LIVE MODELLING WITH REMOTELY CONTROLLED ASSETS

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ABSTRACT

Yarra Valley Water intends to use Live Hydraulic Models as an operational decision support tool in the future. As the first step of this project, we have completed the technological proof trials. This paper discusses how Live Models works, results of the technology proof trial, and possible benefits of live models. The paper further highlights how we can use live models with remotely controlled assets to maximise operational efficiencies.

INTRODUCTION

Yarra Valley Water (YVW) has been using computerised hydraulic models to predict the behaviour of the water supply network and evaluate engineering options associated with extensions and upgrades for many years. One of the key drawbacks of hydraulic modelling is that models are built and calibrated at a point in time, meaning that if they are not kept up to date in line with system changes, their accuracy is compromised. In order to address this issue, an ongoing model build and calibration program is in place, however this is costly and extremely time consuming to manage and deliver.

Live modelling is the next generation of hydraulic modelling. It provides the user with all the benefits of traditional hydraulic modelling, as well as a rapid identification of network faults and a predictive capability. It is essentially a real time comparison of the predictions from a calibrated hydraulic model and live data (from the SCADA remote telemetry system such as zone pressures and flows, tank water levels, pump on/off status etc.). YVW has now completed the technology proof, trialling two live models for Mitcham and Lilydale areas.

Alignment of Planning & Operational Models

To realise the full benefit of Live models, it is essential that both planning and operations teams use the same software. Before embarking on our live modelling journey with IWLive, we adopted InfoWorks WS as our water modelling software.

THE TECHNOLOGY EXPLAINED

The main components of an operational IWLive model are illustrated in Figure1.

Hydraulic models generate predictions based on a number of input parameters such as;

- Asset data (pipe size, roughness, network configuration)
- Operational settings (pump set points, PRV settings, valve setting)
- Boundary conditions (major sources of supply, reservoir levels)
- Customer demand scenarios

YVW have a program to routinely calibrate their hydraulic models to ensure that model predictions are in line with ground conditions at a given time.

As the operational settings can change dynamically where possible these settings in IWLive model should be automatically updated from real, observed data. For example a pump station in Live Model will be configured to use the current SCADA set points. Where assets are not monitored on SCADA (valve opening is commonly not monitored) a default setting observed during calibration time is used (that can be manually overridden by the IWLive operator).

The boundary points of the models are linked either to live data points (such as SCADA) or to a future prediction/assumption. Internal assets (such as tanks) can also have their initial values set from SCADA readings.

Customer demands are a key driver of the model and one that needs updating each day, and during the day. When smart meters are fully deployed, we will be able to connect customer points in the IWLive model to smart meter data hence replicating the actual demands. In absence of smart meters, we have used a demand forecasting tool called DemandWatch, which generates a forecast demand based on a regression analysis of historical data considering a number of parameters such as time of year, day of week and temperature. This demand forecast is then reviewed against current readings and an error correction is applied to ensure the forecast is matching the current observations.

The hydraulic model predictions are then analysed to identify warnings based on user defined criteria (such as a drop in pressure below a minimum threshold). These warnings are reported to the operator, along with a time of onset, so that a mitigation strategy can be developed.

These predictions are also analysed against the recorded data to identify deviations between the model and the observed operations – as this can indicate current issues in the network (such as a burst), errors in the model or problems with the field sensors (faulty readings).

THE TRIALS

To explore any potential risks and to provide YVW with the ability to test and understand the technology it was decided that a trial (2 phases) of Innovyze's IWLive system would be undertaken.

Phase 1 - Technology Trial

The purpose of the technology trial was to check that we could connect the hydraulic model to the other corporate datasets that would be required – and that the outputs from the process would be useful for the organisation.

The type(s) of data that could be linked as follows (although this can vary for each organisation):

- Hydraulic model of the network(s) to be trialled
- Read only access to field data (SCADA or historian)
- Read only access to GIS
- Read only access to the Asset Management System
- Read only access to the Customer Billing System
- For water networks – monitors in the network to determine demand and current operational levels.
- For wastewater networks – access to the Bureau of Meteorology's radar rainfall forecasts and current operational levels.
- For asset management – access to CCTV and other asset condition data sets**.**

Success Factors for Technology Trial

The success factors for the Technology Trial were as follows:

- Successful connection to telemetry
- Validation of configuration files
- Projections of future conditions generated
- Observed data and forecasts can be compared and statistically analysed
- Mapping layers can be utilised

Phase 2 - Engineering Performance Trial

This second trial focusses on the accuracy of the model and input data to determine the usefulness of the predictions to the end user. This phase required more input from Yarra Valley Water Operations team.

