Birmingham Resilience Project - Trimpley WTW

2 ML/d Actiflo® high rate sand ballasted clarification pilot plant part to validate a full scale plant designed to clarify the River Severn and the Elan Valley water

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As part of the Birmingham Resilience Project, Severn Trent Water has been investigating process solutions to treat the River Severn water at the existing 430ML/d Frankley WTW. The current dissolved air flotation plant has been dedicated to treat the Elan Valley water (EVA) which is characterised with peak turbidity below 6NTU. While DAF is very effective at treating highly coloured and relatively low turbidity water, settlement processes are more suited to higher turbidity. As the River Severn water quality entering the plant is in excess of a flotation process capability, this requires the investigation of settlement technologies to provide a new treatment solution.

Actiflo® pilot plant at Trimpley WTW - Courtesy of Veolia Water Technologies UK

Introduction

In order to trial the high rate, sand ballasted clarification Actiflo® at Frankley WTW, Veolia Water Technologies installed a 2ML/d clarification plant at the request of Severn Trent Water at the nearby site of Trimpley WTW. Treating a combination of either the EVA or River Severn water, the pilot plant was started on 14 May 2015.

The installation is a powerful tool to demonstrate the effectiveness of the proposed process in clarifying effectively the River Severn water, EVA or a blend of both sources. The clarification plant is only one component of the comprehensive installation, which includes chemical conditioning and rapid gravity filtration.

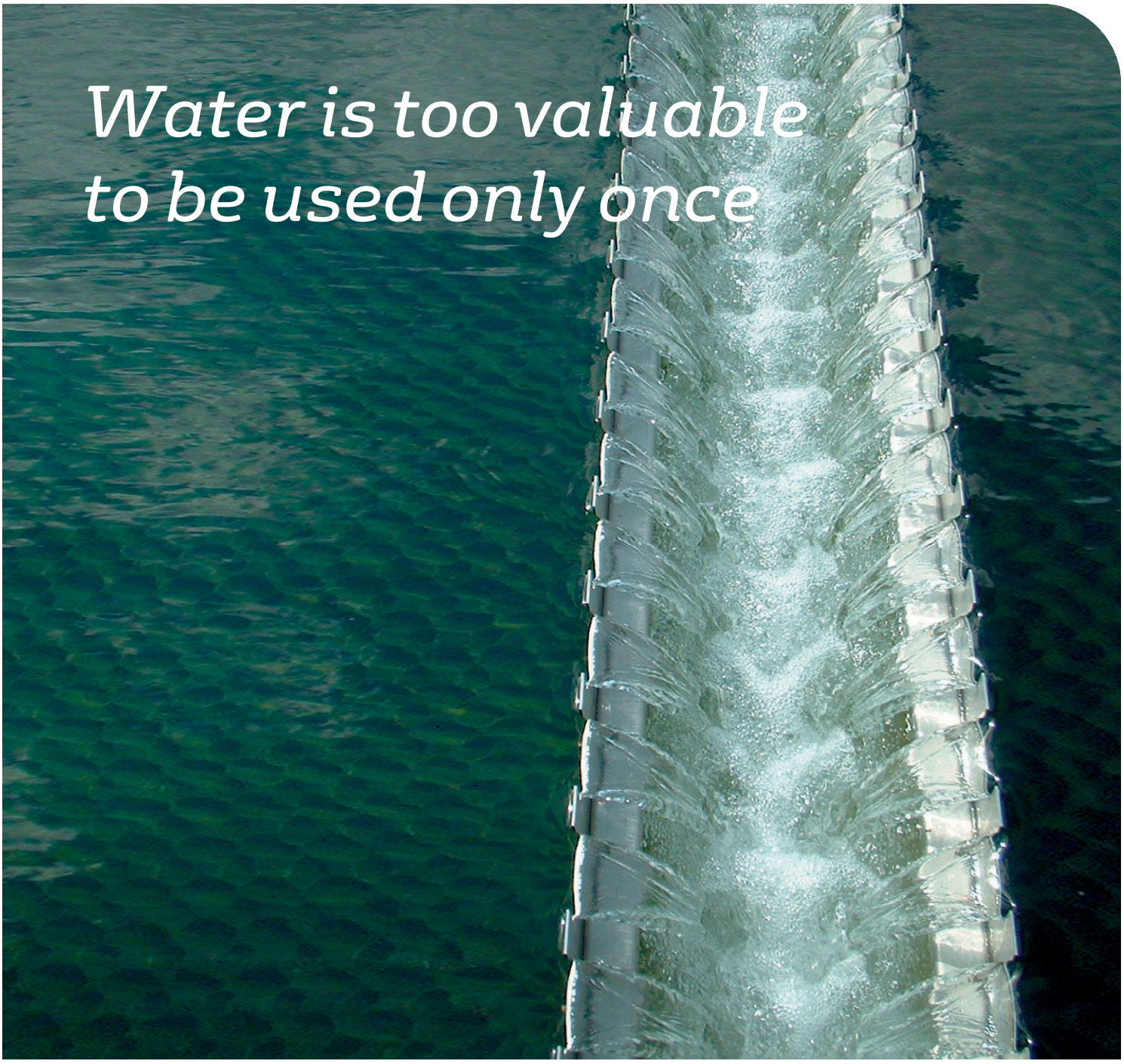
The treatment targets for the Actiflo® process are to produce clarified water compliant with the Severn Trent Water specification, mainly on turbidity, colour, metal residual while remaining of a suitable filterability.

