Digital Pump Monitoring: Striving For Preventative Maintenance

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September 2019

Making a difference.

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01 Preventative Maintenance and Energy Efficiency for Pumps

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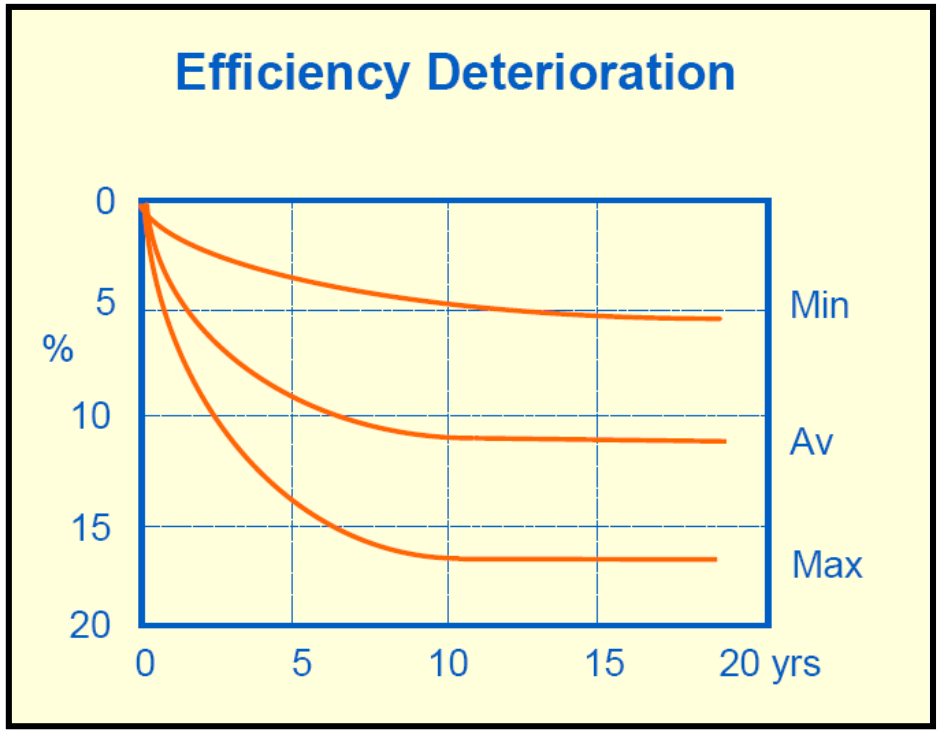
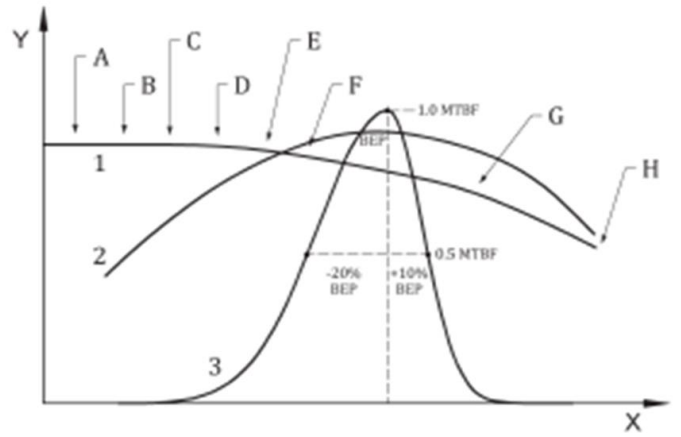
01 Preventative Maintenance and Energy Efficiency for Pumps

- Pumps consume most of the electricity needed for operating water infrastructure.
- Many pumps run at efficiencies below their manufactured state and/or peak due to pump wear.
- Rate of pump efficiency deterioration depends on pump size, pump quality, system conditions, pump selection and run hours.
- Average efficiency deterioration for a water pump is 1.4 % per year for first 7 years.





Key

A	high temperature rise	Curve 1	pump curve $H(Q)$
B	low flow cavitation	Curve 2	pump efficiency curve
C	low flow bearing and seal life	Curve 3	reliability curve/MTBF
D	reduced impeller life	X	flow in percent of flow at BEP
E	suction recirculation	Y	head in percent of head at BEP
F	discharge recirculation		
G	low bearing and seal life		
H	cavitation		

01 Preventative Maintenance and Energy Efficiency for Pumps

- Cardno estimates energy savings of 8 % possible via. targeted pump refurbishment to optimise the timing for performance-based maintenance.
- Selecting to use the most efficient pumps available and ensuring that they are running on the most efficient part of their pump curves can give energy savings of 5 %.
- Target high energy pumps and/or pumps with known performance issues first.