We selected two of our recently calibrated models (Mitcham & Lilydale) for this trial. In total we linked and monitored 82 data points as given in Table 1 & Figure 2.

Success Factors for Engineering Performance Trial

- Model tracks well with live data for agreed verification points
- Users can simulating a planned shutdown using an existing projection, create an incident run, identify valves to be closed, close valves and run the incident and review any warnings
- Users can simulate an emergency burst scenario using an existing projection, create an incident run, and propose a response including an alternate supply scenario

Technology proof trials including two live models were completed in April 2015.

THE RESULTS

Live Model predictions closely matched with field data and their results are given in Figure 3 to 5.

BENEFITS OF LIVE MODELLING

Key Benefit 1: Operational Decision Support Tool

Live models enable the user to see the predicted severity of problems and the time of onset in a single screen. The software also enables the user to test a range of solutions to a predicted or observed problem (such as simulating the closure of valves and/or changes in asset controls). The two potential solutions can be compared to determine the level of improvement, the problems that remain and the customers who will be affected allowing operators to optimise their response.

Key Benefit 2: Continual Audit and Calibration of Hydraulic Models (and SCADA)

Live modelling also enables differences between our theoretical understanding of the system (the model) and our recorded operations (SCADA) to be quickly identified and fixed.

Key Benefit 3: Enhanced Communication and Collaboration

A common, combined, data source (i.e. the model AND SCADA) means that a shared understanding of the physical network can be shared between planning and operation team members as discrepancies can be discussed and understood.

These three benefits provide increased trust in not only the hydraulic modelling technology, but also the SCADA data that underpins the model. As the operator confidence grows in this technology then there is less reliance on operator instinct, based often on many years of intimate system observation, providing the opportunity for an optimised solution.

THE FUTURE

Power of combining Live Models with Remote Controlled Assets:

The live models provide lot of information to assess network issues and possible solutions. The value of this information can be further enhanced if we have the ability to action on that information promptly.

Remote controlled assets allow organisations to provide this swift response. Yarra Valley Water has developed this capability for a number of assets where the operator can remotely control the assets. The Figure 6 to 8 shows pump station with remote control capabilities in SCADA.

OUTCOME:

The technology proof trial has confirmed that good Live Models can be developed to identify network issues accurately and assess possible solutions.

Before we can proceed with the full implementation, we have to establish proper change management process so that any changes in the field can be incorporated in live models simultaneously.

As the trial was conducted in a standalone computer, it was difficult for the operators to get familiarise with Live Models. We are currently in the process of deploying this in a server setup so that many operators can access the live models simultaneously. Engaging the operational team members will be a key focus for the next stage of Live Modelling project and during this phase we expect to quantify the operational benefits.

CONCLUSION:

The complexity of water supply systems can make it difficult for even the most experienced operator to determine the best course of action in a given circumstance, particularly with respect to accurately determining the outcomes of their actions. Although it is not suggested that the water supply system can be operated without a qualified operator, live modelling is a powerful support tool which ensures the right decisions are being made. Having accurate and up to date models which are continually validated by live data means that we are able to trust the model predictions and share the operational knowledge of a few individuals across the whole business.

