FOOT VS FEET

- PRE-V8
- INTERNAL
- HISTORY
- REGS
- HOW TO

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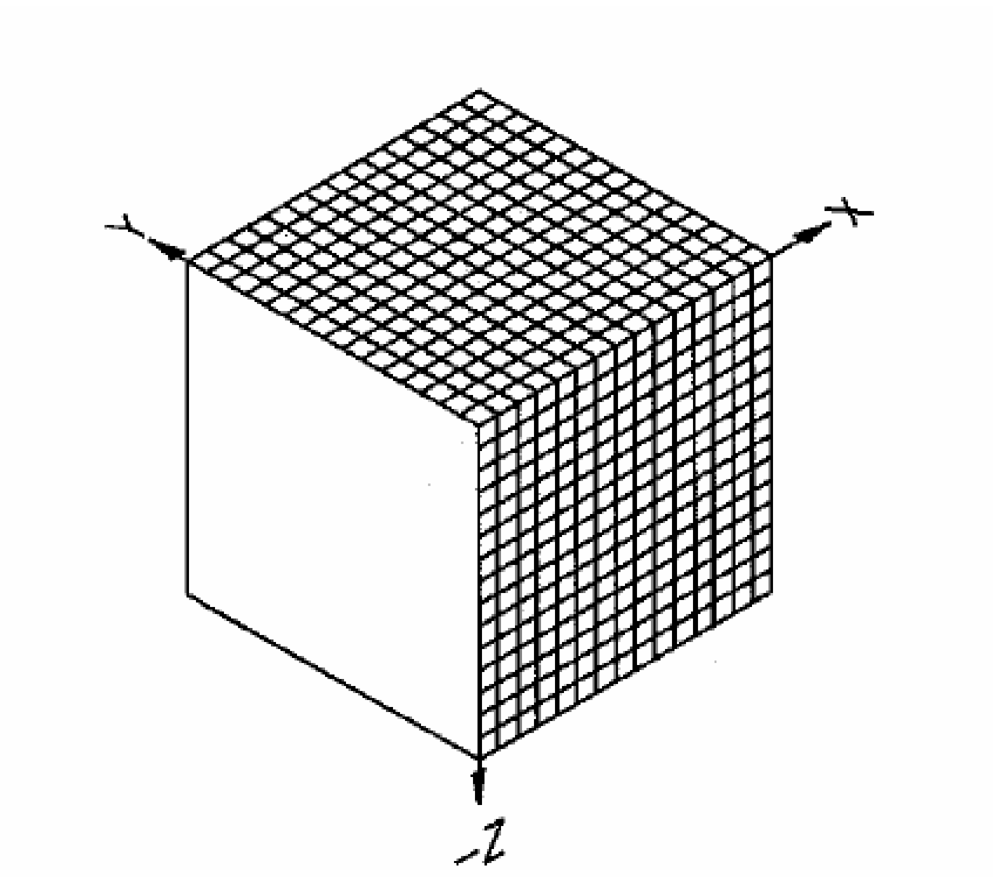
PRE-V8 (MU SU PU'S)



MASTER UNITS (MU)

SUB UNITS (SU)

POSTIONAL UNITS (PU)

Unit = Unit

MICROSTATION V 8 /HISTORY

- Did you know there are two different lengths of a foot in the United States?

- Internally Microstation stores everything as a meter. The official base unit of measure throughout the world is meters.

- V8.1 converts <u>ALL</u> values from feet to meters to store the data.

- Microstation V8 must be setup correctly or you may not be drawing what you think you are drawing. Your data conversion with the desired foot measurement may not be correct, if your units are not set properly.

- This does not include US Survey Foot in the standard units.(Pre V-8)

- HISTORY—Early 1800's, US Coast & Geodetic Survey used meter & kilogram standards brought from France.

- Congress authorized, The US METRIC LAW of 1866 from the 1991edition of ASTM publication E380-89a (*Standard Practice for Use of International System of Units*). Says 1 meter equals 39.37 inches.

- In 1875, US solidified its commitment by becoming one of the original 17 signatory nations to the TREATY OF THE METER (Metric Convention). It took 5 years of meetings in which the metric system was reformulated, refining the accuracy of its standards which became the (BIPM) Bureau of Weights and Measurements in Severs, France to provide standards of measurements for the whole worlds use.

