Mauchline STW

fully innovative Design for Manufacture & Assembly approach to new assets

by Richard Daly BEng (Hons)

Mauchline STW is located in a rural area to the south west of Mauchline and west of the village of Haugh on the banks of the River Ayr. The works receives flow mainly from domestic sources via the Mauchline catchment and some small industrial discharges. Mauchline STW was identified by SEPA as part of SR10 backlog quality programme (WQ01). Investment was required to ensure that the works comply with the current discharge consent. This was limited to the process components necessary to meet the current licence sanitary conditions at the best estimate of the existing flow and load. The works did not fail its consent; the backlog issues were related to performance of the inlet works.

Figure 1: New grit removal plant, iMCC & washwater kiosk - Courtesy of Laing O'Rourke

Brief description of the works

Scottish Water awarded Laing O'Rourke the contract for the construction of:

- New inlet storm screen chamber (CSO) with 6mm screen.
- New flume (flow splitter) channel.
- Huber's inlet fine screens and bypass screen channels.
- Level sensors.
- New grit removal plant.
- New storm return pumps.
- New primary de-sludge pumps.
- Replacement of dewatering pumps and associated pipework and cabling.
- iMCC, control networks, automation of new pumps and telemetry upgrade to existing and incorporation of new plant items.

Design flow

The current estimate of contributing population equivelant (PE) is 6,000, using average flow per head of 157l/d and a design infiltration rate assessed at 505m^3/day (i.e. 55.0% of PG). Using these parameters, the design dry weather flow (DWF) is assessed as 1,462m^3/d. The CAR licence dry weather flow has not to exceed 1,364m^3/d.

Overview of treatment works process

The inlet works consist of a CSO chamber, an open channel inlet screening system with 2 (No.) fine screens and a grit removal plant, designed to receive 110l/s and pass forward flows of 95l/s to PSTs for further treatment.

An inlet flow control modulating penstock is provided at the outlet of the CSO chamber to pass forward all the incoming flows below

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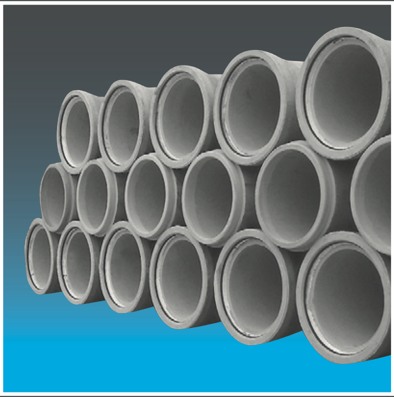
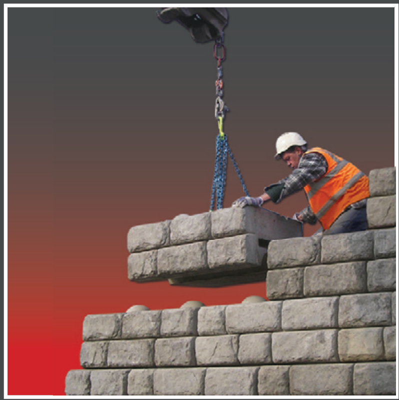


Drainage



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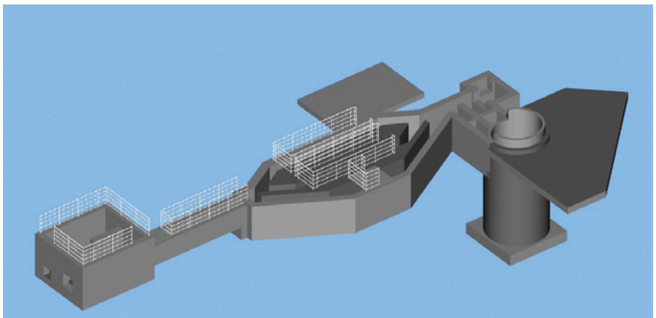

Figure 2: Digital Engineering model of the DfMA sections used in the construction at Mauchline STW - Courtesy of Laing O'Rourke

Figure 3: DfMA solid base slab for the grit removal trap Courtesy of Laing O'Rourke

Figure 4: Completed inlet flue channel leading to the flow splitter Courtesy of Laing O'Rourke

Figure 5: DfMA – showing the CSO chamber, inlet flow splitter channel leading to the grit removal trap - Courtesy of Laing O'Rourke

Figure 6: Installation of the flow splitter channel - Courtesy of LOR

110l/s to the inlet screening channel and divert excess flows to the storm tank via a 6mm weir-mounted screen.

