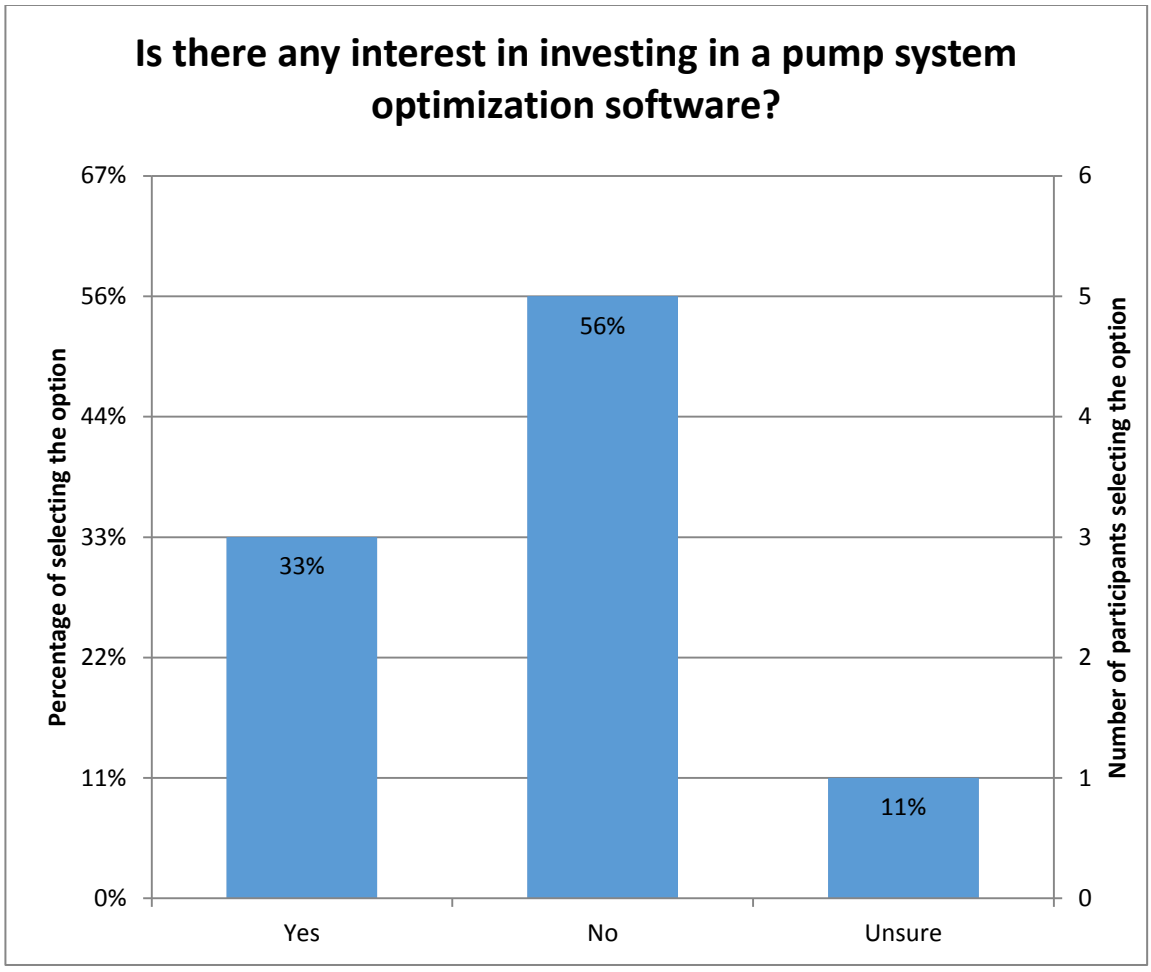
CWWA WATER AND ENERGY EFFICIENCY COMMITTEE RESEARCH PROJECT

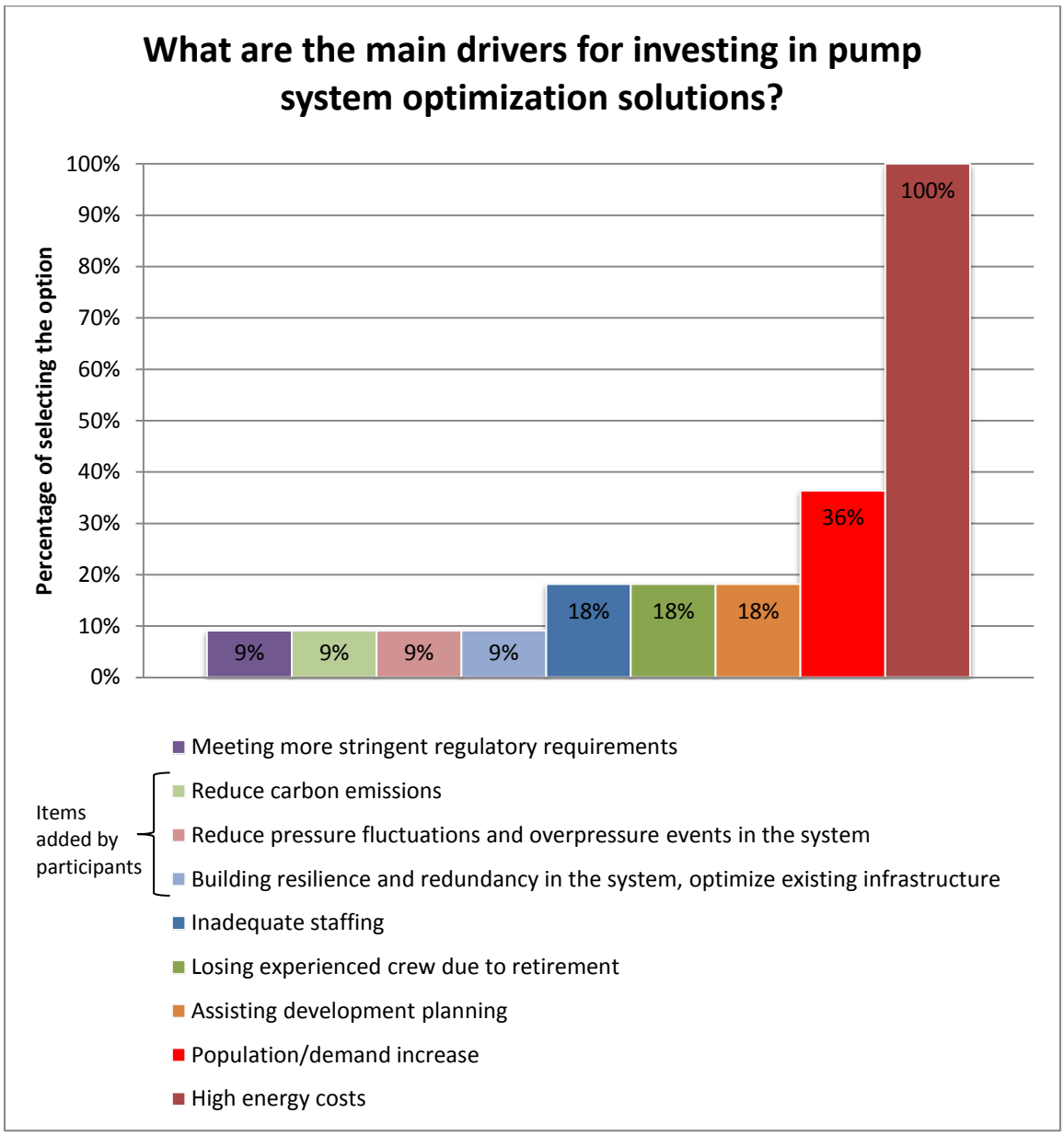
Best Practices of Optimized Operation in Large Scale Pump Systems

Survey Results Summary

- One-thirds of the participants are interested in investing in pump system optimization software. Although the scale and complexity of a municipality's pump system, and the population size have impacts on interests of investment, they are not the root causes.



