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# CALCULATION SUMMARY SHEET



PROJECT NUMBER: 143418

PROJECT NAME: USEN – Trench 13 Design

DATE: September 12, 2014

CALCULATION NUMBER: C.12 Revision: 1 (March 31, 2016)

**CALCULATION TITLE: Final Cover Erosion by Water**

**DESCRIPTION OF CALCULATION:**

This calculation determines the rate of soil cover erosion from Trench 13 surfaces

**REFERENCES USED:**

1. RUSLE2 Version 2.5.6.7.7 (November 6, 2015)
2. Soils Map – Nye County Southwest – US Ecology Facility and Vicinity - USDA
3. Soils Properties 2053 Yermo-Greyeagle-Arizo
4. Particle Distribution for Trench 11 Cover - 2013
5. Particle Distribution for Trench 11 Cover - 2016
6. Design Drawings for Cover Slope of Trench 13
7. RUSLE2 Model Inputs and Outputs
8. NOAA Atlas 14, Volume 1, Version 5, Amargosa Farms Precipitation Frequency
9. Trench 13 Final Cover Basin Delineation and Final Cover Details
10. Technical Release - 55 Model Runs and Summary
11. Hydraulic Design Manual. Texas DOT. August 2015.

**REVIEW COMMENTS:**

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|---|---|---|---|
| CALCULATION MADE BY: | CWK | DATE: | 04/09/2015 |
| CALCULATION CHECKED BY: | CAB | DATE: | 05/15/2015 |
| CALCULATION REVISED BY: | CWK | DATE: | 05/22/2015 |
| CALCULATION REVIEWED BY: | PAZ | DATE: | 06/16/2015 |

## CALCULATION

## RATE OF SOIL COVER EROSION

### PURPOSE

This calculation estimates water erosion from the proposed final cover design of Trench 13 at the US Ecology Beatty Facility. The calculation evaluates necessary armoring or lining criteria for drainages.

### APPROACH

1. Analyze sheet flow on the upper 20H:1V top deck and 3H:1V sideslopes of the proposed final cover for Trench 13 using The Revised Universal Soil Loss Equation (RUSLE). RUSLE is used to calculate the expected soil loss based on soil properties, rainfall, slopes and ground cover. Calculated soil loss is compared to the USEPA recommendations for maximum erosion rate (of 2 tons per acre per year)[1] for a landfill cover and soil tolerance values assigned by the NRCS (of 5 tons per acre per year for site soils).
2. Evaluate the shear stresses developed by sheet flow on the sideslopes.
3. Model concentrated flow in upper deck flumes, sideslope lateral drainages, sideslope flumes, and access road drainages using USDA's Technical Release 55 (TR-55) program and using Mannings equations for open channel flow.
4. Evaluate the shear stresses developed by channelized flow in upper deck flumes, sideslope lateral drainages, sideslope flumes, and access road drainages.

### RUSLE2 EVALUATION OF SHEET FLOW

The 2015 version of the U.S. Natural Resources Conservation Service (NRCS) Revised Universal Soil Loss Equation, Version 2 (RUSLE2) modeling software was used for the analysis (**Reference 1**). RUSLE2 software estimates soil loss, sediment yield, and sediment characteristics from rill and inter-rill (sheet and rill) erosion caused by rainfall and its associated overland flow. RUSLE2 uses factors that represent the effects of climatic erosivity (climatic causes of soil erosion), soil erodibility, topography, cover-management and support practices to compute erosion. The RUSLE equation used by the software is:

$$A = RKLSCP$$

Where

A = computed average annual soil loss

R = rainfall runoff erosivity factor

K = soil erodibility factor

LS = length-slope factor

C = cover management factor

P = supporting practices factor

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

The use of the RUSLE2 computer model allows the user to upload region-specific database information instead of manual determination of the above factors. The following two databases were downloaded from the RUSLE2 NRCS Database web page[2] for modeling the Beatty site.

1. Climate Data (NV climate120303.zip)
2. Soils Data (Nye SW, 785.gdb)

To account for the effects of construction activities on cover erosion, a Construction Site Management template was developed based on representative 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 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 7**).

Using the NRCS database inputs and the Construction Site Management template provides the model with appropriate sources for the above factors, R, K, C, and P. Slope angle and length are site-specific inputs added by the user.

The first input for RUSLE2 is climate, which is based on the location input. For the US Ecology Beatty facility, the location "USA\Nevada\Nye County\NV_Nye R3" was chosen. Values for the climate of Nevada Nye R3 were imported into RUSLE2.

The soil survey for Nye County Southwest Part was used to determine the soil types prevalent in the vicinity of the US Ecology Facility (**Reference 2**). Soil type was selected based on soil particle distribution samples collected from the Trench 11 and compared to soil characteristics provided by NRCS. The NRCS soils map, provided as **Reference 2**, identifies shallow soils to several feet below grade. Because the final cover is a mix of soils from the ground surface to 75 feet below grade, the native surface soils are not necessarily the best representative soil for use to model performance of the final cover, the subject of Calculation C.12. Soil type 2054 Yermo, Hot-Yermo-Arizo Association is the prevalent soil type at the surface, as identified on the soil survey map included as **Reference 2**; However, soil type 2053 Yermo-Greyeagle-Arizo has a description and grain distribution believed closer to that used on the cover of Trench 11, and expected for use on Trench 13. The 2053 Yermo-Greyeagle-Arizo is located at higher energy locations of the alluvial fan that is the geomorphic feature upon which the USEN facility is located. The NRCS- database soil characteristics for the 2053 Yermo-Greyeagle-Arizo Association are provided as **Reference 3** and the soil characteristics of Trench 11 in-place cover soils are provided as **References 4 and 5**.

Values for 2053 Yermo-Greyeagle-Arizo were imported as a database file in RUSLE2. It should be noted that actual soils used on Trench 11 and anticipated for use on Trench 13 did have higher percentage of sand and gravels and lower percentage of silts and clays then specified for the 2053 Yermo-Greyeagle-Arizo.

RUSLE2 modeling of the Trench 13 final cover considered two slope orientations. The longest slope length for each slope type (i.e., 5%, 33%) was assumed as a worst case scenario. See **Reference 6** for the longest slope length applicable to each slope segment and the corresponding length used in the RUSLE2 model.

| Slope (ft/ft) | Slope Length (Horizontally) | Slope Length (Along Slope) |
|---|---|---|
| 20:1 or 5% upper deck | 200 | 200 |
| 3:1 or 33% (north slope) | 100 | 110 |

[2] http://www.ars.usda.gov/Research/docs.htm?docid=6010

RUSLE2 allows the user to specify slope contouring. The "no contouring" option was chosen.

The results of these analyses are shown on the attached "RUSLE2 Erosion Calculation Record" sheets (**Reference 7**) and are summarized below:

| Orientation- | Soil Loss (tons/acre/year) |
|---|---|
| 3:1 slope | 1.9 |
| 20:1 slope | 0.23 |

Both erosion rates are less than the 2 tons per acre per year USEPA-recommended maximum rate[1]. The soil loss tolerance value assigned by NRCS as a standard for protecting soil as natural resource, is 5 tons per acre per year[3] for the 2053 Yermo-Greyeagle-Arizo association. The calculated values are below the NRCS soil loss tolerance value.

**SHEER STRESS EVALUATION OF SHEET FLOW ON SIDESLOPES**

Sheet flow runoff depth experienced across the landfill cover is primarily a function of the storm intensity, flow length, infiltration losses, and steepness. The 100-year, 1-hour storm event at the facility is 1.44 inches as determined by the National Oceanic and Atmospheric Administration (NOAA, 1973), NOAA Atlas 14, Volume 1, Version 6, Amargosa Farms and is included as **Reference 8**. For the 3H:1V sideslopes with a flow length of 100 feet, and an estimated infiltration loss of 80% (20% runoff), then the maximum sheet flow depth is calculated to be approximately 0.05 inches (assuming a flow velocity of approximately 10 ft/min) at the worst case location where sheet flow enters lateral sideslope drainages incorporated into the Trench 13 design. Lower intensity storms would result in a shallower flow depth.

$$Flow\ depth = \frac{Runoff * Storm\ Intesity * \ Slope\ length}{Velocity}$$

$$Flow\ depth = \frac{20\% * ((1.44\ in\ precip)/hr) * (1\ ft)/(12\ in) * 100\ ft\ slope\ length}{10\frac{ft}{min} * 60min/hr} = 0.004 \text{ ft or } 0.05 \text{ in}$$

The recommended EPA guidance document (EPA 909-R11-007)[4] indicates that tractive force analysis is performed by comparing the effective shear stress (applied by runoff) against the allowable shear stress (of the exposed surface). In cases where barren (non-vegetated) surfaces are considered, the effective shear stress applied by the flowing water is equal to:

Shear Stress, $t_e$ = Unit wt water (pcf) * Depth (ft) * Slope

The magnitude of tractive forces associated with sheet flow regimes on the final cover are presented in the following Table. It should be noted that application of shear stress evaluation is best suited for open channel evaluation and not sheet flow.

| Applied Shear Stresses | | | |
|---|---|---|---|
| Flow Regime | Flow Depth (in) | Gradient | Shear Stress (psf) |
| Sheet Flow – 20H:1V Upper Deck | 0.05 | 0.05 | 0.01 |
| Sheet Flow – 3H:1V Sides | 0.05 | 0.33 | 0.09 |

It is acknowledged that minor surface erosion will occur in a large scale (i.e., "global") manner across the completed surface planes of the landfill cover. This global erosion will occur as a result of rain impact, wind

[3] Revised Universal Soil Loss Equation Version 2 (RUSLE2) Handbook. Prepared by the USDA RUSLE Development Team. March 2001.
[4] EPA-909-R-11-007.2011, Closing Small Tribal Landfills and Open Dumps

events, and the effects of sheet flow. The rate of global erosion will be highest immediately after construction when fine particles constitute a substantial fraction of the exposed surface. Recent visual inspections of the Trench 11 cover (2.5 years after construction) reveal that the exposed surface has undergone a natural armoring process, where fine sediments at the surface tend to be blown or washed away and a coarser, more resistant fraction of aggregates (coarse sand and gravel particles) remain exposed to the elements. The rate of global erosion is retarded by the presence of the armored surface, so long as the surface remains undisturbed.

USEN recently attempted to quantify the extent of this natural armoring process, which has occurred on the Trench 11 cover since initial construction in 2013. Surface samples were obtained from four locations in February 2016 for the purpose of determining the gradation of the armored surface. However, these samples were obtained by gathering aggregates located in the upper 2 inches and consequently still included a significant fraction of the underlying fines. The resulting gradations are indicative of increased coarseness (average $D_{50}$ of 0.13 inches (average of 2016 samples) rather than 0.08 inches (average of 2016 samples), but still do not correlate with the concentrated coarse fraction that was visibly present across the armored surface. The 2013 and 2016 soil particle size distribution curves are provided as **References 4** and **5**. The natural armoring process progressively achieves a steady state when the exposed surface approaches the critical particle size associated with each respective storm event. From the Table above (assuming the 100-year, 1-hour storm event) and extrapolating from values provided in **Reference 11**, final cover soil with a $D_{50}$ of approximately 0.25 inch provides good protection from damaging shear stress. Once a steady state condition is achieved then subsequent storms of similar magnitude will result in negligible amounts of global erosion.

**TR-55 EVALUATION OF UPPER DECK BERMS, SIDESLOPE LATERAL DRAINAGES, AND SIDESLOPE FLUMES**

Design Criteria:

- Design to 100 year/24 hour precipitation event (TR-55 does not accept the 1-hour event).
- Flumes and drainages should have a velocity of 2 feet per second to promote self-cleaning.
- Flume and drainages should include 1.0 foot of freeboard.

On January 28, 2016, USEPA requested that the Trench 13 final cover surface-water management features be designed to manage precipitation from the 100-year, 1-hour storm event. The 100-year, 1-hour storm event is estimated at 1.44 inches of precipitation as determined by the National Oceanic and Atmospheric Administration (NOAA, 1973), NOAA Atlas 14, Volume 1, Version 6, Amargosa Farms and is included as **Reference 8**. The TR-55 modeling software accepts inputs for 24-hour precipitation event, thus, the 100-year, 24-hour precipitation event, estimated at 3.13 inches of precipitation (**Reference 8**) was used.

Basin delineations are determined by the final topography of Trench 13. The basin delineations are presented in **Reference 9**.

The TR-55 Model was used to calculate surface-water run-off volume and peak rate of discharge for small watersheds using two independent hydrologic soil groups. A description of the TR-55 procedure was provided in Calculation C.01. In addition, surface water management features, for Facility drainages, are further described and evaluated in Calculation C.01 and are necessary to route surface-water once it leaves the Trench 13 final cover, and at interim stages, during subsurface operations, as operations proceed above grade, and following final cover placement.

The Trench 13 final cover will incorporate surface water management features such as berms, sideslope lateral drains, and flumes shown in plan view and in details included in **Reference 9**. All management features were evaluated using discharge information from the TR-55 model for a 100-year 24-hour precipitation event included in **Reference 10**. Evaluations of management features included water stage height and velocity during maximum flow conditions.

**Upper Deck Berms**

A series of berms will be incorporated on the upper deck (20:1) slopes of the Trench 13 final cover. The purpose of the berms is to limit sheet flow on the upper decks, and prevent concentrated run-off in areas when it could potentially cause scour when released down the 3:1 sideslopes. The berms will incorporate a layer of armoring to prevent scour at locations of concentrated flow. Upper deck run-off control berms will be oriented to direct flow to the protected flumes on the sideslopes which will carry run-off from the final cover. Upper deck berms will be 2 feet in height and at a cross-gradient slope of 1%.

**Upper Deck Flumes**

Flumes will be installed on the upper deck to transport surface water to the 3:1 sideslopes and off the final cover. Flumes will be armored to reduce infiltration of the concentrated flow and to prevent scour of the final cover. Flumes on the upper deck include two 2-foot berms separated by a 4 foot flume bottom width.

Analysis was completed using the TR-55 software to determine the maximum discharge the upper deck flume would receive in a 100-year precipitation event. The Final Cover Upper Deck Middle West (FC-UD-MW) Basins combine to cause the highest run-off (**Reference 9**) and cover approximately 5.16 acres of the upper deck. The TR-55 evaluation of the multiple basins contributing to the upper deck flume predicts a maximum flow of **3.2 cubic feet per second** (cfs) in a 100-year/24-hour precipitation event.

A hydraulic analysis was performed to determine water stage height and velocity in the Upper Deck Flumes, using Manning's Equation for open channel flow.

Manning's Equation is:

$$Q/_A = V = \frac{k}{n} R_h^{\frac{2}{3}} S^{\frac{1}{2}}$$

Where:

$Q$= Flow [ $\frac{ft^3}{sec}$ ]
$A$= Cross Sectional Area [ $ft^2$]
$V$= Velocity [ $\frac{ft}{sec}$ ]
$K$= Conversion Factor = 1.4859
$R_h$ = A / Wp = Hydraulic Radius [ft]
$Wp$= Wetted Perimeter [ft]
$S$= Slope [ $\frac{ft}{ft}$ ]
$n$=Manning's Coefficient [unit-less]

Flume Conditions:

- Trapezoidal channel
- Base of 4 ft
- Sideslope at 3 to 1
- Flume slope of 5%
- Manning's Number of 0.023

Analysis yields a water stage height of **2.1 inches** and a velocity of **4.3 feet per second** (fps). Values indicate that the channel geometry provides greater than 1 foot of free board and sufficient velocity to be self-cleaning.

**Sideslope Lateral Drains**

Lateral drains (benches) will be installed on the sideslope (3:1) portion of the Trench 13 final cover to collect sheet flow run-off and transport it to the sideslope flumes. Lateral drains will limit sheet flow at any point

on the Trench 13 sideslopes to approximately 100 feet to limit concentrated flow which could potentially damage and scour the final cover.

Analysis was completed using the TR-55 software to determine the maximum discharge the sideslope lateral drain would receive in a 100-year/24-hour precipitation event. Final Cover Basin 3A (FC-3A) was chosen because it collects sheet flow from the largest sideslope area, approximately 1.35 acres. TR-55 predicts a maximum discharge of **0.84 cfs**.

A hydraulic analysis was performed to determine water stage height and velocity in FC-3A's lateral drain.

Drainage Conditions:

- Triangular channel
- Sideslope at 3 to 1
- Drainage slope of 2%
- Manning's Number of 0.023

Using Manning's Equation for open channel flow, analysis yields a water stage height of **4.2 inches** and a velocity of **2.7 fps**. Values indicate that the channel geometry provides greater than 1 foot of free board and sufficient velocity to be self-cleaning.

**Sideslope Flumes**

Flumes will be installed on the sideslope (3:1) portion of the Trench 13 final cover to transport surface-water run-off from the upper deck and sideslope lateral drains to the toe of the final cover. Flumes placed on the sideslopes will consisted of two 2-foot sidewalls separated by a 4 foot wide flume base.

Analysis was completed using the TR-55 software to determine the maximum discharge the sideslope flume would receive in a 100-year precipitation event. Final Cover South West (FC-SW) basins were chosen because it collects the largest area of the Trench 13 upper deck and sideslope, approximately 4.69 acres and 3.39 acres, respectively; collecting a total area of 8.08 acres. The TR-55 evaluation of the multiple basins contributing to the sideslope flume predicts a maximum flow of **5.0 cfs** in a 100-year/24-hour precipitation event.

A hydraulic analysis was performed to determine water stage height and velocity in the sideslope flume.

Flume Conditions:

- Trapezoidal channel
- Base of 4 ft
- Sideslope at 3 to 1
- Flume slope of 33%
- Manning's Number of 0.036

Using Manning's Equation for open channel flow, analysis yields a water stage height of **2.0 inches** and a velocity of **6.8 fps**. Values confirm that the channel geometry provides greater than 1 foot of free board and sufficient velocity to be self-cleaning. Energy dissipation structures will be necessary at the base of the Flumes. These structures might include shallow rip-rap channels or concrete barriers.

**Access Road Ditch**

Access roads are incorporated in the Trench 13 design, and act as drainage channels for sideslope basins. Access roads are approximately 18 feet wide and have a 5% cross-gradient into the sideslope. The access road includes a 1-foot deep and 6-foot wide triangular ditch with 3H:1V sides.

The access road ditch was evaluated using TR-55 to determine the maximum discharge the maximum discharge in a 100-year/24 hour precipitation event. The access road varies in grade between 5% and

10%. Basins contributing to the access road ditch have a total area of 2.39 acres. The TR-55 evaluation of these basins determined a maximum discharge of **1.5 cfs** during a 100-year/24-hour precipitation event.

A hydraulic analysis was performed to determine maximum water stage height and velocity in the access road ditch.

Drainage Conditions:

- Triangular channel
- Sideslope at 3 to 1
- Drainage slope of 5% and 10%
- Manning's Number of 0.036

Using Manning's Equation for open channel flow, analysis yields a water stage height of **4.9 inches** and a velocity of **3.1 fps** at 5% road grade and **4.3 inches** and a velocity of **4.0 fps** at 10% road grade. All values confirm that the access road ditch geometry provides greater than 1 foot of free board (when the cross-grade of the road is included) and sufficient velocity to be self-cleaning.

**SHEAR STRESSES OF CHANNELIZED FLOW ALONG UPPER DECK BERMS, IN SIDESLOPE LATERAL DRAINAGES, AND IN SIDESLOPE FLUMES.**

The tractive force exerted by sheet flow regimes are minimal in comparison to the forces associated with concentrated flow. The potential destructive forces of concentrated flow emphasizes the importance of fostering sheet flow across each of the finished surfaces, intercepting sheet flow before it is likely to transition into concentrated flow, and the need to provide armored drainages and flumes, which are designed to convey the concentrated flows off the landfill cover.
Four drainages are evaluated including:

- Upper deck berms are designed with a typical gradient of 0.01.
- Lateral drainages are designed with a typical gradient of 0.02 and will require protective armoring.
- Flume channels will have a typical gradient of 0.33 and will require protective armoring.
- Access road drainages are designed at 5% and 10% grade (0.05 and 0.10 gradient) and will require protective armoring.

The potential tractive forces within these lateral drainages and flumes are identified below, based upon drainage flow depth resulting from a 100-year/24-hour precipitation event.

| **Applied Shear Stress – Typical Ditches and Flumes** | | | |
|---|---|---|---|
| **Flow Regime** | **Flow Depth** (in) | **Gradient** | **Shear Stress** (psf) |
| Upper Deck Flumes | 2.1 | 0.05 | 0.55 |
| Sideslope Lateral Drains | 4.2 | 0.02 | 0.44 |
| Sideslope Flumes | 2.0 | 0.33 | 3.4 |
| Access Road Ditch at 5% | 4.9 | 0.05 | 1.3 |
| Access Road Ditch at 10% | 4.3 | 0.10 | 2.2 |

Literature published by the Texas Department of Transportation (TxDOT) provides some guidance regarding the maximum potential tractive force that various aggregates or lining materials are able to withstand (TxDOT, Hydraulic Design Manual, August 2015). The following guidance was extracted from this literature.

| **Permissible Shear Stress - Various Materials** | |
|---|---|
| **Protective Cover** | **Allowable Stress** (psf) |
| Gravel, $D_{50}$ = 1 in | 0.40 |
| Gravel, $D_{50}$ = 2 in | 0.80 |
| Gravel, $D_{50}$ = 6 in | 2.50 |
| Gravel, $D_{50}$ = 12 in | 5.00 |
| Soil Cement (comparable to grouted aggregates) | >45 |

This guidance indicates that:

- Gravel aggregates exhibiting a $D_{50}$ particle size of 2 inches or greater can be used to line the upper deck flumes and sideslope lateral drainages.
- Gravel aggregates exhibiting a $D_{50}$ particle size of 6 inches or greater can be used to line the access road drainages.
- Large riprap aggregates (up to 12 inches in diameter) are required in steep flume channels and in 10% grade access road drainages. Interstitial cement grout should be added if additional stability is desired.

**CONCLUSION**

Sheet flow was analyzed on the 20H:1V upper deck and 3H:1V sideslopes of Trench 13 using The Revised Universal Soil Loss Equation (RUSLE). Maximum calculated soil loss values of 0.23 tons per acre-year on 20H:1V and 1.9 tons per acre-year on 3H:1V slopes were less than the USEPA recommendations for a maximum erosion rate for a landfill cover of 2 tons per acre-year, and less than soil tolerance values assigned by the NRCS of 5 tons per acre per year for site soils.

Sheet flow shear stresses were evaluated on the 20H:1V upper deck and 3H:1V sideslopes of Trench 13 and found to be approximately 0.01 psf and 0.09 psf, respectively, when considering a 100-year 1-hour precipitation event. Extrapolating from the literature values suggests that a soil surface texture with a $D_{50}$ of 0.25 inch can withstand shear stresses of 0.1 psf. Current surface soils on Trench 11 show a natural armoring that is approaching a $D_{50}$ of 0.25 inch, based on visual classification methods (ASTM D2487)..

The upper deck flumes, sideslope lateral drainages, sideslope flumes, and access road drainages were evaluated using USDA's Technical Release 55 (TR-55) program and using Manning's equations for open channel flow. Based on the evaluation, the anticipated run-off depths are sufficient to provide over 1.0 foot of freeboard and the velocities are large enough to promote self-cleaning of the drainages. The following summarizes the analysis.

| | Max Flow Rate (cfs) | Max Depth (in) | Freeboard (ft) | Max Velocity (fps) |
|---|---|---|---|---|
| Upper Deck Flume | 3.2 | 2.1 | >1.5 | 4.3 |
| Sideslope Lateral Drainage | 0.84 | 4.2 | >1.5 | 2.7 |
| Sideslope Flume | 5.0 | 2.0 | >1.5 | 6.8 |
| Access Road Drainage at 5% | 1.5 | 4.9 | >1.5 | 3.1 |
| Access Road Drainage at 10% | 1.5 | 4.3 | >1.5 | 4.0 |

Shear stresses were evaluated for channelized flow along upper deck flumes, sideslope lateral drainages, sideslope flumes, and along access road ditches. The analysis has concluded that:

- Gravels with a $D_{50}$ of 2 inches are appropriate for use as a protective lining in upper deck flumes and berms, and in sideslope laterals;
- Gravels with a $D_{50}$ of 6 inches are appropriate for access road drainages; and
- Gravels with a $D_{50}$ of 12 inches are appropriate for use on sideslope flumes.

Grout or cement applications to any of the above protective measures would increase the allowable stresses.

REFERENCE 1

# Revised Universal Soil Loss Equation Version 2

# (RUSLE2)

# HANDBOOK

Prepared by the USDA RUSLE Development Team:

March 2001

**ABOUT RUSLE2**

The structure of the revised universal soil loss equation **RUSLE2** is based on the Universal Soil Loss Equation (USLE), which is given by:

**A = R K L S C P**

where **A** = average annual soil loss from rill and interrill erosion caused by rainfall and its associated overland flow (tons $ac^{-1}$ $yr^{-1}$), **R** = the factor for climatic erosivity, **K** = the factor for soil erodibility measured under a standard condition, **L** = the factor for slope length, **S** = the factor for slope steepness, **C** = the factor for cover-management, and **P** = the factor for support practices. A value for soil loss **A** is computed by selecting values for each factor and multiplying them.

These factors represent the effect of climate, soil, topography, and land use on rill and interrill erosion. By assigning values to these factors based on site-specific conditions, the USLE computes soil loss for specific sites, and it can be used to guide conservation planning tailored to individual field sites.

RUSLE1 was a revision and update of the Universal Soil Loss Equation (USLE), which has been widely used since the early 1960s. The first version of the USLE was described in Agriculture Handbook No. 282, published in 1965. The second major version of the USLE was described in Agriculture Handbook No. 537, published in 1978. RUSLE1 is the third version of the USLE, and it is described in Agriculture Handbook No. 703, published in 1998 by the U.S. Department of Agriculture, Washington, D.C. RUSLE1 retained the equation structure of the USLE, but each factor was either updated with recent data, or new relationships were derived based on modern erosion theory and data.

The major fundamental difference between **RUSLE2** and the USLE and RUSLE1 is in the method used to solve governing equations. Mathematical approximations were used in the USLE and RUSLE1 to integrate time varying equations that underlie the erosivity, topographic, erodibility, cover-management, and supporting practices factors. These approximations were used to produce a simple, powerful, method to compute soil loss that could be used in a “paper version” form in field offices. RUSLE1 was also available in a computer program.

**RUSLE2** uses a much more detailed and proper mathematical approach to integrate the underlying governing equations, which makes **RUSLE2** more powerful and accurate for many conditions than either the USLE or RUSLE1. The increased complexity of the mathematical procedures used in **RUSLE2** requires that **RUSLE2** be used as a computer program rather than in a paper version. If a paper version of **RUSLE2** is to be used, its values should be based on computations using **RUSLE2** rather than continuing to use RUSLE1. An appendix to this User Guide describes differences between the USLE, RUSLE1, and **RUSLE2**.

**RUSLE2** uses a hybrid approach that combines empirically derived equations with those derived from theory for erosion processes to estimates rates of rill and interrill erosion. The underlying structure of **RUSLE2** uses empirical indices for the major factors that affect rill and interrill erosion. The governing equations for these indices are derived both from an analysis of empirical

data and from modern theory for erosion processes and mechanics. More than 10,000 plot-years of data from natural runoff plots and an estimated equivalent 2,000 plot-years of rainfall simulator data were used in the derivation and validation of **RUSLE2**. It is an exceptionally well-validated erosion prediction technology that has been proven by more than four decades of use of its predecessors, the USLE and RUSLE1. Modern theory on erosion processes of detachment, transport, and deposition of soil particles by raindrop impact and surface runoff was used to derive several of the **RUSLE2** relationships where the necessary equations could not be derived from empirical data.

A strength of **RUSLE2** is that it has been developed by a group of experienced and nationally recognized erosion scientists and conservationists. Data needed to develop and validate **RUSLE** were not complete in all cases, which necessitated using judgement of both scientists and users of the equation to fill gaps. In addition, **AH703** and publications on various RUSLE components have been reviewed by peer scientists in a process typical of the reporting of rigorous research results. Erosion scientists and NRCS technical specialists have made many runs with **RUSLE2** to ensure that it works well for every imaginable condition where **RUSLE2** will be applied. The scientific documentation for **RUSLE2** will be peered reviewed according to USDA standard procedures. Thus **RUSLE2** can be used with full confidence that the equation meets high scientific standards.

**RUSLE2** is to be used as a guide to conservation planning rather than as a precise estimator of soil loss. It represents the main trends demonstrated in field data, but the accuracy of **RUSLE2** estimates varies depending on the magnitude of the soil loss, land use, and other factors. Uncertainty in **RUSLE2** estimates is discussed in a later section. While **RUSLE2** is based on modern erosion science and includes numerous features never before used in applied erosion prediction technology, it is not designed for research purposes.

