

Thanet Adits Phase 2 - Modelling Collaboratively in the Design & Build Phase

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Introduction and Background

100 years ago, rather than install the public sanitation system for the Isle of Thanet using a conventional trench system, miners dug an extensive network of deep underground tunnels (adits) through the chalk to install sewers and maintain a predominantly gravity network. The combined sewers were simply laid on the floor of the tunnels and the tunnels left open at manhole locations. It would appear to have been acceptable practice at the time of construction for storm waters to flood into the tunnels and dissipate through the tunnel walls and floor. This extensive interconnected adit system is a unique sewer system in the UK and has its challenges for both network maintenance and for modelling.

Sewage is able to enter the adit tunnels via the following:



1. physical damage to the sewers (for example broken pipes, failed laterals and joints) within the tunnels allowing sewage to escape
2. many of the manholes at the entrances to the tunnels are open allowing sewage in surcharged conditions due to wet weather or other factors to enter the chalk tunnels.

Due to the permeability of chalk, the sewage in the chalk network is at risk of exfiltrating from these chalk tunnels into the ground and contaminate a critical aquifer approximately 10-20m below the tunnels. This aquifer is used for drinking water and is in a nitrate vulnerable zone (NVZ) which with considerable contribution from the agricultural industry has resulted in two boreholes in the area to be unable to be used.

As a result of this, there is a lot of pressure from the Environment Agency to reduce the risk of any contributions of the sewerage network to the pollution of the aquifer. Southern Water have therefore publicly committed to minimise this risk by rehabilitating these chalk adits via sealing and lining the tunnels in a three phase, three AMP multi-million pound scheme. The challenge was to identify and prevent exfiltration of storm flows through the network of tunnels.

The three phases are as follows:

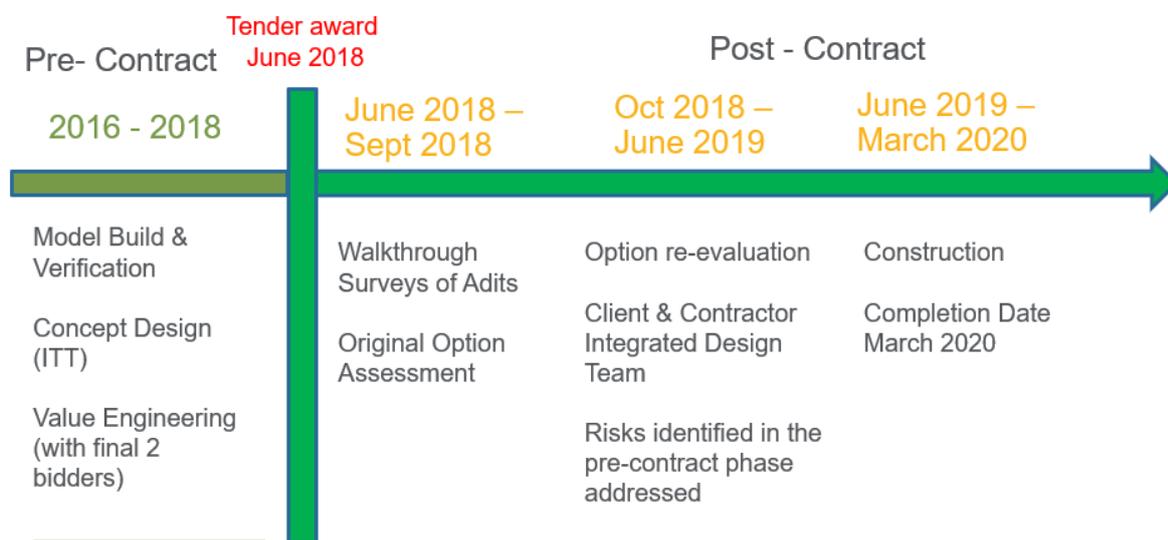
Phase 1 – rehabilitation of the chalk adits directly above the designated aquifer (£28million);

Phase 2 – rehabilitation of the chalk adits in Ramsgate and Broadstairs, directly next to the aquifer (£35million);

Phase 3 – rehabilitation of the chalk adits in other remaining catchments (Margate) furthest away from the aquifer (£30million estimation).

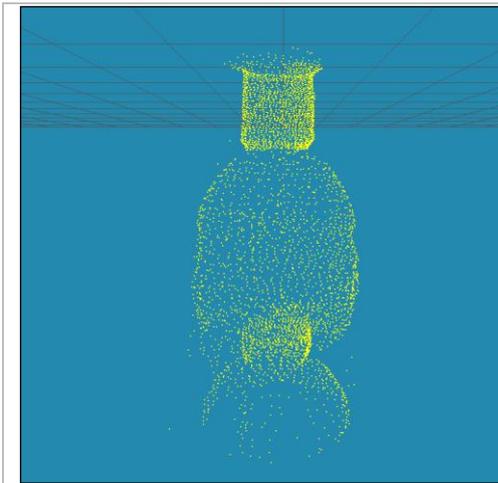
The first phase of this scheme was completed in AMP5, Phase 2 construction work is currently in progress with an EA regulation completion date of March 2020, and Phase 3 is planned to be delivered in AMP7.

