TECHNICAL NOTES - RANGE

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Texas Small Plot Rainfall Simulation: Background and Procedures

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Justification for Range Hydrology Data Collection, Investigations, and Interpretations

Rangeland watersheds provide a substantial amount of water for most of the metropolitan areas in Texas. Dallas, Fort Worth, Wichita Falls, Waco, Temple, Austin, San Antonio, Corpus Christi, Lubbock, and many other cities in Texas are directly dependent on rangeland watersheds for their water supply. Rangeland is the primary land type associated with the recharge areas for the major aquifers in the state. Some of the major aquifers are the Trinity, Edwards-Trinity, Edwards, Carrizo-Wilcox, and Gulf Coast. Approximately 60% of the surface flow in rivers is also from rangeland watersheds. The maintenance of a quality lifestyle, future growth, and economic stability in Texas are dependent on sufficient water quality and quantity of which rangeland watersheds play a major role.

Each plant-soil complex exhibits a characteristic infiltration pattern (Gifford 1989) and the kinds and amounts of vegetation influence infiltration, runoff, and erosion (Rauzi 1960, Rauzi et al. 1968, Blackburn et al. 1986, Wood and Wood 1988, Thurow et al. 1988, Spaeth 1990). As the climax plant community becomes degraded, infiltration is often reduced, overland flow of water is accelerated, forage production is reduced, wildlife habitat is often diminished, and landscape esthetics are detrimentally impacted.

The Soil Conservation Service (SCS) mission is to provide leadership in the conservation and wise use of our natural resources. Resource Conservation planning in SCS considers the following elements: plants, soil, water, animals, and air.

In Texas, there are 115.9 million acres of grazing Lands which include rangeland, pastureland, native pasture, and grazeable forestland. Of the nonfederal and private rangeland in the United States, approximately 23.5% occurs in Texas.

According to 1987 NRI data, rangeland conditions in Texas are as follows:

Percent Range Condition	*Approximate Acres*
1% excellent	1.0 million acres
16% good	15.6 million acres
59% fair	55.9 million acres
24% poor	22.7 million acres

Approximately 18% of the 116 million acres of grazing land in Texas has significant erosion which is greater than the natural soil building processes in nature. Note: soil erosion greater than "T".

Demand for clean water is increasing at an exponential rate due to global population growth, health concerns, a desire to live in a clean environment, rural and urban development, agricultural, industrial, domestic use, and recreational needs. Between 1950 and 1985, the population of the U.S. grew by more than 50%, where the withdrawal of water from U.S. lakes, streams, reservoirs, and underground aquifers increased by 122%, from 180 billion to 400 bgd (U.S. Bureau of the Census 1980).

In Texas, the population is expected to double during the next 50 years (from 15 million people in 1985 to 35 million people in 2040) which will significantly affect a myriad of water needs. Continued long term economic growth in Texas requires that good quality water and sufficient quantity of water is made available. The cost of this water also needs to be reasonable. Texas can prosper if existing supplies of water are efficiently managed and new supplies are developed. Efficient management includes watershed conservation measures, expanded reuse, and water yield enhancement etc. (Texas Water Development Board 1990).

On a regional basis, the Regional Water Resource Area in San Antonio Texas (Uvalde, Bexar, Comal, Medina, and Hays counties) predicts that water use in 1990 was about 476,000 acre feet. In 2010, water use is expected to increase by 25% (total projected use is 594,000 ac/ft). By the year 2040, estimates of water use in the above counties will increase to 896,000 ac/ft, an 88% increase (San Antonio Regional Water Resource Study 1986).

Brush encroachment on approximately 99 million acres in Texas has seriously deteriorated forage production and has altered hydrologic water cycle on hillslopes. A serious resource concern occurs when brush densities exceed about 100 plants per acre and crown canopies are greater than 10%. This condition warrants brush management. Deteriorating range condition has significantly reduced the kinds and amounts of desirable and palatable forage for livestock and wildlife, and has affected the ability to store water for recharge of underground aquifers. Surface water flow to streams has also been reduced in areas where shrub encroachment is severe. Controlling undesir able woody vegetation on deteriorated rangelands in Texas is usually best accomplished by a variety of methods: burning, mechanical treatments, and chemical treatments.

Major metropolitan areas in Texas such as San Antonio, Houston, Dallas, Fort Worth, Austin, and Corpus Christi are all dependent on rangeland watersheds. These communities could improve their water quality, diminish the effects of runoff and erosion, and augment and perpetuate the supply of water in streams and groundwater systems with the wise use of conservation measures and practices.

