Infiltration Reduction Plan
Lower Nailbourne

August 2025
Version 5.1

from
Southern
Water

Contents

Document Control

Format	Version	Date
Full Nailbourne	D1	Sept 2013
Full Nailbourne	2	6 January 2014
Full Nailbourne	2.1	21 February 2014
Full Nailbourne	3.0	24 March 2014
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Full Nailbourne	6.2	8 December 2014
Full Nailbourne	7.0	10 February 2016
Full Nailbourne	7.1	February 2017
Full Nailbourne	8.0	January 2020
Lower Nailbourne	1.0	June 2021
Lower Nailbourne	2.0	July 2021
Lower Nailbourne	3.1	August 2021
Lower Nailbourne	4.1	December 2022
Lower Nailbourne	4.2	January 2023
Lower Nailbourne	4.3	January 2023
Lower Nailbourne	4.4	December 2023
Lower Nailbourne	4.5	July 2024
Lower Nailbourne	5.1	August 2025

Glossary

AMP – Asset Management Programme
CCTV - Closed-circuit television
EA - Environment Agency
GW – GroundWater
IRP - Infiltration Reduction Plans
l/s - litres per second
MH – Manhole
ODI – Customer Outcome Delivery Incentive
RPS - Regulatory Position Statement
SW – Southern Water
WaSC - Water and Sewerage Companies
WC – Water Closet
WPS - Wastewater Pumping Station
WTW - Wastewater Treatment Works

1. Background

This Infiltration Reduction Plan (IRP) for Lower Nailbourne in the Newnham Valley catchment has been prepared in response to the Environment Agency's (EA) Regulatory Position Statement (RPS). SW has been carrying out work for many years to survey and repair sources of infiltration in the catchment for Newnham Valley Wastewater Treatment Works (WTW) in Kent.

Figure 1 shows flows to Newnham Valley WTW. In this area flows from Barham gravitate northwards through Kingston, Bishopsbourne, and Bridge. The resultant flow gravitates in a north-easterly direction to School Lane WPS in Bekesbourne from where it is pumped to Newnham Valley Works.

Flows from Littlebourne gravitate to Nargate St WPS from where it is pumped to join the gravity flow downstream of the rising main from School Lane WPS. The resultant flow gravitates in a north-easterly direction to Newnham Valley WTW in Preston. Sewage flows from adjacent sub-catchments to the north and east are also received by Newnham Valley WTW.

The repairs carried out by SW improve the integrity of the sewerage system. SW has been working with the following organisations and is dependent on their support to achieve the objective of reducing non-sewage flows into the sewers.

- Environment Agency,
- Kent County Council,
- Canterbury City Council
- Shepway District Council
- Little Stour & Nailbourne River Management Group

Southern Water has consulted with representatives of these parties in the meetings of the Little Stour & Nailbourne Multi-Agency Group and through the river management group, with all of the local parish councils.

Up to June 2021 there has been one published Infiltration Reduction Plan for the Nailbourne area covering both the Nailbourne and Elham Valleys. In discussion with the Environment Agency it was agreed that from June 2021 the Nailbourne IRP would be split to two documents Upper and Lower.

