



Real-Time, Wireless

WATER LEVEL MONITORING

Using LoRaWAN™ Technology



Real-Time Water Level Monitoring Utilizing Low Power Wireless Connectivity

The Regional Municipality of Waterloo (Region) provides municipal water supplies to approximately 570,000 residents in Cambridge, Kitchener, Waterloo and 16 settlement areas and towns through a system of approximately 120 wells and a surface water intake on the Grand River. Assessing the sustainability of the supply is undertaken through an extensive water level monitoring program at its supply wells and in dedicated monitoring wells. In total there are 245 locations where water levels are recorded that collect data from 540 measurement points (multiple depths recorded at most sites) in the Region's current monitoring program.

LoRaWAN™ Low Power Connectivity

eleven-x Inc. operates a long range, low power wide area network based on LoRaWAN™ technology. The network is deployed in major centres across Canada, including the Waterloo Region. LoRaWAN technology, and the network, is designed to provide wide area coverage through the deployment of gateways that use relatively low power transmissions compared to cellular and can deliver approximately 20km range from the gateway in any direction. Assets and infrastructure, such as water level dataloggers and meters, can be connected to the network via low cost, long-life [>10 years] battery powered devices to deliver level and temperature monitoring data.

Scope of Pilot Program

This program was designed to work with the Region's remote production and monitoring wells. Currently, SCADA is used to track the Region's onsite supply wells and the premise for the initial pilot program with eleven-x was to collect data from assets remote from the main water infrastructure. The remote assets include over 540 potential monitoring well locations where low power wireless connectivity could be utilized for monitoring water levels and temperature. Other potential areas of consideration for this type of monitoring program includes any off-property assets such as water main or pipelines connecting water sources like lakes to municipal facilities.

eleven-x partnered with the Region to design and install interface units integrated with current dataloggers to transmit water level and temperature data in real-time to the Region. The pilot project included installation of the devices on one supply well and two nearby monitoring wells to confirm the capability of the devices to transmit the data and the connectivity of the system. Data was transmitted to an internet site designed by eleven-x to view and access the data. To validate multiple options, the pilot was divided into two phases with the first involving integrating eleven-x WIU-X interface units with existing dataloggers for real-time level and temperature data communications. The WIU-X interface units also provided additional programmability features compared to the existing dataloggers, and other available 3rd party dataloggers.



The second phase utilized 3rd party dataloggers with built-in LoRaWAN transmit functionality. For each phase, a 60-day trial period was implemented. Water level collection frequency was programmed and/or adjusted into the dataloggers through remote access over the eleven-x network.

In addition to low power network design and operations, eleven-x also managed the deployment process including connecting their WIU-X wireless interface units with the Region's existing dataloggers, integrating the data with the Region's internal database and developing a data analytics dashboard as part of the pilot.

Figures 1 and 2 below illustrate the set up of the data loggers and LoRaWAN™ sensors on the supply well and monitoring wells.

Figure 1: Datalogger and eleven-x WIU-X interface unit at a Supply Well



Figure 2: Two Retrofitted WIU-X's and One 3rd Party Sensor at a Monitoring Well



Figures 3 and 4 (see below) present results of the water level comparison of the data transmitted through the eleven-x WIU-X interface units and data downloaded as part of the Region’s current monitoring program using the retrofitted devices. Figure 3 illustrates the water levels collected on an hourly basis for September 2017. The information provided by the WIU-X interface unit is very similar to that provided by the 3rd party datalogger. There are some minor differences in the data which is attributed to a time difference between when the datalogger stores the level value in the memory with the time that the WIU-X interface unit sends the level value data.

Figure 4 compares the water levels where the frequency was increased to 5-minute communication intervals to be able to evaluate the response of water levels to the turning on and off the supply well being monitored. Again, the results are similar with differences again attributed to the clock setting for collection versus transmission. Similar results were obtained using the 3rd party data loggers that use the manufacturer’s software to directly connect to the data loggers at the site.

