | 0 |
| Jan 01, 01 | Bulldozer, filling-leveling | | 0 |
| Jan 01, 01 | Disk, tandem heavy primary op | | 0 |
| Jan 01, 01 | Roller, smooth | | 0 |
| Jan 01, 01 | Begin weed growth | no crop | |
| | | | |

Project Run ViewOutput Configuration Tools Help

REFERENCE 9

new run_65

**Runs Location**

C:\Users\CBolin\Documents\WEPS Files\Runs

**Client Information**

| | |
|---|---|
| Client Name | USEN |
| Farm No | |
| Tract No | North Face |
| Field No | |

**Region**

| | | |
|---|---|---|
| Shape | Rectangle | |
| X-Length | 2190.0 | ft |
| Y-Length | 300.0 | ft |
| Area | 15.1 | ac |
| Orientation | 0.0 | ° |

**Location**

| | | |
|---|---|---|
| State: | NEVADA | |
| County: | NYE | |
| Latitude: | 36.77 N | ° |
| Longitude: | 116.69 W | ° |
| Elevation: | 2388 | ft |

Cligen:
AMARGOSA_VALLEY_4S(+) 20.4 mi ...

Windgen: < 150.0 mi
MERCURY/DESERT ROCK 38.8 mi ...

View Map

**Simulation**

| | | |
|---|---|---|
| Run Mode | NRCS | |
| Water Erosion | 0.00 | t/ac |
| Region Slope | 0.33 | ft/ft |
| Soil DB Value | 0.10 | ft/ft |
| Rock Fragments | FROM SOIL DB | |
| Soil DB Value | 0.58 | ft³/ft³ |

**Barriers**

| | |
|---|---|
| N | none |
| S | none |
| E | none |
| W | none |

Edit Selected Barrier

**Notes**

```
North Face at 3 to 1
Run Mode: NRCS
Regional Slope  = 0.33
Rock Fragments = From Soil DB
Soil 2053
```

Edit Clear

Man USEN Construction Management

Soil Arizo_2053_15_STV_SL

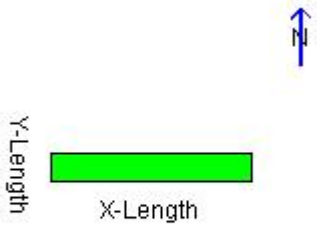
# Run Summary

REFERENCE 9

new run_65

| | | | | | |
|---|---|---|---|---|---|
| **Run Date:** | Wednesday, March 02, 2016, 04:58 PM | | | | |
| **Client Name:** | USEN | | | | |
| **Farm No:** | --- | **Tract No:** | North Face | **Field No:** | --- |
| **Run Location:** | Runs | | | | |
| **Management:** | USEN Construction Management.man | | | | |
| **Soil:** | Arizo_2053_15_STV_SL.ifc | | | | |

## Location Site Information




| | | | |
|---|---|---|---|
| **X-Length:** | 2190.0 ft | **Mode:** | NRCS |
| **Y-Length:** | 299.9 ft | **Soil Loss Tolerance (T):** | 5.0 t/ac/yr |
| **Area:** | 15.1 ac | **Site:** | UNITED STATES<br>NEVADA<br>NYE |
| **Elevation:** | 2388.5 ft | **Location:** | 36.77° N, 116.69° W |
| **Orientation:** | 0.00 ° | **Cligen:** | AMARGOSA_VALLEY_4S(+) |
| | | **Windgen:** | MERCURY/DESERT ROCK |

## Erosion

| Period | Crop/Residue | Gross Loss t/ac | Net Soil Loss From Field ( t/ac ) Total | Creep/Salt. | Suspen. | PM10 |
|---|---|---|---|---|---|---|
| Rot. year: 1 | | 3.96 | 3.96 | 2.905 | 1.051 | 0.06602 |
| Ave. Annual | | 3.96 | 3.96 | 2.905 | 1.051 | 0.06602 |

