APPENDIX C. ESTIMATING RANDOM ROUGHNESS IN THE FIELD

Random roughness is the nonoriented surface roughness that is sometimes referred to as cloddiness (Allmaras et al. 1966, Römkens and Wang 1986). Such roughness is usually created by the action of tillage implements. Random roughness is an important component in computing the soil-loss ratio (ch. 5). It can be contrasted with oriented roughness such as the ridges and furrows created by the passage of a tillage implement through the field. Oriented roughness in ridges and furrows is a component of the P factor (ch. 6).

Random roughness is defined as the standard deviation of elevation from a plane across a tilled area, after oriented roughness is accounted for by appropriate statistical procedures. Random roughness can be determined by mechanical profile meters or by more sophisticated devices such as laser profilers. At this time, no rapid, inexpensive technique is available to measure random roughness in the field. Frequently roughness is estimated as either a mean or a range in clod size. It has also been estimated in terms of the number of hits on clods of greater than a given size using a beaded line. Neither technique provides a value of random roughness as needed by RUSLE or other models.

Based on the need for rapid field assessment of random roughness and the lack of a suitable field technique, photographs of areas of selected random roughness conditions were taken to be used as visual guides to estimate random roughness in the field.

Procedure

It was thought essential to document a wide range of surface conditions, from very fine to very rough. Plot areas on the Palouse Conservation Field Station near Pullman, WA, were inspected for suitable conditions. By conducting additional tillage on selected plots, a wide range of roughness conditions was established on nine plot areas. A 6-ft-wide mechanical profile meter with pins on 1/2-in spacing was used to obtain roughness measurements. A 35-mm single-lens-reflex camera with a wide-angle lens was used to record the pin-top heights against a grid background (McCool et al. 1981). The profile meter was set up parallel to the tillage direction, and 10 lines were taken across a 1-m-deep plot. No attempt was made to establish a common datum elevation for all lines. This research differed from that of Allmaras et al.

(1966), in which all points on a rectangular grid were measured from a common datum. Hence, only random roughness parallel to tillage lines is considered in this study.

Black-and-white enlargements, 8x12 in, were obtained from the profile meter photos, and the pin-top elevations were digitized. A regression line was fitted to each set of readings for use as a reference datum, and the standard deviation was calculated for each cross section. The average standard deviation or random roughness was calculated for each plot by averaging these 10 values.

An undisturbed area measuring 1x1 m beside the profile meter transect was photographed at an oblique angle to provide an image similar to that seen by an observer standing a few feet from the plot. These photographs were taken at right angles to the tillage direction.

Results

The nine plot areas yielded random roughness values, R_t, ranging from 0.25 to 2.15 in. Photos of these plots are presented in figures C-1 through C-9. These figures can be used in the field to estimate random roughness. The soil-loss ratio is moderately sensitive to random roughness. Estimating random roughness as 0.50 when it is actually 0.25 results in a 15% error in the soil-loss ratio.

During the data analysis, it was found that the R_t value was linearly related to the difference in elevation between the highest and lowest pin-top reading (i.e., range) for a given cross section. The data from each of the cross sections is plotted in figure C-10. The R_t values were linearly fitted to the range in pin-top elevations as shown by the line in figure C-10, with a coefficient of determination of 0.93.

Thus random roughness can also be estimated by determining the distance from the highest to the lowest point along a furrow or ridge. Averaging a number of these readings in a field provides an average value to use with figure C-10 to obtain a value of R_t.

