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Pressure Recorders: Low-Cost, Robust, Low-Battery-Use Field Measurement Techniques for Trending Water Pressure

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ABSTRACT

Water users across California need robust, low-cost water level/pressure sensors with integrated data loggers for a high level of precision and accuracy. The Cal Poly Irrigation Training and Research Center (ITRC) has installed Telog Instruments devices in California and Nevada over the last 12 years to provide a performance review of the devices. The two devices focused on were the Telog Instruments WLS-31 Level Tracker and LPR-31i Line Pressure Recorder. Over the study period, ITRC has collected several sets of data in varying situations. After 11 years of use on a reservoir, the two Telog WLS-31 units had a 1% difference in readings. After intensive testing, the LPR-31i has proved to be an accurate, pipeline pressure surge recorder for pressures up to 2,100 kPa. This paper discusses the capabilities of the Telog Instruments devices along with ITRC's research experience and evaluation of the two units.

INTRODUCTION

For water districts and other entities throughout the United States, it is a necessity to know the status of the operating water system(s). Countless tools and methods of obtaining data from water systems have been developed over the past decades. It is essential to be able to single out the best methods to determine the pressures for the entity as a whole. In these decisions, cost, accuracy, and durability are the main factors. This is why Telog Instruments data loggers have been commonly used to record water levels in the agricultural sector over the past 20 years. This is due to the durability and long battery life of the Telog WLS-31 Level Tracker. The ITRC uses both the Telog WLS-31 and LPR-31i units in research. The WLS-31 is simple, compact, and has a robust system designed to measure water level. Telog's LPR-31i is installed in a water or gas line to record pressure. These devices' long battery life and large storage capacity provide for minimal field maintenance without concern of data overload. This paper builds upon ITRC Report No. R 03-007, *Telog PR-31 Water Level Tracker*.

GENERAL OVERVIEW OF TELOG WLS-31 AND LPR-31

The ITRC has extensive experience with data recording using the Telog Instruments WLS-31 and the LPR-31i devices. Both devices have been instrumental in ITRC research. Among the devices' positive attributes are long battery life, accuracy and data storage capabilities.

WLS-31 Level Tracker. The purpose of the WLS-31 is to measure water level. For water level measurement, the ITRC collaborated with Telog to incorporate the General Electric (GE) Druck UNIK Series 5000 differential pressure transducer. The unit comes with a submersible pressure sensor and pressure sensor cable. The differential pressure transducer factors out the influence of atmospheric pressure, so the unit can be transported to a different location without re-calibration. This device measures the pressure exerted on a strain gauge by the water above the gauge. WLS-31 Level Trackers are available to read pressures up to 103 kPa (Telog 2008b). The two WLS-31 units discussed are 17.2-kPa pressure sensors and have a maximum reading of 1.76 meters (George Mayoue, personal communication, November 5, 2012).

LPR-31i Line Pressure Recorder. Telog's LPR-31i is used for measuring pressure in a water line. The LPR-31 Pressure Monitor can be installed in either water or gas lines with a ¼ inch tap fitting as the access point. LPR-31 Pressure Recorders are able to record pressure up to 2068 kPa and burst pressure up to 6895 kPa.

Strain Gauge Pressure Sensor. The pressure is monitored with an internal strain gauge pressure sensor. Telog uses an internal strain gauge pressure transducer that is a conductor that stretches or shrinks with changes in pressure. At higher pressures, the conductor is stretched and the resistance in the wire goes up. Conversely, if the pressure decreases, the conductor shrinks and the resistance goes up.

Battery Life of WLS-31 and LPR-31i. The WLS-31 and LPR-31 require AA Lithium batteries. A new battery is rated at 3.6 VDC. The battery should be replaced at 3 VDC. Based on a 10-second sample rate, the battery should last about 5-7 years. Battery voltages have been monitored on two WLS-31 data collectors: ITRC0001 and ITRC0002, for ten years. The batteries in ITRC0001 were replaced once in ten years. The batteries in ITRC0002 have lasted ten years and have yet to be replaced. Figure 1 shows level of Drumm Reservoir at the ITRC's Water Resources Facility over a decade. These recorders are set at a fifteen minute sample rate. The battery voltage on the LPR-31i has only been monitored by the ITRC for one year. This recorder's batteries are estimated to last 5-7 years.