## SCI Summary

| | | | | |
|---|---|---|---|---|
| **Soil Conditioning Index:** | -0.429 | | **SCI Subfactors** | |
| **Energy Calculator:** | 2.250 | gal diesel/ac | **OM:** | -1.000 |
| **Average Annual STIR:** | 80.275 | | **FO:** | 0.2052 |
| **Wind Erosion Soil Loss:** | 3.956 | t/ac | **ER:** | -0.5574 |
| **Water Erosion Soil** | 0.000 | t/ac | | |

## Rotation Stir Energy

| Date | Operation | Fuel | Stir | Energy Btu/ac | Cost USD/ac |
|---|---|---|---|---|---|
| Jan 01, 01 | Aerator, tandem drum, lugs, angle 10 | Diesel | 35.10 | 81,869 | 2.34 |

# Run Summary

REFERENCE 9

new run_65

## Rotation Stir Energy

| Date | Operation | Fuel | Stir | Energy Btu/ac | Cost USD/ac |
|---|---|---|---|---|---|
| Jan 01, 01 | Bulldozer, filling-leveling | Diesel | 5.20 | 75,583 | 2.16 |
| Jan 01, 01 | Disk, tandem heavy primary op | Diesel | 39.00 | 94,441 | 2.70 |
| Jan 01, 01 | Roller, smooth | Diesel | 0.98 | 31,431 | 0.90 |
| Jan 01, 01 | Begin weed growth | Diesel | 0.00 | 0 | 0.00 |
| | | **Total / ac** | | 283,324 | 8.10 |
| | | **Total** | 80.28 | 4,271,329 | 122.07 |

## Notes

North Face at 3 to 1|Run Mode: NRCS|Regional Slope = 0.33|Rock Fragments = From Soil DB|Soil 2053

Project Run ViewOutput Configuration Tools Help

new run_66

REFERENCE 9

**Runs Location**

C:\Users\CBolin\Documents\WEPS Files\Runs

**Client Information**

| | |
|---|---|
| Client Name | USEN |
| Farm No | |
| Tract No | Upper Deck |
| Field No | |

**Region**

| | | |
|---|---|---|
| Shape | Rectangle | |
| X-Length | 1835.0 | ft |
| Y-Length | 516.0 | ft |
| Area | 21.7 | ac |
| Orientation | 0.0 | ° |

**Location**

| | | |
|---|---|---|
| State: | NEVADA | |
| County: | NYE | |
| Latitude: | 36.77 N | ° |
| Longitude: | 116.69 W | ° |
| Elevation: | 2770 | ft |

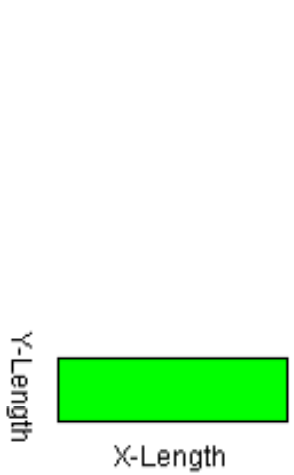
Cligen: < 100.0 mi
AMARGOSA VALLEY 4S(+) 20.4 mi ...

Windgen: < 150.0 mi
MERCURY/DESERT ROCK 38.8 mi ...

View Map

**Simulation**

| | | |
|---|---|---|
| Run Mode | NRCS | |
| Water Erosion | 0.00 | t/ac |
| Region Slope | 0.05 | ft/ft |
| Soil DB Value | 0.10 | ft/ft |
| Rock Fragments | FROM SOIL DB | |
| Soil DB Value | 0.58 | ft³/ft³ |




**Notes**

Upper Deck at 20 to 1
Regional Slope at 0.05%
Rock Fragments from Soil DB

Edit Clear

**Barriers**

| | |
|---|---|
| N | none |
| S | none |
| E | none |
| W | none |

Edit Selected Barrier

| | | |
|---|---|---|
| Man | P | T | USEN Construction Management |
| Soil | P | T | Arizo_2053_15_STV_SL |

