

Review of Pump Control and De-ragging Technologies

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Introduction

This report is produced as part of the support that the Hydro Nation Water Innovation Service (HNWIS) is providing to Clearwater Controls.

HNWIS was established by the Scottish Government through Scottish Enterprise and Highlands and Islands Enterprise, to identify innovative Scottish companies, particularly Small and Medium Enterprises (SMEs), and support them along the innovation path from concept to commercialisation. The service is being delivered by Aecom, WRc and UK Water. WRc's role within HNWIS is to provide support and guidance across a wide range of areas of expertise.

Scope of this report

As part of the support being provided through HNWIS, Clearwater Controls has asked WRc to undertake a desk based review of existing pump control and de-ragging technologies.

This report is designed to support Clearwater Controls in their engagement with potential users of the DERAGGER®+ and DERAGGER PRO[®] technologies. This document provides an introduction to the pump control and de-ragging market with an overview of key features and UK water industry use and experience. It is based on information WRc obtained from published literature and provides a broad and independent view, but should not be taken as a fully comprehensive review, approval or endorsement of any of the technology mentioned.

The function of pumping station controllers

The traditional form of pumping station controllers consisted of the combination of a high-level switch, a low-level switch and a relay connected to the pump motor. The basic functioning of the first systems consisted in starting the pump when the level of the liquid in the wet well reached a given high point and turning it off when the level of the liquid decreased to a given low point. More recently, measurement of the water level in the wet well has been implemented through more sophisticated technologies, such as ultrasonic level detection.







More importantly, a move from a simple electrical system based on switches and relays to systems incorporating microelectronics and computer processing, has enabled pumping station controllers to perform more complex logical functions, allowing the management of more complex operational and asset management information in order to build in automated decisions.

Pumping station asset management and control – an overview

Although most sewer networks operate essentially by gravity, pumps and pumping stations are important in many systems and at the inlets of treatment works. The management of pumps and pumping stations as assets is important to wastewater operators due to:

- The cost of planned and reactive maintenance of pumping stations and pumps;
- The risk of pollution due to unplanned discharges to receiving waters as a result of failure of pumping stations. In England and Wales prosecutions for pollution offences can now result in very substantial fines (in excess of £ ½ million);
- The risk of sewage flooding as a result of failure of pumping stations;
- The need to minimise the energy consumption of pumps for financial and environmental reasons.

Minimising the whole life cost of pumping stations should take into account the following factors:

- A reduction in the number of reactive visits to a pump/pumping station for asset inspection and maintenance.
- An extension of the asset life through timely refurbishment and maintenance.
- A reduction of the energy consumption of pumping devices. Potentially through optimisation of the use of energy according to its variable rates over several time periods.
- The minimisation of the initial purchasing costs.

The features and benefits of pump controllers







As a result of the move to electronic controllers ('smart controllers'), more features have been added to the fundamental start-and-stop functions. Table 1 provides a list of the most common features of contemporary pumping station controllers.

Pump control features	Description and main benefits of the feature
Control to fixed level (with variable speed drives)	Control to fixed level, in combination with a variable speed drive (VSD) pump, reduces the vertical distance between the point of suction and the outlet of the pump, thus reducing the static head imposed on the pump. The direct benefit of this function is a reduction in the static head delivered by the pump and thus a reduction in energy consumption.
Wet well cleaning cycle	Accumulation of sediment in wet wells is common especially in the
	case of combined and surface water sewer systems. Deposition of sediment at the bottom of the wet well poses a risk to pumps through impeller wear and blockage.
	In addition fats, oils and grease (FOG) and rags can form a crust on the surface of the wastewater in the wet well. If this becomes too thick it can obstruct the level detection causing the pumps to stay on and run dry.
	The activation of an automatic wet well cleaning cycle allows the pump to draw down the water level and generate suction close to the bottom of the well, allowing the introduction of air in the liquid to generate the turbulence required to re-suspend sediment and remove both sediments and floating solids.
	An alternative mechanism used to achieve wet well cleaning is the use of <i>flush valves</i> . Flush valves are connected to the outlet of the pump and they operate a recycle of part of the pumped sewage back into the wet well to generate turbulence. Control mechanisms automatically open the valves to initiate the cleaning cycle.

Table 1 Features and assocated benefits









Pump control features	Description and main benefits of the feature
Surrogate flow measurement	Because of the cost and the difficulty in finding suitable locations for flow metering devices downstream of pumping stations, measurement of the flow rate by <i>drop test</i> represents a feasible alternative to downstream flow monitoring.
	The drop test consists of measurement of the time required to drop the level of the wet well by a given depth. This function can be operated automatically and the results recorded to provide an alternative measurement of the flow in the system.
Tariff management	This feature enables a reduction in energy cost by scheduling duty cycles outside of daily peak energy tariff periods. If pumps are operated accordingly, the level in the wet well can be kept as low as possible ahead of peak periods to provide maximum storage capacity and minimise pump operation during these in turn.
Energy monitoring	Wearing of the impeller corresponds to a decrease in efficiency and an increase in energy consumption. Detection of unusual increases in consumption can indicate deteriorations in the conditions of the pump. For some systems, energy is monitored for a whole pumping station (W) and for others it is for individual pumps (P).
Energy optimisation	Energy optimisation is the result of a set of features to optimise energy costs. The automatic decision-making process that emerges from the combined analysis of the above can yield substantial short and long- term savings in capital and operating costs, via reduced asset deterioration and efficiency gains.
Pump performance monitoring	By monitoring parameters such as pump capacity, energy consumption, hours run and a log of failures, performance monitoring allows the reconstruction of the real operating performance of the pump, by building analytical indicators such as real pump curves and real pump efficiency curves. Use of the above information, in turn, allows planning of predictive maintenance.
Run most efficient pump	When more than one pump is available, smart controllers enable pump selection to utilise the pump with the highest efficiency. This is a variation of the duty cycling function.