Water quality on grazing land watersheds in Texas can be improved in all areas of the state with vegetative, facilitating, and/or accelerating management practices. However, **caution** must be used when predicting what grazingland watershed areas in the state are capable of producing significant increases in water yield: Some areas are more favorable than others.

Objectives:

The objectives for performing rainfall simulations on grazing lands in Texas are as follows:

1) Predict, model, and identify the relationships of infiltration, runoff, and sediment yield with vegetative and soil measurements such as above ground biomass, root biomass, plant height, percent canopy cover, bulk density, soil texture, and organic matter etc.

2) Develop a range hydrology data base for Texas grazing lands. This information can be used in range site descriptions. Benchmark range sites can also be used to provide initial hydrology information for similar range sites where hydrology data is not yet available.

3) Use this information in developing, creating, supporting and implementing programs which address water quality and quantity on grazing land watersheds i.e., GPCP, targeted projects restoration of springs and seeps, bioremediation of hydro logically depleted range watersheds, RC&D projects, PL-566 watershed programs, and river basin studies.

4) This data would also supplement the development of the WEPP Rangeland Resource Model. The data would also be used to parameterize and validate water erosion models such as WEPP, RUSLE, CREAMS, and SPUR-91 in Texas.

Methods and Operating Procedures for Portable Rainfall Simulators

Description of Rainfall Simulator:

The SCS in Texas has purchased 8 portable drip needle rainfall simulators from Texas A&M University. Each simulator is equipped with a tubular frame which can extend 6.5 ft (2 m) in height. The plexiglass applicator module contains 3600 dripper needles on 1/2 inch (1.27 cm) centers with an area of 6.25 ft2 (0.58 m2).

Water is fed into the module through a velocity meter from an overhead tank 1 ft. (0.3 m) above the module. Flow can be regulated to maintain a constant application rate. Flow rates may be varied from 10 (37.9 l/hr) to 20 gallons per hour (75.8 l/hr). A main tank which supplies the water needs for the rainfall simulation should be at least 50 gallons (189.3 liters) or greater.

Number of Rainfall Simulations Needed per Study Site:

As a general guideline, a minimum of 3 simulation runs per treatment to ascertain variability and minimize erroneous results.

Range hydrology studies should be carefully planned. Clear and explicit objectives should be determined and documented before any field work begins. A soil scientist should be consulted to identify the soil series, provide the taxonomic soil classification, characterize the soil profile, and investigate any microsite differences that may be present.

Prior to going to the field, the techniques for hydrology data collection and the field worksheet (TX ECS-17a) information should be reviewed. Complete the checklist (TX-ECS-17b) of field equipment needed to operate the rainfall simulator.

Prewetting Procedure:

Dry and wet rainfall simulations can be conducted on the same plot. If a dry run is desired, soil moisture samples should be collected at 1.0 in (2.54 cm), 3.0 in (7.6 cm), and 6.0 in (15 cm). After the dry run, the plot can be covered with a clear plastic for the next day's wet run.

If only a wet run is desired, the site must be prewetted and covered with a clear plastic tarp the day before. The soil surface (approximately 15 cm depth) at the onset of a wet run rainfall simulation should be at field capacity.

Prewet plots with approximately 25 gallons (95 liters) the day before the simulation and cover with clear plastic. On sites with high bare ground, a fabric should be placed on the soil surface to avoid scouring or disturbance during the wetting process. Anchor the plastic on the edges with rebar rods and pins. Depth of wetting on sandy loams, loams etc. should be to about 6 inches (15 cm). On clayey or lithic soils, the wetting front may approximate 2 to 4 inches (5.0 to 10.0 cm). The area of wetting should be at least 4 x 4 feet (1.2 x 1.2 m) to insure that a sufficient wetted buffer area exists beyond the dimensions of the plot. Care should be taken when applying the water so that the soil surface is not disturbed and erosion is created by the process.

After prewetting, the actual simulation should be performed within 24 hours. This technique re duces variability in antecedent moisture prior to wetting that would have existed between sample dates under normal conditions.

Alternative Method for Prewetting:

Plot frames may be placed in the ground and wetted inside and around the outside of the plot frame. The frame and buffer area should be covered as directed above.

Simulator Plot Size:

A plot size should be based on these criteria:

- The frame should completely fit under the simulator and receive equal amounts of rainfall.
- A buffer area around the plot frame (at least 6.0 in, 15.24 cm) should also receive equal amounts of rainfall.

