Considerations and Development of the Hydrologic Function Section in Rangeland ESD’s

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Hydrologic Cycle

Interception
Kinds and amounts of vegetation
Management effects
Wildlife, livestock, and other biotic components
Runoff, soil detachment, sedimentation, nutrients
Soil surface characteristics (crusts, cryptogams)
Soil physical properties
Infiltration and percolation
Biotic and abiotic components in the soil
Soil chemistry
Soil morphology
## Chapter 7

### Rangeland and Pastureland

#### Hydrology and Erosion

## Section 1

### Hydrologic Cycle and Effects of Vegetation, Grazing, and Management on Hydrology and Erosion

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Rangeland Hydrology: Key Issues to Consider
(See Handout)

- Climatic flux is an inevitable factor which affects ecological and hydrologic cycles in rangeland plant communities.
- We need to look beyond average climate values to understand the affect of drought and unexpected storm events.
- Examine interacting factors (veg—soil—env—mgt.)
- Relate unexpected events to thresholds in “State and Transition Models”.

3/8/2011
Handout

NRCS Ecological Site Descriptions: Hydrology and Erosion Considerations

Hydrologic Functions:

ESIS allows a narrative description about the hydrology of the site. The purpose of this document is to provide a guide to types of information which may included in this section. Future ESIS templates will allow Figures and Tables.

ESIS: Hydrologic Function Data Entry

Hydrology (infiltration and runoff), water quality, and erosion information about the respective site should be included in the Hydrologic Functions Section of the ESD.

Suggestions:

• Use state and transition model and describe corresponding hydrologic changes
• Can use RHEM model outputs for various states—compare and contrast.
• Evaluate trends in runoff and sediment yield for S&T’s
• Describe how changes in vegetation affect hydrology
• Describe how changes in hydrology affect vegetation
• Discuss plant community composition and distribution relative to infiltration and runoff
• How do conservation practices (prescribed burning, and brush management affect hydrology and erosion?
• What are the impacts of wildfire or intense burns on hydrology and erosion?
• Discuss grazing intensity and changes in plant community composition (in context with S&T model). As plant community composition shifts i.e., species, growth forms, life forms, what are the effects on hydrology and erosion?
• What are the impacts of hoof action and compaction with given soil surface physical properties (texture) on hydrology and erosion?
• What is the role of rainfall interception on this site. How many canopy layers for vegetation (reference vegetation in S&T)
• What are the rainfall dynamics associated with this ESD. Refer to climate section and explain peak rainfall months and possible accelerated runoff
 Rare Climatic Events: High Intensity Convective Storms, Design Storm Frequency, Time of Year, Drought, Rain on frozen soils etc.
Water Erosion 3/12/03
Water Erosion 3/12/03: Leavitt Creek Wyo.
Spring Runoff from a severely damaged watershed
3/12/03
Climatic Features
Precipitation amounts and yearly storm return periods (Tarrant Co.)

0.5 to 24 hr ppt (storm duration) for return periods
Muleshoe, Texas, shortgrass prairie
Design Storms and Runoff

Storm runoff (in)
Storm ppt (in)

Storm Return Intervals (yrs)

100-yr  20-yr  10-yr  5-yr  2-yr

Storm ppt (in)

Storm runoff (in)
## When does Runoff and Soil Loss Occur?
(Denio, Nevada, Mountain Big Sage Site)

<table>
<thead>
<tr>
<th>year</th>
<th>ppt</th>
<th>inf</th>
<th>ro</th>
<th>sed</th>
<th>months</th>
<th>soil loss</th>
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<tr>
<td></td>
<td>in.</td>
<td>in.</td>
<td>in.</td>
<td>t/ac</td>
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<tr>
<td>2003</td>
<td>16.50</td>
<td>10.30</td>
<td>2.70</td>
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<td>4</td>
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<td>3.90</td>
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<td>5</td>
<td>17.40</td>
<td>11.30</td>
<td>5.00</td>
<td>0.28</td>
<td>AMJ/ASON</td>
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</tr>
<tr>
<td>6</td>
<td>19.70</td>
<td>13.00</td>
<td>5.30</td>
<td>0.44</td>
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<tr>
<td>7</td>
<td>21.70</td>
<td>9.80</td>
<td>8.20</td>
<td>0.54</td>
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<tr>
<td>8</td>
<td>13.90</td>
<td>10.00</td>
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</table>

Months in red = 2 highest soil loss
Bare Ground, Canopy, and Basal Gaps

- Bare areas erode
- Nutrients are depleted
- Invasives can become established
Prescribed Burning and Wildfire Effects on Hydrology and Erosion
Effects of Grazing Management
What are the effects of Kentucky bluegrass and smooth bromegrass invasion into Mixed grass prairie?
Effect of Disturbances (Natural and Imposed) on Hydrology and Erosion
Using Tools to Study and Evaluate Hydrologic Response in a State and Transition Context.

About the RHEM Web Tool

The RHEM Web Tool is a simple web-based interface for the Rangeland Hydrology and Erosion Model. The interface will allow the user to input commonly known rangeland characteristics and use parameter estimation equations to construct model input files, run the model, view the results, and compare different scenarios.