Pump control features	Description and main benefits of the feature
Logging of pump statistics	Medium and long-term recording of the data provided by the functions in a pump controller allows informed asset management such as pump refurbishment. 'Basic' logging (B) is defined in this document as recording limited information (e.g. the count of pump starts). 'Advanced' logging (A) has been defined as recording detailed live pump data.
Auto reset/Remote reset	Restarting a pump automatically after tripping has the benefit to save working hours needed to access the device and manually restart it. This is especially relevant for pumping stations located in remote areas. However, frequent restarting that ignores fundamental mechanical problems and blockages could lead to complete burn out of pumps.
Time to spill	By monitoring the flow patterns and measurement of incoming flow rate, the controller can calculate the time needed for the volume accumulated to reach a level that would cause a spill to a watercourse in the event of pump failure or due to excessive flow. This allows operators to prioritise dispatch of maintenance crews and minimise out- of-hours work.
Storm detection	An increase in flow due to heavy rainfall can be detected through analysis of the flow pattern recorded by the controller. This potentially enables the controller to trigger a draw-down of the water level in the wet well to maximise storage capacity and reduce the risk of spill. In addition, knowing that anomalies in the normal flow pattern are due to a storm provides greater information when making decisions on responding to wet well alarms.
Insulation test	Insulation break-downs represent a common cause of pump replacement. The periodic and automatic testing of insulation can help identify the problem in advance, allowing planned replacement before failure occurs.
Blockage detection	When external materials (rags) accumulate on pump impellers, this can lead to temporary and permanent changes in the electrical current taken by the pump motor. Analysis of the current into the motor allows early blockage detection before this causes tripping or break-downs. This offers the potential for energy saving if potential blockages, which reduce the efficiency of the pump, can be detected and removed early.









Pump control features	Description and main benefits of the feature
Auto-reverse	The external material responsible for a potential blockage can be removed by reversing the direction of the pump's impeller, when the mechanics allows. Auto-reversal can be in response to the detection of a blockage, or be operated on a time interval. The duration of the reversal needed to clear a blockage depends on the extent of the blockage. The benefits related to auto-reversing are related to the avoidance of site visits and the minimisation of energy inefficiencies due to trapped materials (in the short term) and motor burn-outs (in the long term).
On board telemetry	Using on board telemetry is an effective solution where integration with existing telemetry is complex, expensive or due to limited capacity is not possible. The industry uses a common standard communication protocol (WITS DMP3).
Dry run detection	By analysis of motor current and power, this function can detect pumping of air due to low water levels or due to a blockage at the inlet of the pump. The benefit of this feature is the minimisation of burn-out and insulation damage risks.
Modular control system	Control system can control a flexible number of pumps.
Periodic flush	The flow from a pump is ramped up for a short period to clean out pipe work.
Anti-cling	The top level in a wet well that triggers pump operation is varied to prevent a ring of fat or grease building up on the walls of the wet well.
Odour control / well stagnation	The contents at the bottom of the wet well are periodically removed to prevent the wastewater from becoming more odorous due to septicity.
User interface styles	Style A – Minimal display
	Style B – Simple graphical display Style C – Detailed graphical display
	Style D – Full touch screen with gesture







Overview of pump controllers and de-ragging technology

Table 2 and Table 3 summarise the results obtained through a survey of existing individual pump controllers and whole pumping station controllers, respectively, and their features, undertaken by WRc. The tables compare the most widespread controllers available on the market against a set of fundamental features, which are described in Table 1, above. The tables are supported by the information on individual pump controllers and whole pumping station controllers contained in Appendix A and B, respectively.







Table 2 Summary of features and suppliers for individual pump controllers

Supplier & Product	Control to fixed level	Wet well cleaning	Surrogate flow measurement	Tariff Management	Energy Monitoring	Energy Optimisation	Pump Performance Monitoring	Run most efficient pump	Logging of pump stats	Auto reset/Remote reset	Time to spill	Storm detection	Insulation test	Blockage Detection	Auto-reverse	On board telemetry	Dry run protection	Modular Control System	Periodic flush	Anti-cling	Odour control / well stagnation	User Interface
DERAGGER [®] +		Y	Y	Y	P		Y		A	Y				Y	Y	Y	Y	Y			Y	Style B – Simple graphical display
Xylem Concertor pump system		Y				Y	Y			Y				#BL								Style B – Simple graphical display
Xylem Intelligent VSD - PumpSmart	Y	Y	#F					Y	В	Y												Style B – Simple graphical display
Xylem Intelligent VSD - SmartRun		Y				Y	?										#D					Style B – Simple graphical display
Emerson Intelligent VSD			#F				Ŷ							#BL		Ŷ	?					Style B – Simple graphical display
ABB Intelligent Control	Y		#F			Y		Y						Y	Y				Y	Y		Style A – Minimal display

Key: Y: Indicates the presence of a feature that meets the definition in Table 1, based on the evidence documented in Appendix A.