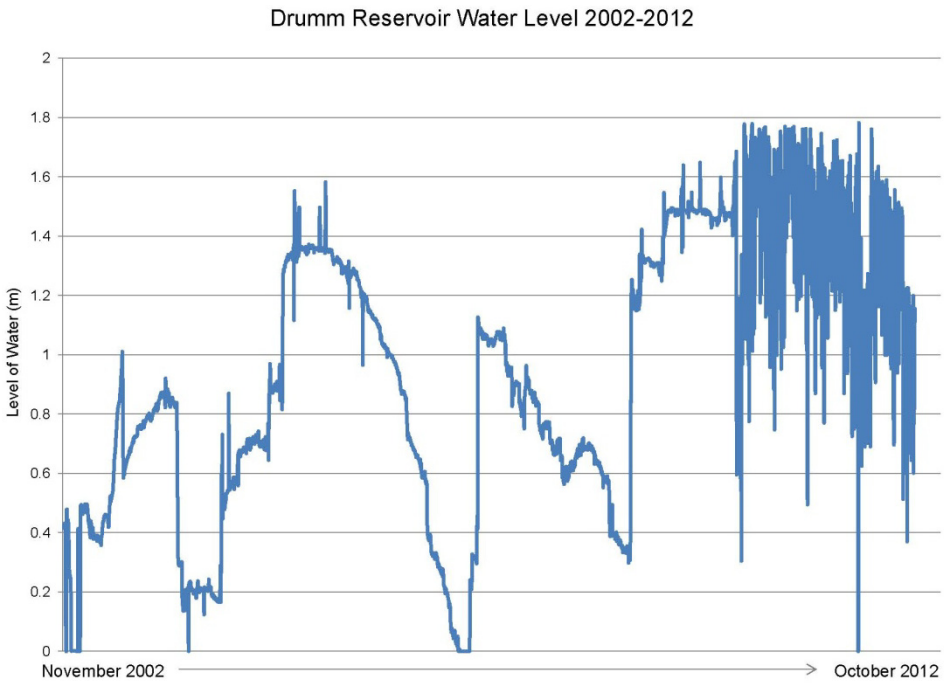

Figure 1. Recording of Drumm Reservoir Level over a decade

APPLICATIONS OF TELOG

Overview of Telog Units. The Water Level Tracker is used mainly for water level monitoring. Depths of water are needed for reservoir levels, stream levels, well and groundwater monitoring, and canal levels (Telog 2008b). One of ITRC's applications of the WLS-31 is the monitoring of the Drumm Reservoir. The LPR-31i, in which the "i" stands for "impulse", can be configured to record 20 readings per second. Impulse recordings are very useful for observing pressure surges and water hammer in lines. On top of routine pressure readings, the LPR-31i has the ability to capture water hammer events or negative pressures, and investigate pressure complaints (Telog 2008a). The ITRC has impulses that cause water hammer with the LPR-31i.

Reservoir monitoring at Drumm Reservoir with the WLS-31. Drumm Reservoir has been monitored by the ITRC since November 2002. Two WLS-31 Telogs were installed at set heights on the reservoir. Figure 2 shows the tracking of the reservoir in Excel over 2012.