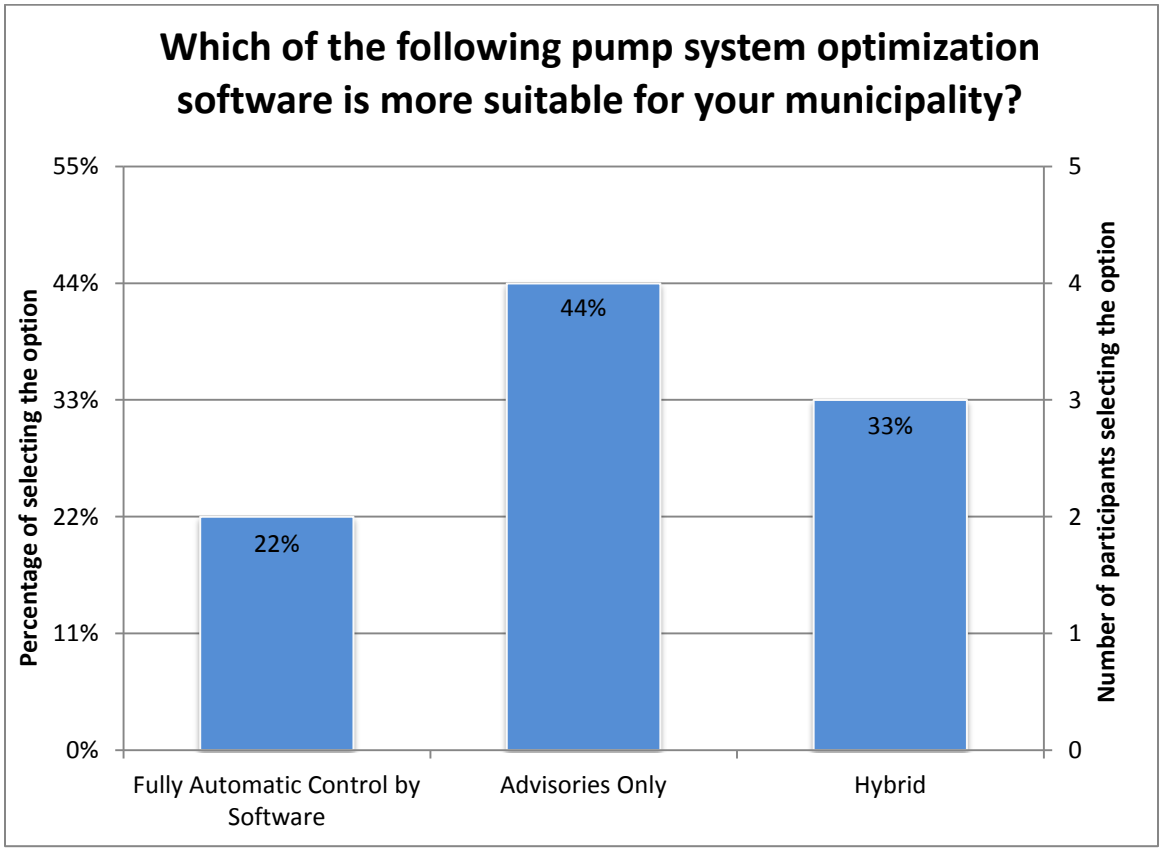
- High energy cost is the No.1 common reason for municipalities/utilities across Canada to invest in water distribution system optimizer. Population and/or demand increase is the second largest common driver.



- To understand what type of pump system optimization software is preferred among municipalities/utilities across Canada, three options were summarized from the survey. They are:

Fully Automatic Control by Software	Advisories Only	Hybrid
Software integrates with SCADA, the pump system is fully controlled by software under default setting, except the time when pumps require maintenance and emergency response	Software extracts data from SCADA and provides optimized operating recommendations to the operators, while has no control of the pump system	Software integrates with SCADA and has partial control of the pumping equipment. Operator's action/decision is required before letting the software proceed with the optimum solution