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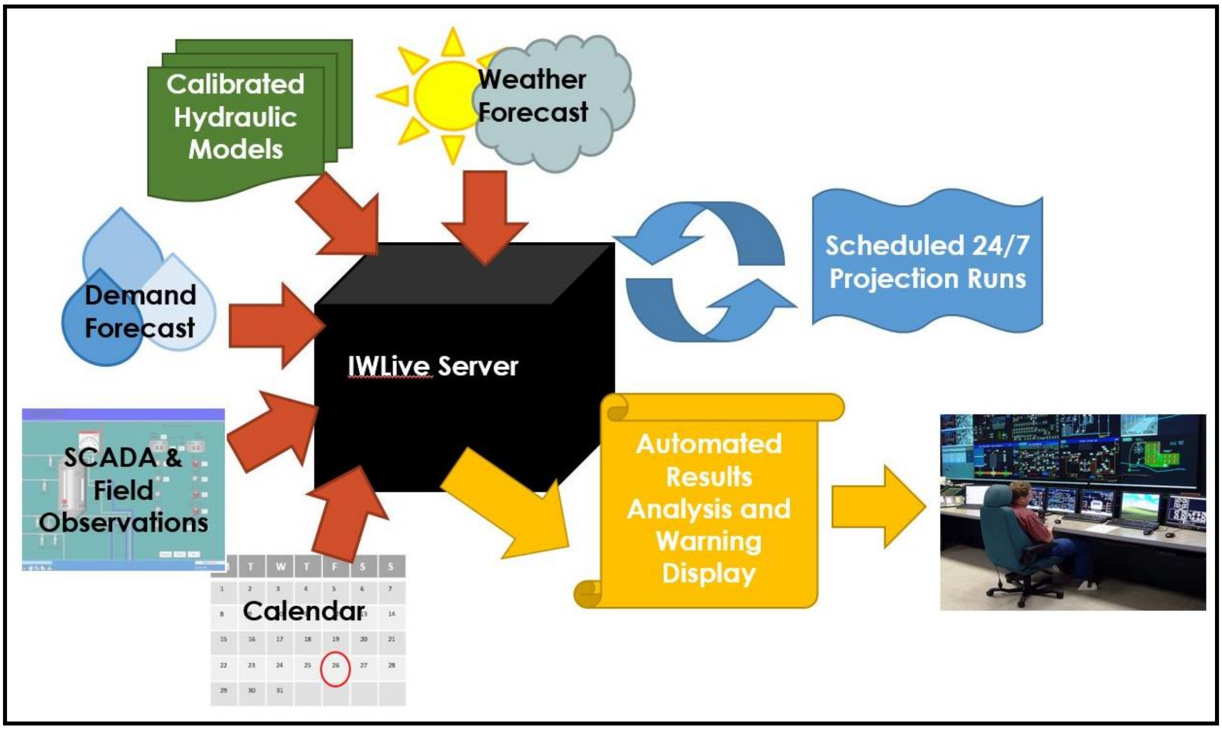

Figure 1: Schematic representation of a Live Model

Table 1: Monitoring Points in Each Live Model

Zone	Total Points	Flow Meter Points	Pressure Logger Points	Live Data Boundary Points	Demand Watch Points
Mitcham	53	16	32	1	4
Lilydale	29	9	16	3	1