- Plot size should not be less than 3.0 ft^2 (0.278 m^2)

- On stony or rocky sites a pliable frame can be used.

The plot outlet should be oriented downslope with the receiving frame. All contacts between frame and soil should be tamped down gently by hand and sealed with moist clay (caulking) and/or a soil seal solution where needed. **Minimize disturbance to the plot as much as possible.**

Runoff water can be collected by pumping directly from:

.) the nipple on the receiving frame;

2) from a secondary collection point--a sump located below the nipple of the receiving frame. A plastic container may be used for collection; or

3) water may be pumped directly from a completely walled plot frame. This procedure is recommended on very flat slopes where runoff does not occur in one direction.

MEASUREMENT OF INFILTRABILITY AND RUNOFF:

Hillel (1982) proposed the term infiltrability to replace "infiltration capacity" which has several shortcomings: Infiltrability "designates the infiltration flux resulting when water at atmospheric pressure is made freely available at the soil surface" p. 212.

Prior to the simulation run, soil moisture samples should be taken at three depths, 1.0 in (2.54 cm), 3 in (7.6 cm), and 6 in (15 cm). The gravimetric method can be used to calculate mass wetness (w):

$$w = \frac{\text{(wet weight) - (dry weight)}}{\text{dry weight}} = \frac{\text{(wet soil + can wt.) - (dry soil + can wt.)}}{\text{(dry soil - can wt.)}}$$

Generally, 2.5 in/hr (6.35 cm/hr) is a minimum rainfall simulation rate (note: the National Range Study Team simulator is set up to apply 2.5 and 5 in/hr of simulated rainfall). Consult technical paper no. 40, rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. A simulation rate should approximate average rainfall intensities--at least in the early phases of the simulation. On lighter textured soils, a rate of 5 in/hr (12.7 cm/hr) or more may be needed to insure runoff. Runoff should be collected at periodic intervals throughout each 5- minute collection period. Do not let water backup on the plot during the simulation. Record time when 50% ponding occurs and when runoff starts. Runoff water can be pumped directly to a one or 4-liter plastic graduated cylinder and measured in milliliters at 5-minute intervals. The contents are then emptied into a larger open plastic container. Rainfall simulations will be run for 60 minutes.

The rainfall simulator rate should be calibrated prior to the run by collecting water from a simulation run for at least 5- minutes. A 5-gal plastic bucket or a pan (the same dimensions as the plot) can be used. Measure the 5-minute volume in milliliters.

CALCULATIONS: EXAMPLE 1

$1 cm^3 = 1$ ml
1 $ft^2 = 0.0929\ m^2$
3.5 ft^2 plot frame = 0.32515 m^2 = 3251.5 cm^2

For example: a 5-minute run produced 2753 ml of water was collected from a the 3251.5 cm2 catchment pan. Note: 1 ml = 1 cm^3

$(3251.5\ cm^2)(\ x\ ) = 2753\ cm^3$ or ml

x = 0.8466 cm, the height level of water in the pan. 0.8466 x 12 = 10.16 cm/hr or 4.0 in/hr rate of application.

CALCULATIONS: EXAMPLE 2

A 5-gal plastic bucket was placed under a drip needle simulator (6.25 ft^2, 0.58 m^2 simulator module). The diameter of the container opening was 11.25 in.

(1 .25 in)(2.54) = 28.575 cm

radius = 14.2875

$(14.2875^2)(3.14) = 641.3016\ cm^2$

The rainfall simulator was run for 5-min with the flow gauge setting on 10. The measured volume was 545 ml.

$(641.3016\ cm^2)$(5-min application rate cm) = 545 cm^3

5-min application rate = 0.8498 cm

(0.8498)(12) = 10.2 cm/hr or 4.0 in/hr

SEDIMENT SAMPLE COLLECTION:

Sediment samples are collected from runoff every 5 minutes by obtaining a 1-liter subsample. Pour the remaining volume of water into a 30 gal plastic container. As a minimum, runoff collection periods are 5-, 10-, 15-, 30-, and 60-minutes. After 1 hr, thoroughly agitate the total runoff volume and take a 1-liter total cumulative subsample.

About 5 ml of Calgon solution [sodium hexametaphosphate, $(NaPO_3)_6$ should be added to the sample and be allowed to stand overnight. The sample is filtered through a funnel containing a tared Whatman #1 paper filter and oven-dried (105°C, 48 hours) and weighed in grams.