02 Pump Performance Testing

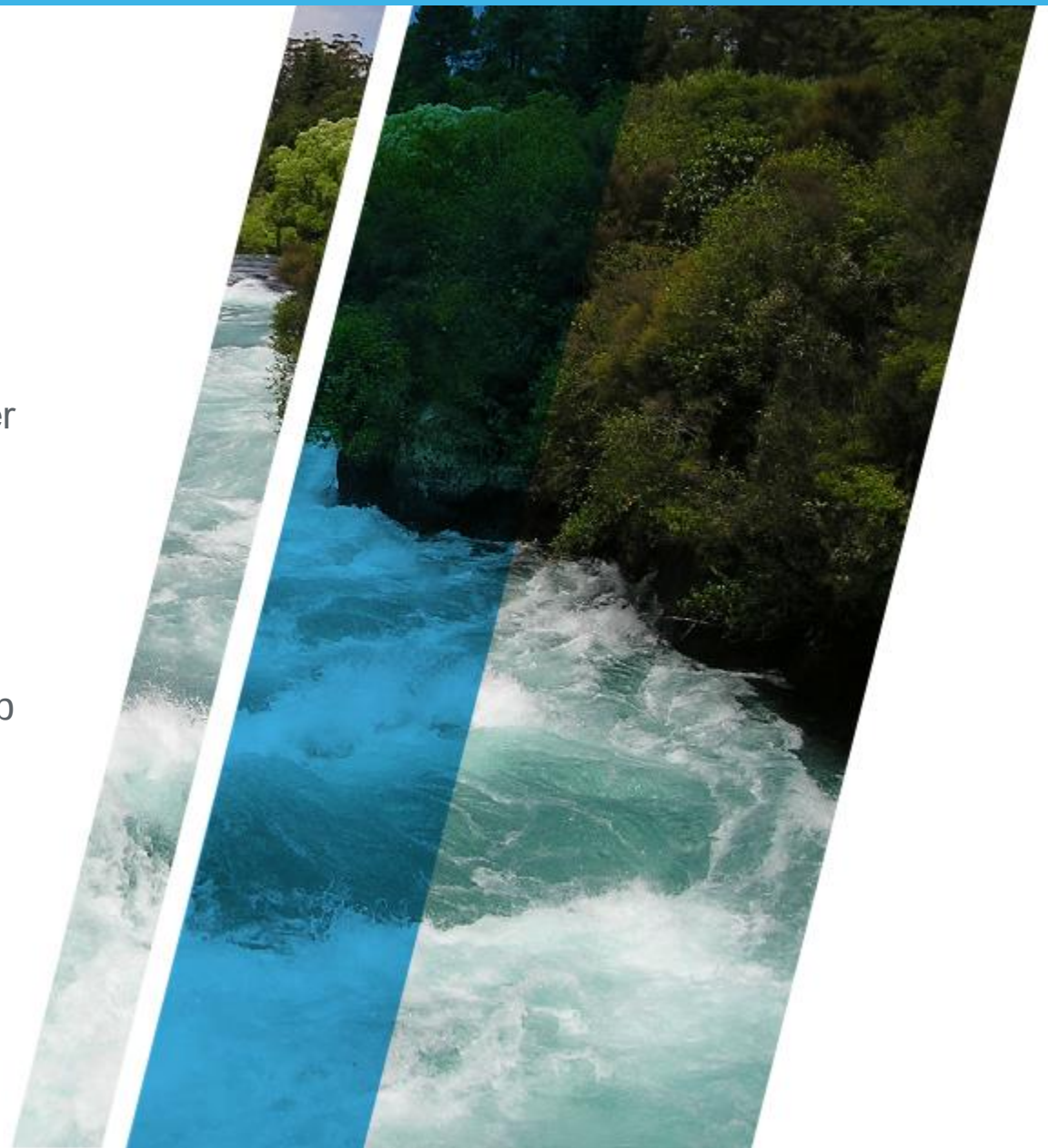
02 Pump Performance Testing

- Pump performance testing (PPT) provides either a snapshot in time of pump efficiency or live and complete data over all operating conditions and longer periods of time when continuous.
- Test results can help with deciding which pumps need refurbishment, which pumps are the most efficient and whether the pumps are operating at their peak.
- Individual flow rate, discharge pressure, suction pressure, motor power and speed measurements are required.
- Conventional method uses existing pump station instrumentation and magnetic flow meter (if available).
- Thermodynamic method uses independent instruments and flow measurement and is more accurate.

03 Wellington Water's Info360 Software Pilot

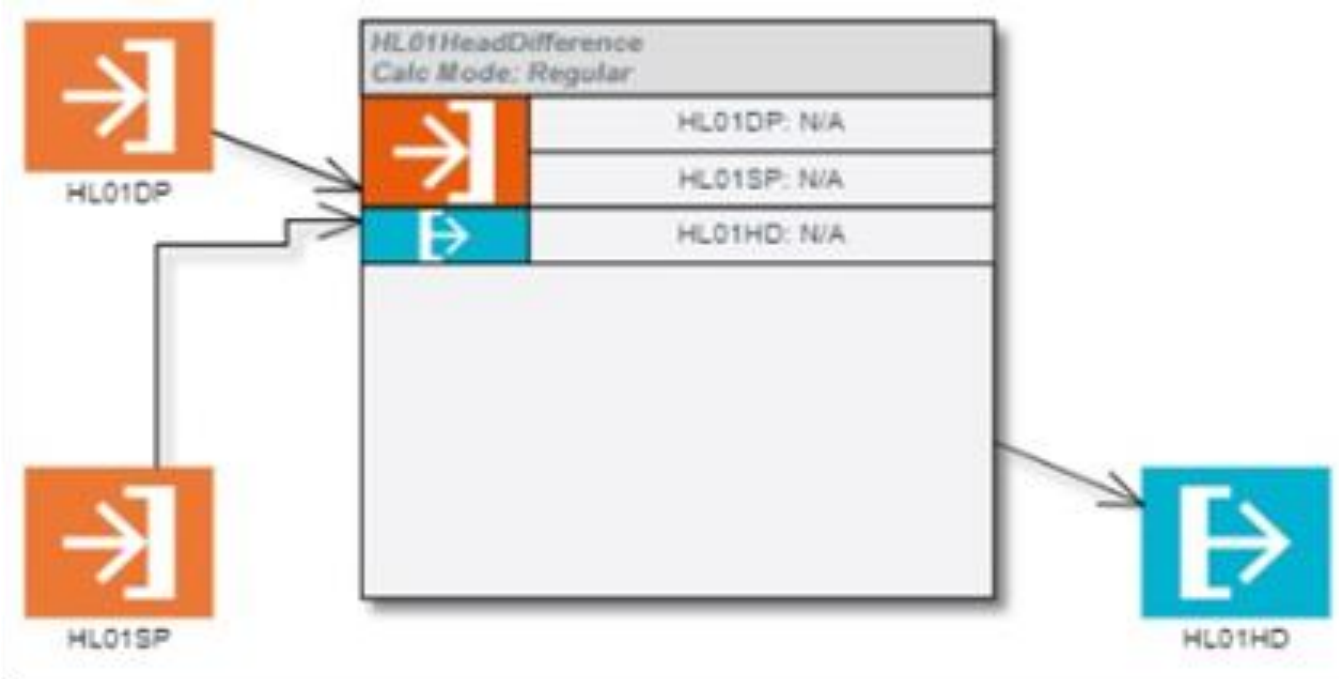
03 Wellington Water's Info360 Software Pilot

- Wellington Water wanted to use/share existing time series SCADA data more effectively.
- Continuous monitoring/testing of pump performance using SCADA sensor data envisioned.
- Water network balance and water infrastructure leakage index calculations.
- Info360 software by Innovyze could bring all SCADA data 'under one roof' for analysis.
- Info360 'sits on top' of SCADA system/SCADA sensors.
- Info360 offered possibility of uploading thousands of sensors.
- Holistic approach - multiple assets can be looked at together.
- Eliminate antiquated Excel spreadsheet calculations and free up time to spend on data analytics.
- Cardno engaged to help with pump performance calculations.