The trial has been designed to treat a number of different water sources which present seasonal challenges in natural organic matter, turbidity and temperature. The low temperature conditions have been simulated using chillers capable of reducing the temperature of 80m³/h flow by 12°C.

The clarification trial investigates the following:

- Suitability of ferric sulphate as main coagulant .
- Assessment of the natural alkalinity buffer in either water supply.
- Suitability of pre-selected polymer.
- Requirement for pH correction.
- Coagulation contact time requirement especially at low temperature.
- Design and maximum mirror velocity of circa 50 and 65m/h.

Although ferric sulphate is providing a slightly higher organic carbon removal rate than aluminium based coagulant it is not usually the preferred coagulant for cold water application with high turbidity. A key objective has been to validate the suitable performances of a settlement process using ferric sulphate as it is in place on the existing Frankley WTW.



WATER TECHNOLOGIES

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	Maximum/Average	River Severn	EVA	
Turbidity	Maximum	300	5.7	NTU
	Average	30	0.9	
True Colour	Maximum	150	33	Deg.Hazen
	Average	20	20	
Alkalinity	Maximum	214	27	mg/l CaCO3
	Average	90	14	
pH	Maximum	9.2	8.4	pH units
	Average	7.8	7.3	
Conductivity	Maximum	500	200	µS/cm
	Average	300	50	

Table 1: Birmingham Resilience Project: indicative river quality data before attenuation across the reservoir - Courtesy of Veolia Water Technologies UK

The second part of the trial sees additional tests such as dosing aluminium based coagulants, powdered activated carbon in the feed water to assess the removal rate of the dissolved organic carbon. Post-clarification injection of metallic salts or sodium hypochlorite will also be conducted to evaluate the impact on clarified water filterability.