#F: Surrogate flow measurement does not use wet well level drop test as specified in feature definition in Table 1

Energy monitoring: P: Energy monitoring of individual pumps; W: Energy monitoring of whole pumping stations

Logging of pump stats: A: Advanced logging of pump stats; B: Basic logging of pump stats

#BL: Blockage detection does not use current monitoring as specified in feature definition in Table 1

#D: Dry run protection is based on level probes and/or float switches and not on monitoring pump as specified in feature definition in Table 1

?: Uncertain whether feature meets the definition in Table 1







Table 3

Summary of features and suppliers for whole pumping station controllers

Supplier & Product	Control to fixed level	Wet well cleaning	Surrogate flow measurement	Tariff Management	Energy Monitoring	Energy Optimisation	Pump Performance Monitoring	Run most efficient pump	Logging of pump stats	Auto reset/Remote reset	Time to spill	Storm detection	Insulation test	Blockage Detection	Auto-reverse	On board telemetry	Dry run protection	Modular Control System	Periodic flush	Anti-cling	Odour control / well stagnation	User Interface
DERAGGER [®] PRO		Y	Y		Ρ		Y	Y	A	Y				Y	Y	Y	Y	Y	Y	Y	Y	Style D – Full touch screen with gesture
Xylem Multismart		Y	Y		W		Y	Y	A	Y	Y		Y	Y	Y	Y	#D					Style B – Simple graphical display
Xylem APP700		Y	#F		W		?		В							Y						Style B – Simple graphical display
Pulsar Ultimate	Y		#F	Y	W			Y	A	Y	Y	#S	Y	Y	Y	Y	#D	Y		Y	Y	Style C – Detailed graphical display
Pulsar Quantum 2+				Y					В	Y	Y	#S					#D			Y		Style B – Simple graphical display
Pulsar Quantum 3			#F	Y					A	Y	Y	#S					#D			Y		Style B – Simple graphical display
Seprol / Servelec ControlPack									A	Y				?		Y						Style B – Simple graphical display
Grundfos CU 362			#F		W											Y	#D					Style B – Simple graphical display
SCADA Pack (RealStream)			#F						В	Y					Y		#D					Style B – Simple graphical display

Key: Y: Indicates the presence of a feature, based on the evidence documented in Appendix B, that meets the definition in Table 1

#F: Surrogate flow measurement does not use wet well level drop test

Energy monitoring: P: Energy monitoring of individual pumps; W: Energy monitoring of whole pumping stations

Logging of pump stats: A: Advanced logging of pump stats; B: Basic logging of pump stats

#S: Storm detection does not involve drawing down the wet well to maximise capacity when a storm is detected

#D: Dry run protection is based on level probes and/or float switches and not on monitoring pump







?: Uncertain whether feature meets the definition in Table 1 **Appendix A**

Supporting information for individual pump controllers

Supplier & Product	Features(*)	Reference
DERAGGER®+	Wet well cleaning: DERAGGER Apps webpage says: "The DERAGGER"+ will allow the pump to pump the well down below its normal stop level, passing the rags gathered at the bottom of the well forward and FOG or other floating debris from the water surface. This app can be configured to stop just prior to pump suction, should breaking prime be a concern. It can also be used to prevent ice layers forming." Surrogate flow measurement: The DERAGGER+ has a 'Derived Flow' app, described on website as: "The DERAGGER+ is able to use a number of data feeds to calculate derived flow of the pump and therefore the station with a good level of accuracy." Tariff Management: The DERAGGER webpage says: "The DERAGGER is able to schedule activities around peak energy tariffs, usually to ensure well is as empty as possible in advance of such periods, and therefore minimising pump runtime during peak periods." Energy Monitoring: The DERAGGER webpage states: "Stores one year's worth of data in relation to daily energy consumption per pump', plus the DERAGGER Keypad (which comes as standard with all DERAGGERs) is described as: "Logs 20 years of pump performance, such as energy, flows and run time". Pump performance monitoring: DERAGER Apps webpage says: "The DERAGGER TM + has sophisticated motor protection included. The following is protection is available: Overload, Phase Loss, Current Imbalance, Overcurrent, Undercurrent & Frequency out of range" Logging of pump stats: Has advanced data logging, with brochure stating: "Stores one year's worth of data in relation to daily energy consumptions, power, current, flow and pump efficiency in terms of pumped volume to consumed energy ratio. Additionally stores alarms and pump trip events." Blockage detection: DERAGGER brochure states: " The multi-award-winning DERAGGER®+ anti-ragging device is a retrofit, patented electronic pump management system that delivers real-time monitoring to automatically eliminate wastewater pump blockages before they form." Auto reverse: DERAGGER FAQs	http://clearwatercontrols.c o.uk/deragger-ii/