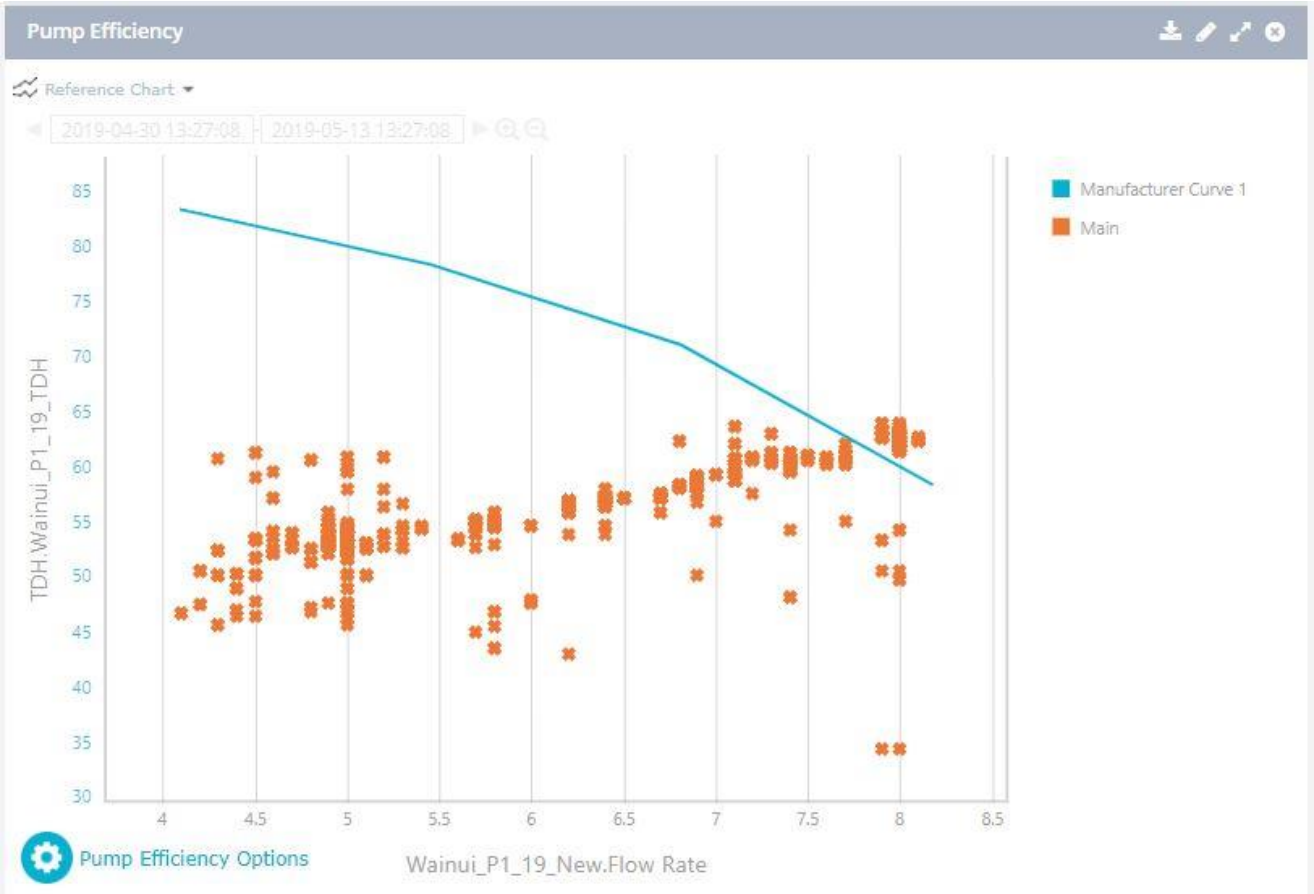


03 Wellington Water's Info360 Software Pilot

> Info360 plotted typical pump curves and customised pump efficiency calculations.
> BizBlocks made new 'sensors', calculated from existing ones



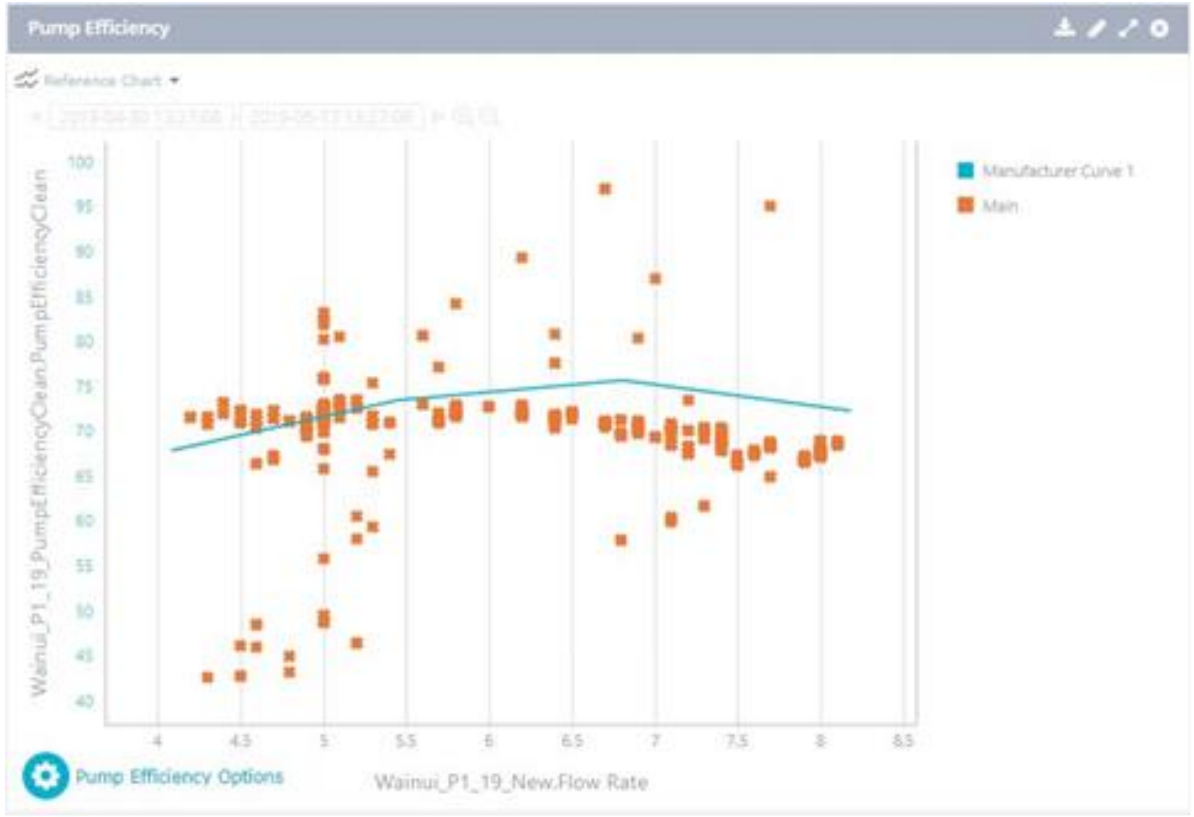
03 Wellington Water's Info360 Software Pilot



> Head Difference vs. Flow Rate chart with manufacturer's data adjusted (using the pump infinity laws) for the actual pump operating speed on SCADA (due to variable speed drive).

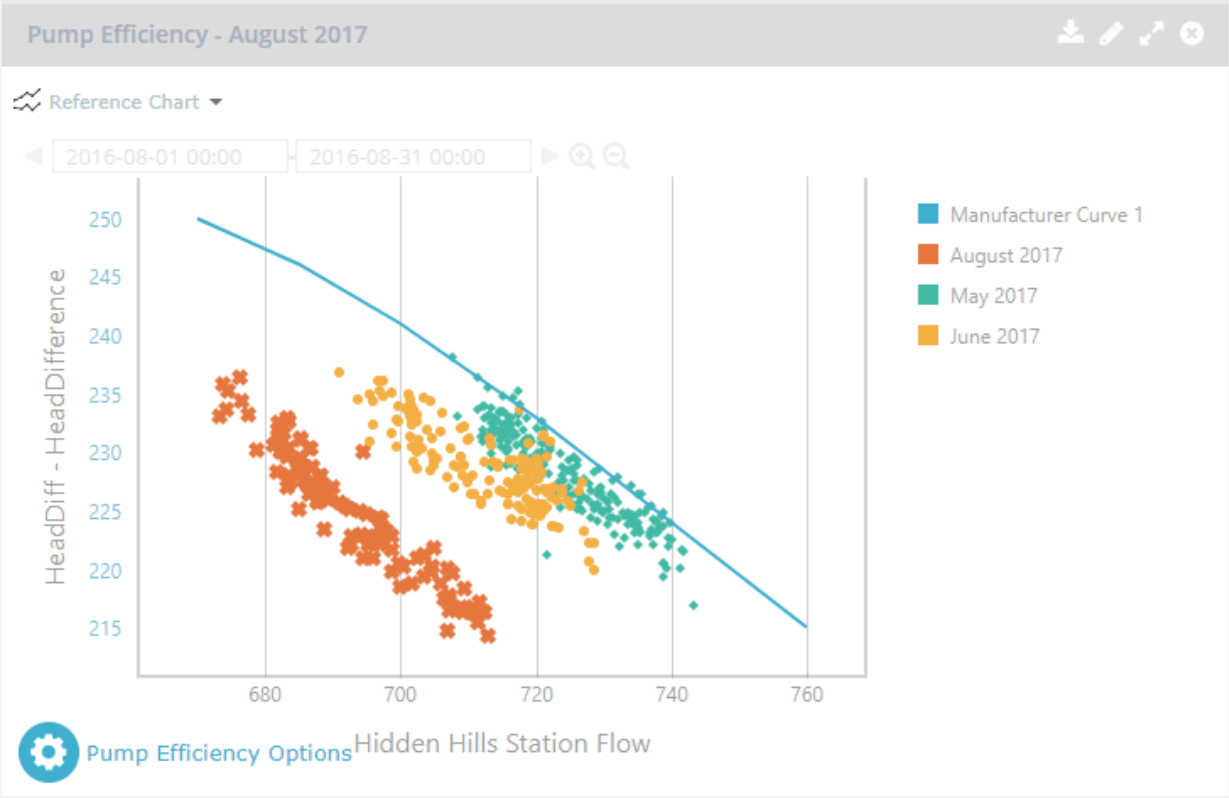
> Outliers in data removed with an 'if statement', based on defined range and/or standard deviation from the mean of the outputs.