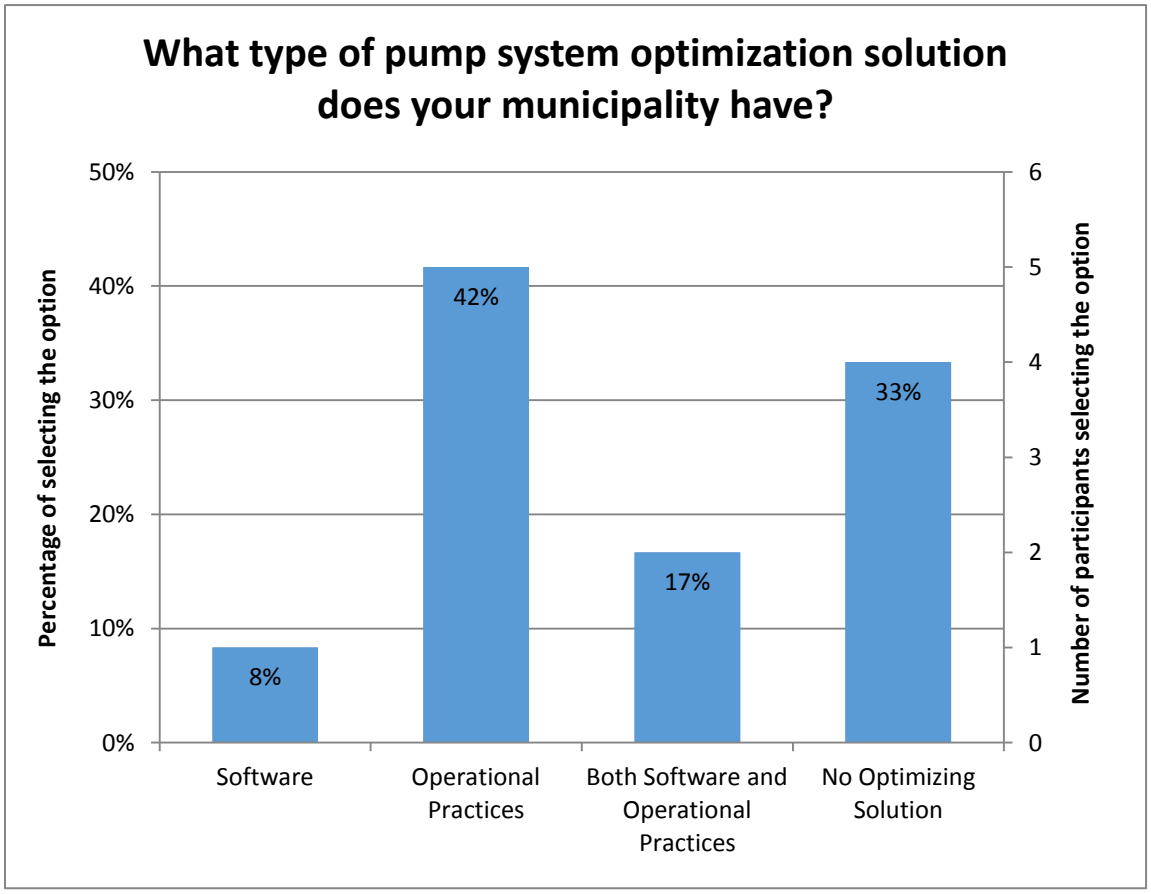
Advisories only software has slightly higher selection rate. However, the municipalities/utilities that already have optimization software implemented all select the Hybrid option.



- Two-thirds of survey participants use one or more pump system optimization solution in their water distribution system. The solution can be software, an operational practice or both. Some examples of operational practices used to optimize pump system performance are:

  a). Operating pumps during off peak period
  b). Thermodynamic testing of pumps to establish real-world up to date pump curves
  c). Running VFD in the most efficient energy and flow zones
  d). Continuously monitoring pump efficiency in conjunction with pump retrofits
  e). Proper pump selection during design stage
  f). Educating operators so that they know the most efficient pumping schedule and combination