Supplier & Product	Features(*)	Reference
	Odour Control: DERAGGER Brochure states: "Runs the pump through a clean, if it has not run for a while. This prevents stagnation and settling in the well." User interface: Style B – simple graphical display. Image: stagnation prevents of the pump through a clean, if it has not run for a while. This prevents stagnation and settling in the well." User interface: Style B – simple graphical display. Image: stagnation prevents of the pump through a clean, if it has not run for a while. This prevents the pump through a clean, if it has not run for a while. This prevents the pump through a clean, if it has not run for a while. This prevents the pump through a clean, if it has not run for a while. This prevents the pump through a clean, if it has not run for a while. This prevents the pump through a clean, if it has not run for a while. This prevents the pump through a clean, if it has not run for a while. This prevents the pump through a clean, if it has not run for a while. This prevents the pump through a clean, if it has not run for a while. This prevents the pump through a clean, if it has not run for a while. This prevents the pump through a clean, if it has not run for a while. This prevents the pump through a clean of the pump through a clean	
Xylem Intelligent VSD - PumpSmart	 Control to fixed level: PumpSmart Installation, Operation and Maintenance manual states that, "PumpSmart will work to maintain a defined level based on a level transmitter's feedback, although a pressure transmitter at the pump suction can also be used." Wet well cleaning: PumpSmart Installation, Operation and Maintenance manual includes the feature, "Snore. The PS220's snore function overrides the stop level while emptying a tank for the purpose of removing oil & grease and other floating debris from the water surface. This results in a cleaner sump with eliminating the need to pump down and clean the sump manually." (#) Surrogate flow measurement: PumpSmart Installation, Operation and Maintenance manual includes the feature, "Smartflow. PS220's calculated Pump flow output." Run most efficient pump: PumpSmart Installation, Operation and Maintenance manual includes the feature, "Multipump. PumpSmart drives can work together to coordinate the output of up to 6 pumps to meet a pressure, flow, level, temperature or SmartFlow set point. In a Multipump system the pumps stage on and off to meet the changing demand, at the same time enhancing reliability and maximizing pump performance." Logging of pump stats: PumpSmart Installation, Operation and Maintenance manual states that, "The PS220 has two event logs that can be accessed from the main Menu on the control panel. The logs can also be accessed (and reset) using the Drive composer PC tool. One of the logs contains faults and fault resets. The other log lists warning and pure events, as well clearing entries. Both logs contain 32 most recent events. All indications are stored in the event logs with a time stamp and other information." Basic level of pump stats logging. Auto reset / remote reset: PumpSmart Installation, Operation and Maintenance manual includes the following feature, "Pump Fault Auto Reset. The PS220 can auto reset a pump related fault due to an upset condition. When a pum	https://www.ittproservices .com/ittgp/medialibrary/IT TPROServices/website/A ftermarket%20Products/ Control%20Solutions/PS 220/PS220_IOM.pdf







Supplier & Product	Features(*)	Reference
	condition is detected the drive can be configured to either go to a safe minimum speed or fault the pump. It can then be configured to automatically restart after a set time delay. (#) Dry run protection: PumpSmart Installation, Operation and Maintenance manual includes the feature, "Pump & VFD Protection" which "is where the user can protect the pump from operation below minimum flow, dry running or excessive flow using Basic Pump Protection limits or Sensorless Pump Protection." User interface: Style B – simple graphical display (\$) Final Affective Configuration of Protection is the feature of the pump	
Xylem Intelligent VSD - SmartRun	 Wet well cleaning: Flygt SmartRun installation and operation manual includes the feature: "Sump cleaning". Energy optimisation: Flygt SmartRun installation and operation manual includes the feature: 'Energy efficient speed finder. This function calculates the optimal speed that is used by the High-low level sump pump control.' (?) Pump performance monitoring: Flygt SmartRun installation and operation manual includes the feature: 'Dump monitoring'. (#) Dry run protection: Flygt SmartRun installation and operation manual includes the feature: 'Stop level. Sump level where the level sensor is hung and pump will stop pumping." Dry run protection is based on level probes and/or float switches and not on monitoring pump as specified in feature definition in Table 1. User interface: Style B – simple graphical display (\$) 	http://flygtus- link.flygt.com/catalog/co mmon/applications/FusC at/files/Devices/Flygt%20 SmartRun%20Installation %20and%20Operation% 20Manual.pdf https://www.xylem.com/si teassets/brand-specific- content-including- catalog/flygt/flygt- resources/flygt- resources/flygt-smartrun-
		leanet.pdf







Supplier & Product	Features(*)	Reference
Xylem Concertor pump system	Wet well cleaning: Flygt Concerto brochure states, "Built-in sump and pipe, cleaning reduces odour and maintenance." Energy optimisation: Flygt Concerto brochure states, "Energy Minimizer automatically optimizes performance to reduce	http://info.xyleminc.com/r s/198-DLL-
	Pump performance monitoring: Flygt Concerto brochure states, "By collecting and analysing relevant data, the pump	tor_brochure.pdf
	Auto reset / Remote reset: Flygt Concerto brochure states: "The control system inside the pump, which is placed in a stable	
	and protected environment, will try to reset the pump automatically after a failure" (#) Blockage detection: Flygt Concerto brochure states, "Clog detection and pump cleaning functions ensure clog-free	
	operation." Blockage detection does not use current monitoring as specified in feature definition in Table 1. User interface: Style B – simple graphical display (\$)	
Emerson Intelligent VSD	(#)Surrogate flow measurement: Emerson Industrial website states, "Control Techniques' IPC system accurately monitors pump performance by 'live' continuous measurement of torque producing current, plus flow and pump speed where	http://www.emersonindus trial.com/en-
	appropriate." However, this is not a drop test measurement. WRc's understanding is that it requires a separate flowmeter.	EN/controltechniques/pro