Numerous erosion variables are computed by **RUSLE2** depending on how the landscape is represented for a **RUSLE2** computation. The basic application is to a hillslope profile defined as the path from where overland flow originates to where it enters a major flow concentration. **RUSLE2** can consider the effect of conditions varying along the hillslope profile, including those related to steepness, soil, and cover-management conditions. In addition to computing rill and interrill erosion on the eroding portions of hillslopes, it also computes the deposition that occurs on hillslope segments induced by changes in topography and cover-management conditions. The main erosion variables computed by **RUSLE2** are sediment yield from the hillslope profile, total sediment detached on the hillslope profile, soil loss from eroding portions of the hillslope profile, and a conservation planning soil loss that takes in account amount and location of deposition on the hillslope profile. **RUSLE2** also computes erosion and deposition rates along a hillslope profiles. The sediment yield computed by **RUSLE2** is not necessarily the sediment yield from a field or watershed unless the end of the hillslope profile happens to end at the field or watershed boundary.

Several important terms are used with **RUSLE** to describe the erosion process. In the mid-1940's, W. D. Ellison defined erosion as, "... a process of detachment and transport of soil particles." Detachment is the removal of soil particles from the soil mass and is expressed in units like tons $ac^{-1}$. Once soil particles are removed from the soil mass, these particles are referred to as sediment. The movement of sediment downslope is sediment transport, and a measure of

sediment transport is sediment load. Sediment load is expressed in units like lbs./(ft width of slope)$^{-1}$. The sediment load at the end of the hillslope profile is defined as sediment yield.

Sediment load on a hillslope profile increases with distance downslope where detachment is occurring. That is, detachment adds to the sediment load. Conversely at locations where runoff is slowed like at the toe of concave slopes or by strips of dense vegetation, deposition occurs, transfers sediment from the sediment load to the soil mass. That is, deposition removes sediment from the sediment load, and sediment accumulates on the soil surface. Deposition is a selective and sorting process. When deposition occurs on a portion of a landscape, coarse sediment is deposited in the depositional area and fine sediment remains in the sediment load that is transported downslope. The size of the particles in the sediment load downslope from the depositional area is finer than the particles in the sediment load upslope from the depositional area and finer than the particles in the soil where the sediment was originally produced by detachment. Sediment yield from a landscape experiencing deposition is enriched in fines in relation to sediment from a similar area not experiencing deposition.

**RUSLE2** computes values for the size of sediment classes and the distribution of the sediment among classes based on soil texture and the degree that deposition has reduced the sediment load. **RUSLE2** computes deposition using equations for transport capacity and deposition mechanics as a function of runoff hydraulics and sediment characteristics and how these variables change along a hillslope profile. For example, **RUSLE2** takes in account how the sediment load becomes progressively finer as deposition occurs along a concave slope.

Two types of deposition, remote and local, occur. Remote deposition is that deposition that occurs some distance away from the origin of the sediment. Deposition on the toe of a concave slope, on the upper side of vegetative strips, and in terrace channels is an example of remote deposition. Local deposition is where sediment is deposited very near, within several inches, of where it was detached. Deposition in micro-depressions and in low gradient furrows is an example of local deposition. The difference between detachment and local deposition is called net detachment. Full credit for soil saved is taken in **RUSLE2** for local deposition, but the credit given to remote deposition as soil saved depends on the location of the deposition. Sediment deposited at the end of a hillslope profile is given very little credit as soil saved.

**RUSLE2** computes soil loss as the amount of net amount of sediment produced on a segment of the hillslope profile divided by the length of the segment. Typical units are tons ac$^{-1}$. **RUSLE2** also computes sediment load (delivery) at locations along the hillslope profile at ends of segments. These values as computed as sediment load at a given location divided by the slope length to that location. Typical units are tons ac$^{-1}$.

**RUSLE2** is principally used to estimate the rate that erosion is removing soil from critical parts of the landscape and to guide the choice of conservation practices to control erosion to a "soil loss tolerance" level. Soil loss tolerance is the average erosion rate that can occur with little or no long-term degradation of the soil. Soil loss tolerance, or **T**, values have been assigned by the NRCS to major soils in the US. Typical values of **T** range from 3 to 5 tons ac$^{-1}$ yr$^{-1}$ with some values as low as 1 ton ac$^{-1}$ yr$^{-1}$ for lands where the soil is very fragile.

In a typical application, RUSLE2 computes soil loss values based on site-specific values for the main variables that affect rill and interrill erosion based. These values are related to climatic

erosivity at the location, erodibility of the soil based on soil survey information, length and steepness of the hillslope profile representing the critical portion of the site, and land use. If the computed soil loss is less than the **T** value, control of rill and interrill erosion is assumed to be adequate. If computed soil loss exceeds the **T** value, rill and interrill erosion is considered to be excessive and improved erosion control is needed. Alternative conservation practices are proposed and evaluated with **RUSLE2**. Those practices that give estimated values of soil loss less than or equal to the **T** value are considered acceptable.

**RUSLE2** can be used to estimate sediment yield from large watersheds by multiplying soil loss estimates by a sediment delivery ratio that depends primarily on watershed area. Sediment yield on a per unit area basis and sediment delivery ratios generally decrease as watershed size increases. **RUSLE2** is not a sediment yield equation but is an equation for sediment production by rill and interrill erosion on overland flow areas, which is a major source of sediment in many watersheds. In addition, erosion in concentrated flow areas (ephemeral gullies), classical gullies, stream channels, and mass movement of material into channels are other major sources of sediment that contribute to sediment yield but are not estimated by **RUSLE2**.

Sediment yield from most watersheds is often less than sediment production within the watershed. Thus, much sediment is deposited within a typical watershed. **RUSLE2**, in contrast to the USLE and RUSLE1, can estimate the deposition that occurs on the overland flow portion of the landscape. The amount of this deposition can be substantial on many hillslopes. If **RUSLE2** is being used to estimate sediment yield in watersheds, it should be applied to the eroding portion of the landscape to make a soil loss computation comparable to that produced by the USLE. Otherwise, a different set of sediment delivery ratio values from those used by the USLE would have to be used with **RUSLE2**.

**General Use of the RUSLE2 Program**

The **RUSLE2** program is simple and easy to use. Rill and interrill erosion at a specific site is a function of the weather, soils, topography, and land use at the location. Data for variables that represent these factors are stored in **RUSLE2** databases. **RUSLE2** is run by selecting database entries to represent site-specific conditions. **RUSLE2** then computes soil values using this information. Most of the input values needed to run **RUSLE2** are readily available in existing database files that are supplied with the program. If the necessary data are not available, the parameters used in RUSLE2 are simple so that new values can be easily developed.

Erosivity (**R** factor) values for locations where a particular user will apply **RUSLE** are in a database file in the **RUSLE** computer program or in AH703, Figures 2-1 through 2-5. RUSLE2 also uses values for the bimonthly distribution of the erosivity, which are available in AH703. Values used by RUSLE2 for average monthly temperatures and precipitation are available in the RUSLE2 data files supplied with the program or can be obtained from readily available weather records.

Soil erodibility (**K** factor) values are selected from soil survey information available in field offices of the USDA-Natural Resources Conservation Service (NRCS). The particular site is located on a soil survey map, and the erodibility of the soil-mapping unit at the site is identified

and entered into the **RUSLE2** program. If values are not available, they can be calculated using the Soil Erodibility Nomograph in the **RUSLE2** program.

Slope length, steepness, and other topographic values are determined from an on-site visit or from other topographic information such as highly detailed contouring maps. These values are entered directly in the **RUSLE** program.

Land use is the simple most important factor that determines rill and interrill erosion. The typical objective in conservation planning is to use RUSLE2 as a guide in choosing a land use practice that controls erosion to an acceptable rate. The effect of land use in RUSLE2 is considered in the terms of management practices along with supporting practices like contouring that is added to the basic management practice.

Management practices refer to such things as the tillage, cropping, vegetation, and erosion control materials that are applied to the hillslope. A database file for a management practice in RUSLE2 involves a set of dates with corresponding operations, vegetations, and residues. A typical management file for a "conventional" cropping system for corn is illustrated in Table ??. Numerous management files are include in the management database that comes with the RUSLE2 program. When RUSLE2, the user selects an existing management file, or a new one is created to represent the particular field condition. In almost all cases, an existing management file can be used, but if a new one is created, it is saved for use in other similar applications.

Operations are discrete events that change properties of live vegetation, residue, and/or the soil that affect rill and interrill erosion. Examples of operations include tillage, planting, harvesting, grazing, burning, frost, ripping, and blading. Certain information used to describe operations is stored in operation files that are contained in a RUSLE2 operations database that comes with the RUSLE2 program. Operations are selected from the operation database to describe management practices. If an operation is not available in the operations database, one can be created and stored in the database for later reuse.

Vegetation is one of the most important factors that affect erosion. Certain operations like those associated with planters and drills that seed crops call a vegetation file that represents live vegetation that is being considered in the application of RUSLE2. Just like for operations, vegetation files are developed for the various vegetations that are encountered in RUSLE2 applications. Several vegetations are in the vegetation database that comes with RUSLE2. If the necessary file is not available in the RUSLE2 database, a new vegetation file can be created and added to the database.

Ground cover produced by crop residue and plant litter is the single factor having the greatest effect on erosion. Plant residue is the vegetative material left after live vegetation is killed. Such operations as shredding and tillage convert standing residue to flat residue and to buried residue. RUSLE2 also track both live and dead roots. Each vegetation produces residue. Residue data files are included in the residue database provided with RUSLE2. A residue file is assigned to each vegetation file, and additional residue files can be created and saved in the RUSLE2 database.

Residue data files are also used to describe mulch and manufactured materials applied to construction sites to control erosion.

RUSLE2 comes with an incomplete database, which is intended primarily to illustrate typical information in the database rather than to serve as a working database. A much more complete RUSLE2 database is available from the NRCS state office, which can usually be obtained by contacting the NRCS State Agronomist.

BASIC OPERATION OF RUSLE2

The purpose of this User's Guide is primarily to describe individual RUSLE2 factors and to provide guidance on how to choose values used by RUSLE2. However, that information is best described by having the RUSLE2 program open and moving through the program as various topics are discussed. The following information is a general overview. Other documents should be consulted to provide details on the mechanics of the RUSLE2 program.

When RUSLE2 is initially started, the opening screen requires two selections. The first choice is to choose from objects for worksheet, hillslope profile, climate, storm erosivity, soil, management, operation, vegetation, and residue. The worksheet and hillslope profile objects are used to make erosion computations. The other objects are used to place information in the RUSLE2 database.

Worksheet
The worksheet object is used to carry out computations for multiple management practices on a single hillslope profile or carry out computations for multiple hillslope profiles. Individual worksheets and the information in them can be saved with a name for the worksheet chosen by the user.

Hillslope profile
The hillslope profile object is used to compute erosion for a single hillslope profile. Hillslope profiles and the information associated with them can be saved with a name chosen by the user. A single hillslope profile can be viewed as the erosion computation for a specific overland flow path at a particular location on a particular landscape with a particular land use or possible land use. Thus the information associated with a profile includes location, soil, topography, management, and supporting practices.

Climate
The climate object describes the weather information for the site. The information in this object includes data on annual erosivity, 10 yr EI storm, average monthly temperature, and average monthly precipitation. Information is cataloged in the database according to names of locations.

Storm erosivity
Storm erosivity varies through the year depending on location. The information in the storm erosivity object describes how erosivity varies during the year as a function of zones or regions. Information is cataloged in the database according to a zone number.

Soil
The soil object includes information on soil erodibility, soil texture, hydrologic soil group, and rock cover. Also, this object includes the soil erodibility to compute a value for the soil

erodibility factor if one is not available. Information is cataloged in the database according to a soil name, which could be a soil-mapping unit from an NRCS soil survey.

Management
The management object contains information on management practices. Each practice typically includes a list of dates and the operations, vegetations, and applied materials like mulch and manure associated with each date. Information is cataloged in the database according to a management name chosen by the user.

Operation
The operation object contains the information used to describe operations. A key component of the information used to describe an operation is processes including begin growth, kill vegetation, flatten standing residue, disturb surface, remove surface cover, and remove live biomass. Information is cataloged in the database according to an operation name chosen by the user.

Vegetation
The vegetation object contains the information used to describe live vegetation. This information includes a name for the residue to associate with the vegetation and data on yield, the relationship of above ground biomass to yield, how the vegetation slow runoff, and temporally varying values on root biomass, canopy cover, fall height, and live ground cover. Information is cataloged in the database according to a vegetation name chosen by the user.

Residue
The residue object contains the information used to describe residue. This information includes data related to the rate that the residue decomposes on and in the soil and the amount of mass that covers a particular portion of the soil surface. Information is cataloged in the database according to a residue name assigned by the user.

Template
The other choice is a template that controls the amount of information that RUSLE2 displays. Templates are customized for particular applications, where increasing amounts of information is displayed. Also, the templates can be customized to use terminology that is common to a particular organization or discipline.

Chose the NRCS Field Office (beginners) template and the profile object when you first begin to use RUSLE2. This template shows the steps of using RUSLE2. Simply follow the steps to compute a soil loss value. Try changing some of the inputs and notice the change in the computed soil loss value.

Now, switch to the NRCS Field Office (summary) template. To switch to that template, use the icon on the toolbar. Move the cursor to the load template icon on the tool bar and click. Select the summary template.

This template uses a set of folders for soil, topography, and management that are opened to enter values. Not only are these folders included input, they also contain output directly associated with the variable represented by the folder. The output in these folders becomes especially important when the hillslope profile is divided into segments.

# REFERENCE 2

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 2

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%** |

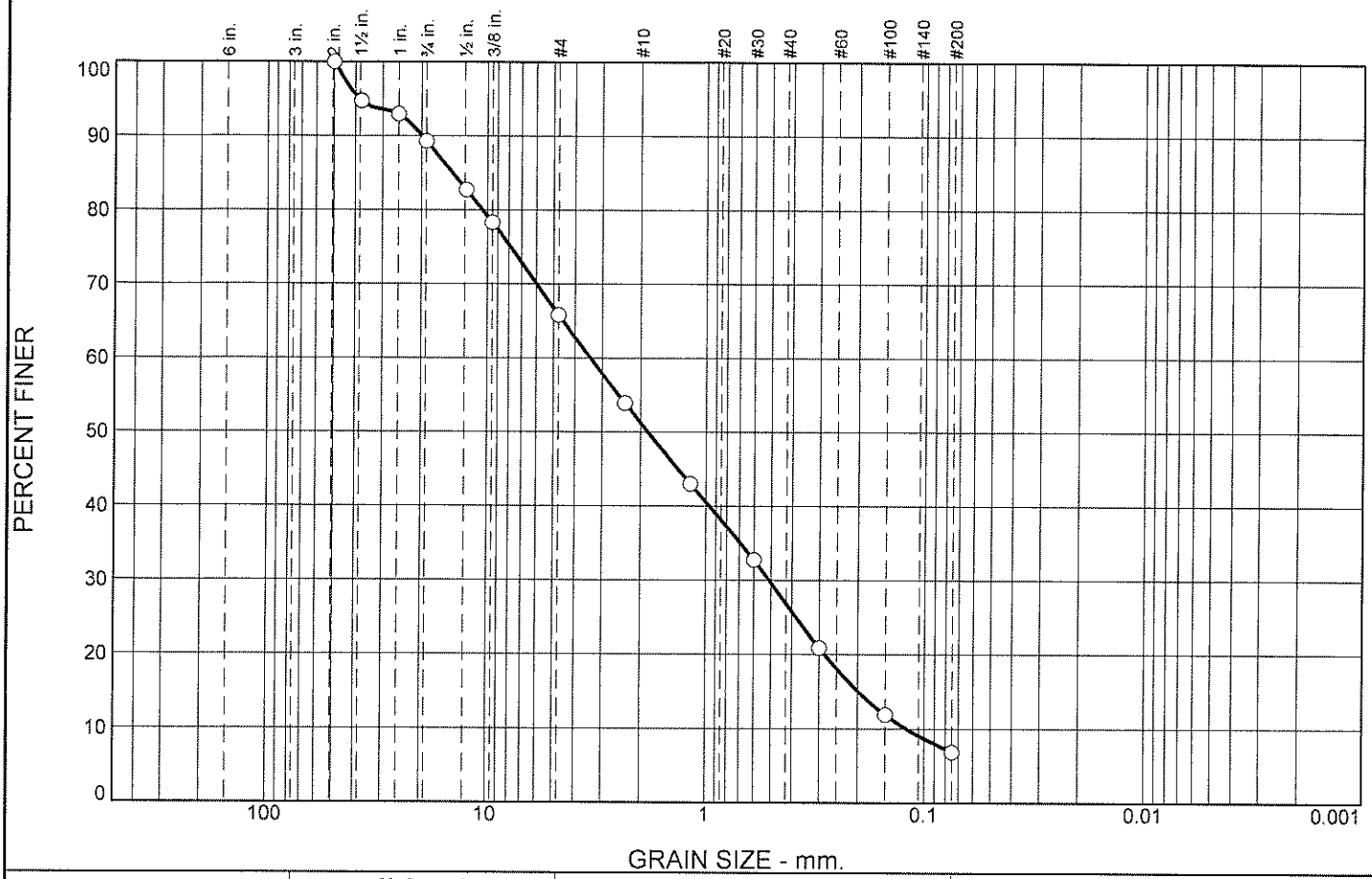
# Initial Field Conditions Data

**REFERENCE 3**

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

# Particle Size Distribution Report

**REFERENCE 4**




| % +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

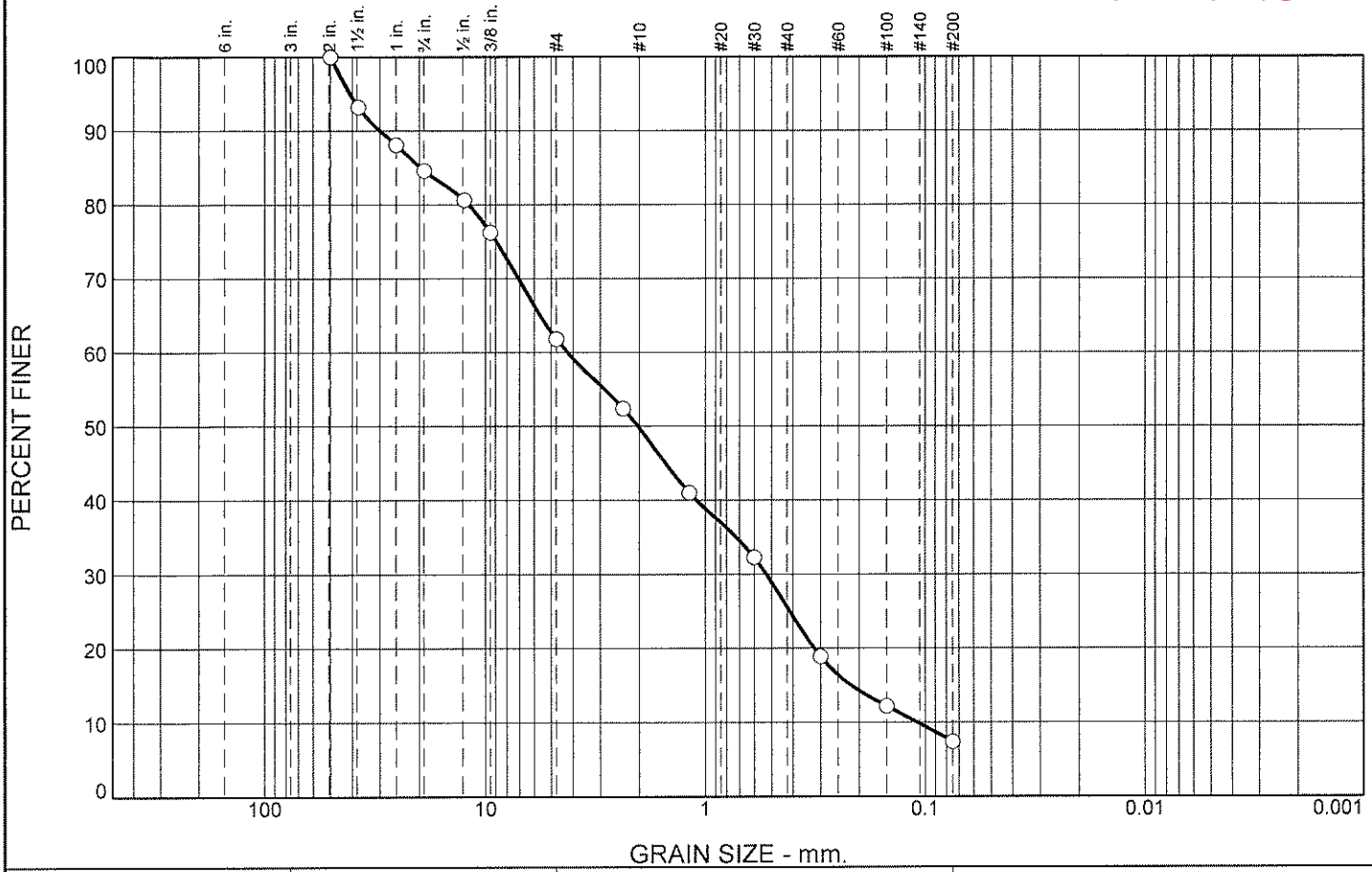
**Date:** 10/09/2013

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 4**




| % +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

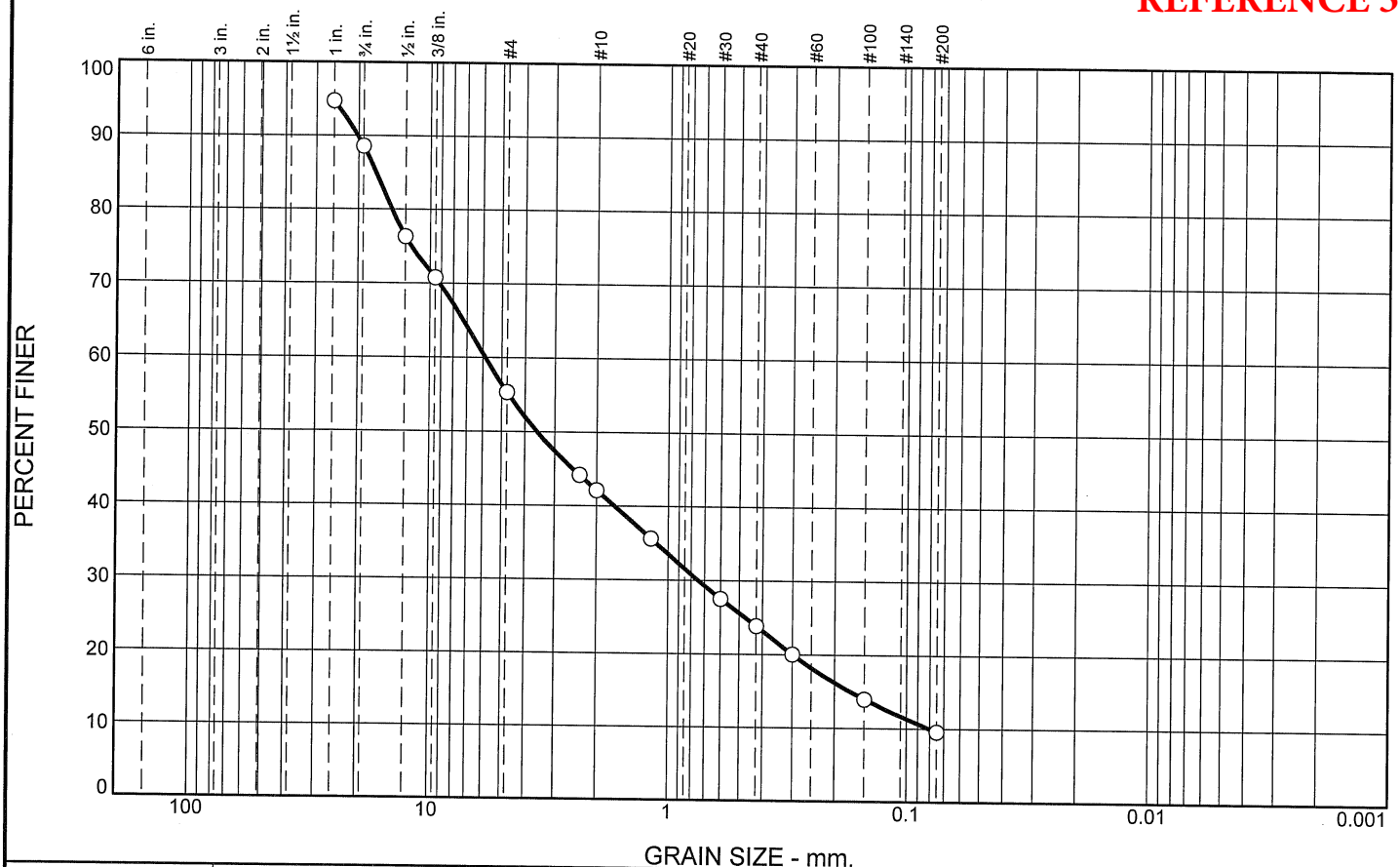
**Date:** 10/09/2013

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

# Particle Size Distribution Report

**REFERENCE 5**




| % +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

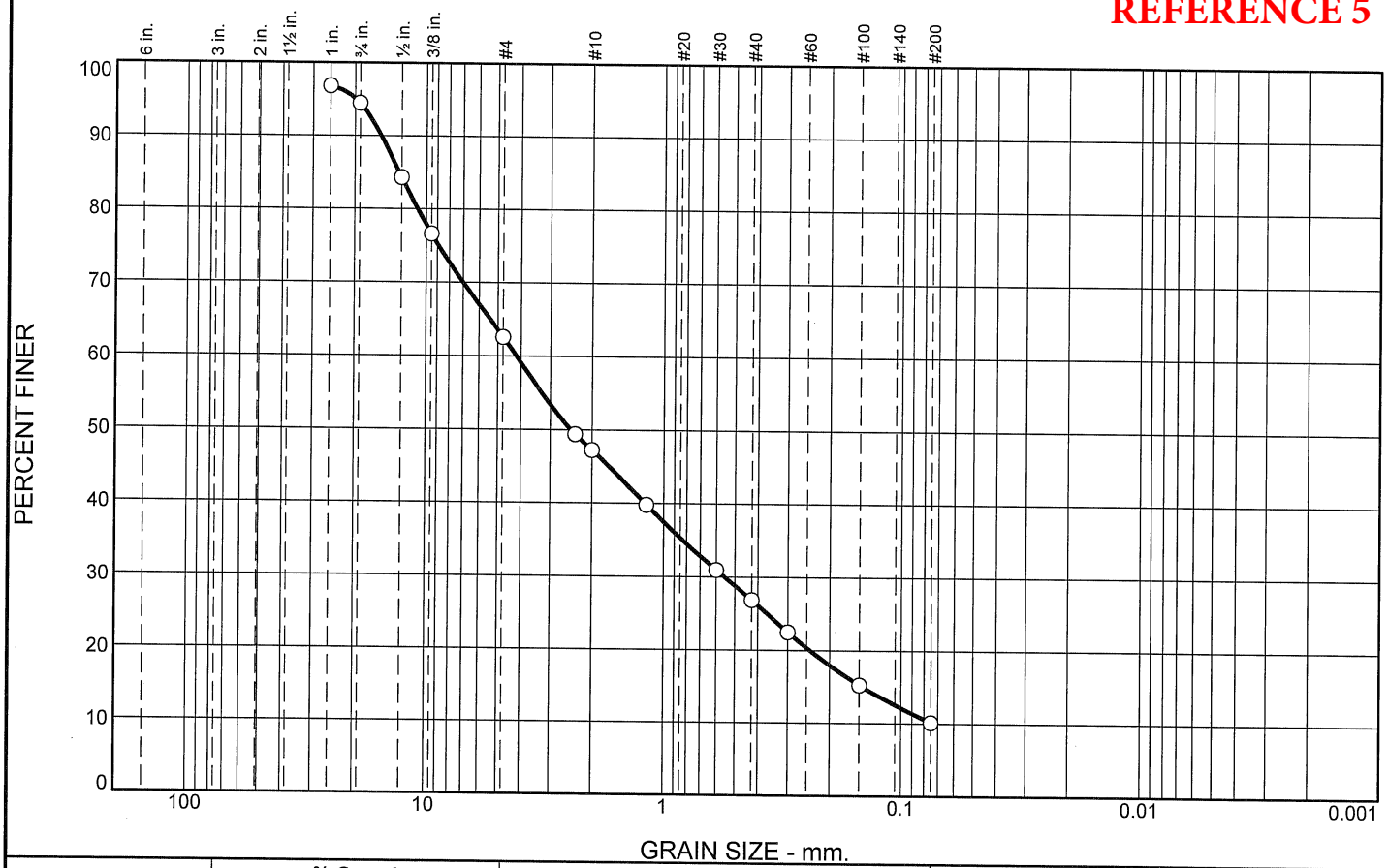
GES GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