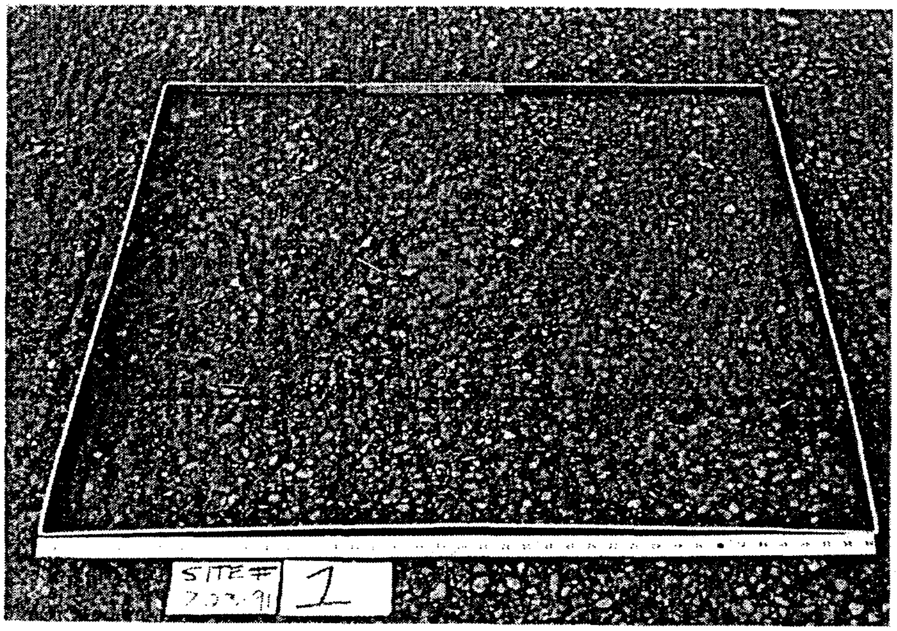

Figure C-1. Random roughness, R_t, of 0.25 in, site 1

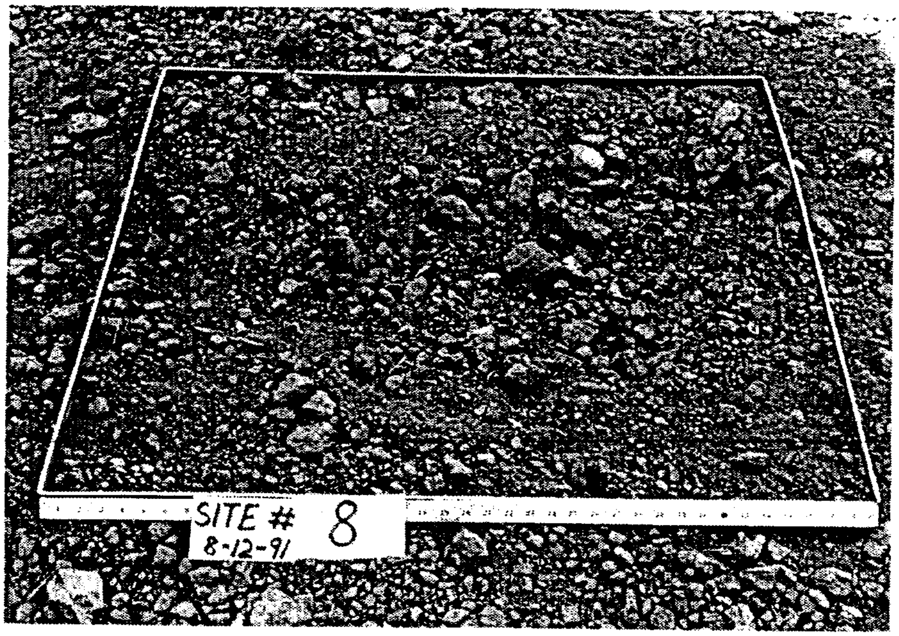

Figure C-2. Random roughness, R_t, of 0.40 in, site 8

