

Base from U.S. Geological Survey, 1973

NTSPP-0000000 SURVEY NOTES, N-109-478347
Slope data compiled 1978

EXPLANATION

- Slopes of 0-8 percent predominate; nearly level to gently sloping terrain
- Slopes of 9-15 percent predominate; moderately sloping terrain
- Slopes of 16-30 percent predominate; moderately steep to steep terrain
- Slopes greater than 30 percent predominate; steep to very steep terrain
- Areas of steep cliffs along shorelines

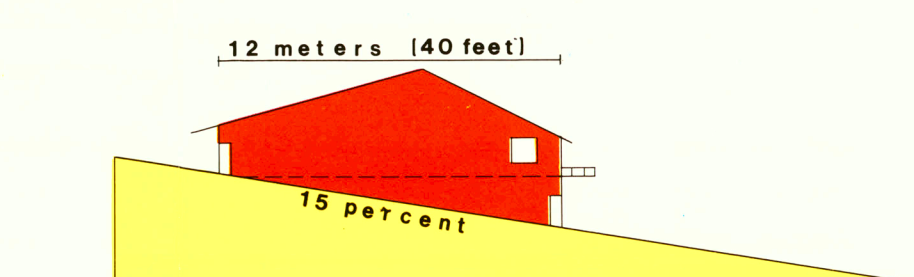
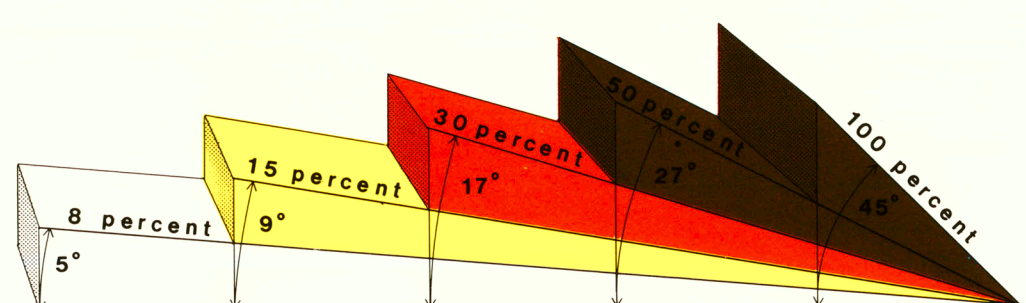


Figure 2.—House built on a 15-percent slope has one entrance a full story above the entrance at the lower end of the house.

SCALE 1:100 000

0 1 2 3 4 5
KILOMETERS

0 1 2 3 4 5
MILES

0 5000 10000 15000 20000 25000
FEET

CONTOUR INTERVAL 50 METERS
WITH SUPPLEMENTARY CONTOURS AT 10-METER INTERVALS
NATIONAL GEODETIC VERTICAL DATUM OF 1985

WASHINGTON

PUGET SOUND REGION

QUADRANGLE LOCATION

Table 1.—Relation between map unit, maximum angle of slope, and maximum spacing between adjacent contours for each unit.

Slope (percent)	Angle (degrees)	Contour spacing (cm)
0-8	≤5	≥0.63
9-15	≤9	<0.63-0.33
16-30	≤17	<0.33-0.17
>30	>17	<0.17