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

**Tested By:** T. RAMOS

# Particle Size Distribution Report

REFERENCE 5




| % +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

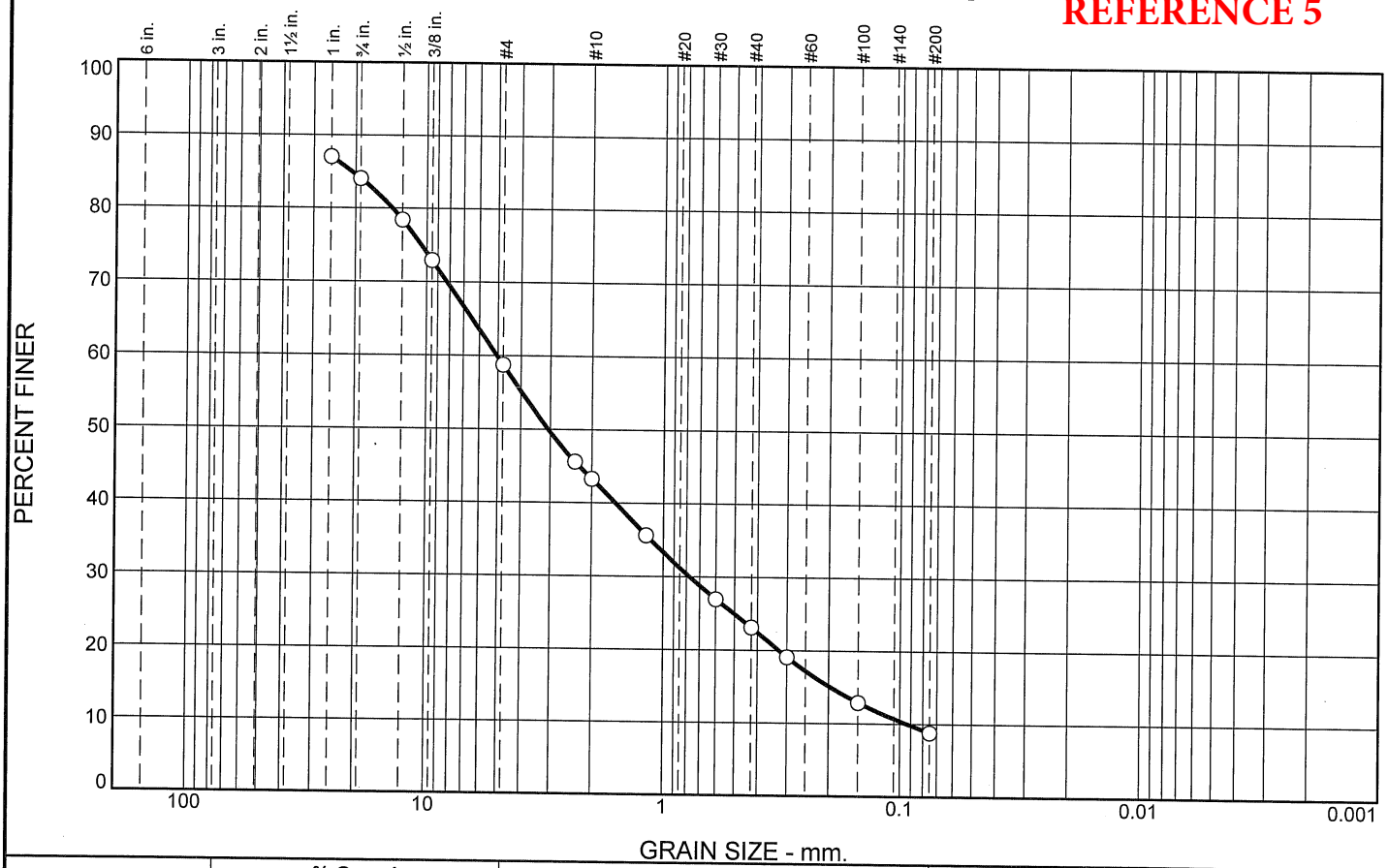
GES GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

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

**Tested By:** T. RAMOS

# Particle Size Distribution Report

REFERENCE 5




| % +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

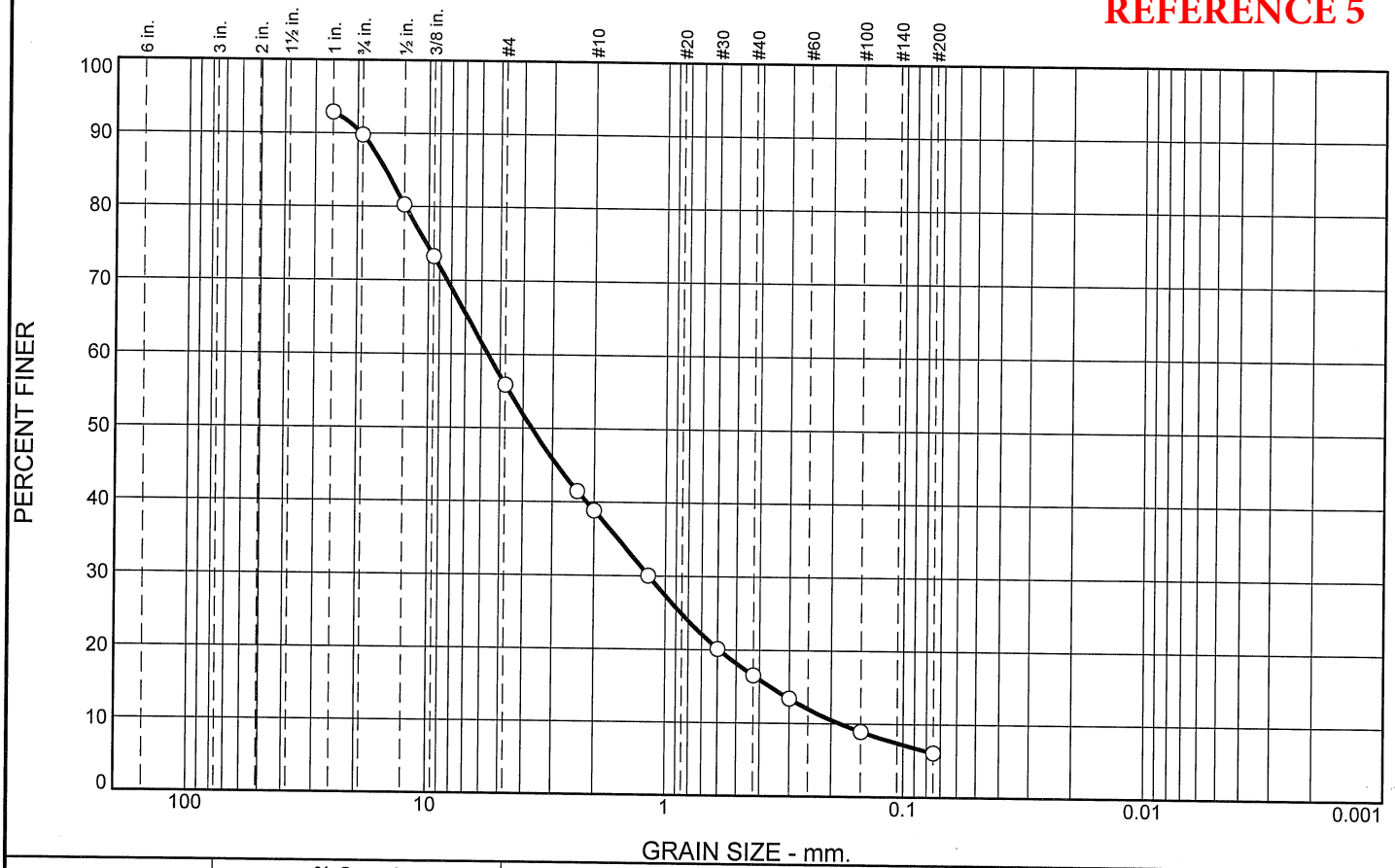
GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.
GES

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

**Tested By:** T. RAMOS

# Particle Size Distribution Report

REFERENCE 5




| % +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

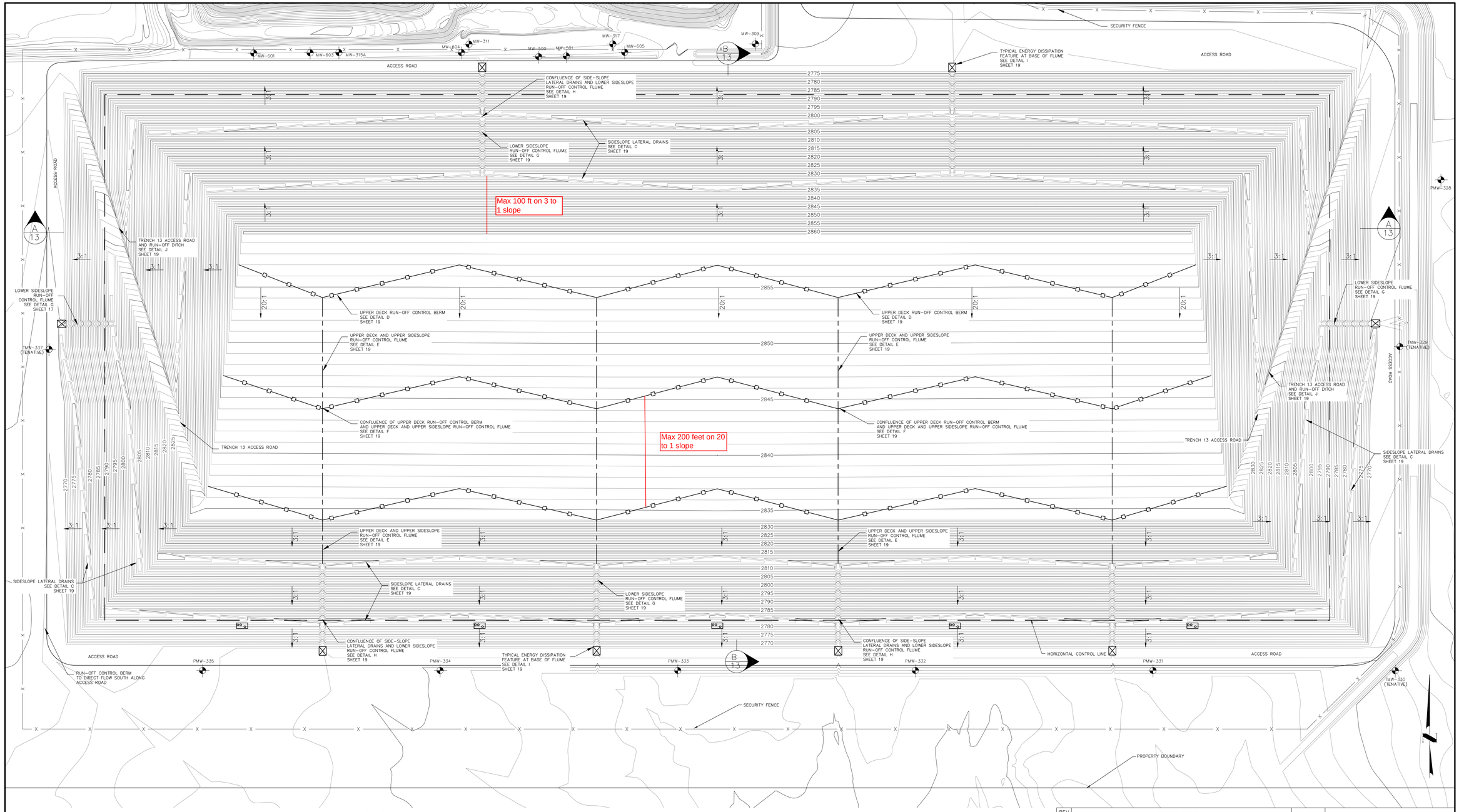
**Date:** 2/23/16

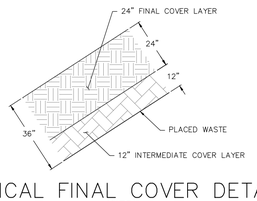
GES GEOTECHNICAL & ENVIRONMENTAL SERVICES, INC.

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

**Tested By:** T. RAMOS

**REFERENCE 6**




## 14 TYPICAL FINAL COVER DETAIL
(NTS)

LEGEND

- LCRS AND LDS SUMP RISERS AND LEACHATE STORAGE
- PMW-335 — PLANNED MONITORING WELL
- MW-601 — EXISTING MONITORING WELL
- TMW-329 — TENTATIVELY PLANNED MONITORING WELL
- SECURITY FENCE
- UPPER DECK RUN-OFF CONTROL BERMS
- UPPER DECK AND LOWER SIDESLOPE RUN-OFF CONTROL FLUMES
- TYPICAL ENERGY DISSAPATION FEATURE

ELEVATION: FEET (NAVD 1988)
HORIZONTAL CONTROL: SITE COORDINATE SYSTEM

80 0 80 160
SCALE: 1"= 80'

NOTES:

1. FINAL COVER IS 3.0 FEET MINIMUM THICKNESS OVER PLACED WASTE (SEE SHEET 11 AND 13)
2. CONTROL POINTS NOT PROVIDED, VERIFICATION OF PLACED FINAL COVER THICKNESS WILL BE BY COMPARISON OF 50'X50' GRID SURVEY ON TOP OF PLACED WASTE AND TOP OF FINAL COVER
3. SEE SHEET 14, 15, AND 16 FOR STORMWATER MANAGEMENT FEATURES OUTSIDE THE LIMIT OF WASTE DISPOSAL.
4. SEE SHEET 18 FOR FINAL COVER PLACEMENT SEQUENCING

| REV. # | DESCRIPTION | DATE |
|---|---|---|
| 0 | ISSUED FOR REGULATORY REVIEW | 10/19/15 |
| 1 | ISSUED FOR REGULATORY REVIEW | 3/08/16 |
| 2 | | |

FINAL COVER PLAN VIEW

PROFESSIONAL ENGINEER-STATE OF NEVADA
STEPHEN L. WAMPLER
Exp. 6/30/16
CIVIL
No. 013641

US ecology

BEATTY NEVADA HAZARDOUS WASTE MANAGEMENT FACILITY

PROJECT NUMBER: 143418

AquAeTer
optimizing resources | water, air, earth

| DRWN. BY | DATE | CHKD. BY | DATE | APRVD. BY | DATE | SCALE: |
|---|---|---|---|---|---|---|
| CWK | 2/20/15 | CAB | 3/25/15 | SLW | 10/12/15 | 1" = 80' |

DRAWING NO: NV13-15-012

# REFERENCE 7

Management: CMZ 31\d.Construction Site Templates\Construction site-USEN

Graphic
Rel. row grade, % 100

Long-term natural rough., in. 0.24
Normally used as a rotation? No
Duration, yr 100

Add to this management to make new one Open
View/edit rotation builder used to make this management ope

Operations | Info

Management Operations

| Date, m/d/y + - | Operation | Vegetation | Yield (harv. units), #/ac | Type of cover material | Cover matl add/remove, lb/ac | Cover from addition, % |
|---|---|---|---|---|---|---|
| 1/1/0 | Bulldozer, clearing/cutting | | | | | |
| 1/2/0 | Bulldozer, filling/leveling | | | | | |
| 1/3/0 | Disk, tandem heavy primary op. | | | | | |
| 1/4/0 | Roller, smooth | | | | | |

# REFERENCE 7

## RUSLE2 Profile Erosion Calculation Record

Info:
**File:** profiles\New Folder\USEN Profile

**Inputs:**
Location: USA\Nevada\Nye County\NV_Nye R 3
**Soil Segments**

| *Segment* | *Seg length (horiz)* | *Soil* |
|---|---|---|
| 1 | 200 | Nye SW, NV785\2053 YERMO-GREYEAGLE-ARIZO ASSOCIATION\ARIZO very stony sandy loam 15% |

**Slope Segments**

| *Segment* | *Seg length (horiz)* | *Seg length (along slope)* | *Steepness* | *Vertical drops* | *Sediment delivery, t/ac/yr* |
|---|---|---|---|---|---|
| 1 | 200 | 200 | 5.0 | 10 | 0.23 |

**Management Segments**

| *Segment* | *Seg length (horiz)* | *Seg length (along slope)* | *Management* | *Sed. delivery, t/ac/yr* |
|---|---|---|---|---|
| 1 | 200 | 200 | CMZ 31\d.Construction Site Templates\Construction site-USEN | 0.23 |

| *Management* | *Vegetation* | *Yield units* | *# yield units, #/ac* |
|---|---|---|---|
| | | | |

Contouring: a. not contoured
Vegetative Barriers and Filter Strips: (none)
Diversions, Terraces, Sediment Basins: (none)

**Sediment Barrier Set**

| *Num.* | *Sediment barrier type* | *Barrier strip width* | *How place?* | *Dist. slope top to bottom of strip* | *Date barrier installed* | *Op. installing barrier* | *Date barrier removed* | *Op. removing barrier* |
|---|---|---|---|---|---|---|---|---|
| 1 | (none) | 1.0 | Bottom | 200 | 1/1/0 | (none) | 1/3/0 | (none) |

**Outputs:**
Net K factor: 0.13 US
Net LS factor: 0.75
Net C factor: 0.46
Detachment on slope: 0.23 t/ac/yr
Sediment delivery: 0.23 t/ac/yr
Crit. slope length: 200 ft

| *Date* | *Operation* | *Vegetation* | *Surf. res. cov. after op, %* |
|---|---|---|---|
| 1/1/0 | Bulldozer, clearing/cutting | | 0 |
| 1/2/0 | Bulldozer, filling/leveling | | 0 |
| 1/3/0 | Disk, tandem heavy primary op. | | 0 |
| 1/4/0 | Roller, smooth | | 0 |

# REFERENCE 7

## RUSLE2 Profile Erosion Calculation Record

Info:
**File:** profiles\New Folder\USEN Profile

**Inputs:**
Location: USA\Nevada\Nye County\NV_Nye R 3
**Soil Segments**

| *Segment* | *Seg length (horiz)* | *Soil* |
|---|---|---|
| 1 | 100 | Nye SW, NV785\2053 YERMO-GREYEAGLE-ARIZO ASSOCIATION\ARIZO very stony sandy loam 15% |

**Slope Segments**

| *Segment* | *Seg length (horiz)* | *Seg length (along slope)* | *Steepness* | *Vertical drops* | *Sediment delivery, t/ac/yr* |
|---|---|---|---|---|---|
| 1 | 100 | 110 | 33 | 33 | 1.9 |

**Management Segments**

| *Segment* | *Seg length (horiz)* | *Seg length (along slope)* | *Management* | *Sed. delivery, t/ac/yr* |
|---|---|---|---|---|
| 1 | 100 | 110 | CMZ 31\d.Construction Site Templates\Construction site-USEN | 1.9 |

| *Management* | *Vegetation* | *Yield units* | *# yield units, #/ac* |
|---|---|---|---|
| | | | |

Contouring: a. not contoured
Vegetative Barriers and Filter Strips: (none)
Diversions, Terraces, Sediment Basins: (none)

**Sediment Barrier Set**

| *Num.* | *Sediment barrier type* | *Barrier strip width* | *How place?* | *Dist. slope top to bottom of strip* | *Date barrier installed* | *Op. installing barrier* | *Date barrier removed* | *Op. removing barrier* |
|---|---|---|---|---|---|---|---|---|
| 1 | (none) | 1.0 | Bottom | 100 | 1/1/0 | (none) | 1/3/0 | (none) |

**Outputs:**
Net K factor: 0.13 US
Net LS factor: 5.6
Net C factor: 0.46
Detachment on slope: 1.9 t/ac/yr
Sediment delivery: 1.9 t/ac/yr

Crit. slope length: 100 ft

| *Date* | *Operation* | *Vegetation* | *Surf. res. cov. after op, %* |
|---|---|---|---|
| 1/1/0 | Bulldozer, clearing/cutting | | 0 |
| 1/2/0 | Bulldozer, filling/leveling | | 0 |
| 1/3/0 | Disk, tandem heavy primary op. | | 0 |
| 1/4/0 | Roller, smooth | | 0 |

**REFERENCE 8**

**NOAA Atlas 14, Volume 1, Version 5**
**AMARGOSA FARMS GAREY**
**Station ID: 26-0150**
**Location name: Amargosa Valley, Nevada, US***
**Latitude: 36.5717°, Longitude: -116.4619°**
**Elevation:**
**Elevation (station metadata): 2450 ft***
* source: Google Maps

**POINT PRECIPITATION FREQUENCY ESTIMATES**

Sanja Perica, Sarah Dietz, Sarah Heim, Lillian Hiner, Kazungu Maitaria, Deborah Martin, Sandra Pavlovic, Ishani Roy, Carl Trypaluk, Dale Unruh, Fenglin Yan, Michael Yekta, Tan Zhao, Geoffrey Bonnin, Daniel Brewer, Li-Chuan Chen, Tye Parzybok, John Yarchoan

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

## PF tabular

**PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]**

| Duration | Average recurrence interval (years) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 5 | 10 | 25 | 50 | 100 | 200 | 500 | 1000 |
| 5-min | 0.108 (0.072–0.109) | 0.140 (0.097–0.147) | 0.196 (0.148–0.223) | 0.244 (0.190–0.289) | 0.319 (0.257–0.396) | 0.384 (0.312–0.490) | 0.459 (0.376–0.606) | 0.543 (0.446–0.746) | 0.677 (0.557–0.976) | 0.795 (0.653–1.20) |
| 10-min | 0.165 (0.109–0.166) | 0.213 (0.148–0.224) | 0.298 (0.225–0.339) | 0.372 (0.288–0.439) | 0.485 (0.391–0.602) | 0.584 (0.474–0.746) | 0.699 (0.572–0.923) | 0.827 (0.679–1.14) | 1.03 (0.848–1.49) | 1.21 (0.995–1.82) |
| 15-min | 0.205 (0.136–0.206) | 0.265 (0.183–0.277) | 0.370 (0.279–0.421) | 0.461 (0.358–0.545) | 0.602 (0.484–0.746) | 0.724 (0.588–0.925) | 0.866 (0.709–1.14) | 1.03 (0.841–1.41) | 1.28 (1.05–1.84) | 1.50 (1.23–2.26) |
| 30-min | 0.276 (0.183–0.278) | 0.356 (0.246–0.373) | 0.498 (0.376–0.566) | 0.621 (0.482–0.734) | 0.810 (0.652–1.01) | 0.974 (0.792–1.25) | 1.17 (0.955–1.54) | 1.38 (1.13–1.90) | 1.72 (1.42–2.48) | 2.02 (1.66–3.04) |
| 60-min | 0.341 (0.226–0.344) | 0.441 (0.305–0.462) | 0.616 (0.465–0.701) | 0.768 (0.596–0.908) | 1.00 (0.807–1.24) | 1.21 (0.980–1.54) | 1.44 (1.18–1.91) | 1.71 (1.40–2.35) | 2.13 (1.75–3.07) | 2.50 (2.06–3.76) |
| 2-hr | 0.326 (0.275–0.396) | 0.438 (0.370–0.538) | 0.657 (0.545–0.801) | 0.843 (0.694–1.04) | 1.15 (0.924–1.41) | 1.42 (1.13–1.73) | 1.73 (1.36–2.15) | 2.11 (1.61–2.63) | 2.71 (2.01–3.41) | 3.25 (2.34–4.14) |
| 3-hr | 0.375 (0.314–0.446) | 0.503 (0.426–0.605) | 0.728 (0.617–0.881) | 0.923 (0.774–1.11) | 1.24 (1.02–1.49) | 1.51 (1.22–1.82) | 1.83 (1.46–2.22) | 2.20 (1.73–2.70) | 2.80 (2.13–3.49) | 3.35 (2.48–4.21) |
| 6-hr | 0.469 (0.399–0.558) | 0.628 (0.540–0.746) | 0.910 (0.778–1.08) | 1.15 (0.970–1.35) | 1.49 (1.25–1.76) | 1.79 (1.48–2.11) | 2.14 (1.74–2.54) | 2.53 (2.02–3.03) | 3.16 (2.47–3.82) | 3.72 (2.85–4.55) |
| 12-hr | 0.591 (0.502–0.678) | 0.785 (0.677–0.917) | 1.15 (0.987–1.33) | 1.43 (1.23–1.66) | 1.84 (1.57–2.13) | 2.17 (1.83–2.52) | 2.54 (2.12–2.96) | 2.94 (2.41–3.45) | 3.52 (2.83–4.17) | 4.07 (3.23–4.89) |
| 24-hr | 0.694 (0.580–0.836) | 0.944 (0.787–1.12) | 1.39 (1.15–1.66) | 1.75 (1.43–2.08) | 2.26 (1.83–2.68) | 2.68 (2.15–3.17) | 3.13 (2.48–3.74) | 3.63 (2.82–4.34) | 4.35 (3.29–5.24) | 4.95 (3.66–6.02) |
| 2-day | 0.766 (0.647–0.914) | 1.04 (0.877–1.23) | 1.54 (1.30–1.82) | 1.94 (1.62–2.28) | 2.50 (2.07–2.90) | 2.97 (2.42–3.45) | 3.47 (2.79–4.05) | 4.02 (3.14–4.74) | 4.81 (3.65–5.77) | 5.47 (4.05–6.68) |
| 3-day | 0.791 (0.670–0.943) | 1.08 (0.909–1.27) | 1.60 (1.35–1.88) | 2.01 (1.69–2.36) | 2.60 (2.15–3.02) | 3.09 (2.52–3.59) | 3.63 (2.90–4.24) | 4.21 (3.29–4.98) | 5.06 (3.84–6.09) | 5.76 (4.27–7.05) |
| 4-day | 0.816 (0.694–0.973) | 1.11 (0.941–1.31) | 1.65 (1.40–1.93) | 2.08 (1.75–2.43) | 2.70 (2.24–3.14) | 3.22 (2.62–3.73) | 3.79 (3.02–4.42) | 4.40 (3.45–5.22) | 5.30 (4.03–6.40) | 6.06 (4.48–7.43) |
| 7-day | 0.887 (0.750–1.05) | 1.21 (1.03–1.44) | 1.83 (1.55–2.14) | 2.31 (1.93–2.70) | 2.99 (2.47–3.49) | 3.56 (2.90–4.15) | 4.17 (3.33–4.89) | 4.84 (3.79–5.76) | 5.80 (4.43–7.03) | 6.60 (4.92–8.11) |
| 10-day | 0.965 (0.797–1.17) | 1.32 (1.10–1.59) | 1.99 (1.66–2.37) | 2.51 (2.08–2.98) | 3.25 (2.65–3.85) | 3.86 (3.10–4.61) | 4.52 (3.59–5.43) | 5.24 (4.08–6.35) | 6.27 (4.74–7.73) | 7.13 (5.27–8.92) |
| 20-day | 1.15 (0.950–1.38) | 1.57 (1.31–1.88) | 2.35 (1.96–2.79) | 2.95 (2.45–3.49) | 3.79 (3.13–4.48) | 4.48 (3.62–5.31) | 5.21 (4.15–6.23) | 6.00 (4.70–7.24) | 7.11 (5.42–8.72) | 8.02 (5.96–9.99) |
| 30-day | 1.32 (1.08–1.58) | 1.81 (1.48–2.16) | 2.72 (2.23–3.23) | 3.41 (2.79–4.05) | 4.39 (3.56–5.19) | 5.17 (4.17–6.14) | 6.00 (4.80–7.14) | 6.89 (5.42–8.28) | 8.14 (6.27–9.95) | 9.16 (6.93–11.3) |
| 45-day | 1.45 (1.18–1.75) | 2.00 (1.63–2.41) | 3.07 (2.51–3.67) | 3.90 (3.18–4.65) | 5.08 (4.08–6.04) | 6.03 (4.83–7.20) | 7.07 (5.59–8.49) | 8.18 (6.38–9.93) | 9.78 (7.42–12.1) | 11.1 (8.26–13.8) |
| 60-day | 1.61 (1.30–1.97) | 2.24 (1.81–2.74) | 3.48 (2.82–4.20) | 4.45 (3.59–5.34) | 5.84 (4.65–6.98) | 7.00 (5.54–8.39) | 8.26 (6.47–9.98) | 9.63 (7.42–11.7) | 11.6 (8.69–14.3) | 13.3 (9.75–16.6) |