03 Wellington Water's Info360 Software Pilot



> New 'sensors' used to calculate other new 'sensors'
>
> e.g. head difference with motor power and flow rate to calculate pump efficiency.

03 Wellington Water's Info360 Software Pilot

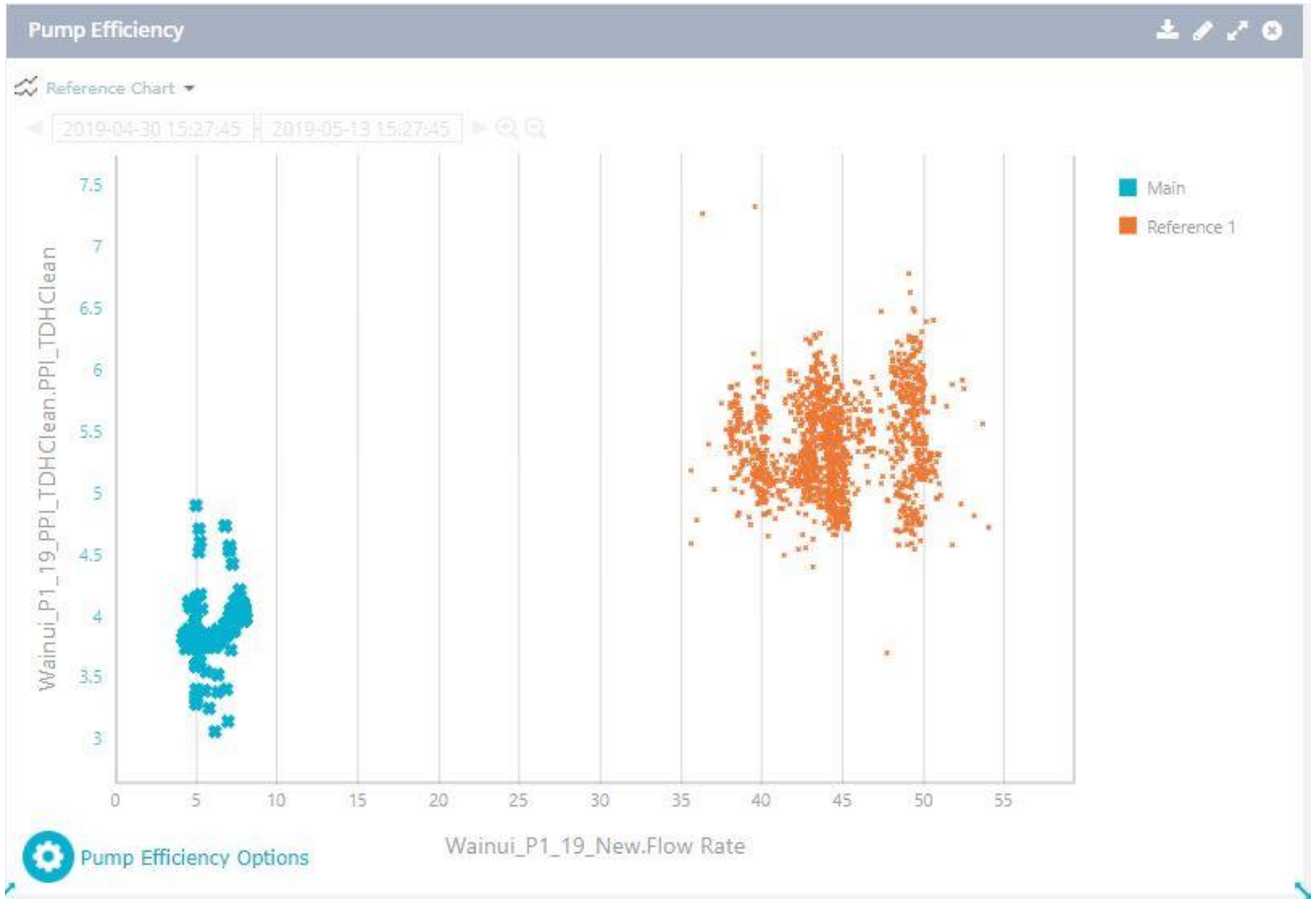


> Different time periods or pumps were shown together.

> When pump operating significantly below manufacturer's efficiency, take actions such as pump refurbishment or choosing best pumps at the best speeds (install variable speed drives if required).

03 Wellington Water's Info360 Software Pilot

> Water Research Foundation's pump performance indicator PPI_TDH vs. Flow Rate chart with two pumps.



