**CARTERTON STW**

**site Control Philosophy**

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# **1 Introduction**

Carterton STW has been identified under the Water Framework Directive for a revised Phosphorus and Ammonia consent under No Deterioration of 0.6mg/l and 4 mg/l which is to come into effect in March 2018.

* Current consent is 30/15/6/2/5 (SS/BOD/NH3/P/Fe) mg/l
* P consent tightening to 0.6 mg/L in March 2018
* Ammonia consent tightening to 4 mg/L in March 2018
* Current FFT is 115 L/s

This control philosophy defines the system operation and design of the new and additional plant for Carterton STW.

Site Address:

Burford Road, Black Bourton,

Bampton, Oxfordshire

CARTS1ZZ

OX18 2PN

# **2 General**

This document sets the overall control system requirements for the project. This specification shall be used for the development of the Functional Design Specification (FDS), which is to be written for the control system by the Systems Integrator. The FDS shall follow the format required by the Thames Water Specification F24.

# **3 Drawings and Documents**

## **3.1 Drawings**

Table 01 lists the specification drawings forming part of this specification.

|  |  |  |  |
| --- | --- | --- | --- |
| **Drawing No.** | **Drawing Title** | **Revision** | **Twexnet Link** |
| 3002 | TUKE & BELL Carterton STW LCP Drawings | A | [Link](https://twexnet.withbc.com/bc/bc.cgi/0/189548486?op=lp) |
| D339\_A13-AB-CARTS1ZZ-102-DR-P-0002 | Process & Instrumentation Diagram Final Effluent Sampling Monitors | P01 | [Link](https://twexnet.withbc.com/bc/bc.cgi/0/189572988?op=lp) |
| D339\_A13-AB-CARTS1ZZ-102-DR-P-0003 | Process & Instrumentation Diagram Recirculation Pump Station | P01 | [Link](https://twexnet.withbc.com/bc/bc.cgi/0/189572995?op=lp) |
| XXXXXX | Process & Instrumentation Diagram Final effluent monitoring system Vendor package | TBC | TBC |
| ***Table 01*** | | | |

## **3.2 Documents**

|  |  |  |  |
| --- | --- | --- | --- |
| **Document No.** | **Document Title** | **Revision** | **Twexnet Link** |
| D339\_A13-ICA-SCH-10052 | Carterton STW Telemetry Schedule | A | [Link](https://twexnet.withbc.com/bc/bc.cgi/0/189886905?op=lp) |
| ***Table 02*** | | | |

# **4 Process Description**

**Existing Plant**

Carterton STW is a percolating filter works located west of Oxford. Flow arrives at the site by a gravity line from RAF Brize Norton to the Inlet Pumping Station and by off-site pumping stations directly to the inlet works. The treatment consists of:-

* 1No. escalator screen and 1No. automatically bar raked screen, with bypass
* 1No.Huber screening handling plant compactor
* 1No. pista grit removal system
* Storm Separation at inlet works
* 2No. Storm Tanks, c/w 2No. storm return pumps, and copatrawl on outlet of storm tanks
* 3 No Circular half bridge scraped PST with auto-desludge pumps
* 6 No Circular percolating filters
* 3 No Secondary Circular half bridge scraped Humus Tank with auto-desludge
* 5 No. Nitrifying Sand Filters (NSF) units
* Return Liquor PS
* Washwater PS
* 1No. sludge transfer tank, sludge transfer pumps and 2No Sludge holding tanks with decant valves
* Recirculation pumping station consisting of 2No. pumps D/S.
* Existing Chemical dosing unit (Ferric Sulphate) located at inlet of PST’S to remove phosphorus by 2X dosing pumps controlled by a chemitrol controller.

**New and Additional Scope**

A single solution was considered to meet the new consent under No Deterioration. The option put forward

is as detailed below.

