Greatstone - First Time Sewerage Scheme

vacuum station built in former car park

by
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The Urban Waste Water Treatment Directive (UWWTD) requires that all conurbation with a resident population of 2000 or more should be connected to the public sewerage system. The population of Greatstone-on-Sea and Lydd-on-Sea in Kent is 2500. Most of the properties dispose of their foul wastewater via septic tanks. Although Southern Water has a statutory duty to install the new public sewerage system, there is no obligation on the residents to connect to it. Greatstone is surrounded by environmentally sensitive areas, including Dungeness Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSIs), The only areas where construction was permitted was in the roads and on existing built-up-areas. However, the main road through Greatstone is an important access road to Dungeness Power Station so it was not possible to completely close it. Similarly, residential access had to be maintained to all areas during the course of construction.

Greatstone Vacuum Pumps *courtesy 4D Delivery Ltd*

4Delivery, a consortium comprising United Utilities, Costain and Montgomery Watson Harza, took on the job of carrying out this multi-million scheme as part of £750 million worth of environmental and water quality improvements throughout Kent, Sussex, Hampshire and the Isle of Wight on behalf of Southern Water

Feasibility design

The Greatstone catchment is 5km long but very narrow. It is also very flat with only one metre difference in level from one end of the catchment to the other. A convenient gravity sewerage system would require a total fall of approximately 30m to drain the length of the catchment, entailing laying sewers in open cut trenches up to 3m deep and constructing 31 small pumping stations to lift the flow every 200m. Alternatively, four deep pumping stations over seven metres deep would have been required with tunnels connecting the chambers and shallow rider sewers and smaller pumping stations to enable the properties to connect. This would have been prohibitively expensive and due to the environmental constraints would have been virtually impossible to construct. For these reasons it was decided to install **a vacuum sewerage system.**

Vacuum sewerage

Vacuum sewerage systems have been used for over a century but are not generally used in this country because, although they can offer significant savings in capital costs, they are more difficult and expensive to run than conventional gravity systems.

Vacuum sewers are laid at a shallow gradient with 300mm lifts every 100m. The vacuum system operates at 0.6 bar vacuum at the vessel with a minimum of 0.3 bar required to operate the vacuum valves in the collection chambers. There is consequently a limit of about 3m, depending on distance from the station, that the sewerage can be raised.

Wastewater flows from properties by gravity into underground collection chambers located in the highway. From here a vacuum station is required to draw the sewerage to a collection point and then pump it on for treatment. In this case the vacuum station had to be located in the middle of the catchment as the maximum distance a vacuum sewer can operate is approximately 3.5km.The only suitable location for the vacuum station that did not infringe environmental restrictions was at an existing car park as this area was already developed. A condition of planning consent was that the existing toilet block located in the car park be demolished and reconstructed as part of the new vacuum station.

Rockbourne Environmental vacuum sewerage underpins Greatstone project

Rockbourne Environmental, working with 4D, has installed the largest vacuum sewerage system currently under construction in the UK. The 14-kilometer vacuum sewer network will serve the Kentish towns Greatstone and Lydd-on-Sea.

Wastewater from 1074 houses and two pubs connected to the network will flow by gravity to collection chambers for release into the vacuum sewer prior to being pumped to New Romney Wastewater Treatment Works for cleaning and recycling back into the environment.

Vacuum sewerage is required in the Greatstone/Lydd-on-Sea area because the land is flat, making traditional gravity systems expensive. Not only would the scheme require several pumping stations but also costly deep trenching in the shingle on which the houses are built.

Martin Roche, Operations Director, Rockbourne Environmental notes: "Our new-design collection chambers, combined with vacuum sewers and central vacuum station, provide the most cost-effective solution for first-time sewering at Greatstone".

The network comprises vacuum sewers, installed at depths of up to two metres, connected via 421 custom-designed vacuum collection chambers to a single vacuum station.

Rockbourne has installed numerous vacuum sewerage systems for sewage and effluents collection from houses, industrial estates, commercial and leisure complexes.

Located on Coast Drive in the Lade car park, this pumping station contains three 15kW pumps, a 20m³ vacuum tank and a pneumatic discharge system.

The company is currently undertaking an integrated vacuum sewerage system and MBR treatment plant for a large new housing development that offers the client many technical benefits and cost savings. Projects at feasibility stage include hotel and leisure resorts – in the UK and overseas – marinas, railway stations and research facilities.

Two unique applications very relevant today are flood-proof foul drainage – vacuum sewers continue to work even with the chambers under many feet of surface/flood water - and contained leak-free drainage for effluents with viruses. Our global partners have installed vacuum systems at Palm Island (Dubai), Beijing's F1 circuit and several Olympic villages.

For further information, contact Rockbourne Environmental on Tel: 01202 480980 or visit www.rockbourne.net

Design Details

The Greatstone first time sewerage scheme is primarily a vacuum sewer system consisting of four sub-catchment areas. Each sub - catchment is separately served by a network of polyethylene vacuum sewer mains. The vacuum mains terminate at a single vacuum station. Wastewater is discharged via an ejector system, into the existing gravity sewerage system serving the adjacent catchment.