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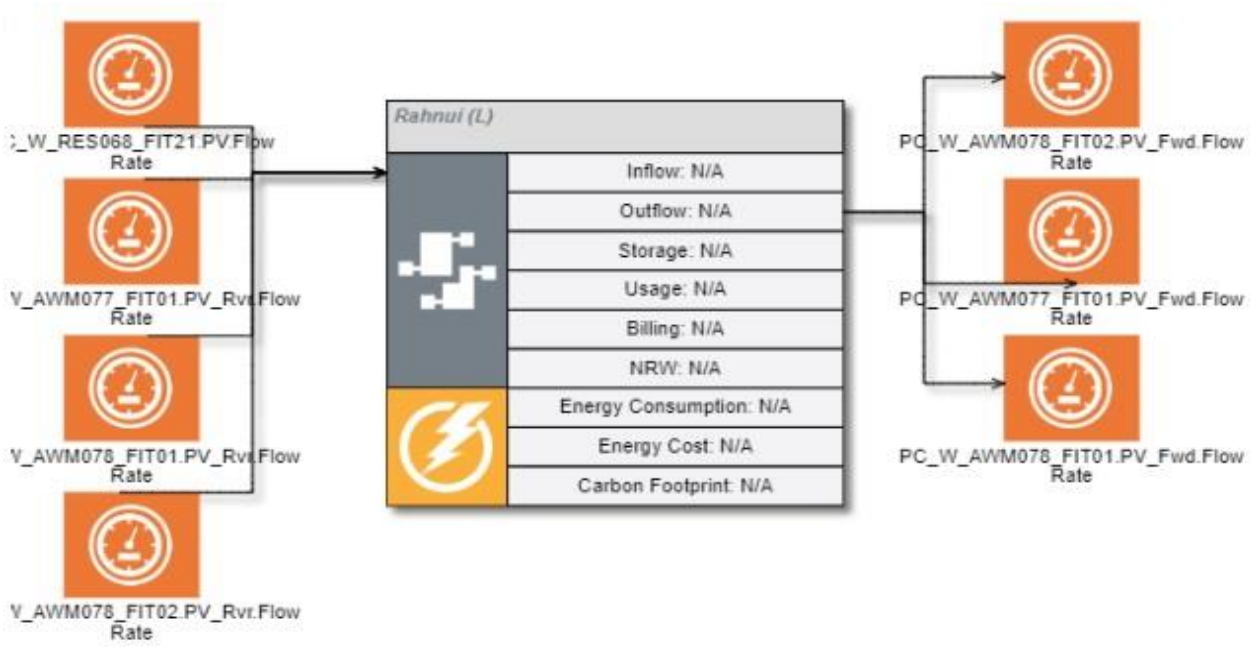
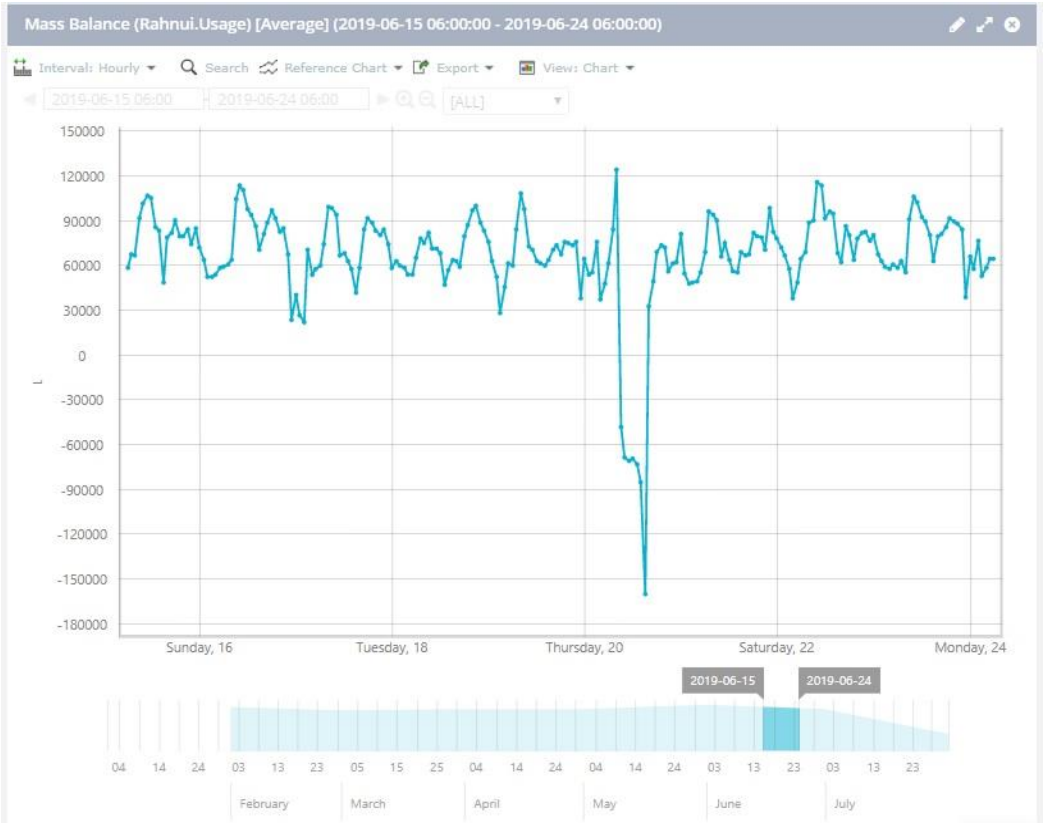
> Water network balance BizBlock calculation and chart.





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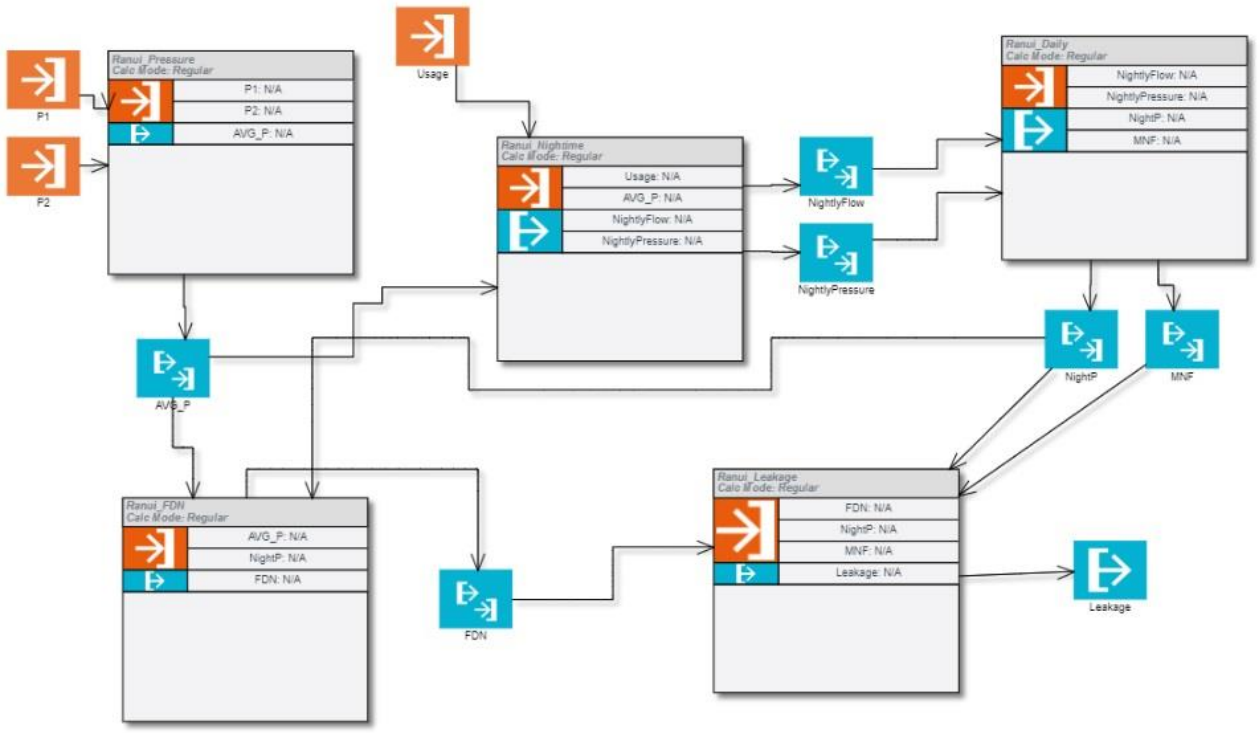
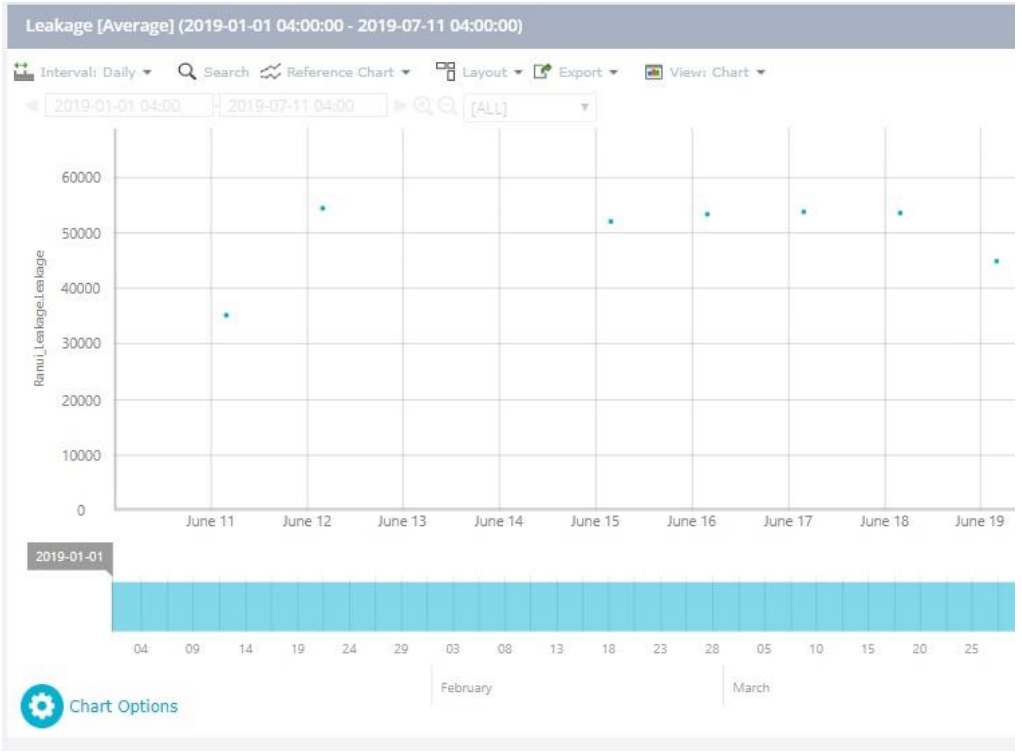
> Water infrastructure leakage index BizBlock calculation and chart.

