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Thursday 10th Nov 14.00 – 15.40 – Paper 3

SWMP- 'Smoking Out Stormwater'

Introduction

In September 2010 Atkins was commissioned by Southern Water Services (SWS) to undertake a Surface Water Management Plan (SWMP) study of a location on the South Coast. This study was commissioned to assess long standing flooding problems which have occurred during winter periods following prolonged rainfall.

As with most SWMPs stakeholder engagement was vitally important within this study to allow crucial data to be shared with the aim of supporting the study. Key stakeholders in addition to SWS included a residential management company, Local District Council, EA and County Council.

To assist with the evaluation of the drainage system an integrated approach was adopted to evaluate the main river, the land drainage system, public foul sewer system and private highway drainage system. In addition the influence of groundwater and tide levels were also considered. To support this analysis an integrated Infoworks CS/2D hydraulic model was developed to replicate the hydraulic performance of all drainage assets serving the estate together with the impact of tides and groundwater where data allows.

The primary flooding mechanism which affects the study area was identified and defined. High groundwater is considered to be the main trigger for surface water flooding. This impacts on the effectiveness of the soakaways in the study area which are responsible for 75% of the surface water disposal. As a consequence, this causes widespread surface water ponding and pluvial flooding which leads to inundation of the highway and foul drainage systems and overland flow of surface water. Further issues including high tides and tide locking of the main river restrict the operation of the land drainage and the highway drainage systems, thereby increasing the risk and extent of pluvial flooding in the area.

Flood mapping was completed for 1 in 1 year, 1 in 30 year, 1 in 70 year and 1 in 100 year return period storm events. In addition a Flood Hazard Map for 1 in 100 year return period event was also prepared to show the calculated risk to individuals.

Outline options were developed focusing on schemes which are most applicable based on their final potential benefit, build ability and sustainability. These schemes range from a number of lower cost initiatives increasing up to more technical and costly large scale hydraulic design schemes such as the installation of new surface water sewer system.

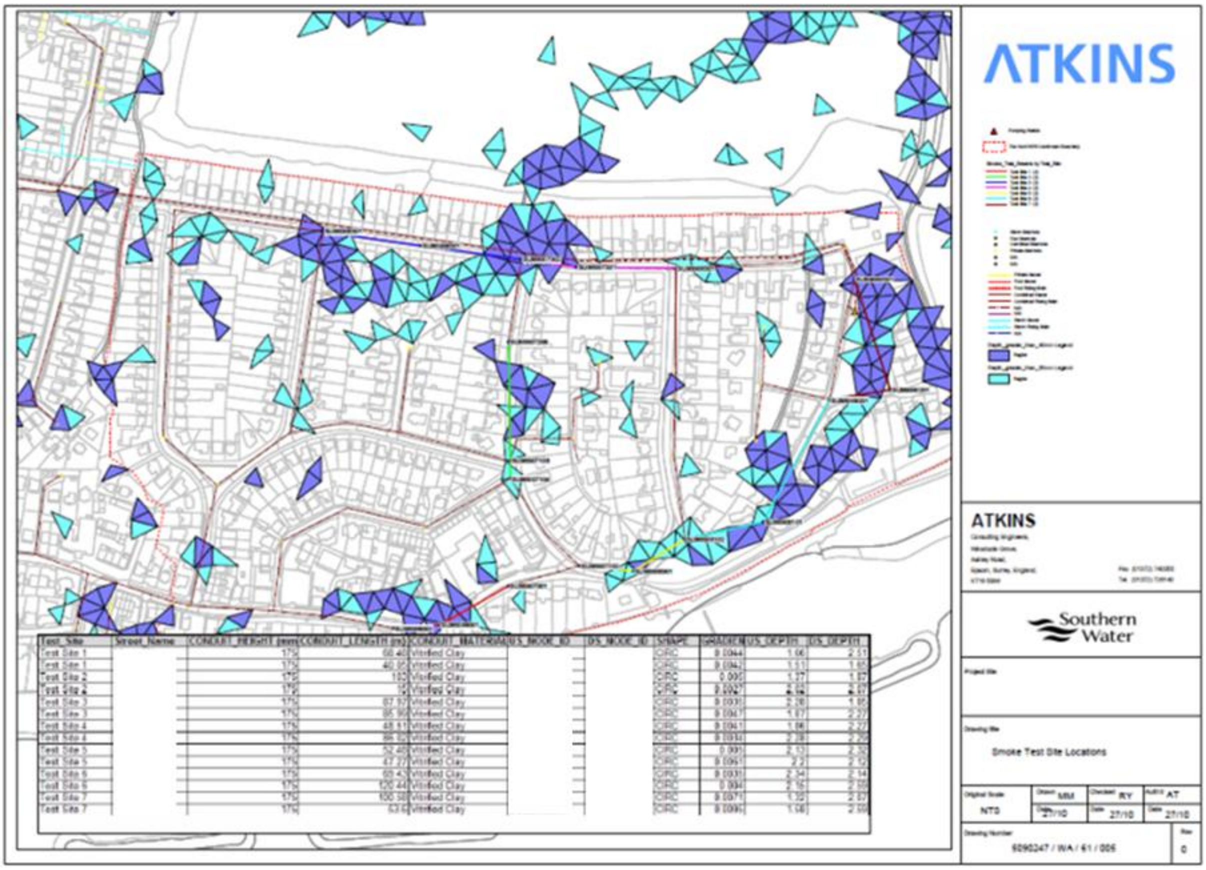
As part of this SWMP study, it was felt that direct benefit from the use of smoke testing of the foul sewers would enhance the standard IAS surveys. Results from this survey were considered important as it was suspected that large volumes of surface water were entering the public foul sewer system when flooding occurred. This paper outlines the planning, implementation and results of this survey technique, more commonly used in the USA, in relation to the study.