1. The arms for trickling filters 5 and 6 arms to be replaced as per Asset Standards WWT4.1.2.5.1. 25m diameter Nozzle type arms shall be installed to ensure proper distribution of flow across the filter. Arm orifices must be horizontal discharge and shall not be less than 12mm diameter. One section of each arm shall be reversible to act as a brake arm if required. Splash plates shall be provided on nozzle type arms set on plastic media filters, to improve local flow distribution and prevent channelling. Splash plates shall also be provided on the inner nozzles of arms used on slag media filters.
2. To provide temperature, phosphorous and turbidity monitors for the final effluent.
3. Existing recirculation pump station to be replaced with 2 nos. new 3 phase 5.9kW duty/standby variable speed vertical shaft driven pumps each with a capacity of 40l/s, c/w pipework connection and isolation valves shall be installed in the recirculation pump station.

# **5 System**

## **5.1 System PLC Software and Hardware**

The ICA Framework Sub-contractor is responsible for design and for ensuring compliance with the functionality specified herein and STW requirements.

All hardware and software elements necessary to complete a fully operating system shall be provided.

A new PLC is also envisaged in the local control panel provided for the recirculation Pump station.

Existing control system interface point shall be identified later during detailed design (via carrying out site survey) as required for new scope process control philosophy.

## **5.2 SCADA/HMI Display Hierarchy**

A new HMI is envisaged in the ICA section of recirculation pump station with new MCC. HMI shall be door mounted colour display with graphical functionality. The database shall be configured to include mimics, alarms, settings and trends for the drives, equipment and instrumentation associated with or fed from the associated MCC under this scope.

HMI facilities shall include:

* Display in graphical (mimic) and tabular semi-graphic formats real time data from PLC registers and/or data derived from it
* Display in tabular/semi-graphic formats the configuration data used within the PLC programs, together with secure facilities to amend or set values within default limits. This shall include process set points and control parameters

Existing control system interface point shall be identified later during detailed design (via carrying out site survey) as required for new scope process control philosophy.

# **6 Control Philosophy**

The control system is based around Programmable Logic Controllers (PLC), working in conjunction with Motor Control Centres (MCC) and local control panels, panel-mounted operator interfaces and field instrumentation and monitored by HMI / telemetry system. All data required for offsite monitoring of the works will be made available via Telemetry link.

The HMI / telemetry system will include the following facilities using tables and mimics where appropriate:

a) Overview screens detailing individual parameters for the site

b) Mimic and control set point screens for each process and the plant

c) Display screens detailing all analogue and digital signals/values

d) Display and adjustment of control set points, timers and alarm limits

e) Display screens detailing condition and stage within sequences of the major plant

f) Selection of duty and standby drives, or other configurations as appropriate

g) Faceplates of motors, valves, PID, instrumentation.

h) Display screens detailing real time and historical trends

i) Display of record alarms and events

Alarms shall be raised on the HMI for all failures and abnormal conditions.

***Control (all modes) of the existing pumps/motors and other instrumentations will be retained as per the original philosophy. The control modes for existing equipment and plant specified in this document have been assumed. Any new control features will be incorporated in the existing HMI / telemetry system (where appropriate).***

## **6.1 Trickling Filters 5 & 6 modifications**

Trickling filters 5 and 6 arms shall be replaced. The trickling filters will continue to operate as per the existing control philosophy. Each filter arm will be operated from its LCP. The existing loss of rotation sensor and alarm will remain as existing.

## **6.2 Final Effluent sample Monitoring**

Final Effluent phosphorous monitoring shall be a supplier package. The supplier shall provide a sampling pump, 110 V transformer, phosphorous and turbidity monitors with associated piping, valves, flow indicators and switches. A local control panel shall be provided in an appropriately sized enclosure. Required signal cables shall be installed from the monitoring local control panel to the new recirculation PS MCC and on to telemetry.

The final effluent monitoring system shall be monitored by the LCP and new PLC system. For details of operation, refer to the vendor document “XXXX”.

## **6.3 Recirculation Pump Station Modification**

Existing recirculation pumping station is installed upstream of the final effluent outfall. Recirculation pump station suction is drawn from existing FE sampling chamber. Existing vertical shaft driven pumps shall be replaced with two new 5.9kW variable speed vertical shaft driven pumps each with a capacity of 48 l/s. The replaced recirculation pumps shall be controlled/monitored from the new VSD starters in new MCC panel located in the recirculation pump station. There shall be a new ICA section in new MCC. The replaced new pumps shall operate in Duty / Standby configuration with duty rotation. Duty pump rotation shall be utilised to equalise pump wear. A local control station with an Isolator, Emergency Stop Push Button shall be mounted within 2m of the pump.