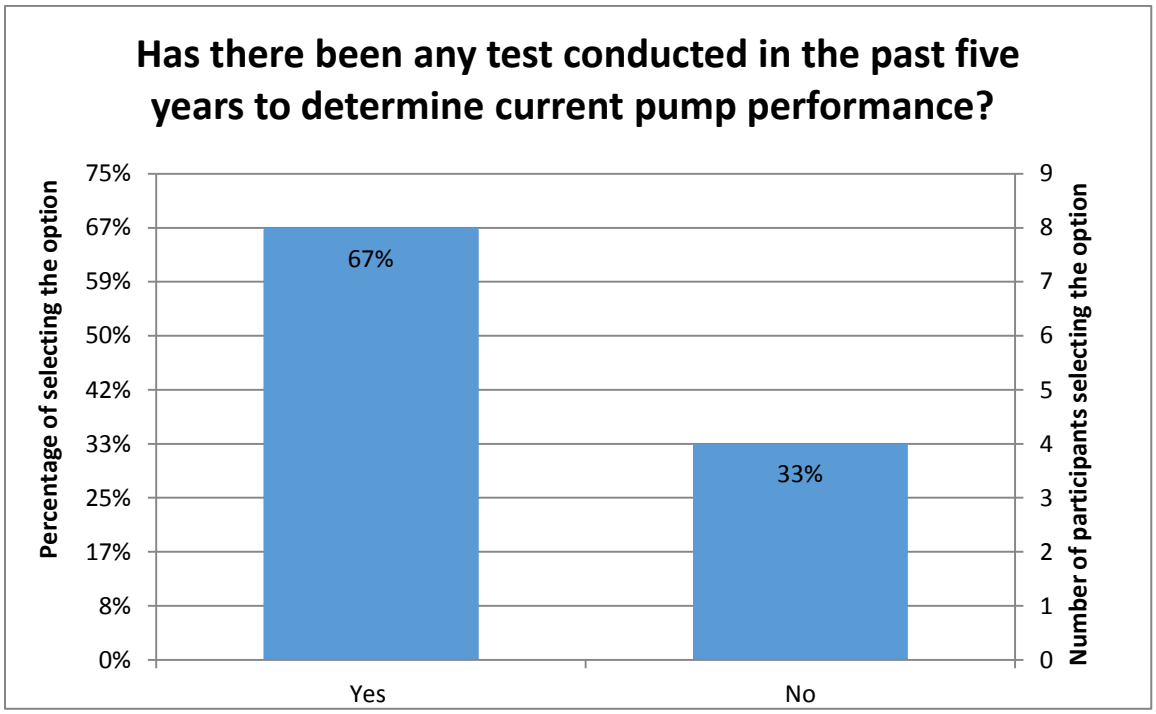
  One of the four municipalities/utilities who currently do NOT have any optimizing strategy showed interests in investing in optimization software.



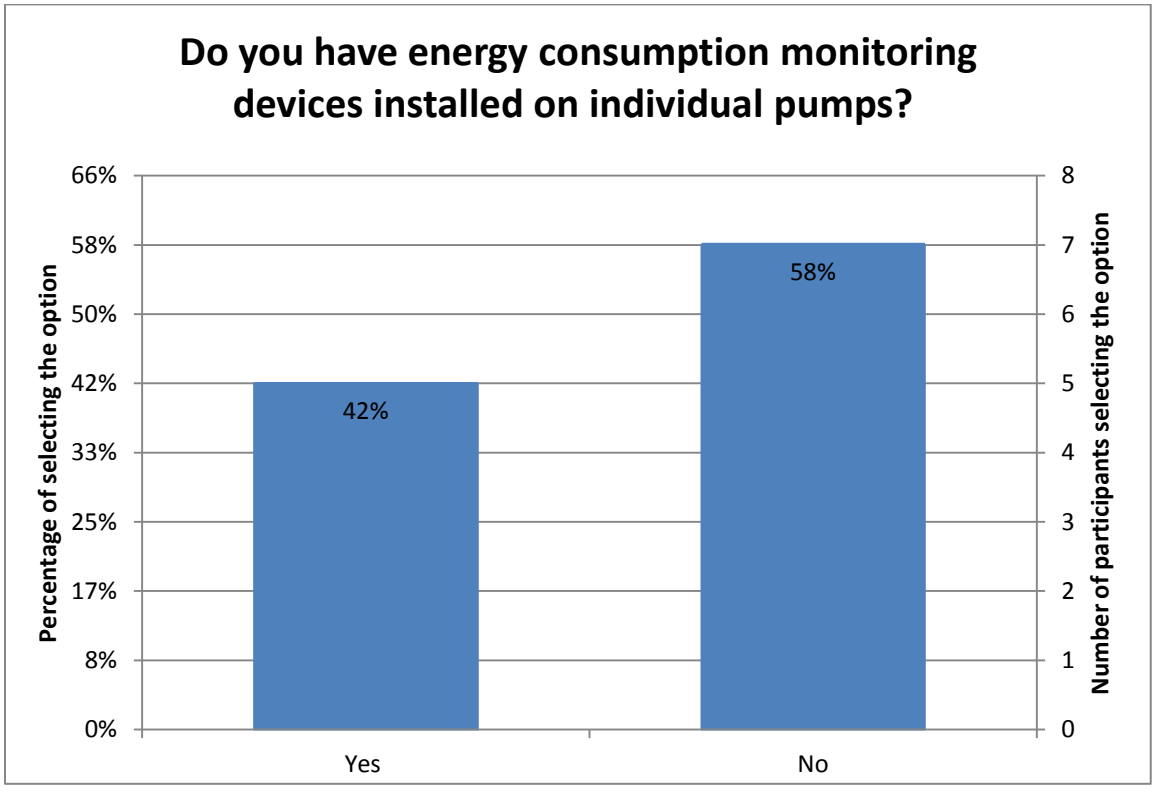
- A number of software products were mentioned by the participants in the survey responses. A summary of the products which are capable to optimize pump system in real-time or non real-time is in the chart below:

