

MEMORANDUM

To: Trustee Gianopulos, Insurance, Health, Environment
Buildings & Grounds Chair
Robert Kosin, Village Administrator

850 Forest Edge Drive, Vernon Hills, IL 60061
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From: Daniel J. Strahan, P.E., CFM
Gewalt Hamilton Associates

www.gha-engineers.com

Date: August 22, 2012

Re: Village Hall Well Monitoring- Equipment Calibration

In 2009 equipment was installed in the domestic well at the Village Hall to monitor changes in the groundwater elevation. The equipment gathers data and posts current data to the Village website as well as the BACOG website. Earlier this summer, we noticed a steady downward trend in the groundwater elevation that continued into July, resulting in groundwater elevations approximately ten feet lower than any observed elevations from the previous three years of observation. While intuitively it may be thought to be connected to the drought conditions that were present in June and July, past studies of the hydrogeology in this area would have suggested a groundwater recharge time as high as ten years or more, which would be inconsistent with an immediate response to a seasonal drought condition.

To verify that the data observed was reliable and not due to equipment malfunction, our office coordinated with Water Well Solutions (formerly Henry Boysen Inc.) to open the well cap and manually check the groundwater elevation. On July 19, 2012, it was found that the groundwater elevation as measured manually was 5.3' higher than what the equipment was reporting. A second manual check will be performed in the fall in conjunction with removal of the equipment to allow for calibration by the manufacturer.

cc: Board of Trustees

Memorandum

To: Robert Kosin, Village Administrator
Village of Barrington Hills

From: Dan Strahan
Gewalt Hamilton Associates, Inc.

Date: February 4, 2011

Re: Village Hall Groundwater Monitoring
2010 Data Review

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As you know in October 2009 the Solinst groundwater monitoring equipment installed at the Village Hall began collecting data. As a result we now have a full calendar year of data demonstrating the dynamics of groundwater elevations, covering the full range of service conditions at the Village Hall. Our office has reviewed the data and offers this memo, summarizing the lessons learned from the information gathered in 2010.

Two specific instruments were installed in the existing domestic well at the Village Hall during the summer of 2009. A Solinst Levellogger Gold was installed at an elevation of 747.9, submerged well below the normal groundwater level. The Levellogger measures the depth of the water it is submerged in indirectly through a measurement of pressure. The second instrument is a Solinst Barologger Gold, and was installed at an elevation of 863.9, above the normal groundwater elevation. The purpose of the Barologger is to measure the atmospheric pressure, which is then subtracted from the Levellogger pressure reading to provide a measure of hydrostatic pressure without any influence from atmospheric pressure; the water depth can then be calculated directly from the hydrostatic pressure. These readings are communicated by cable to a control panel installed on the south wall of the Village Hall, then transferred by radio to a work station inside the Village Hall. The downloaded data provides readings on an hourly basis.

Variability in Groundwater Elevation

The elevation of groundwater varied throughout the year, and the variability in this groundwater elevation came from two sources. As the Village Hall well is active, serving both administrative staff and the police department, a drop in the groundwater elevation is observed each time the pump turns on to draw water. This is discussed further in the section below. The second source of variability is due more simply to the dynamics of the aquifer. Ignoring the effects of the draw down, the "normal" ground water level varied over the course of the year from a maximum of 783.26 in early April to a minimum of 776.33 in early September. As the recharge time for the aquifer is unknown and can vary widely, from a few days to several years, the rate at which precipitation levels are impacting groundwater levels is difficult to determine from this data alone.

Well Drawdown

Throughout the year momentary elevation readings of 10-15' below the normal water level were observed, corresponding to the activation of the pump to draw water from the aquifer into the building. This momentary drawdown occurs as the pump draws water from the aquifer and water moves through the pores in the soil toward the pump, forming a cone of depression centered on the well. It is noted that

the cone of depression disappears almost immediately after pumping stops; even during the early stages of testing when results were downloaded every five minutes, typical drawdown events were observed in only one observation period, with the elevation returning to the normal elevation immediately after the initial reading.

Impacts of Irrigation System

From July 25 to October 4, the Village Hall property irrigation system was in operation. This caused a significant increase in water usage as evident from the number of drawdown events observed. During the two weeks prior to July 25th, the pump kicked on a total of five times as evidenced by instances in which the ground water elevation was observed below the normal water level. During the following two weeks, a total of 48 drawdown events were observed, approximately a tenfold increase in the frequency of this occurrence.