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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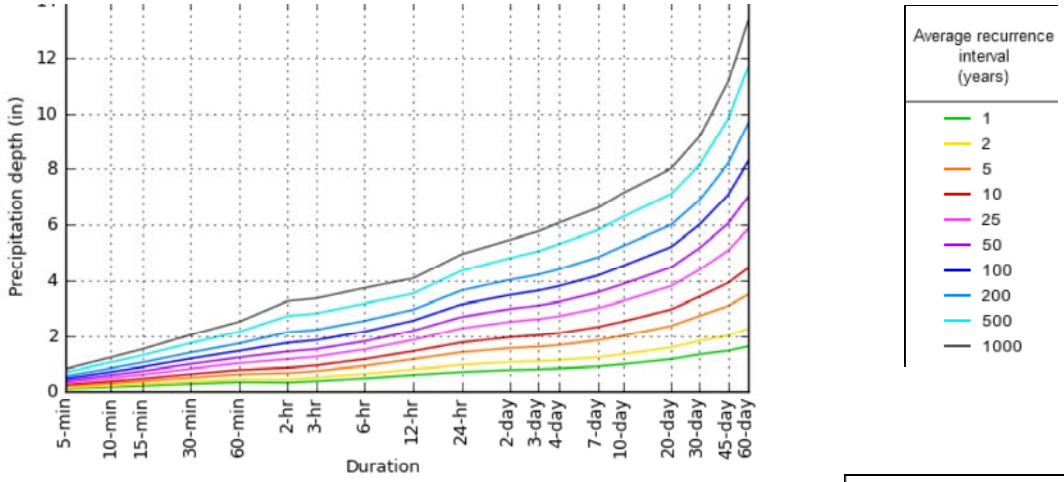
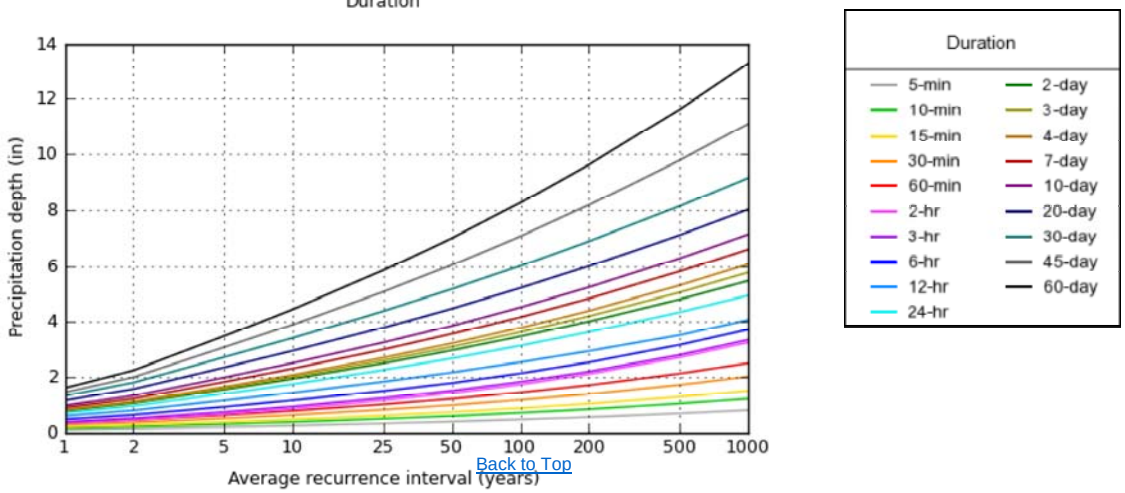
## PF graphical

**REFERENCE 8**

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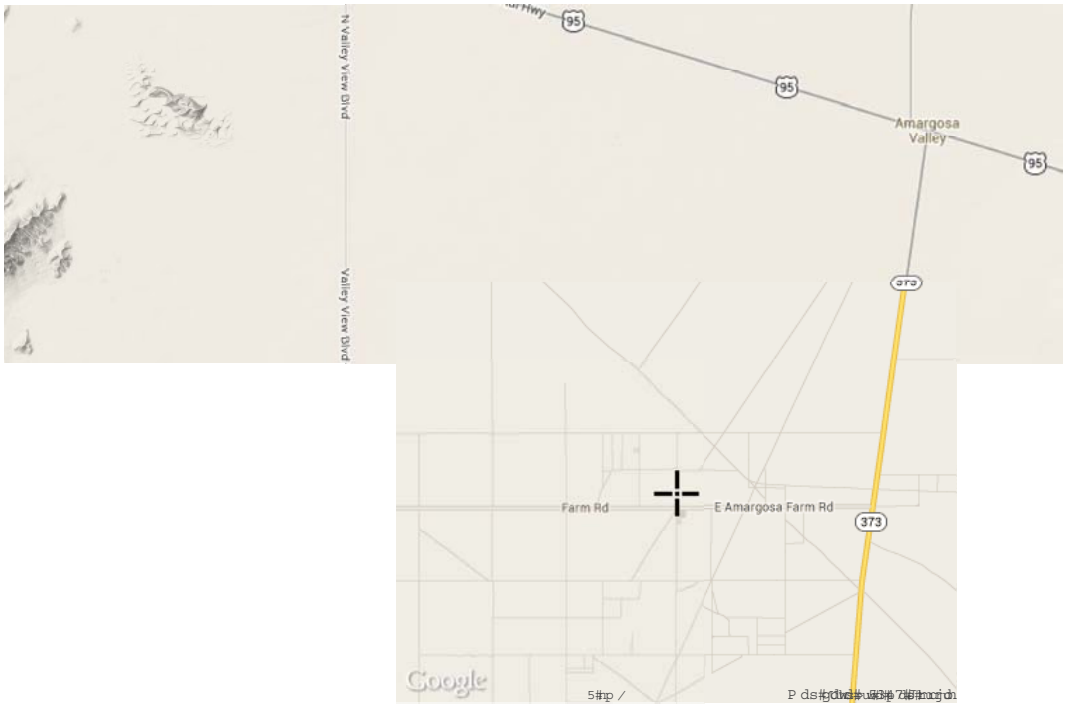
## Maps & aerials

NOAA Atlas 14, Volume 1, Version 5 Created (GMT): Fri Jul 25 17:05:28 2014

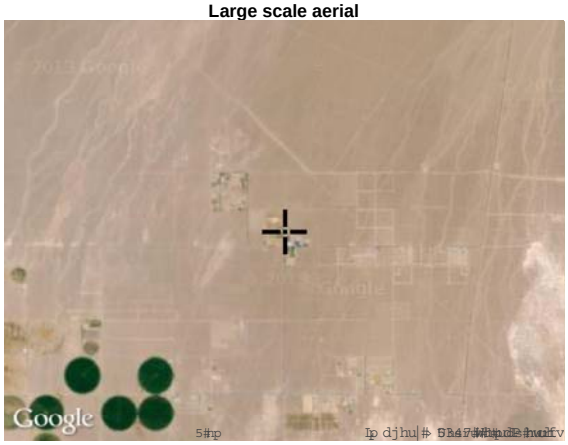
**Small scale terrain**

**Large scale terrain**

**REFERENCE 8**




**Large scale aerial**

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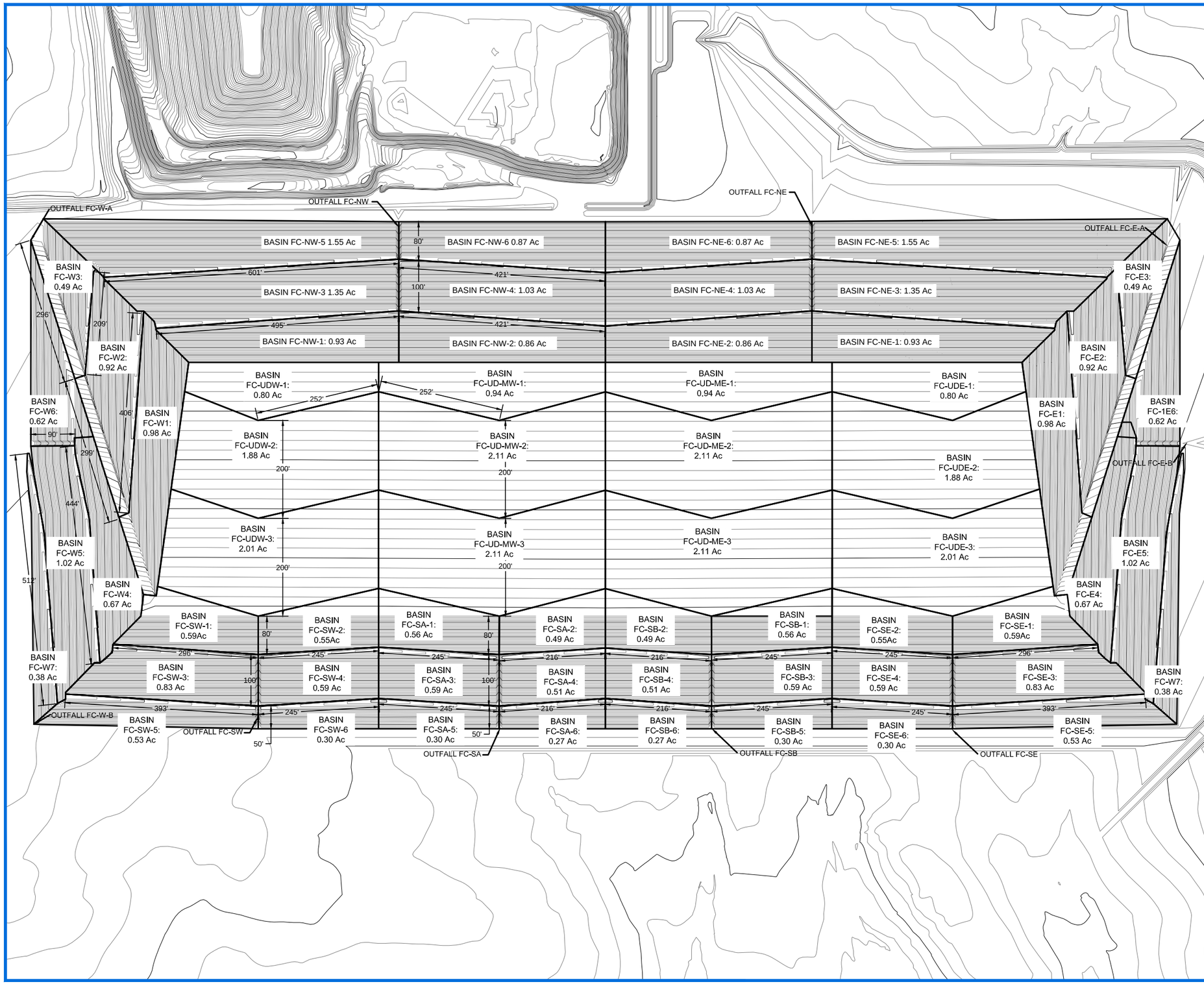
US Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service
Office of Hydrologic Development
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

Disclaimer

REFERENCE 9




TRENCH 13 FINAL COVER

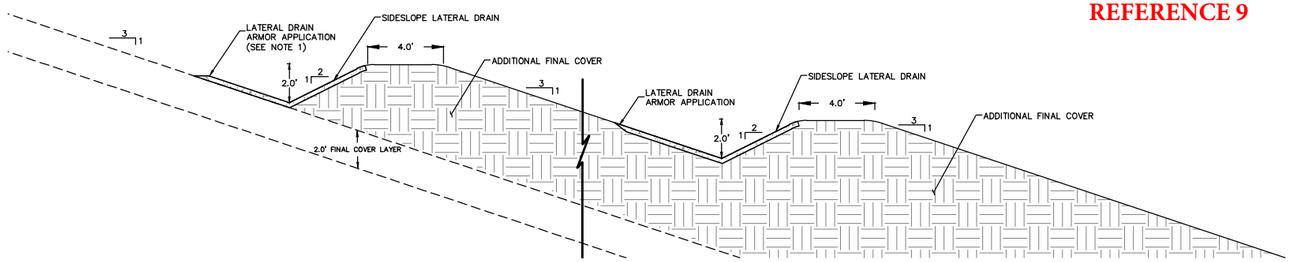
BASIN IDENTIFICATION

| | |
|---|---|
| CLIENT: | US ECOLOGY |
| LOCATION: | BEATTY, NV |
| PROJECT NUMBER: | 143418 |
| DATE: | 3/4/16 |
| DRAWN BY: | CWK |

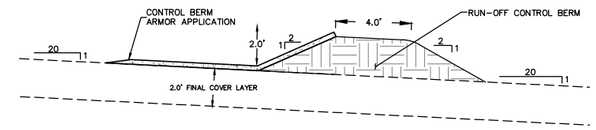
AquAeTer

optimizing resources | water, air, earth

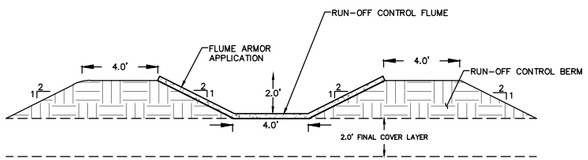
REFERENCE 9



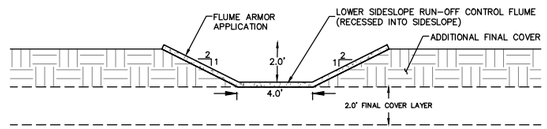

Ⓐ SIDE SLOPE LATERAL DRAIN PROFILE
(N.T.S.)



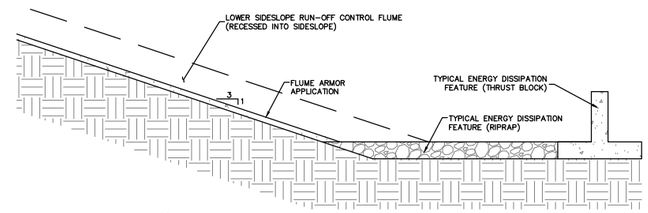

Ⓑ UPPER DECK RUN-OFF CONTROL BERM PROFILE
(N.T.S.)



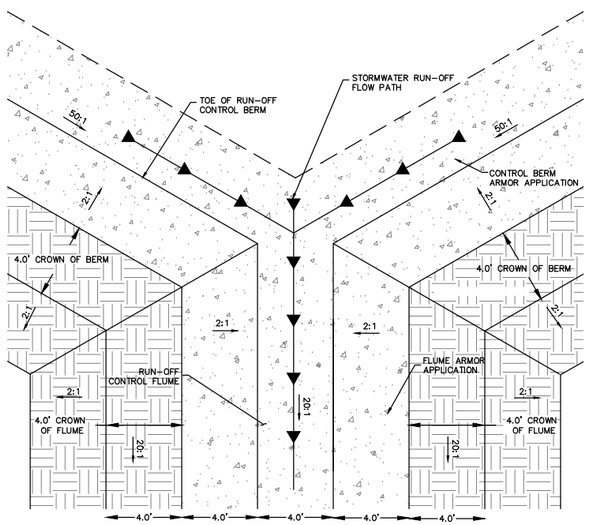

Ⓒ UPPER DECK AND UPPER SIDESLOPE RUN-OFF CONTROL FLUME PROFILE
(N.T.S.)



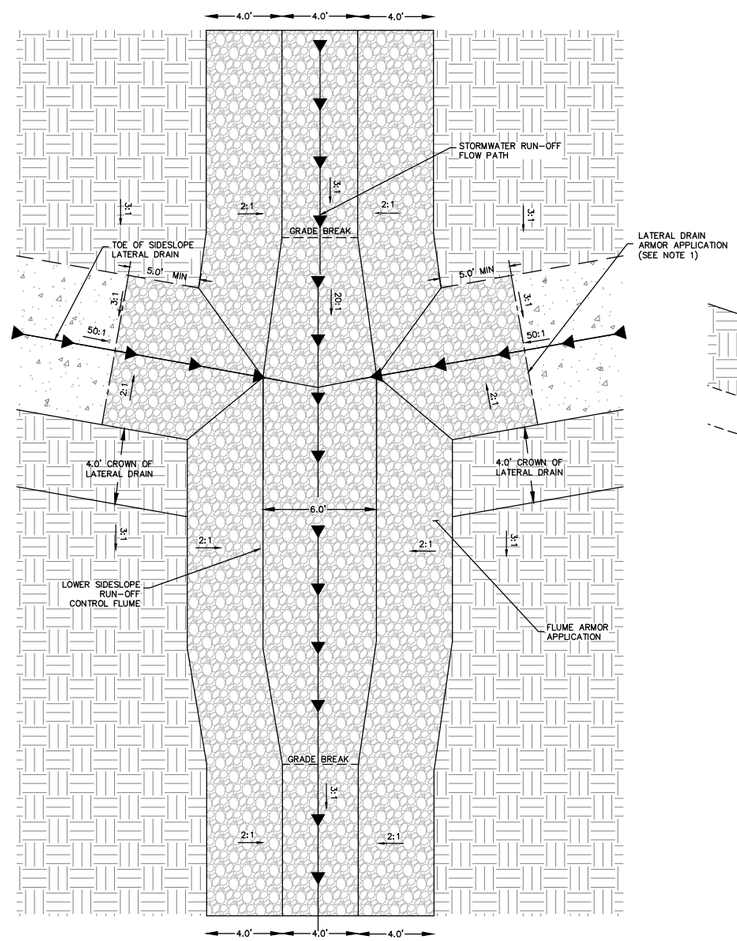

Ⓔ LOWER SIDESLOPE RUN-OFF CONTROL FLUME PROFILE
(N.T.S.)



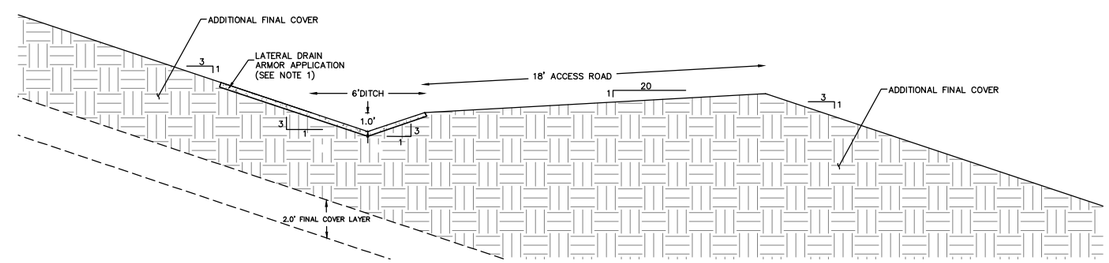

Ⓖ TYPICAL ENERGY DISSIPATION FEATURE
(N.T.S.)




Ⓓ CONFLUENCE OF RUN-OFF CONTROL BERM AND UPPER DECK AND UPPER SIDESLOPE RUN-OFF CONTROL FLUME
(N.T.S.)




Ⓕ CONFLUENCE OF SIDESLOPE LATERAL DRAINS AND LOWER SIDESLOPE RUN-OFF CONTROL FLUME
(N.T.S.)




Ⓗ TRENCH 13 ACCESS ROAD AND DRAINAGE DITCH PROFILE
(N.T.S.)

NOTE

1. AT INTERSECTION OF LATERAL DRAINS AND ACCESS ROAD DITCHES OR SIDESLOPE RUN-OFF CONTROL FLUMES, ADDITIONAL ARMORING WILL BE NECESSARY TO CONTAIN FLOW

| REV. # | DESCRIPTION | DATE |
|---|---|---|
| 0 | ISSUED FOR REGULATORY REVIEW | 10/19/15 |
| 1 | ISSUED FOR REGULATORY REVIEW | 3/29/16 |
| 2 | | |

FINAL COVER DETAILS

PROFESSIONAL ENGINEER-STATE OF NEVADA
STEPHEN L. WAMPLER
Exp. 6/30/16
CIVIL
No. 013641

US ecology

BEATTY NEVADA
HAZARDOUS WASTE
MANAGEMENT FACILITY

PROJECT NUMBER: 143418

AquAeTer
optimizing resources | water, air, earth

| DRWN. BY | DATE | CHKD. BY | DATE | APRVD. BY | DATE | SCALE: |
|---|---|---|---|---|---|---|
| CWK | 9/23/15 | CAB | 9/23/15 | SLW | 10/16/15 | VARIES |

DRAWING NO: NV13-15-019

**REFERENCE 10**

WinTR-55 Current Data Description

--- Identification Data ---

User: CWK
Project:
SubTitle: OUTFALL FC-NW
State: Nevada
County: Nye
Filename: F:\Data\143418 - USEN T13 Design\Design\Calculations\Erosion\Water Erosion\TR-55 Model Runs - Fi

Date: 3/7/2016
Units: English
Areal Units: Acres

--- Sub-Area Data ---

| Name | Description | Reach | Area(ac) | RCN | Tc |
|---|---|---|---|---|---|
| FC-NW-1 | | FLUME NW-A | 0.93 | 63 | 0.1 |
| FC-NW-2 | | FLUME NW-A | 0.86 | 63 | 0.1 |
| FC-NW-3 | | FLUME NW-B | 1.35 | 63 | 0.1 |
| FC-NW-4 | | FLUME NW-B | 1.03 | 63 | 0.1 |
| FC-NW-5 | | Outlet | 1.55 | 63 | 0.1 |
| FC-NW-6 | | Outlet | 0.87 | 63 | 0.1 |

Total area: 6.59 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

| 2-Yr (in) | 5-Yr (in) | 25-Yr (in) | 100-Yr (in) | -Yr (in) | -Yr (in) | -Yr (in) |
|---|---|---|---|---|---|---|
| .94 | 1.39 | 2.26 | 3.13 | .0 | .0 | .0 |

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

# REFERENCE 10

CWK

OUTFALL FC-NW
Nye County, Nevada

Storm Data

Rainfall Depth by Rainfall Return Period

| 2-Yr (in) | 5-Yr (in) | 25-Yr (in) | 100-Yr (in) | -Yr (in) | -Yr (in) | -Yr (in) |
|---|---|---|---|---|---|---|
| .94 | 1.39 | 2.26 | 3.13 | .0 | .0 | .0 |

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

REFERENCE 10

CWK

OUTFALL FC-NW
Nye County, Nevada

Watershed Peak Table

| Sub-Area or Reach Identifier | Peak Flow by Rainfall Return Period 2-Yr (cfs) | 5-Yr (cfs) | 25-Yr (cfs) | 100-Yr (cfs) |
|---|---|---|---|---|
| SUBAREAS | | | | |
| FC-NW-1 | .00 | .00 | 0.13 | 0.58 |
| FC-NW-2 | .00 | .00 | 0.12 | 0.54 |
| FC-NW-3 | .00 | .00 | 0.19 | 0.84 |
| FC-NW-4 | .00 | .00 | 0.14 | 0.64 |
| FC-NW-5 | .00 | .00 | 0.22 | 0.97 |
| FC-NW-6 | .00 | .00 | 0.12 | 0.54 |
| REACHES | | | | |
| FLUME NW-B | .00 | .00 | 0.58 | 2.60 |
| Down | .00 | .00 | 0.58 | 2.60 |
| FLUME NW-A | .00 | .00 | 0.25 | 1.12 |
| Down | .00 | .00 | 0.25 | 1.12 |
| OUTLET | .00 | .00 | 0.92 | 4.11 |

# REFERENCE 10

CWK

OUTFALL FC-NW
Nye County, Nevada

Hydrograph Peak/Peak Time Table

| Sub-Area or Reach Identifier | Peak Flow and Peak Time (hr) by Rainfall Return Period 2-Yr (cfs) | (hr) | 5-Yr (cfs) | (hr) | 25-Yr (cfs) | (hr) | 100-Yr (cfs) | (hr) |
|---|---|---|---|---|---|---|---|---|
| SUBAREAS | | | | | | | | |
| FC-NW-1 | .00 | n/a | .00 | n/a | 0.13 | 12.04 | 0.58 | 12.02 |
| FC-NW-2 | .00 | n/a | .00 | n/a | 0.12 | 12.04 | 0.54 | 12.02 |
| FC-NW-3 | .00 | n/a | .00 | n/a | 0.19 | 12.04 | 0.84 | 12.02 |
| FC-NW-4 | .00 | n/a | .00 | n/a | 0.14 | 12.04 | 0.64 | 12.02 |
| FC-NW-5 | .00 | n/a | .00 | n/a | 0.22 | 12.04 | 0.97 | 12.02 |
| FC-NW-6 | .00 | n/a | .00 | n/a | 0.12 | 12.04 | 0.54 | 12.02 |
| REACHES | | | | | | | | |
| FLUME NW-B | .00 | n/a | .00 | n/a | 0.58 | 12.04 | 2.60 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 0.58 | 12.04 | 2.60 | 12.02 |
| FLUME NW-A | .00 | n/a | .00 | n/a | 0.25 | 12.04 | 1.12 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 0.25 | 12.04 | 1.12 | 12.02 |
| OUTLET | .00 | | .00 | | 0.92 | | 4.11 | |

REFERENCE 10

CWK

OUTFALL FC-NW
Nye County, Nevada

Sub-Area Summary Table

| Sub-Area Identifier | Drainage Area (ac) | Time of Concentration (hr) | Curve Number | Receiving Reach | Sub-Area Description |
|---|---|---|---|---|---|
| FC-NW-1 | .93 | 0.100 | 63 | FLUME NW-A | |
| FC-NW-2 | .86 | 0.100 | 63 | FLUME NW-A | |
| FC-NW-3 | 1.35 | 0.100 | 63 | FLUME NW-B | |
| FC-NW-4 | 1.03 | 0.100 | 63 | FLUME NW-B | |
| FC-NW-5 | 1.55 | 0.100 | 63 | Outlet | |
| FC-NW-6 | .87 | 0.100 | 63 | Outlet | |

Total Area: 6.59 (ac)

REFERENCE 10

CWK

OUTFALL FC-NW
Nye County, Nevada

Reach Summary Table

| Reach Identifier | Receiving Reach Identifier | Reach Length (ft) | Routing Method |
|---|---|---|---|
| FLUME NW-B | Outlet | 80 | CHANNEL |
| FLUME NW-A | FLUME NW-B | 100 | CHANNEL |

**REFERENCE 10**

CWK

OUTFALL FC-NW
Nye County, Nevada

Sub-Area Time of Concentration Details

| Sub-Area Identifier/ | Flow Length (ft) | Slope (ft/ft) | Mannings's n | End Area (sq ft) | Wetted Perimeter (ft) | Velocity (ft/sec) | Travel Time (hr) |
|---|---|---|---|---|---|---|---|
| FC-NW-1 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 495 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.594 | 0.016 |
| | | | | | Time of Concentration | | 0.1 |
| FC-NW-2 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 421 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.996 | 0.013 |
| | | | | | Time of Concentration | | 0.1 |
| FC-NW-3 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 610 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.918 | 0.019 |
| | | | | | Time of Concentration | | 0.1 |
| FC-NW-4 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 421 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.996 | 0.013 |
| | | | | | Time of Concentration | | 0.1 |
| FC-NW-5 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| | | | | | Time of Concentration | | 0.1 |
| FC-NW-6 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| | | | | | Time of Concentration | | 0.1 |

# REFERENCE 10

CWK

OUTFALL FC-NW
Nye County, Nevada

Sub-Area Land Use and Curve Number Details

| Sub-Area Identifier | Land Use | | Hydrologic Soil Group | Sub-Area Area (ac) | Curve Number |
|---|---|---|---|---|---|
| FC-NW-1 | Desert shrub | (poor) | A | .93 | 63 |
| | Total Area / Weighted Curve Number | | | .93 | 63 |
| | | | | === | == |
| FC-NW-2 | Desert shrub | (poor) | A | .86 | 63 |
| | Total Area / Weighted Curve Number | | | .86 | 63 |
| | | | | === | == |
| FC-NW-3 | Desert shrub | (poor) | A | 1.35 | 63 |
| | Total Area / Weighted Curve Number | | | 1.35 | 63 |
| | | | | ==== | == |
| FC-NW-4 | Desert shrub | (poor) | A | 1.03 | 63 |
| | Total Area / Weighted Curve Number | | | 1.03 | 63 |
| | | | | ==== | == |
| FC-NW-5 | Desert shrub | (poor) | A | 1.55 | 63 |
| | Total Area / Weighted Curve Number | | | 1.55 | 63 |
| | | | | ==== | == |
| FC-NW-6 | Desert shrub | (poor) | A | .87 | 63 |
| | Total Area / Weighted Curve Number | | | .87 | 63 |
| | | | | === | == |

# REFERENCE 10

CWK

OUTFALL FC-NW
Nye County, Nevada

Reach Channel Rating Details

| Reach Identifier | Reach Length (ft) | Reach Manning's n | Friction Slope (ft/ft) | Bottom Width (ft) | Side Slope |
|---|---|---|---|---|---|
| FLUME NW-B | 80 | 0.036 | 0.33 | 4 | 2 :1 |
| FLUME NW-A | 100 | 0.036 | 0.33 | 4 | 2 :1 |

| Reach Identifier | Stage (ft) | Flow (cfs) | End Area (sq ft) | Top Width (ft) | Friction Slope (ft/ft) |
|---|---|---|---|---|---|
| FLUME NW-B | 0.0 | 0.000 | 0 | 4 | 0.33 |
| | 0.5 | 32.230 | 2.5 | 6 | |
| | 1.0 | 113.039 | 6 | 8 | |
| | 2.0 | 436.973 | 16 | 12 | |
| | 5.0 | 3182.968 | 70 | 24 | |
| | 10.0 | 16475.771 | 240 | 44 | |
| | 20.0 | 93056.651 | 880 | 84 | |
| FLUME NW-A | 0.0 | 0.000 | 0 | 4 | 0.33 |
| | 0.5 | 32.230 | 2.5 | 6 | |
| | 1.0 | 113.039 | 6 | 8 | |
| | 2.0 | 436.973 | 16 | 12 | |
| | 5.0 | 3182.968 | 70 | 24 | |
| | 10.0 | 16475.771 | 240 | 44 | |
| | 20.0 | 93056.651 | 880 | 84 | |