Supplier & Product	Features(*)	Reference
	 Pump performance monitoring: Emerson Industrial website states "Control Techniques' IPC system accurately monitors pump performance by 'live' continuous measurement of torque producing current, plus flow and pump speed where appropriate." (#) Blockage detection: Emerson Industrial website states, "Flow monitoring to enhance pump ragging detection." WRc's understanding is that it requires a separate flowmeter. Blockage detection does not use current monitoring as specified in feature definition in Table 1. On board telemetry: Emerson Industrial website states, "Integration with telemetry through I/O." (?) Dry run protection: Emerson Industrial website states, "Dry running detection." 	ducts/industrysolutions/ip c/Pages/intelligentpumpc ontrol.aspx
	User interface: Style B – simple graphical display (\$)	http://www.emersonindus trial.com/en- EN/documentcenter/Cont rolTechniques/Brochures/ water_brochure.pdf
ABB Intelligent Control	 Control to fixed level: ABB website states, "Level control is typically used to control the filling or emptying of waste water storage tanks." Anti-cling: ABB website states, "Special feature of the software seeks to prevent sediment build-up on the tank walls by randomly varying the surface level within a range preset by the user." (#)Surrogate flow measurement: ABB website states, "Flow calculation can be used in a single-pump installation to make the drive into a flow meter, substituting the need for a flow meter in applications where the flow data is not required for invoicing purposes. Sensorless flow measurement is possible, or pressure transmitters can be used to supply the Necessary measurement data." However, this calculation method is not a drop test measurement. 	https://library.e.abb.com/ public/11238b54a8f1559f c1257a48003b3408/EN FactFilePD6_REVC.pdf







Supplier & Product	Features(*)	Reference
	Periodic flush: ABB website states, "Fast-ramp starting creates a flush effect to keep pipelines clear, and the pump is operated at a favourable point in its efficiency curve to minimize energy consumption." Run most efficient pump: ABB website states, "Pump priority control balances the operating time of all the pumps in the system over the long term. This facilitates maintenance planning, and can boost energy efficiency by operating pumps closer to their best efficiency point." Blockage detection: ABB website states, "The anti-jam function enables the drive to perform preventive maintenance on the pump. When the function is triggered, the pump is run at high speed and either reversed or stopped in a number of user-defined cleaning cycles. This helps to prevent congestion through the build-up of particles and avoids rusting in "sleeping" pumps. The trigger parameters are set by the user, with three different options available (high current, run-on time and external input). Auto-reverse: See blockage detection. User interface: Style A – Minimal display (\$)	

(*)The mention of a feature in the table above for a product indicates that a particular feature has been identified in the product literature WRc has been able to obtain but the absence of a feature does not necessarily mean that the feature does not exist (see a copy of the feature definitions in Table 1).

(#) Denotes that a feature exists but is used for a different purpose and/or is carried out using a different approach to that defined by WRc (see copy of the feature definitions in Table 1).

(\$) User interface - see Table 1 for user interface styles as defined by WRc

(?) Denotes that it is not clear what is included in the product feature for this product.







Appendix B Supporting information for whole pumping station controllers

Supplier & Product	Features(*)	Reference
DERAGGER [®] PRO	Wet well cleaning: DERAGGER Apps webpage says: "The DERAGGER™+ will allow the pump to pump the well down below its normal stop level, passing the rags gathered at the bottom of the well forward and FOG or other floating debris from the water surface. This app can be configured to stop just prior to pump suction, should breaking prime be a concern. It can also be used to prevent ice layers forming." Surrogate flow measurement: The DERAGGER+ has a 'Derived Flow' app, described on website as: "The DERAGGER+ is able to use a number of data feeds to calculate derived flow of the pump and therefore the station with a good level of accuracy." Energy Monitoring: The DERAGGER PRO webpage states: "Stores one year's worth of data in relation to daily energy consumption per pump, not just for the overall station which greatly aids understanding as to overall energy efficiency". Pump performance monitoring: DERAGGER Apps webpage says: "The DERAGGER™+ has sophisticated motor protection included. The following is protection is available: Overload, Phase Loss, Current Imbalance, Overcurrent, Undercurrent & Frequency out of range." Run most efficient pump: The DERAGGER PRO webpage states: "The DERAGGER PRO can automatically select the most efficient pump within a station and make this the duty pump." Logging of pump stats: Has advanced data logging, with brochure stating: "Stores one year's worth of data in relation to daily energy consumptions, power, current, flow and pump efficiency in terms of pumped volume to consumed energy ratio. Additionally stores alarms and pump trip events." Auto-reset: The DERAGGER PRO webpage states "System will auto-reset trip events in the DERAGGER®+ multiple times a day."	http://clearwatercontrols.c o.uk/deragger-pro-info/







Supplier & Product	Features(*)	Reference
	Blockage detection: DERAGGER brochure states: "The multi-award-winning DERAGGER®+ anti-ragging device is a retrofit, patented electronic pump management system that delivers real-time monitoring to automatically eliminate wastewater pump blockages before they form." Auto reverse: DERAGGER website says: "It then passes the rags by modifying the pump behaviour; it slows the pump, reverses it which dislodges the rag, and puts the pump back into forward motion to pass the rag through." On board telemetry: DERAGGER FAQs says: "The DERAGGER has full 3 phase power monitoring built in. This can be logged via our DERAGGER Dataloger or presented to SCADA." Dry run protection: Brochure states: "Monitors the pump's power, and on low torque will inhibit the pump. This provides dry run protection. If this happens regularly, the device can be set up to trip the pump." Periodic Flush: The DERAGGER PRO webpage states: "In order to prevent build-up of debris in the bottom of the well, the DERAGGER PRO is able to alter these start levels automatically so the pump then starts and/or stops at varying heights." Odour Control: DERAGGER Brochure states: "Runs the pump through a clean, if it has not run for a while. This prevents stagnation and settling in the well." Modular Control System: BROCHURE states: "By spreading intelligence between multiple devices, the DERAGGER® PRO will automatically so the riggered in the well to dart the overall pumping system fails. If the ultrasonic fails, for example, a high level float switch will be triggered in the well to dart of one pump fails, the DERAGGER® PRO will sutomatically so the riggered in the well to the DERAGGER®+. User interface: Style D – full touch-screen with gesture (swipe) control as standard.	