Smoke Testing - Planning

Smoke testing of the foul sewerage system was undertaken to supplement the dye testing and acoustic assessment techniques used during the IAS. The aim of the smoke testing was to identify likely surface water drainage connections into the foul sewer. Smoke testing in sewers is more commonly undertaken in the United States. Generally smoke testing in the UK is not typically undertaken. It should be noted that this was also the first time smoke testing in sewers has been undertaken by Southern Water Services. Dene-Tech completed the smoke testing in conjunction with the IAS and the results of this survey were used to determine surface water drainage routes from properties and gullies contributing to the final IAS results.

Seven sites were selected for smoke testing; this included the assessment of approximately 1,000 m of foul sewer. The smoke test sites were strategically selected based on a coarse 2D modelling process undertaken using Infoworks CS2D. Under simulation conditions a 1 in 5 year 30 minute stochastically generated FEH (Flood Estimation Handbook) rainfall event was applied onto the 2D generated grid mesh. This topographic grid mesh was developed using the LiDAR data. Those sites showing greatest surface water ponding and flooding (pluvial flooding) were selected as sites which held the greatest potential for contributing surface water runoff into the foul sewer through inundation of foul manholes and property gullies. Figure 1 shows the results of the coarse 2D modelling and location of selected smoke test sites. It should be noted that the smoke testing identified additional impermeable connections which were not identified using the traditional dye testing and acoustic inspections during the IAS.

Figure 1 – Smoke Test Sites



Letters were posted to all 480 properties in the study area to ensure the public were aware of the pending sewer smoke surveys. 48 hours prior to the smoke tests letters were hand delivered into the residents by the survey crew in the locations where testing was to be completed. This was aimed at maximising resident's knowledge of the surveys. The letter outlined the sewer smoke surveys being undertaken and asked that residents run their taps for 5 minutes the day prior to the smoke testing. This was to ensure water traps in their private drainage held water and offered a suitable seal to the smoke. This was particularly important as some of the properties in the study area were holiday lets and second homes and were likely to have been left vacant for a period of time prior to the surveys.