- In 1893, BIPM, the US Yard (3 feet) was derived from the meter. The General Conference of Weights and Measures was the governing body that has the responsibility for the metric system

- In 1959/1960, refinement was made to define the yard (3 feet) to bring the US yard & yard used in the other countries together. Thus, the yard (3 feet) was changed to 3600/3937 meters to 0.9144 meters exactly. This made the new length shorted by two (2) parts per million. (A difference of 2 feet in 1 million feet. For most practical work it does not make any difference to the average surveyor since they do not encounter distances this large.

- At the same time, any data in feet derived from & published because of the geodetic surveys within the US would stay with the old standard (1 foot equals 1200/3937 meters) until further decision. This foot is named <u>US Survey Foot</u>.

- These are the definitions that are in existence today:

  - 1 International foot = 0.3048000 meters

  - 1 US Survey foot = 1200/3937 meters (0.3048006 meters)

Example:

304,800 meters = 999,998.000 US Survey Feet
304,800 meters = 1,000,000.000 International Feet

To explain this a little farther—starting with the equation that 3937 US Survey Feet equals 1200 meters, & 10000 Feet equals 3048 meters. You can use Algebra and ratios and set the two equations equal to each other ending up with 3937/1200 US Survey Ft. = 10000/3048 FT. Then using your Math skills you can multiply each side of the equal sides by 1200/10000 to obtain the same units. This will result in 0.39370000 Survey Ft. = 0.39370008 FT.

Some documents also call the International foot a “statute” foot or Imperial.

- If you have data based on geodetic surveying disciplines—using the standard unit definition you will get incorrect results.

- Microstation & Inroads use the International foot definition (most widely used) as its standard unit definition.

- Microstation does NOT include the US Survey foot in the standard unit list by default to avoid confusion. However, Microstation does understand the US Survey foot as has been configured to select US Survey foot as a option – the option will just need to be enabled.

Excerpt From EAST SUPPORT’s document on the Inroads working units exception.

The InRoads Working Units Exception When Transforming

An important distinction to remember is that when you are transforming an InRoads surface from Metric to English units, you technically transforming meters to US Survey Feet. This is how the InRoads program was designed to convert from meters. You need to be aware of that; this is the process where you are converting the InRoads data from metric to English units.

For a detailed explanation of the process that InRoads uses to perform a data transformation, refer to the following excerpt from the **ODOT Desktop training** manual, appendix L for a detailed explanation.

The **SURFACE > EDIT SURFACE > TRANSFORM SURFACE** menu option can be used to convert surface data from Metric to English. The thing to remember though is that when you select the method "Meters to Feet" in that dialog:

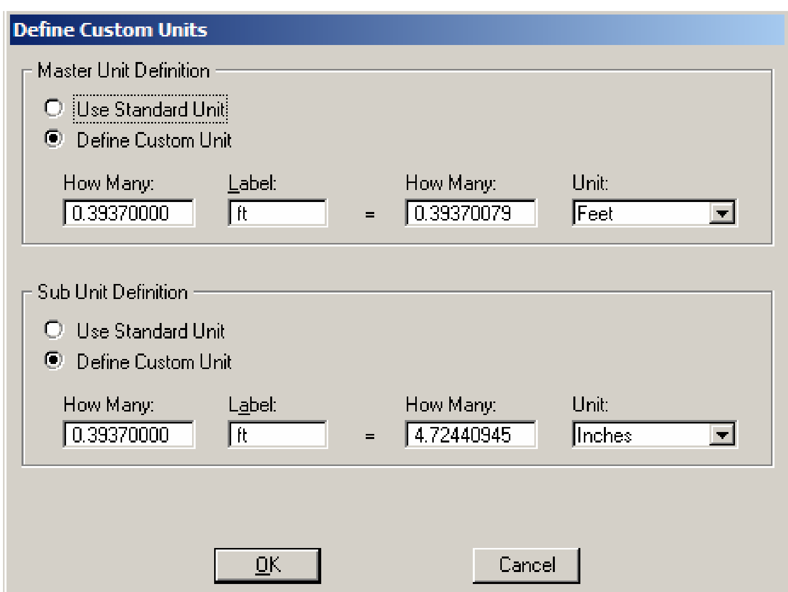
- Inroads uses a conversion factor appropriate for converting data to U.S. Survey Feet.

- MicroStation uses a conversion factor appropriate for converting graphical elements to international feet.