Other techniques can be used such evaporating the water in the plastic liter runoff sample bottle in a drying oven after the Calgon solution has been added.

Calculations:

To determine the conversion factor for any size plot:

$96/N = \text{plot size ft}^2$

where N = the conversion factor from grams to lbs/ac.

For a 3.5 ft^2 plot, 2 grams of sediment was obtained in a liter sample bottle at 5 minutes. Total runoff at 5 minutes was 1.75 liters.

$96/3.5 = 27.428$

(2 grams of oven dried sediment)(27.428)(1.75) = 96 lbs/ac/5 min.
conversion to kg/ha = (96)(1.12) = 107.52 kg/ha

Vegetation and Soils as Related to Hydrology

The amount of data or variables that can be used to predict or model hydrological assessments (infiltration, runoff, and sediment) are infinite. Predicting and modelling infiltration from vegetative and soil variables (from field measurements such as % cover, above ground biomass, root biomass, bulk density, soil texture etc.) can be more tedious than measuring infiltration itself. Infiltration and runoff can be determined directly; however, this approach provides no information about how the plant/soil complex affects hydrologic relationships.

Collection of Vegetation Data in a Macroplot Around the Simulation Frame:

Collect vegetation information from the plots and the surrounding site the day after the simulation run.

Establish a 375 m2 (approx. 0.1 acre) circular plot [72 ft, (21.8 m) diameter] around the area of the hydrology plot. The 0.1 acre macroplot will be used to further verify (quantify and identify) that the sample area is an actual representation of the respective range site. In the 0.1 acre macroplot, estimate percent canopy cover to the nearest percent and percent composition by weight for all plant species. Estimates of canopy coverage classes can also be used: T = trace; (1) 1 to 5%; (2) 5 to 25%; (3) 25 to 50%; (4) 50 to 75%; (5) 75 to 95%; and (6) 95 to 100%. If the canopy cover class is near the high or low end, use the symbols + or -, respectively (e.g., 2+ if the canopy cover class is closer to 25%). If + or - is not designated, use the mean value for the class (e.g., cover class 2 is 15% cover). Canopy cover can exceed 100%. especially if there are several canopy layers e.g., shrub grass canopies. The plant species data from the 0.1 acre macroplots will be used for range watershed models, establishing range condition class, and calculating other ecological attributes for range site descriptions.

Canopy Coverage Estimation Guide:

Dimensions of Plant Canopy for Various Canopy Cover Classe in a 375 m^2 Circular Plot

Plot	% Area	Diameter meters	Diameter ft.
375.00 m^2	100.00	21.85 m	71.69 ft
93.75 m^2	25.00	10.92 m	35.84 ft
37.50 m^2	10.00	6.91 m	22.67 ft
18.75 m^2	5.00	4.88 m	16.03 ft
3.75 m^2	1.00	2.18 m	7.17 ft
1.87 m^2	0.05	1.54 m	5.10 ft
0.375 m^2	0.01	0.69 m	2.26 ft
0.0375 m^2	0.001	0.22 m	0.71 ft

Vegetation in the Hydrology Micro-Plot:

Measure plant height in inches or centimeters and clip plants by species. Standing dead height and mass should also be collected. Mulch or litter on the soil surface should be collected separately. Label paper bag (site, species, date), and bag separately. Air dry or oven dry weights by species are recorded on the field sheet.

Record canopy cover in the micro-plot for each species to the nearest percent. Perform necessary calculations for total weight and composition by species. From the micro-plot, record average number of canopy layers e.g., tall or mid grass overstory (first layer), forb understory (second layer), and shortgrass understory (3rd layer) equals three layers. Also record % bare ground, % of the soil surface covered by litter or mulch, % rock cover, and % cryptogam cover. Describe rock fragment size and record % rock fragments on the soil surface. Other site information included on the hydrology field worksheet (TX-ECS-17a) should also be completed.

Root Samples:

Plant species are not equitable with respect to root morphology and how the roots affect the hydrological dynamics of a site (Weaver and Albertson 1956, Estes et al. 1979, Richards 1986). A circular 11 in (28 cm) x 4-in (10.2 cm) depth root sample should be taken in the sample plot during the time the vegetation in the plot is clipped. Use subjectivity without preconceived bias when locating the sample. The root sample can be stored in sample bags. To prepare a root sample for washing, soak the soil/root samples in water with calgon solution (water softener). Overnight soaking is usually adequate. A 12-in diameter 2 mm sieve is sufficient to wash the sample. Wash the soil from the roots with a gentle stream of water from a garden hose. A clayey sample generally takes about 20 minutes. Place washed roots in a sample bag and air dry for at least 2 weeks. Oven drying is preferable (60° C for 48 hours).