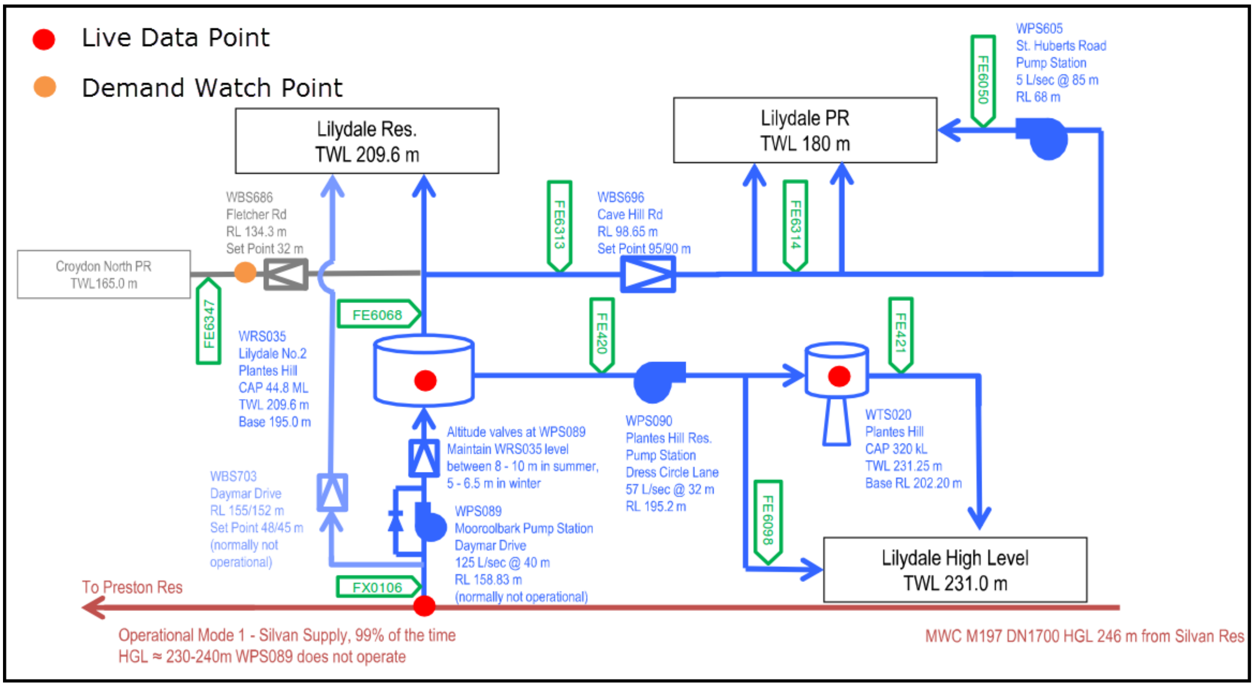

Figure 2: Lilydale Model Schematic with Live and Demand Watch Points

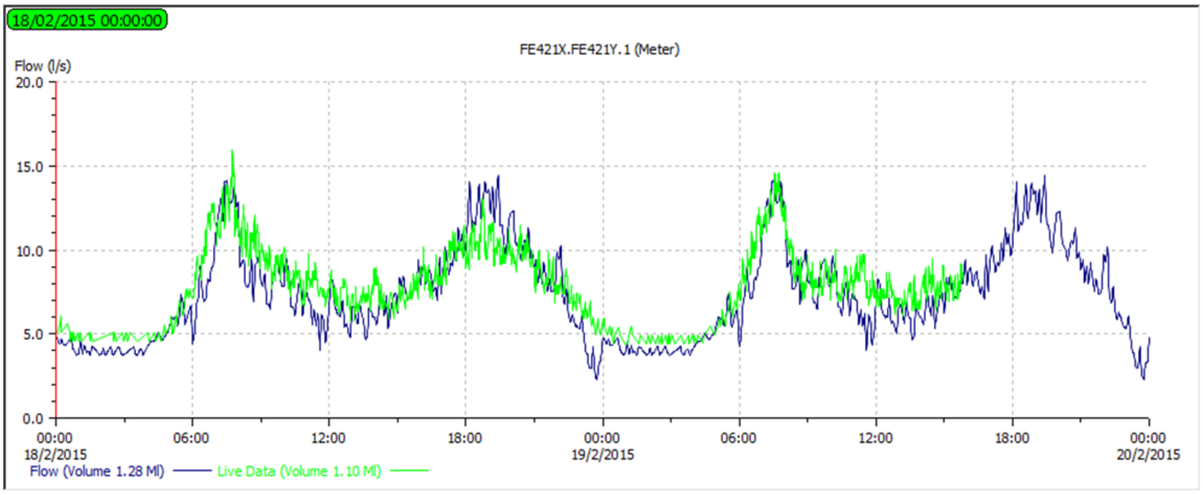

Figure 3: Model Prediction Vs Actual Flow (Verification Point)