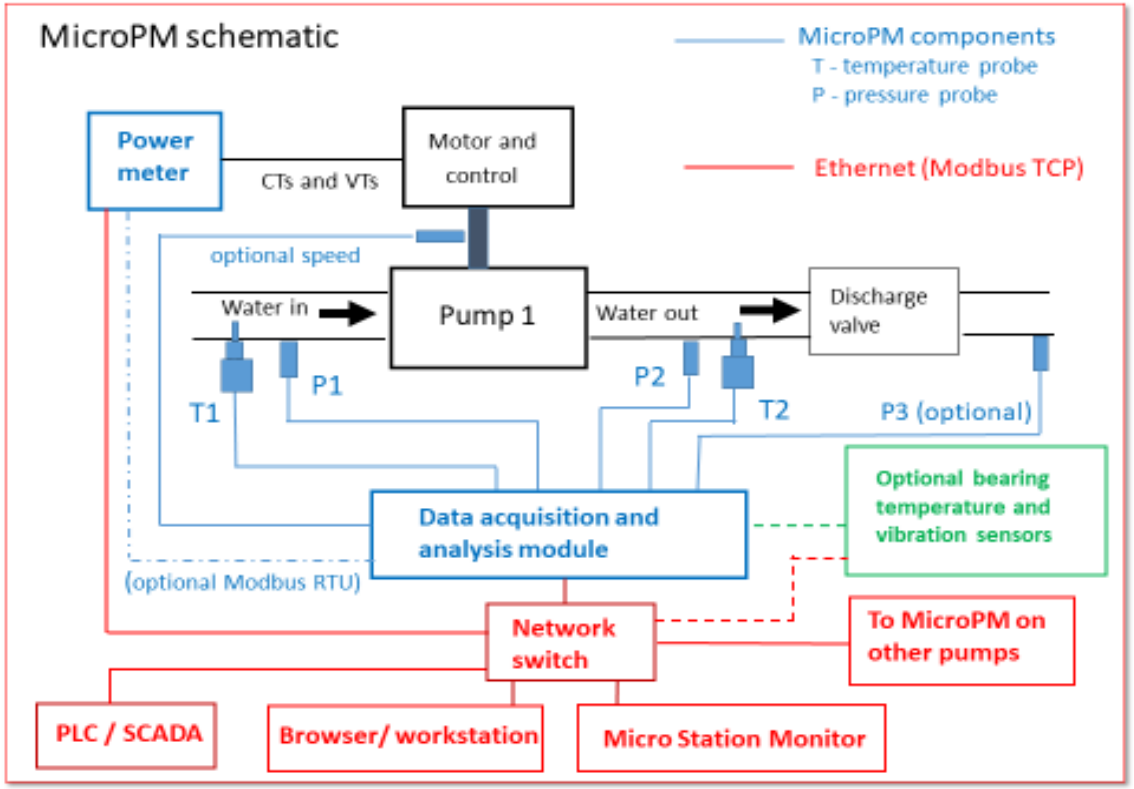




03 Wellington Water's Info360 Software Pilot

- Continuous monitoring/testing of pump performance achievable using SCADA sensor data on Info360 software.
- BizBlocks provided a template which could be extended and scaled with more scope and longer data timeframes automatically using SCADA data directly.
- Calculations and charts were shared with and repeated easily on user-defined dashboards, providing the relevant data to the right people.
- Snapshot thermodynamic method PPT should continue on pumps larger than 30 kW for more accurate estimation of energy savings.
- SCADA sensor data should provide enough information to plan pump refurbishment and pump station upgrades for pumps smaller than 30 kW.
- Info360 could help 'redflag' inefficient pumps for further investigation e.g. snapshot thermodynamic method PPT.

03 Wellington Water's Info360 Software Pilot



- Alternative to SCADA data is a permanently installed thermodynamic method continuous monitoring/testing of pump performance system

  e.g. MicroPM by Robertson Technology.

- Eliminates the limitations/barriers using SCADA sensor data / provides more accurate data.

- Thermodynamic method's flow rate measurement uncertainty is less than 2.0 % with water.

- Thermodynamic method measures pump efficiency directly via. temperature across the pump.

- Flowrate calculated from pump efficiency, total dynamic head and power measurements.

04 WRF's Pump Performance Benchmarking Database

04 WRF's Pump Performance Benchmarking Database

- Water Research Foundation (WRF) report Performance Benchmarking of Pumps and Pumping Systems for Drinking Water Utilities (Badruzzaman et al., 2017).
- Aim was to develop a pump performance benchmarking database to help peer utilities run their pumps more efficiently.
- Provide guidance for screening inefficient pumps for further assessment of energy performance improvement opportunities.
- Eighteen water utilities provided data for the study including Wellington Water, Hunter Water and Unitywater – 177 pumps.
- WRF used pump station SCADA sensor data for the pump performance calculations.

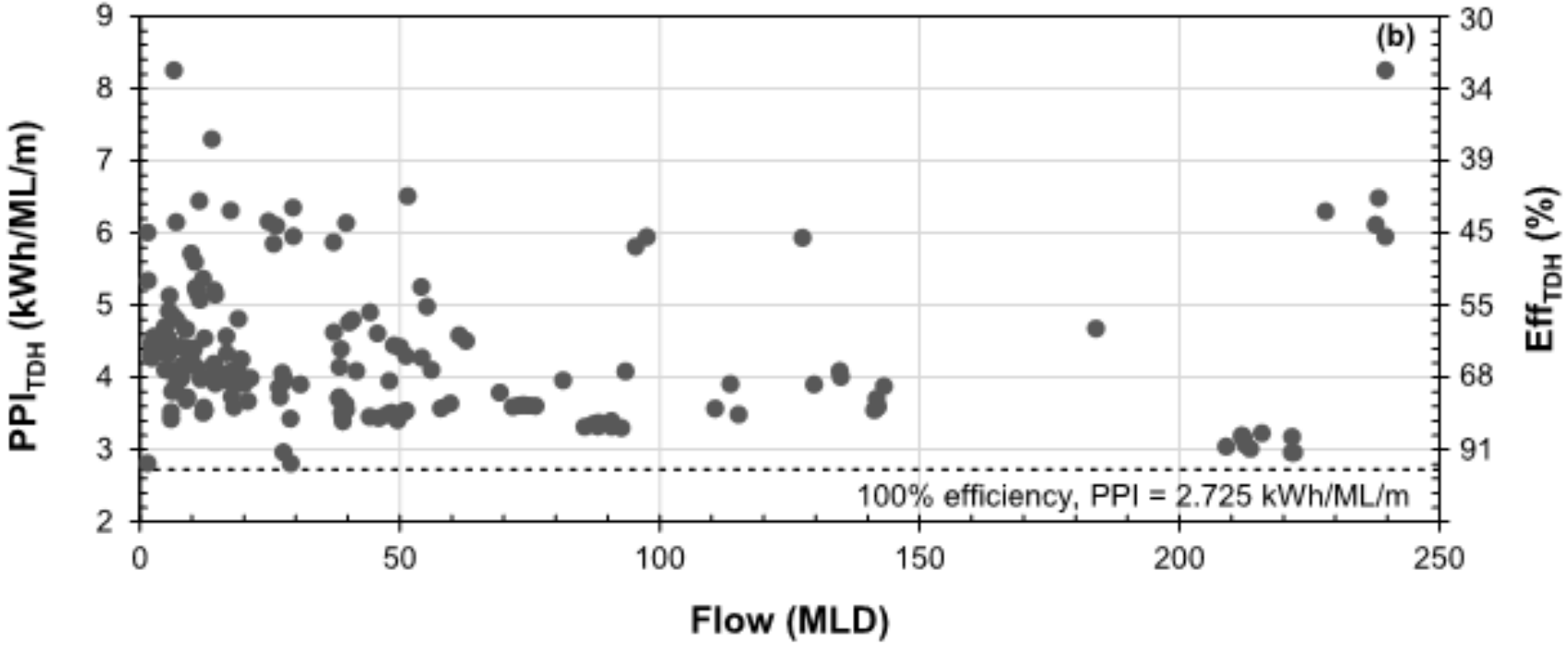
04 WRF's Pump Performance Benchmarking Database