**REFERENCE 10**

WinTR-55 Current Data Description

--- Identification Data ---

User: CWK
Project:
SubTitle: OUTFALL FC-NE
State: Nevada
County: Nye
Filename: F:\Data\143418 - USEN T13 Design\Design\Calculations\Erosion\Water Erosion\TR-55 Model Runs - Fi

Date: 3/7/2016
Units: English
Areal Units: Acres

--- Sub-Area Data ---

| Name | Description | Reach | Area(ac) | RCN | Tc |
|---|---|---|---|---|---|
| FC-NE-1 | | FLUME NE-A | 0.93 | 63 | 0.1 |
| FC-NE-2 | | FLUME NE-A | 0.86 | 63 | 0.1 |
| FC-NE-3 | | FLUME NE-B | 1.35 | 63 | 0.1 |
| FC-NE-4 | | FLUME NE-B | 1.03 | 63 | 0.1 |
| FC-NE-5 | | Outlet | 1.55 | 63 | 0.1 |
| FC-NE-6 | | Outlet | 0.87 | 63 | 0.1 |

Total area: 6.59 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

| 2-Yr (in) | 5-Yr (in) | 25-Yr (in) | 100-Yr (in) | -Yr (in) | -Yr (in) | -Yr (in) |
|---|---|---|---|---|---|---|
| .94 | 1.39 | 2.26 | 3.13 | .0 | .0 | .0 |

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

# REFERENCE 10

CWK

OUTFALL FC-NE
Nye County, Nevada

Storm Data

Rainfall Depth by Rainfall Return Period

| 2-Yr (in) | 5-Yr (in) | 25-Yr (in) | 100-Yr (in) | -Yr (in) | -Yr (in) | -Yr (in) |
|---|---|---|---|---|---|---|
| .94 | 1.39 | 2.26 | 3.13 | .0 | .0 | .0 |

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

# REFERENCE 10

CWK

OUTFALL FC-NE
Nye County, Nevada

Watershed Peak Table

| Sub-Area or Reach Identifier | Peak Flow by Rainfall Return Period 2-Yr (cfs) | 5-Yr (cfs) | 25-Yr (cfs) | 100-Yr (cfs) |
|---|---|---|---|---|
| SUBAREAS | | | | |
| FC-NE-1 | .00 | .00 | 0.13 | 0.58 |
| FC-NE-2 | .00 | .00 | 0.12 | 0.54 |
| FC-NE-3 | .00 | .00 | 0.19 | 0.84 |
| FC-NE-4 | .00 | .00 | 0.14 | 0.64 |
| FC-NE-5 | .00 | .00 | 0.22 | 0.97 |
| FC-NE-6 | .00 | .00 | 0.12 | 0.54 |
| REACHES | | | | |
| FLUME NE-B | .00 | .00 | 0.58 | 2.60 |
| Down | .00 | .00 | 0.58 | 2.60 |
| FLUME NE-A | .00 | .00 | 0.25 | 1.12 |
| Down | .00 | .00 | 0.25 | 1.12 |
| OUTLET | .00 | .00 | 0.92 | 4.11 |

# REFERENCE 10

CWK

OUTFALL FC-NE
Nye County, Nevada

Hydrograph Peak/Peak Time Table

| Sub-Area or Reach Identifier | Peak Flow and Peak Time (hr) by Rainfall Return Period 2-Yr (cfs) | (hr) | 5-Yr (cfs) | (hr) | 25-Yr (cfs) | (hr) | 100-Yr (cfs) | (hr) |
|---|---|---|---|---|---|---|---|---|
| SUBAREAS | | | | | | | | |
| FC-NE-1 | .00 | n/a | .00 | n/a | 0.13 | 12.04 | 0.58 | 12.02 |
| FC-NE-2 | .00 | n/a | .00 | n/a | 0.12 | 12.04 | 0.54 | 12.02 |
| FC-NE-3 | .00 | n/a | .00 | n/a | 0.19 | 12.04 | 0.84 | 12.02 |
| FC-NE-4 | .00 | n/a | .00 | n/a | 0.14 | 12.04 | 0.64 | 12.02 |
| FC-NE-5 | .00 | n/a | .00 | n/a | 0.22 | 12.04 | 0.97 | 12.02 |
| FC-NE-6 | .00 | n/a | .00 | n/a | 0.12 | 12.04 | 0.54 | 12.02 |
| REACHES | | | | | | | | |
| FLUME NE-B | .00 | n/a | .00 | n/a | 0.58 | 12.04 | 2.60 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 0.58 | 12.04 | 2.60 | 12.02 |
| FLUME NE-A | .00 | n/a | .00 | n/a | 0.25 | 12.04 | 1.12 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 0.25 | 12.04 | 1.12 | 12.02 |
| OUTLET | .00 | | .00 | | 0.92 | | 4.11 | |

REFERENCE 10

CWK

OUTFALL FC-NE
Nye County, Nevada

Sub-Area Summary Table

| Sub-Area Identifier | Drainage Area (ac) | Time of Concentration (hr) | Curve Number | Receiving Reach | Sub-Area Description |
|---|---|---|---|---|---|
| FC-NE-1 | .93 | 0.100 | 63 | FLUME NE-A | |
| FC-NE-2 | .86 | 0.100 | 63 | FLUME NE-A | |
| FC-NE-3 | 1.35 | 0.100 | 63 | FLUME NE-B | |
| FC-NE-4 | 1.03 | 0.100 | 63 | FLUME NE-B | |
| FC-NE-5 | 1.55 | 0.100 | 63 | Outlet | |
| FC-NE-6 | .87 | 0.100 | 63 | Outlet | |

Total Area: 6.59 (ac)

REFERENCE 10

CWK

OUTFALL FC-NE
Nye County, Nevada

Reach Summary Table

| Reach Identifier | Receiving Reach Identifier | Reach Length (ft) | Routing Method |
|---|---|---|---|
| FLUME NE-B | Outlet | 80 | CHANNEL |
| FLUME NE-A | FLUME NE-B | 100 | CHANNEL |

REFERENCE 10

CWK

OUTFALL FC-NE
Nye County, Nevada

Sub-Area Time of Concentration Details

| Sub-Area Identifier/ | Flow Length (ft) | Slope (ft/ft) | Mannings's n | End Area (sq ft) | Wetted Perimeter (ft) | Velocity (ft/sec) | Travel Time (hr) |
|---|---|---|---|---|---|---|---|
| FC-NE-1 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 495 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.594 | 0.016 |
| | | | | | | Time of Concentration | 0.1 |
| FC-NE-2 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 421 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.996 | 0.013 |
| | | | | | | Time of Concentration | 0.1 |
| FC-NE-3 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 610 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.918 | 0.019 |
| | | | | | | Time of Concentration | 0.1 |
| FC-NE-4 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 421 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.996 | 0.013 |
| | | | | | | Time of Concentration | 0.1 |
| FC-NE-5 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| | | | | | | Time of Concentration | 0.1 |
| FC-NE-6 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| | | | | | | Time of Concentration | 0.1 |

# REFERENCE 10

CWK

OUTFALL FC-NE
Nye County, Nevada

Sub-Area Land Use and Curve Number Details

| Sub-Area Identifier | Land Use | | Hydrologic Soil Group | Sub-Area Area (ac) | Curve Number |
|---|---|---|---|---|---|
| FC-NE-1 | Desert shrub | (poor) | A | .93 | 63 |
| | Total Area / Weighted Curve Number | | | .93 | 63 |
| | | | | === | == |
| FC-NE-2 | Desert shrub | (poor) | A | .86 | 63 |
| | Total Area / Weighted Curve Number | | | .86 | 63 |
| | | | | === | == |
| FC-NE-3 | Desert shrub | (poor) | A | 1.35 | 63 |
| | Total Area / Weighted Curve Number | | | 1.35 | 63 |
| | | | | ==== | == |
| FC-NE-4 | Desert shrub | (poor) | A | 1.03 | 63 |
| | Total Area / Weighted Curve Number | | | 1.03 | 63 |
| | | | | ==== | == |
| FC-NE-5 | Desert shrub | (poor) | A | 1.55 | 63 |
| | Total Area / Weighted Curve Number | | | 1.55 | 63 |
| | | | | ==== | == |
| FC-NE-6 | Desert shrub | (poor) | A | .87 | 63 |
| | Total Area / Weighted Curve Number | | | .87 | 63 |
| | | | | === | == |

# REFERENCE 10

CWK

OUTFALL FC-NE
Nye County, Nevada

Reach Channel Rating Details

| Reach Identifier | Reach Length (ft) | Reach Manning's n | Friction Slope (ft/ft) | Bottom Width (ft) | Side Slope |
|---|---|---|---|---|---|
| FLUME NE-B | 80 | 0.036 | 0.33 | 4 | 2 :1 |
| FLUME NE-A | 100 | 0.036 | 0.33 | 4 | 2 :1 |

| Reach Identifier | Stage (ft) | Flow (cfs) | End Area (sq ft) | Top Width (ft) | Friction Slope (ft/ft) |
|---|---|---|---|---|---|
| FLUME NE-B | 0.0 | 0.000 | 0 | 4 | 0.33 |
| | 0.5 | 32.230 | 2.5 | 6 | |
| | 1.0 | 113.039 | 6 | 8 | |
| | 2.0 | 436.973 | 16 | 12 | |
| | 5.0 | 3182.968 | 70 | 24 | |
| | 10.0 | 16475.771 | 240 | 44 | |
| | 20.0 | 93056.651 | 880 | 84 | |
| FLUME NE-A | 0.0 | 0.000 | 0 | 4 | 0.33 |
| | 0.5 | 32.230 | 2.5 | 6 | |
| | 1.0 | 113.039 | 6 | 8 | |
| | 2.0 | 436.973 | 16 | 12 | |
| | 5.0 | 3182.968 | 70 | 24 | |
| | 10.0 | 16475.771 | 240 | 44 | |
| | 20.0 | 93056.651 | 880 | 84 | |

**REFERENCE 10**

WinTR-55 Current Data Description

--- Identification Data ---

User: CWK
Project: T13 Final Cover
SubTitle: OUTFALL FC-E-A
State: Nevada
County: Nye
Filename: F:\Data\143418 - USEN T13 Design\Design\Calculations\Erosion\Water Erosion\TR-55 Model Runs - Fi

Date: 3/7/2016
Units: English
Areal Units: Acres

--- Sub-Area Data ---

| Name | Description | Reach | Area(ac) | RCN | Tc |
|---|---|---|---|---|---|
| FC-E1 | | UpperDitch | 0.98 | 63 | 0.1 |
| FC-E2 | | LowerDitch | 0.92 | 63 | 0.1 |
| FC-E3 | | Outlet | 0.49 | 63 | 0.1 |

Total area: 2.39 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

| 2-Yr (in) | 5-Yr (in) | 25-Yr (in) | 100-Yr (in) | -Yr (in) | -Yr (in) | -Yr (in) |
|---|---|---|---|---|---|---|
| .94 | 1.39 | 2.26 | 3.13 | .0 | .0 | .0 |

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

# REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-E-A
Nye County, Nevada

Storm Data

Rainfall Depth by Rainfall Return Period

| 2-Yr (in) | 5-Yr (in) | 25-Yr (in) | 100-Yr (in) | -Yr (in) | -Yr (in) | -Yr (in) |
|---|---|---|---|---|---|---|
| .94 | 1.39 | 2.26 | 3.13 | .0 | .0 | .0 |

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

**REFERENCE 10**

CWK

T13 Final Cover
OUTFALL FC-E-A
Nye County, Nevada

Watershed Peak Table

| Sub-Area or Reach Identifier | Peak Flow by Rainfall Return Period 2-Yr (cfs) | 5-Yr (cfs) | 25-Yr (cfs) | 100-Yr (cfs) |
|---|---|---|---|---|
| SUBAREAS | | | | |
| FC-E1 | .00 | .00 | 0.14 | 0.61 |
| FC-E2 | .00 | .00 | 0.13 | 0.58 |
| FC-E3 | .00 | .00 | 0.07 | 0.31 |
| REACHES | | | | |
| LowerDitch | .00 | .00 | 0.26 | 1.18 |
| Down | .00 | .00 | 0.26 | 1.18 |
| UpperDitch | .00 | .00 | 0.14 | 0.61 |
| Down | .00 | .00 | 0.14 | 0.61 |
| OUTLET | .00 | .00 | 0.33 | 1.48 |

# REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-E-A
Nye County, Nevada

Hydrograph Peak/Peak Time Table

| Sub-Area or Reach Identifier | Peak Flow and Peak Time (hr) by Rainfall Return Period 2-Yr (cfs) | (hr) | 5-Yr (cfs) | (hr) | 25-Yr (cfs) | (hr) | 100-Yr (cfs) | (hr) |
|---|---|---|---|---|---|---|---|---|
| SUBAREAS | | | | | | | | |
| FC-E1 | .00 | n/a | .00 | n/a | 0.14 | 12.04 | 0.61 | 12.02 |
| FC-E2 | .00 | n/a | .00 | n/a | 0.13 | 12.04 | 0.58 | 12.02 |
| FC-E3 | .00 | n/a | .00 | n/a | 0.07 | 12.04 | 0.31 | 12.02 |
| REACHES | | | | | | | | |
| LowerDitch | .00 | n/a | .00 | n/a | 0.26 | 12.02 | 1.18 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 0.26 | 12.00 | 1.18 | 12.04 |
| UpperDitch | .00 | n/a | .00 | n/a | 0.14 | 12.04 | 0.61 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 0.14 | 11.99 | 0.61 | 12.03 |
| OUTLET | .00 | | .00 | | 0.33 | | 1.48 | |

REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-E-A
Nye County, Nevada

Sub-Area Summary Table

| Sub-Area Identifier | Drainage Area (ac) | Time of Concentration (hr) | Curve Number | Receiving Reach | Sub-Area Description |
|---|---|---|---|---|---|
| FC-E1 | .98 | 0.100 | 63 | UpperDitch | |
| FC-E2 | .92 | 0.100 | 63 | LowerDitch | |
| FC-E3 | .49 | 0.100 | 63 | Outlet | |

Total Area: 2.39 (ac)

REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-E-A
Nye County, Nevada

Reach Summary Table

| Reach Identifier | Receiving Reach Identifier | Reach Length (ft) | Routing Method |
|---|---|---|---|
| LowerDitch | Outlet | 296 | CHANNEL |
| UpperDitch | LowerDitch | 299 | CHANNEL |

**REFERENCE 10**

CWK

T13 Final Cover
OUTFALL FC-E-A
Nye County, Nevada

Sub-Area Time of Concentration Details

| Sub-Area Identifier/ | Flow Length (ft) | Slope (ft/ft) | Mannings's n | End Area (sq ft) | Wetted Perimeter (ft) | Velocity (ft/sec) | Travel Time (hr) |
|---|---|---|---|---|---|---|---|
| FC-E1 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 406 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.675 | 0.013 |
| | | | | | Time of Concentration | | 0.1 |
| FC-E2 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 209 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.294 | 0.007 |
| | | | | | Time of Concentration | | 0.1 |
| FC-E3 | | | | | | | |
| SHEET | 100 | 0.3330 | 0.011 | | | | 0.012 |
| | | | | | Time of Concentration | | 0.1 |

REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-E-A
Nye County, Nevada

Sub-Area Land Use and Curve Number Details

| Sub-Area Identifier | Land Use | | Hydrologic Soil Group | Sub-Area Area (ac) | Curve Number |
|---|---|---|---|---|---|
| FC-E1 | Desert shrub | (poor) | A | .98 | 63 |
| | Total Area / Weighted Curve Number | | | .98 | 63 |
| | | | | === | == |
| FC-E2 | Desert shrub | (poor) | A | .92 | 63 |
| | Total Area / Weighted Curve Number | | | .92 | 63 |
| | | | | === | == |
| FC-E3 | Desert shrub | (poor) | A | .49 | 63 |
| | Total Area / Weighted Curve Number | | | .49 | 63 |
| | | | | === | == |

# REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-E-A
Nye County, Nevada

Reach Channel Rating Details

| Reach Identifier | Reach Length (ft) | Reach Manning's n | Friction Slope (ft/ft) | Bottom Width (ft) | Side Slope |
|---|---|---|---|---|---|
| LowerDitch | 296 | 0.036 | 0.1 | 0.3 | 2 :1 |
| UpperDitch | 299 | 0.036 | 0.1 | 0.3 | 2 :1 |

| Reach Identifier | Stage (ft) | Flow (cfs) | End Area (sq ft) | Top Width (ft) | Friction Slope (ft/ft) |
|---|---|---|---|---|---|
| LowerDitch | 0.0 | 0.000 | 0 | 0.3 | 0.1 |
| | 0.5 | 3.250 | 0.6 | 2.3 | |
| | 1.0 | 17.917 | 2.3 | 4.3 | |
| | 2.0 | 105.294 | 8.5 | 8.3 | |
| | 5.0 | 1154.331 | 51.3 | 20.3 | |
| | 10.0 | 7207.766 | 202.5 | 40.3 | |
| | 20.0 | 45380.713 | 805 | 80.3 | |
| UpperDitch | 0.0 | 0.000 | 0 | 0.3 | 0.1 |
| | 0.5 | 3.250 | 0.6 | 2.3 | |
| | 1.0 | 17.917 | 2.3 | 4.3 | |
| | 2.0 | 105.294 | 8.5 | 8.3 | |
| | 5.0 | 1154.331 | 51.3 | 20.3 | |
| | 10.0 | 7207.766 | 202.5 | 40.3 | |
| | 20.0 | 45380.713 | 805 | 80.3 | |

**REFERENCE 10**

WinTR-55 Current Data Description

--- Identification Data ---

User: CWK
Project: T13 Final Cover
SubTitle: FC-E-B
State: Nevada
County: Nye
Filename: F:\Data\143418 - USEN T13 Design\Design\Calculations\Erosion\Water Erosion\TR-55 Model Runs - Fi

Date: 3/7/2016
Units: English
Areal Units: Acres

--- Sub-Area Data ---

| Name | Description | Reach | Area(ac) | RCN | Tc |
|---|---|---|---|---|---|
| FC-E4 | | FLUME EAST | 0.67 | 63 | 0.1 |
| FC-E5 | | Outlet | 1.02 | 63 | 0.1 |
| FC-E6 | | Outlet | 0.62 | 63 | 0.1 |
| FC-E7 | | Outlet | 0.38 | 63 | 0.1 |

Total area: 2.69 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

| 2-Yr (in) | 5-Yr (in) | 25-Yr (in) | 100-Yr (in) | -Yr (in) | -Yr (in) | -Yr (in) |
|---|---|---|---|---|---|---|
| .94 | 1.39 | 2.26 | 3.13 | .0 | .0 | .0 |

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

# REFERENCE 10

CWK

T13 Final Cover
FC-E-B
Nye County, Nevada

Storm Data

Rainfall Depth by Rainfall Return Period

| 2-Yr (in) | 5-Yr (in) | 25-Yr (in) | 100-Yr (in) | -Yr (in) | -Yr (in) | -Yr (in) |
|---|---|---|---|---|---|---|
| .94 | 1.39 | 2.26 | 3.13 | .0 | .0 | .0 |

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

**REFERENCE 10**

CWK

T13 Final Cover
FC-E-B
Nye County, Nevada

Watershed Peak Table

| Sub-Area or Reach Identifier | Peak Flow by Rainfall Return Period 2-Yr (cfs) | 5-Yr (cfs) | 25-Yr (cfs) | 100-Yr (cfs) |
|---|---|---|---|---|
| SUBAREAS | | | | |
| FC-E4 | .00 | .00 | 0.09 | 0.42 |
| FC-E5 | .00 | .00 | 0.14 | 0.64 |
| FC-E6 | .00 | .00 | 0.09 | 0.39 |
| FC-E7 | .00 | .00 | 0.05 | 0.24 |
| REACHES | | | | |
| FLUME EAST | .00 | .00 | 0.09 | 0.42 |
| Down | .00 | .00 | 0.09 | 0.42 |
| OUTLET | .00 | .00 | 0.38 | 1.68 |

# REFERENCE 10

CWK

T13 Final Cover
FC-E-B
Nye County, Nevada

Hydrograph Peak/Peak Time Table

| Sub-Area or Reach Identifier | Peak Flow and Peak Time (hr) by Rainfall Return Period 2-Yr (cfs) | (hr) | 5-Yr (cfs) | (hr) | 25-Yr (cfs) | (hr) | 100-Yr (cfs) | (hr) |
|---|---|---|---|---|---|---|---|---|
| SUBAREAS | | | | | | | | |
| FC-E4 | .00 | n/a | .00 | n/a | 0.09 | 12.04 | 0.42 | 12.02 |
| FC-E5 | .00 | n/a | .00 | n/a | 0.14 | 12.04 | 0.64 | 12.02 |
| FC-E6 | .00 | n/a | .00 | n/a | 0.09 | 12.04 | 0.39 | 12.02 |
| FC-E7 | .00 | n/a | .00 | n/a | 0.05 | 12.04 | 0.24 | 12.02 |
| REACHES | | | | | | | | |
| FLUME EAST | .00 | n/a | .00 | n/a | 0.09 | 12.04 | 0.42 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 0.09 | 11.99 | 0.42 | 12.02 |
| OUTLET | .00 | | .00 | | 0.38 | | 1.68 | |

**REFERENCE 10**

CWK

T13 Final Cover
FC-E-B
Nye County, Nevada

Sub-Area Summary Table

| Sub-Area Identifier | Drainage Area (ac) | Time of Concentration (hr) | Curve Number | Receiving Reach | Sub-Area Description |
|---|---|---|---|---|---|
| FC-E4 | .67 | 0.100 | 63 | FLUME EAST | |
| FC-E5 | 1.02 | 0.100 | 63 | Outlet | |
| FC-E6 | .62 | 0.100 | 63 | Outlet | |
| FC-E7 | .38 | 0.100 | 63 | Outlet | |

Total Area: 2.69 (ac)

REFERENCE 10

CWK

T13 Final Cover
FC-E-B
Nye County, Nevada

Reach Summary Table

| Reach Identifier | Receiving Reach Identifier | Reach Length (ft) | Routing Method |
|---|---|---|---|
| FLUME EAST | Outlet | 90 | CHANNEL |

**REFERENCE 10**

CWK

T13 Final Cover
FC-E-B
Nye County, Nevada

Sub-Area Time of Concentration Details

| Sub-Area Identifier/ | Flow Length (ft) | Slope (ft/ft) | Mannings's n | End Area (sq ft) | Wetted Perimeter (ft) | Velocity (ft/sec) | Travel Time (hr) |
|---|---|---|---|---|---|---|---|
| FC-E4 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 444 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.810 | 0.014 |
| | | | | | Time of Concentration | | 0.1 |
| FC-E5 | | | | | | | |
| SHEET | 100 | 0.3330 | 0.011 | | | | 0.012 |
| CHANNEL | 512 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.889 | 0.016 |
| | | | | | Time of Concentration | | 0.1 |
| FC-E6 | | | | | | | |
| SHEET | 90 | 0.3330 | 0.011 | | | | 0.011 |
| | | | | | Time of Concentration | | 0.1 |
| FC-E7 | | | | | | | |
| SHEET | 90 | 0.3300 | 0.011 | | | | 0.011 |
| | | | | | Time of Concentration | | 0.1 |

REFERENCE 10

CWK

T13 Final Cover
FC-E-B
Nye County, Nevada

Sub-Area Land Use and Curve Number Details

| Sub-Area Identifier | Land Use | | Hydrologic Soil Group | Sub-Area Area (ac) | Curve Number |
|---|---|---|---|---|---|
| FC-E4 | Desert shrub | (poor) | A | .67 | 63 |
| | Total Area / Weighted Curve Number | | | .67 | 63 |
| | | | | === | == |
| FC-E5 | Desert shrub | (poor) | A | 1.02 | 63 |
| | Total Area / Weighted Curve Number | | | 1.02 | 63 |
| | | | | ==== | == |
| FC-E6 | Desert shrub | (poor) | A | .62 | 63 |
| | Total Area / Weighted Curve Number | | | .62 | 63 |
| | | | | === | == |
| FC-E7 | Desert shrub | (poor) | A | .38 | 63 |
| | Total Area / Weighted Curve Number | | | .38 | 63 |
| | | | | === | == |

# REFERENCE 10

CWK

T13 Final Cover
FC-E-B
Nye County, Nevada

Reach Channel Rating Details

| Reach Identifier | Reach Length (ft) | Reach Manning's n | Friction Slope (ft/ft) | Bottom Width (ft) | Side Slope |
|---|---|---|---|---|---|
| FLUME EAST | 90 | 0.036 | 0.33 | 4 | 2 :1 |

| Reach Identifier | Stage (ft) | Flow (cfs) | End Area (sq ft) | Top Width (ft) | Friction Slope (ft/ft) |
|---|---|---|---|---|---|
| FLUME EAST | 0.0 | 0.000 | 0 | 4 | 0.33 |
| | 0.5 | 32.230 | 2.5 | 6 | |
| | 1.0 | 113.039 | 6 | 8 | |
| | 2.0 | 436.973 | 16 | 12 | |
| | 5.0 | 3182.968 | 70 | 24 | |
| | 10.0 | 16475.771 | 240 | 44 | |
| | 20.0 | 93056.651 | 880 | 84 | |

**REFERENCE 10**

WinTR-55 Current Data Description

--- Identification Data ---

User: CWK
Project: T13 Final Cover
SubTitle: Outfall FC-SE
State: Nevada
County: Nye
Filename: F:\Data\143418 - USEN T13 Design\Design\Calculations\Erosion\Water Erosion\TR-55 Model Runs - Fi

Date: 3/7/2016
Units: English
Areal Units: Acres

--- Sub-Area Data ---

| Name | Description | Reach | Area(ac) | RCN | Tc |
|---|---|---|---|---|---|
| FC-SE-1 | | FLUME SE-B | 0.59 | 63 | 0.1 |
| FC-SE-2 | | FLUME SE-B | 0.55 | 63 | 0.1 |
| FC-SE-3 | | FLUME SE-A | 0.83 | 63 | 0.1 |
| FC-SE-4 | | FLUME SE-A | 0.59 | 63 | 0.1 |
| FC-SE-5 | | Outlet | 0.53 | 63 | 0.1 |
| FC-SE-6 | | Outlet | 0.3 | 63 | 0.1 |
| FC-UDE-3 | | FLUME SE-C | 2.01 | 63 | 0.1 |
| FC-UDE-2 | | FLUME SE-D | 1.88 | 63 | 0.1 |
| FC-UDE-1 | | FLUME SE-E | 0.8 | 63 | 0.1 |

Total area: 8.08 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

| 2-Yr (in) | 5-Yr (in) | 25-Yr (in) | 100-Yr (in) | -Yr (in) | -Yr (in) | -Yr (in) |
|---|---|---|---|---|---|---|
| .94 | 1.39 | 2.26 | 3.13 | .0 | .0 | .0 |

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

# REFERENCE 10

CWK

T13 Final Cover
Outfall FC-SE
Nye County, Nevada

Storm Data

Rainfall Depth by Rainfall Return Period

| 2-Yr (in) | 5-Yr (in) | 25-Yr (in) | 100-Yr (in) | -Yr (in) | -Yr (in) | -Yr (in) |
|---|---|---|---|---|---|---|
| .94 | 1.39 | 2.26 | 3.13 | .0 | .0 | .0 |

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

REFERENCE 10

CWK

T13 Final Cover
Outfall FC-SE
Nye County, Nevada

Watershed Peak Table

| Sub-Area or Reach Identifier | Peak Flow by Rainfall Return Period 2-Yr (cfs) | 5-Yr (cfs) | 25-Yr (cfs) | 100-Yr (cfs) |
|---|---|---|---|---|
| SUBAREAS | | | | |
| FC-SE-1 | .00 | .00 | 0.08 | 0.37 |
| FC-SE-2 | .00 | .00 | 0.08 | 0.34 |
| FC-SE-3 | .00 | .00 | 0.12 | 0.52 |
| FC-SE-4 | .00 | .00 | 0.08 | 0.37 |
| FC-SE-5 | .00 | .00 | 0.07 | 0.33 |
| FC-SE-6 | .00 | .00 | .00 | 0.19 |
| FC-UDE-3 | .00 | .00 | 0.28 | 1.26 |
| FC-UDE-2 | .00 | .00 | 0.26 | 1.18 |
| FC-UDE-1 | .00 | .00 | 0.11 | 0.50 |
| REACHES | | | | |
| FLUME SE-A | .00 | .00 | 1.01 | 4.52 |
| Down | .00 | .00 | 1.01 | 4.52 |
| FLUME SE-B | .00 | .00 | 0.81 | 3.63 |
| Down | .00 | .00 | 0.81 | 3.63 |
| FLUME SE-C | .00 | .00 | 0.66 | 2.92 |
| Down | .00 | .00 | 0.66 | 2.92 |
| FLUME SE-D | .00 | .00 | 0.38 | 1.67 |
| Down | .00 | .00 | 0.38 | 1.67 |
| FLUME SE-E | .00 | .00 | 0.11 | 0.50 |
| Down | .00 | .00 | 0.11 | 0.50 |
| OUTLET | .00 | .00 | 1.08 | 5.03 |

