Fleetwood WwTW

AMP4 supply and demand project

by
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Fleetwood WwTW in Lancashire is owned and operated by United Utilities and serves a catchment population of 248,000. Numerous tourist attractions in Blackpool and the surrounding Fylde Coast attract large numbers of visitors to the area and the population equivalent (PE) is 321,000. The PE is forecast to rise to 427,000 by 2016, requiring investment in new processes to ensure consistent standards for wastewater treatment. This article describes the design and construction of a Supply and Demand project at Fleetwood WwTW.

Primary settlement tanks and de-sludging chamber *Courtesy of UU Process Alliance*

Background and Description of Fleetwood WwTW

Fleetwood WwTW was constructed during AMP2 and is one of United Utilities' largest wastewater treatment works, treating sewage from Fleetwood, Blackpool and surrounding areas on the Fylde Coast. The consented Flow to Full Treatment (FTFT) of 198Ml/d is controlled by three inlet pumps and treated to achieve a final effluent consent of 30mg/l BOD and 45mg/l solids. The existing inlet works includes a rotating bar interceptor, inlet pumping station, four escalator screens (installed under another AMP4 project) and three constant velocity channels for grit removal. Up to 50% FTFT passes through an Actiflo to reduce the onward load to secondary treatment by 66 No. Submerged Biological Contactors (SBCs), followed by 14 No. final settlement tanks. The treated final effluent is discharged into the Irish Sea via a 5km long outfall. Sludge is dewatered by two gravity belt thickeners and a temporary centrifuge for off-site disposal. The existing processes are covered by large buildings and odours are controlled by a three-stage chemical scrubber.

Since being commissioned Fleetwood WwTW has regularly been subjected to increased and transient loads. This is partly due to the seasonal nature of the tourist resorts on the Fylde Coast that cause wide variations in population throughout the year. The WwTW is also vulnerable to high fluctuations in load that occur during storms, when large quantities of sludge are flushed from the network. The impact is to blind the inlet screens, severely reduce the effectiveness of the grit removal and Actiflo and to overload the SBCs with organics and grit.

The purpose of the AMP4 Supply and Demand project was to enhance the treatment capacity of the works for the increase in load due to population growth. The project provides the sludge treatment, storage and loading facilities needed to export sludge cake from Fleetwood WwTW to United Utilities' new regional sludge treatment centre at Davyhulme WwTW. The project is being delivered by an integrated team of United Utilities, MWH and KMI+ (Kier, Murphy, Interserve), who together form the Process Alliance North. The Concept and Definition phases were the responsibility of UU and MWH and the solution design package was issued in September 2008. Principal Contractor KMI+ is responsible for delivering the Implementation and Handover phases. Detailed design began in July 2008 and construction commenced with bulk earthworks activities in January 2009.

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Steel formwork system used for PST wall construction *Courtesy of UU Process Alliance*

Grit Removal and Primary Treatment

A connection downstream of the inlet screens diverts FTFT through elevated pipework to 2 No. new 10m diameter cross-flow detritors. From here grit drops to a pair of classifier rakes and is deposited into skips inside a new building. Detritor effluent is passed forward to a distribution chamber and split equally between 4 No. 38m diameter primary settlement tanks (PSTs) for suspended solids and BOD removal. The PSTs also protect the SBCs from overloading by attenuating load fluctuations. A chemical dosing plant improves solids capture by applying ferric sulphate to the PST influent during periods of high load.

Computational flow dynamics was used during the PST design development to optimise flow characteristics and solids removal. A sludge hopper providing four hours retention time was developed and deflection baffles installed around the diffuser drums deflect incoming flow away from the hoppers, thus preventing scour.

The integrated team has made significant savings on the foundations for the new structures. Results of pile load tests carried out early in the Implementation phase were better than expected and enabled the total length of piles installed to be reduced by 3,800m. This led to significant schedule and cost savings in the construction of 1,374 No. continuous flight auger (CFA) displacement piles for the new structures.