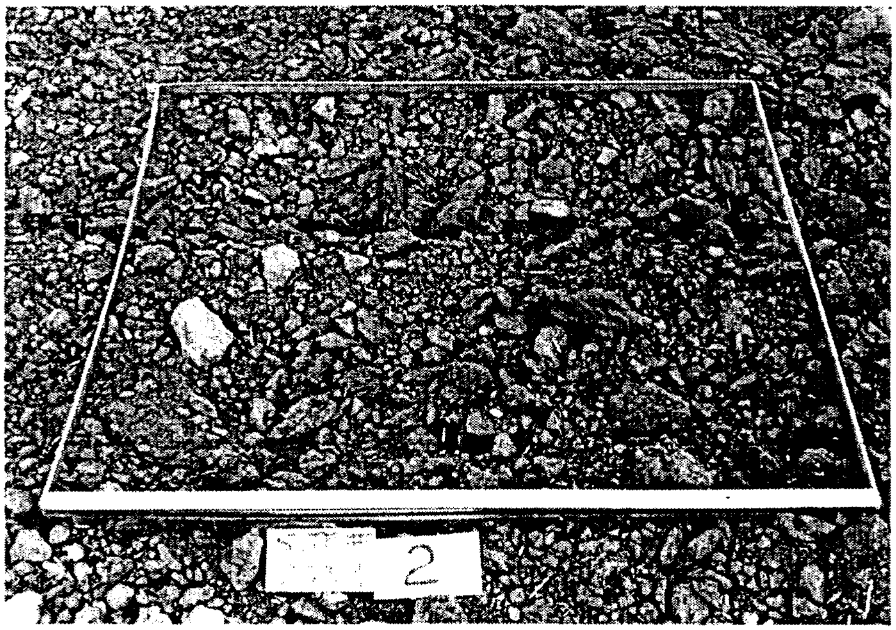

Figure C-3. Random roughness, R_t, of 0.65 in, site 2

Figure C-4. Random roughness, R_t, of 0.75 in, site 6

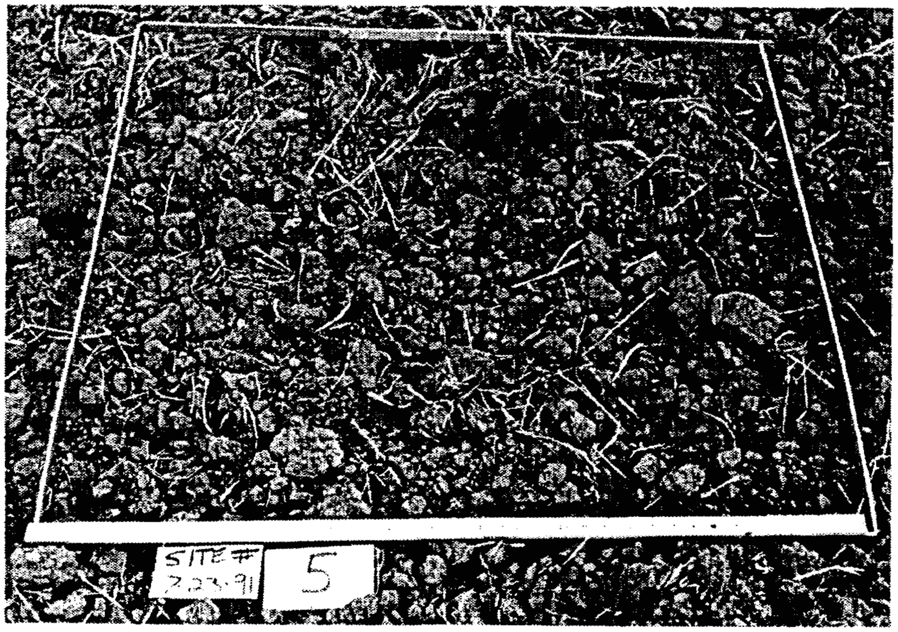