Calculations:

A 11 inch circular frame = 0.65995 ft^2,

96/N = 0.65995; where N = conversion factor gms to lbs/ac

N = 145.46

The oven dried root sample = 50 g.

(145.46)(50) = 7273.3 lbs/ac root biomass at 4 inches.

Collection of Soils Data

Soils data is a valuable component in range hydrology studies and models. Soil variables can be classified as quantitative and qualitative. Particle size analysis (% sand, silt, and clay) is a quantitative measure whereas soil structure is a qualitative measure. Range conservationists knowledge of hydrology and soils will be strengthened by the collection of soils data on range hydrology sites.

All hydrology sites should be correlated with a soil scientist. Each site should be characterized, with special attention given to the surface horizons. Samples should be sent to the National Soil Survey Lab (NSSL). Work through the Area and State Soil Scientist to request these analyses. Attach a Soils 232 form to the soil sample with a cover letter explaining the analyses desired.

Each horizon selected for complete characterization will be sampled following the Procedures for Collecting Soil Samples and Methods of Analysis for Soil Survey (Soil Survey Staff, 1984), usually by excavation. Where applicable, three clod samples will be taken and coated with saran for laboratory determination of bulk density (where possible). In the field, measure bulk density at 2 depths (0 to 1 in, and 1 to 3 inches) with the compliance cavity technique (Grossman 1992). See attachment #1 and complete TX-ECS-17c form.

Complete soil characterization will be performed by the SCS National Soil Survey Laboratory and the SCS Soil Mechanics Laboratory in Lincoln, Nebraska, and will include:

a. **Particle-size Analyses:**

- Coarse fragments 5-20 mm and 2-5 mm(>20 mm fragments will be sieved and weighed at the time of sampling)
- Sand, 5 fractions; 1-2 mm, 0.5-1 mm, 0.25-0.5 mm, 0.10- 0.25 mm and 0.05-0.10 mm
- Silt, 2 fractions and total; 0.02-0.05 mm, 0.002-0.02 mm and 0.002-0.05 mm
- Clay, 2 fractions and total; coarse, 0.0002-0.002 mm; fine, <0.0002 mm
- Water dispersible total clay (surface layer)
- Carbonate clay (calcareous samples only)

b. Fabric-related Analyses:

Moist and oven-dry bulk density from clods

- Coefficient of linear extensibility (COLE)
- Water retention differences (WRD)
- Water release curve with tension of 1/10 or 1/3 bar (1/10 bar for sandy textures, 1/3 bar for other textures), 2-bar, 15 bar, and total porosity with Baumer model
- Reconstituted bulk density and test for crusting propensity (experimental, surface layer)

c. Cation Exchange Analyses:

- Ammonium acetate extractible bases
- Extractible acidity at 8.2
- Al extractible by KCl (only when pH <5.2)
- Cation exchange capacity by ammonium acetate method
- Cation exchange capacity by summing base and acidity
- Effective cation exchange capacity by summing bases and Al
- Exchangeable Na percent (where applicable)

d. Soluble Salt:

- Electrical conductivity where salts suspected and the following analyses made if salt detected
- Electrical conductivity of saturation extract cations and anions of saturation extract
- Computed total salts
- Sodium adsorption ratio

e. Other Chemical Analyses:

- Organic C
- Total C (surface layer)
- Total N
- Dithionite-citrate extractible Fe and Al

INSTRUCTIONS

oll wing :lipping the plot remove the loose terial and than place glass ring the simulation lot

Dri 3 al' thread ho fficientl the ground so they stab

3. Using the bubble :l, evel the plexiglass in directions by ad ustin uts

Lin the ıvity th thin terial

Set ga ge between fixed ders the glass rin

'il' the ty with careful' measured amount ıf water water level reach the po the ga ge

(Note U olumetri cylinder and calibrated yringe to ll the cavity. Also make remove air spaces between plasti and

Carefully remove plastic and contained water Do not spill water on area to be vated