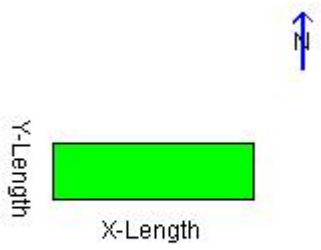
# Run Summary

REFERENCE 9

new run_66

| | | | | | |
|---|---|---|---|---|---|
| **Run Date:** | Wednesday, March 02, 2016, 05:03 PM | | | | |
| **Client Name:** | USEN | | | | |
| **Farm No:** | --- | **Tract No:** | Upper Deck | **Field No:** | --- |
| **Run Location:** | Runs | | | | |
| **Management:** | USEN Construction Management.man | | | | |
| **Soil:** | Arizo_2053_15_STV_SL.ifc | | | | |

## Location Site Information




| | | | |
|---|---|---|---|
| **X-Length:** | 1835.0 ft | **Mode:** | NRCS |
| **Y-Length:** | 516.1 ft | **Soil Loss Tolerance (T):** | 5.0 t/ac/yr |
| **Area:** | 21.7 ac | **Site:** | UNITED STATES<br>NEVADA<br>NYE |
| **Elevation:** | 2770.0 ft | **Location:** | 36.77° N, 116.69° W |
| **Orientation:** | 0.00 ° | **Cligen:** | AMARGOSA_VALLEY_4S(+) |
| | | **Windgen:** | MERCURY/DESERT ROCK |

## Erosion

| Period | Crop/Residue | Gross Loss t/ac | Net Soil Loss From Field ( t/ac ) Total | Creep/Salt. | Suspen. | PM10 |
|---|---|---|---|---|---|---|
| Rot. year: 1 | | 4.86 | 4.86 | 3.240 | 1.616 | 0.10305 |
| Ave. Annual | | 4.86 | 4.86 | 3.240 | 1.616 | 0.10305 |

## SCI Summary

| | | | | |
|---|---|---|---|---|
| **Soil Conditioning Index:** | -0.426 | | **SCI Subfactors** | |
| **Energy Calculator:** | 2.200 | gal diesel/ac | **OM:** | -1.000 |
| **Average Annual STIR:** | 61.425 | | **FO:** | 0.3918 |
| **Wind Erosion Soil Loss:** | 4.856 | t/ac | **ER:** | -0.9119 |
| **Water Erosion Soil** | 0.000 | t/ac | | |

## Rotation Stir Energy

| Date | Operation | Fuel | Stir | Energy Btu/ac | Cost USD/ac |
|---|---|---|---|---|---|
| Jan 01, 01 | Bulldozer, clearing-cutting | Diesel | 16.25 | 75,583 | 2.16 |

# Run Summary

REFERENCE 9

new run_66

## Rotation Stir Energy

| Date | Operation | Fuel | Stir | Energy Btu/ac | Cost USD/ac |
|---|---|---|---|---|---|
| Jan 01, 01 | Bulldozer, filling-leveling | Diesel | 5.20 | 75,583 | 2.16 |
| Jan 01, 01 | Disk, tandem heavy primary op | Diesel | 39.00 | 94,441 | 2.70 |
| Jan 01, 01 | Roller, smooth | Diesel | 0.98 | 31,431 | 0.90 |
| Jan 01, 01 | Begin weed growth | Diesel | 0.00 | 0 | 0.00 |
| | | **Total / ac** | | 277,038 | 7.92 |
| | | **Total** | 61.43 | 6,022,750 | 172.13 |

## Notes

Upper Deck at 20 to 1|Regional Slope at 0.05%|Rock Fragments from Soil DB

Project Run ViewOutput Configuration Tools Help

new run_67

REFERENCE 9

**Runs Location**

C:\Users\CBolin\Documents\WEPS Files\Runs

**Client Information**

| | |
|---|---|
| Client Name | USEN |
| Farm No | |
| Tract No | S. Slope |
| Field No | |

**Region**

| | | |
|---|---|---|
| Shape | Rectangle | |
| X-Length | 2190.0 | ft |
| Y-Length | 225.0 | ft |
| Area | 11.3 | ac |
| Orientation | 0.0 | ° |

**Location**

| | | |
|---|---|---|
| State: | NEVADA | |
| County: | NYE | |
| Latitude: | 36.77 N | ° |
| Longitude: | 116.69 W | ° |
| Elevation: | 2770 | ft |