# REFERENCE 10

CWK

T13 Final Cover
Outfall FC-SE
Nye County, Nevada

Hydrograph Peak/Peak Time Table

| Sub-Area or Reach Identifier | Peak Flow and Peak Time (hr) by Rainfall Return Period 2-Yr (cfs) | (hr) | 5-Yr (cfs) | (hr) | 25-Yr (cfs) | (hr) | 100-Yr (cfs) | (hr) |
|---|---|---|---|---|---|---|---|---|
| SUBAREAS | | | | | | | | |
| FC-SE-1 | .00 | n/a | .00 | n/a | 0.08 | 12.04 | 0.37 | 12.02 |
| FC-SE-2 | .00 | n/a | .00 | n/a | 0.08 | 12.04 | 0.34 | 12.02 |
| FC-SE-3 | .00 | n/a | .00 | n/a | 0.12 | 12.04 | 0.52 | 12.02 |
| FC-SE-4 | .00 | n/a | .00 | n/a | 0.08 | 12.04 | 0.37 | 12.02 |
| FC-SE-5 | .00 | n/a | .00 | n/a | 0.07 | 12.04 | 0.33 | 12.02 |
| FC-SE-6 | .00 | n/a | .00 | n/a | .00 | n/a | 0.19 | 12.02 |
| FC-UDE-3 | .00 | n/a | .00 | n/a | 0.28 | 12.04 | 1.26 | 12.02 |
| FC-UDE-2 | .00 | n/a | .00 | n/a | 0.26 | 12.04 | 1.18 | 12.02 |
| FC-UDE-1 | .00 | n/a | .00 | n/a | 0.11 | 12.04 | 0.50 | 12.02 |
| REACHES | | | | | | | | |
| FLUME SE-A | .00 | n/a | .00 | n/a | 1.01 | 12.04 | 4.52 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 1.01 | 12.04 | 4.52 | 12.02 |
| FLUME SE-B | .00 | n/a | .00 | n/a | 0.81 | 12.04 | 3.63 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 0.81 | 12.04 | 3.63 | 12.02 |
| FLUME SE-C | .00 | n/a | .00 | n/a | 0.66 | 12.04 | 2.92 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 0.66 | 12.04 | 2.92 | 12.02 |
| FLUME SE-D | .00 | n/a | .00 | n/a | 0.38 | 12.04 | 1.67 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 0.38 | 12.04 | 1.67 | 12.02 |
| FLUME SE-E | .00 | n/a | .00 | n/a | 0.11 | 12.04 | 0.50 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 0.11 | 12.04 | 0.50 | 12.02 |
| OUTLET | .00 | | .00 | | 1.08 | | 5.03 | |

REFERENCE 10

CWK

T13 Final Cover
Outfall FC-SE
Nye County, Nevada

Sub-Area Summary Table

| Sub-Area Identifier | Drainage Area (ac) | Time of Concentration (hr) | Curve Number | Receiving Reach | Sub-Area Description |
|---|---|---|---|---|---|
| FC-SE-1 | .59 | 0.100 | 63 | FLUME SE-B | |
| FC-SE-2 | .55 | 0.100 | 63 | FLUME SE-B | |
| FC-SE-3 | .83 | 0.100 | 63 | FLUME SE-A | |
| FC-SE-4 | .59 | 0.100 | 63 | FLUME SE-A | |
| FC-SE-5 | .53 | 0.100 | 63 | Outlet | |
| FC-SE-6 | .30 | 0.100 | 63 | Outlet | |
| FC-UDE-3 | 2.01 | 0.100 | 63 | FLUME SE-C | |
| FC-UDE-2 | 1.88 | 0.100 | 63 | FLUME SE-D | |
| FC-UDE-1 | .80 | 0.100 | 63 | FLUME SE-E | |

Total Area: 8.08 (ac)

REFERENCE 10

CWK

T13 Final Cover
Outfall FC-SE
Nye County, Nevada

Reach Summary Table

| Reach Identifier | Receiving Reach Identifier | Reach Length (ft) | Routing Method |
|---|---|---|---|
| FLUME SE-A | Outlet | 50 | CHANNEL |
| FLUME SE-B | FLUME SE-A | 100 | CHANNEL |
| FLUME SE-C | FLUME SE-B | 80 | CHANNEL |
| FLUME SE-D | FLUME SE-C | 200 | CHANNEL |
| FLUME SE-E | FLUME SE-D | 200 | CHANNEL |

# REFERENCE 10

CWK

T13 Final Cover
Outfall FC-SE
Nye County, Nevada

Sub-Area Time of Concentration Details

| Sub-Area Identifier/ | Flow Length (ft) | Slope (ft/ft) | Mannings's n | End Area (sq ft) | Wetted Perimeter (ft) | Velocity (ft/sec) | Travel Time (hr) |
|---|---|---|---|---|---|---|---|
| FC-SE-1 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 296 | 0.0200 | 0.023 | 10.00 | 10.79 | 9.136 | 0.009 |
| | | | | | Time of Concentration | | 0.1 |
| FC-SE-2 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 245 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.507 | 0.008 |
| | | | | | Time of Concentration | | 0.1 |
| FC-SE-3 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 393 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.397 | 0.013 |
| | | | | | Time of Concentration | | 0.1 |
| FC-SE-4 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 245 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.507 | 0.008 |
| | | | | | Time of Concentration | | 0.1 |
| FC-SE-5 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| | | | | | Time of Concentration | | 0.1 |
| FC-SE-6 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| | | | | | Time of Concentration | | 0.1 |
| FC-UDE-3 | | | | | | | |
| SHEET | 100 | 0.0500 | 0.011 | | | | 0.026 |
| SHALLOW | 252 | 0.0100 | 0.944 | | | | 0.043 |
| | | | | | Time of Concentration | | 0.1 |
| FC-UDE-2 | | | | | | | |
| SHEET | 100 | 0.0500 | 0.011 | | | | 0.026 |
| SHALLOW | 252 | 0.0100 | 0.944 | | | | 0.043 |
| | | | | | Time of Concentration | | 0.1 |
| FC-UDE-1 | | | | | | | |
| SHEET | 100 | 0.0500 | 0.011 | | | | 0.026 |
| SHALLOW | 252 | 0.0100 | 0.944 | | | | 0.043 |
| | | | | | Time of Concentration | | 0.1 |

# REFERENCE 10

CWK

T13 Final Cover
Outfall FC-SE
Nye County, Nevada

Sub-Area Land Use and Curve Number Details

| Sub-Area Identifier | Land Use | | Hydrologic Soil Group | Sub-Area Area (ac) | Curve Number |
|---|---|---|---|---|---|
| FC-SE-1 | Desert shrub | (poor) | A | .59 | 63 |
| | Total Area / Weighted Curve Number | | | .59 | 63 |
| | | | | === | == |
| FC-SE-2 | Desert shrub | (poor) | A | .55 | 63 |
| | Total Area / Weighted Curve Number | | | .55 | 63 |
| | | | | === | == |
| FC-SE-3 | Desert shrub | (poor) | A | .83 | 63 |
| | Total Area / Weighted Curve Number | | | .83 | 63 |
| | | | | === | == |
| FC-SE-4 | Desert shrub | (poor) | A | .59 | 63 |
| | Total Area / Weighted Curve Number | | | .59 | 63 |
| | | | | === | == |
| FC-SE-5 | Desert shrub | (poor) | A | .53 | 63 |
| | Total Area / Weighted Curve Number | | | .53 | 63 |
| | | | | === | == |
| FC-SE-6 | Desert shrub | (poor) | A | .3 | 63 |
| | Total Area / Weighted Curve Number | | | .3 | 63 |
| | | | | == | == |
| FC-UDE-3 | Desert shrub | (poor) | A | 2.01 | 63 |
| | Total Area / Weighted Curve Number | | | 2.01 | 63 |
| | | | | ==== | == |
| FC-UDE-2 | Desert shrub | (poor) | A | 1.88 | 63 |
| | Total Area / Weighted Curve Number | | | 1.88 | 63 |
| | | | | ==== | == |
| FC-UDE-1 | Desert shrub | (poor) | A | .8 | 63 |
| | Total Area / Weighted Curve Number | | | .8 | 63 |
| | | | | == | == |

# REFERENCE 10

CWK

T13 Final Cover
Outfall FC-SE
Nye County, Nevada

Reach Channel Rating Details

| Reach Identifier | Reach Length (ft) | Reach Manning's n | Friction Slope (ft/ft) | Bottom Width (ft) | Side Slope |
|---|---|---|---|---|---|
| FLUME SE-A | 50 | 0.036 | 0.33 | 4 | 2 :1 |
| FLUME SE-B | 100 | 0.036 | 0.33 | 4 | 2 :1 |
| FLUME SE-C | 80 | 0.036 | 0.33 | 4 | 2 :1 |
| FLUME SE-D | 200 | 0.023 | 0.05 | 4 | 2 :1 |
| FLUME SE-E | 200 | 0.023 | 0.05 | 4 | 2 :1 |

| Reach Identifier | Stage (ft) | Flow (cfs) | End Area (sq ft) | Top Width (ft) | Friction Slope (ft/ft) |
|---|---|---|---|---|---|
| FLUME SE-A | 0.0 | 0.000 | 0 | 4 | 0.33 |
| | 0.5 | 32.230 | 2.5 | 6 | |
| | 1.0 | 113.039 | 6 | 8 | |
| | 2.0 | 436.973 | 16 | 12 | |
| | 5.0 | 3182.968 | 70 | 24 | |
| | 10.0 | 16475.771 | 240 | 44 | |
| | 20.0 | 93056.651 | 880 | 84 | |
| FLUME SE-B | 0.0 | 0.000 | 0 | 4 | 0.33 |
| | 0.5 | 32.230 | 2.5 | 6 | |
| | 1.0 | 113.039 | 6 | 8 | |
| | 2.0 | 436.973 | 16 | 12 | |
| | 5.0 | 3182.968 | 70 | 24 | |
| | 10.0 | 16475.771 | 240 | 44 | |
| | 20.0 | 93056.651 | 880 | 84 | |
| FLUME SE-C | 0.0 | 0.000 | 0 | 4 | 0.33 |
| | 0.5 | 32.230 | 2.5 | 6 | |
| | 1.0 | 113.039 | 6 | 8 | |
| | 2.0 | 436.973 | 16 | 12 | |
| | 5.0 | 3182.968 | 70 | 24 | |
| | 10.0 | 16475.771 | 240 | 44 | |
| | 20.0 | 93056.651 | 880 | 84 | |
| FLUME SE-D | 0.0 | 0.000 | 0 | 4 | 0.05 |
| | 0.5 | 19.637 | 2.5 | 6 | |
| | 1.0 | 68.870 | 6 | 8 | |
| | 2.0 | 266.230 | 16 | 12 | |
| | 5.0 | 1939.255 | 70 | 24 | |
| | 10.0 | 10038.029 | 240 | 44 | |
| | 20.0 | 56695.699 | 880 | 84 | |
| FLUME SE-E | 0.0 | 0.000 | 0 | 4 | 0.05 |
| | 0.5 | 19.637 | 2.5 | 6 | |
| | 1.0 | 68.870 | 6 | 8 | |
| | 2.0 | 266.230 | 16 | 12 | |
| | 5.0 | 1939.255 | 70 | 24 | |
| | 10.0 | 10038.029 | 240 | 44 | |
| | 20.0 | 56695.699 | 880 | 84 | |

# REFERENCE 10

WinTR-55 Current Data Description

--- Identification Data ---

User: CWK
Project: T13 Final Cover
SubTitle: OUTFALL FC-SB
State: Nevada
County: Nye
Filename: F:\Data\143418 - USEN T13 Design\Design\Calculations\Erosion\Water Erosion\TR-55 Model Runs - Fi

Date: 3/7/2016
Units: English
Areal Units: Acres

--- Sub-Area Data ---

| Name | Description | Reach | Area(ac) | RCN | Tc |
|---|---|---|---|---|---|
| FC-SB-1 | | FLUME SB-D | 0.56 | 63 | 0.1 |
| FC-SB-2 | | FLUME SB-D | 0.49 | 63 | 0.1 |
| FC-SB-3 | | FLUME SB-E | 0.59 | 63 | 0.1 |
| FC-SB-4 | | FLUME SB-E | 0.51 | 63 | 0.1 |
| FC-SB-5 | | Outlet | 0.3 | 63 | 0.1 |
| FC-SB-6 | | Outlet | 0.27 | 63 | 0.1 |
| FC-UD-ME-3 | | FLUME SB-C | 2.11 | 63 | 0.1 |
| FC-UD-ME-2 | | FLUME SB-B | 2.11 | 63 | 0.1 |
| FC-UD-ME-1 | | FLUME SB-A | 0.94 | 63 | 0.1 |

Total area: 7.88 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

| 2-Yr (in) | 5-Yr (in) | 25-Yr (in) | 100-Yr (in) | -Yr (in) | -Yr (in) | -Yr (in) |
|---|---|---|---|---|---|---|
| .94 | 1.39 | 2.26 | 3.13 | .0 | .0 | .0 |

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

# REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-SB
Nye County, Nevada

Storm Data

Rainfall Depth by Rainfall Return Period

| 2-Yr (in) | 5-Yr (in) | 25-Yr (in) | 100-Yr (in) | -Yr (in) | -Yr (in) | -Yr (in) |
|---|---|---|---|---|---|---|
| .94 | 1.39 | 2.26 | 3.13 | .0 | .0 | .0 |

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-SB
Nye County, Nevada

Watershed Peak Table

| Sub-Area or Reach Identifier | Peak Flow by Rainfall Return Period 2-Yr (cfs) | 5-Yr (cfs) | 25-Yr (cfs) | 100-Yr (cfs) |
|---|---|---|---|---|
| SUBAREAS | | | | |
| FC-SB-1 | .00 | .00 | 0.08 | 0.35 |
| FC-SB-2 | .00 | .00 | 0.07 | 0.31 |
| FC-SB-3 | .00 | .00 | 0.08 | 0.37 |
| FC-SB-4 | .00 | .00 | 0.07 | 0.32 |
| FC-SB-5 | .00 | .00 | .00 | 0.19 |
| FC-SB-6 | .00 | .00 | .00 | 0.17 |
| FC-UD-ME-3 | .00 | .00 | 0.30 | 1.32 |
| FC-UD-ME-2 | .00 | .00 | 0.30 | 1.32 |
| FC-UD-ME-1 | .00 | .00 | 0.13 | 0.59 |
| REACHES | | | | |
| FLUME SB-E | .00 | .00 | 1.02 | 4.56 |
| Down | .00 | .00 | 1.02 | 4.56 |
| FLUME SB-D | .00 | .00 | 0.87 | 3.88 |
| Down | .00 | .00 | 0.87 | 3.88 |
| FLUME SB-C | .00 | .00 | 0.72 | 3.22 |
| Down | .00 | .00 | 0.72 | 3.22 |
| FLUME SB-B | .00 | .00 | 0.43 | 1.91 |
| Down | .00 | .00 | 0.43 | 1.90 |
| FLUME SB-A | .00 | .00 | 0.13 | 0.59 |
| Down | .00 | .00 | 0.13 | 0.59 |
| OUTLET | .00 | .00 | 1.02 | 4.91 |

# REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-SB
Nye County, Nevada

Hydrograph Peak/Peak Time Table

| Sub-Area or Reach Identifier | Peak Flow and Peak Time (hr) by Rainfall Return Period 2-Yr (cfs) | (hr) | 5-Yr (cfs) | (hr) | 25-Yr (cfs) | (hr) | 100-Yr (cfs) | (hr) |
|---|---|---|---|---|---|---|---|---|
| SUBAREAS | | | | | | | | |
| FC-SB-1 | .00 | n/a | .00 | n/a | 0.08 | 12.04 | 0.35 | 12.02 |
| FC-SB-2 | .00 | n/a | .00 | n/a | 0.07 | 12.04 | 0.31 | 12.02 |
| FC-SB-3 | .00 | n/a | .00 | n/a | 0.08 | 12.04 | 0.37 | 12.02 |
| FC-SB-4 | .00 | n/a | .00 | n/a | 0.07 | 12.04 | 0.32 | 12.02 |
| FC-SB-5 | .00 | n/a | .00 | n/a | .00 | n/a | 0.19 | 12.02 |
| FC-SB-6 | .00 | n/a | .00 | n/a | .00 | n/a | 0.17 | 12.02 |
| FC-UD-ME-3 | .00 | n/a | .00 | n/a | 0.30 | 12.04 | 1.32 | 12.02 |
| FC-UD-ME-2 | .00 | n/a | .00 | n/a | 0.30 | 12.04 | 1.32 | 12.02 |
| FC-UD-ME-1 | .00 | n/a | .00 | n/a | 0.13 | 12.04 | 0.59 | 12.02 |
| REACHES | | | | | | | | |
| FLUME SB-E | .00 | n/a | .00 | n/a | 1.02 | 12.04 | 4.56 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 1.02 | 12.03 | 4.56 | 12.02 |
| FLUME SB-D | .00 | n/a | .00 | n/a | 0.87 | 12.04 | 3.88 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 0.87 | 12.04 | 3.88 | 12.02 |
| FLUME SB-C | .00 | n/a | .00 | n/a | 0.72 | 12.04 | 3.22 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 0.72 | 12.04 | 3.22 | 12.02 |
| FLUME SB-B | .00 | n/a | .00 | n/a | 0.43 | 12.04 | 1.91 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 0.43 | 12.04 | 1.90 | 12.02 |
| FLUME SB-A | .00 | n/a | .00 | n/a | 0.13 | 12.04 | 0.59 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 0.13 | 12.04 | 0.59 | 12.02 |
| OUTLET | .00 | | .00 | | 1.02 | | 4.91 | |

**REFERENCE 10**

CWK

T13 Final Cover
OUTFALL FC-SB
Nye County, Nevada

Sub-Area Summary Table

| Sub-Area Identifier | Drainage Area (ac) | Time of Concentration (hr) | Curve Number | Receiving Reach | Sub-Area Description |
|---|---|---|---|---|---|
| FC-SB-1 | .56 | 0.100 | 63 | FLUME SB-D | |
| FC-SB-2 | .49 | 0.100 | 63 | FLUME SB-D | |
| FC-SB-3 | .59 | 0.100 | 63 | FLUME SB-E | |
| FC-SB-4 | .51 | 0.100 | 63 | FLUME SB-E | |
| FC-SB-5 | .30 | 0.100 | 63 | Outlet | |
| FC-SB-6 | .27 | 0.100 | 63 | Outlet | |
| FC-UD-ME-3 | 2.11 | 0.100 | 63 | FLUME SB-C | |
| FC-UD-ME-2 | 2.11 | 0.100 | 63 | FLUME SB-B | |
| FC-UD-ME-1 | .94 | 0.100 | 63 | FLUME SB-A | |

Total Area: 7.88 (ac)

REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-SB
Nye County, Nevada

Reach Summary Table

| Reach Identifier | Receiving Reach Identifier | Reach Length (ft) | Routing Method |
|---|---|---|---|
| FLUME SB-E | Outlet | 50 | CHANNEL |
| FLUME SB-D | FLUME SB-E | 100 | CHANNEL |
| FLUME SB-C | FLUME SB-D | 80 | CHANNEL |
| FLUME SB-B | FLUME SB-C | 200 | CHANNEL |
| FLUME SB-A | FLUME SB-B | 200 | CHANNEL |

# REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-SB
Nye County, Nevada

Sub-Area Time of Concentration Details

| Sub-Area Identifier/ | Flow Length (ft) | Slope (ft/ft) | Mannings's n | End Area (sq ft) | Wetted Perimeter (ft) | Velocity (ft/sec) | Travel Time (hr) |
|---|---|---|---|---|---|---|---|
| FC-SB-1 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 245 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.507 | 0.008 |
| | | | | | Time of Concentration | | 0.1 |
| FC-SB-2 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 216 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.571 | 0.007 |
| | | | | | Time of Concentration | | 0.1 |
| FC-SB-3 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 245 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.507 | 0.008 |
| | | | | | Time of Concentration | | 0.1 |
| FC-SB-4 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 216 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.571 | 0.007 |
| | | | | | Time of Concentration | | 0.1 |
| FC-SB-5 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| | | | | | Time of Concentration | | 0.1 |
| FC-SB-6 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| | | | | | Time of Concentration | | 0.1 |
| FC-UD-ME-3 | | | | | | | |
| SHEET | 100 | 0.0500 | 0.011 | | | | 0.026 |
| SHALLOW | 252 | 0.0100 | 0.944 | | | | 0.043 |
| | | | | | Time of Concentration | | 0.1 |
| FC-UD-ME-2 | | | | | | | |
| SHEET | 100 | 0.0500 | 0.011 | | | | 0.026 |
| SHALLOW | 252 | 0.0100 | 0.944 | | | | 0.043 |
| | | | | | Time of Concentration | | 0.1 |
| FC-UD-ME-1 | | | | | | | |
| SHEET | 100 | 0.0500 | 0.011 | | | | 0.026 |
| SHALLOW | 252 | 0.0100 | 0.944 | | | | 0.043 |
| | | | | | Time of Concentration | | 0.1 |

# REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-SB
Nye County, Nevada

Sub-Area Land Use and Curve Number Details

| Sub-Area Identifier | Land Use | | Hydrologic Soil Group | Sub-Area Area (ac) | Curve Number |
|---|---|---|---|---|---|
| FC-SB-1 | Desert shrub | (poor) | A | .56 | 63 |
| | Total Area / Weighted Curve Number | | | .56 | 63 |
| | | | | === | == |
| FC-SB-2 | Desert shrub | (poor) | A | .49 | 63 |
| | Total Area / Weighted Curve Number | | | .49 | 63 |
| | | | | === | == |
| FC-SB-3 | Desert shrub | (poor) | A | .59 | 63 |
| | Total Area / Weighted Curve Number | | | .59 | 63 |
| | | | | === | == |
| FC-SB-4 | Desert shrub | (poor) | A | .51 | 63 |
| | Total Area / Weighted Curve Number | | | .51 | 63 |
| | | | | === | == |
| FC-SB-5 | Desert shrub | (poor) | A | .3 | 63 |
| | Total Area / Weighted Curve Number | | | .3 | 63 |
| | | | | == | == |
| FC-SB-6 | Desert shrub | (poor) | A | .27 | 63 |
| | Total Area / Weighted Curve Number | | | .27 | 63 |
| | | | | === | == |
| FC-UD-ME-3 | Desert shrub | (poor) | A | 2.11 | 63 |
| | Total Area / Weighted Curve Number | | | 2.11 | 63 |
| | | | | ==== | == |
| FC-UD-ME-2 | Desert shrub | (poor) | A | 2.11 | 63 |
| | Total Area / Weighted Curve Number | | | 2.11 | 63 |
| | | | | ==== | == |
| FC-UD-ME-1 | Desert shrub | (poor) | A | .94 | 63 |
| | Total Area / Weighted Curve Number | | | .94 | 63 |
| | | | | === | == |

# REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-SB
Nye County, Nevada

Reach Channel Rating Details

| Reach Identifier | Reach Length (ft) | Reach Manning's n | Friction Slope (ft/ft) | Bottom Width (ft) | Side Slope |
|---|---|---|---|---|---|
| FLUME SB-E | 50 | 0.036 | 0.33 | 4 | 2 :1 |
| FLUME SB-D | 100 | 0.036 | 0.33 | 4 | 2 :1 |
| FLUME SB-C | 80 | 0.036 | 0.33 | 4 | 2 :1 |
| FLUME SB-B | 200 | 0.023 | 0.05 | 4 | 2 :1 |
| FLUME SB-A | 200 | 0.023 | 0.05 | 4 | 2 :1 |

| Reach Identifier | Stage (ft) | Flow (cfs) | End Area (sq ft) | Top Width (ft) | Friction Slope (ft/ft) |
|---|---|---|---|---|---|
| FLUME SB-E | 0.0 | 0.000 | 0 | 4 | 0.33 |
| | 0.5 | 32.230 | 2.5 | 6 | |
| | 1.0 | 113.039 | 6 | 8 | |
| | 2.0 | 436.973 | 16 | 12 | |
| | 5.0 | 3182.968 | 70 | 24 | |
| | 10.0 | 16475.771 | 240 | 44 | |
| | 20.0 | 93056.651 | 880 | 84 | |
| FLUME SB-D | 0.0 | 0.000 | 0 | 4 | 0.33 |
| | 0.5 | 32.230 | 2.5 | 6 | |
| | 1.0 | 113.039 | 6 | 8 | |
| | 2.0 | 436.973 | 16 | 12 | |
| | 5.0 | 3182.968 | 70 | 24 | |
| | 10.0 | 16475.771 | 240 | 44 | |
| | 20.0 | 93056.651 | 880 | 84 | |
| FLUME SB-C | 0.0 | 0.000 | 0 | 4 | 0.33 |
| | 0.5 | 32.230 | 2.5 | 6 | |
| | 1.0 | 113.039 | 6 | 8 | |
| | 2.0 | 436.973 | 16 | 12 | |
| | 5.0 | 3182.968 | 70 | 24 | |
| | 10.0 | 16475.771 | 240 | 44 | |
| | 20.0 | 93056.651 | 880 | 84 | |
| FLUME SB-B | 0.0 | 0.000 | 0 | 4 | 0.05 |
| | 0.5 | 19.637 | 2.5 | 6 | |
| | 1.0 | 68.870 | 6 | 8 | |
| | 2.0 | 266.230 | 16 | 12 | |
| | 5.0 | 1939.255 | 70 | 24 | |
| | 10.0 | 10038.029 | 240 | 44 | |
| | 20.0 | 56695.699 | 880 | 84 | |
| FLUME SB-A | 0.0 | 0.000 | 0 | 4 | 0.05 |
| | 0.5 | 19.637 | 2.5 | 6 | |
| | 1.0 | 68.870 | 6 | 8 | |
| | 2.0 | 266.230 | 16 | 12 | |
| | 5.0 | 1939.255 | 70 | 24 | |
| | 10.0 | 10038.029 | 240 | 44 | |
| | 20.0 | 56695.699 | 880 | 84 | |

# REFERENCE 10

WinTR-55 Current Data Description

--- Identification Data ---

User: CWK
Project: T13 Final Cover
SubTitle: OUTFALL FC-SA
State: Nevada
County: Nye
Filename: F:\Data\143418 - USEN T13 Design\Design\Calculations\Erosion\Water Erosion\TR-55 Model Runs - Fi

Date: 3/7/2016
Units: English
Areal Units: Acres

--- Sub-Area Data ---

| Name | Description | Reach | Area(ac) | RCN | Tc |
|---|---|---|---|---|---|
| FC-SA-1 | | FLUME SA-D | 0.56 | 63 | 0.1 |
| FC-SA-2 | | FLUME SA-D | 0.49 | 63 | 0.1 |
| FC-SA-3 | | FLUME SA-E | 0.59 | 63 | 0.1 |
| FC-SA-4 | | FLUME SA-E | 0.51 | 63 | 0.1 |
| FC-SA-5 | | Outlet | 0.3 | 63 | 0.1 |
| FC-SA-6 | | Outlet | 0.27 | 63 | 0.1 |
| FC-UD-MW-3 | | FLUME SA-C | 2.11 | 63 | 0.1 |
| FC-UD-MW-2 | | FLUME SA-B | 2.11 | 63 | 0.1 |
| FC-UD-MW-1 | | FLUME SA-A | 0.94 | 63 | 0.1 |

Total area: 7.88 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

| 2-Yr (in) | 5-Yr (in) | 25-Yr (in) | 100-Yr (in) | -Yr (in) | -Yr (in) | -Yr (in) |
|---|---|---|---|---|---|---|
| .94 | 1.39 | 2.26 | 3.13 | .0 | .0 | .0 |

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

# REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-SA
Nye County, Nevada

Storm Data

Rainfall Depth by Rainfall Return Period

| 2-Yr (in) | 5-Yr (in) | 25-Yr (in) | 100-Yr (in) | -Yr (in) | -Yr (in) | -Yr (in) |
|---|---|---|---|---|---|---|
| .94 | 1.39 | 2.26 | 3.13 | .0 | .0 | .0 |