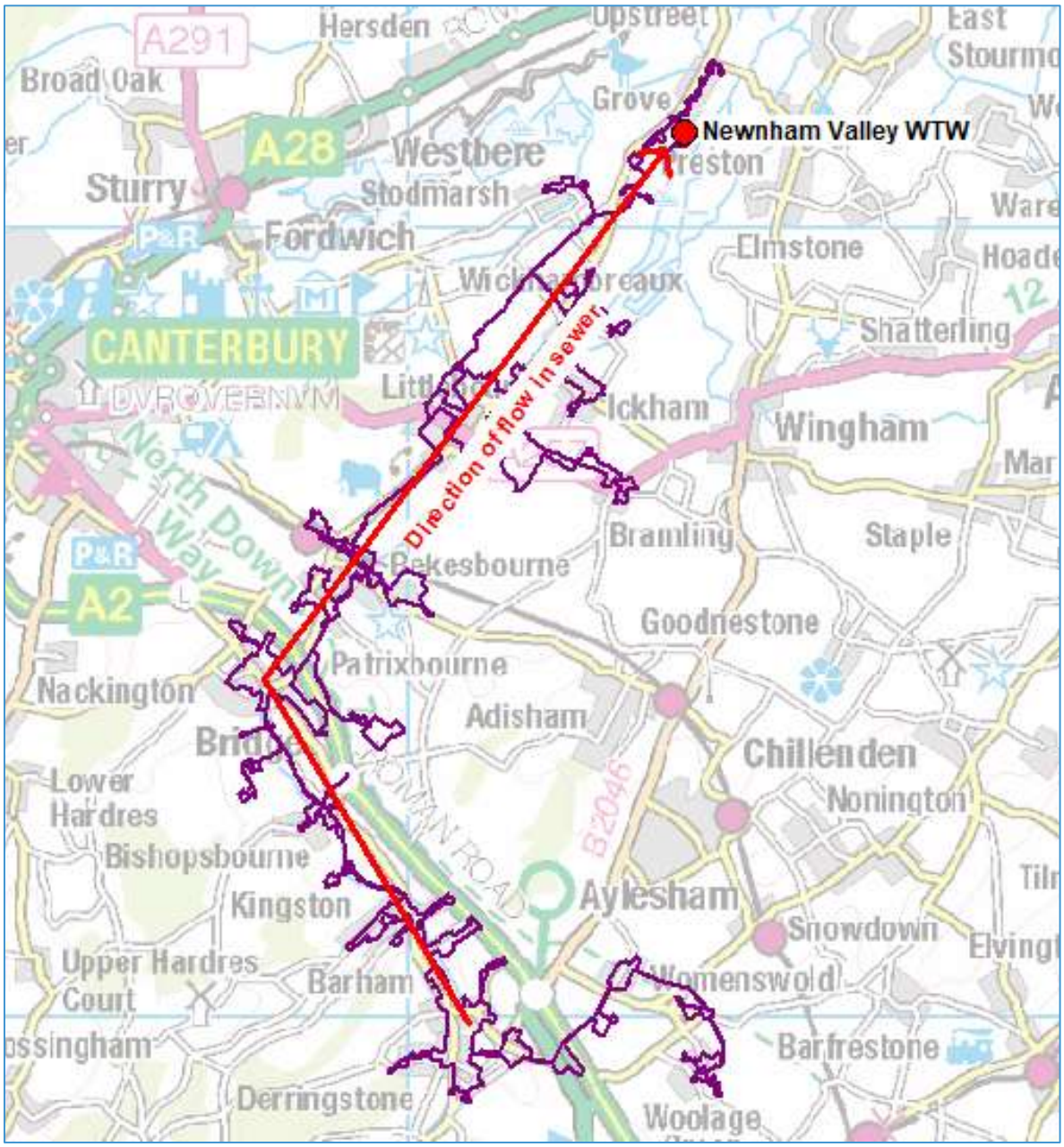

Figure 1 - Representation of the sewerage system for the Nailbourne in the Newnham Valley WTW catchment

2. Groundwater Infiltration at Lower Nailbourne

2.1. The significance of groundwater infiltration at Lower Nailbourne.

Lower Nailbourne is one of a number of areas in Southern Water's operating area where, during excessively wet winters, customers have been inconvenienced by the effects of groundwater infiltration into sewers. Such effects can include flooding and restricted toilet use (RTU).

Southern Water strives to maintain services for customers by a programme of investigation, repair, maintenance and mitigation. Mitigation measures include the use of tankers and groundwater treatment. Such mitigation measures are not sustainable. Since 2013 SW has invested in excess of £2.5m carrying out major improvements to the integrity of the sewers and manholes in the vicinity of the Nailbourne in order to minimise the occasions on which groundwater treatment is required.

2.2. What would happen if Southern Water did not take action?

Despite the significant groundwater flow through the valley during these conditions, incidents of sewer flooding have been relatively infrequent. Table 2.1 below show reported incidents of sewer flooding since April 2010.

A hydraulic model of the Newnham Valley was developed in 2014 to understand the performance of the system and determine options to address risks. However, SW is aware from historical reports of the villages and properties which are likely to be the first to suffer from the effects of flooding.

Table 2.1 on the next page shows that there have been three reported instances of internal sewer flooding since 2010, all of which occurred in winter 2014 - the wettest winter on record. Incidents of External Flooding and Restricted Toilet Use (RTU) occurred more frequently, external flooding is split into that affecting customers properties and boundaries which is referred to as curtilage flooding and other flooding. The groundwater levels in 2021 were comparable to those that occurred in 2014 and it is noted that 7 properties reported restricted toilet use during this period. However, far fewer incidents of flooding and RTU were reported overall in 2021 compared to 2014 which does suggest that the sewer sealing work undertaken to date continues to be effective. In addition to this, instances of restricted toilet use are much less frequent than previous, this is in part the benefit of tankering of low lying AFDs that become locked due to high sewer levels.

Year	External Flooding (properties / gardens)	External Flooding Highways & Other	Internal Flooding	Restricted toilet use	Total
2010	1	4	0	0	**5**
2011	1	0	0	2	**3**
2012	0	0	0	0	**0**
2013	4	4	0	0	**8**
2014	19	3	3	14	**39**
2015	2	2	0	1	**5**
2016	1	0	0	0	**1**
2017	0	0	0	0	**0**
2018	0	0	0	0	**0**
2019	0	0	0	0	**0**
2020	2	0	0	0	**2**
2021	3	1	0	7	**11**
2022	0	0	0	0	**0**
2023	1	0	0	0	**1**
2024	2	0	0	0	**2**
2025	0	0	0	0	**0**
Totals	**36**	**14**	**3**	**24**	**77**

Table 2.1 – Reported Flooding Incidents by Category, in Newnham Valley Catchment

3. Investigation & repairs

3.1. Outline Plans to Investigate Sources of Infiltration

The Generic Plan describes Southern Water's Infiltration Reduction process. The specifics of the investigations and repairs at Lower Nailbourne are captured in Section 3.2 below, and includes the following elements:

- Manhole Inspections and CCTV Surveys
- Flow Monitoring Surveys
- Manhole and Sewer Repairs
- Follow-Up Surveys and Repairs

3.2. Investigation and Repairs in the Newnham Valley

Groundwater infiltration into sewers has been a long-running issue for the villages by the Nailbourne. SW has been making significant investments over many years to minimise infiltration and the need for groundwater treatment.