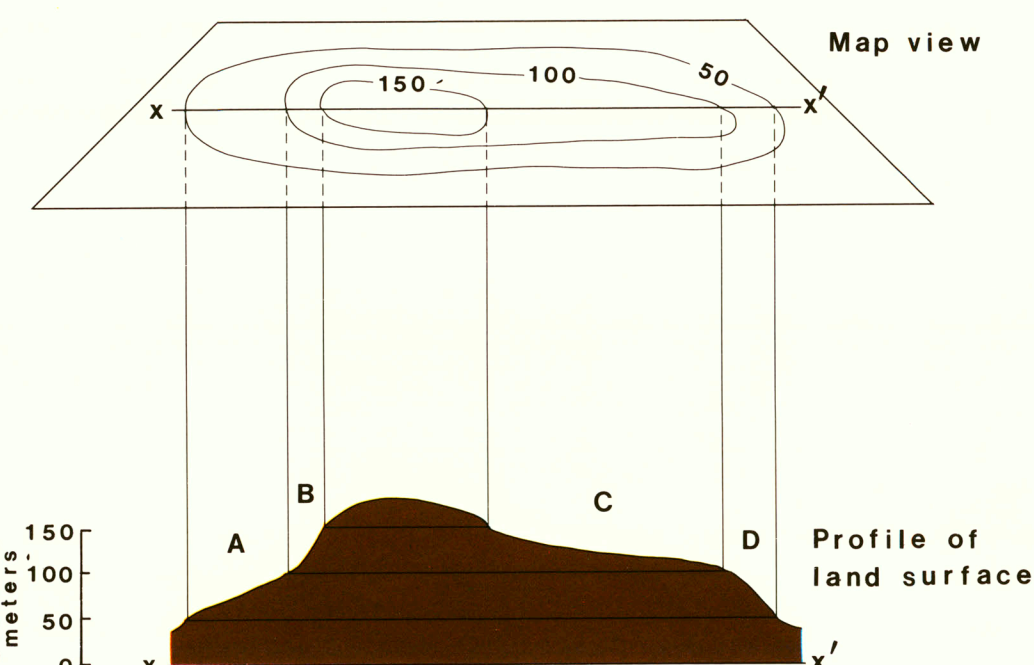
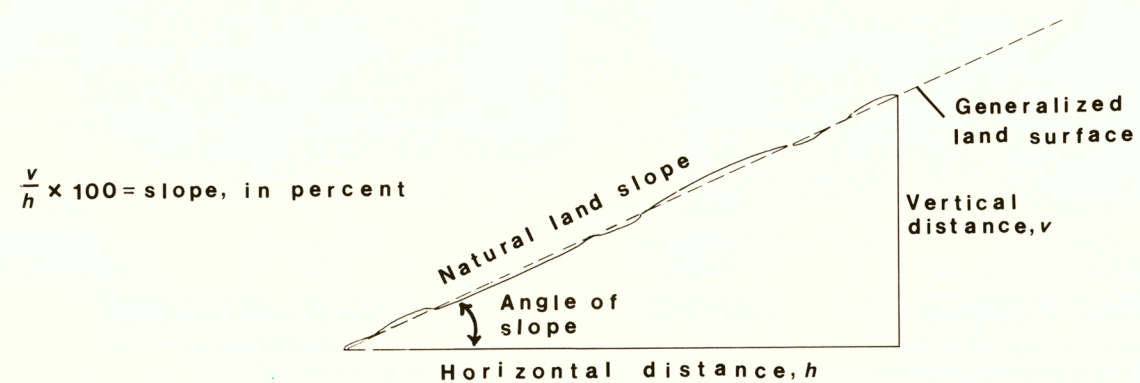


Figure 1.—Map view and profile of land surface across hill between points x and x'. The wider the spacing between contour lines, the more gentle the slope, as in segments A and C. The narrower the spacing, the steeper the slope, as in B and D.

INTRODUCTION

Land slope is the generalized degree of inclination of the land surface from a horizontal plane and can be expressed in terms of percentage, ratio, angle, or gradient. Virtually every modern zoning, subdivision, sanitary, and building regulation includes restrictions relating to land slopes. For planning and zoning, slope is most commonly defined as a percentage, that is, the vertical distance, v , divided by the horizontal distance, h , multiplied by 100.



This map presents slope information for an area of about 1543 mi² (4,000 km²) at a scale of 1:100,000. Areas with generalized similar slopes are shown by distinctive colors for the following slope intervals: 0-8 percent, 9-15 percent, 16-30 percent, and greater than 30 percent slope. These intervals best reflect some of the ranges in slope that are associated with natural landforms and processes. In addition, they coincide with the intervals specified in county slope regulations. This map is one of a series presenting basic information and interpretations to assist land-use planning, resource development, and environmental protection in parts of the Puget Sound region. The land-use and planning implications of these slope categories are discussed further in the section "Applications and Limitations of Slope Information."