Based on available documentation for the design of the irrigation system, the sprinkler heads in use have a discharge rate of 1.5 gallon per minute. With 6 sprinkler heads per zone and noting that two two-hour cycles are completed each day during the irrigation period, the irrigation system accounts for approximately 2,160 gallons per day. For reference typical residential water use is 60-80 gallons per person per day; therefore, this estimate equates to the daily water usage of approximately seven single family (four- person) homes, or enough to fill up a typical residential swimming pool in approximately one week.

Based on the significant increase in the use of the aquifer, there may be a concern that during this time period the irrigation system was causing a general drawdown in the normal water level of the aquifer, often referred to as “mining”. If this were the case a steady reduction in the normal water level would be expected during this time of the year, but this was not observed. In the two weeks leading up to the initiation of irrigation, the average “normal” water level fell from 779.68 on July 11 to 778.58 on July 24. During the first two weeks in which the irrigation system was in use, the average normal water level actually increased from 778.84 on July 25th to 779.04 on August 7th. Considering the entire period in which irrigation was in use, the average normal water level rose from 778.58 on July 24th to 778.64 on October 5th. Based on these observations, the additional water demand resulting from the irrigation system did not appear to result in a negative impact to the aquifer. To provide further perspective on the scope of the system’s water usage, in 2006 the Village of East Dundee completed testing for a municipal well adjacent to the western boundary of the Village near IL Rte. 68 and found a sustainable yield of 1000 gallons per *minute*, or 1.44 million gallons per day.

Levellogger Gold

Model 3001

The Levellogger® Gold represents the next generation of water level dataloggers. Vastly improved over previous versions, the Levellogger Gold is completely designed, developed and manufactured in-house, in the tradition of all Solinst high quality products.

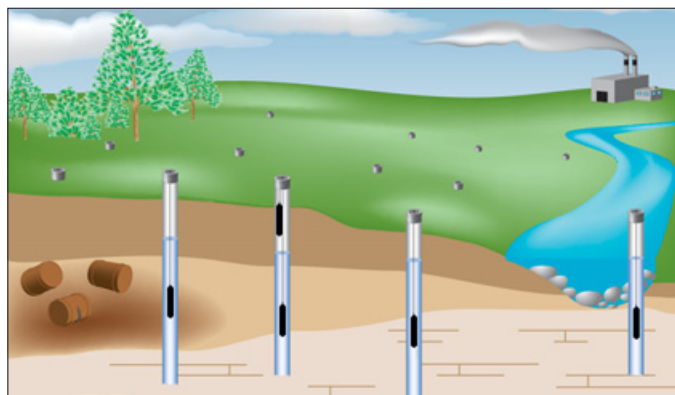
The Levellogger Gold offers higher resolution and high accuracy of 0.05%, for a much reduced price. The Levellogger Gold has improved transducer, temperature and clock accuracies. Altitude, water density and improvements to temperature and barometric compensations also add to the significant increase in accuracy and instrument stability. A Zirconium Nitride coating resists corrosion.

The Levellogger is a water level and temperature recording device. It combines a datalogger, 10-year battery, pressure transducer and temperature sensor, in a small, minimal maintenance, 7/8" x 6" (22 mm x 154 mm) stainless steel housing. The sealed Faraday cage design greatly simplifies maintenance and provides protection against electrical spikes caused by lightning.

High accuracy, long-term stability and an internal battery that lasts for 10 years when reading every minute, make Levelloggers the ideal devices for recording water levels. A Barologger provides the easiest and most accurate method of barometric compensation.

Applications

- Pumping and slug tests
- Watershed, drainage basin and recharge
- Stream gauging, lake levels and reservoirs
- Harbor and tidal fluctuation monitoring
- Wetlands and stormwater run-off monitoring
- Tank level monitoring
- Long-term water level monitoring in wells, surface water bodies and seawater environments



Features

- Self-test capability
- Backward compatible
- Maintenance-free, water-tight design
- Protected from power surges, such as lightning
- Real-time viewing; data can be exported
- Radio or cellular telemetry
- User-selectable, 30 line sampling schedule

Memory Improvements

The Levellogger Gold memory allows a maximum of 40,000 readings of level and temperature, set up in individual logs. The user has a choice of slate or continuous logging modes when operating in linear mode. In event-based and schedule sampling, memory is a form of circular slate, which starts logging from the end of the last log and wraps around to eventually overwrite older logs, but which will stop at the start of the current log. A separate redundant memory provides backup of the last 1200 readings, which can be accessed by a Diagnostic Utility program.