SW have completed a major programme of survey and repairs to the sewers in the Nailbourne catchment. The investigations and repairs followed the process set out in the Generic Plan. The timing and status of each step is in Table 3.1 below.

Table 3.1 – Summary of Survey and Repairs at Nailbourne Villages and Environs

Step.	Description	Approx Date	Status
1.	Manhole lifting followed by CCTV Investigation	Spring 2013	Complete
3.	Determination of required repairs	Spring/ Summer 2013	Complete
5a.	Dry Weather Flow Survey	July 2013 – August 2013	Complete
4.	Repairs – [refer to plans in Appendix A]	September 2013 - January 2014	Complete
5b.	Wet Weather Flow Survey	May 2014 – June 2014	Complete
7a.	Property Level Protection	October 2014	Complete
6.	Targeted follow up survey (Bishopsbourne)	Spring 2014	Complete
7b.	Targeted Repairs (Bishopsbourne)	Autumn 2014	Complete
6a.	Further Targeted Survey	April 2015	Complete

Step.	Description	Approx Date	Status
7c.	Further Targeted Repairs: repair of sewers at Bourne Cottages, Bishopsbourne & relining of sewers at Brewery Lane, Bridge	December 2015/ April 2016/Autumn 2019	Complete
8.	Long term system winter monitoring	Commences each year	Ongoing
9.	Further surveys	Summer 2021 – Spring 2022	Complete
10	Repairs following surveys	Summer 2023	Complete
11	Further repairs following 2022 surveys	Ongoing into Autumn 2025	Ongoing
12	Installation of sewer level monitors at strategic points	2023	Complete
13	Review of sewer level data to identify blockages and infiltration areas to target	Continuous From 2023	Ongoing
14	Measure benefit	From April 2026	Pending

Since the inception of the infiltration reduction plan, CCTV surveys of 10.7km of public sewer have been completed and in excess of 250 manholes inspected. Repairs to sewers and manholes where infiltration was found to occur have been sealed. This amounted 3.6km of sewer and 10 manholes. Root cutting also took place to maintain appropriate flow along the sewage network.

In addition to physical investigations on site, SW has instigated a programme of monitoring flows in critical catchments, including the Nailbourne catchment. Further details are given in Section 5.6.

Flow monitoring (Step 5 in Figure 3.1 of the Generic Plan document) was carried out both in dry weather conditions (18th July to 15th August 2013) to establish baseline flows, and in wet weather conditions (21st May to 18th June 2014). Good data was obtained from these surveys which was subsequently used for validation of a hydraulic model of the Nailbourne catchment.

During 2021/22 a new survey technique called Electroscan was introduced to the business. This method of surveying is advantageous over traditional CCTV inspection as it allows surveys to be undertaken during dry and wet conditions and also identifies leaking joints in pipes that a visual survey would not pick up. We surveyed 20 km of the sewer system from Barham to the Newnham Valley WTW in 2021/22 as shown by the purple line in figures 3.1 and 3.2 below.

These surveys identified sewers with leaking joints which will be addressed by sewer lining activity during 2023. This is discussed further in Section 5.

Due to the ongoing issues in this and other networks which are impacted by high groundwater and that data appears to show that high groundwater events are becoming more frequent, Southern Water included in its business plan for the period 2025 to 2030 an increased allowance specifically for the sealing of public and private sewers at risk of infiltration. The funding case was approved by OFWAT as a pilot study to trial and report the effectiveness of new sealing techniques delivered at scale. One of the systems included in the pilot study is the Lower Nailbourne. It is proposed that a high proportion of public sewers in the IRP area will be sealed in the period 2025 – 2030 with the anticipation that this will be effective in reducing the risk of the system becoming overwhelmed in wet winters and that tankering of flow in winter is only required in the most extreme conditions.