At the MCC the drive is provided with Hand/Off/Auto selector switch, Start/Stop push buttons, reset buttons and indication lamps. There is an ultrasonic level transmitter (PER01LT01) and backup Low-Low level switch (PER01LS01) installed in recirculation pump station along with a flow meter (PER01FT01) installed in common discharge line for monitoring flow. Also each pump is protected from dry running by respective discharge low flow switches (PER01FS01\PER01FS02).

Additionally new temperature element (FEL01TE01) with temperature indicating transmitter (FEL01TT01) is installed in FE chamber for inhibiting recirculation pumps on low temperature. Existing instrument signals and new instruments shall be connected to the new ICA section of the recirculation pump station for monitoring and control of the recirculation pumps. Signals as listed in telemetry schedule shall be made available for connecting to the existing telemetry outstation panel.

**6.3.1 Operation**

The basic purpose of recirculation pump station is to continuously maintain wetting of filters at constant flow in order to improve the performance of the filters in regards to ammonia removal. The influent flow is monitored by an existing electromagnetic flow meter (IFL1FT101) installed between inlet works and PST distribution chamber. The 4-20mA signal for the existing flow meter shall be replicated with a signal isolator and connected at the new MCC/ICA panel for controlling recirculation pump speed. Existing functions and telemetry monitoring signals shall be retained as far as appropriate.

When the level in the recirculation pumping station is above a preset value as measured by the ultrasonic level Transmitter PER01LT01 the pumps shall be enabled to start. If the level as measured by PER01LT01 falls below a configurable stop level the pumps shall be inhibited.

Upon failure of the recirculation pump station ultrasonic level transmitter (PER01LT01), the pumps shall be enabled to start (by default) and will be protected from dry running by the backup low-low level switch (PER01LS01). Additionally the pumps shall be protected from running dry by the respective flow switch (PER01FS01/PER01FS02).

Upon failure of the existing inlet flow meter IFL1FT101 the recirculation pumps shall continue to operate as they had prior to the instrument failure.

When recirculation is enabled, the duty recirculation pump shall run continuously at an operator preset speed, as required by the process design unless the inlet flow as measured by IFL1FT101 exceeds the operator adjustable flow setpoint (40 l/sec). Duty recirculation pump speed shall be set via HMI or VSD manually by setting % speed command depending on seasonal variations.

Should the influent flow measured by the existing flow meter (IFL1FT101) rise above the configurable flow setpoint (60 l/sec) then the duty recirculation pump shall be stopped.

During the cold weather periods, the pumps shall be operated in timer mode. When the FE temperature falls below 10° **(TBC)** Celsius (operator configurable) as measured by the temperature element/ transmitter (FEL01TE01/ FEL01TT01) the pump control shall be passed to the timer mode and the common timer will be activated. Duty pump (PER01P\_01/PER01P\_02) will run for preset duration **(“T” min TBC**) and when the timer is elapsed the pump will be stopped and remain off for preset duration **(“T” min TBC**) and again the run timer will be activated. This On/Off cycle will run until the final effluent temperature is above 10° Celsius (**TBC**).

The common timer shall be provided for both pumps and the operator shall be able to set the run and off duration **(“T” min TBC**) for each pumps.

If the FE temperature falls below 8° celsius (operator adjustable) as measured by the temperature element/ transmitter (FEL01TE01/ FEL01TT01) then duty recirculation pump shall be stopped/inhibited.

When the duty pump is in operation, should the discharge flow as measured by flow meter (PER01FT01) fall below the preset flow setpoint (set during commissioning) then the duty recirculation pump shall be stopped and standby pump will be started. A pump failed alarm shall be raised at the local HMI and to telemetry.