Supplier & Product	Features(*)	Reference
Xylem Multismart	 Wet well cleaning: Xylem Multismart specification document includes the feature: 'Well clean out control capability' Surrogate flow measurement: Xylem Multismart specification document includes the feature: 'Flow measurement – calculated flow via liquid level drawn down data' Energy monitoring: Xylem Multismart specification document includes the feature: 'Energy, power and pump efficiency monitoring.' WRc's understanding is that this system cannot monitor multiple VSDs. Pump performance monitoring: Xylem Multismart specification document includes the feature: 'Energy, power and pump efficiency monitoring' Run most efficient pump: Xylem Multismart specification document includes the feature: 'Pump alternation modes, including run most efficient pump' Logging of pump stats: Xylem Multismart specification document includes the feature: 'Information screens' for hour run and pump accumulators for each pump, power and efficiency etc. plus 'Database viewer to review all statistics, data information and available tags in real time.' This is an advanced level of logging of pumps stats. Auto reset/remote reset: Xylem Multismart specification document includes the feature: 'Automatic restart function after fault condition is no longer present' Insulation test: Xylem Multismart specification document includes the feature: 'Automatic restart function after fault condition is a display of the 'Insulation resistance value for each pump motor in Ohms'. On-board telemetry: Xylem Multismart specification document includes the feature: 'Remote control via remote telemetry monitoring'. 	http://www.multitrode.co m/products/multismart- and-probes/multismart- pump-station-manager- and-rtu/technical- information/specifying/
	Auto-reverse: Xylem Multismart webpage includes the following feature: 'pump reversal, which prevents clogging' User interface: Style B – Simple graphical display (\$)	https://www.xylem.com/si teassets/brand-specific- content-including- catalog/flygt/flygt- resources/flygt- multismart.pdf







Supplier & Product	Features(*)	Reference
	 Time to Spill: Xylem Multismart operating manual includes the 'Time to Spill' feature 'which calculates and displays the time period within which a spill may happen if the current conditions do not change' Blockage detection: Xylem Multismart operating manual states that "The Smart Outflow feature present in the flow module can detect a partially blocked pump from a large inflow." The manual states that "Faults can be configured to automatically trigger pump reversals. For example, over-current may be triggered by a pump blockage" (#) Dry run protection: Xylem Multismart manual states that, "Deactivation of a pump is dependent on the level in the well where the pump is located. This is to prevent problems with equalization between the two wells allowing a well to run dry while a pump is still operating." Dry run protection is based on level probes and/or float switches and not on monitoring pump as specified in feature definition in Table 1. 	http://www.multitrode.co m/assets/product- manuals/multismart- manuals/MultiSmart-IO- Manual-R20.pdf
Xylem APP700	Wet well cleaning: Flygt APP700 sales brochure states that there is the following feature "Automatic sump cleaning". (#)Surrogate flow measurement: Flygt APP700 sales brochure states that there is the following feature "Flow calculation. The Flygt APP controller calculates incoming flows and pumped volumes with a high degree of Accuracy." It is not clear what approach is used for this. Energy monitoring: Flygt APP700 sales brochure states that there is the following feature: "Monitoring energy costs. By measuring and reporting power consumption, Flygt APP gives you better control over your energy costs." Logging of pump stats: Flygt APP700 sales brochure states that, "The Flygt APP controller logs everything that happens at your pump station. With 16 MBs of built in memory, it stores up to 1,000 alarms and all operational data which is the basis for generating easy-to-read reports and trend graphs. The data is time & date stamped. Its integrity is protected by on-board Li- lon battery." This is a basic level of logging of pump stats. On board telemetry: Flygt APP700 sales brochure states that, "Every bit of the station data is also available remotely though standard telemetry & Microsoft Windows compatible viewing software." User interface: Style B – simple graphical display (\$)	http://flygtus- link.flygt.com/catalog/co mmon/applications/FusC at/files/Multi/APP%20700 %20Sales%20Brochure.p df







Supplier & Product	Features(*)	Reference
	(?) Pump performance monitoring: Flygt APP741 operating manual states that "The RTU standard software contains: Performance monitoring." It is not stated what the monitoring covers.	http://flygtus- link.flygt.com/catalog/co mmon/applications/FusC at/files/Multi/APP%20741 %20User%20Manual.pdf
Pulsar Ultimate	Control to fixed level Blockage detection On board telemetry Retroflo's website states, "Pulsar's Ultimate Pump Controller integrates Retroflo's patented pre-blockage detection technology with a range of control features such as level and flow control, pump efficiency and telemetry." The Pulsar Ultimate manual states that the Retroflow "feature continually compares the pump's electrical current profile to a stored "calibration" profile, which means that an initial calibration cycle is required (per pump) when the pump is deemed to be in good running condition."	http://www.retroflo.com/re troflo-news/196-new- pump-controller-unveiled
	 Anti-cling: Pulsar Ultimate manual includes the 'Cling wall' feature which aims "to reduce material build up (such as fat), on the wall of the sump or vessel, at the 'normal' material level the pump set points can be varied within a specified band." Odour control: Pulsar Ultimate manual includes the 'Septicity prevention' feature which does the following, "If all pumps have been idle for a period of time and the level is above a minimum level, then the duty pump will be allowed to start and pump until it reaches the minimum level in order reduce the amount of corrosion or gas build up in a sump or vessel." (#)Surrogate flow measurement: Pulsar Ultimate manual states that "When the Ultimate has been set up for an OCM application, the display can be configured to show the type of PMD selected, and additional information such as any MicroFlow / Speedy velocity sensors and current velocity measurements obtained." WRc understands a separate flowmeter is needed. This is not a drop test. Tariff management: Pulsar Ultimate manual includes the 'Peak tariff' feature which "is used to reduce or avoid the use of pumps during high tariff periods by continually monitoring the level and inflow conditions of the well and optimise the level and intelligently control the pumps according to any impending tariff changes." Energy monitoring: Pulsar Ultimate manual includes the 'Efficiency' feature, which "allows connection of power monitors to the controller so that you are able to monitor energy use and additional specific electrical parameters of a load. Run most efficient pump: Pulsar Ultimate manual includes the 'Logged Performance Data' feature, which "Provides chart views of the historical performance data of the station and pumps. The amount of available data will depend up on the sensors connected to the system e.g. power monitors, FlowPulse or flow meters etc." This is an advanced level of logging of pump stats. 	https://www.pulsar- pm.com/Portals/0/docs/m anuals/Ultimate- Controller-Manual-1ed- R2-Pulsar-Process- Measurement.pdf