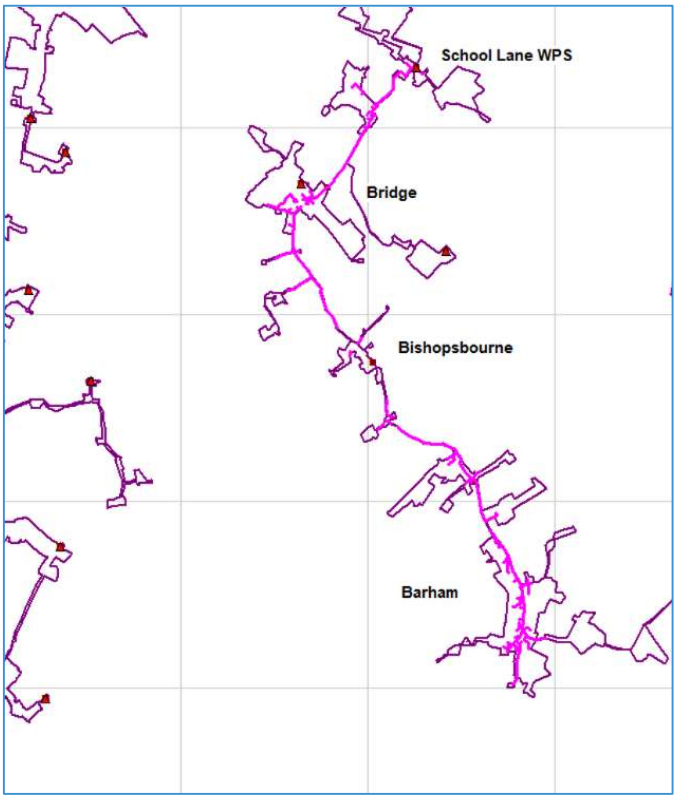

Figure 3.1 sewers electroscan surveyed Barham to Bekesbourne (shown in pink), catchment boundary in purple.

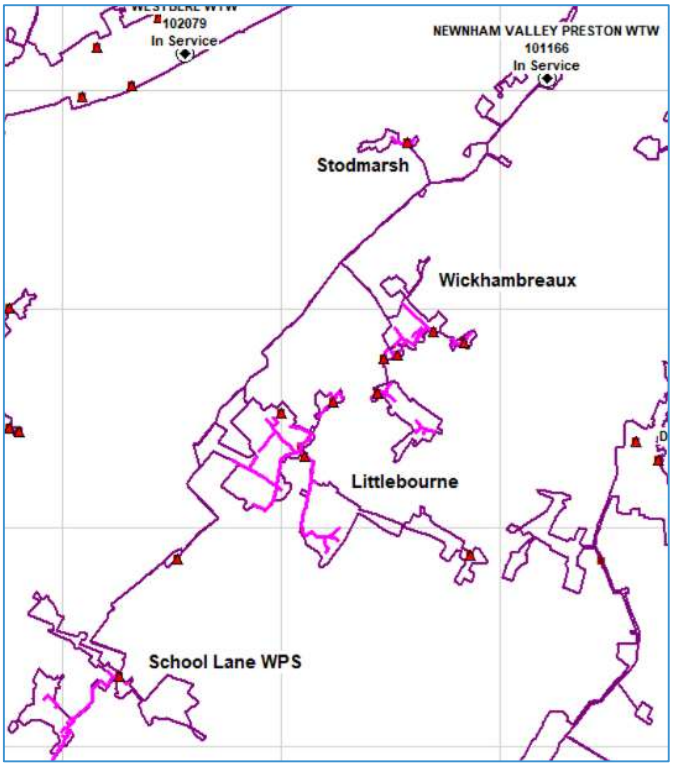

Figure 3.2 sewers electroscan surveyed Bekesbourne to Newnham Valley WTW, (shown in pink), catchment boundary in purple.

4. Mitigation Measures

4.1. Circumstances that lead to mitigation

Since 2013, SW has made significant investment to reduce infiltration and to protect specific properties at risk of flooding, with the objective of reducing the frequency of discharges to watercourses.

In January 2013, prior to the start of the major reinstatement work, pumps needed to be turned on when the groundwater level measured at Little Bucket reached 78.5m. In January 2014, after completion of major repairs, over-pumps were only required when the groundwater level reached 81.3m. In February 2015, when the level reached 84.7m, tankers needed to be deployed at Bishopsbourne, but over pumps were not required despite the Little Bucket groundwater level being more than 5m higher than when pumps were required in Jan 2013 and over 3m higher than when pumps were required in Jan 2014. This demonstrates the effectiveness of SW's investment to reduce infiltration and thus to reduce the requirement for discharges.

However, despite the investment, following prolonged wet weather, to maintain services and avoid significant spills, SW expects that there will continue to be an occasional need to remove excess flow from the network. This goes to show the difficulty in fully resolving infiltrating sewers due to the scale, complexity and ownership of the different parts of the holistic network.

Based on experience in 2014 and 2015, groundwater treatment could be expected to be required when the groundwater level at Little Bucket borehole exceeds 85m (in Feb/ March 2015, groundwater levels peaked at 85.0m and groundwater treatment was not required). However, to allow time for investigation and preparation, SW has historically retained a ‘trigger level’ of 78.5m in the winter planning report.