About RHEM

The Rangeland Hydrology and Erosion Model (RHEM) is designed to provide sound, science-based technology to model and predict runoff and erosion rates on rangelands and to assist in assessing rangeland conservation practices effects. RHEM is a newly conceptualized, process-based erosion prediction tool specific for rangeland application, based on fundamentals of infiltration, hydrology, plant science, hydraulics and erosion mechanics.
RHEM developed from actual field data
Rangeland soil erosion study sites used to develop and validate the Rangeland Hydrology and Erosion Models and displayed over Omernik level III ecoregions.
Welcome

To begin using this tool please start building a scenario using steps 1 to 6.
You can also compare scenarios by clicking on the "7. Compare Scenarios" panel at the bottom left.
Parameterization
for infiltration/runoff/erosion

sodgrass  bunchgrass  shrub
RHEM Outputs

**SCENARIO INPUTS**

<table>
<thead>
<tr>
<th>No Practice</th>
<th>With Practice</th>
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<tr>
<td>State ID</td>
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<tr>
<td>Climate Station</td>
<td>ALBUQUERQUE WB AP</td>
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<tr>
<td>Soil Texture</td>
<td>Sandy Clay Loam</td>
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<tr>
<td>Moisture Content</td>
<td>0.25</td>
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<tr>
<td>Slope Length (meters)</td>
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<tr>
<td>Slope Shape</td>
<td>S-Shaped</td>
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<tr>
<td>Slope Steepness</td>
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<td>Vegetation Community</td>
<td>Bunch Grass</td>
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<td>Canopy Cover %</td>
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</tr>
<tr>
<td>Basal Cover %</td>
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</tr>
<tr>
<td>Cryptogams Cover %</td>
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</tr>
<tr>
<td>Rock Cover %</td>
<td>0</td>
</tr>
<tr>
<td>Litter Cover %</td>
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<tr>
<td>Total Ground Cover %</td>
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**RETURN PERIOD GRAPHS**

**Total Ground Cover %**
- 60%
- 96%

**2 YEAR RETURN PERIOD RESULTS**

<table>
<thead>
<tr>
<th>Rain (mm)</th>
<th>No Practice</th>
<th>With Practice</th>
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<table>
<thead>
<tr>
<th>Runoff (mm)</th>
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<td>2.31</td>
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<table>
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<tr>
<th>Sediment Yield (ton/ha)</th>
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</table>

<table>
<thead>
<tr>
<th>Soil Loss (ton/ha)</th>
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<tbody>
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<td>0.02</td>
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**RHEM Inputs**

**RHEM Outputs**

### Benefit

- Total Ground Cover %
  - No Practice: 60%
  - With Practice: 96%

- Return Period Graphs
  - P-Rain
  - Q-Runoff
  - Sediment Yield
  - Soil Loss

- 2 Year Return Period Results
  - Rain (mm): 21.80
  - Runoff (mm): 2.31
  - Sediment Yield (ton/ha): 0.02
  - Soil Loss (ton/ha): 0.02

- 10 Year Return Period Results
Using RHEM to Evaluate Hydrologic Response to Management: Before and After Conditions

Denio, Nevada burn site 1999

Denio, Nevada burn site Summer 2000, 1 yrs. postfire

Burned Site 2005

Denio Nevada Fire Sequence
Hydrology and Erosion info for STM’s
State and Transition Model:
Granitic loam 14-18 in ARTRV/STIPA
Hydrology and Erosion Patterns

(I.) Annual ppt: 406 mm/yr
Canopy intercept: 59 mm/yr
Runoff: 120 mm/yr
Infiltration: 257 mm/yr
ET: 271 mm/yr
Erosion: 1016 kg/ha
HCPC: Historic Plant Climax
% composition/wt
Mnt. Big Sagebrush 0-20%
Needlegrass 35-50%

(II.) Annual ppt: 406 mm/yr
Canopy intercept: 75 mm/yr
Runoff: 147 mm/yr
Infiltration: 226 mm/yr
ET: 213 mm/yr
Erosion: 896 kg/ha
> Sagebrush canopy < of graz. sensitive C3 bunchgrasses
> S. Bluegrass understory
Dominant > C3 graz sensitive bunchgrasses
>P. Forbs (Lupine, Crepis, l. Paintbrush, mustards, Phacelia et al.)