8. Ex ate the area inside the to depth, and plac soil and rocks gh lastic bag

9. Repeat steps and for second depth level (inches).

Aı the lab gh ist weight ıf rocks and soil material

Ov dry rocks soil materi degrees grade degrees F) f minimum f hours

Separate rocks and il. Weigh these separately for the oven dry gh

C ım ete data and alculations

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COMPLIANT CAVITY WORKSHEET FOR HYDROLOGICAL EVALUATIONS

1. Volume of water to fill original cavity:
   (Step 6)

2. Volume of water to fill cavity and excavation:
   (Step 9)

3. Volume of excavated soil: (2-1)

4. Moist weight of whole excavated soil:
   (Step 10)

5. Weight of excavated rocks: (if present)
   (Step 12)

6. Moist weight of soil < 2mm: (4-5)
   (or weigh soil separately)

7. Oven dry weight of soil:
   (Step 12)

8. % water content of soil < 2mm: (6-7 / 7) X 100

9. Volume of rocks: (5 / 2.65)

10. Volume of soil < 2mm: (3-9)

11. Moist bulk density of soil < 2mm: (6 / 10)

12. Moist bulk density of whole soil: (6+5 / 3)

13. Dry bulk density of soil < 2mm: (7 / 10)

14. Dry bulk density of whole soil: (7+5 / 3)

RAINFALL SIMULATION EQUIPMENT LIST TEXAS

____________BATTERY (12 VOLT)
____________BOTTLES, PLASTIC (1000 ML)
____________BARRELS, WATER (15 - 20 GAL - 3)
____________BUCKETS (5 GAL - 3)
____________CALCULATOR
____________CAMERA
____________CAULKING
____________CAULKING GUN
____________CLAMPS (EXTRA)
____________CLEAR PLASTIC (5'x5')
____________CLIPBOARD
____________CLIPPING EQUIPMENT
____________COMPASS
____________CONTAINER (OPEN TOP-15 GAL)
____________FABRIC OR TOESACK (4'X4')
____________FILTER (EXTRA FOR WATER PUMP)
____________FORMS (HYDROLOGY)
____________GRADUATED CYLINDER (3-1000 ML)
____________GUITAR STRING (B OR G)
____________HATCHET
____________HOSE CLAMPS (EXTRA)
____________HOSE WASHERS
____________HOSES W/EXTRA COUPLINGS (4)
____________LADDER
____________LEVEL
____________MARKER, PERMANENT
____________MEASURING RULER
____________METAL STRIPS
____________PERMANENT MARKER
____________PLIERS
____________PUMP (EXTRA)
____________PUMP AND FILTER SYSTEM
____________RUNOFF TROUGHS
____________SCREWDRIVER (BLADE)
____________SCREWDRIVER (PHILLIPS)
____________SHARPSHOOTER
____________SIMULATOR BOTTLE (5 GAL)
____________SIMULATOR FRAME
____________SIMULATOR MODULE
____________SLEDGE HAMMER
____________SOIL MOISTURE CANS
____________STOP WATCH
____________TAPE (MASKING OR DUCT)
____________TARP WITH STRAPS OR STRING
____________TROUGH COVER (PLASTIC)
____________WIRE FLAGS
____________WRENCH

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RAINFALL SIMULATION CHECKLIST AND REMINDERS

Prior to any rainfall simulation work, it is recommended that the range site and soil series be correlated with a soil scientist. Attach a site specific soil profile description with taxonomic classification.

DAY

______________SELECT SITES AND NUMBER
______________INSTALL TROUGHS
______________SELECT AND PROTECT BULK DENSITY SITES
______________SURVEY VEGETATION BY SPECIES IN SIMULATION PLOT (% CANOPY COVER, HEIGHT)
______________RECORD NUMBER OF CANOPY LEVELS
______________RECORD DATA ON FIELD SHEET: % ROCK FRAGMENTS, SOIL CRUSTS, ETC
______________DETERMINE SLOPE
______________DETERMINE ASPECT DATA
______________LAY FABRIC
______________PRE-WET PLOT
______________COVER PLOT WITH CLEAR PLASTIC

DAY 2

______________COLLECT SOIL MOISTURE SAMPLES
______________ARRANGE AND LEVEL SIMULATOR
______________DO NOT REMOVE CLEAR PLASTIC
______________CHECK ALL PUMPS AND CONNECTIONS
______________CHECK FOR AIR BUBBLES
______________POSITION STOP WATCH
______________CALIBRATE RAINFALL RATE WITH 5 GAL BUCKET FOR 5 MINUTES (USUALLY 4"/HR)
______________CAULK TROUGH CORNERS
______________POSITION PLASTIC TROUGH COVER
______________POSITION 15 GAL OPEN TOP CONTAINER
______________PLACE RUN-OFF WATER HOSE IN GRADUATED CYLINDER
______________POSITION EXTRA GRADUATED CYLINDER
______________RECORD WHEN RUNOFF BEGINS
______________KEEP 5 GAL SIMULATOR BOTTLE (AT LEAST 3/4TH FULL)
______________CHECK FLOW METER PERIODICALLY