Downloading Improvements

The Levellogger Gold offers 4 download options: 'All Data' downloads the complete log, or the user can save time by selecting 'Append Data', when only new data is desired. A selected period of time prior to the last date stamp can be downloaded using 'Partial Download'. 'Recover Previous Log' is a safeguard in case the Levellogger has been restarted without downloading data. A complete data dump is also available as a feature of the Diagnostic Utility, which downloads all available memory in the Levellogger Gold.

More Accurate than Ever

The Levellogger Gold has a typical accuracy of 0.05% net FS, a resolution of 0.0006 to 0.002% depending on range, a Barologger with algorithms based on air not water, improved altitude, density, temperature and barometric compensation, as well as a more accurate clock.



Levellogger Operation

Solinst has made programming the Levellogger Gold extremely intuitive. Simply place the Levellogger in the optical reader or connect to the direct read cable. All in one screen, fill in the information fields for location, project ID, sample mode and rate, altitude, density adjustment and any desired offset.

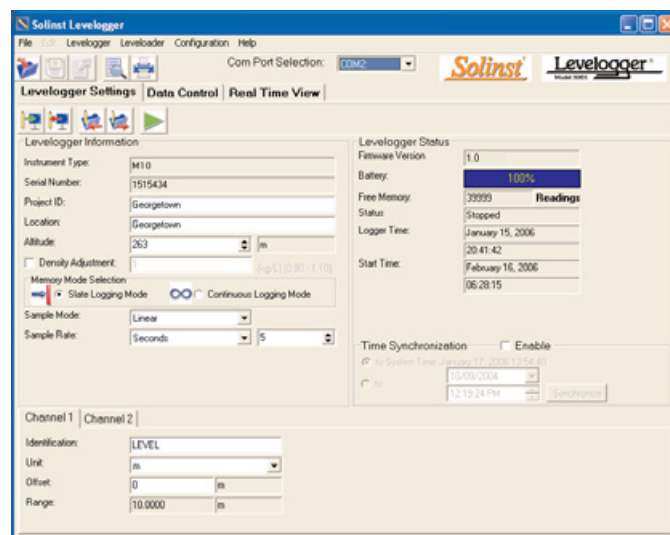
Levellogger time may be synchronized to the computer clock, or the Levellogger Gold clock, or it can be user defined. There are options for immediate start or a future start time. The percentage battery life remaining and the amount of free memory are indicated on the programming screen.

A manual measurement of the initial water depth is usually taken at each location, and noted as a base line measurement. When a Barologger is used for barometric pressure measurement, it is set above high water level in one location on site. If direct read cables are being used, data can also be viewed, logged on demand and retrieved from the Levellogger at any time using a Levelloader or a portable computer.

Sampling Option Improvements

Solinst has added a very flexible, user-selectable sampling schedule, as well as the standard linear and event-based sampling options. Linear sampling can be anywhere from 0.5 seconds to 99 hours. Event-based sampling can be set to record when the level changes anywhere from 0.1% up to 25% of the full range of the logger. Readings will be checked at the selected time interval and discarded if not \geq the percent change selected, but recorded if the condition has been matched or exceeded.

The Schedule option allows up to 30 schedule items, each with its own sampling rate of seconds, minutes or hours, and a duration of seconds, minutes, hours, days or weeks. A running total of sample time and number of readings available are indicated and updated. Templates of these Schedules, and Levellogger Settings, can be saved for easy re-use.



