Online Surveying FE 208
Lecture 21

Maps and Mapping

Learning Objectives for this Lecture

1. **Know the different types of maps resource professionals might use**
2. **Know the mapping process**
3. **Know about the National Map Accuray Standards**
4. **Know the NMAS Horizontal and vertical standards**
5. **Be able to understand and apply the supplemental information on USGS quad maps**

Maps and mapping

Types of maps – Resource professionals

- Topographic maps
- Soil maps
- Transportation maps
- Hydrologic maps
- Forest stand maps

Mapping process

- **Planning**
- **Aerial Photography**
- **Field control and survey**
- **Photogrammetric surveys**
- **Cartography**
- **Reproduction**
- **Distribution**

USGS quadrangle maps

- Classified by publication scale (at varying paper sizes)

7.5 minute series	24,000
County map series	100,000
30’ * 60’ series	100,000
1 * 2 degrees	250,000
State map series	1,000,000 500,000
Sectional	2,000,000 (shows multi-state regions)

- USGS maps claim compliance with NMAS

National map accuracy standards (NMAS)

- Originally developed by the Bureau of the Budget in 1941
- Provides guidelines for the establishment of horizontal and vertical map accuracy at multiple scales
- Guidelines were also intended to protect and inform consumers about the quality of the map products they acquire
- Guidelines assume that organizations that claim adherence to the NMAS are responsible for compliance

Applying the NMAS

The NMAS applies to both horizontal and vertical positions.

Accuracy and precision are a function of the scale at which a map (paper or digital) was created. The NMAS guidelines employed by the United States Geological Survey specify that:

Horizontal Accuracy

- Not more than 10% of points tested shall be in error by more than 1/30th of an inch for maps at a scale of 1:20,000 or larger (e.g. 1:10,000) and 1/50th of an inch for maps at scales smaller than 1:20,000 (e.g. 1:24,000).
- Applies to well defined points only (Right angle road intersections, building corners, bridges)
- Must be easily or recoverable on the ground and mapable on the scale of the map at $1/100^{th}$ of an inch

Vertical Accuracy

- Not more than 10% of points tested shall be in error by more than ½ the contour interval
- Generally 20 feet but not always

Accuracy Standards for Various Scale Maps

1:1,200 ± 3.33 feet
1:2,400 ± 6.67 feet
1:4,800 ± 13.33 feet
1:10,000 ± 27.78 feet
1:12,000 ± 33.33 feet
1:24,000 ± 40.00 feet
1:63,360 ± 105.60 feet
1:100,000 ± 166.67 feet

Adherence to the NMAS means that when we see a point or line on a map we have its likely location within a threshold distance.

For horizontal distances on the Corvallis 7.5 minute Quadrangle, this threshold would be 40 feet, indicating that 90% of the tested map points should be within 40 feet of their actual location.

For vertical accuracy of the primary contour lines (20' intervals) of the Corvallis 7.5 minute Quadrangle, the threshold would be 10 feet, indicating that 90% of the elevation points checked along the contour lines should be within 10 feet of their true elevation. ***Beware of the dangers of false accuracy and false precision, that is reading locational information from map to levels of accuracy and precision beyond which they were created.***

This is a very great danger in computer systems that allow users to pan and zoom at will to an infinite number of scales. Accuracy and precision are tied to the original map scale and do not change even if the user zooms in and out. Zooming in and out can however mislead the user into believing--falsely--that the accuracy and precision have improved.

Implications of NMAS
The best places are used for checking, would expect that the other places are more subject to interpretation and error.
Typically, only 28 check points are used on a 1:24000 scale map!
Fairly wide errors are acceptable for the 90%
10% can be off by any amount and are acceptable.