Figure C-5. Random roughenss, R_t, of 0.85 in, site 5

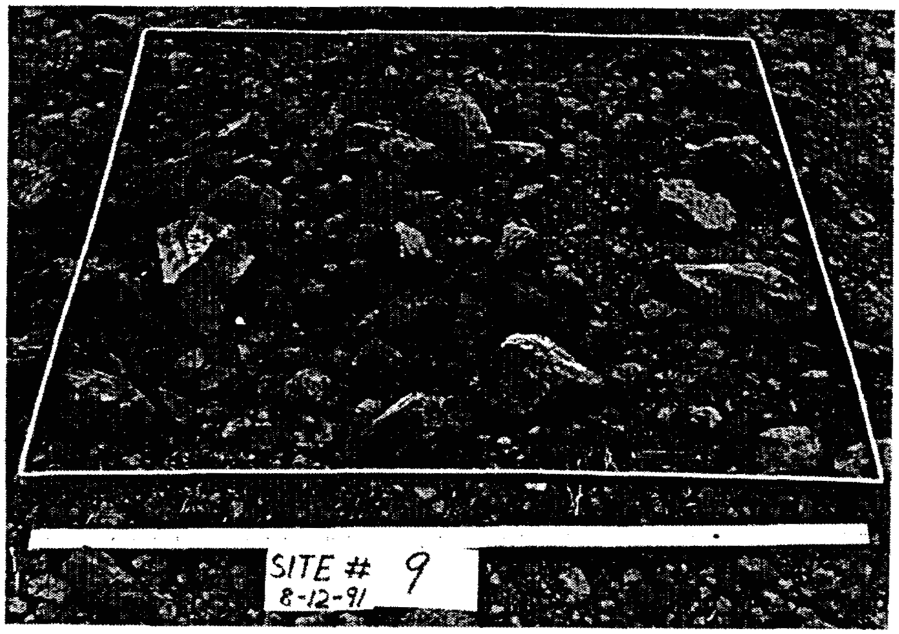

Figure C-6. Random roughness, R_t, of 1.05 in, site 9

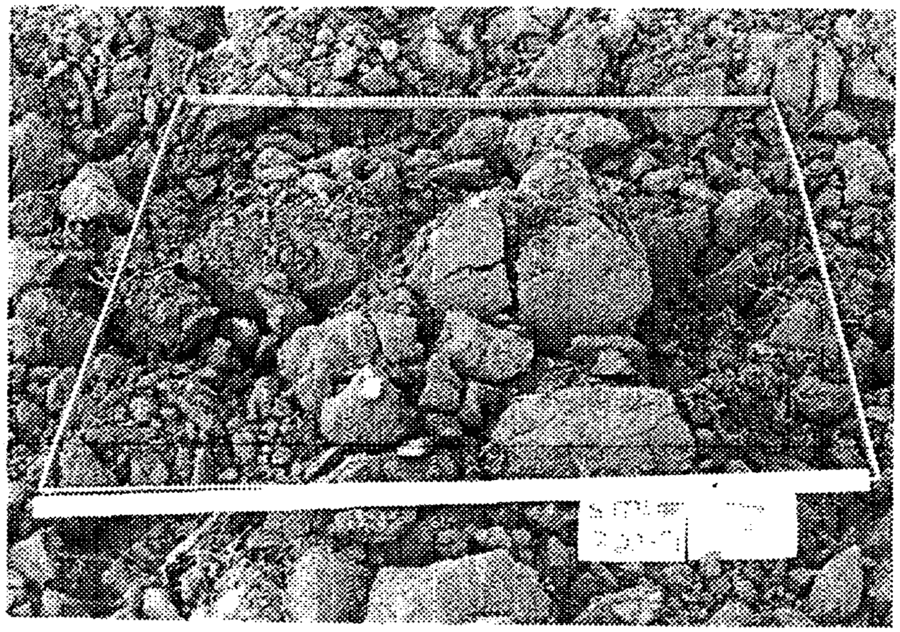