The treatment works also contains a storm storage tank, primary treatment consisting of PSTs, secondary treatment including an aeration tank and a FST, trickling filters and humus tanks.

The final effluent discharges to the River Ayr through an outfall at the west end of the works. Flows up to 3 x DWF pass forward to full treatment, flows above 3 x DWF overflow at the 6DWF and 3DWF weirs routed to the storm tank.

Electrical supply

A 415V 3-phase supply is laid underground to the main control pump house. Electricity is supplied to all plant equipment from here and can be operated locally. The main incoming supply from Scottish Power is located in the switch room electrical mains building at the top side of the works. In 2014, a new 400v, TPN, 50HZ iMCC/main switchboard was installed by Laing O'Rourke at the top of the works to power the new inlet works, as well as to back feed the existing switch room to supply the rest of the site.

Logistics

The primary challenge on the Mauchline site was logistics and the lack of storage areas, as it is located at the bottom of a valley, with hilly access and egress. Therefore a *'just-in-time'* approach was implemented to mitigate any risk and Laing O'Rourke opted to design the new inlet works using a Design for Manufacture & Assembly (DfMA) approach.

Delivery approach

Laing O'Rourke and Scottish Water worked together with the DfMA design and construction approach enabling the design phase to be agreed much earlier, therefore reducing the programme and reducing on-site working-hours. This made the construction inherently safer and reduced the site carbon footprint through the early involvement in design allowing raw material wastage to be driven out from the outset, while maximising recycling throughout the manufacturing process.

The DfMA solid wall construction components for the combined sewer overflow (CSO) chamber included geometric blocks to form the flow splitter channel, solid slab and wall construction for the grit removal trap with a conical base section greatly reducing the need for on-site shuttering, and steel fixing activities and reduced requirement for working space excavations which was key given the logistic of the site and the relatively narrow strip of ground between the upper and lower tier of the site at which the majority of works took place.

The use of Digital Engineering on the project enabled the staff and workforce to visualise the more complex elements of the works and analyse pre-construction, where interface issues may have arisen and where developing connection details needed to be focused upon. The model allowed the site to carry out pre-construction checks of each section of the works for compatibility of the package plant items supplied by Scottish Water framework contractors and facilitated early detection of clashes and dimensional discrepancies.

This allowed the site to initiate changes and interventions in the virtual world rather than costly and time consuming reworking and procurement route delays also promoting steel working sub-contractor early involvement i.e. grills, steps, hand rails and secondary steel work. Sections through and rotational virtual tours were also incorporated in to visual task sheets to promote safe, right first time construction.

Construction phase

The CSO chamber was constructed using solid wall components *(see figure 3)* complete with pull out bars for connection to the inlet channel walls, supplied by Bison Manufacturing Ltd. As a result these were erected in a much shorter period, using a crane to lift the walls into position onto the previously poured in situ concrete base slab.

Corner joints/junctions had full height dowel bar (H12), inside a Pfiefer VS PLUS box, 20mm nominal joint filled with Thixotropic joint filler to seal the joints. The downstream external facing wall incorporated pull out bars (H12s at 150mm centres) to tie into the flume channel formed immediately downstream of the CSO.

The inlet flume channel *(see figure 4)* was formed in situ with a preformed stainless steel flume former incorporated to ensure dimensional and cross sectional accuracy.