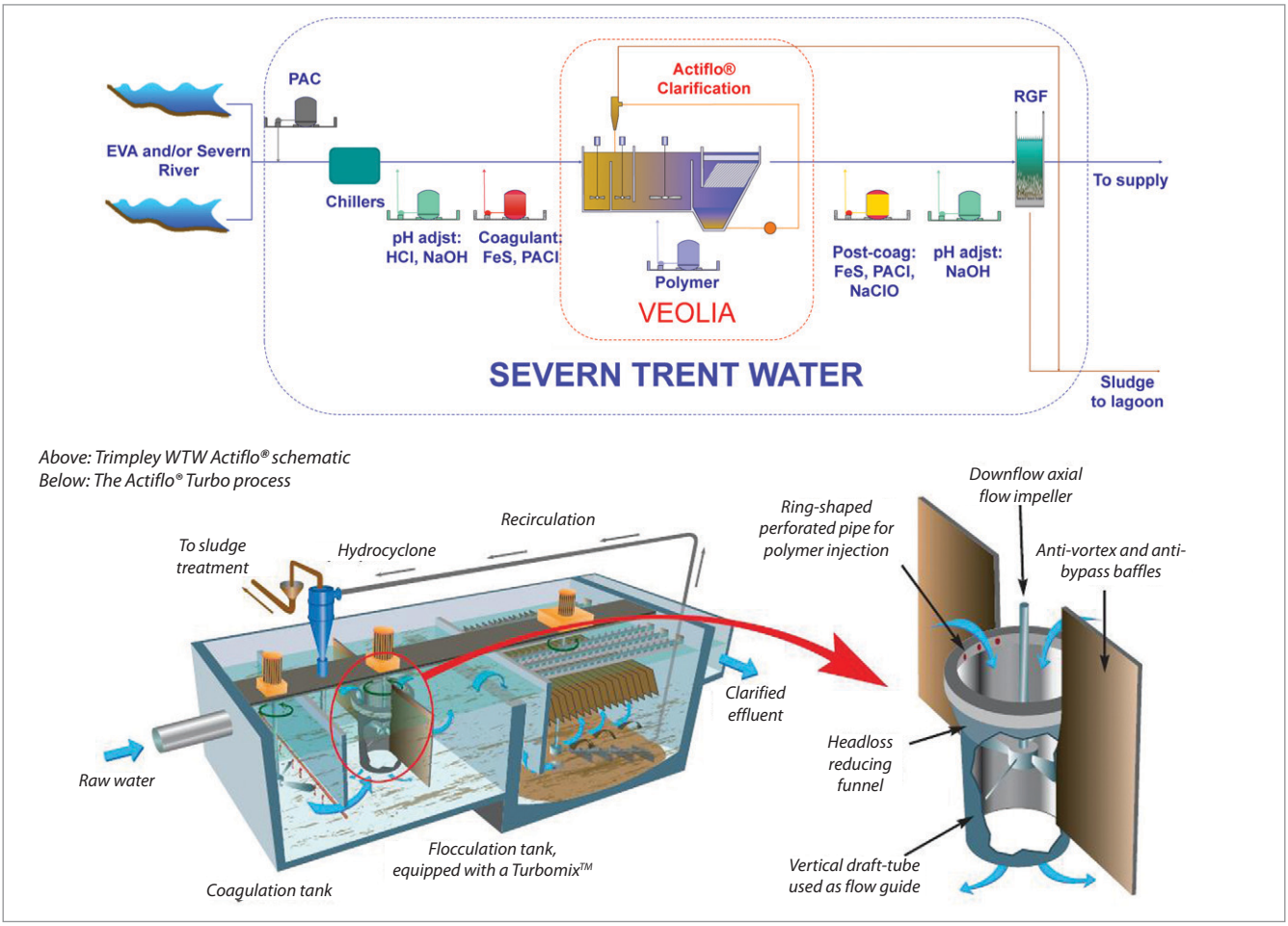
Actiflo® technology

The Veolia proposed technical solution centers upon the Actiflo® process, which is ideally suited for difficult-to-treat sources with sudden variations of turbidity and colour. Actiflo® is a patented extremely versatile, high-rate, sand ballasted clarification system that effectively removes suspended solids and organic matter in surface water by coagulation/flocculation and lamella settling, achieving extremely low levels of outlet turbidity and true colour. Microsand (known as Actisand®) is utilised as a seed for floc formation, providing surface area that enhances flocculation and acts as a ballast or weight. The resulting sand ballasted floc enables clarifier designs with high rise rates and short retention times, having a typical footprint between 5 and 20 times smaller than conventional clarification systems of a similar capacity.

The Actiflo® process is the most compact clarification process on the market with mirror velocity up to 80m/h in surface water clarification. It offers a high degree of operating flexibility, such as rapid and automatic start up/shut down combined with an outstanding capacity to cope with flows and loads variations.

Actiflo® pilot plant set-up

The pilot plant is an automatic system equipped with its own MCC and SCADA system. Fitted with extensive analytical in-line instrumentation, it provides the operator with the facility to monitor the operating conditions and the quality of the treatment in a similar way to a full scale plant including remote monitoring.



It is equipped with 2 different automatic coagulation modes, a conventional Turbidity/UV_{254} control application and an innovative S::Can/Com::Pass monitor using solids compensated UV-Vis spectra and turbidity to characterise Natural Organic Matter (NOM).

The pilot plant installation can treat either type of water, under a combination of:

- Water temperature conditions (chilled to circa 2ºC or ambient).
- Coagulation contact time (3.5-4.0 minutes and 6.5-8.5 minutes).
- Mirror velocity between 50 and 80m/h.

Further tests will include the addition of powder activated carbon in the raw water to simulate organic matter and pesticides removal.

A recent Actiflo® Carb trial demonstrated removal rates of pesticides greater than 95%. Whether fresh powder activated carbon is dosed at a loss in an Actiflo® or recirculated in the Actiflo® Carb, the discharge limit of 0.1µg/l for an individual pesticide and 0.5 µg/l for the total pesticides will be met while maintaining compliant clarified water quality.

Key results

While the trial is ongoing, three main tests have been summarised below: clarification of the River Severn, the EVA and a blend of both under chilled conditions which is considered to be particularly testing. The environmental conditions have prevented from reaching the 2ºC water temperature target but managed to get below 4ºC; this is still a reliable indication of the plant performances under cold conditions. Focusing on the impact of temperature in relation to the selected coagulation time, the clarified water quality was hardly degraded when switching from ambient to chilled conditions as illustrated in the following figure.

Further testing is on going to assess the benefit of an extended coagulation time as the raw water temperature decreases. As autumn approaches, the raw water characteristics are expected to display greater turbidity. Consideration is given to artificially spike the raw water with solids should the natural values be lower than usual.

The performances of the clarification Actiflo® plant under cold conditions are reflected below. These results have been recorded through a wide range of mirror velocity, testing the coagulation process under different type of water at low temperature. initial results indicate satisfactory coagulation using ferric sulphate at low temperature with an extended contact time.

		River Severn	EVA	Blend
Clarified water average parameters	Turbidity (NTU)	0.62	0.48	0.36
	Temperature (°C)	6.2	5.3	4.9
	True UV_{254} (abs/m)	4.65	1.95	0.59

Table 2: Actiflo® average key laboratory results on under cold temperature across the River Severn, EVA and blend of water. Mirror velocity from circa 50 to 80m/h, with average polymer dose of 0.15mg/L as active product - Courtesy of Veolia Water Technologies UK

The current trial will continue for a further 6 months to capture natural raw water events in wintery conditions, test additional water conditioning and gain operational data on the filtration stage.

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