The local fire brigade were also contacted to ensure suitable communication lines and initial agreement was made. Contacting the fire brigade was considered an important activity to reduce the risk of false alarm emergency calls linked to the smoke testing activity.

Details of preparation phase of the smoke test are shown in Figure 2.

Figure 2 – Smoke Test Preparation

Smoke Testing - Implementation

The seven test sites selected for the smoke test comprised of on average 140 m of sewer. Each test site included three manholes on the main sewer. This allowed for flows to be isolated through the use of inflatable bungs on the upstream and downstream manholes. The intermediate manhole was then used as the point where gas and air was vented through into the sewer test sections. The gas then fills the drainage voids and where possible travels to the surface. Figure 3 and Figure 4 show this typical site test process.

Figure 3 – Smoke Testing Site Process

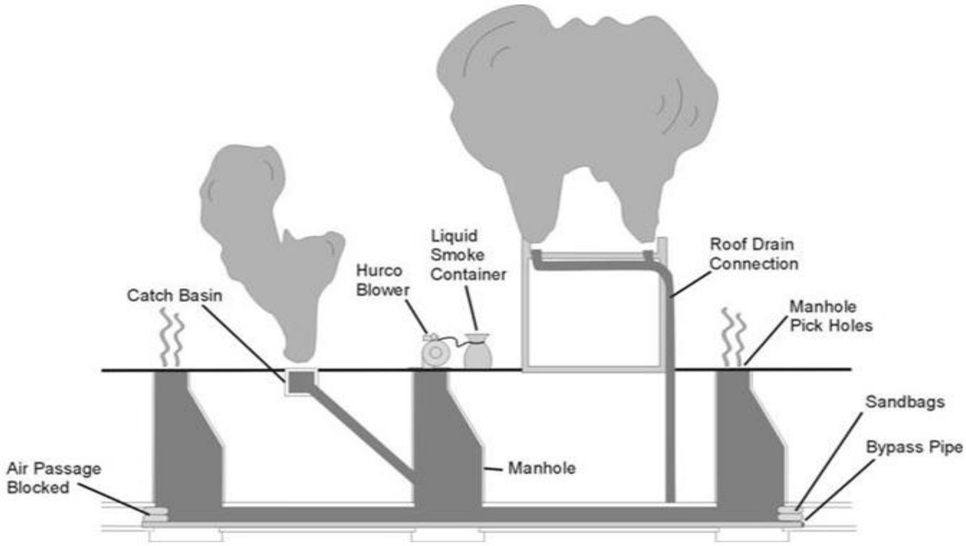


Figure 4 – Smoke Testing Site Process

Figure 5 shows smoke exiting a gully hidden in a gravel trench located in the study area. Figure 6 shows an uncharted manhole located under a paving slab which was proven to connect to the foul sewer system during the smoke testing. This uncharted manhole was found to have a poor seal and was identified as a significant source of surface water inflow into the foul sewer system.

Figure 5 - Smoke exits a hidden gully

Figure 6 – Uncharted Manhole

Smoke Testing – Results / Conclusions

Smoke testing provided:

- Identification of an uncharted manhole in the study area which is now known to have contributed significant surface water inflow into the foul sewerage system, based on the integrated hydraulic model results.
- Of the 0.5 ha of paved road and roof area identified to contribute to the foul drainage system 15% was identified directly through the use of smoke testing.
- enhanced results from the IAS.
- Increased the general public awareness of the problems and the efforts of stakeholders to investigate and remedy the flooding issues.

Smoke testing can also:

- Assist with the development of stormwater separation schemes.
- Identify structurally defective pipes given suitable ground conditions.
- Assist with identifying hazardous private drainage (ineffective traps).
- Assist with identifying system interaction (uncharted overflows, dual manholes etc).

Based on the smoke test results provided within this SWMP study we shall recommend the future use of this survey technique for similar detailed drainage evaluation studies.