

ELEVATIONS FROM GPS DATA

Three elements are involved when working with elevations and GPS data. If any two of the three elements are known, the third element can be computed at a comparable level of accuracy. They are:

1. **Ellipsoid height, h** from GPS or $h = H + N$
2. **Orthometric height, H** from leveling or $H = h - N$
3. **Geoid height, N** from a geoid model or $N = h - H$

- **Ellipsoid Height (proven GPS technology):**

Computed from three-dimensional GPS data with respect to a mathematical surface, the reference ellipsoid. If the GPS data are part of a three-dimensional network and attached to a HARN, the ellipsoid height can be quite accurate. Although the answer is ellipsoid dependent, WGS84 & GRS80 (NAD 83) answers agree within .5 mm.

- **Orthometric Height (time-honored differential leveling procedures):**

Typically determined by conventional differential leveling which provides elevation with respect to a physical surface, the geoid. Elevation differences over short distances can be determined very precisely. Absolute elevation is more difficult to find and the answer should be qualified according to datum, e.g. NGVD29 or NAVD88.

- **Geoid Height (GEOID96 or similar model):**

Geoid height is defined as the difference between ellipsoid height and orthometric height. Because the geoid is a continuous level surface (affected by gravity anomalies), geoid heights change gradually. Stokes's Formula is a known mathematical relationship between gravity and the geoid height. If one knew the strength of gravity at all points, the geoid height could be computed by integration. Regrettably the value of gravity is not known at all places and it changes from one place to another. Many precise gravity measurements are needed to compute geoid height accurately. However, reliable changes in geoid height can be computed using representative gravity measurements. Geoid models are obtained by using known geoid heights at specific points and representative gravity measurements to model the shape of the geoid between points having a known geoid height.