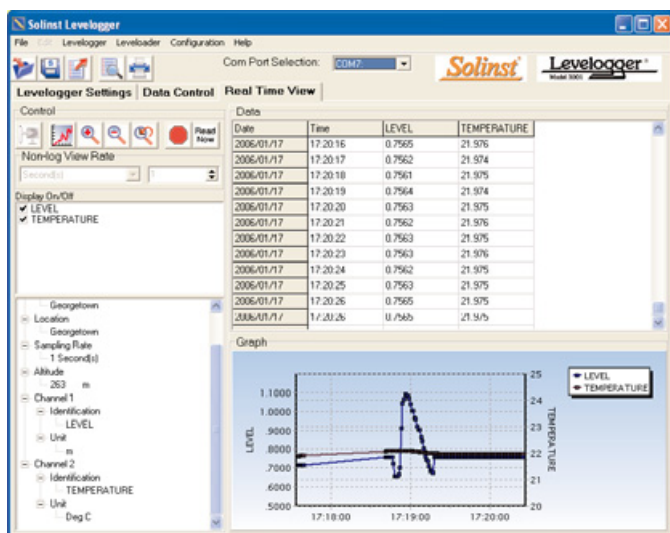
Levellogger Settings Window

Data Download, Viewing and Export

Data is downloaded to a PC with the click of a screen icon or with the push of a button on the Levellogger. Collected data is retained in the Levellogger until it has been written over. The level data downloaded from a Levellogger has already been automatically compensated for temperature and altitude and the temperature data is also downloaded. Barometric compensation of the Levellogger data is performed by a Wizard that can be used to input elevation offsets and adjust for Barometric efficiency. The software allows immediate viewing of the data in graph or table format using the 'Real Time View' option. It also allows easy export into a spreadsheet or database for further processing.

Backward Compatibility

The software can be used with any type of Levellogger including previous versions and any product in the Levellogger family including, Levelloaders, telemetry and the Rain Logger.



Real Time View Window

Use of Direct Read Cables

When it is desired to get real-time data and communicate with Levelloggers without removal from the water, they can be deployed using direct read cables.

The lower end of the direct read cable has a miniaturized infra-red optical reader. The top cap of the Levellogger is removed and the direct read cable is threaded in its place. In turn, the upper end of the cable is attached to a portable computer or Levellogger, via a USB or RS232 PC Interface Cable. This allows viewing of the data, downloading and/or programming in the field.

The full benefits of a sealed Levellogger with no vent tube or electrical cable connection are also maintained. The logger is still sealed from all electrical interference through a Faraday cage design. Cable handling problems are minimized.



Levellogger connected to Direct Read Cable



PC Interface Cable and 2" Wellcap and Cover



PC Interface Cable connected to the Direct Read Cable



Enviro Cap™ lockable cap and key used with Wireline and Hooks

Helpful Utilities

The 'Self-Test Diagnostic Utility' can be used in case of an unexpected problem. It checks the functioning of the program, calibration, backup and logging memories, the pressure transducer, temperature sensor and battery voltage, as well as enabling a complete Memory Dump, if required. A Firmware Upgrade will be available from time to time, to allow upgrading of the Levellogger Gold, as new features are added.

Direct Read Cable Specifications

Direct read cables are available for attachment to any Levellogger, new or old, in standard lengths of: 50', 100', 200', 250', 350', 300' and 15 m, 30 m, 60 m, 80 m, 100 m. Custom cable lengths up to 1640 ft. (500 m) are also available to fit particular monitoring situations, as required. Cable markings are available upon request.

The 1/10" dia. (2.54 mm) coaxial cable has an HDPE outer jacket for strength and durability. A stranded stainless steel braided conductor gives non-stretch accuracy.

The upper end of the direct read cable is fitted with a connector that can act as a well cap for a 1" well. This connector fits Solinst Levellogger well caps designed for 2" or 4" wells, and can easily be tethered at surface in other situations.

Use of Suspension Wireline

Levelloggers may also be suspended in the water on wireline. This is a very inexpensive method of deployment, and if in a well, allows the Levellogger to be easily locked, out of sight and inaccessible to anyone without a special key.

Solinst has adapted the Enviro Cap™ by adding a vent hole in the cap to allow for the equalization of barometric pressure in the well. The well cap has a convenient eyelet from which to suspend the Levellogger. It slips into the casing and is locked in place with the tamper-proof key, as shown.

The Enviro Caps are available sized for 2" and 4" wells. Well caps for other sizes of well can also be used.

Accurate Barometric Compensation

Levelloggers measure absolute pressure (water pressure + atmospheric pressure) expressed in feet, meters or centimeters of water column.

The most accurate method of obtaining changes in water level is to compensate for atmospheric pressure fluctuations using a Barologger. This avoids any time lag in the compensation calculation and any errors introduced due to moisture buildup, kinking or damage to vented cable. The new Barologger Gold uses algorithms based on air rather than water pressure, which gives superior accuracy. The recorded barometric information can also be very useful to help determine barometric lag and/or barometric efficiency of the monitored aquifer.

The Data Compensation Wizard in the Levellogger software greatly simplifies the barometric adjustment of the water level measurements by using the synchronized data from one on-site Barologger with all the Levelloggers.

The overall results give more reliable, highly accurate level data than that obtained when using high maintenance and expensive vented cable.