Supplier & Product	Features(*)	Reference
	Auto reset / Remote reset: Pulsar Ultimate manual includes the 'Auto reset' feature, which is described as follows "When using digital inputs to monitor pump failure and have assigned relays to "Pump Reset", this function allows for a pre- programmed number of pump "fails" (Consecutive, or trips in a 24-hour period) to be automatically reset before putting a pump out of service." Time to spill: Pulsar Ultimate manual includes the 'Time to spill' feature. (#)Storm detection: Pulsar Ultimate manual includes the 'Detect storm' feature but this "enables all pumps to be disabled during a storm condition to prevent the futile running or potential damage due to the continued use of pumps during flood conditions." This is different to the storm detection definition provided by WRc, which potentially enables the controller to trigger a draw-down of the water level in the wet well to maximise storage capacity and reduce the risk of spill. Insulation test: Pulsar Ultimate manual includes the 'ITE Function' which 'Enables/Disables the Insulation Resistance Test function." Auto-reverse: Pulsar Ultimate manual, which includes Retroflo, states, "If Pump reversing is required, a Control Relay with a function of pump reverse needs to be configured (one per pump)." (#) Dry run protection: Pulsar Ultimate manual, includes the setting of the 'minimum head', which is as follows "To prevent the dry running and the possibility of cavitation, of the pump, enter the minimum level (head) of material, in metres, that is to be present before permitting pump as specified in feature definition in Table 1. Modular control system: Pulsar Ultimate manual states that the "Ultimate Controller has been designed to be modular and expandable offering you a customised solution." User interface: Style C – Detailed graphical display (\$)	
Puisar Quantum 2+	Time to spill Auto resets/remote reset	pm.com/instrumentation/
		product-type3/pump-







Supplier & Product	Features(*)	Reference
	Pulsar Quantum 2+ web page states the following features: "Time to spill calculation and warning, Peak power tariff avoidance, Automatically resets tripped pumps"	<u>control/quantum-2-</u> <u>plus.aspx</u>
	Wet well cleaning: Pulsar Quantum 2+ manual includes the 'Cling wall', which aims "to reduce material build up (such as fat), on the wall of the sump or vessel, at the 'normal' material level the pump set points can be varied within a specified band." (#)Storm detection: Pulsar Quantum 2+ manual includes the 'Storm' feature but this "enables all pumps to be disabled during a storm condition to prevent the futile running or potential damage due to the continued use of pumps during flood conditions." This is different to the storm detection definition provided by WRc, which potentially enables the controller to trigger a draw-down of the water level in the wet well to maximise storage capacity and reduce the risk of spill. (#) Dry run protection: Pulsar Quantum 2+ manual, includes the setting of the 'minimum head', which is as follows "To prevent the dry running and the possibility of cavitation, of the pump, enter the minimum level (head) of material, in measurement units (P104), that is to be present before permitting pump exercising to take place." Dry run protection is based on level probes and/or float switches and not on monitoring pump as specified in feature definition in Table 1. Logging of pump stats: Pulsar Quantum 2+ manual includes the 'Pump log' feature. There is a basic level of logging of pump stats. User interface: Style B – simple graphical display (\$)	https://www.pulsar- pm.com/Portals/0/docs/m anuals/Quantum-2-plus- PPM142-2nd-ed-R1- Manual.pdf?ver=2017- 12-15-095601-427
Pulsar Quantum 3	Tariff management Time to spill Auto resets/remote reset Pulsar Quantum 3 web page states the following features: "Time to spill calculation and warning, Peak power tariff avoidance, Automatically resets tripped pumps" (#)Surrogate flow measurement:	https://www.pulsar- pm.com/instrumentation/ product-types/pump- control/quantum-3.aspx