To apply this statistically:

RMSE Horizontal = (40/1.66) = 24’

* 1.66 is the probability of an accidental error at the 90% level.
RMSE Vertical = (0.5 C.I./1.66) = 0.3 C.I.
Adding the vertical component of the horizontal error = 24T
RMSE Vertical = 0.3C.I. + 24T
T = the tangent of the slope angle

Example on a 30% slope

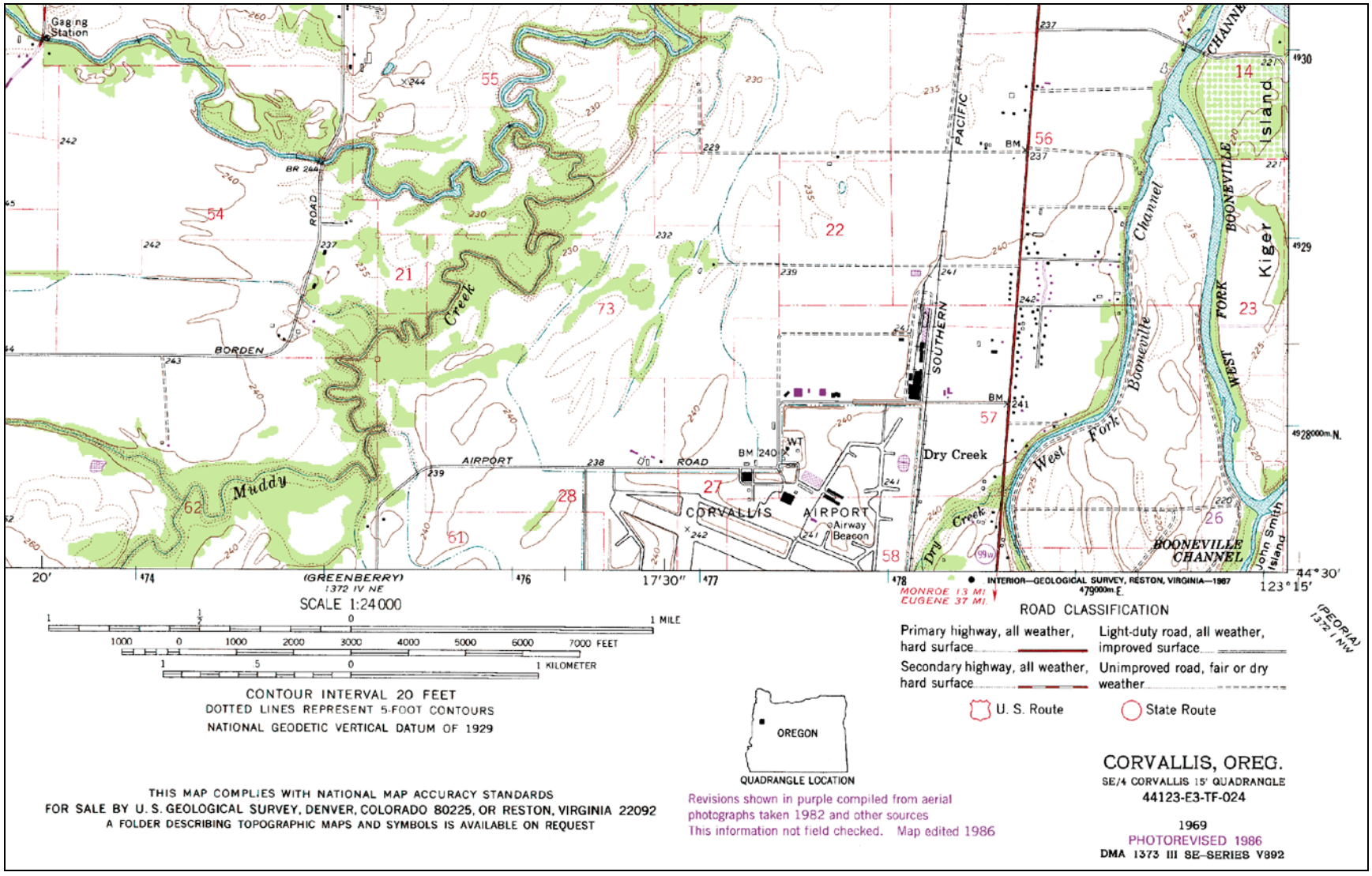
Vertical = 0.3(40) + 24 (tan 30%)

Vertical = 0.3(40) + 24 (tan 0.58) = 25.9’

