

MAP COORDINATE SYSTEM

I. PURPOSE

Standards for a map coordinate system are critical to retaining the integrity of Vermont Geographic Information System (VGIS) spatial data. Therefore geographic data stored in other coordinate systems require conversion for use in VGIS.

II. COORDINATE SYSTEM STANDARD

The **standard** map coordinate system used in VGIS is the Vermont State Plane Coordinate System (SPCS) based on the North American Datum (NAD) of 1983 (historically NAD27). The **standard** for storing coordinates is meters.

Until recently, most contemporary maps of Vermont used NAD27 as the reference datum. This made it the logical option for direct digital conversion and subsequent inclusion in the Vermont GIS database. With the arrival of the new Vermont Digital Orthophotography, expanded GPS activity and new maps from the U.S. Geological Survey being prepared using NAD83, it has become increasingly necessary to convert existing NAD27 data to NAD83 to properly incorporate new information. In 1997, VCGI converted all VGIS data holdings from SPCS NAD27 to SPCS NAD83. VCGI encourages data users and developers to migrate toward the NAD83 standard.

The Vermont State Plane Coordinate System (SPCS) is a system of rectangular (X and Y) grid coordinates derived from a transverse Mercator projection. This projection is used for states having a large north-south extent, including Vermont. Computed state plane coordinates are available for horizontal geodetic stations established by Federal agencies.

In certain cases coordinates may be entered in units of U.S. survey feet rather than meters. To convert from feet to meters, the following relationship should be used:

$$1 \text{ meter} = 3937/1200 \text{ (or } 3.280833333 \text{) U.S. survey feet.}$$

$$1 \text{ U.S. survey foot} = .3048006096 \text{ meters}$$

**III. DATUM
CONVERSION
PROCEDURES**

Procedures exist to convert from NAD 1927 to NAD 1983 and vice versa. NAD 83 is the official civilian horizontal datum for U.S. surveying and mapping activities performed or financed by the Federal government. All Global Positioning Satellite (GPS) data uses NAD 1983. Maps utilizing NAD 1983 are also available.

Methods for conversion shall be stated in the data coverages documentation (see *VGIS Data Documentation*). VCGI recommends the use of NADCON, a federally adopted software program that performs NAD conversion. Horizontal datum conversion guidelines adopted by VCGI are included in the *VGIS Handbook*, Part 3, Guidelines, Section K.

(NOTE: Vermont Statutes require all new projects by the year 2000 to use NAD83; refer to Chapter 17 of Vermont Statutes Annotated; Section 679.)

The differences in the NAD27 and NAD83 datum are significant! These differences or errors amount to about a 7 meter shift in northing or latitude and a 35 meter shift in easting or longitude in much of Vermont. In addition to the base error there are local differences on the magnitude of +/- 2 meters in northing and/or easting. These differences tend to be gradual and spread over the entire state.

**IV. MAP
PROJECTION
CONVERSION
PROCEDURES**

It may be necessary to automate a source map which is based on USGS topographical maps. These maps must be digitized in the Universal Transverse Mercator (UTM) projection, with coordinates in meters. Before data based on different map projections can be used together it is necessary to convert the coordinates to a common projection, using the ARC/INFO PROJECT command or equivalent. Section VI. contains the PROJECT commands needed to convert from UTM to SPCS.

NOTE: The UTM zone for Vermont is determined as follows: If the USGS quad is west of 72° west longitude and east of 78° west longitude, zone 18 is used. Most of Vermont is in zone 18. A "yshift" of -4000000 meters is applied to all UTM northing measurements. That is, 4,000,000 can be subtracted from the UTM northing coordinates when digitizing. Use of this procedure is intended to preserve the precision of coordinates which are stored with approximately 7 significant digits. Since all northings in Vermont are in the 4000000 range, the millions digit is not required.)

V. REFERENCES

- 1) NOAA manual NOS NGS 5
"State Plane Coordinate System of 1983"
James Stem; January 1989.

- 2) NOAA technical memorandum NOS NGS-50
NADCON
"The Application of Minimum curvature derived surfaces in the transformation of positional data from the north american datum of 1927 to the north american datum of 1963"
Warren T. Dewhurst; January 1990.
- 3) USGS Professional Paper 1395
"Map Projections a Working Manual"
by John P. Snyder; 1987.
- 4) NOAA Professional Paper #2
"North American Datum of 1983"
Charles Schwarz, Editor; December 1989.

VI. METHOD FOR CONVERTING A MAP PROJECTION

ARC/INFO software offers a "PROJECT" function to convert a digitized map from the UTM NAD27 projection to SPCS of 1983. Please note that precise command syntax may vary with the version of this software.

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INPUT
PROJECTION UTM
UNITS METERS
YSHIFT 4000000
ZONE 18 *
DATUM NAD27
PARAMETERS
OUTPUT
PROJECTION STATE
UNITS METERS
ZONE 5526
DATUM NAD83
PARAMETERS
END

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Note the YSHIFT 4000000 command in the UTM projection specification. This causes the northing coordinate to be restored to its true value. The northing values are stored with the millions digit removed to prevent computer round-off error.

- * The UTM zone specification should be "18" if the USGS quadrangle is west of 72° west longitude. Other zones may be appropriate at other longitudes.

**VII. NOTE ON
COORDINATE
SYSTEMS**

There are the two plane coordinate systems commonly used to express positions.

Universal Transverse Mercator (UTM) coordinates (northings and eastings) are derived from a rectangular grid based on a transverse Mercator projection. The UTM system consists of 60 north-south zones, each 6° wide in longitude. The zones are numbered consecutively, starting with zone 1 between 180° and 174° and 180° E. longitude.

The UTM system is designed to be used for latitudes between 80° S. and 84° N. and does not include the polar regions. Unlike state plane coordinates, UTM coordinates are available for the whole world (minus the poles). UTM coordinate values are given in meters.

When SPCS are used, a Lambert conformal conic projection with two standard parallels is used as the basis for SPCS for states having a large east-west extent. A transverse Mercator projection is used for states having a large north-south extent, including Vermont. Most states have more than one zone to minimize the distortions inherent in the projections, and the zone boundaries follow county lines.