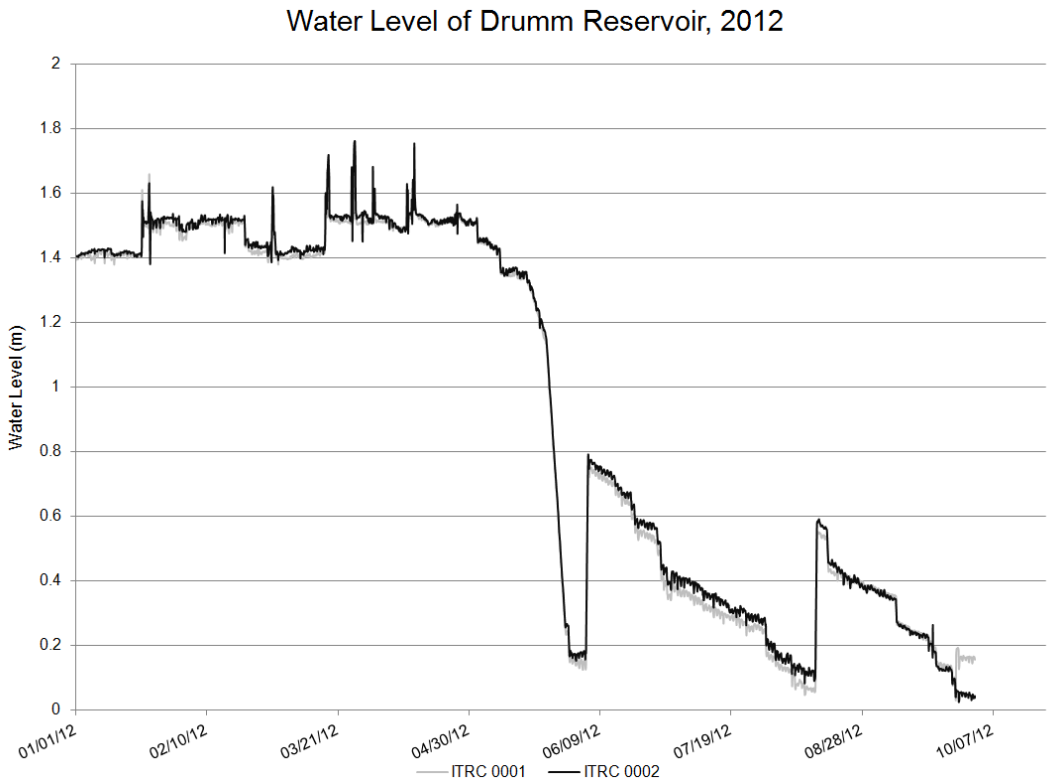

Figure 2. Reservoir level recording with the WLS-31

On the graph, two Telog units (ITRC0001 and ITRC 0002) are shown to trend in proximity to each other. This shows the precision of the WLS-31 units. Precise tracking is essential in various applications such as a delivery canal in an irrigation or water district or stream monitoring.

Telog WLS-31 Pressure Limit Setting. When using the Telog WLS-31 for water level monitoring, the user must select a pressure measurement limit of either 17.2 or 34.4 kPa. This decision is based on the amount of precision needed. Using the 12 bit resolution of the unit, the ITRC determined that the water depth precision at 17.2 kPa is 0.43 mm and at 34.4 kPa is 0.86 mm. It is recommended that if the sensor is used purely for measuring the water depth, the 0.86 mm precision of the 34.4 kPa setting is adequate for the application. If the sensor is used for calculating the flow rate over the weir, or other flow measurement structure, the normal range of the head over the weir must be considered. If the head over the weir normally ranges from 12.3-30.5 cm, then the 0.43 precision of the 17.2 kPa setting would be essential to assure flow rate accuracy less than 5%. If the head over the weir is normally above 30.5 cm, then either setting can be selected.

Water hammer with the LPR-31i. As mentioned before, the LPR-31i has the ability to record 20 impulses per second. Recording of water hammer is essential to determining what is happening in pipelines. Figure 3 shows one of the water hammer events that the ITRC has captured.