Actions and events associated with recirculation pumping station operation are as follows:

|  |  |  |
| --- | --- | --- |
| EVENT | ACTION | COMMENT |
| Plant influent flow (**IFL1FT101**) above high pre-set value (60 l/sec) | Stop duty recirculation pump (PER01P\_01/ PER01P\_02). |  |
| Plant influent flowmeter failure (**IFL1FT101**) | Raise alarm, recirculation pump operation continues as it was before failure |  |
| Duty Recirculation pump/ Motor failure | Start Standby recirculation pump | Raise a Level 3 (**TBC**) alarm |
| Standby recirculation pump/ Motor failure | If by this time, reset has been performed by operator for the earlier duty pump and is enabled, it should be started when required. | Raise a Level 3 (**TBC**) alarm |
| Both Duty/Standby pump failure | Raise an Level 1 (**TBC**) alarm | Operator reset |
| Level Transmitter (**PER01LT01**) Failure | Raise an Level 1 (**TBC**) alarm | Operator reset |
| Flow Transmitter **PER01FT01** Failure | Raise an Level 1 (TBC) alarm at the HMI and to telemetry | Operator reset |
| Level Switch **PER01LS01** Low-Low activated | Stop / Inhibit recirculation pump. Raise Alarm. | Operator reset |
| Final effluent Low Temperature  **FEL01TT01** below 10° (**TBC**) Celsius (operator adjustable) | Timer mode activated. Start/stop duty transfer pump based on timer preset run/off timer duration (“T” **TBC**) | Raise a Level 3 (TBC) alarm. |
| Final effluent Low Temperature  **FEL01TT01** below 8° Celsius (operator adjustable) | Stop / Inhibit recirculation pump and raise an Level 1 (**TBC**) alarm | To be set at commissioning |
| Final effluent Low Temperature instrument (**FEL01TT01**) failure | Raise alarm. Recirculation continues without influence of temperature. |  |
| Discharge Flow **PER01FT01** below low flow set point when inlet flow is below 60l/s as measured by **IFL1FT101** | Stop duty recirculation pump, and start standby recirculation pump if available. Raise alarm. | Low flow setpoint to be set at commissioning |
| Recirculation Pumping Station level transmitter PER01LT01 falls to low level | Inhibit pumping station and raise alarm |  |
| Recirculation Pumping Station level transmitter PER01LT01 rises to high level | Enable pumping station and cancel alarm |  |
| Flow Switch (**PER01FS01**) Low flow | Stop / Inhibit recirculation pump 1 |  |
| Flow Switch (**PER02FS01**) Low flow | Stop / Inhibit recirculation pump 2 |  |
| ***Table 03*** | | |

**6.3.2 Manual control mode**

The duty / standby Filter recirculation pumps (PER01P\_01/ PER01P\_02) can be stopped/ started at the MCC.

The speed of the pumps can be manually controlled at the VSD.

**6.3.3 Alarms**

Following alarms shall be raised at MCC/local HMI and same shall be communicated to the site telemetry system.

|  |  |  |  |
| --- | --- | --- | --- |
| Alarm Description | Source | Alarm Level | COMMENT |
| Plant influent flowmeter failure | Existing flowmeter via repeat circuit |  |  |
| Recirculation Pump Station Level Low-Low | Level Switch (PER01LS01) | Level 1 (TBC) |  |
| Recirculation Pump in Timer mode (FE Temperature Low <10 degree Celsius) | Temperature Transmitter (**FEL01TT01**) | Level 1 (TBC) | Pump timer mode activated |
| FE Temperature Low (<8 degree Celsius) | Temperature Transmitter (**FEL01TT01**) | Level 1 (TBC) |  |
| Recirculation Pump Station Level Transmitter Failure | Level Transmitter (**PER01LT01**) | Level X (TBC) |  |
| Recirculation Pump Station Discharge Flow Transmitter Failure | Flow Transmitter (**PER01FT01**) | Level X (TBC) |  |
| Recirculation Pumps (Duty / Standby) Failed. Separately for respective pump and also for both pumps. | MCC | Level X (TBC) |  |
| Recirculation Pump 1 Discharge Flow Low | Recirculation Pump 1 Discharge Flow Switch (**PER01FS01**) | Level X (TBC) |  |
| Recirculation Pump 2 Discharge Flow Low | Recirculation Pump 2 Discharge Flow Switch (**PER01FS02**) | Level X (TBC) |  |
| Recirculation pump low flow alarm | Recirculation pump flow meter (**PER02FT01**) | Level X (TBC) |  |
| ***Table 04*** | | | |

# **7 LCP Front Display**

In accordance with Thames Water framework standard specifications.