Due to the success of the repairs, tankering is now only required at higher groundwater levels, therefore the trigger level has been raised to 80.0m. Whilst SW would not expect to start physical measures such as tankers at that level, the purpose of the 'trigger level' is to trigger actions to prepare for an appropriate response. Refer to Section 4.2 below - 'Steps to prevent discharges to the environment'.

Figure 4.1 shows the groundwater levels recorded at Little Bucket since 2012. Pumping was required in 2012/13 and 2013/14, and tankering in 2014/15 with some repair activities in 2013/14 and 2014/15. Tankering was used for one day in February 2016, but only as a precautionary measure. From February 2016 to end 2019 the groundwater levels did not rise above circa 75m AOD and no tankering was required. However in both winter/spring 2020 and 2021 the groundwater levels recorded at Little Bucket peaked at around 87mAOD and tankering was required. The peaks recorded in these two groundwater seasons are the highest cumulative recordings in the time that infiltration has been tracked to this level of detail.

It can be seen for Figure 4.1 that the maximum groundwater level in 2022 was around 15m below that recorded in 2020 and 2021, tankering of flows was not required. It can also be seen that due to the wet winter of 2022/23 the groundwater recharge has commenced and levels in January have recovered to the normal range for the time of year despite the low starting point. Due to the wet summer and autumn of 2023 groundwater levels in December 2023 are similar to the levels recorded in the high groundwater seasons of 2014, indeed winter 2023/24 was particularly high groundwater event, where mitigation was required. Since the spring of 2024 groundwater levels have been more typical and no mitigation activity to manage excess flow was required in winter 2024/25.

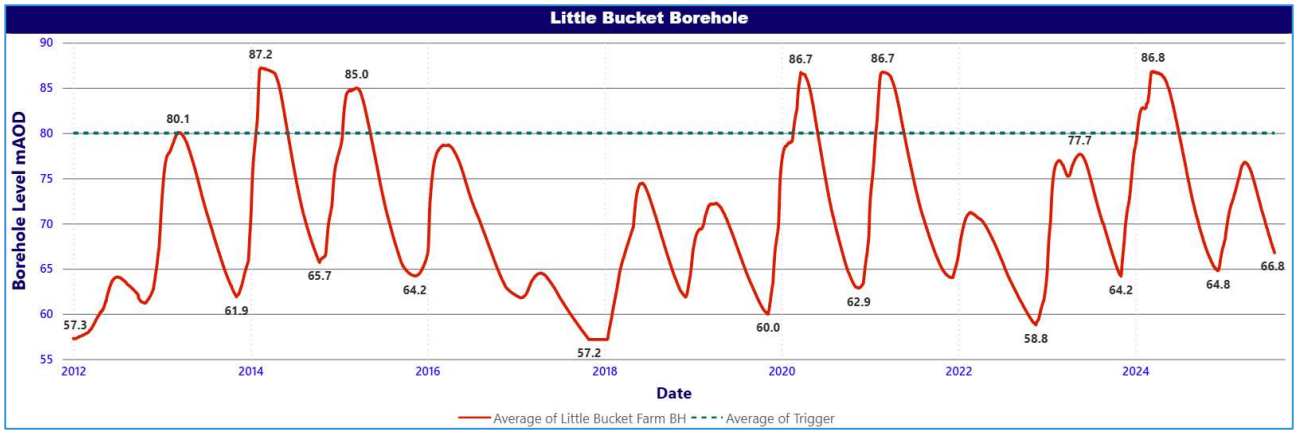

Figure 4.1 - Groundwater levels from 2012 to 2025

The details of where tankering has been necessary in the past are given in Appendix B. The repairs carried out, combined with the winter preparation checks. However, as a consequence of repairs and potentially other factors outside SW's control (such as the severity of the weather), the hydraulics may dictate that groundwater treatment is required at locations either in addition to, the sites described in Appendix B.

4.2. Steps to prevent discharges to the environment

Since 2013, SW has undertaken extensive surveys and repaired sewers and manholes where infiltration had been found (the extent of the work is shown in Appendix A, and summarised in Section 3.2). This built on the repairs that had been carried out in previous years (listed at the end of Appendix A) and has raised the trigger level at which groundwater treatment would be required to 80m AOD.

Following the main repairs, property level protection was installed in 2014, and further targeted repairs were completed. In addition to this work, SW also carries out other activities to minimise the requirement for discharges to watercourses including tankering from strategic locations within the catchment and tankering from locations where property level flood protection such as AFDs are not effective due to sewers being full continuously

There are multiple AFDs installed around the Newnham Valley catchment in response to previous instances of internal and external flooding. These are located within the villages of Barham, Bishopsbourne, Patrixbourne and Ickham.

Where these AFDs reach capacity (as identified in the inspection chamber monitoring), a tankering milk round will be implemented to prevent restricted toilet use, see appendix B..

SW attends and convenes meetings with a number of local groups. In particular the Multi-Agency Group was influential in helping to shape the IRP. During the flooding of 2013/14 SW had representatives on site who visited affected customers to help them. The latest version of the IRP approved by the EA, will be published on SW's website.