	Software Name/Owner		
	Transmission Operations Optimizer(TOO)/City of Toronto	**Rockwell Advanced Process Control (APC) or Model Predictive Control (MPC)/ Rockwell Automation**	**InfoWater Scheduler/ Innovyze**
Distribution System Description	There are 29 pump stations, 19 reservoirs and 9 elevated tanks, 153 pumps in Toronto and southern portion of York Region. Four filtration plants in City of Toronto	2 pump stations and a booster station, 2 reservoirs, 2 treatment plants	6 surface water supply plants, 17 booster pump stations, 28 groundwater wells, 18 remote water storage facilities, 1900 km of water mains (50mm~1350mm)
Software Description and Main Features	TOO is a smart real-time water control system that automatically determines control strategies. Key features are: water consumption/demand prediction, energy rate prediction, hydraulic modelling, mathematical optimization considering time-varying constraints (reservoir critical limits, capacities, equipment status), analytical algorithms, data integration and on-line monitoring of system performance and spot market rate. This system is fully integrated into the SCADA system, but give the operator choices to use manual or auto model. Also, operators need to review and accept suggested control strategies before letting the software carrying out the strategies.	Software is part of SCADA. System monitors pressure telemetry stations throughout the city and trims pumps using VFDs and valve throttling to meet a minimum pressure. Pumps are turned on by operators but their speeds are controlled automatically. Pressure monitor, drives for FCV and VFDs are also Rockwell's products. This software implementation is targeting pressure fluctuations and overpressure events in the system, as a result, reducing watermain breaks.	Manual optimization performed daily using Innovyze water model to create optimized pump schedule based on forecasted demand. The software forecast the energy price and water demand (based on historical data), abstract boundary condition from SCADA (tank level, pump status etc.) and input these data into InforWater Scheduler. The software will generate the operating strategy for the distribution system one day (24hours) ahead of time. The results are analyzed by engineers and then handover to operation team for action. It is not a real-time automation practice.
Launched time	November, 2015	January, 2014	February, 2010
Annual Saving	Estimated $1.0 Million Saving in 2016. Estimated 16 Million kWh over 12 months by Toronto Hydro	$125,000 due to reduced main break, another $125,000 due to lower electricity costs and system leakage	The saving range between 1% and 11% of energy costs from month to month, with an annual projected savings over $100,000

- Two-thirds of the participants conducted pump test in the past five years to determine current pump performance.



- Five out of twelve participants have energy consumption monitoring devices installed on individual pumps.



- Municipalities/utilities across Canada are facing diverse challenges for pump system energy management. These challenges include:

  a). Aging infrastructure
  b). Operators' buy-in
  c). Maintaining adequate storage for potential sudden demand increase
  d). Pipe leakage
  e). Raising water over 300 meters in height from the river valley (individual case)
  f). Oversized pumps
  g). Difficult to gather reliable data for demand prediction / current pump curve
  h). Pump operating far from the Best Efficiency Point
  i). High water demand often occurred during on-peak hours under a variable-electric-rate schedule

For any further questions or comments regarding to the survey summary, please contact:

Morris Liu, P. Eng.
Energy Management Engineer
Energy Management, Asset Planning
Infrastructure Planning, Water Resources
The City of Calgary
T (403) 268-5874 | **C** (403) 819-5175 | morris.liu@calgary.ca

OR

Rita Zhang, EIT
Energy Management, Asset Planning
Infrastructure Planning, Water Resources
The City of Calgary
T (403) 268-4343 | rita.zhang@calgary.ca