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-SA
Nye County, Nevada

Watershed Peak Table

| Sub-Area or Reach Identifier | Peak Flow by Rainfall Return Period 2-Yr (cfs) | 5-Yr (cfs) | 25-Yr (cfs) | 100-Yr (cfs) |
|---|---|---|---|---|
| SUBAREAS | | | | |
| FC-SA-1 | .00 | .00 | 0.08 | 0.35 |
| FC-SA-2 | .00 | .00 | 0.07 | 0.31 |
| FC-SA-3 | .00 | .00 | 0.08 | 0.37 |
| FC-SA-4 | .00 | .00 | 0.07 | 0.32 |
| FC-SA-5 | .00 | .00 | .00 | 0.19 |
| FC-SA-6 | .00 | .00 | .00 | 0.17 |
| FC-UD-MW-3 | .00 | .00 | 0.30 | 1.32 |
| FC-UD-MW-2 | .00 | .00 | 0.30 | 1.32 |
| FC-UD-MW-1 | .00 | .00 | 0.13 | 0.59 |
| REACHES | | | | |
| FLUME SA-E | .00 | .00 | 1.02 | 4.56 |
| Down | .00 | .00 | 1.02 | 4.56 |
| FLUME SA-D | .00 | .00 | 0.87 | 3.88 |
| Down | .00 | .00 | 0.87 | 3.88 |
| FLUME SA-C | .00 | .00 | 0.72 | 3.22 |
| Down | .00 | .00 | 0.72 | 3.22 |
| FLUME SA-B | .00 | .00 | 0.43 | 1.91 |
| Down | .00 | .00 | 0.43 | 1.90 |
| FLUME SA-A | .00 | .00 | 0.13 | 0.59 |
| Down | .00 | .00 | 0.13 | 0.59 |
| OUTLET | .00 | .00 | 1.02 | 4.91 |

# REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-SA
Nye County, Nevada

Hydrograph Peak/Peak Time Table

| Sub-Area or Reach Identifier | Peak Flow and Peak Time (hr) by Rainfall Return Period 2-Yr (cfs) | 5-Yr (cfs) | 25-Yr (cfs) | 100-Yr (cfs) |
|---|---|---|---|---|
| | (hr) | (hr) | (hr) | (hr) |
| SUBAREAS | | | | |
| FC-SA-1 | .00 | .00 | 0.08 | 0.35 |
| | n/a | n/a | 12.04 | 12.02 |
| FC-SA-2 | .00 | .00 | 0.07 | 0.31 |
| | n/a | n/a | 12.04 | 12.02 |
| FC-SA-3 | .00 | .00 | 0.08 | 0.37 |
| | n/a | n/a | 12.04 | 12.02 |
| FC-SA-4 | .00 | .00 | 0.07 | 0.32 |
| | n/a | n/a | 12.04 | 12.02 |
| FC-SA-5 | .00 | .00 | .00 | 0.19 |
| | n/a | n/a | n/a | 12.02 |
| FC-SA-6 | .00 | .00 | .00 | 0.17 |
| | n/a | n/a | n/a | 12.02 |
| FC-UD-MW-3 | .00 | .00 | 0.30 | 1.32 |
| | n/a | n/a | 12.04 | 12.02 |
| FC-UD-MW-2 | .00 | .00 | 0.30 | 1.32 |
| | n/a | n/a | 12.04 | 12.02 |
| FC-UD-MW-1 | .00 | .00 | 0.13 | 0.59 |
| | n/a | n/a | 12.04 | 12.02 |
| REACHES | | | | |
| FLUME SA-E | .00 | .00 | 1.02 | 4.56 |
| | n/a | n/a | 12.04 | 12.02 |
| Down | .00 | .00 | 1.02 | 4.56 |
| | n/a | n/a | 12.03 | 12.02 |
| FLUME SA-D | .00 | .00 | 0.87 | 3.88 |
| | n/a | n/a | 12.04 | 12.02 |
| Down | .00 | .00 | 0.87 | 3.88 |
| | n/a | n/a | 12.04 | 12.02 |
| FLUME SA-C | .00 | .00 | 0.72 | 3.22 |
| | n/a | n/a | 12.04 | 12.02 |
| Down | .00 | .00 | 0.72 | 3.22 |
| | n/a | n/a | 12.04 | 12.02 |
| FLUME SA-B | .00 | .00 | 0.43 | 1.91 |
| | n/a | n/a | 12.04 | 12.02 |
| Down | .00 | .00 | 0.43 | 1.90 |
| | n/a | n/a | 12.04 | 12.02 |
| FLUME SA-A | .00 | .00 | 0.13 | 0.59 |
| | n/a | n/a | 12.04 | 12.02 |
| Down | .00 | .00 | 0.13 | 0.59 |
| | n/a | n/a | 12.04 | 12.02 |
| OUTLET | .00 | .00 | 1.02 | 4.91 |

**REFERENCE 10**

CWK

T13 Final Cover
OUTFALL FC-SA
Nye County, Nevada

Sub-Area Summary Table

| Sub-Area Identifier | Drainage Area (ac) | Time of Concentration (hr) | Curve Number | Receiving Reach | Sub-Area Description |
|---|---|---|---|---|---|
| FC-SA-1 | .56 | 0.100 | 63 | FLUME SA-D | |
| FC-SA-2 | .49 | 0.100 | 63 | FLUME SA-D | |
| FC-SA-3 | .59 | 0.100 | 63 | FLUME SA-E | |
| FC-SA-4 | .51 | 0.100 | 63 | FLUME SA-E | |
| FC-SA-5 | .30 | 0.100 | 63 | Outlet | |
| FC-SA-6 | .27 | 0.100 | 63 | Outlet | |
| FC-UD-MW-3 | 2.11 | 0.100 | 63 | FLUME SA-C | |
| FC-UD-MW-2 | 2.11 | 0.100 | 63 | FLUME SA-B | |
| FC-UD-MW-1 | .94 | 0.100 | 63 | FLUME SA-A | |

Total Area: 7.88 (ac)

REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-SA
Nye County, Nevada

Reach Summary Table

| Reach Identifier | Receiving Reach Identifier | Reach Length (ft) | Routing Method |
|---|---|---|---|
| FLUME SA-E | Outlet | 50 | CHANNEL |
| FLUME SA-D | FLUME SA-E | 100 | CHANNEL |
| FLUME SA-C | FLUME SA-D | 80 | CHANNEL |
| FLUME SA-B | FLUME SA-C | 200 | CHANNEL |
| FLUME SA-A | FLUME SA-B | 200 | CHANNEL |

# REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-SA
Nye County, Nevada

Sub-Area Time of Concentration Details

| Sub-Area Identifier/ | Flow Length (ft) | Slope (ft/ft) | Mannings's n | End Area (sq ft) | Wetted Perimeter (ft) | Velocity (ft/sec) | Travel Time (hr) |
|---|---|---|---|---|---|---|---|
| FC-SA-1 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 245 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.507 | 0.008 |
| | | | | | Time of Concentration | | 0.1 |
| FC-SA-2 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 216 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.571 | 0.007 |
| | | | | | Time of Concentration | | 0.1 |
| FC-SA-3 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 245 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.507 | 0.008 |
| | | | | | Time of Concentration | | 0.1 |
| FC-SA-4 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 216 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.571 | 0.007 |
| | | | | | Time of Concentration | | 0.1 |
| FC-SA-5 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| | | | | | Time of Concentration | | 0.1 |
| FC-SA-6 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| | | | | | Time of Concentration | | 0.1 |
| FC-UD-MW-3 | | | | | | | |
| SHEET | 100 | 0.0500 | 0.011 | | | | 0.026 |
| SHALLOW | 252 | 0.0100 | 0.944 | | | | 0.043 |
| | | | | | Time of Concentration | | 0.1 |
| FC-UD-MW-2 | | | | | | | |
| SHEET | 100 | 0.0500 | 0.011 | | | | 0.026 |
| SHALLOW | 252 | 0.0100 | 0.944 | | | | 0.043 |
| | | | | | Time of Concentration | | 0.1 |
| FC-UD-MW-1 | | | | | | | |
| SHEET | 100 | 0.0500 | 0.011 | | | | 0.026 |
| SHALLOW | 252 | 0.0100 | 0.944 | | | | 0.043 |
| | | | | | Time of Concentration | | 0.1 |

# REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-SA
Nye County, Nevada

Sub-Area Land Use and Curve Number Details

| Sub-Area Identifier | Land Use | | Hydrologic Soil Group | Sub-Area Area (ac) | Curve Number |
|---|---|---|---|---|---|
| FC-SA-1 | Desert shrub | (poor) | A | .56 | 63 |
| | Total Area / Weighted Curve Number | | | .56 | 63 |
| | | | | === | == |
| FC-SA-2 | Desert shrub | (poor) | A | .49 | 63 |
| | Total Area / Weighted Curve Number | | | .49 | 63 |
| | | | | === | == |
| FC-SA-3 | Desert shrub | (poor) | A | .59 | 63 |
| | Total Area / Weighted Curve Number | | | .59 | 63 |
| | | | | === | == |
| FC-SA-4 | Desert shrub | (poor) | A | .51 | 63 |
| | Total Area / Weighted Curve Number | | | .51 | 63 |
| | | | | === | == |
| FC-SA-5 | Desert shrub | (poor) | A | .3 | 63 |
| | Total Area / Weighted Curve Number | | | .3 | 63 |
| | | | | == | == |
| FC-SA-6 | Desert shrub | (poor) | A | .27 | 63 |
| | Total Area / Weighted Curve Number | | | .27 | 63 |
| | | | | === | == |
| FC-UD-MW-3 | Desert shrub | (poor) | A | 2.11 | 63 |
| | Total Area / Weighted Curve Number | | | 2.11 | 63 |
| | | | | ==== | == |
| FC-UD-MW-2 | Desert shrub | (poor) | A | 2.11 | 63 |
| | Total Area / Weighted Curve Number | | | 2.11 | 63 |
| | | | | ==== | == |
| FC-UD-MW-1 | Desert shrub | (poor) | A | .94 | 63 |
| | Total Area / Weighted Curve Number | | | .94 | 63 |
| | | | | === | == |

# REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-SA
Nye County, Nevada

Reach Channel Rating Details

| Reach Identifier | Reach Length (ft) | Reach Manning's n | Friction Slope (ft/ft) | Bottom Width (ft) | Side Slope |
|---|---|---|---|---|---|
| FLUME SA-E | 50 | 0.036 | 0.33 | 4 | 2 :1 |
| FLUME SA-D | 100 | 0.036 | 0.33 | 4 | 2 :1 |
| FLUME SA-C | 80 | 0.036 | 0.33 | 4 | 2 :1 |
| FLUME SA-B | 200 | 0.023 | 0.05 | 4 | 2 :1 |
| FLUME SA-A | 200 | 0.023 | 0.05 | 4 | 2 :1 |

| Reach Identifier | Stage (ft) | Flow (cfs) | End Area (sq ft) | Top Width (ft) | Friction Slope (ft/ft) |
|---|---|---|---|---|---|
| FLUME SA-E | 0.0 | 0.000 | 0 | 4 | 0.33 |
| | 0.5 | 32.230 | 2.5 | 6 | |
| | 1.0 | 113.039 | 6 | 8 | |
| | 2.0 | 436.973 | 16 | 12 | |
| | 5.0 | 3182.968 | 70 | 24 | |
| | 10.0 | 16475.771 | 240 | 44 | |
| | 20.0 | 93056.651 | 880 | 84 | |
| FLUME SA-D | 0.0 | 0.000 | 0 | 4 | 0.33 |
| | 0.5 | 32.230 | 2.5 | 6 | |
| | 1.0 | 113.039 | 6 | 8 | |
| | 2.0 | 436.973 | 16 | 12 | |
| | 5.0 | 3182.968 | 70 | 24 | |
| | 10.0 | 16475.771 | 240 | 44 | |
| | 20.0 | 93056.651 | 880 | 84 | |
| FLUME SA-C | 0.0 | 0.000 | 0 | 4 | 0.33 |
| | 0.5 | 32.230 | 2.5 | 6 | |
| | 1.0 | 113.039 | 6 | 8 | |
| | 2.0 | 436.973 | 16 | 12 | |
| | 5.0 | 3182.968 | 70 | 24 | |
| | 10.0 | 16475.771 | 240 | 44 | |
| | 20.0 | 93056.651 | 880 | 84 | |
| FLUME SA-B | 0.0 | 0.000 | 0 | 4 | 0.05 |
| | 0.5 | 19.637 | 2.5 | 6 | |
| | 1.0 | 68.870 | 6 | 8 | |
| | 2.0 | 266.230 | 16 | 12 | |
| | 5.0 | 1939.255 | 70 | 24 | |
| | 10.0 | 10038.029 | 240 | 44 | |
| | 20.0 | 56695.699 | 880 | 84 | |
| FLUME SA-A | 0.0 | 0.000 | 0 | 4 | 0.05 |
| | 0.5 | 19.637 | 2.5 | 6 | |
| | 1.0 | 68.870 | 6 | 8 | |
| | 2.0 | 266.230 | 16 | 12 | |
| | 5.0 | 1939.255 | 70 | 24 | |
| | 10.0 | 10038.029 | 240 | 44 | |
| | 20.0 | 56695.699 | 880 | 84 | |

# REFERENCE 10

WinTR-55 Current Data Description

--- Identification Data ---

User: CWK
Project: T13 Final Cover
SubTitle: Outfall FC-SW
State: Nevada
County: Nye
Filename: F:\Data\143418 - USEN T13 Design\Design\Calculations\Erosion\Water Erosion\TR-55 Model Runs - Fi

Date: 3/7/2016
Units: English
Areal Units: Acres

--- Sub-Area Data ---

| Name | Description | Reach | Area(ac) | RCN | Tc |
|---|---|---|---|---|---|
| FC-SW-1 | | FLUME SW-B | 0.59 | 63 | 0.1 |
| FC-SW-2 | | FLUME SW-B | 0.55 | 63 | 0.1 |
| FC-SW-3 | | FLUME SW-A | 0.83 | 63 | 0.1 |
| FC-SW-4 | | FLUME SW-A | 0.59 | 63 | 0.1 |
| FC-SW-5 | | Outlet | 0.53 | 63 | 0.1 |
| FC-SW-6 | | Outlet | 0.3 | 63 | 0.1 |
| FC-UDW-3 | | FLUME SW-C | 2.01 | 63 | 0.1 |
| FC-UDW-2 | | FLUME SW-D | 1.88 | 63 | 0.1 |
| FC-UDW-1 | | FLUME SW-E | 0.8 | 63 | 0.1 |

Total area: 8.08 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

| 2-Yr (in) | 5-Yr (in) | 25-Yr (in) | 100-Yr (in) | -Yr (in) | -Yr (in) | -Yr (in) |
|---|---|---|---|---|---|---|
| .94 | 1.39 | 2.26 | 3.13 | .0 | .0 | .0 |

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

# REFERENCE 10

CWK

T13 Final Cover
Outfall FC-SW
Nye County, Nevada

Storm Data

Rainfall Depth by Rainfall Return Period

| 2-Yr (in) | 5-Yr (in) | 25-Yr (in) | 100-Yr (in) | -Yr (in) | -Yr (in) | -Yr (in) |
|---|---|---|---|---|---|---|
| .94 | 1.39 | 2.26 | 3.13 | .0 | .0 | .0 |

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

REFERENCE 10

CWK

T13 Final Cover
Outfall FC-SW
Nye County, Nevada

Watershed Peak Table

| Sub-Area or Reach Identifier | Peak Flow by Rainfall Return Period 2-Yr (cfs) | 5-Yr (cfs) | 25-Yr (cfs) | 100-Yr (cfs) |
|---|---|---|---|---|
| SUBAREAS | | | | |
| FC-SW-1 | .00 | .00 | 0.08 | 0.37 |
| FC-SW-2 | .00 | .00 | 0.08 | 0.34 |
| FC-SW-3 | .00 | .00 | 0.12 | 0.52 |
| FC-SW-4 | .00 | .00 | 0.08 | 0.37 |
| FC-SW-5 | .00 | .00 | 0.07 | 0.33 |
| FC-SW-6 | .00 | .00 | .00 | 0.19 |
| FC-UDW-3 | .00 | .00 | 0.28 | 1.26 |
| FC-UDW-2 | .00 | .00 | 0.26 | 1.18 |
| FC-UDW-1 | .00 | .00 | 0.11 | 0.50 |
| REACHES | | | | |
| FLUME SW-A | .00 | .00 | 1.01 | 4.52 |
| Down | .00 | .00 | 1.01 | 4.52 |
| FLUME SW-B | .00 | .00 | 0.81 | 3.63 |
| Down | .00 | .00 | 0.81 | 3.63 |
| FLUME SW-C | .00 | .00 | 0.66 | 2.92 |
| Down | .00 | .00 | 0.66 | 2.92 |
| FLUME SW-D | .00 | .00 | 0.38 | 1.67 |
| Down | .00 | .00 | 0.38 | 1.67 |
| FLUME SW-E | .00 | .00 | 0.11 | 0.50 |
| Down | .00 | .00 | 0.11 | 0.50 |
| OUTLET | .00 | .00 | 1.08 | 5.03 |

# REFERENCE 10

CWK

T13 Final Cover
Outfall FC-SW
Nye County, Nevada

Hydrograph Peak/Peak Time Table

| Sub-Area or Reach Identifier | Peak Flow and Peak Time (hr) by Rainfall Return Period 2-Yr (cfs) | (hr) | 5-Yr (cfs) | (hr) | 25-Yr (cfs) | (hr) | 100-Yr (cfs) | (hr) |
|---|---|---|---|---|---|---|---|---|
| SUBAREAS | | | | | | | | |
| FC-SW-1 | .00 | n/a | .00 | n/a | 0.08 | 12.04 | 0.37 | 12.02 |
| FC-SW-2 | .00 | n/a | .00 | n/a | 0.08 | 12.04 | 0.34 | 12.02 |
| FC-SW-3 | .00 | n/a | .00 | n/a | 0.12 | 12.04 | 0.52 | 12.02 |
| FC-SW-4 | .00 | n/a | .00 | n/a | 0.08 | 12.04 | 0.37 | 12.02 |
| FC-SW-5 | .00 | n/a | .00 | n/a | 0.07 | 12.04 | 0.33 | 12.02 |
| FC-SW-6 | .00 | n/a | .00 | n/a | .00 | n/a | 0.19 | 12.02 |
| FC-UDW-3 | .00 | n/a | .00 | n/a | 0.28 | 12.04 | 1.26 | 12.02 |
| FC-UDW-2 | .00 | n/a | .00 | n/a | 0.26 | 12.04 | 1.18 | 12.02 |
| FC-UDW-1 | .00 | n/a | .00 | n/a | 0.11 | 12.04 | 0.50 | 12.02 |
| REACHES | | | | | | | | |
| FLUME SW-A | .00 | n/a | .00 | n/a | 1.01 | 12.04 | 4.52 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 1.01 | 12.04 | 4.52 | 12.02 |
| FLUME SW-B | .00 | n/a | .00 | n/a | 0.81 | 12.04 | 3.63 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 0.81 | 12.04 | 3.63 | 12.02 |
| FLUME SW-C | .00 | n/a | .00 | n/a | 0.66 | 12.04 | 2.92 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 0.66 | 12.04 | 2.92 | 12.02 |
| FLUME SW-D | .00 | n/a | .00 | n/a | 0.38 | 12.04 | 1.67 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 0.38 | 12.04 | 1.67 | 12.02 |
| FLUME SW-E | .00 | n/a | .00 | n/a | 0.11 | 12.04 | 0.50 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 0.11 | 12.04 | 0.50 | 12.02 |
| OUTLET | .00 | | .00 | | 1.08 | | 5.03 | |

# REFERENCE 10

CWK

T13 Final Cover
Outfall FC-SW
Nye County, Nevada

Sub-Area Summary Table

| Sub-Area Identifier | Drainage Area (ac) | Time of Concentration (hr) | Curve Number | Receiving Reach | Sub-Area Description |
|---|---|---|---|---|---|
| FC-SW-1 | .59 | 0.100 | 63 | FLUME SW-B | |
| FC-SW-2 | .55 | 0.100 | 63 | FLUME SW-B | |
| FC-SW-3 | .83 | 0.100 | 63 | FLUME SW-A | |
| FC-SW-4 | .59 | 0.100 | 63 | FLUME SW-A | |
| FC-SW-5 | .53 | 0.100 | 63 | Outlet | |
| FC-SW-6 | .30 | 0.100 | 63 | Outlet | |
| FC-UDW-3 | 2.01 | 0.100 | 63 | FLUME SW-C | |
| FC-UDW-2 | 1.88 | 0.100 | 63 | FLUME SW-D | |
| FC-UDW-1 | .80 | 0.100 | 63 | FLUME SW-E | |

Total Area: 8.08 (ac)

REFERENCE 10

CWK

T13 Final Cover
Outfall FC-SW
Nye County, Nevada

Reach Summary Table

| Reach Identifier | Receiving Reach Identifier | Reach Length (ft) | Routing Method |
|---|---|---|---|
| FLUME SW-A | Outlet | 50 | CHANNEL |
| FLUME SW-B | FLUME SW-A | 100 | CHANNEL |
| FLUME SW-C | FLUME SW-B | 80 | CHANNEL |
| FLUME SW-D | FLUME SW-C | 200 | CHANNEL |
| FLUME SW-E | FLUME SW-D | 200 | CHANNEL |

# REFERENCE 10

CWK

T13 Final Cover
Outfall FC-SW
Nye County, Nevada

Sub-Area Time of Concentration Details

| Sub-Area Identifier/ | Flow Length (ft) | Slope (ft/ft) | Mannings's n | End Area (sq ft) | Wetted Perimeter (ft) | Velocity (ft/sec) | Travel Time (hr) |
|---|---|---|---|---|---|---|---|
| FC-SW-1 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 296 | 0.0200 | 0.023 | 10.00 | 10.79 | 9.136 | 0.009 |
| | | | | | Time of Concentration | | 0.1 |
| FC-SW-2 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 245 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.507 | 0.008 |
| | | | | | Time of Concentration | | 0.1 |
| FC-SW-3 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 393 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.397 | 0.013 |
| | | | | | Time of Concentration | | 0.1 |
| FC-SW-4 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 245 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.507 | 0.008 |
| | | | | | Time of Concentration | | 0.1 |
| FC-SW-5 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| | | | | | Time of Concentration | | 0.1 |
| FC-SW-6 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| | | | | | Time of Concentration | | 0.1 |
| FC-UDW-3 | | | | | | | |
| SHEET | 100 | 0.0500 | 0.011 | | | | 0.026 |
| SHALLOW | 252 | 0.0100 | 0.944 | | | | 0.043 |
| | | | | | Time of Concentration | | 0.1 |
| FC-UDW-2 | | | | | | | |
| SHEET | 100 | 0.0500 | 0.011 | | | | 0.026 |
| SHALLOW | 252 | 0.0100 | 0.944 | | | | 0.043 |
| | | | | | Time of Concentration | | 0.1 |
| FC-UDW-1 | | | | | | | |
| SHEET | 100 | 0.0500 | 0.011 | | | | 0.026 |
| SHALLOW | 252 | 0.0100 | 0.944 | | | | 0.043 |
| | | | | | Time of Concentration | | 0.1 |

# REFERENCE 10

CWK

T13 Final Cover
Outfall FC-SW
Nye County, Nevada

Sub-Area Land Use and Curve Number Details

| Sub-Area Identifier | Land Use | | Hydrologic Soil Group | Sub-Area Area (ac) | Curve Number |
|---|---|---|---|---|---|
| FC-SW-1 | Desert shrub | (poor) | A | .59 | 63 |
| | Total Area / Weighted Curve Number | | | .59 | 63 |
| | | | | === | == |
| FC-SW-2 | Desert shrub | (poor) | A | .55 | 63 |
| | Total Area / Weighted Curve Number | | | .55 | 63 |
| | | | | === | == |
| FC-SW-3 | Desert shrub | (poor) | A | .83 | 63 |
| | Total Area / Weighted Curve Number | | | .83 | 63 |
| | | | | === | == |
| FC-SW-4 | Desert shrub | (poor) | A | .59 | 63 |
| | Total Area / Weighted Curve Number | | | .59 | 63 |
| | | | | === | == |
| FC-SW-5 | Desert shrub | (poor) | A | .53 | 63 |
| | Total Area / Weighted Curve Number | | | .53 | 63 |
| | | | | === | == |
| FC-SW-6 | Desert shrub | (poor) | A | .3 | 63 |
| | Total Area / Weighted Curve Number | | | .3 | 63 |
| | | | | == | == |
| FC-UDW-3 | Desert shrub | (poor) | A | 2.01 | 63 |
| | Total Area / Weighted Curve Number | | | 2.01 | 63 |
| | | | | ==== | == |
| FC-UDW-2 | Desert shrub | (poor) | A | 1.88 | 63 |
| | Total Area / Weighted Curve Number | | | 1.88 | 63 |
| | | | | ==== | == |
| FC-UDW-1 | Desert shrub | (poor) | A | .8 | 63 |
| | Total Area / Weighted Curve Number | | | .8 | 63 |
| | | | | == | == |

# REFERENCE 10

CWK

T13 Final Cover
Outfall FC-SW
Nye County, Nevada

Reach Channel Rating Details

| Reach Identifier | Reach Length (ft) | Reach Manning's n | Friction Slope (ft/ft) | Bottom Width (ft) | Side Slope |
|---|---|---|---|---|---|
| FLUME SW-A | 50 | 0.036 | 0.33 | 4 | 2 :1 |
| FLUME SW-B | 100 | 0.036 | 0.33 | 4 | 2 :1 |
| FLUME SW-C | 80 | 0.036 | 0.33 | 4 | 2 :1 |
| FLUME SW-D | 200 | 0.023 | 0.05 | 4 | 2 :1 |
| FLUME SW-E | 200 | 0.023 | 0.05 | 4 | 2 :1 |

| Reach Identifier | Stage (ft) | Flow (cfs) | End Area (sq ft) | Top Width (ft) | Friction Slope (ft/ft) |
|---|---|---|---|---|---|
| FLUME SW-A | 0.0 | 0.000 | 0 | 4 | 0.33 |
| | 0.5 | 32.230 | 2.5 | 6 | |
| | 1.0 | 113.039 | 6 | 8 | |
| | 2.0 | 436.973 | 16 | 12 | |
| | 5.0 | 3182.968 | 70 | 24 | |
| | 10.0 | 16475.771 | 240 | 44 | |
| | 20.0 | 93056.651 | 880 | 84 | |
| FLUME SW-B | 0.0 | 0.000 | 0 | 4 | 0.33 |
| | 0.5 | 32.230 | 2.5 | 6 | |
| | 1.0 | 113.039 | 6 | 8 | |
| | 2.0 | 436.973 | 16 | 12 | |
| | 5.0 | 3182.968 | 70 | 24 | |
| | 10.0 | 16475.771 | 240 | 44 | |
| | 20.0 | 93056.651 | 880 | 84 | |
| FLUME SW-C | 0.0 | 0.000 | 0 | 4 | 0.33 |
| | 0.5 | 32.230 | 2.5 | 6 | |
| | 1.0 | 113.039 | 6 | 8 | |
| | 2.0 | 436.973 | 16 | 12 | |
| | 5.0 | 3182.968 | 70 | 24 | |
| | 10.0 | 16475.771 | 240 | 44 | |
| | 20.0 | 93056.651 | 880 | 84 | |
| FLUME SW-D | 0.0 | 0.000 | 0 | 4 | 0.05 |
| | 0.5 | 19.637 | 2.5 | 6 | |
| | 1.0 | 68.870 | 6 | 8 | |
| | 2.0 | 266.230 | 16 | 12 | |
| | 5.0 | 1939.255 | 70 | 24 | |
| | 10.0 | 10038.029 | 240 | 44 | |
| | 20.0 | 56695.699 | 880 | 84 | |
| FLUME SW-E | 0.0 | 0.000 | 0 | 4 | 0.05 |
| | 0.5 | 19.637 | 2.5 | 6 | |
| | 1.0 | 68.870 | 6 | 8 | |
| | 2.0 | 266.230 | 16 | 12 | |
| | 5.0 | 1939.255 | 70 | 24 | |
| | 10.0 | 10038.029 | 240 | 44 | |
| | 20.0 | 56695.699 | 880 | 84 | |

**REFERENCE 10**

WinTR-55 Current Data Description

--- Identification Data ---

User: CWK
Project: T13 Final Cover
SubTitle: OUTFALL FC-W-A
State: Nevada
County: Nye
Filename: F:\Data\143418 - USEN T13 Design\Design\Calculations\Erosion\Water Erosion\TR-55 Model Runs - Fi

Date: 3/7/2016
Units: English
Areal Units: Acres

--- Sub-Area Data ---

| Name | Description | Reach | Area(ac) | RCN | Tc |
|---|---|---|---|---|---|
| FC-W1 | | UpperDitch | 0.98 | 63 | 0.1 |
| FC-W2 | | LowerDitch | 0.92 | 63 | 0.1 |
| FC-W3 | | Outlet | 0.49 | 63 | 0.1 |

Total area: 2.39 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

| 2-Yr (in) | 5-Yr (in) | 25-Yr (in) | 100-Yr (in) | -Yr (in) | -Yr (in) | -Yr (in) |
|---|---|---|---|---|---|---|
| .94 | 1.39 | 2.26 | 3.13 | .0 | .0 | .0 |

