Meadowhead & Stevenston Stormwater Transfer

new stormwater drainage systems improve quality of rivers and bathing water in Kilmarnock and Irvine, Scotland

by Alastair Graham MSc CEng MICE

Within the towns of Irvine and Kilmarnock, poor water quality and aesthetic failings were identified in inland and coastal watercourses namely the Kilmarnock Water, River Irvine and the bathing waters of Irvine Bay. The environmental drivers for this scheme are the Urban Wastewater Directive, Bathing Water Guideline & Mandatory Standards and the Water Framework Directive. Studies carried out by Scottish Water identified sources of diffuse pollution entering the watercourses impacting water quality. During heavy rainfall, stormwater from several combined sewer overflows spilled into the local river systems. These Unsatisfactory Intermittent Discharges (UIDs) became the subject of a programme of investigation and analysis to determine the best solution to reduce these overflows and improve the water quality for more than 80,000 people in this area.

Installation of 10,000m³ storm storage tank at North Lodge, Kilmarnock - by Hawkeye Photography - Courtesy of Scottish Water

Individual Drainage Area Planning (DAP) models were used to build a large catchment hydraulic model which in turn was used to confirm the needs identified by the Scottish Environment Protection Agency (SEPA). Hydraulic modelling was managed by Halcrow and the model was subjected to a process of verification and independent audit.

An extensive Value Management process was utilised by Scottish Water in assessing the range of solutions proposed to resolve the water quality and aesthetic failings. Following a tender process the design and construct contract for Meadowhead and Stevenston was awarded by Scottish Water to joint venture contractor Morrison Black & Veatch (MBV) in November 2010.

Scheme description

The design solution adopted includes the following key components:

Kilmarnock Riverside Transfer Scheme: The existing Cheapside Street CSO is to be abandoned. An existing 600mm diameter sewer is supplemented by a new 900mm diameter parallel storm sewer laid over a length of 500m in the Kilmarnock Water. At Howard Park the new storm sewer picks up another connection and continues as a 1,350mm sewer through the park, into a residential area and crossing the site of a former carpet factory. The pipe increases to 2,100mm diameter and continues in a tunnel beneath the A71 dual carriageway before discharging to a new pumping station at North Lodge.

Irvine Valley Transfer Sewer: The new North Lodge Pumping Station will pump up to 900l/s directly via a new 1,000mm external diameter PE pumping main/pressurised gravity sewer to a new screening facility at Meadowhead WwTW. The rising main is 7.8km in length laid in open farmland and crossing roads, a river and a railway.

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Flows in excess of 900l/s are discharged via a 6mm mechanical screening chamber into a new storm tank which, together with the pumping station wet well and associated pipework, provides a stormwater storage capacity of 10 million litres. The storm tank comprises 16 (No.) 2.6m internal diameter Weholite plastic pipes each 96m in length, laid in a grid or 'radiator' pattern and connected by manifolds at each end. In storm events of greater than a 1 in 5 year return period if the tank capacity is exceeded, twin 1,350mm overflow pipes carry the flow to a new outfall spilling to the River Irvine. Once a storm event has abated the stored stormwater is pumped forward to Meadowhead for screening.

Irvine East Bank Transfer Scheme: In this element of the scheme, 9 (No.) unsatisfactory intermittent discharges (UIDs) are addressed as well as the construction of 2 (No.) new stormwater interceptor sewers, collecting storm flows and transferring them by gravity to 2 (No.) new pumping stations.

The Irvine Sports Club Pumping Station has a 700l/s capacity and the Milgarholm Pumping Station has a 200l/s capacity. At peak rainfall events the combined 900l/s flow is transferred via a new 700mm diameter increasing to 800mm diameter pipeline 4.2km in length to Meadowhead Wastewater Treatment Works. This element of the works includes 5 (No.) pipelines laid by tunnelling techniques including one under the River Irvine. Tunnelling work was carried out under separate sub-contracts by Ward & Burke and AE Yates. The work is mainly in urban areas.

Meadowhead Inlet Works: The new stormwater screening facility accepts pumped flows up to 1,800l/s combined from Irvine and Kilmarnock at a new inlet chamber from which the flows gravitate to the 6mm escalator screens. The 3 (No.) lane screening chamber discharges flows to a downstream manhole connecting to the existing final effluent pipeline from Meadowhead WwTW. The combined flows are conveyed by gravity to the existing Gailes Pumping Station and discharged by a long sea outfall. In the event of screen failure or blinding at Meadowhead a 15mm bar screen bypass overflow is provided.