- Pump performance indicator PPI_TDH developed as comprehensive metric to characterise pump energy performance.
- $PPI_{TDH} = motor\ power\ consumption \div (volume\ pumped \times total\ dynamic\ head)$
- PPI_TDH units are kWh/ML/m.
- PPI_TDH normalises the power consumption against the head produced by the pump, providing a more consistent comparison across pumps of different pressure ranges.

04 WRF's Pump Performance Benchmarking Database

> PPI_TDH ranged from 2.8 to 8.2 (lower PPI_TDH, more efficient pump).

> WRF recommended median value of the database, which was 4 should be considered as the threshold value for a good performing pump.



04 WRF’s Pump Performance Benchmarking Database

- WRF’s major challenge was accessibility and accuracy of SCADA sensor data.
- Half of the pumps had missing pressure data (a work-around was used where the pressures were estimated from the manufacturer’s pump data based on the flow rate).
- Power data estimated from monthly energy bills as no SCADA power sensors.
- Common magnetic flow meters meant SCADA data needed sorting for individual pumps.
- Instrumentation reading errors cause accumulated errors in PPI_TDH calculations.
- Artificial increase in PPI_TDH due to pressure sensors being installed far away from pumps.

05 Cardno's Pump Performance Benchmarking Database

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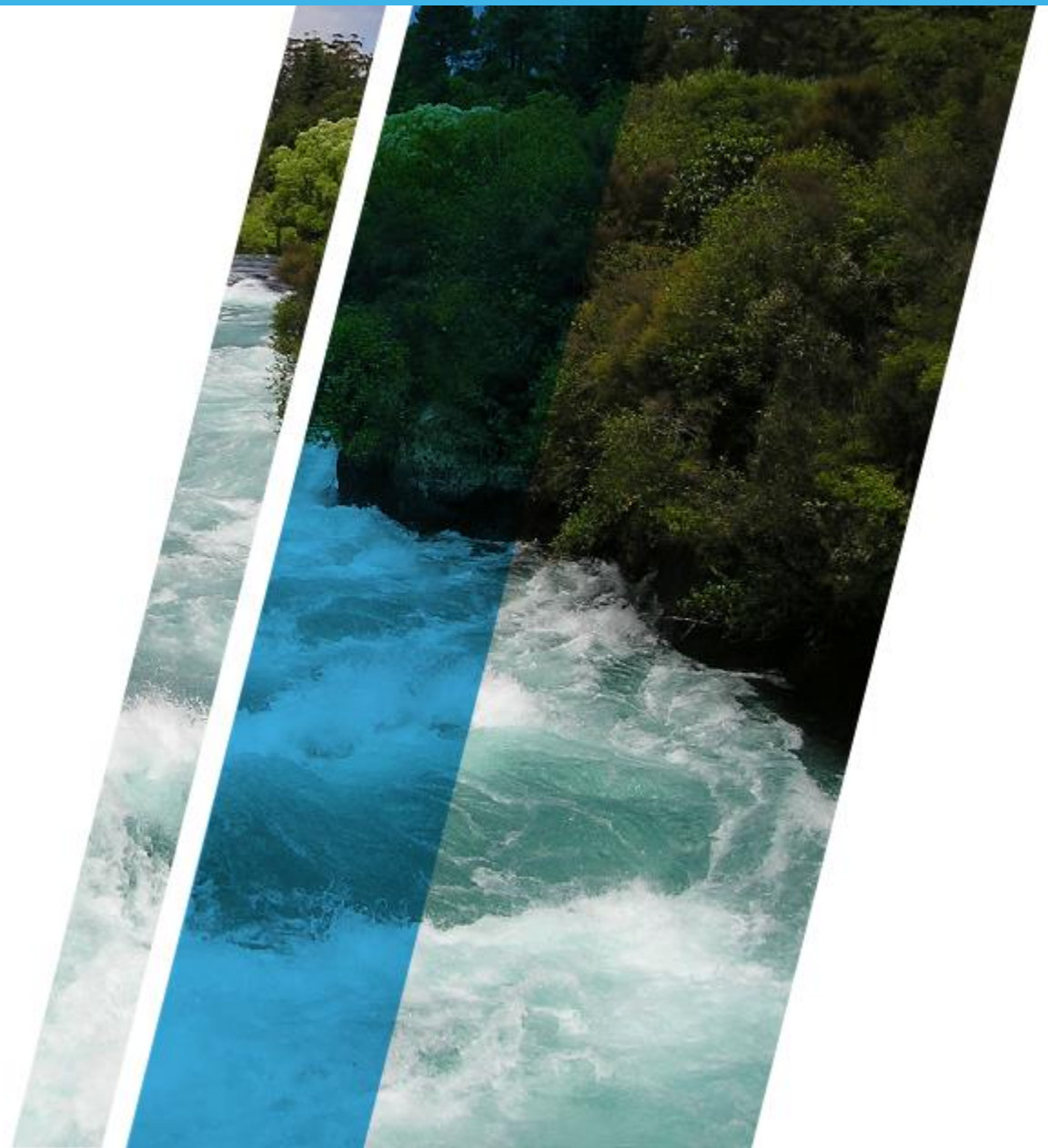
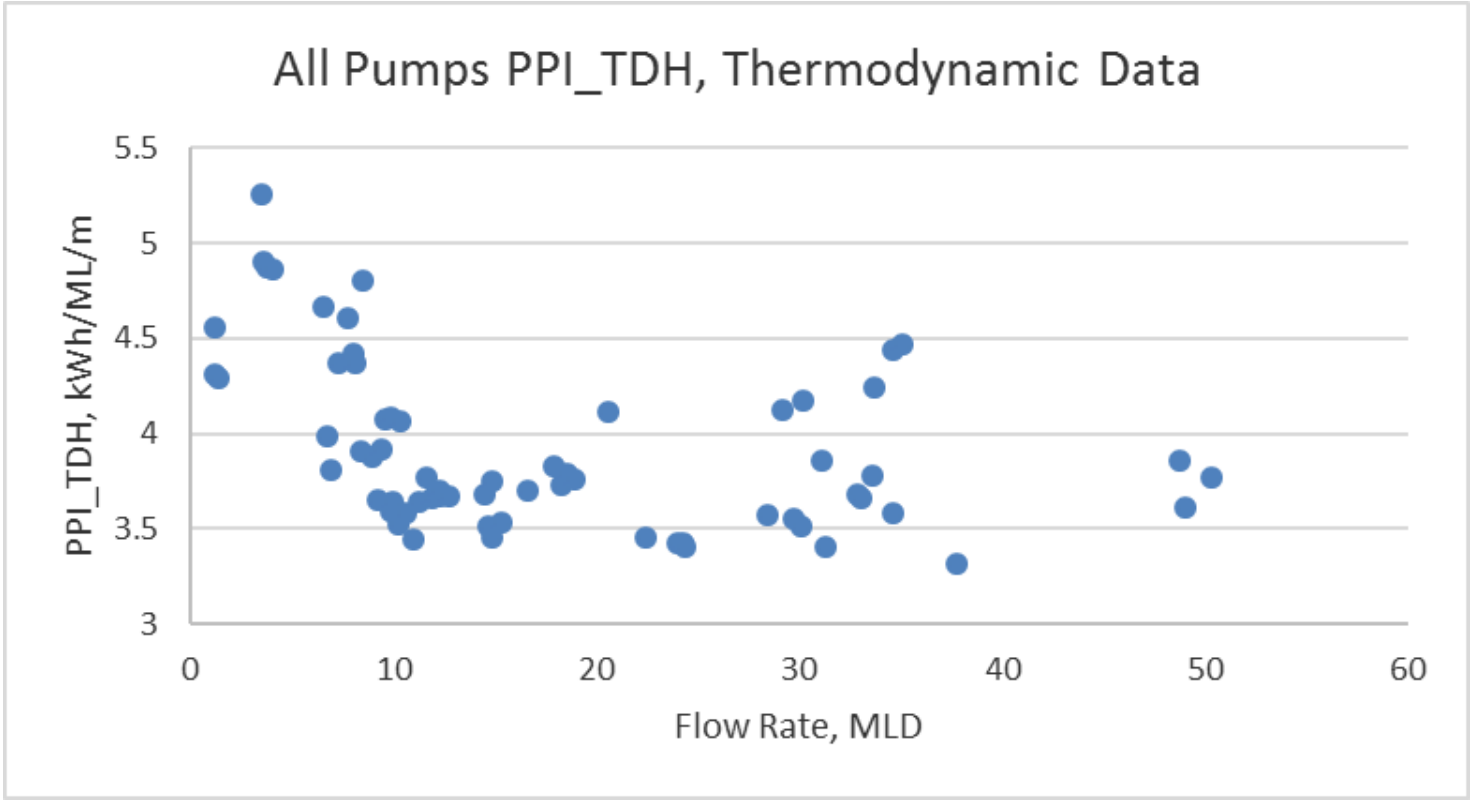
05 Cardno’s Pump Performance Benchmarking Database