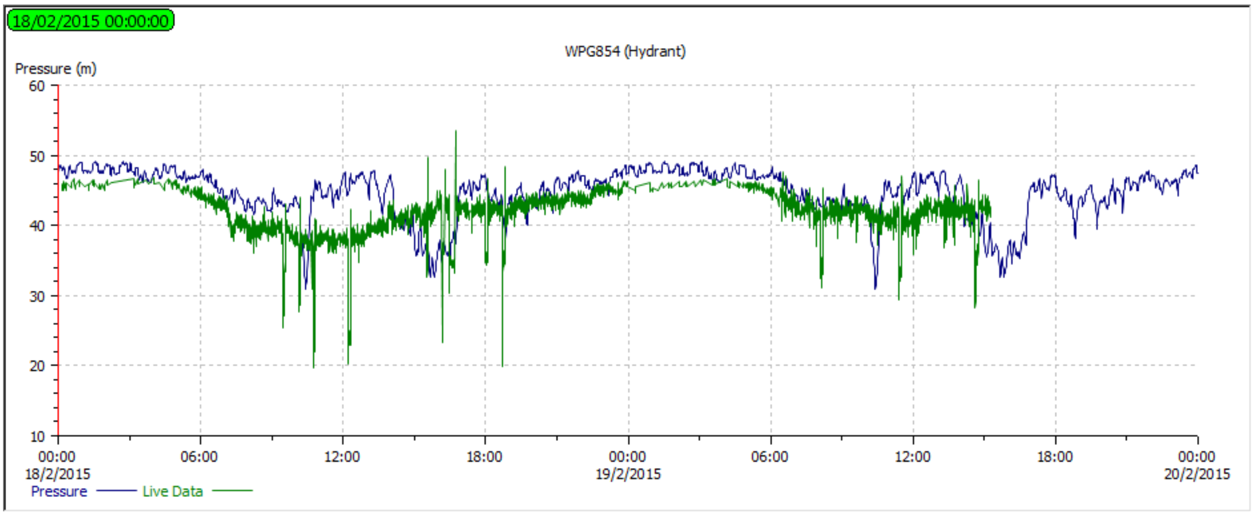

Figure 4: Model Prediction Vs Actual Pressure (Verification Point)

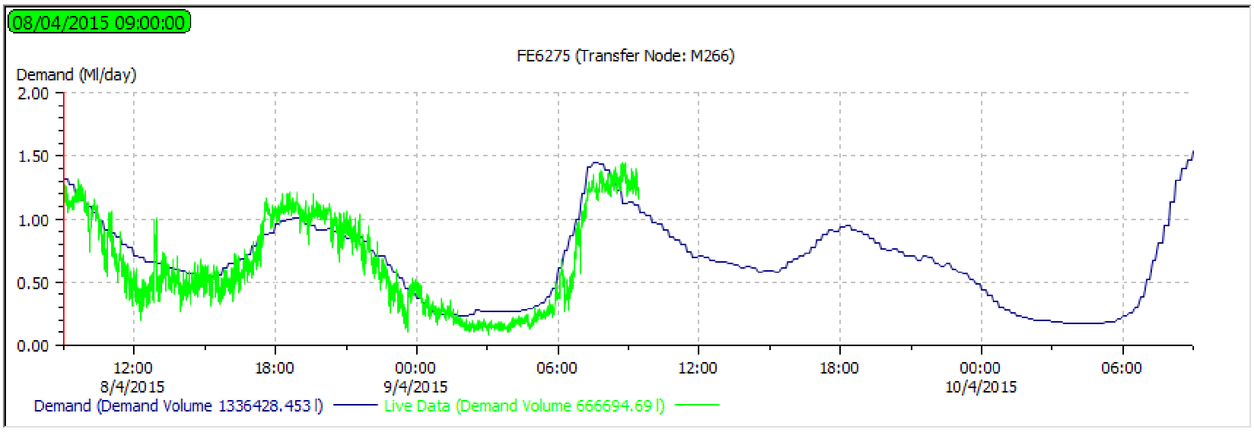

Figure 5: Model Prediction Vs Actual Flow (Demand Watch Point)