Supplier & Product	Features(*)	Reference
	Pulsar Quantum 3 web page states that: "Quantum 3 adds the ability to interface with up to four Flow Pulse non-invasive flow monitors, so all flow-rate based alarms and control is based on measured rather than calculated flow". However, it does not use the drop test approach. Storm detection: Pulsar Quantum 3 web page includes the feature "Storm detection alarm" but it is unclear what other actions are activated. Wet well cleaning: Pulsar Quantum 3 manual includes the 'Cling wall', which aims "to reduce material build up (such as fat), on the wall of the sump or vessel, at the 'normal' material level the pump set points can be varied within a specified band." (#)Storm detection: Pulsar Quantum 3 manual includes the 'Storm' feature but this "enables all pumps to be disabled during a storm condition to prevent the futile running or potential damage due to the continued use of pumps during flood conditions." This is different to the storm detection definition provided by WRc, which potentially enables the controller to trigger a draw-down of the water level in the wet well to maximise storage capacity and reduce the risk of spill. (#) Dry run protection: Pulsar Quantum 3 manual, includes the setting of the 'minimum head', which is as follows "To prevent the dry running and the possibility of cavitation, of the pump, enter the minimum level (head) of material, in measurement units (P104), that is to be present before permitting pump exercising to take place." Dry run protection is based on level probes and/or float switches and not on monitoring pump as specified in feature definition in Table 1. Logging of pump stats: Pulsar Quantum 3 manual includes the 'Pump log' feature. There is an advanced level of logging of pump stats.	https://www.pulsar- pm.com/Portals/0/docs/m anuals/Quantum-3- PPM142-2nd-ed-R1- Manual.pdf?ver=2017- 12-15-095602-757
Seprol / Servelec ControlPack	Logging of pump stats: The Seprol S2000 technology brochure states that the S2000 features a "Report/fault log facility" WRc's understanding is that this is an advanced level of logging of pump stats. Auto reset / remote reset: The Seprol S2000 technology brochure states that "Using the S2000 as a pump controller allows you to perform a wide range of waste water functions, including remote resets." (2) Blockage detection: The Seprol S2000 technology brochure states that "Using the S2000 as a pump controller allows	https://www.servelectech nologies.com/media/3563 /201711 tech-brochure- uk-seprol-s2000_02- opline pdf
	you to perform a wide range of waste water functions, including blockage detection."	







Supplier & Product	Features(*)	Reference
Grundfos CU 362	On board telemetry: The Seprol S2000 technology brochure states that the "S2000 is a WITS and Native DNP3 based intelligent remote telemetry unit (RTU)". User interface: Style B – simple graphical display (\$) (#) Surrogate flow measurement: Can be connected to a flowmeter. However, this is a different approach to a drop test. Energy monitoring: Grundfos CU 362 Operating Manual states that it is possible to "Connect either an energy meter or a flowmeter to the IO 351B-1 (DI1) input/output unit." On board telemetry: Grundfos CU 362 Operating Manual states that, "The control system is operated via a user-friendly control panel on the CU 362 Operating Manual states that, "The control system is operated via a user-friendly control panel on the CU 362 Operating Manual states that there are "Float switches. The CU 362 has a set of factory settings for the float switches. The functions of the float switches can be used, and they are used as safety high-level and/or dry-running float switches." The float switches and not on monitoring pump as specified in feature definition in Table 1. User interface: Style B – simple graphical display (\$)	[PDF]Dedicated Controls – Grundfos net.grundfos.com/Appl/cc msservices/public//Gru ndfosliterature- 3207411.pdf







Supplier & Product	Features(*)	Reference
	BH CHUNDEOS X CHUNDEOS X	
SCADA Pack (RealStream)	 Control to fixed level: Realstream Lift Station configuration manual states that the, "RealStream Lift Station is an advanced Lift Station controller for automating the process of maintaining a level in a wet well, while extending the life of the pumps." (#) Surrogate flow measurement: Realstream Lift Station configuration manual states that influent and effluent flowmeters can be connected to the pumping station controller, but this does not involve the drop test. Logging of pump stats: Realstream Lift Station configuration manual states that the, "RealStream Lift Station logs the number of times that the pump starts and the number of hours that the pump has been running." WRc's understanding is that this is a basic level of logging of pump stats. Auto-reset/remote reset: Realstream Lift Station configuration manual states that, "If a pump is prompted to start and does not start within the pump start delay time, or a pump stops unexpectedly, the auto restart sequence is initiated. If the pump does not restart after the configured number of tries, the pump is removed from the pump alternation scheme and is made unavailable." 	https://download.schneid er- electric.com/files?p_enD ocType=User+guide&p_F ile_Id=6762970548&p_Fil e_Name=Lift+Station+Co nfiguration+Manual.pdf& p_Reference=RealStrea m_Config_Manual
	Auto-reverse: Realstream Lift Station configuration manual states that, "The fixed interval deragging cycle involves reversing the direction of the motor and allowing the impeller to rotate in the opposite direction from normal operation. The motor runs in the reverse direction to dislodge rags or other materials that have built up in the impeller." (#) Dry run protection: Realstream Lift Station configuration manual states that the user "can monitor the level of your lift station using four to seven float level switches that are linked to the SCADAPack inputs. These float level switches are configured in the GDT [Graphic Display Terminal]. At a minimum, it is recommended that two float level switches and two backup level switches be configured for robust station operation. The two floats, High High and Low Low, act as backups in case the readings from the other floats, are incorrect." The float switches are external devices that are connected to the pumping station controller. Dry run protection is based on level probes and/or float switches and not on monitoring pump as specified in feature definition in Table 1. User interface: Style B – simple digital display (\$)	









(*)The mention of a feature in the table above for a product indicates that a particular feature has been identified in the product literature WRc has been able to obtain but the absence of a feature does not necessarily mean that the feature does not exist (see a copy of the feature definitions in Table 1).

(#) Denotes that a feature exists but is used for a different purpose and/or is carried out using a different approach to that defined by WRc (see copy of the feature definitions in Table 1).

(?) Denotes that it is not clear what is included in the product feature for this product.

(\$) User interface - see Table 1 for user interface styles as defined by WRc