- Using the WRF’s approach.
- Used historical thermodynamic method snapshot PPT data, from NZ council water pumps, for the pump performance calculations.
- Tested using the Robertson Technology P22 system.



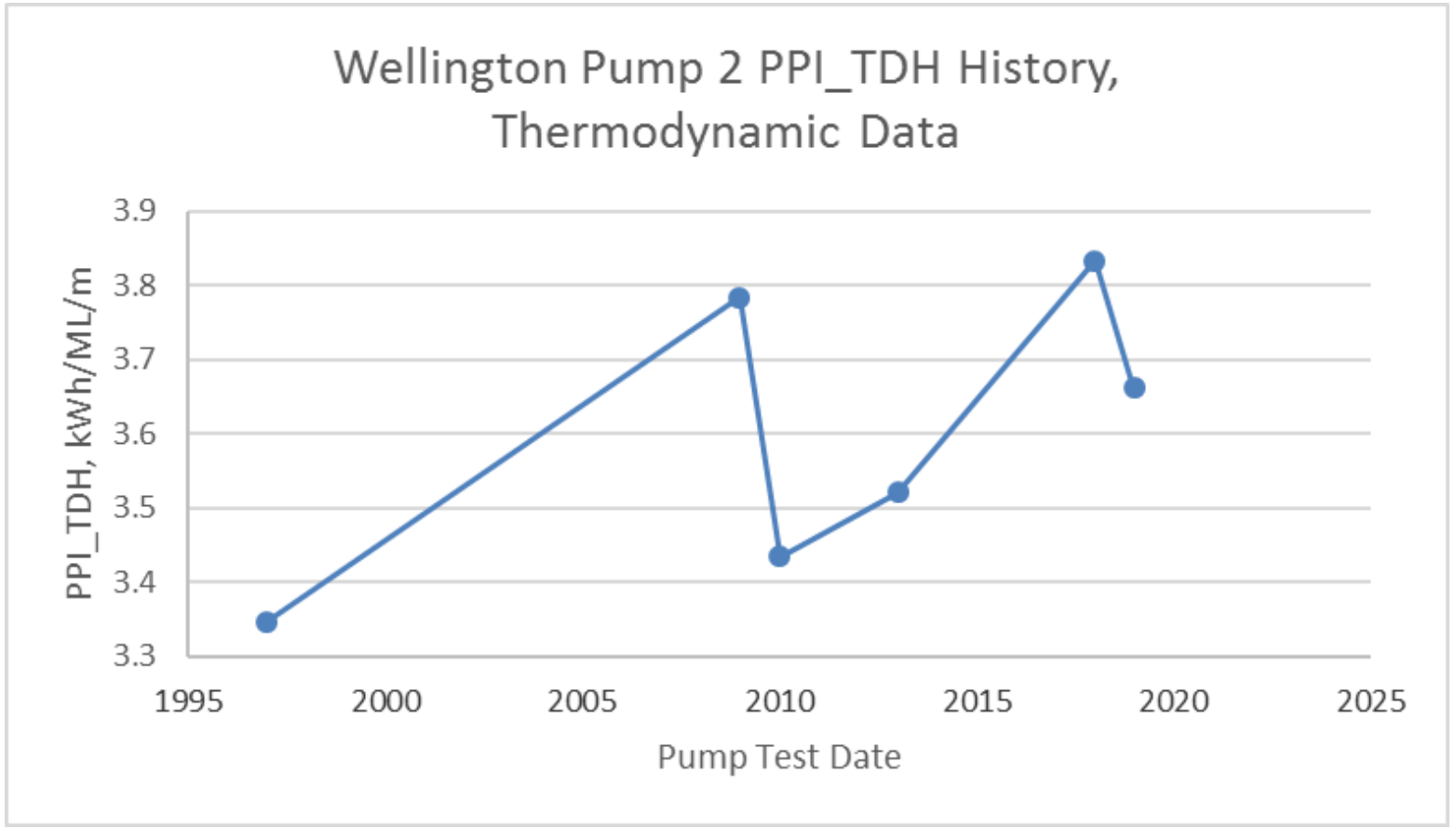
05 Cardno's Pump Performance Benchmarking Database

- PPI_TDH from 3.3 to 5.3.
- Median of the database is 3.7.



05 Cardno's Pump Performance Benchmarking Database

> PPI_TDH value increases over time until pump refurbished.



05 Cardno’s Pump Performance Benchmarking Database

- Recommended database as tool to help Councils get the most out of their pumps through preventative maintenance and to achieve their sustainability targets.
- Database to be developed further and continuously updated within New Zealand and worldwide.

Thank you!

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