The main body of the works, *(see figures 6-9)* the inlet channel outer walls, flow splitter channels and screen bases, were formed using complex geometric blocks.

The inlet channel outer walls were positioned, lined and levelled, dowelled and grouted to form structural tie-in detail for incorporation into the in situ concrete base which overlaid the horizontal leg of the precast L-shaped section of the retaining walls. This base in turn supported the DfMA flow splitter blocks.

The geometric flow splitter blocks, complete with rebates for penstocks and incorporating Wells Tube voids to take 63mm dowel bars to tie the structure together vertically, were then craned into position. Using the same detail as the CSO for filling the external wall joints the flow splitter structure was formed in 4 (No.) layers at 300mm thick sitting on levelling shims and grouted with non shrink, free flowing grout.

The final section of DfMA was the assembly of the precast base slabs complete with starter bars, profiled walls and circular chamber complete with conical deepening for the grit removal plant - *(see figure 10)*.

These components were supplied by a specialist precast supplier and had rebates, recesses and penetrations preformed to obtain the level of accuracy and uniformity required to position the package plant from Ovivo (now Jacopa), slot in the penstocks and achieve planned tie in to the adjacent structural elements.

The overall inlet works construction was completed by casting in situ stitch wall sections between the CSO, flume channel, flow splitter walls and channels and the GRP.

Conclusion

The project gained CAPEX 3 approval in October 2012 and construction started in December 2013 by Scottish Water Solutions' (SWS) in-house delivery partners, Expanded, CHt and Jacobs. The project was completed in March 2015 and was signed off by Scottish Water with plant acceptance in April 2015.

Jim Clarke of Scottish Water Solutions said:

> *"The successful completion of this project demonstrates the importance of good relationship building between all stakeholders"*

The total investment was in the region of £3.1m.

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Figure 7: Flow splitter channel installation - Courtesy of Laing O'Rourke

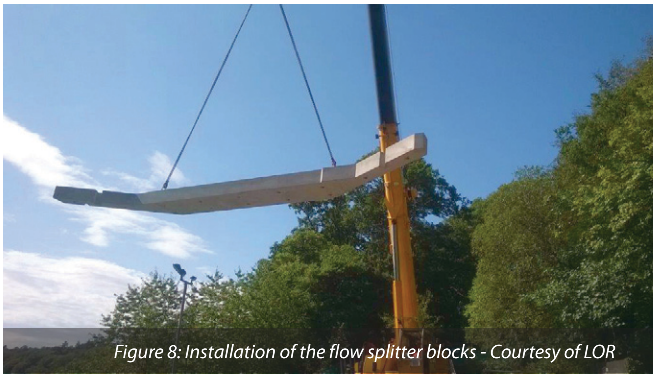

Figure 8: Installation of the flow splitter blocks - Courtesy of LOR

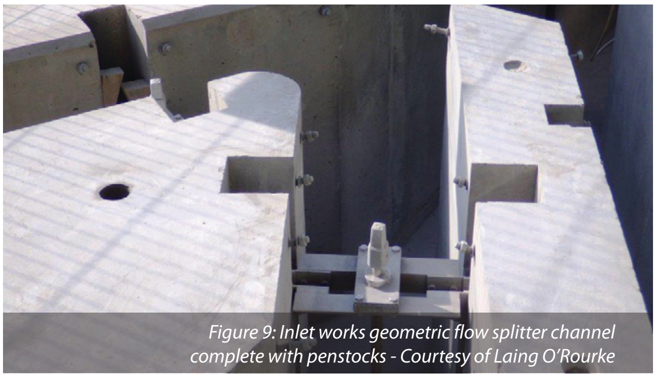

Figure 9: Inlet works geometric flow splitter channel complete with penstocks - Courtesy of Laing O'Rourke

Figure 10: Precast solid wall and base slab from CPM used to form grit removal trap - Courtesy of Laing O'Rourke

Figure 11: Completed new inlet works at Mauchline Courtesy of Laing O'Rourke