Construction Challenges

One of the greatest challenges has been the large geographical area covered by the project with many different work fronts in operation at any one time. This creates logistical and management challenges for delivering the project and maintaining a very high standard of health and safety. A Project Charter was drawn up at the start by Scottish Water and MBV giving commitments to health and safety, stakeholder needs and sustainability. A huge effort has gone into the project through regular toolbox talks, stop-shift briefings and a real commitment by the integrated joint venture team to deliver a safe and successful project.

Ground conditions

The site at North Lodge, Kilmarnock, is an area of past extensive mine working activity, much of it prior to 1850 when keeping plans of mines became a statutory requirement. Most of the mine workings are uncharted with their exact location and condition unknown. Boreholes sunk at the site confirmed the presence of shallow 'stoop and room' coal workings. In this method of coal extraction, pillars or 'stoops' of coal are left in place to form support to the roof. Voids or 'rooms' remain open on abandonment of the workings. The voids create a risk of collapse of mine workings leading to a progressive strata collapse and the appearance of crown holes at the surface – potentially underneath our proposed structures.

There was an added risk that ground permeability in this area of coal workings would cause unpredictably high levels of flow leading to inundation of open excavations. These risks were deemed unacceptable for both long term stability and for construction purposes. Advice on this matter was sought from Donaldson Associates Ltd and from JWH Ross & Co Ltd.

New storm inlet works, Meadowhead Treatment Works, Irvine
By Hawkeye Photography - Courtesy of Scottish Water

Storm transfer pumping station, Milgarholm, Irvine
By Hawkeye Photography - Courtesy of Scottish Water

Storm screens and compactor unit at Meadowhead Inlet Works, Irvine
By Hawkeye Photography - Courtesy of Scottish Water

Storm screens at Meadowhead Inlet Works, Irvine
By Hawkeye Photography - Courtesy of Scottish Water

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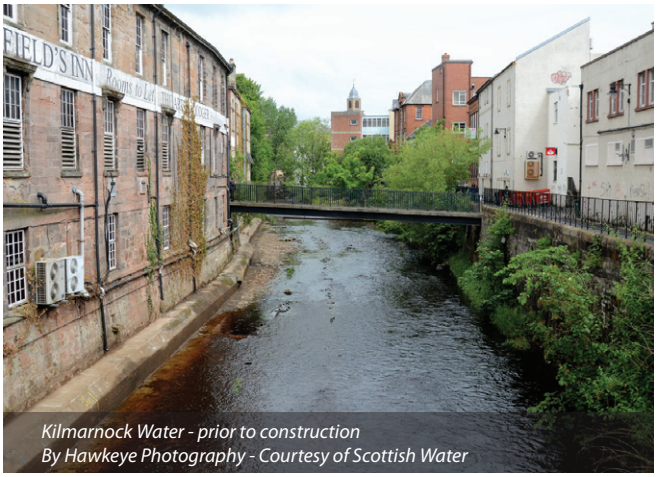
Installation of 1,350mm gravity sewer by tunnelling at Barbadoes Place, Kilmarnock - By Hawkeye Photography - Courtesy of Scottish Water

Construction of storm storage tank & pumping station at North Lodge, Kilmarnock - By Hawkeye Photography - Courtesy of Scottish Water



Kilmarnock Water - prior to construction By Hawkeye Photography - Courtesy of Scottish Water

Kilmarnock Water - new storm sewer installed By Hawkeye Photography - Courtesy of Scottish Water

A decision was taken to proceed with a programme of drilling and grouting in a predetermined grid pattern at the planned location of the storage tank and pumping station. The grouting was carried out in two phases; first bulk grouting to fill voids created by the mine working, followed by pressure grouting to reduce the permeability in effect forming a perimeter grout 'curtain' prior to opening the ground. The intention was to reduce any groundwater inflow to the excavations to manageable levels.

This specialist operation by sub-contractor Vinci lasted three months and required 2,800 holes and 6,500 tonnes of grout employing six drilling rigs at the peak, and concluding with a programme of permeability testing to confirm that the necessary permeability had been achieved. Subsequent excavations proceeded with manageable levels of groundwater ingress and only one small area requiring a second visit by the grouting team.

Stormwater storage tank

Design and construction of the stormwater storage tank presented a particular problem. The site selected had several constraints; for example the hydraulic operation of the system and the site locale being within a designated flood plain.

The original design of a rectangular reinforced concrete open topped storage tank located on higher ground was changed to the Weholite solution of a buried plastic pipes in a 'radiator' pattern. This buried tank solution leaves very little visual impact and allows land above to be returned to agricultural use. It did not require planning permission, and it does not take up any of the flood plain capacity. From initial excavation to completion of backfilling took only three months, compared to fourteen months for the construction of the alternative concrete tank solution. The Weholite suppliers, KWH Pipe and Asset International, have confirmed that this storage tank is the largest of its type worldwide.