From time to time, SW updates stakeholders about completed and planned work. The most recent meeting was held in December 2024 with the chair of the Nailbourne Flood Action Group.

5. OPTIONS TO REDUCE INFILTRATION

5.1. Sewer Rehabilitation Programme

SW acknowledges that infiltration reduction is on-going process. Since 2013, SW has invested over £2 million in surveys and repairs in the Nailbourne. The major repair work was completed in 2013, property level protection and pump replacement at School Lane WPS completed (2014), December 2015 to April 2016 further targeted repairs were completed. However, on a company-wide basis, to ensure that benefit continues to be gained from the work that has been done, SW is continuing the programme of infiltration reduction investment. As discussed in section 3 a new survey technique was used in 2021/22 which has the benefit of identifying leaking joints in otherwise structurally sound pipes. Sewer rehabilitation work planned for 2023 which arises from these surveys are shown in Appendix A. Of the 20km of sewer surveyed around 2.5km require sewer lining work to prevent groundwater infiltration. The rehabilitation work must be undertaken in low flow conditions. It was planned to be undertaken during late spring and summer 2023 when groundwater levels have reduced. However, due to the wet summer and autumn 2023 this work was not completed and was carried over into 2024 and 2025, it was completed in 2025.
Work up until April 2025 is included in the measurement of length sealed in tables 5.1 & 5.2, the remainder of sewer sealing completed in 2025 will be captured in the 2026 (JR26) measure, reported in 2026.

Action	Km of sewer
Length Surveyed	86.32
Length with no work required	73.76
Length Sealed	10.175
Length to be sealed	2.27
Manholes sealed	7
Manholes to be sealed	0

Table 5.1 below summarises the work undertaken in the system since 2014.

Year	Surveyed (km)	Sealed (km)
Pre 2013	39.66	0
2013	17.7	0
2014	0.5	3.3
2015	0	0.2
2016	6.5	0.1
2017	5.2	0.4
2018	0	0.5
2019	0	0.1
2020	0	0
2021	0	0.8
2022	15.5	0.9
2023	0	1.3
2024	0	1.6
2025	0	0.9

Table 5.2 – annual summary of work completed

5.2. Property Level Protection

During 2014, SW installed six non-return valves protecting seven properties. There are no plans currently to install any more NRVs, but the potential benefit of further property level protection will be considered if it is considered to be required for any further vulnerable properties.

5.3. Local Flow Control

As noted in Section 4.1 despite groundwater levels having risen higher in early 2015, than they had in early 2013, groundwater treatment was not required. Localised tankering was required in February and March 2015 to remove the groundwater from the sewer at Bishopsbourne to protect services for a few customers. SW has identified that whilst the sewers in Bishopsbourne were significantly surcharged, levels in manholes further upstream were not. Consequently SW fabricated, and fitted, a throttle upstream of Bishopsbourne village. This was fitted during March 2016; levels in the sewer in Bishopsbourne fell sufficiently that within a few days tankering could be stopped. As expected, upstream of the throttle, sewer levels rose, but did not cause any problems. The throttle was removed when levels returned to normal.

5.4. Pumping Stations

Pump refurbishments were completed in October 2014 at School Lane WPS in Bekesbourne, the largest pumping station in the Newnham Valley catchment. This will help to ensure that the design discharge continues to be reliably delivered.

5.5. Control Structure

SW is committed to reducing the frequency with which groundwater treatment will be required. The work carried out since 2013 has improved the resilience of the sewerage system, making it less susceptible to the effects of high groundwater levels. SW is minimising the flow into the sewers through its rehabilitation programme, ensuring that the pumping stations deliver the design flows and that vulnerable properties are protected. Despite these measures, there will still be occasions during severe weather when the flow into the sewerage system exceeds its capacity.

Southern Water accepts the need to reduce the frequency of groundwater treatment, so investigated other options to reduce the need to tanker. One option considered was a bio retention pond. The objective was to remove dilute effluent at a critical location if flow in the sewer exceeds a set 'pass forward' rate. Proposals were developed for this option in 2018. The objective was to ensure that during times of unusually high levels of groundwater infiltration, customers would be able to retain use of their sewerage facilities, whilst also ensuring that the effluent did not cause detriment to the watercourse. The option was developed through outline design stage and the concept was for groundwater treatment from the sewer to a bio-retention pond where dilute flow would infiltrate into the ground. However, on wider stakeholder discussion the location of the bio retention pond would need to be sited quite a distance from the watercourse. This caused the installation cost to increase significantly to a point where the option was no longer viable. The current plan is to therefore continue to address the root cause of the issue by surveying and sealing the public sewer network whilst identifying other potential methods of reducing the reliance on tankering.

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5.6. Monitoring

The Nailbourne catchment is one of 18 locations, where groundwater levels have been monitored via electronic data since January 2015. This monitoring helps inform SW's response, in terms of when tankering and groundwater treatment are required. The Generic Plan has more detail on the overall monitoring strategy.