MAP PREPARATION

Maps of land slopes are usually compiled from information about the configuration of the land surface obtained from the patterns of contour lines on a topographic map. A contour line is an imaginary line on the ground that takes any shape necessary to maintain a constant altitude above or below a reference level. In this case, the reference level is mean sea level, and contour altitudes are given in meters above sea level. The ring left around a bathtub after the water has drained or the watermark left on trees or buildings after floodwaters have receded can be considered to be contour lines. The spacings between contour lines represent different slopes on the land surface (figure 1); the wider the spacing, the more gentle the slope. This slope map was prepared by measuring spacings between contour lines on the 1:100,000-scale topographic map. Areas of steep seaciff exposures were identified from 1:25,000-scale topographic maps and are shown as solid green bands on this map. The spacing between contours necessary for each slope category was determined by use of the equation shown above. For example, by substituting the appropriate numerical values into the equation for the 9- to 15-percent slope category (percent slope = 15, $v = 50$) and solving for h gives a horizontal distance of 333 m, equal to 0.33 cm on the map (table 1).

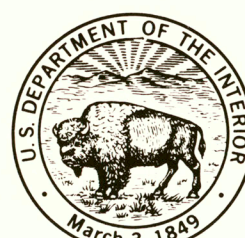
APPLICATIONS AND LIMITATIONS OF SLOPE INFORMATION

A map showing land slopes, when used in combination with other data such as the distribution of rock materials, soils, and ground water, provides information useful to the planner involved in decisions concerning ground stability, excavation conditions, and erosion potential (Brown and others, 1979). The areas with gentle slopes, 1-8 percent, and to a somewhat lesser extent those with 9- to 15-percent slopes, have traditionally been most favored for agriculture as well as housing and industry. Historical occurrences of landslides and considerations of soil mechanics indicate that 15 percent is the critical boundary for slope stability of the glacial deposits that make up much of the Puget Lowland; slopes less than 15 percent tend to be more stable than those greater than 15 percent (Miller, 1973; Tubbs, 1974). For areas with slopes greater than 15 percent, restrictions commonly are placed on uses for sewage drainfields, residential lots, roads, and landfill sites. Tractors and other farm machinery tend to be unstable when traversing slopes greater than 15 percent, and a house built on such a slope may require one entrance a full story above the entrance at the lower end of the house (figure 2). Extensive site preparation and special engineering design are commonly required for areas of slope greater than 15 percent; for areas of slopes greater than 30 percent, the problems are even more prevalent. Some counties designate areas of slopes steeper than 30 percent as open space, suitable for little or no development (King County Department of Budget and Program Planning, 1973).

Use of this intermediate-scale map permits rapid and convenient identification of regional slope patterns. The user can delineate large tracts of land where slopes are not of major concern or areas where more detailed surveys may be needed. The slope information on this map at 1:100,000 scale is not suitable for site evaluation for grading plans, or for engineering designs for excavations and structures. The slope units shown represent the most prevalent slopes in each area, but each unit on the map commonly includes areas of a different slope range that are too small to be shown. The accuracy of the slope map cannot be greater than that of the data from which it is derived. Factors that must be considered include the accuracy of the contours (a one-half contour interval) and the locations of other points on the topographic source map. Enlarging this map may make it more readable, but in no way increases its accuracy.

REFERENCES CITED

- Brown, W.H., Hines, W.G., Rickert, D.A., and Beach, G.L., 1979, A synoptic approach for analyzing erosion as a guide to land-use planning: U.S. Geological Survey Circular 715-1, 15 p.
- King County Department of Budget and Program Planning, 1973, Steep slopes as open spaces: King County, Washington, mimeographed report, 19 p.
- Miller, R.D., 1973, Map showing relative slope stability in part of west-central King County, Washington: U.S. Geological Survey Miscellaneous Investigations Series Map I-52A.
- Tubbs, D.W., 1974, Landslides in Seattle: Washington Division of Geology and Earth Resources Information Circular 32, 15 p.



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MAP SHOWING NATURAL LAND SLOPES, PORT TOWNSEND QUADRANGLE, PUGET SOUND REGION, WASHINGTON

By
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1979

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no. 1198-A
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