DAY 3

______________CLIP PLANTS BY SPECIES
______________COMPLIANCE CAVITY TECHNIQUE FOR BULK DENSITY

WHEN CONVENIENT (WITHIN 2 TO 3 WEEKS)

______________SOIL CHARACTERIZATION
______________SOIL SAMPLES FOR LABORATORY ANALYSIS

Worksheet for Plant Data: Range Hydrology Investigations

Kind of Land:

Describe Use History and Grazing Systems (if any):

Kind of Animals:

Season of Use:

Fire History: *Unknown, Rarely burned, Occasionally burned, Systematically burned, Accidently burned*

Specify Fire Frequency and Purpose:

Brush Management History:

Type of Brush Control: *Mechanical, Biological, Chemical, Fire*

Describe Previous Year and Current Growing Season Status:

Vegetation in 0.1 Acre (72 ft diameter) macroplot				
Plant Name Scientific Symbol/Common Name	% Canopy Cover	Estimated Weight lbs/ac	% Composition by Weight	% Climax by Weight
Totals				

Canopy coverage class T = trace; (1) 1 to 5%; (2) 5 to 25%; (3) 25 to 50%; (4) 50 to 75%; (5) 75 to 95%; (6) 95 to 100%

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RANGE HYDROLOGY FIELD WORKSHEET

Data by___________________ Date of simulation_________________ Date of Prewetting_________________
Range Site___________________ Range Site #____________________ Mapping Unit Name________________
Soil Series___________________ % Slope_ Elevation_ ____ Aspect________ (________ deg.)
Location of site:
Describe Rock Fragment Size (Stones, Cobbles, Gravels):

Describe Soil Crusts, Desert Pavement, Vesicular Crusts, Cryptogamic crust makeup etc. if present:

Describe location of hydrology plot: Shrub coppice, interspace, tree understory, grass stand etc.

Micro-Plot Data: Plant Name Sci. Symbol/Common Name)	Avg. Height (in)	%Canopy Cover	Clipped Weight (g)
Standing Dead			
Root Sample	xxxxxxxxxxxx	xxxxxxxxxxxx	

Average Number Canopy Layers	% Bare Ground	% Soil Surface Litter Cover	% Rock Cover	% Cryptogam Cover

Calibration Area______cm²; Water collected in 5 min.______ml; Rainfall Simulation Rate______in/hr; ______ cm/hr
Simulation start time_______; Simulation end time________; Plot size ________ft²; ________m²; Plot shape________
Time 50% ponding_______; Start of Runoff_______; % Soil Moisture______0.0 to 1.0 in; ______3.0 in; ______6.0 in;
Wind Speed________; Wind Direction________; Notes____

Time	Runoff (ml)	Runoff (ml)	Runoff (ml)	Sediment Bottle No.
0 - 5 min				
5 - 10 min				
10 - 15 min				
15 - 20 min				
20 - 25 min				
25 -30 min				
30 - 35 min				
35 - 40 min				
40 - 45 min				
45 - 50 min				
50 - 55 min				
55 - 60 min				
			Cumulative Sediment	

Note: Attach a Site Specific Soil Profile Description with Taxonomic Classification.

Three threaded rods 25 to 40 cm long and 1.0 or 1.3 cm diameter (3/8 or 1/2 inch) are employed to mount the compliant cavity. Preferably, the rods should be sharpened. The threaded rods have wing nuts to position the compliant cavity and two regular nuts may be placed at the end of the threaded rod to increase the area of the surface struck.

DISCUSSION

The field aspects fo the measurement can be completed easily in 20 minutes under favorable conditions. Presence of rots increase the time required markedly. If possible, horizons should be moist enough that desiccation cracks are absent. Local wetting of the specimen volume may be desirable. If desiccation cracks are present, either the measurement should be made between the cracks and the areal percentage cracks determined overall, or the areal percent crack space in the specimen should be measured. With either approach, the bulk density inclusive and exclusive of the crack space may be calculated. The sponge rings may be shaped to form an oval for the determination of linear features such as tractor tire indentations. Replication depends on the objectives. For the most careful work, three determinations are made about 1/2 cm apart. The method permits a high degree of specificity within a tillage-determined configuration or a closely spaced natural near-surface pattern. The location of the ring should be carefully recorded if there are apparent large differences in bulk density among kinds of positions over the near surface.