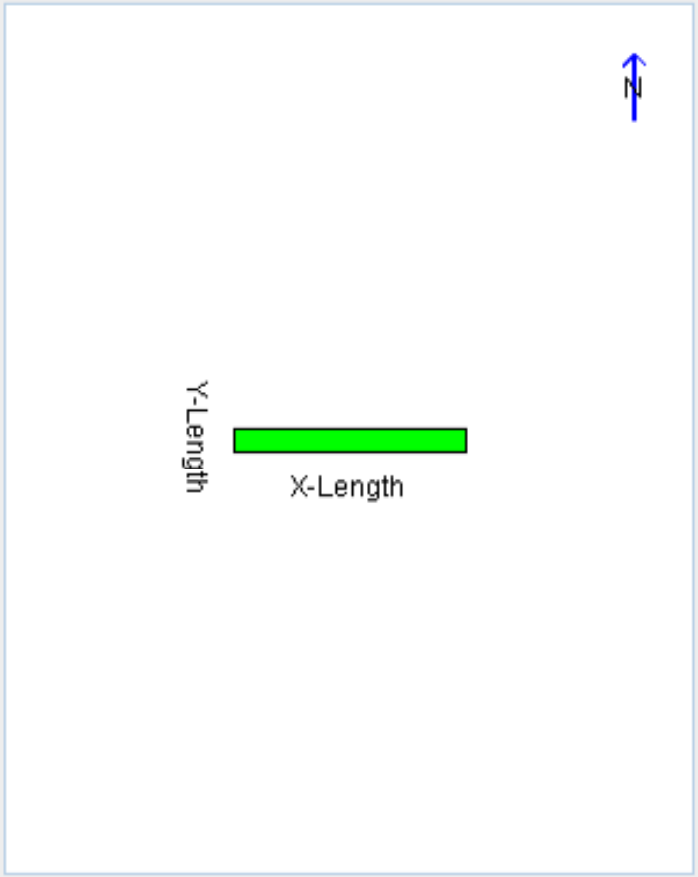
Cligen: < 100.0 mi
AMARGOSA VALLEY 4S(+) 20.4 mi ...

Windgen: < 150.0 mi
MERCURY/DESERT ROCK 38.8 mi ...

View Map

**Simulation**

| | | |
|---|---|---|
| Run Mode | NRCS | |
| Water Erosion | 0.00 | t/ac |
| Region Slope | 0.33 | ft/ft |
| Soil DB Value | 0.10 | ft/ft |
| Rock Fragments | FROM SOIL DB | |
| Soil DB Value | 0.58 | ft³/ft³ |




**Notes**

```
South Slope
Run Mode NRCS
Regional Slope = 0.33
Rock Fragments from Soil DB
Soil 2054
```

Edit Clear

**Barriers**

| | |
|---|---|
| N | none |
| S | none |
| E | none |
| W | none |

Edit Selected Barrier

| | | |
|---|---|---|
| Man | P T | Construction site |
| Soil | P T | Arizo_2053_15_STV_SL |

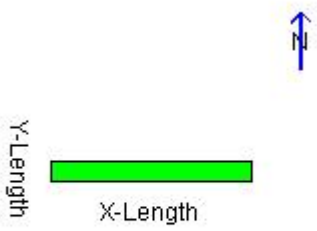
# Run Summary

REFERENCE 9

new run_67

| | | | | | |
|---|---|---|---|---|---|
| **Run Date:** | Wednesday, March 02, 2016, 05:09 PM | | | | |
| **Client Name:** | USEN | | | | |
| **Farm No:** | --- | **Tract No:** | S. Slope | **Field No:** | --- |
| **Run Location:** | Runs | | | | |
| **Management:** | Construction site.man | | | | |
| **Soil:** | Arizo_2053_15_STV_SL.ifc | | | | |