Pipelaying

The pipe laid in the bed of Kilmarnock Water has proved particularly challenging. The original design proposal had around 150m of pipe laid in the river, connecting the Cheapside Street CSO removing this significant source of river pollution. Contractor MBV elected to extend this pipe in the river to 500m, thereby avoiding laying the pipe in tunnel through the oldest part of the historic town centre which would have inevitably caused disruption to many shops, businesses and residents. The selected alternative route was constructed over two summer seasons due to restrictions imposed due to the salmon spawning season. The winter months in any event would be too wet to have allowed reasonable pipe laying progress to have been achieved.

Temporary works in advance of pipe laying included forming a stone haul road on geotextile matting laid directly on the river bed. Sheet piling in the river assisted with temporary dewatering allowing the construction of shuttering for the concrete surround to the PE pipe. The squads engaged in this work all wore lifejackets over the normal PPE. A system of automated river level monitoring was deployed, whereby in the event of a rising river level upstream an automated text is sent to the worker's mobile phones giving them adequate warning to leave the site before the river level reaches unsafe levels.

An unusual aspect to the river works was the removal of fish with the help of local angling associations by a process of electro-fishing to stun, trap then release over 1,500 fish from this stretch of river.

Community engagement

The engineering challenges were matched by the challenges of stakeholder management. The development and delivery of the project has at each step taken into consideration the concerns of residents, landowners and businesses. The initial site investigation was the largest undertaken by Scottish Water.

Early consultation with around 1,300 customers paved the way for project delivery following the principle of 'no surprises'. Building and maintaining strong relationships with customers has been fundamental to the project's success. In both communities of Irvine and Kilmarnock the new pipeline ran close to primary schools. The project team visited the schools, gave education talks and safety advice and provided project updates. Competitions were held and prizes were given to the children who named our two tunnelling machines '*Twirling Tina*' and '*Bella Borealot*'.

Open forum events were held in Irvine, Gatehead and Kilmarnock to promote the environmental benefits, allowing people to meet the project team and find out how they might be affected during construction. Presentations were made to councillors in the two council areas affected by the project with repeat visits to provide updates.

The team worked closely with SEPA and with the Ayrshire Rivers Trust throughout the development and construction phases. Scottish Water has provided regularly updated information about the project with press releases, newsletters, site information boards, posters in libraries and update letters delivered to homes as well as providing information via the internet, Twitter and Facebook. The site hosted a visit by 3rd year pupils from Kilmarnock Academy who were given a site tour and the opportunity to experience some hands-on engineering with setting out, cable detection training and a spaghetti tower construction challenge. This was well received with several of the young students expressing an interest in a career in engineering.

The Royal Borough of Irvine holds an annual Festival of Marymass dating back to the middle ages, including a week of pageantry and events, a race meeting and a hugely popular fair attracting thousands to the Towns Moor. The moor was the site of several hundred metres of pipework for the new storm system including deep shafts and CSO chambers. Early contact with the landowner and festival organisers by the project team gave comfort that this festival would keep its place on the calendar. Reinstatement was successfully completed and a local councillor thanked Scottish Water for 'fast work on the moor'.

Conclusion

The Irvine phase of the project completed commissioning and entered into service in October 2012. The project enters the final phase of construction and commissioning in July 2013 with wet testing of the pumps at North Lodge Kilmarnock using abstracted river water. At peak flow, the pumps will deliver 900l/s via the 7.8km rising main to Meadowhead.

The Meadowhead and Stevenston project is Scottish Water's largest ever stormwater transfer scheme. Following a construction period of some 33 months, the construction of 12 miles of pipeline, three substantial new pumping stations, a 10,000m^3 storage tank and several new Combined Sewer Overflow (CSO) structures will bring significant environmental improvement to rivers in Kilmarnock and Irvine and to the coastal waters of Irvine Bay.

The project team has been recognised for their performance both at a very local level, with congratulatory messages from schools, from North Ayrshire Council and other stakeholders, but also at industry level. The project gained the Galliford Try Infrastructure Excellence Award for 2011. Scottish Water's delivery partner Morrison Black and Veatch has been recognised with two RoSPA Gold Awards and one Gold and three Silver awards from the Considerate Constructors scheme. The site was chosen as runner up to Most Considerate Site in 2013.

The Editor & Publishers would like to thank Alastair Graham, Senior Project Manager with Scottish Water, for providing the above article for publication.

Construction of storm sewer pipe in Kilmarnock Water - by Hawkeye Photography - Courtesy of Scottish Water