(III.) Annual ppt: 406 mm/yr
Runoff: 53 mm/yr
Infiltration: 329 mm/yr
Erosion: 506 kg/ha
Dominant > C3 graz sensitive bunchgrasses
>P. Forbs

(IV.) Bare Soil Conditions
Annual ppt: 406 mm/yr
Runoff: 138 mm/yr
Infiltration: 262 mm/yr
Erosion: 1600 kg/ha
> Sagebrush canopy < of graz. sensitive C3 bunchgrasses
> S. Bluegrass understory
> P. forbs
1-5% cheatgrass

(V.)< Sagebrush canopy
> Graz. Resist. C3 grasses

WF = wildfire; F - = No fire; PF = Pres fire
PG = Prop. Graz
G + = Abusive Graz
G - = No Graz
Bmgt = Brush Management

> Sagebrush dominant canopy
> Rabbitbrush
< Graz. Resist. C3 grasses
S. Bluegrass
< P. forbs
Fire Resistant Snowberry and Rabbitbrush, gradual appearance of sagebrush

> Sagebrush canopy
> Graz. Resist. C3 grasses (S. bluegrass)
ECCOLOGICAL SITE DESCRIPTION

ECLOGICAL SITE CHARACTERISTICS

Site Name: Adobe 29-37° PZ

Site ID: RO01CY5537X

Major Land Resource Area: OC1 - Edwards Plateau, Eastern Part

Physiographic Features

This site is classified as upland. Slope gradient range from 1 to 20 percent. It is presumed that this site was formed in residuum from westward-linerite. Elevation for this site ranges from 1600 to 1700 feet above sea level.

Land Form: Hill

Elevation (feet): 1600 - 1700

Stage Approach: 0 - 20

Water Table Depth

Groundwater:

Frequency: None

Duration: None

Feeding:

Depth (feet):

Frequency: None

Duration: None

Sedimentation:

Clay: Low

Aspect:

No Influence on this site

Physiographic Features

The climate is humid subtropical and is characterized by hot summers and relatively mild winters. The average first frost should occur around November 15 and the last frost of the season should occur around March 19.

Hydrologic Features

The soils on this site are well drained with very low water holding capacity. Surface runoff can be rapid due to the slope and physiography of the site. Soils correlated with this site are in Hydrologic Groups C and D. The reference HCPC site is dominated by tall bunchgrass species that are correlated with high hydrologic function. When conditions degrade, into states 2 and 3, composition of desirable tall grasses decreases and mid and short grasses become more dominant. If soil conditions also degrade and management is consistent with oversees, hydrologic function decreases significantly. Hydrology and erosion dynamics are discussed for these states 2  and 3.

The Open Grassland/Oak Hillside State, representative of HCPC, is the most productive of the plant communities phases. Reference to the State and Transition model, state 1 is the most hydrologically stable with lowest runoff and soil loss. This is due to the prominence of tall grass cover. Greater fallar and bunc plant cover of big and little bluestem create many rainfall interception layers. In addition, many slower saturated (flood) waters are located in the understory. Under cover accumulation during the winter months can provide protection from spring impact. The morphology of big bluestem roots is characterized by thick coarse ventral and lateral roots. Knees and form a rapid, coarse, open network in the upper 2 inches of soil with branching roots arising from them. Where fractures occur in the underlying rock, roots can penetrate into deeper strata. Infiltration studies have shown the bluegrass, indian grass, and switch grass are associated with higher infiltration capacity compared to other short statured grasses which tend to have more thin fibrous surface roots (e.g., grama, buffalograss, droopgrasses, three-awn grasses).

Where the geologic substrate is fractured (commonly associated with outcrops), infiltration is rapid and immediate. This water percolates deep into the substrate and carries the overtopped vegetation (e11) process. In the non outcrop portions of this site, runoff occurs during high intensity, short duration storms. This is a common occurrence, even when range condition is good. In this state, runoff, on the average, displace and erodes little soil. Water quality is high with little or no sediment. Intermittent channels and water flow path carry runoff water with appreciable degradation in the channels. Snows and spring flow are common on this site after high rainfall periods and may last several weeks. If adequate rainfall is received throughout the growing season, snow melt may last throughout the year. Stream channels and intermittent adjacent channels serve as recharge areas. water can percolate in fractures in the geologic substrate. This water moves downward. It contributes to the recharge of aquifers and provides a constant source of subsurface water for sustained base flow to creeks and streams.

State 1: Open Grassland/Oak Hillside Community (HCPC)

Model Predictions: runoff periods based on 50 years climate data.

Return Period (Runoff): (inches) (1/yr)

(50 yr) 0.008
(25 yr) 0.011
(10 yr) 0.016
(5 yr) 0.026
(2.5 yr) 0.039
(1.5 yr) 0.040
(1.0 yr) 0.040
(0.5 yr) 0.040

Based on 50 years of climate data, there is a 1.5% chance there will be runoff and delivered soil loss for these conditions. (Rangeland hydrology and erosion Model (RHEM) predictions—model calibrated from field data). The average sediment to runoff ratio is 0.21/0.3 = 0.5. For every 1 inch
Rangeland NRI Data to assist in development of ESD’s

Conservation Treatment Unit Determinations
- Conservation practices
- Resource concerns

Macroplot measurements
- Rangeland Health Assessment
- Noxious and invasive weeds
- Disturbance indicators

PSU point, GPS located

Transect measurements
- Plant productivity
- Plant canopy and groundcover
- Canopy and basal gap
- Soil aggregate stability test
- Cover pole and height measurements
- Soil and Ecological site identification
- Site characteristics

Transect 1 - 150 ft

Transects 2 - 150 ft