The innovative use of a purpose made profiled steel formwork system, by KMI+, achieved savings on the PST wall construction, by improving the turnaround times of concrete pours, while its built-in access platforms also provided a safer environment for the workforce.

Contaminated Ground

Land used for the new primary treatment facility was previously a mixed waste domestic landfill. Site investigation identified that large areas of ground were contaminated with polychlorinated biphenyls and other hazardous substances. A detailed risk assessment was carried out on the hazards posed by the contamination and the suitability of the material for reuse. The findings demonstrated to the Environment Agency (EA) and the local contaminated land officer that much of the planned spoil arising from the works would be suitable for reuse. The EA requested that the earthworks be undertaken in accordance with a new Contaminated Land: Applications in Real Environments (CL:AIRE) industry code of practice, "The Definition of Waste". This required the production of a Materials Management Plan, documenting how the earthworks would be controlled and the appointment of an Authorised Person to supervise activities, in accordance with the plan. Volumes of unsuitable excavated material have been much less than expected and 75,000m^3 has been reused in backfill to pipework and structures and landscaping around the site, resulting in multi-million pound savings to the project.

Sludge Treatment

PST sludge is pumped to a 1,570m^3 tank, where air mixers blend it with secondary sludge from the existing process. The blended sludge is pumped through a two-stage sludge screen arrangement in a new building and back outside to three further 1,570m^3 holding tanks. The sludge tanks were installed in a reinforced concrete bund for Environmental Permitting Regulations' compliance. The total capacity of the sludge storage equates to four days at average sludge production of 2,153m^3/d. De-watering of the screened sludge takes place inside the new building, where three 75m^3/hr centrifuges, in duty/duty/assist configuration, thicken it to 25% dry solids. Sludge liquors are collected in a 10m^3 tank and a drywell pumping station returns flow to the wastewater treatment process, downstream of the detritors. Thickened sludge cake is transferred by a series of screw and chain conveyors to two, 288m^3 sludge cake storage silos, with sufficient capacity for three days' production. A second series of conveyors transfers sludge cake from the silos to a dual lane truck tunnel, for loading and transportation to Davyhulme WwTW, Manchester.

From left to right: sludge treatment building, sludge cake silos, truck loading tunnel *Courtesy of UU Process Alliance*

From back to front: sludge storage tanks, treatment building, odour control plant, cake silos and truck loading tunnel *Courtesy of UU Process Alliance*

Odour Control

Separation of the primary treatment and sludge treatment facilities made provision of dedicated odour control plants for each more economical. The new process units, including the detritors, PSTs, sludge tanks, sludge liquors return tank and cake silos are covered and the foul air is extracted to one of the two new odour control plants. The primary area odour control plant treats 16749m^3/hr air flow and comprises a hypochlorite-caustic scrubber followed by a carbon filter. Air flow to the sludge area odour control plant is 11,508m^3/hr, but higher odour loads required the addition of a hypochlorite-caustic venturi as the first stage. This acts as a roughing unit for removal of solids drawn through the ventilation ductwork from the sludge processes. Waste liquids from the chemical scrubber are recycled in the venturi to assist sulphide removal and to reduce overall chemical consumption. By using air ionisation to remove odours in the new sludge buildings, flow to the sludge treatment odour control plant has been reduced by more than 80%.

Conclusion

The delivery of the project is currently in the early stages of commissioning and is expected to be in use during autumn 2010. To date 1200t of reinforcement has been fixed; 15,600m^3 of concrete poured and an outstanding 400,000 man-hours have been safely worked without a RIDDOR reportable accident.

The project has presented exceptional challenges to time and cost, but the teamwork, dedication and capabilities of the Process Alliance will deliver on schedule and within the £51.2m approved spend.

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Primary settlement tanks and de-sludging chamber *Courtesy of UU Process Alliance*