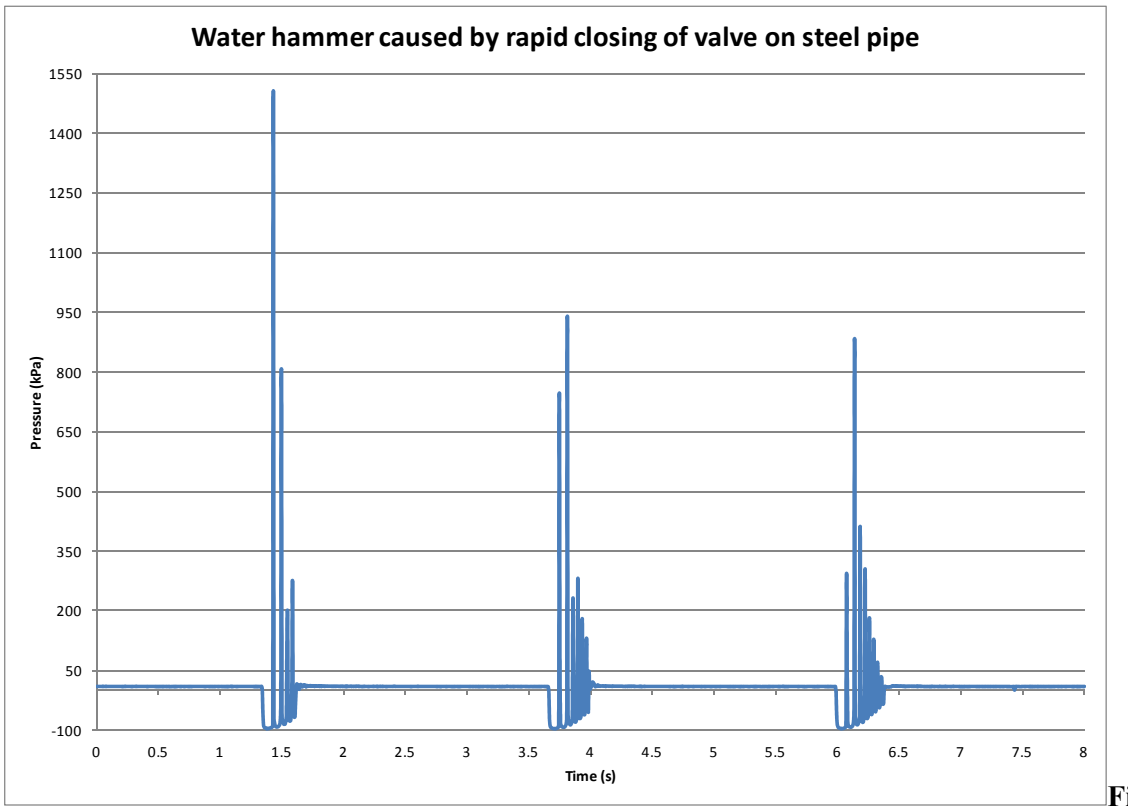

Figure 3. Figure 3. Recording of water hammer with the LPR-31i

The water hammer recorded in Figure 3 shows that the pressure goes from 1,503 kPa to -96 kPa. A pressure change of 1,600 kPa in 0.45 seconds can be very detrimental to pipelines. For large water districts, the timing, cause and damage of the event can be difficult to determine. The Telog LPR-31i can help solve these problems and further inform the operator of the state of the system. Having a tool that can easily measure events like this is useful to detect water hammer instead of blaming pipe failures on other causes.

ATMOSPHERIC PRESSURE IMPACT ON DEVICE

Detecting Atmospheric Influence of Measurements. The pressure recorder has a built-in, 0.02 micron Gore-Tex filter (see Figure 4). This filter is instrumental in keeping the atmospheric pressure from having an impact on the pressure reading output. In the ten years that the ITRC has monitored the two recorders, only one filter has worn out. It was evident that the filter needed to be replaced by looking at the output pressure reading compared to the atmospheric pressure.

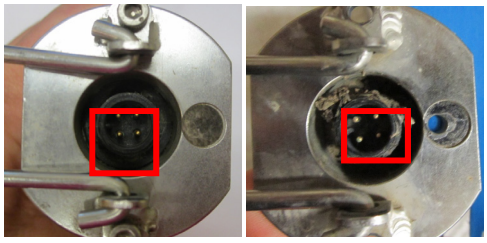

Figure 4. 0.02 micron Gore-Tex filter in the Telog WLS-31 and removed from the device

As shown in Figure 5 the ITRC 0001 pressure recorder trends with the atmospheric pressure, while the ITRC 0002 shows the actual depth of the reservoir.