## Location Site Information




| | | | |
|---|---|---|---|
| **X-Length:** | 2190.0 ft | **Mode:** | NRCS |
| **Y-Length:** | 225.1 ft | **Soil Loss Tolerance (T):** | 5.0 t/ac/yr |
| **Area:** | 11.3 ac | **Site:** | UNITED STATES<br>NEVADA<br>NYE |
| **Elevation:** | 2770.0 ft | **Location:** | 36.77° N, 116.69° W |
| **Orientation:** | 0.00 ° | **Cligen:** | BEATTY 8 N |
| | | **Windgen:** | MERCURY/DESERT ROCK |

## Erosion

| Period | Crop/Residue | Gross Loss t/ac | Net Soil Loss From Field ( t/ac ) Total | Creep/Salt. | Suspen. | PM10 |
|---|---|---|---|---|---|---|
| Rot. year: 1 | | 3.99 | 3.99 | 2.993 | 0.993 | 0.05175 |
| Ave. Annual | | 3.99 | 3.99 | 2.993 | 0.993 | 0.05175 |

## SCI Summary

| | | | | |
|---|---|---|---|---|
| **Soil Conditioning Index:** | -0.357 | | **SCI Subfactors** | |
| **Energy Calculator:** | 2.200 | gal diesel/ac | **OM:** | -1.000 |
| **Average Annual STIR:** | 61.425 | | **FO:** | 0.3918 |
| **Wind Erosion Soil Loss:** | 3.987 | t/ac | **ER:** | -0.5696 |
| **Water Erosion Soil** | 0.000 | t/ac | | |

## Rotation Stir Energy

| Date | Operation | Fuel | Stir | Energy Btu/ac | Cost USD/ac |
|---|---|---|---|---|---|
| Jan 01, 01 | Bulldozer, clearing-cutting | Diesel | 16.25 | 75,583 | 2.16 |

# Run Summary

REFERENCE 9

new run_67

## Rotation Stir Energy

| Date | Operation | Fuel | Stir | Energy Btu/ac | Cost USD/ac |
|---|---|---|---|---|---|
| Jan 01, 01 | Bulldozer, filling-leveling | Diesel | 5.20 | 75,583 | 2.16 |
| Jan 01, 01 | Disk, tandem heavy primary op | Diesel | 39.00 | 94,441 | 2.70 |
| Jan 01, 01 | Roller, smooth | Diesel | 0.98 | 31,431 | 0.90 |
| Jan 01, 01 | Begin growth | Diesel | 0.00 | 0 | 0.00 |
| | | **Total / ac** | | 277,038 | 7.92 |
| | | **Total** | 61.43 | 3,134,705 | 89.59 |

## Notes

South Slope|Run Mode NRCS|Regional Slope = 0.33|Rock Fragments from Soil DB|Soil 2054|

Project Run ViewOutput Configuration Tools Help

new run_21

REFERENCE 9

**Runs Location**

F:\Data\143418 - USEN T13 Design\Design\Calculations\Erosion\Wind

**Client Information**

| | |
|---|---|
| Client Name | USEN |
| Farm No | |
| Tract No | East&West |
| Field No | |

**Region**

| | | |
|---|---|---|
| Shape | Rectangle | |
| X-Length | 300.0 | ft |
| Y-Length | 940.0 | ft |
| Area | 6.5 | ac |
| Orientation | 0.0 | ° |

**Location**

| | | |
|---|---|---|
| State: | NEVADA | |
| County: | NYE | |
| Latitude: | 36.77 N | ° |
| Longitude: | 116.69 W | ° |
| Elevation: | 2770 | ft |

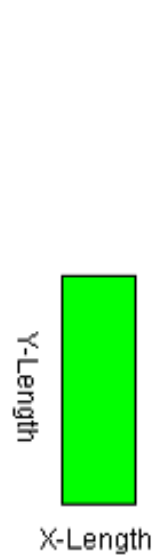
Cligen:
AMARGOSA_VALLEY_4S(+) 20.4 mi ...

Windgen: < 150.0 mi
MERCURY/DESERT ROCK 38.8 mi ...