A vacuum interface valve and a high level alarm is provided for each sewage collection chamber. A PC workstation-based valve monitoring system will be used to assist in system optimisation.

The proposed vacuum station building is a single storey building comprising of a basement housing the vacuum vessel and ejector vessels with the vacuum pumps, compressors and control panel located at a ground floor level.

The pumps to be installed within the vacuum station comprise: three vacuum pumps and two compressors for the ejector system and a small compressor for the pneumatically operated valves. The vacuum/sewage vessel will be monitored for low vacuum and high sewage conditions. A “Low Vacuum Lockout” and a ‘High Sewage” telemetry alarm shall be initiated (respectively) when all the system auto-recovery programmes fail to reset normal overall system operation.

The initial number of properties connecting to the new public sewerage system at the time of commissioning is expected to be relatively low, which will result in the system initially operating at 20% of the design capacity. One consequence of this is that with a conventional pumping main the sewage would remain in the rising main for over 36 hours. This would result in the sewage becoming septic, causing odour and operational problems. Chemical dosing was considered but this would have required chemical deliveries to the vacuum station which is in a public car park. It was, therefore, decided to install an ejector system which transfers the flow with compressed air. This has the advantage of keeping the sewage aerated and preventing septicity. The ejector system can also be used to empty the delivery main at least once a day.

Operation of vacuum system

On registering a low vacuum in the sewerage system, the PLC will activate one of the vacuum pumps which will draw air out of the vacuum chamber and discharge it through a biological odour filter. If the required vacuum pressure is not reached a second pump will be activated. There is also a third pump which could be used if one of the duty pumps fails.

There are 423 collection chambers connected to the vacuum system. Up to four properties will be connected to each collection chamber through a gravity lateral connection. As wastewater is discharged to the collection chamber the water level in the chamber rises, this causes the pressure in a sensor tube to rise and when it reaches a pre-set level the pneumatic controller causes the vacuum valve to open.The wastewater is evacuated down the vacuum line and the vacuum valve remains open for several seconds to allow a volume of air into the system.The air at atmospheric pressure behind the wastewater pushes it along the vacuum line towards the vacuum station.

The vacuum line is laid at a gradient of not less than 1:500 for 100 metres or so and then a sharp rise brings the sewer back to the original level. This is known as a ‘sawtooth’ profile. When a valve operates a volume of waster water will be drawn into and along the sewer until the pressures equalise. The wastewater will then sit in the bottom of a sawtooth blocking the pipe until another valve operates releasing

Greatstone Vacuum Pumps *courtesy 4D Delivery Ltd*

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more water and also more air into the system which causes the wastewater plug to be pushed up the sawtooth slope and along the pipe. Eventually the wastewater reaches the vacuum vessel in the station.

Operation of the ejector system

Wastewater entering the vacuum vessel gravitates from there into one of the two ejector vessels. When the water reaches the required level the valves between the ejector vessel and the vacuum vessel will close, the valve to the discharge main opens, the compressor starts up and the wastewater is ejected down the delivery main. While one vessel discharges, the inlet to the other ejector vessel will be open receiving flow from the vacuum vessel for the next cycle.Main items of plant.

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- **14km of 90-225mm dia vacuum sewer;**
- **3km of 200mm dia rising mains;**
- **423 No. 330 litre collection chambers;**
- **1 No.20 m3 vacuum vessel;**
- **2 No. 1750 litre pressure vessels;**
- **3 No. 15kW vacuum pumps;**
- **2 No. 18.5kW compressors for the ejector system;**
- **1 No. 1.7kW compressor for the pneumatic valves;**
- **1 No. 14.7 m^3 odour control biofilter;**
- **1 No. 1.65 m^3 air release silencer.**

Construction

Almost the entire vacuum sewer construction is in an area of free running beach shingle. Although the vacuum sewer trench depth was only 1 to 1.5m, the loose shingle caused difficulties in maintaining the sides of the trenches and necessitated close sheeted trench supports. The collection chambers were constructed using pre-cast concrete manhole rings sunk as caissons. The polypropylene chambers were concreted into the rings to provide support for the chamber walls and to resist flotation. The roads are predominantly of reinforced concrete construction so the trench opening had to be saw cut for nearly the entire depth of the concrete to mitigate damage to adjacent properties caused by vibrations from breaking out the surface.After laying the pipes and backfilling, replacement reinforcement in the road had to be lapped with the existing to maintain continuity of the road.

Traffic management

Traffic management was a major issue on the scheme. One of the conditions of planning consent was that the main coast road could not be closed as it is an emergency access route for Dungeness Power Station.

Services

The vacuum sewerage system has an advantage over a gravity system as the height and position of the ‘sawtooth’ can be adjusted to cross over or under other mains. There were, however, difficulties with services crossing the roads as, frequently they were laid at shallow depth because of the problems with supporting trenches. In some cases, service pipes were located just below the concrete road service. This necessitated extreme care in ‘breaking out’ of the road construction.

Progress

Construction of the new public sewerage system commenced in October 2005 and is planned to be operational by Spring 2007. In parallel with this, work is continuing with construction of a new gravity sewerage system for the adjacent community of New Romney, which together will provide first time drainage for up to 1,900 properties.■

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