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

# REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-W-A
Nye County, Nevada

Storm Data

Rainfall Depth by Rainfall Return Period

| 2-Yr (in) | 5-Yr (in) | 25-Yr (in) | 100-Yr (in) | -Yr (in) | -Yr (in) | -Yr (in) |
|---|---|---|---|---|---|---|
| .94 | 1.39 | 2.26 | 3.13 | .0 | .0 | .0 |

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

**REFERENCE 10**

CWK

T13 Final Cover
OUTFALL FC-W-A
Nye County, Nevada

Watershed Peak Table

| Sub-Area or Reach Identifier | Peak Flow by Rainfall Return Period 2-Yr (cfs) | 5-Yr (cfs) | 25-Yr (cfs) | 100-Yr (cfs) |
|---|---|---|---|---|
| SUBAREAS | | | | |
| FC-W1 | .00 | .00 | 0.14 | 0.61 |
| FC-W2 | .00 | .00 | 0.13 | 0.58 |
| FC-W3 | .00 | .00 | 0.07 | 0.31 |
| REACHES | | | | |
| LowerDitch | .00 | .00 | 0.27 | 1.18 |
| Down | .00 | .00 | 0.27 | 1.18 |
| UpperDitch | .00 | .00 | 0.14 | 0.61 |
| Down | .00 | .00 | 0.14 | 0.61 |
| OUTLET | .00 | .00 | 0.33 | 1.49 |

# REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-W-A
Nye County, Nevada

Hydrograph Peak/Peak Time Table

| Sub-Area or Reach Identifier | Peak Flow and Peak Time (hr) by Rainfall Return Period 2-Yr (cfs) | 5-Yr (cfs) | 25-Yr (cfs) | 100-Yr (cfs) |
|---|---|---|---|---|
| | (hr) | (hr) | (hr) | (hr) |
| SUBAREAS | | | | |
| FC-W1 | .00 | .00 | 0.14 | 0.61 |
| | n/a | n/a | 12.04 | 12.02 |
| FC-W2 | .00 | .00 | 0.13 | 0.58 |
| | n/a | n/a | 12.04 | 12.02 |
| FC-W3 | .00 | .00 | 0.07 | 0.31 |
| | n/a | n/a | 12.04 | 12.02 |
| REACHES | | | | |
| LowerDitch | .00 | .00 | 0.27 | 1.18 |
| | n/a | n/a | 12.04 | 12.02 |
| Down | .00 | .00 | 0.27 | 1.18 |
| | n/a | n/a | 12.04 | 12.03 |
| UpperDitch | .00 | .00 | 0.14 | 0.61 |
| | n/a | n/a | 12.04 | 12.02 |
| Down | .00 | .00 | 0.14 | 0.61 |
| | n/a | n/a | 11.98 | 12.02 |
| OUTLET | .00 | .00 | 0.33 | 1.49 |

REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-W-A
Nye County, Nevada

Sub-Area Summary Table

| Sub-Area Identifier | Drainage Area (ac) | Time of Concentration (hr) | Curve Number | Receiving Reach | Sub-Area Description |
|---|---|---|---|---|---|
| FC-W1 | .98 | 0.100 | 63 | UpperDitch | |
| FC-W2 | .92 | 0.100 | 63 | LowerDitch | |
| FC-W3 | .49 | 0.100 | 63 | Outlet | |

Total Area: 2.39 (ac)

**REFERENCE 10**

CWK

T13 Final Cover
OUTFALL FC-W-A
Nye County, Nevada

Reach Summary Table

| Reach Identifier | Receiving Reach Identifier | Reach Length (ft) | Routing Method |
|---|---|---|---|
| LowerDitch | Outlet | 296 | CHANNEL |
| UpperDitch | LowerDitch | 299 | CHANNEL |

REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-W-A
Nye County, Nevada

Sub-Area Time of Concentration Details

| Sub-Area Identifier/ | Flow Length (ft) | Slope (ft/ft) | Mannings's n | End Area (sq ft) | Wetted Perimeter (ft) | Velocity (ft/sec) | Travel Time (hr) |
|---|---|---|---|---|---|---|---|
| FC-W1 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 406 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.675 | 0.013 |
| | | | | | Time of Concentration | | 0.1 |
| FC-W2 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 209 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.294 | 0.007 |
| | | | | | Time of Concentration | | 0.1 |
| FC-W3 | | | | | | | |
| SHEET | 100 | 0.3330 | 0.011 | | | | 0.012 |
| | | | | | Time of Concentration | | 0.1 |

REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-W-A
Nye County, Nevada

Sub-Area Land Use and Curve Number Details

| Sub-Area Identifier | Land Use | | Hydrologic Soil Group | Sub-Area Area (ac) | Curve Number |
|---|---|---|---|---|---|
| FC-W1 | Desert shrub | (poor) | A | .98 | 63 |
| | Total Area / Weighted Curve Number | | | .98 | 63 |
| | | | | === | == |
| FC-W2 | Desert shrub | (poor) | A | .92 | 63 |
| | Total Area / Weighted Curve Number | | | .92 | 63 |
| | | | | === | == |
| FC-W3 | Desert shrub | (poor) | A | .49 | 63 |
| | Total Area / Weighted Curve Number | | | .49 | 63 |
| | | | | === | == |

# REFERENCE 10

CWK

T13 Final Cover
OUTFALL FC-W-A
Nye County, Nevada

Reach Channel Rating Details

| Reach Identifier | Reach Length (ft) | Reach Manning's n | Friction Slope (ft/ft) | Bottom Width (ft) | Side Slope |
|---|---|---|---|---|---|
| LowerDitch | 296 | 0.023 | 0.1 | 0.3 | 2 :1 |
| UpperDitch | 299 | 0.023 | 0.1 | 0.3 | 2 :1 |

| Reach Identifier | Stage (ft) | Flow (cfs) | End Area (sq ft) | Top Width (ft) | Friction Slope (ft/ft) |
|---|---|---|---|---|---|
| LowerDitch | 0.0 | 0.000 | 0 | 0.3 | 0.1 |
| | 0.5 | 5.086 | 0.6 | 2.3 | |
| | 1.0 | 28.044 | 2.3 | 4.3 | |
| | 2.0 | 164.808 | 8.5 | 8.3 | |
| | 5.0 | 1806.779 | 51.3 | 20.3 | |
| | 10.0 | 11281.721 | 202.5 | 40.3 | |
| | 20.0 | 71030.681 | 805 | 80.3 | |
| UpperDitch | 0.0 | 0.000 | 0 | 0.3 | 0.1 |
| | 0.5 | 5.086 | 0.6 | 2.3 | |
| | 1.0 | 28.044 | 2.3 | 4.3 | |
| | 2.0 | 164.808 | 8.5 | 8.3 | |
| | 5.0 | 1806.779 | 51.3 | 20.3 | |
| | 10.0 | 11281.721 | 202.5 | 40.3 | |
| | 20.0 | 71030.681 | 805 | 80.3 | |

**REFERENCE 10**

WinTR-55 Current Data Description

--- Identification Data ---

User: CWK
Project: T13 Final Cover
SubTitle: FC-W-B
State: Nevada
County: Nye
Filename: F:\Data\143418 - USEN T13 Design\Design\Calculations\Erosion\Water Erosion\TR-55 Model Runs - Fi

Date: 3/7/2016
Units: English
Areal Units: Acres

--- Sub-Area Data ---

| Name | Description | Reach | Area(ac) | RCN | Tc |
|---|---|---|---|---|---|
| FC-W4 | | FLUME WEST | 0.67 | 63 | 0.1 |
| FC-W5 | | Outlet | 1.02 | 63 | 0.1 |
| FC-W6 | | Outlet | 0.62 | 63 | 0.1 |
| FC-W7 | | Outlet | 0.38 | 63 | 0.1 |

Total area: 2.69 (ac)

--- Storm Data --

Rainfall Depth by Rainfall Return Period

| 2-Yr (in) | 5-Yr (in) | 25-Yr (in) | 100-Yr (in) | -Yr (in) | -Yr (in) | -Yr (in) |
|---|---|---|---|---|---|---|
| .94 | 1.39 | 2.26 | 3.13 | .0 | .0 | .0 |

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

# REFERENCE 10

CWK

T13 Final Cover
FC-W-B
Nye County, Nevada

Storm Data

Rainfall Depth by Rainfall Return Period

| 2-Yr (in) | 5-Yr (in) | 25-Yr (in) | 100-Yr (in) | -Yr (in) | -Yr (in) | -Yr (in) |
|---|---|---|---|---|---|---|
| .94 | 1.39 | 2.26 | 3.13 | .0 | .0 | .0 |

Storm Data Source: User-provided custom storm data
Rainfall Distribution Type: Type II
Dimensionless Unit Hydrograph: <standard>

**REFERENCE 10**

CWK

T13 Final Cover
FC-W-B
Nye County, Nevada

Watershed Peak Table

| Sub-Area or Reach Identifier | Peak Flow by Rainfall Return Period 2-Yr (cfs) | 5-Yr (cfs) | 25-Yr (cfs) | 100-Yr (cfs) |
|---|---|---|---|---|
| SUBAREAS | | | | |
| FC-W4 | .00 | .00 | 0.09 | 0.42 |
| FC-W5 | .00 | .00 | 0.14 | 0.64 |
| FC-W6 | .00 | .00 | 0.09 | 0.39 |
| FC-W7 | .00 | .00 | 0.05 | 0.24 |
| REACHES | | | | |
| FLUME WEST | .00 | .00 | 0.09 | 0.42 |
| Down | .00 | .00 | 0.09 | 0.42 |
| OUTLET | .00 | .00 | 0.38 | 1.68 |

# REFERENCE 10

CWK

T13 Final Cover
FC-W-B
Nye County, Nevada

Hydrograph Peak/Peak Time Table

| Sub-Area or Reach Identifier | Peak Flow and Peak Time (hr) by Rainfall Return Period 2-Yr (cfs) | (hr) | 5-Yr (cfs) | (hr) | 25-Yr (cfs) | (hr) | 100-Yr (cfs) | (hr) |
|---|---|---|---|---|---|---|---|---|
| SUBAREAS | | | | | | | | |
| FC-W4 | .00 | n/a | .00 | n/a | 0.09 | 12.04 | 0.42 | 12.02 |
| FC-W5 | .00 | n/a | .00 | n/a | 0.14 | 12.04 | 0.64 | 12.02 |
| FC-W6 | .00 | n/a | .00 | n/a | 0.09 | 12.04 | 0.39 | 12.02 |
| FC-W7 | .00 | n/a | .00 | n/a | 0.05 | 12.04 | 0.24 | 12.02 |
| REACHES | | | | | | | | |
| FLUME WEST | .00 | n/a | .00 | n/a | 0.09 | 12.04 | 0.42 | 12.02 |
| Down | .00 | n/a | .00 | n/a | 0.09 | 11.99 | 0.42 | 12.02 |
| OUTLET | .00 | | .00 | | 0.38 | | 1.68 | |

# REFERENCE 10

CWK

T13 Final Cover
FC-W-B
Nye County, Nevada

Sub-Area Summary Table

| Sub-Area Identifier | Drainage Area (ac) | Time of Concentration (hr) | Curve Number | Receiving Reach | Sub-Area Description |
|---|---|---|---|---|---|
| FC-W4 | .67 | 0.100 | 63 | FLUME WEST | |
| FC-W5 | 1.02 | 0.100 | 63 | Outlet | |
| FC-W6 | .62 | 0.100 | 63 | Outlet | |
| FC-W7 | .38 | 0.100 | 63 | Outlet | |

Total Area: 2.69 (ac)

REFERENCE 10

CWK

T13 Final Cover
FC-W-B
Nye County, Nevada

Reach Summary Table

| Reach Identifier | Receiving Reach Identifier | Reach Length (ft) | Routing Method |
|---|---|---|---|
| FLUME WEST | Outlet | 90 | CHANNEL |

**REFERENCE 10**

CWK

T13 Final Cover
FC-W-B
Nye County, Nevada

Sub-Area Time of Concentration Details

| Sub-Area Identifier/ | Flow Length (ft) | Slope (ft/ft) | Mannings's n | End Area (sq ft) | Wetted Perimeter (ft) | Velocity (ft/sec) | Travel Time (hr) |
|---|---|---|---|---|---|---|---|
| FC-W4 | | | | | | | |
| SHEET | 100 | 0.3300 | 0.011 | | | | 0.012 |
| CHANNEL | 444 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.810 | 0.014 |
| | | | | | Time of Concentration | | 0.1 |
| FC-W5 | | | | | | | |
| SHEET | 100 | 0.3330 | 0.011 | | | | 0.012 |
| CHANNEL | 512 | 0.0200 | 0.023 | 10.00 | 10.79 | 8.889 | 0.016 |
| | | | | | Time of Concentration | | 0.1 |
| FC-W6 | | | | | | | |
| SHEET | 90 | 0.3330 | 0.011 | | | | 0.011 |
| | | | | | Time of Concentration | | 0.1 |
| FC-W7 | | | | | | | |
| SHEET | 90 | 0.3300 | 0.011 | | | | 0.011 |
| | | | | | Time of Concentration | | 0.1 |

REFERENCE 10

CWK

T13 Final Cover
FC-W-B
Nye County, Nevada

Sub-Area Land Use and Curve Number Details

| Sub-Area Identifier | Land Use | | Hydrologic Soil Group | Sub-Area Area (ac) | Curve Number |
|---|---|---|---|---|---|
| FC-W4 | Desert shrub | (poor) | A | .67 | 63 |
| | Total Area / Weighted Curve Number | | | .67 | 63 |
| | | | | === | == |
| FC-W5 | Desert shrub | (poor) | A | 1.02 | 63 |
| | Total Area / Weighted Curve Number | | | 1.02 | 63 |
| | | | | ==== | == |
| FC-W6 | Desert shrub | (poor) | A | .62 | 63 |
| | Total Area / Weighted Curve Number | | | .62 | 63 |
| | | | | === | == |
| FC-W7 | Desert shrub | (poor) | A | .38 | 63 |
| | Total Area / Weighted Curve Number | | | .38 | 63 |
| | | | | === | == |

# REFERENCE 10

CWK

T13 Final Cover
FC-W-B
Nye County, Nevada

Reach Channel Rating Details

| Reach Identifier | Reach Length (ft) | Reach Manning's n | Friction Slope (ft/ft) | Bottom Width (ft) | Side Slope |
|---|---|---|---|---|---|
| FLUME WEST | 90 | 0.036 | 0.33 | 4 | 2 :1 |

| Reach Identifier | Stage (ft) | Flow (cfs) | End Area (sq ft) | Top Width (ft) | Friction Slope (ft/ft) |
|---|---|---|---|---|---|
| FLUME WEST | 0.0 | 0.000 | 0 | 4 | 0.33 |
| | 0.5 | 32.230 | 2.5 | 6 | |
| | 1.0 | 113.039 | 6 | 8 | |
| | 2.0 | 436.973 | 16 | 12 | |
| | 5.0 | 3182.968 | 70 | 24 | |
| | 10.0 | 16475.771 | 240 | 44 | |
| | 20.0 | 93056.651 | 880 | 84 | |

REFERENCE 11

# Hydraulic Design Manual

Texas Department of Transportation

Revised August 2015

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REFERENCE 11

# Manual Notice 2015-1

**From:** *Rene Garcia*, P.E.

**Manual:** *Hydraulic Design Manual*

**Effective Date:** August 31, 2015

## Contents

The following updates were made to the *Hydraulic Design Manual*:

- Chapter 4 - Hydrology
  - Section 6 - Updated the note to Table 4-2 regarding AEP for scour computations.
  - Section 11 - Modified language regarding sheet flow to limit length to 100 feet,
  - Section 14 - Included WinTR-55 in References.
- Chapter 13 - Storm Water
  - Section 1 – Updated the link for *Storm Water Management Guidelines for Construction Activities* (TxDOT, 2002) to reflect that the manual is under revision.

## Supersedes

The revised manual supersedes prior versions of the manual.

## Contact

Contact Stan Hopfe at Stan.Hopfe@txdot.gov (512) 416-2219, Roadway Design Section, Design Division with any questions or comments.

## Archives

Past manual notices are available in a PDF archive.

# Section 3 — Roadside Channel Design

## Roadside Drainage Channels

According to the AASHTO Roadside Design Guide, roadside drainage channel is an open channel usually paralleling the highway embankment and within limits of the ROW. The primary function of a drainage channel is to collect surface runoff from the roadway and areas that drain to the ROW and to convey the accumulated runoff to acceptable outlet points. Drainage channels must be designed to carry the design runoff and to accommodate excessive storm water with minimal roadway flooding or damage. The design frequency should correspond with the storm drain frequency. For details of roadway safety design which governs ditch shape design, see the Roadway Design Manual, Chapter 2, Section 6, Slopes and Ditches, and Median Design, and Chapter 2, Section 7, Side Ditches. Where the Roadway Design Manual requirements can't be met, the channel will have to be enclosed in a pipe or box. See Chapter 10, Storm Drains.

## Channel Linings

Channel lining may be desirable or necessary to minimize maintenance, resist the erosive forces of flowing water, improve hydraulic efficiency, and/or limit the channel size for right-of-way or safety considerations. The considerations of flow volumes, topography, and soil conditions may dictate the channel lining material to be used. Wherever possible, highway drainage channel design should make use of native, natural materials such as grass, crushed rock, and earth. Other types of materials for reasons of hydraulics, economics, safety, aesthetics, and environment may be considered.

The following section contains a short discussion on channel linings. For comprehensive descriptions, advantages, and disadvantages of different types of channel linings, refer to the FHWA Hydraulic Engineering Circular No. 15 (HEC-15).

## Rigid versus Flexible Lining

Engineers may design roadside channels with rigid or flexible linings. Flexible linings in channels conform better to a changing channel shape than rigid linings. However, a rigid lining may resist an erosive force of high magnitude better than a flexible one.

The following types of rigid linings are common:

- cast-in-place concrete
- soil cement
- fabric form work systems for concrete
- grouted riprap.

Rigid channel linings have the following disadvantages when compared to natural or earth-lined channels:

- Initial construction cost of rigid linings is usually greater than the cost of flexible linings.
- Maintenance costs may also be high because rigid linings are susceptible to damage by undercutting, hydrostatic uplift, and erosion along the longitudinal interface between the lining and the unlined section.
- Inhibition of natural infiltration in locations where infiltration is desirable or permissible.
- Smooth linings usually cause high flow velocities with scour occurring at the terminus of the sections unless controlled with riprap or other energy dissipating devices
- Contaminants may be transported to the receiving waters in areas where water quality considerations are of major concern. A vegetative or flexible type of lining may filter the contaminants from the runoff.

Permanent flexible linings include the following:

- rock riprap
- wire enclosed riprap (gabions)
- vegetative lining
- geotextile fabrics.

Flexible linings generally have the following advantages:

- less costly to construct
- have self-healing qualities that reduce maintenance costs
- permit infiltration and exfiltration
- present a more natural appearance and safer roadsides.

Various species of grass may be used as permanent channel lining if flow depths, velocities, and soil types are within acceptable tolerances for vegetative lining. The turf may be established by sodding or seeding. Sod is usually more expensive than seeding, but it has the advantage of providing immediate protection. Some type of temporary protective covering is often required for seed and topsoil until vegetation becomes established.

The following are classified as temporary flexible linings:

- geotextile fabrics
- straw with net
- curled wood mat
- jute, paper, or synthetic net

- synthetic mat
- fiberglass roving.

Temporary channel lining and protective covering may consist of jute matting, excelsior mats, or fiberglass roving. Straw or wood-chip mulch tacked with asphalt is usually not well suited for channel invert lining but may be used for side slopes. Geotextile materials, known as soil stabilization mats, may be used for protective linings in ditches and on side slopes. These materials are not biodegradable and serve as permanent soil reinforcement while enhancing the establishment of vegetation.

## Channel Lining Design Procedure

Use the following design procedure for roadside channels. Even though each project is unique, these six basic design steps normally apply:

1. Establish a roadside plan. Collect available site data:
   - Obtain or prepare existing and proposed plan/profile layouts including highway, culverts, bridges, etc.
   - Determine and plot on the plan the locations of natural basin divides and roadside channel outlets.
   - Lay out the proposed roadside channels to minimize diversion flow lengths.
2. Establish cross section geometry: Identify features that may restrict cross section design including right-of-way limits, trees or environmentally sensitive areas, utilities, and existing drainage facilities. Provide channel depth adequate to drain the subbase and minimize freeze-thaw effects. Choose channel side slopes based on the following geometric design criteria: safety, economics, soil, aesthetics, and access. Establish the bottom width of trapezoidal channel.
3. Determine initial channel grades. Plot initial grades on plan-profile layout (slopes in roadside ditch in cuts are usually controlled by highway grades) by establishing a minimum grade to minimize ponding and sediment accumulation, considering the influence of type of lining on grade, and where possible, avoiding features that may influence or restrict grade, such as utility locations.
4. Check flow capacities, and adjust as necessary. Compute the design discharge at the downstream end of a channel segment (see Chapter 5). Set preliminary values of channel size, roughness, and slope. Determine the maximum allowable depth of channel including freeboard. Check the flow capacity using Manning's Equation for Uniform Flow and single-section analysis (see Equation 7-1 and Chapter 6). If the capacity is inadequate, possible adjustments are as follows:
   - increase bottom width
   - make channel side slopes flatter

- make channel slope steeper
- provide smoother channel lining
- install drop inlets and a parallel storm drain pipe beneath the channel to supplement channel capacity
- provide smooth transitions at changes in channel cross sections
- provide extra channel storage where needed to replace floodplain storage or to reduce peak discharge

$$Q = \frac{z}{n} A R^{2/3} S^{1/2}$$

*Equation 7-1.*

where:

$Q$ = discharge (cfs or $m^3/s$)

$A$ = cross-sectional area of flow (sq. ft. or $m^2$)

$R$ = hydraulic radius (ft. or m)

Z = conversion factor; 1.486 for English units, and 1.0 for metric

5. Determine channel lining or protection needed. Calculate uniform flow depth ($y_m$ in ft. or m) at design discharge using the Slope Conveyance Method. Compute maximum shear stress at normal depth (see Equation 7-2 and Equation 7-3). Select a lining and determine the permissible shear stress (in lbs./sq.ft. or $N/m^2$) using the tables titled Retardation Class for Lining Materials and Permissible Shear Stresses for Various Linings. If $\tau_d < \tau_p$, then the lining is acceptable. Otherwise, consider the following options: choose a more resistant lining, use concrete or gabions or other more rigid lining as full lining or composite, decrease channel slope, decrease slope in combination with drop structures, or increase channel width or flatten side slopes.

6. Analyze outlet points and downstream effects. Identify any adverse impacts to downstream properties that may result from one of the following at the channel outlet: increase or decrease in discharge, increase in velocity of flow, confinement of sheet flow, change in outlet water quality, or diversion of flow from another watershed. Mitigate any adverse impacts identified in the previous step. Possibilities include enlarging the outlet channel or installing control structures to provide detention of increased runoff in channel, installing velocity control structures, increasing capacity or improving the lining of the downstream channel, installing sedimentation/infiltration basins, installing sophisticated weirs or other outlet devices to redistribute concentrated channel flow, and eliminating diversions that result in downstream damage and that cannot be mitigated in a less expensive fashion.

$$\tau_d = \gamma R S$$

*Equation 7-2.*

where:

$\tau$ = average shear stress at normal depth (lb./sq.ft. or N/m$^2$)

$\gamma$ = unit weight of water (62.4 lb./ft.$^3$or 9810 N./m.$^2$)

R = hydraulic radius (ft. or m.) at uniform depth ($y_m$)

S = channel slope (ft./ft. or m./m.)

The maximum shear stress for a straight channel occurs on the channel bed.

$$\tau_d = \gamma d S$$

*Equation 7-3.*

where:

$\tau_d$ = maximum sheer stress (lb./sq ft. or N/m$^2$)

$\gamma$ = unit weight of water (62.4 lb./ft.$^3$or 9810 N./m.$^2$)

d = maximum depth of flow (ft. or m.)

S = channel slope (ft./ft. or m./m.)

**Retardation Class for Lining Materials**

| Retardance Class | Cover | Condition |
|---|---|---|
| A | Weeping Lovegrass | Excellent stand, tall (average 30 in. or 760 mm) |
| | Yellow Bluestem Ischaemum | Excellent stand, tall (average 36 in. or 915 mm) |
| B | Kudzu | Very dense growth, uncut |
| | Bermuda grass | Good stand, tall (average 12 in. or 305 mm) |
| | Native grass mixture<br>little bluestem, bluestem, blue gamma, other short and long stem midwest grasses | Good stand, unmowed |
| | Weeping lovegrass | Good Stand, tall (average 24 in. or 610 mm) |
| | Lespedeza sericea | Good stand, not woody, tall (average 19 in. or 480 mm) |
| | Alfalfa | Good stand, uncut (average 11 in or 280 mm) |
| | Weeping lovegrass | Good stand, unmowed (average 13 in. or 330 mm) |
| | Kudzu | Dense growth, uncut |
| | Blue gamma | Good stand, uncut (average 13 in. or 330 mm) |
| C | Crabgrass | Fair stand, uncut (10-to-48 in. or 55-to-1220 mm) |
| | Bermuda grass | Good stand, mowed (average 6 in. or 150 mm) |

**Retardation Class for Lining Materials**

| Retardance Class | Cover | Condition |
|---|---|---|
| | Common lespedeza | Good stand, uncut (average 11 in. or 280 mm) |
| | Grass-legume mixture: summer (orchard grass redtop, Italian ryegrass, and common lespedeza) | Good stand, uncut (6-8 in. or 150-200 mm) |
| | Centipedegrass | Very dense cover (average 6 in. or 150 mm) |
| | Kentucky bluegrass | Good stand, headed (6-12 in. or 150-305 mm) |
| D | Bermuda grass | Good stand, cut to 2.5 in. or 65 mm |
| | Common lespedeza | Excellent stand, uncut (average 4.5 in. or 115 mm) |
| | Buffalo grass | Good stand, uncut (3-6 in. or 75-150 mm) |
| | Grass-legume mixture: fall, spring (orchard grass Italian ryegrass, and common lespedeza | Good Stand, uncut (4-5 in. or 100-125 mm) |
| | Lespedeza sericea | After cutting to 2 in. or 50 mm (very good before cutting) |
| E | Bermuda grass | Good stand, cut to 1.5 in. or 40 mm |
| | Bermuda grass | Burned stubble |

**Permissible Shear Stresses for Various Linings**

| Protective Cover | (lb./sq.ft.) | $t_p$ (N/m$^2$) |
|---|---|---|
| Retardance Class A Vegetation (See the "Retardation Class for Lining Materials" table above) | 3.70 | 177 |
| Retardance Class B Vegetation (See the "Retardation Class for Lining Materials" table above) | 2.10 | 101 |
| Retardance Class C Vegetation (See the "Retardation Class for Lining Materials" table above) | 1.00 | 48 |
| Retardance Class D Vegetation (See the "Retardation Class for Lining Materials" table above) | 0.60 | 29 |
| Retardance Class E Vegetation (See the "Retardation Class for Lining Materials" table above) | 0.35 | 17 |
| Woven Paper | 0.15 | 7 |
| Jute Net | 0.45 | 22 |
| Single Fiberglass | 0.60 | 29 |
| Double Fiberglass | 0.85 | 41 |
| Straw W/Net | 1.45 | 69 |
| Curled Wood Mat | 1.55 | 74 |
| Synthetic Mat | 2.00 | 96 |

**Permissible Shear Stresses for Various Linings**

| Protective Cover | (lb./sq.ft.) | $t_p$ (N/m$^2$) |
|---|---|---|
| Gravel, $D_{50}$ = 1 in. or 25 mm | 0.40 | 19 |
| Gravel, $D_{50}$ = 2 in. or 50 mm | 0.80 | 38 |
| Rock, $D_{50}$ = 6 in. or 150 mm | 2.50 | 120 |
| Rock, $D_{50}$ = 12 in. or 300 mm | 5.00 | 239 |
| 6-in. or 50-mm Gabions | 35.00 | 1675 |
| 4-in. or 100-mm Geoweb | 10.00 | 479 |
| Soil Cement (8% cement) | >45 | >2154 |
| Dycel w/out Grass | >7 | >335 |
| Petraflex w/out Grass | >32 | >1532 |
| Armorflex w/out Grass | 12-20 | 574-957 |
| Erikamat w/3-in or 75-mm Asphalt | 13-16 | 622-766 |
| Erikamat w/1-in. or 25 mm Asphalt | <5 | <239 |
| Armorflex Class 30 with longitudinal and lateral cables, no grass | >34 | >1628 |
| Dycel 100, longitudinal cables, cells filled with mortar | <12 | <574 |
| Concrete construction blocks, granular filter underlayer | >20 | >957 |
| Wedge-shaped blocks with drainage slot | >25 | >1197 |

## Trial Runs

To optimize the roadside channel system design, make several trial runs before a final design is achieved. Refer to HEC-15 for more information on channel design techniques and considerations.