Figure C-7. Random roughness, R_t, of 1.60 in, site 7

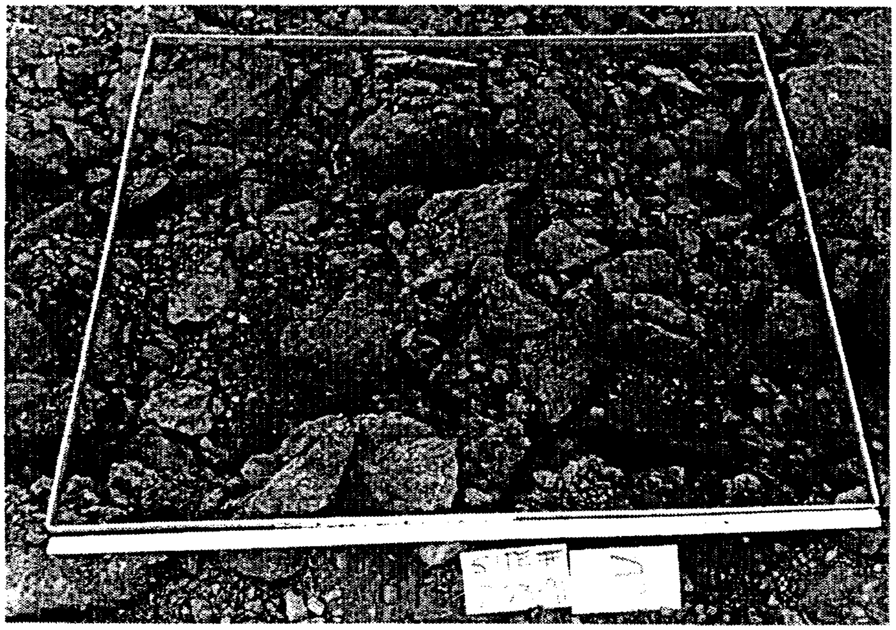

Figure C-8. Random roughness, R_t, of 1.70 in, site 3

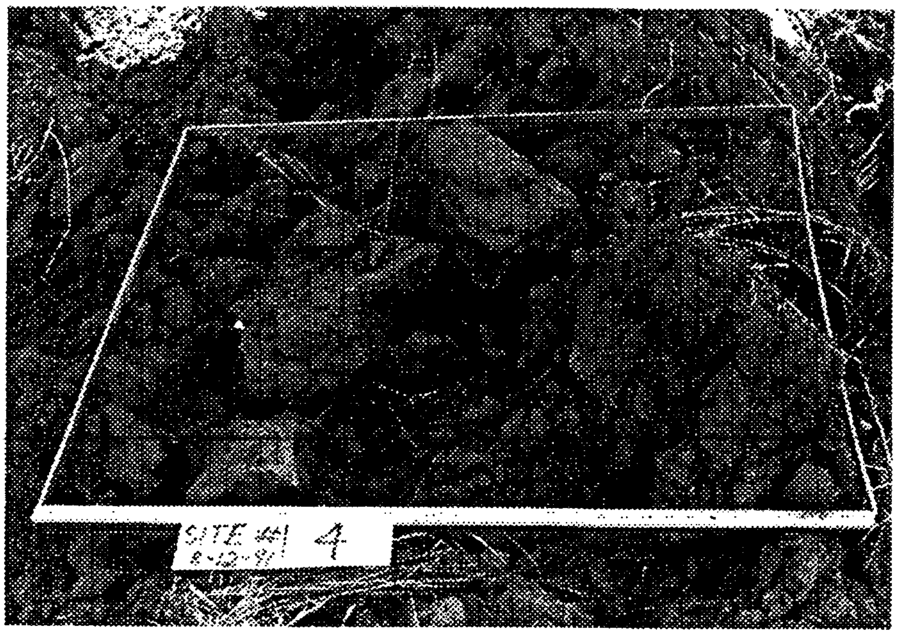

