Manual Level Mode Correction for Non-Vented Sensors

Sean Smith, Data Services Field Engineer, In-Situ Inc.

Overview

This technical note is an addendum to the *Manual Level Mode Correction for Vented Sensors* technical note, which describes how to manually correct vented (gauged) pressure sensor data.

To understand the difference between vented and non-vented (absolute) pressure sensors, read the *Comparing Absolute and Gauged Pressure Sensors* technical note.

To understand the methodology of manually correcting level data using a reference, read the *Manual Level Mode Correction for Vented Sensors* technical note.

Non-Vented Level Correction

Since a non-vented sensor requires barometric correction in most applications, manual level correction for non-vented pressure sensors requires the added variable of accounting for barometric pressure.

A reference is used in Depth to Water (DTW) and Level Surface Elevation (LS) modes. The key to post correcting data using a reference is to post correct the pressure head at reference (Pr) with barometric pressure at the time the reference was taken.

The titanium BaroTROLL Instrument has an accuracy of ±0.2% full scale.

Level Mode Non-Vented Equations

Level Depth

Depth is the amount of water over the pressure sensor plus barometric pressure. Water level can be calculated in meters using the following equation:

D = (0.703073 X (Pm-Bm)) / SG

D = Depth in meters
Pm = Total Pressure measured in PSI
Bm = Barometric Pressure measured at the time Pm was taken in PSI
SG = Specific Gravity

Level Surface Elevation

Level Surface Elevation uses a reference to measure water level with respect to groundwater elevation or surface-water elevation (staff gauge in streams or wetlands). It can be calculated in meters using the following equation:

Ls = Lr + ((0.703073 * ((Pm-Bm) – (Pr-Br))) / SG)

Ls = Level Surface in meters
Lr = Level Reference set in meters
Pm = Total Pressure measured in PSI
Bm = Barometric Pressure measured at the time Pm was taken in PSI
Pr = Pressure Head at Reference in PSI
Br = Barometric Pressure measured at the time Pr was taken in PSI
SG = Specific Gravity

Level Depth to Water (DTW)

DTW is used to monitor water level in wells relative from the top of casing. The reference is determined by using a water level tape. DTW is also known as "positive down" because increasing values will indicate that water levels are dropping relative from the top of casing. It can be calculated in meters using the following equation:

DTW = Lr – ((0.703073 * ((Pm-Bm) – (Pr-Br))) / SG)

DTW = Level Depth To Water in meters
Lr = Level Reference set in meters
Pm = Total Pressure measured in PSI
Bm = Barometric Pressure measured at the time Pm was taken in PSI
Pr = Pressure Head at Reference in PSI
Br = Barometric Pressure measured at the time Pr was taken in PSI
SG = Specific Gravity

All of the above equations can substitute 2.30667 as the constant instead of 0.703073 to calculate the units in feet, and equations using Lr must be in the units of feet.

Barometric Pressure

Having a record of barometric pressure during the logging of non-vented level data is needed for post correction. Using an In-Situ® BaroTROLL® or Rugged BaroTROLL® Instrument is the best method to capture barometric pressure data. This will allow accurate post correction through Win-Situ® Baro Merge™ Software or through manual correction.

However, in some cases, a user forgets to collect barometric pressure data during the deployment of non-vented level data. In these cases, some users will try to use data from a weather station. When using weather station data for barometric post correction of non-vented level data, keep in mind two main considerations:

1. Most weather stations normalize barometric pressure to sea level. The barometric pressure must be corrected for elevation. Barometric pressure drops 0.5 PSI per 305 meters (1000 ft). The following equation can be used to derive true barometric pressure from weather stations normalization to sea level:

Bc = Bw – ((0.5 X E)/305)

Bc = Corrected Barometric Pressure for elevation in PSI
Bw = Barometric Pressure from the weather station in PSI
E = Elevation in meters

2. Weather station data does not necessarily represent barometric pressure where the non-vented level data is being recorded due to differences in distance and elevation from the weather station and the site location.

Therefore, the corrected level data using barometric data from weather stations can not be guaranteed to be within the specified accuracy of the level sensor. However, this method is more accurate than not doing a correction at all.

