Penicuik WwTW

extension/upgrade presented many challenges

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Penicuik WwTW is a long established works situated due south of Edinburgh and to the north east of Penicuik town centre. Nestling on a bend in the River North Esk, in a steeply sided valley, it suffers from severe frosts in winter. The works currently services a population of approximately 13,700 and requires an extension/upgrade of the treatment process to meet a design population of 15,100 together with stricter consent standards set by the Scottish Environmental Protection Agency under the control of Pollution Act 1974 and the Urban Waste Water Treatment (Scotland) Regulations 1994. Penicuik is a tight operational site with weight and height limitations imposed by bridges over and under access to the site and building the new works presented many challenges.

In transition - Penicuik WwTW *(courtesy Scottish Water)*

The existing process consists of an inlet works, screens/screenings removal followed by a primary tank with fixed bridge and rotating scraper, followed by aeration (by surface aerators) using three separate tanks, then final settlement and discharge to the river. Sludges are pumped to high level tanks, thickened by picket fence thickeners and removed by road tanker.

Factors affecting the new design were:

* limited head to accommodate new hydraulics of the inlet works;
* lack of reasonably level ground on which to build the new works;
* contaminated ground to the north caused by tipping of waste from a now extinct paper mill;
* close proximity of mature trees on the river banks;
* need for storm storage on site requiring new construction potentially using valuable space;
* restricted access around the existing site due to its layout;
* need to maintain the existing process during construction.

Any design considered had to take into account all these factors

Temporary final settlement tank *(courtesy Scottish Water)*

and a client's preference towards the use of Sequencing Batch Reactors (SBRs). This process had to achieve a consent standard based on a 95%ile of: BOD16mg/l; ammonia 4 mg/l; COD 100mg/l.

Due to the confines of the site, the final design approach centred on firstly constructing a temporary final settlement tank (FST) to replace the existing one, which had to be demolished to make way for construction of the PURACtor SBRs and a final balancing tank. This temporary FST would be used for storm storage in the final design once the process had been commissioned. Since this would only be required for approximately six months the scraper would use the "suction" principle to remove sludges from the flat bottomed tank. A de-icing system was incorporated to prevent the drive wheel from skidding as the site suffers from severe frost in winter. In addition, to make way for construction of the PURACtor SBRs, one aeration tank had to be taken out of service and demolished. To maintain operation of the works, additional aeration was introduced into the two remaining aeration tanks.

The process now consists of an inlet works with screened storm overflow (1570 l/s) directly to a new outfall into the River North Esk. The flow then passes, via a measuring flume, through a grit trap with classifier to the 6mm band screens. A by-pass channel with hand raked screens is also included. Flow then discharges into a Hydrobrake., which physically controls forward flow to treatment. An overflow in this chamber then discharges into the "flow-through storm tank" the refurbished existing primary settlement tank), and into the new blind storm tank. (Currently, the temporary final settlement tank). Flow to treatment then enters a pumping chamber where it is forwarded to each PURACtor SBR in sequence.

Sludge process

An activated sludge process is used for the biological treatment stage, carried out in the PURACtor SBR plant, incorporating three reactors. The PURACtor SBR is a fill and draw process with a cycle that includes the following sequence of steps:

* static fill;
* aerated fill;
* react (aerate);
* settle;
* decant (including sludge wasting);
* idle.

During normal operation all reactors will be in service. They will normally operate on a 4.5 hour cycle but during periods of high flow to the works, caused by storm events, the cycle time is reduced. Control of the PURACtor SBR cycles is achieved by the plant PLC and is based on elapsed time and level in the reactors. Aeration control is achieved by use of dissolved oxygen measurement, in each reactor. Each tank is provided with a submersible mixer for the first fill period of the cycle.

Settled liquors are removed from the SBRs via dual floating decanting arms and flow to the balance tank, where discharge to river is measured by a flow meter and controlled by an actuated valve. Final auto sampling also takes place at this point.

Sludges are removed from the base of the SBR tank and currently discharge directly to a local sewer for further processing downstream,.

Aeration is carried out using conventional blowers, one dedicated to each SBR with one common standby. A series of fine bubble diffusers mounted across the base of the tank gives even air distribution over the whole liquid mass.

Unique features incorporated into the new works are:

* use of new pre-cast concrete tanks, primarily due to their speed of erection and minimal risk of leakage;
* re-use of existing bridge structure (in very good order despite its age) in the new flow through storm tank;
* use of new blind storm tank as a temporary final settlement tank and use of a suction scraper due to the required flat floor for final uses;
* incorporation of a Hydrobrake to control flow forward for treatment;
* storm tank cleaning facilities utilising ABS vertical submersibles;
* storm mode provided for high flow/low load conditions.

To date (March 2002)

Phase 1, the introduction of temporary FST, was achieved on programme and final commissioning was commenced to achieve full operation of the PURACtor SBRs. When they have completed their take-over tests at the end of Phase 11, the final phase, removing the two remaining aeration tanks, old inlet works and conversion of the existing tanks to storm tanks can take place. This will be coupled with total refurbishment of the administration building including canteen, laboratory, toilet and washing facilities, together with final finishing of access road and hardstanding. Phase 111 is anticipated to be complete at the end of April 2002. ■

Note on the authors: *David Eastwood is Project Manager and Camilla Needham is Process Engineer, both with Purac Ltd.*