Other information found on 1:24000 maps

(refer to overhead on the lower left corner of the quad maps)

(refer to overhead on the mapable features of the quad maps)



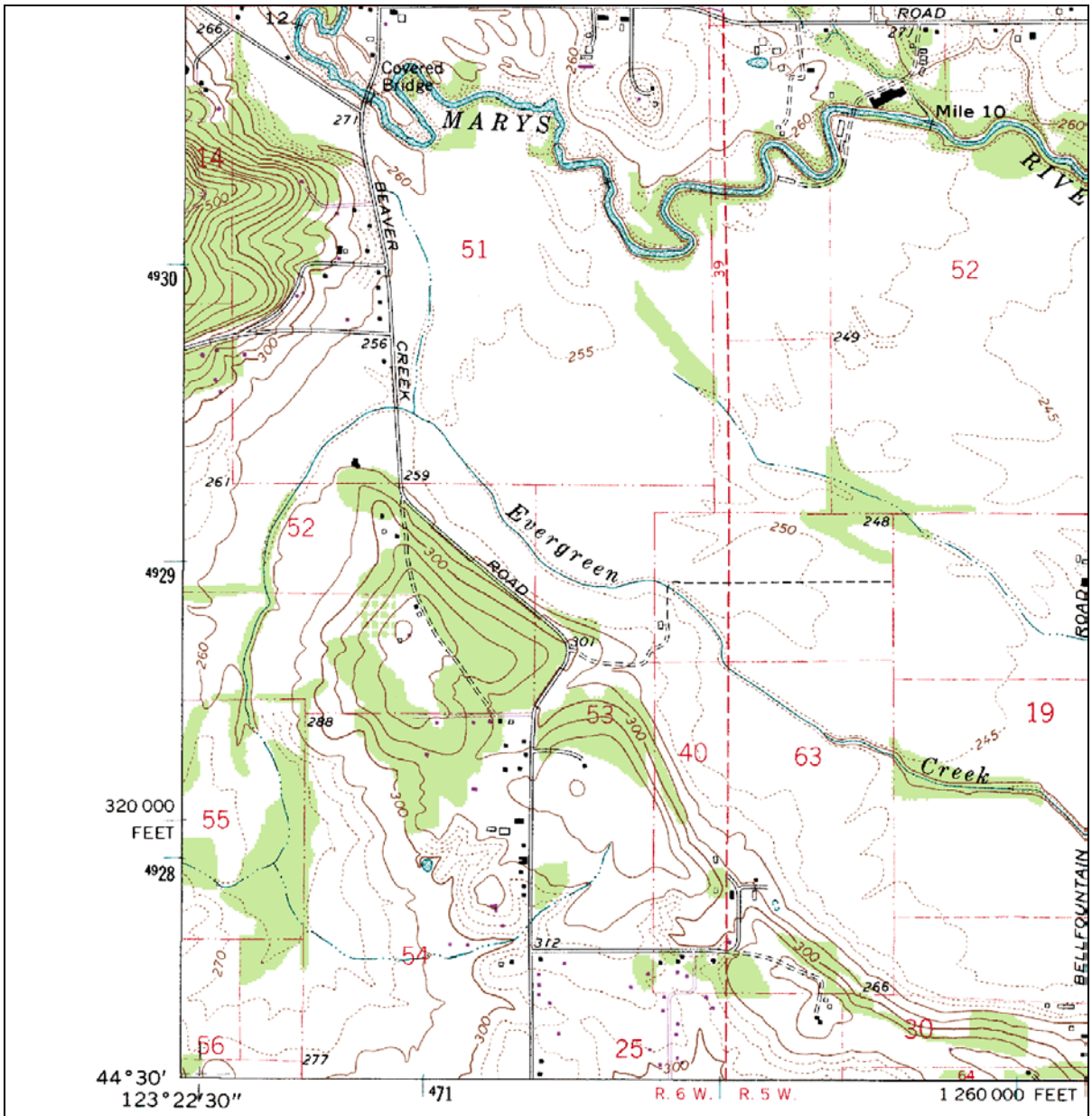
THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225, OR RESTON, VIRGINIA 22092
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

Revisions shown in purple compiled from aerial photographs taken 1982 and other sources
This information not field checked. Map edited 1986

CORVALLIS, OREG.