The graph on the next page, in Figure 5.1, is an example of those used for predicting the earliest, average, and latest dates for when the trigger levels are forecast to be breached. This graph shows groundwater levels and an indication of flows.

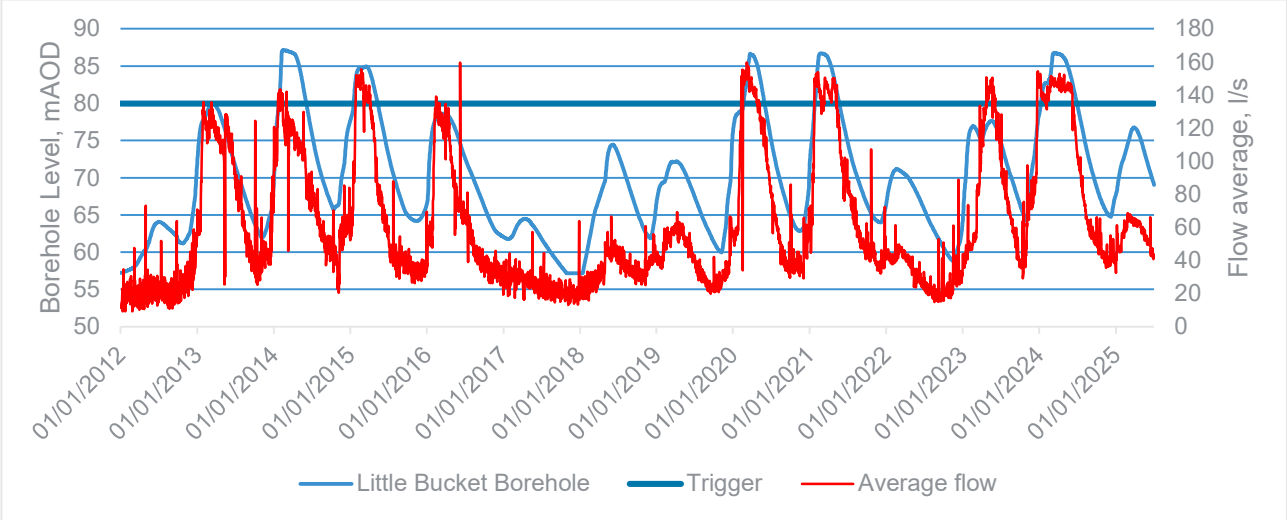

Figure 5.1 – recorded data with trigger levels

In addition to the groundwater flooding forecasts explained above, SW is also looking at longer-term trends to monitor the effectiveness of the completed rehabilitation work. From figure 5.1 in 2024/25 the average flow in the sewer peaked at around 60 l/s when the groundwater level was around 77 m AOD. On previous occasions when ground water has been at similar level e.g. 2023/24, the flow in the sewer has been much higher at around 140 l/s. An alternative way of looking at this is that in previous years 60 l/s flow has been achieved when the groundwater level has been at 72 mAOD (2019 data point). Initial conclusion from this is that groundwater now has to be 5 m higher before having the same impact on flow and this could be due to the sewer sealing work undertaken since 2019. It is perhaps too early to say this categorically as we only have one year's data to draw conclusions from but the signs are positive. We will continue to analyse this as more data becomes available over time.

Figure 5.2 shows the groundwater levels at Little Bucket Farm borehole plotted against flows to Newnham Valley WTW. Note that Newnham Valley WTW is located in the Nailbourne catchment, downstream of the major repair works. However, it also processes sewage discharged from two adjacent sub-catchments. (Refer to the Background Section for a description of the catchments feeding Newnham Valley WTW). Thus the flows from the Nailbourne sub-catchment, form a part of the total flows to Newnham Valley WTW.

Figure 5.2 quantitatively illustrates how flow varies with groundwater levels. It is reasonable that as groundwater levels increase, the rate of infiltration increases. Data points prior to the major repairs are plotted in blue: (Dec 2009 – Aug 2013). The data points for the period after major repairs (Jan 2014 – Jun 2021) are plotted in orange. Linear regression lines are also included for each set of data. These give an indication of the difference between average conditions for 'before' and 'after' repairs.