This paper will focus on the Phase 2 part of the project. Phase 2 ran over the following time frame:



Pre-contract Award

As part of the concept design and Invitation to Tender (ITT) process, Southern Water Engineering Technical Solutions (SW ETS) team took responsibility for scoping the survey works and the initial optioneering stage. A review of existing data was undertaken to refine the length of CCTV surveys required. Asset data was also used to eliminate a number of pipes based on age and function. Due to the depths of these chalk tunnels which is 15m deep in places, 184 of the manholes were vertically scanned in 3D using an innovative 360° panoramic camera; this saved 92 hours of confined space entries. The output formats included point cloud data and “unwrapped images” as shown in figure below, which allowed adit dimensions and condition to be assessed.

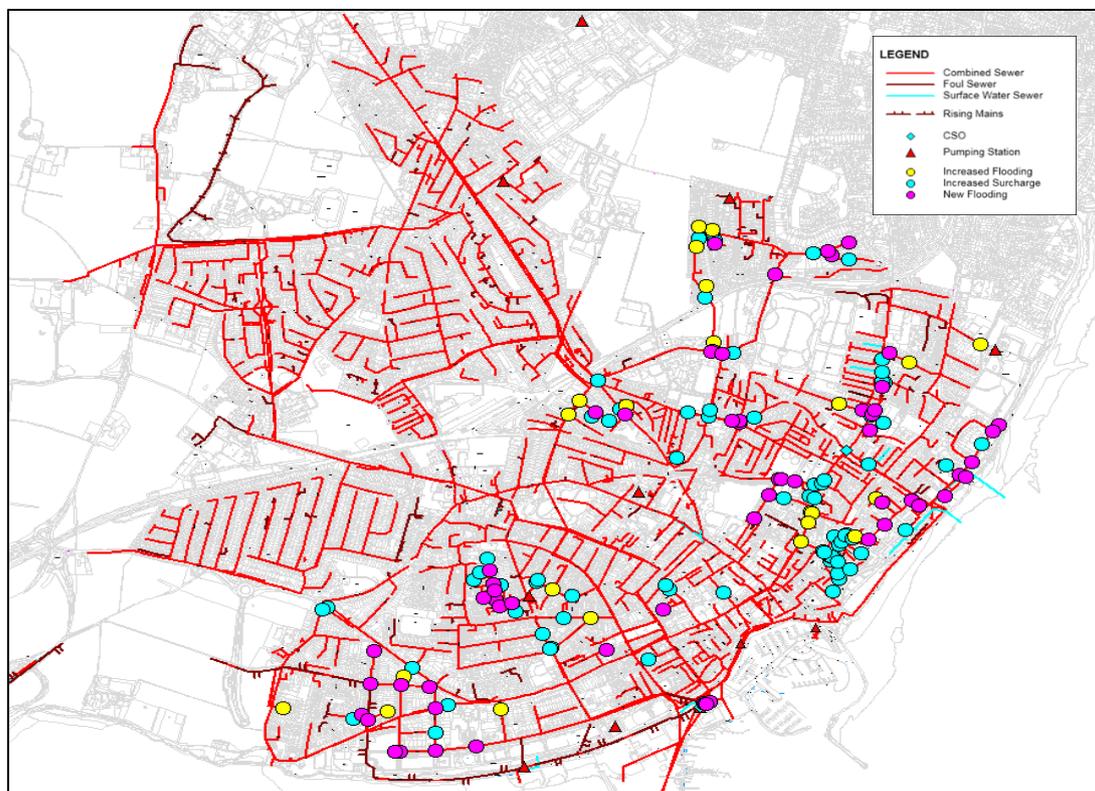


Point cloud data from panoramic scan.



"Unwrapped" 360° manhole image.

SW ETS hydraulic modelling team carried out model update using survey data and model verification based on a short-term flow survey. A historical verification was also carried out to further improve model prediction accuracy. A concept of design was prepared for the Invitation to Tender (ITT) stage. In order to eliminate the exfiltration risk, the easiest and cheapest option is to seal all of the adits in the network but by doing so significant extra flooding is experienced in the Ramsgate and Broadstairs catchments, in the region of 4,000m³ because of the storage loss. Figure below shows the predicted flooding in Ramsgate if all adits are sealed. Therefore, adits play very important part in the local sewer network.