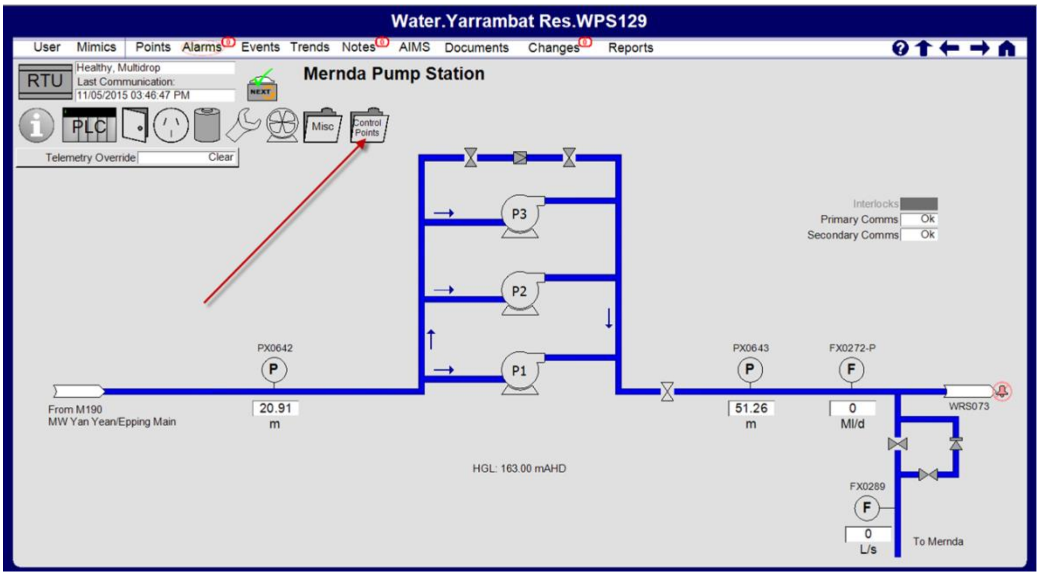

Figure 6: Remote Controlled Pump Station- SCADA Overview

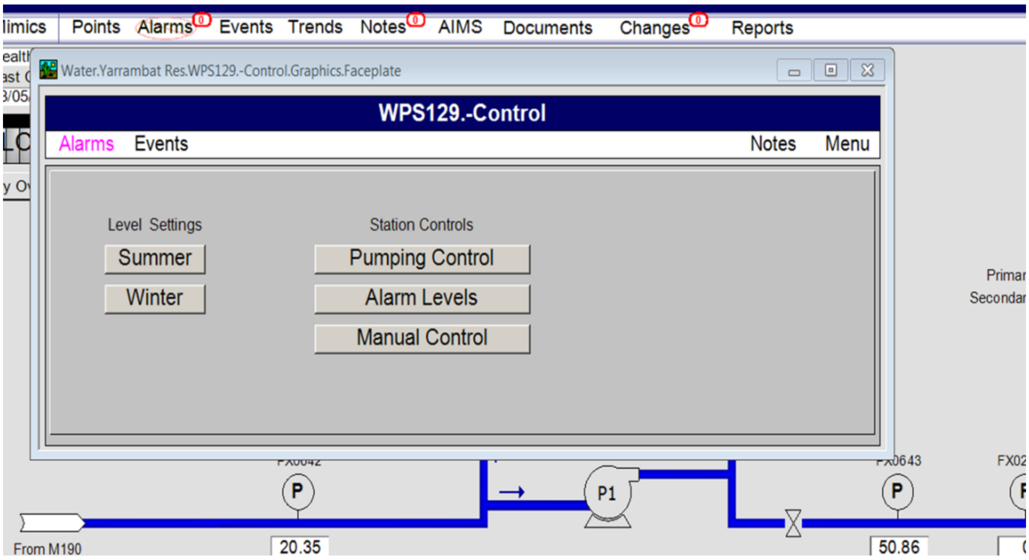

Figure 7: Remote Controlled Pump Station- Different Controls

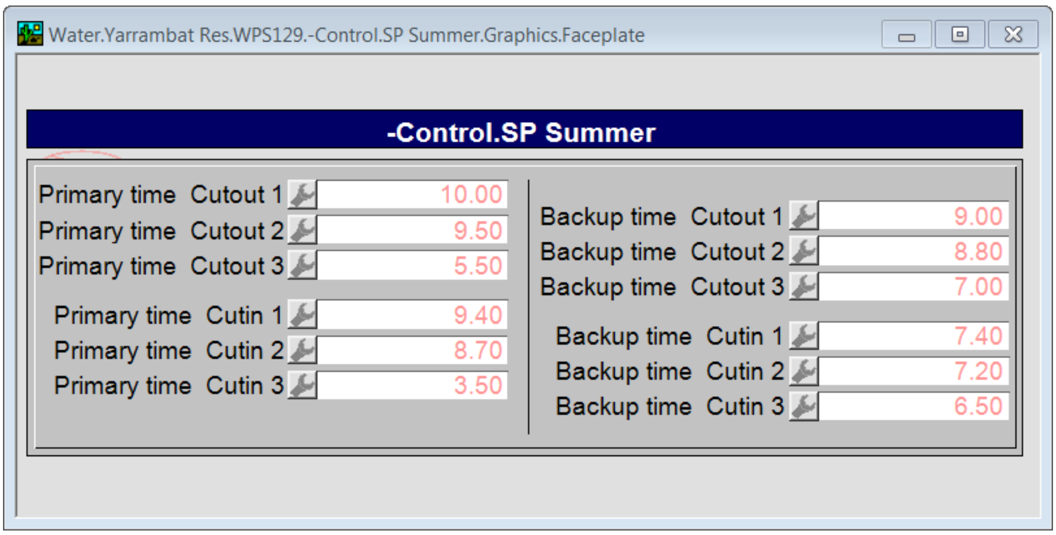

Figure 8: Remote Controlled Pump Station- Summer Controls