View Map

**Simulation**

| | | |
|---|---|---|
| Run Mode | NRCS | |
| Water Erosion | 0.00 | t/ac |
| Region Slope | 0.33 | ft/ft |
| Soil DB Value | 0.10 | ft/ft |
| Rock Fragments | FROM SOIL DB | |
| Soil DB Value | 0.58 | ft³/ft³ |




**Notes**

```
East and West Slopes at 3 to 1
Regional Slope = 0.33
Rock Fragment from DB
```

Edit Clear

**Barriers**

| | |
|---|---|
| N | none |
| S | none |
| E | none |
| W | none |

Edit Selected Barrier

| | |
|---|---|
| Man | USEN Construction Management |
| Soil | Arizo_2053_15_STV_SL |

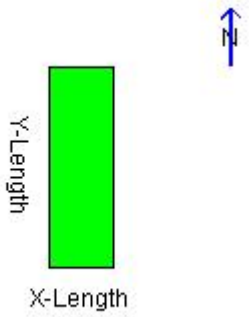
# Run Summary

REFERENCE 9

new run_21

| | |
|---|---|
| **Run Date:** | Wednesday, March 02, 2016, 04:45 PM |
| **Client Name:** | USEN |
| **Farm No:** | --- **Tract No:** East&West **Field No:**--- |
| **Run Location:** | F:\Data\143418 - USEN T13 Design\Design\Calculations\Erosion\Wind |
| **Management:** | USEN Revised Management.man |
| **Soil:** | Arizo_2053_15_STV_SL.ifc |

## Location Site Information




| | |
|---|---|
| **X-Length:** | 299.9 ft |
| **Y-Length:** | 940.0 ft |
| **Area:** | 6.5 ac |
| **Elevation:** | 2770.0 ft |
| **Orientation:** | 0.00 ° |

| | |
|---|---|
| **Mode:** | NRCS |
| **Soil Loss Tolerance (T):** | 5.0 t/ac/yr |
| **Site:** | UNITED STATES<br>NEVADA<br>NYE |
| **Location:** | 36.77° N, 116.69° W |
| **Cligen:** | AMARGOSA_VALLEY_4S(+) |
| **Windgen:** | MERCURY/DESERT ROCK |

## Erosion

| Period | Crop/Residue | Gross Loss t/ac | Net Soil Loss From Field ( t/ac ) Total | Creep/Salt. | Suspen. | PM10 |
|---|---|---|---|---|---|---|
| Rot. year: 1 | | 4.19 | 4.19 | 3.000 | 1.188 | 0.07182 |
| Ave. Annual | | 4.19 | 4.19 | 3.000 | 1.188 | 0.07182 |

## SCI Summary

| | | | | |
|---|---|---|---|---|
| **Soil Conditioning Index:** | -0.373 | | **SCI Subfactors** | |
| **Energy Calculator:** | 2.200 | gal diesel/ac | **OM:** | -1.000 |
| **Average Annual STIR:** | 61.425 | | **FO:** | 0.3918 |
| **Wind Erosion Soil Loss:** | 4.189 | t/ac | **ER:** | -0.6492 |
| **Water Erosion Soil** | 0.000 | t/ac | | |

## Rotation Stir Energy

| Date | Operation | Fuel | Stir | Energy Btu/ac | Cost USD/ac |
|---|---|---|---|---|---|
| Jan 01, 01 | Bulldozer, clearing-cutting | Diesel | 16.25 | 75,583 | 2.16 |

# Run Summary

REFERENCE 9

new run_21

## Rotation Stir Energy

| Date | Operation | Fuel | Stir | Energy Btu/ac | Cost USD/ac |
|---|---|---|---|---|---|
| Jan 01, 01 | Bulldozer, filling-leveling | Diesel | 5.20 | 75,583 | 2.16 |
| Jan 01, 01 | Disk, tandem heavy primary op | Diesel | 39.00 | 94,441 | 2.70 |
| Jan 01, 01 | Roller, smooth | Diesel | 0.98 | 31,431 | 0.90 |
| Jan 01, 01 | Begin weed growth | Diesel | 0.00 | 0 | 0.00 |
| | | **Total / ac** | | 277,038 | 7.92 |
| | | **Total** | 61.43 | 1,792,636 | 51.23 |

## Notes

East and West Slopes at 3 to 1|Regional Slope = 0.33|Rock Fragment from DB