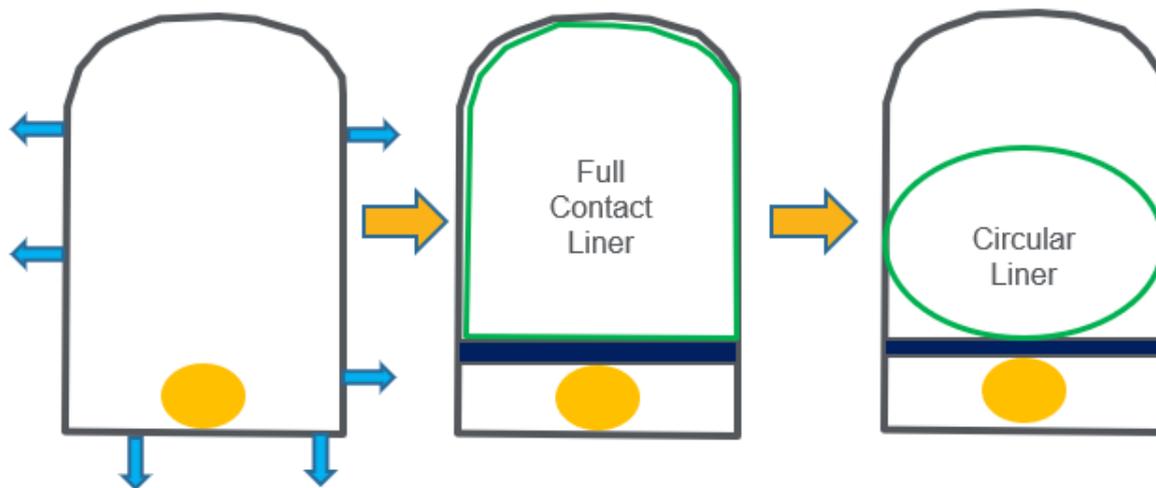


As a result, the design concept was devised. SW ETS utilised a ‘toolbox’ of options as part of concept design including: utilisation of existing adits using cure in-place Pipe (CIPP) technique; Rehabilitation of Grade 4 and 5 pipes within adits, upsizing the existing sewer, enlarge manholes and provide offline compensatory storage. Prior to the contract award, Southern Water carried out value engineer between the final two bidders. In June 2018 the contract was awarded to TPMD.

Post- Contract Award: Survey Stage

Following the award of the design and build contract to TPMD, a full adit walkthrough survey of approximately 16km of adits was undertaken to assess the condition and determine the amount of preparation work that would be required (e.g. timber headings, rehab) to install the liners. The conclusion from these walkthrough surveys were the adits in the Phase 2 area were in a lot worse condition than anticipated, with several collapses, major dimension changes and changes in direction which were not present in the Phase 1 area.

As a result of this, the original assumption from the concept design and value engineering of using full contact liners to rehabilitate the adits was not feasible, resulting in the lining method being changed to circular.



This change to a circular liner resulted in a large loss in the amount of storage available so the option that was originally designed no longer achieved no detriment to both Ramsgate and Broadstairs. Therefore, a re-evaluation of the proposed options was required to take into account this change in lining method with the option inevitably increasing in size as a result.

Option Re-evaluation

At this option re-evaluation stage, the use of hydraulic modelling of the ETS modelling team changed to be a lot more collaborative and in partnership with TPMD. As the contractor now had the design and build responsibility, hydraulic modelling was used as a central link between both the Southern Water project team and the contractor to ensure that the views and needs of both were considered and to ensure that the EA regulation date would be met. The progress of the hydraulic modelling was constantly fed back to both the project team as well as TPMD, allowing for parallel decisions to be made, ensuring that the option re-evaluation stage was as efficient as possible.

The option re-evaluation design also gave the team an opportunity to address risks that were identified in the concept and value engineering stages and tailor the options to meet the requirements and needs of both Southern Water and the contractor. For example, the opportunity was taken to decrease manhole sizes as much as possible, prioritise lining adits in good condition to minimise the cost and hazardous preparation work required, and also use the existing sewer network in particularly Ramsgate to greater effect by raising downstream weirs to hold more flow in the network rather than build additional offline storage tanks.

Both catchments also have significant numbers of basements, and there was a risk that all were not being accounted for in the option. As a result, a walkover survey of all areas at risk of basement flooding was carried out by the contractor to identify additional basements, and a subsequent level survey was carried out to increase confidence that the basements are predicted by the model to not flood as a result of the scheme.



As the scheme increased in size due to the change to the circular liner method, the option was constantly challenged for budgetary reasons. The modelling approach was therefore changed to 2D, modelling a simple mesh over the model to quantify the overland flow paths. This was used to compare the baseline against the proposed option and to help determine and understand the above ground risk and whether the option was definitely needed.

Construction Stage

Phase 2 is currently under construction and is on track to meet the EA regulation date of March 2020.

The adits are being lined using CIPP lining, made of glass reinforced plastic which is cured using UV light. This method of construction is a no waste solution chosen due to the risks to the aquifer underneath.



As the Principal Contractor encounters conditions on site that have the potential to affect the scheme delivery such as location of services, ground conditions and clearing collapses, the close collaborative approach between the Principal Contractor and the Southern Water Project Team is continuing to ensure the optimum solution is maintained and updated until construction work is completed.