*Now, what's tomorrow's challenge?*

## Technical Bulletin

## GEOID ISSUE

*What is a Geoid?*

The equipotential surface which best represents mean sea-level. (An equipotential surface is any surface where gravity is constant.)  This surface not only covers the water but is projected throughout the continents. Most heights throughout North America use this surface as its zero value, i.e., all heights are referenced to this surface.

When heights were being determined through conventional surveys using levels at the turn of the century, surveyors used tidal gauges on the east or west coast as their zero value. Subsequent surveys then went inland using this reference system.
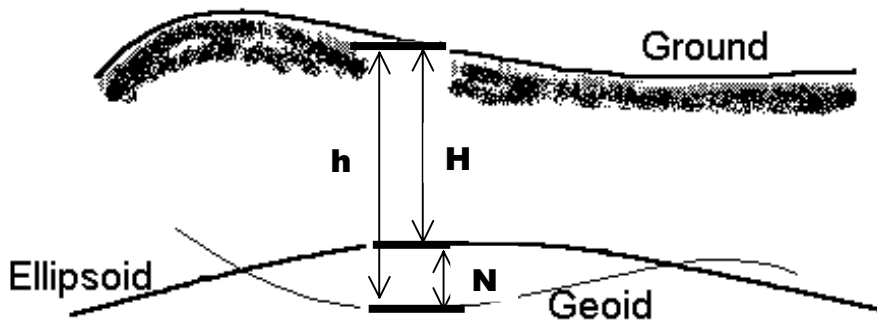
*What is an Ellispsoid?*

An ellipsoid is a mathematical surface which is sometimes used to represent the earth. Whenever you see latitudes and longitudes describing the location, this coordinate is being referred to a specific ellipsoid. GPS positions are referred to an ellipsoid known as WGS84 (World Geodetic System of 1984).

*What is the relationship between a Geoid and an Ellipsoid?*

The relationship between the geoid and ellispoid is shown in the diagram Figure 1.

*Figure 5   Geoidal Relationships*



**N** =  **geoid / ellipsoid separation or geoid undulation**

**H** =  **mean sea-level height or geoid height or orthometric height**
         **(height above the geoid)**

**h** =  **ellipsoidal height (height above ellipsoid)**

**h = H + N**

From the above diagram and formula, to convert heights between the ellipsoid and geoid, we require the geoid-ellipsoid separation value. This value is not easy to determine. Therefore, a world-wide model is generally used to provide these values. NovAtel (www.novatel.ca) GPS receivers store this value internally. This model can also be augmented with local height and gravity information. A more precise geoid model is available from governement survey agencies, e.g., U.S National Geodetic Survey (www.ngs.noaa.gov) or Geodetic Survey of Canada (www.geod.emr.ca).

## *Why is this important for GPS users?*

The above formula is critical for GPS users as they typically obtain ellipsoidal heights and need to convert these into mean sea-level heights. Once this conversion is complete, users can relate their GPS derived heights to more "usable" mean sea-level heights.