In other words, your DTM will probably not align with your MicroStation graphics, which represent those DTM features. You must be aware of the datum in which your survey data was collected and decide whether to scale the graphics within MicroStation or to apply a custom scale factor when converting InRoads data. The same principle applies to alignment data.

FYI: ODOT's EAST SUPPORT has modified the label that MicroStation uses for the US Survey foot to "**US_SF**". There are errors that occur during the migration process from SE to V8 if the US Survey Foot is not distinctly identified separately from the international feet label.

For those of you who are curious about the internal workings of MicroStation, you may decide to select the "Custom Units" button on the "DGN File Settings" dialog box. You must be very careful and fully understand the consequences of any changes that you make. **DO NOT make any changes under the "Advanced…" button**. When you change the working units of your design file (file pull down menu **>Settings>Design File…**) the **DGN File Settings** dialogue box appears. Selecting the **Custom Units** button will open up the **Define Custom Units** dialogue box. **It is very important that you do not** arbitrarily change the values that are displayed. As an example, that may draw your attention is the definition for the custom units. The correct values for the US Survey Foot are in the dialog box.



ODOT Survey Requirements

Ron Singh, ODOT Chief of Survey states, that ODOT is **required** to use the values provided in Oregon law when it comes to using State Plane Coordinates.

A summary of the Survey requirements are:

- We have two (2) State Plane Coordinate systems available to us in Oregon.
    - The Oregon Coordinate System of 1927 (NAD27),
    - The Oregon Coordinate System of 1983 (NAD83).
- ORS 93.330(a & b) defines the US Survey foot as 1200/3937 meters exactly. This factor **must** be used when using NAD27
- ORS 93.330(c & d) defines the (International) foot as 0.3048 meters exactly. This factor **must** be used when using NAD83
- We will not use NAD27 unless there is a very compelling reason to do so.
- Many people feel that the difference between SI feet and US feet is insignificant. This opinion is not correct. Use of US feet instead of SI feet during coordinate conversions could shift the project several meters from its true position.
- We should avoid using NAD27 any time we are using GPS in our work.

Excerpt from ORS Chapter 93:

93.330 Definition. (1) For more precisely defining the Oregon coordinate systems, the following definitions by the National Geodetic Survey of the National Ocean Service are adopted:

(a) The Oregon Coordinate System of 1927, north zone, is a Lambert conformal projection of the Clarke Spheroid of 1866, having standard parallels at north latitudes 44 degrees 20 minutes and 46 degrees 00 minutes, along which parallels the scale shall be exact. The origin of coordinates is at the intersection of the meridian 120 degrees 30 minutes west of Greenwich and the parallel 43 degrees 40 minutes north latitude. This origin is given the coordinates: x-2,000,000 survey feet and y-0 survey feet, where one survey foot equals 1,200 divided by 3,937 meters exactly.

(b) The Oregon Coordinate System of 1927, south zone, is a Lambert conformal projection of the Clarke Spheroid of 1866, having standard parallels at north latitudes 42 degrees 20 minutes and 44 degrees 00 minutes along which parallels the scale shall be exact. The origin of coordinates is at the intersection of the meridian 120 degrees 30 minutes west of Greenwich and the parallel 41 degrees 40 minutes north latitude. This origin is given the coordinates: x-2,000,000 survey feet and y-0 survey feet, where one survey foot equals 1,200 divided by 3,937 meters exactly.

(c) The Oregon Coordinate System of 1983, north zone, is a Lambert conformal projection of the Geodetic Reference System of 1980, having standard parallels at north latitudes 44 degrees

20 minutes and 46 degrees 00 minutes, along which parallels the scale shall be exact. The origin of coordinates is at the intersection of the meridian 120 degrees 30 minutes west of Greenwich and the parallel 43 degrees 40 minutes north latitude. This origin is given the coordinates: x-2,500,000 meters (8,202,099.74 feet) and y-0 meters (0 feet), where one foot equals 0.3048 meters exactly.

(d) The Oregon Coordinate System of 1983, south zone, is a Lambert conformal projection of the Geodetic Reference System of 1980, having standard parallels at north latitudes 42 degrees 20 minutes and 44 degrees 00 minutes, along which parallels the scale shall be exact. The origin of coordinates is at the intersection of the meridian 120 degrees 30 minutes west of Greenwich and the parallel 41 degrees 40 minutes north latitude. This origin is given the coordinates: x-1,500,000 meters (4,921,259.84 feet) and y-0 meters (0 feet), where one foot equals 0.3048 meters exactly.