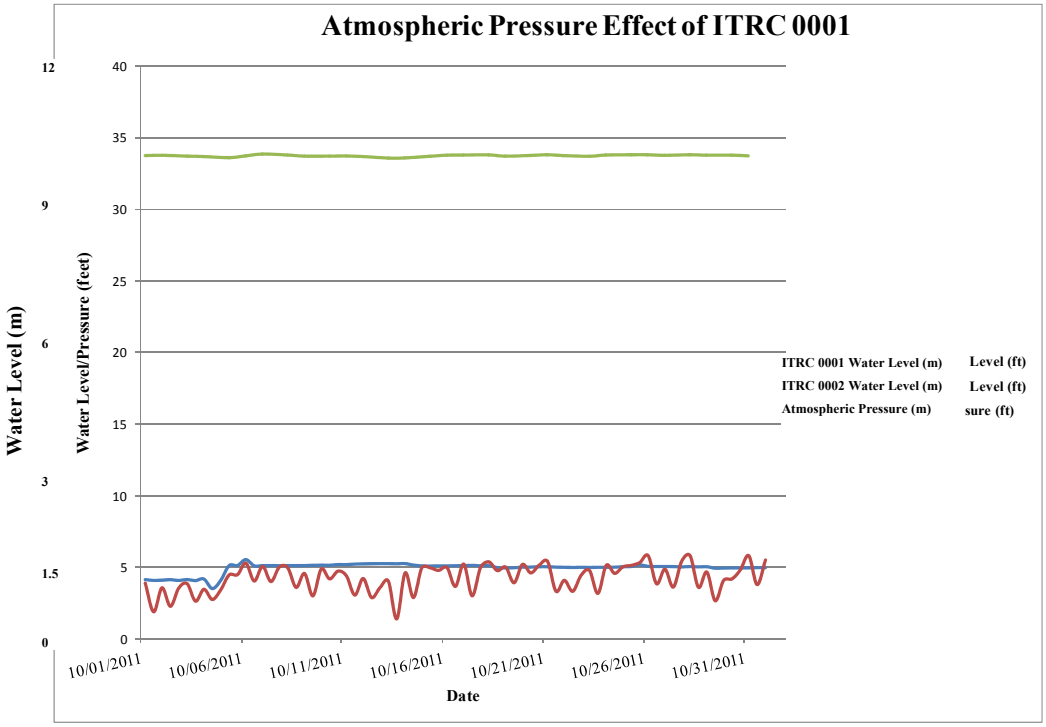

Figure 5. Atmospheric pressure effect on pressure recording device

When the pressure reading trends along with the atmospheric pressure, readings appear to be inaccurate (see ITRC0001 in Figure 5). Normally, the entire Telog would be replaced in order to operate correctly (see ITR 0002 in Figure 5). Fortunately, a simple desiccant tube will solve the problem.

Repairing the Telog against Atmospheric Pressure. To maintain the moisture-free environment that the sensor requires, a plastic tube filled with silica desiccant was installed in the hole of the filter. This removed the influence of the atmospheric pressure on the Telog reading. The desiccant is similar to the silica used in shoeboxes to keep moisture out of shoes.

Figure 6. Desiccant tube fix against atmospheric pressure effect

The WLS-31 unit (ITRC0001) shown in Figure 6 was repaired in November 2011. It trends along with the WLS-31 unit (ITRC0002) mounted on Drumm Reservoir at the Water Resources Facility. Although the desiccant tube is not a completely permanent fix, it saves money without loss of readings from the water body.

CONCLUSION

Both the WLS-31 Level Tracker and the LPR-31i Line Pressure Recorder have proved to be a viable solution for water level and pressure tracking in agriculture. The extensive battery life in the units enables long-term reading capacity. Telog Pressure Recorders have proved to be useful and applicable in several hydraulic applications. The WLS-31 can be used to measure the water level in various water bodies. The LPR-31i, installed in water lines, can record negative pressures and water hammer. In case of filter failure, atmospheric pressure can possibly influence a Telog reading. Fortunately, the ITRC has found an inexpensive, efficient way to replace the filter without replacing the whole unit. All in all, the Telog WLS-31 and LPR-31i are accurate, easy, inexpensive solutions for water body level tracking and pressure reading.

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