There are some tangible technical differences between the 3rd party dataloggers verses ones retrofitted with the eleven-x WIU-X interface units. Examples of improved functionality includes the ability to remotely change reporting times. This capability enables real-time Step-Down testing to test well response to sudden fluctuations in water levels. Additionally, limits can be configured with alerts being programmed should the upper or lower ranges be reached. Other capabilities enabled by the eleven-x WIU-X is the identification of malfunctioning dataloggers, as well as real-time updates on the battery levels of both the datalogger, and the eleven-x interface unit.

Figure 3: Water Level Comparison for September 2017

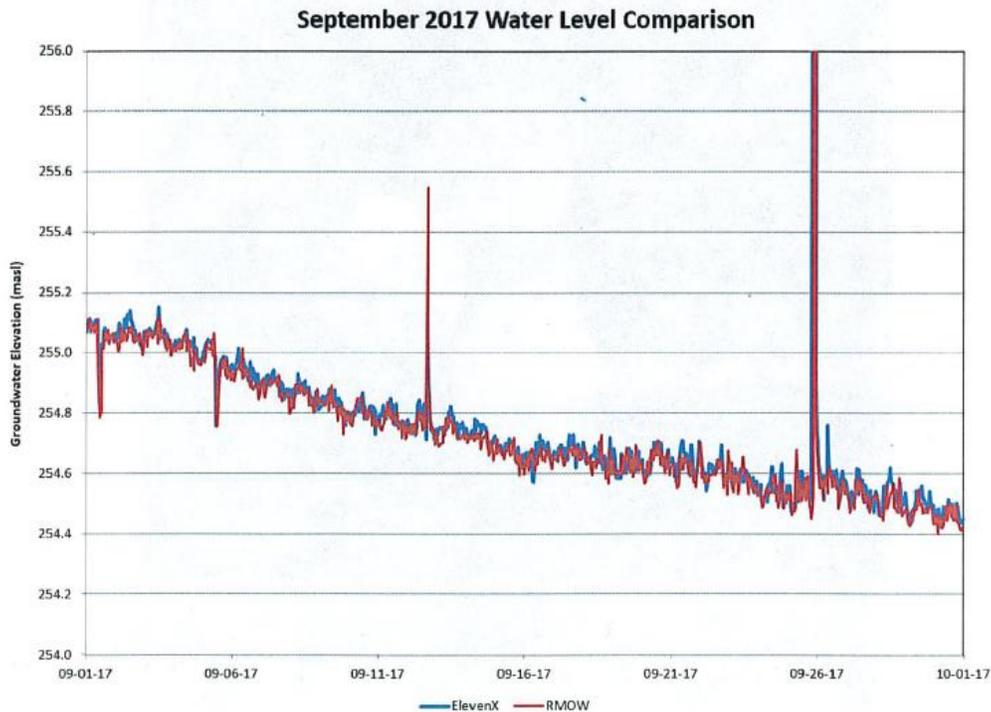
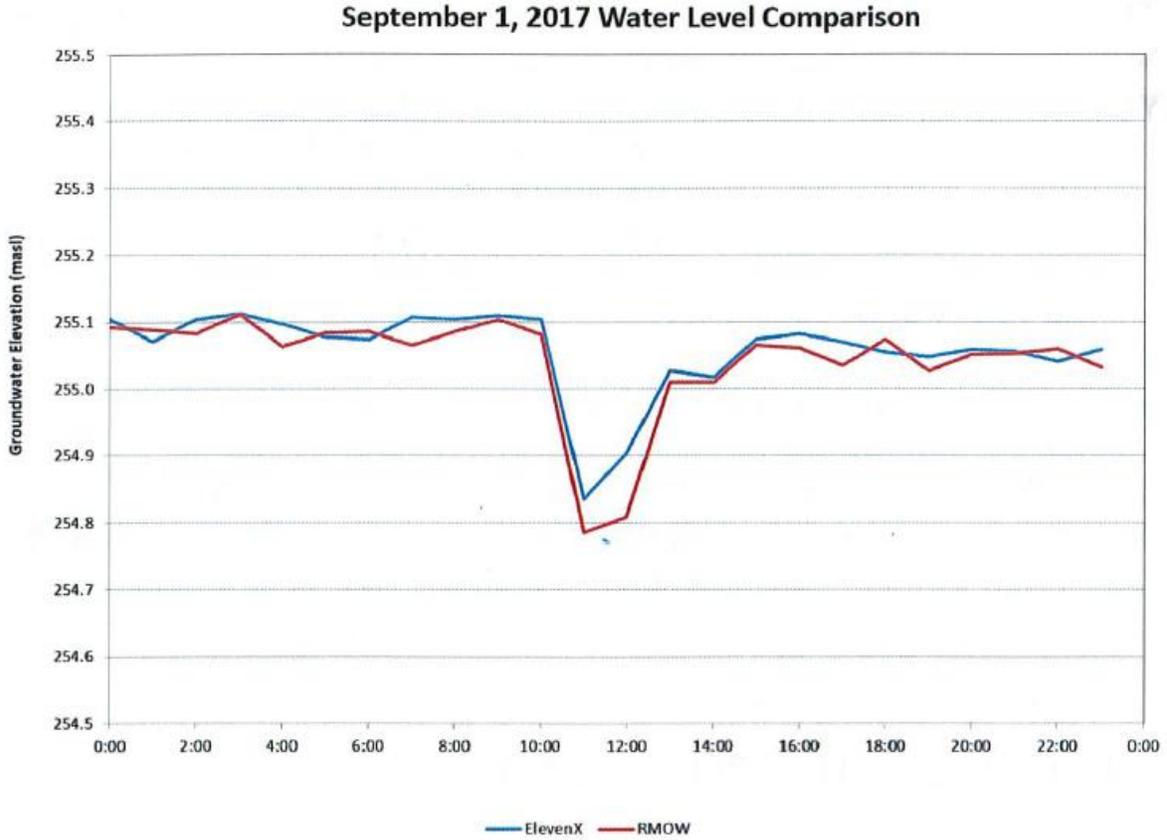