(2) The position of the Oregon Coordinate System shall be as marked on the ground by monumented horizontal control stations established in conformity with the standards and specifications adopted by the Federal Geodetic Control Committee for first-order and second-order geodetic surveying, whose geodetic positions have been rigidly adjusted on the North American datum of 1927 or 1983, and whose coordinates have been computed on a system defined in this section. Any such station may be used for establishing a survey connection with the Oregon Coordinate System.

(3) Nothing in this section is intended to limit the use of any coordinate system not identified as the "Oregon Coordinate System." [Amended by 1985 c.202 §2]

93.320 Oregon Coordinate System; zones. (1) The systems of plane coordinates which have been established by the National Geodetic Survey of the National Ocean Service, formerly the United States Coast and Geodetic Survey, for defining and stating the positions of points on the surface of the earth within the State of Oregon are known and designated as the Oregon Coordinate System of 1927 and the Oregon Coordinate System of 1983.

(2) For the purpose of the use of these systems the state is divided into a "north zone" and a "south zone."

(3) The area included in the following counties on June 16, 1945, constitutes the north zone: Baker, Benton, Clackamas, Clatsop, Columbia, Gilliam, Grant, Hood River, Jefferson, Lincoln, Linn, Marion, Morrow, Multnomah, Polk, Sherman, Tillamook, Umatilla, Union, Wallowa, Wasco, Washington, Wheeler and Yamhill.

(4) The area included in the following counties on June 16, 1945, constitutes the south zone: Coos, Crook, Curry, Deschutes, Douglas, Harney, Jackson, Josephine, Klamath, Lake, Lane and Malheur.

(5) Any document submitted for recording that utilizes an Oregon Coordinate System shall use only one specified zone and system for the entire document.

(6) The use of the term "Oregon Coordinate System" on any document submitted for filing as a public record is limited to coordinates based on the Oregon coordinate systems as defined in ORS 93.330 and must include appropriate system date and zone designations. [Amended by 1985 c.202 §1]

Excerpt from Tower Maps.com:

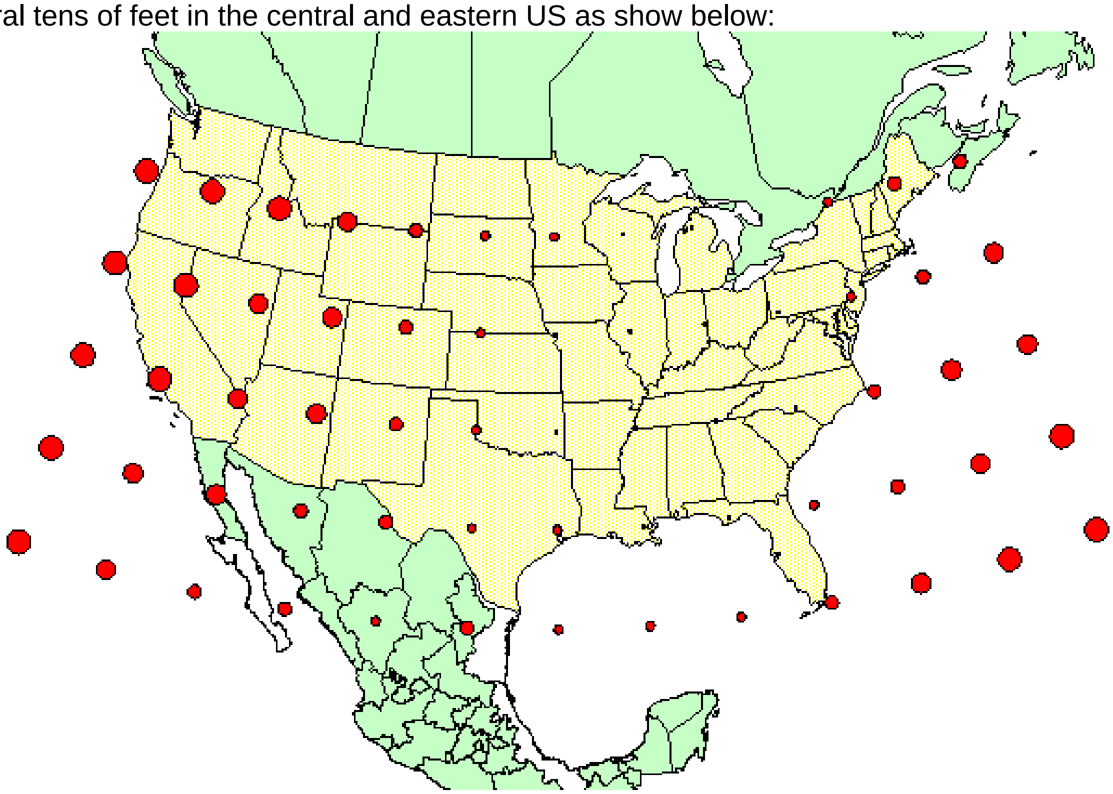
Latitude and Longitude

The earth is not a perfect sphere and bulges somewhat around the equator. What many people are not aware is that different ellipsoids are used in projecting.

North American Datum of 1927 (NAD27) is a datum based on the Clarke ellipsoid of 1866. The reference or base station is located at Meades Ranch in Kansas. The geoidal height at Meades Ranch (was) assumed to be zero. Geodetic positions on the North American Datum of 1927 were derived from the (coordinates of and an azimuth at Meades Ranch) through a readjustment of the triangulation of the entire network in which Laplace azimuths were introduced, and the Bowie method was used. There are over 50,000 surveying monuments throughout the US and these have served as starting points for more local surveying and mapping efforts. Use of this datum is gradually being replaced by the North American Datum of 1983.

North American Datum of 1983 (NAD83) is an earth-centered datum (horizontal control datum for the US, Canada, Mexico, & Central America) based on the Geodetic Reference System of 1980. This datum, designated as NAD 83, is the new geodetic reference system. ... NAD 83 is based on the adjustment of 250,000 points including 600 satellite Doppler stations which constrain the system to a geocentric origin. The size and shape of the earth was determined through measurements made by satellites and other sophisticated electronic equipment; the measurements accurately represent the earth to within two meters.

There are differences in the two ellipsoids ranging from 200-300 feet in the western US to several tens of feet in the central and eastern US as show below:



Excerpts from NGS/NOAA website:

- **Why did NGS change from NAD 27 to NAD 83?**

NAD 83 was computed by the geodetic agencies of Canada (Federal and Provincial) and the National Geodetic Survey for several reasons. The horizontal control networks had expanded piecemeal since 1933 to cover much more of the countries and it was very difficult to add new surveys to the network without altering large areas of the previous network. Field observations had added thousands of accurate Electronic Distance Measuring Instrument (EDMI) base lines, hundreds of additional points with astronomic coordinates and azimuths, and hundreds of Doppler satellite determined positions. It was also recognized that the Clarke Ellipsoid of 1866 no longer served the needs of a modern geodetic network. For an in-depth explanation see NOAA Professional Paper NOS 2 "The North American Datum of 1983", Charles R. Schwarz, Editor, National Geodetic Survey, Rockville, MD 20852, December 1989.

- **How do the horizontal datums differ? Which should I use?**

The NAD 27 was based on the Clarke Ellipsoid of 1866 and the NAD 83 is based on the Geodetic Reference System of 1980. The NAD 27 was computed with a single survey point, MEADES RANCH in Kansas, as the datum point, while the NAD 83 was computed as a geocentric reference system with no datum point. NAD 83 has been officially adopted as the legal horizontal datum for the United States by the Federal government, and has been recognized as such in legislation in 44 of the 50 states. The computation of the NAD 83 removed significant local distortions from the network which had accumulated over the years, using the original observations, and made the NAD 83 much more compatible with modern survey techniques.

- **Converting NAD27 to NAD83**

There are several ways to convert between these two systems. Many desktop GIS software have conversion routines built in. Additionally you can use online calculators, download the underlying software program, or purchase a geographic calculator.

References:

I used many websites to obtain data used in this document which have included:

NGS/NOAA-FAQ’s, Policy, Federal Register, National Bureau of Standards
NIST-National Institute of Standards and Technology, Special Pub 814
BENTLEY-Ask?Inga, Bentley’s Microstation V8 for Civil Engineers
VTERRAIN – Virtual Terrain Project
WSDOT-Washington Dept. of Transportation
BIPM-International Bureau of Weights and Measurements (100yrs 2/28-3/4/2005
SHAW-One Metre: Metric in Canada
ODOT-Inroads Desktop Training Manual, Appendix L, Email From EAST Support
Tower Maps-Datum