Attachment #1

BULK DENSITY BY THE EXCAVATION PROCEDURE USING COMPLIANT CAVITIES (GROSSMAN, 1992)

This method is designed to measure the bulk density of weak or loose soil material for which the core or clod methods are unsuitable. The method is particularly applicable to the near surface including fragile tillage zones. It also may find application for deeper zones through sampling on benches from a pit. Zones as thin as 2 cm may be measure and the immediate soil surface need not be disturbed. Figure 1 shows the device.

MATERIALS AND PARTS

Plexiglass rings are fabricated 0.9 cm thick, either 13 or 20 cm inside diameter and with outside diameters 20 cm more than the inside. Three holes are made 1.6 cm diameter and 1 cm in from the outer edge of the ring. The holes are positioned equal distance apart. Three pieces 2 1/2 by 5 cm of the 0.9 cm thick plexiglass are used to form guides. Two pieces are attached on one side to form an "L" with a 1/2 cm gap between to facilitate cleaning away soil material. On the other side, the single piece is positioned in line with the longer leg of the "L" and so located that a parallel, adjacent line forms a diameter.

Foam rings are made from flexible polyurethane with an Initial Load Displacement of 15-18 kg. Thickness is 5 to 10 cm. The foam rings have the same inside diameter as the plexiglass rings. Width is 4 cm for the 13 cm plexiglass ring and 5 for the 20 cm. The foam rings need not be attached to the plexiglass ring.

A crossbar is fabricated from metal rod. Shelf support standards are satisfactory. These are U-shaped rods with slots. For the 13 cm ring, the support used is 1.5 cm wide and 1.0 cm high. A piece 23 cm long forms the support rod for the 13 cm ring. The support rod is 1.5 cm wide and 1.0 cm high. A piece 23 cm long forms the support rod for the 13 cm ring. Legs are attached at each end. These are 3 cm long pieces of support standard rod. The flat sides of the rod and the legs are glued together. An appropriately larger crossbar is made for the 20 cm diameter ring; support standard rod with slots 5 cm apart is satisfactory. The two ends of the crossbar should be distinguished by shape or by color.

A hook gauge is mounted on the crossbar. The hook gauge is made from No. 6 round-headed machine screws 10 cm long and hexagonal nuts. The machine screws commonly may be obtained from toggle bolt assemblies. The machine screw is sharpened to a fine point. A hole is drilled in the center of the crossbar. The machine screw is then inserted in the hole with nuts placed above and beneath the bar. The two nuts permit adjustment of the length of the hook below the crossbar and also provide rigidity. While held rigidly by the tightened nuts, the machine screw is heated to soften and the low 2 cm bent sharply upward to form a U-shaped.

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Other Study Site Measurements

During site characterization, record depth of root penetration of the surface horizons. In a shrub community, determine depth of root penetration in the coppice and interspace areas.

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- pH (1:1 in H^2O)
- pH (1:2 in $CaCl^2$)
- Calcium carbonate equivalent (where applicable) Gypsum (where applicable)

f. Mineralogical Analyses (total clay fraction):

- X-ray diffraction analysis and interpretation (qualitative to semi-qualitative)
- Differential scanning calorimetry
- Total chemical analysis (K, Fe, Si, Al)
- CEC/clay
- General interpretation of mineralogy
- Volcanic glass content of very fine sand or silt fraction

g. Other Analyses:

- Modulus of rupture (Reeve, 1985)
- Moisture release curves
- Aggregate stability by sieving (National Soil Survey Lab methodology)

Study Site Soil Characterizations by Soil Mechanics Laboratory

The following analyses will be performed by the SCS Soil Mechanics Laboratory, Lincoln, Nebraska on samples maintained at field moisture content. These analyses will include:

a. Atterberg limits (ASTM, 1984);

b. Unconfined compressive strength (ASTM, 1984);

c. Direct shear strength at low confining pressure;

d. Pin-hole test for dispersion/erodibility (test ran with distilled water and the water used for the field rainfall simulation) (ASTM, 1984);

e. Middleton dispersion ratio (modification of ASTM, 1984);

f. Volume change under variable 1-dimensional applied loads for saturated and unsaturated conditions; and

g. Saturated hydraulic conductivity.