Levellogger Gold Specifications

Level Sensor:	Piezoresistive Silicon in 316L Stainless Steel
Accuracy (Typical):	0.05% net FS
Accuracy (Max Error):	0.1% net FS
Stability of Readings:	Superior, low noise
Resolution:	0.002 to 0.0006% FS
Normalization:	Automatic Temp Compensation
Temperature Sensor:	Platinum Resistance Temperature Detector
Temp. Sensor Accuracy:	± 0.05°C
Temp. Sensor Resolution:	0.003°C
Temp. Comp. Range:	-10 to +40°C
Response Time:	< 1 minute
Battery Life:	10 Years - based on one reading/min
Clock Accuracy:	± 1 minute /year
Operating Temperature:	-20°C to 80°C
Maximum # Readings:	40,000 of level and temperature
Memory:	Superior reliability EEPROM Slate, rollover and redundant backup of last 1200 logs
Communication:	Optical Infra-Red Interface, Serial at 9600 Baud, Conversion to RS232 or USB Computer Connection
Size:	7/8" x 6" (22 mm x 154 mm)
Weight:	6.3 oz (179 grams)
Backwards Compatibility:	Full
Corrosion Resistance:	Zirconium Nitride (ZrN) Coating
Other Wetted Materials:	316-L Stainless Steel, Delrin, Viton
Sampling Modes:	Linear, Event and User-Selectable with 30 separate line items
Measurement Rates:	0.5 sec to 99 hrs
Barometric Compensation:	Software Wizard and one Barologger in local area (approx. 20 miles/30 km) radius

Models	Resolution	Accuracy (typical)	Water Fluctuation Range
Barologger	0.002% FS	± 0.003 ft., 0.1 cm	Air Only
F15, M5	0.001% FS	± 0.010 ft., 0.3 cm	13.1 ft., 4 m
F30, M10	0.0006% FS	± 0.016 ft., 0.5 cm	29.5 ft., 9 m
F60, M20	0.0006% FS	± 0.032 ft., 1 cm	62.3 ft., 19 m
F100, M30	0.0006% FS	± 0.064 ft., 1.5 cm	95.1 ft., 29 m
F300, M100	0.0006% FS	± 0.164 ft., 5 cm	325 ft., 99 m

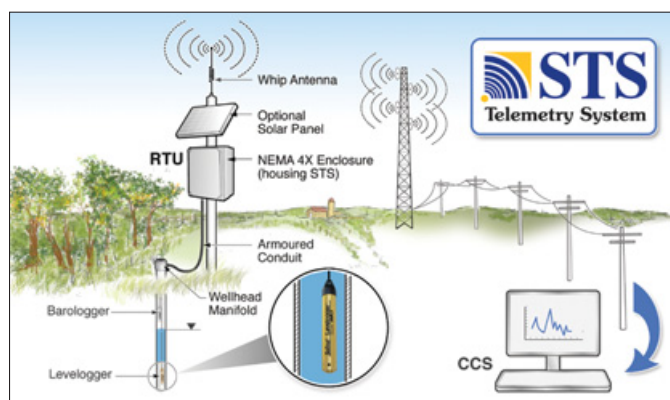
Conductivity Levellogger: See Model 3001 LTC Data Sheet for details

Leveloader Gold

The Leveloader Gold is a significantly improved, data transfer unit designed for use with all versions of the Solinst Levellogger, Barologger and Rainlogger. It is used to download and store multiple data files.

The 8 Mb FLASH memory stores up to 1,390,000 LT readings, 930,000 LTC readings, or 34 full Levellogger downloads. It can also be used to display data in real-time, and has optional password protection.

Simply use the two-ended 'Y' cable for attachment to a Levellogger, or to a direct read cable, to allow downloading or reprogramming of the Levellogger settings in the field. It comes with cables for USB and RS232 connection to a PC for data transfer. (See Model 3001 Leveloader Gold Data Sheet.)



STS Telemetry

Solinst offers a variety of telecommunication options to transfer data from Levelloggers and Rainloggers in the field to your location including radio, GSM & CDMA digital cellular, and landline telephone.

Solinst Telemetry software allows self-management of the Levellogger data, and is suitable for large or small systems. An STS can control many remote Levelloggers, Barologgers or Rainloggers, with selectable automated reading schedules, as well as high and low level alarm options. Long term cost savings come from time saved through automated data collection and reduced travel costs. (See Model 9100 Data Sheet.)

RRL Telemetry

The inexpensive RRL Radio Telemetry is ideal for short range applications up to 1000 ft. (300 m). Distances can be increased by using some radios as 'repeater' stations. (See Model 9200 Data Sheet.)