Figure 4: Water Level Comparison for Supply Well Pumping Test



Financial Analysis

A summary of equipment and recurring costs related to the eleven-x pilot program and expansion of the program to the Region’s highest priority monitoring wells are presented in Table 1.

Table 1: Cost Analysis	
Description	Based on Initial Expansion of 25 locations
Phase I - eleven-x Solution	
WIU-X Interface Units	\$11,725
Data cable upgrades (assume 20% of locations will require upgrades)	\$11,000
Annual Managed Service fees	\$3,000
Total Cost of Phase I Option	\$25,725
Phase II - 3rd Party Sensor	
Datalogger units purchase	\$97,500
Annual Managed Service fees	\$10,000
Total Cost of Phase II Option	\$107,500

As well as the financial savings, as noted earlier, the eleven-x WIU-X solution provides additional programmability features when compared with the 3rd party sensors. Moreover, the 3rd party sensors require the purchase of a software license to house the data which potentially violates the Region's intellectual property policies.

When comparing the pilot project of the Region's twenty-five initial sites to the purchase of new dataloggers, using the eleven-x WIU-X interface solution provides a significant financial benefit due to reduced hardware and managed service costs, as well as overall program costs. In total, a 76% savings is realized when comparing the cost of purchasing new sensors for the priority sites to the combined cost of integrating the WIU-X with existing dataloggers and purchasing fewer replacements.

In addition to significant hardware savings, the Region will save another 20% per annum through the elimination of quarterly manual data collection costs by deploying the eleven-x WIU-X interface solution. The return on investment from utilizing the eleven-x solution is just a couple of years, which is approximately one quarter the payback time if purchasing new 3rd party dataloggers.

About eleven-x Inc.

eleven-x simplifies IoT and facilitates faster, evidence-driven decisions through wireless connectivity and real-time data collection for Smart Cities, Campuses, Buildings and Industry. We offer complete device to cloud LoRaWAN™ solutions, comprised of accurate and reliable sensor networks delivering secure data to our customers through easy to use dashboards and industry standard APIs. Organizations rely on eleven-x's wireless connectivity expertise to deliver turnkey solutions that improve operations, simplify processes and deliver value in today's connected world. Visit eleven-x.com for more information.

Follow us on Twitter: [@eleven_x](https://twitter.com/eleven_x) and on [LinkedIn](https://www.linkedin.com/company/eleven-x).