SE/4 CORVALLIS 15' QUADRANGLE
44123-E3-TF-024

1969
PHOTOREVISED 1986
DMA 1373 III SE–SERIES V892



(FLAT MOUNTAIN)
1372 IV NW

Mapped, edited, and published by the Geological Survey

Control by USGS, USC&GS, and State of Oregon

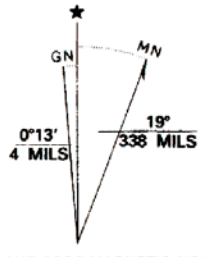
Topography by photogrammetric methods from aerial photographs taken 1967. Field checked 1969

Polyconic projection. 1927 North American datum
10,000-foot grid based on Oregon coordinate system, north zone
1000-meter Universal Transverse Mercator grid ticks, zone 10, shown in blue

To place on the predicted North American Datum 1983, move the projection lines 23 meters north and 96 meters east as shown by dashed corner ticks

There may be private inholdings within the boundaries of the National or State reservations shown on this map

Red tint indicates areas in which only landmark buildings are shown



UTM GRID AND 1986 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

United States National Map Accuracy Standards

With a view to the utmost economy and expedition in producing maps which fulfill not only the broad needs for standard or principal maps, but also the reasonable particular needs of individual agencies, standards of accuracy for published maps are defined as follows:

1. **Horizontal accuracy.** For maps on publication scales larger than 1:20,000, not more than 10 percent of the points tested shall be in error by more than 1/30 inch, measured on the publication scale; for maps on publication scales of 1:20,000 or smaller, 1/50 inch. These limits of accuracy shall apply in all cases to positions of well-defined points only. Well-defined points are those that are easily visible or recoverable on the ground, such as the following: monuments or markers, such as bench marks, property boundary monuments; intersections of roads, railroads, etc.; corners of large buildings or structures (or center points of small buildings); etc. In general what is well defined will also be determined by what is plottable on the scale of the map within 1/100 inch. Thus while the intersection of two road or property lines meeting at right angles would come within a sensible interpretation, identification of the intersection of such lines meeting at an acute angle would obviously not be practicable within 1/100 inch. Similarly, features not identifiable upon the ground within close limits are not to be considered as test points within the limits quoted, even though their positions may be scaled closely upon the map. In this class would come timber lines, soil boundaries, etc.
2. **Vertical accuracy,** as applied to contour maps on all publication scales, shall be such that not more than 10 percent of the elevations tested shall be in error more than one-half the contour interval. In checking elevations taken from the map, the apparent vertical error may be decreased by assuming a horizontal displacement within the permissible horizontal error for a map of that scale.
3. **The accuracy of any map may be tested** by comparing the positions of points whose locations or elevations are shown upon it with corresponding positions as determined by surveys of a higher accuracy. Tests shall be made by the producing agency, which shall also determine which of its maps are to be tested, and the extent of such testing.
4. **Published maps meeting these accuracy requirements** shall note this fact on their legends, as follows: "This map complies with National Map Accuracy Standards."
5. **Published maps whose errors exceed those aforestated** shall omit from their legends all mention of standard accuracy.
6. **When a published map is a considerable enlargement** of a map drawing (manuscript) or of a published map, that fact shall be stated in the legend. For example, "This map is an enlargement of a 1:20,000-scale map drawing," or "This map is an enlargement of a 1:24,000-scale published map."
7. **To facilitate ready interchange and use of basic information for map construction** among all Federal mapmaking agencies, manuscript maps and published maps, wherever economically feasible and consistent with the uses to which the map is to be put, shall conform to latitude and longitude boundaries, being 15 minutes of latitude and longitude, or 7.5 minutes, or 3-3/4 minutes in size.

Issued June 10, 1941
Revised April 26, 1943
Revised June 17, 1947

U.S. BUREAU OF THE BUDGET