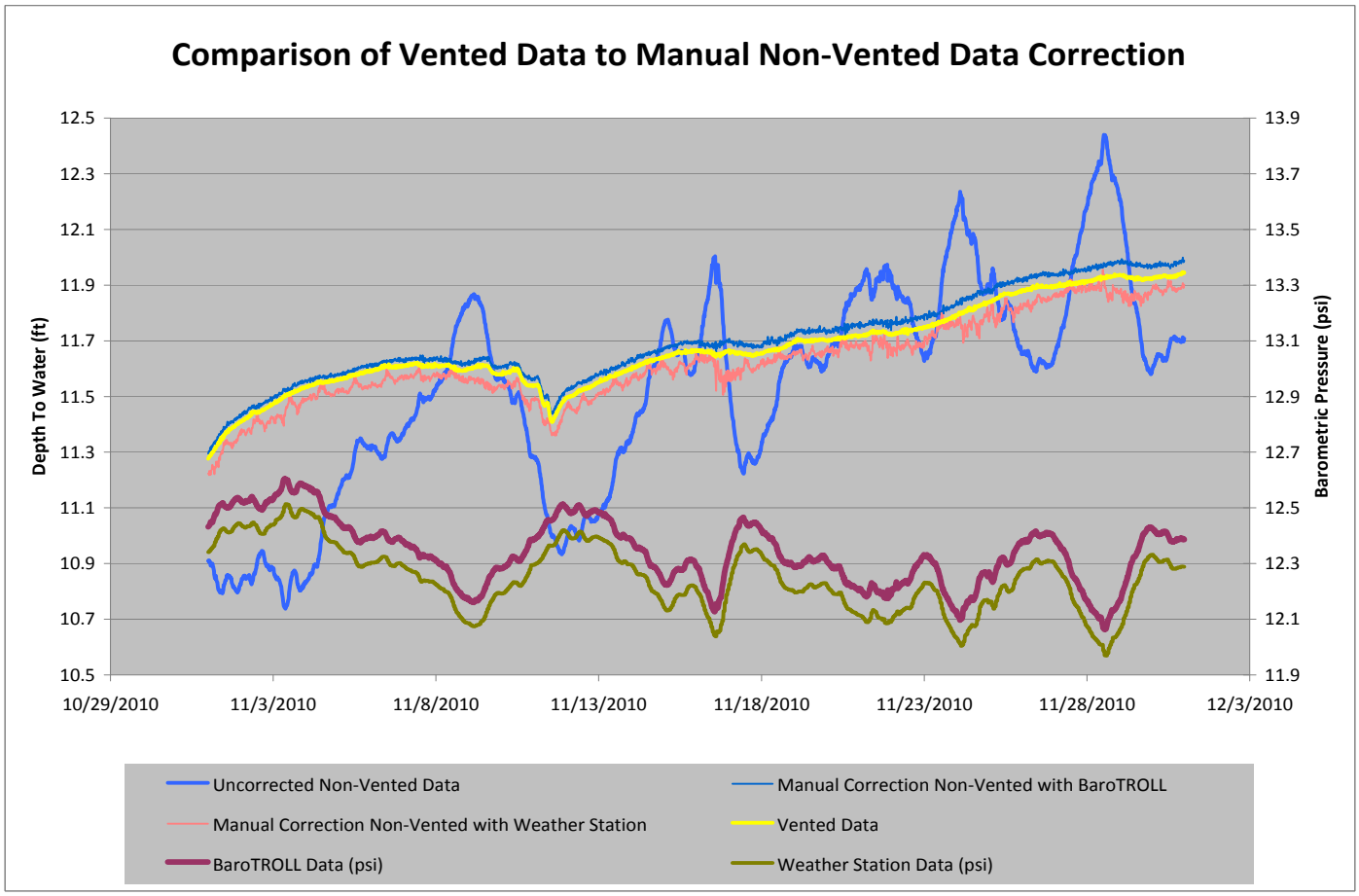
Data Example

The graph on page 3 shows one month of water level data and barometric pressure data. The graph shows a vented data set and a non-vented data set to compare true water level. The graph shows two manually corrected data sets from one non-vented sensor. One manually corrected data set uses data from a BaroTROLL Instrument, which was located on site. The other manually corrected data set used barometric pressure data from a weather station located approximately 2 miles away from the pressure sensors.

The manually corrected data set from weather station data is less accurate, and it has more variation due to the limitations of using a weather station data. As shown, the Uncorrected Data set tracks with barometric pressure (inversly because DTW is the mirror image of Depth) and water level combined.

The graph on page 3 summarizes the technical points explained in this technical note.

1. Uncorrected Non-Vented data does not provide accurate water level because pressure changes with both barometric pressure and water level fluctuations.
2. Barometric pressure obtained from a BaroTROLL Instrument and a Weather Station track the same. However, notice the differences in barometric values between the two data sets as a result of differences in distance and elevation from a site only 2 miles away.



3. The corrected Non-Vented sensor with a BaroTROLL tracks with the Vented data set, and it has less noise in the values. The values are slightly higher due to the cumulative error in accuracy from the two sensors, but it is within the specification of the sensors.
4. The corrected Non-Vented sensor from a weather station tracks well with the Vented data set. However, there is more noise in the post corrected data set, and the accuracy of the post corrected data set can not be guaranteed. Yet, this post corrected data set is more accurate to the true water level compared to no correction at all.

Conclusion

Manually post correcting non-vented level is possible as long as there is some form of barometric record to use in the post correction calculation. The most accurate way to post correct data is through the use of a BaroTROLL Instrument. However, using barometric data from a weather station is possible as long as the user understands weather station data limitations. Weather station barometric data for post correction may not guarantee the accuracy of the non-vented level sensor data, but it is much more accurate than not doing any post correction. Typically, non-vented pressure sensor data that is not post corrected by any means will generally plot out as a sinusodal-like wave because the barometric pressure is fluctuating on a daily and weekly basis. At the very least, weather station barometric data will provide a better trend of water level fluctuations over time.

After downloading data from a RuggedReader® Handheld PC to a computer, use Win-Situ® Baro Merge™ Software to simplify post correction of water level data. Barometric readings are automatically subtracted from data collected by a pressure sensor to compensate for changes in pressure due to barometric fluctuations.

The titanium Rugged BaroTROLL® Instrument has an accuracy of ±0.3% full scale.

Deploy a BaroTROLL or Rugged BaroTROLL Instrument in a location close to Level TROLL® 300/500/700 Instruments or Rugged TROLL® 100/200 Instruments.

For more information, contact In-Situ Inc.
221 East Lincoln Avenue, Fort Collins, CO 80524
1-800-446-7488 (toll-free in U.S. & Canada)
1-970-498-1500 (international & domestic)
www.in-situ.com

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