Figure C-9. Random roughness, R_t, of 2.15 in, site 4

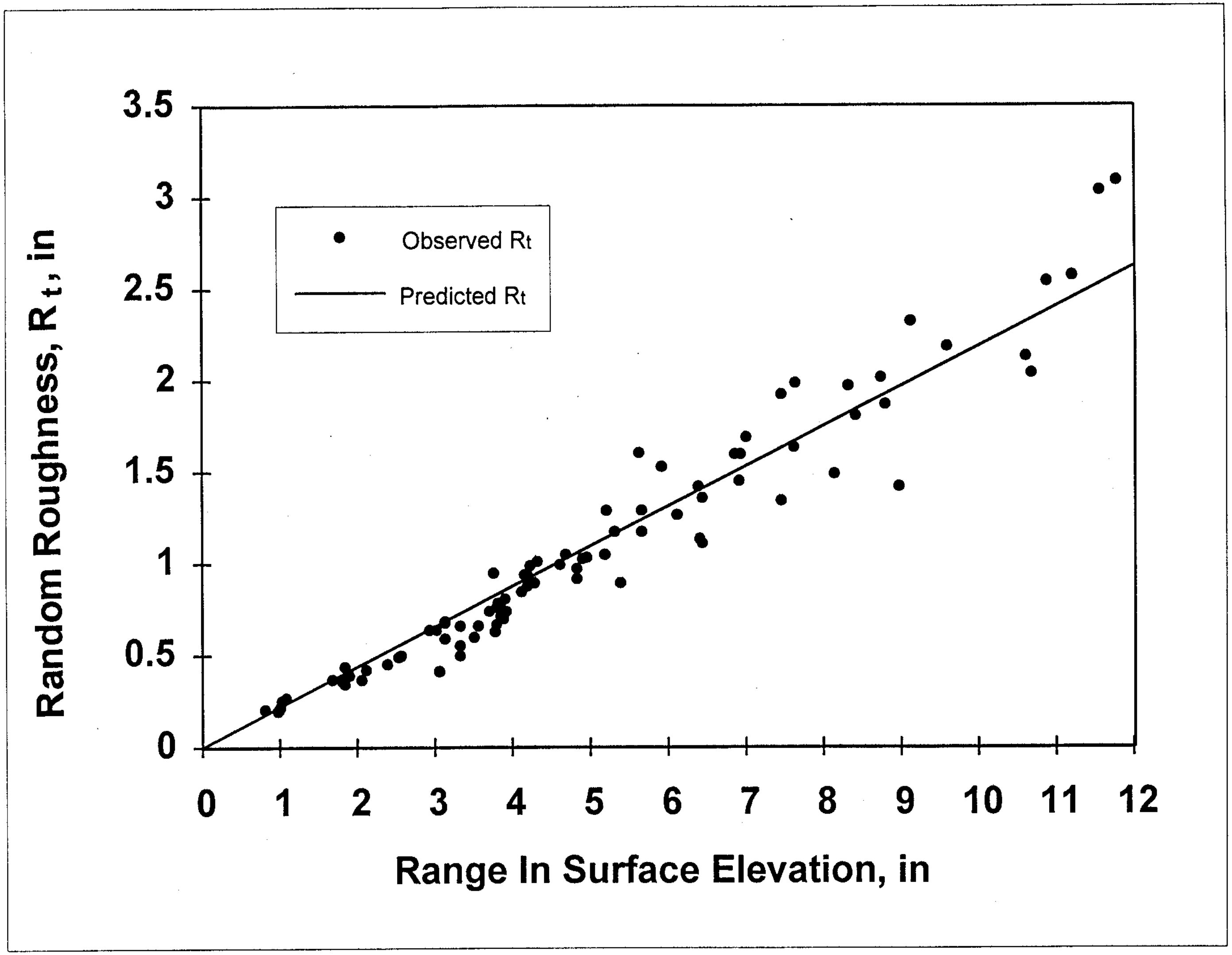

Figure C-10. Random roughness, R_t, versus range in surface elevation along a 6-ft transect