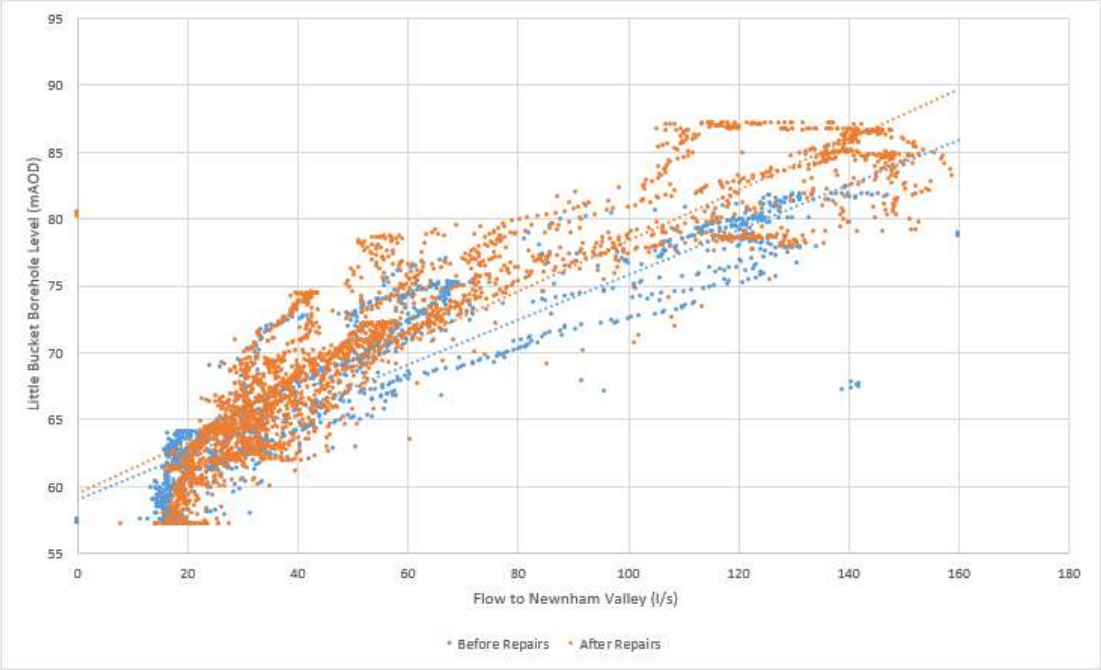

Figure 5.2 – Long Term Monitoring (Dec 2009 to Feb 2021)

The difference in groundwater level between the lines is approximately 1.5 - 3m. In other words, for a given groundwater level, the corresponding flow is lower after the repairs. This confirms that the repair work has been effective.

For the period Dec 2009 to Feb 2021, the graph shows that groundwater levels rose higher after the repairs than they had before. This was due to natural variations in the weather. The maximum groundwater level before the repairs was 81.9 mAOD. After the repairs, groundwater levels at Little Bucket reached 87.2m. Despite these higher groundwater levels, flows to Newnham Valley WTW generally did not increase. Indeed, for the period of time after the repair works, the groundwater levels have been higher than 81.9 mAOD for approximately 18% of the time, yet flows have remained in a similar range to that which existed before.

In future we will look to compare high groundwater season flows pre and post sewer sealing. Next we will look to compare winter 20/21 flows with that in 23/24 and the next high groundwater season.

6. ACTION PLANS

A significant amount has been achieved in the Nailbourne catchment in the last eight years. Some actions are ongoing which reflects the continuous improvement process for dealing with infiltration due to groundwater. To make it easy to track progress, the following tables set out the actions to reduce infiltration and also to mitigate the effects of it, if the infiltration cannot be controlled at economic cost. Tables 6.1 and 6.2 cover the actions by SW and by other parties, respectively, to reduce infiltration. Tables 6.3 and 6.4 cover mitigation of the effects of flooding (Communication and other activities).

SW is committed to continuing to pursue infiltration to reduce the frequency of tankering. This IRP describes the work that has been done by SW to improve the situation. In addition, it describes what is being done to monitor flows, the 'winter preparation' work to be carried out to ensure assets are operating correctly, and the work to be developed with other agencies to improve an integrated plan to address flooding.

Colour coding of actions in tables:

- Green – completed
- Orange – imminent action required
- Red – overdue
- White – on-going actions with no specific end dates.

Table 6.1. Southern Water Current Activities to Reduce Groundwater Infiltration

Ref.	Item	Actions	Timescale and Status	Outcomes
1.1	Develop an approach for reduction of infiltration and maintenance of reduced levels of infiltration.	Refer to Section 1 above and the report in Appendix A.	Summer 2013, Complete	The steps are being followed to deliver results.
1.2	'Dry weather' flow surveys (to measure background levels of infiltration during low groundwater periods)	Identify suitable measurement points, carry out survey over four week period in Summer, match rainfall records with flow data.	July/ August 2013 - Complete	Groundwater infiltration is greater than would be expected for summer conditions.
1.3	'Wet weather' flow surveys (to identify remaining areas of infiltration following initial sewer rehabilitation/repair).	Identify suitable measurement points, carry out survey over four week period, match rainfall records with flow data.	May/ June 2014 – Survey complete Analysis - complete	Wet Weather and Dry Weather flow monitoring data used in hydraulic model completed in December 2014.
1.4	CCTV etc survey of sewers	Identify Strategic Manholes, survey manholes to identify clear flow and infiltration. Carry out CCTV survey where clear flow was identified.	Barham to Bekesbourne Summer 2013 – Complete	Identify major sources of infiltration to determine scope of rehabilitation work.

Ref.	Item	Actions	Timescale and Status	Outcomes
1.5	Carry out sewer rehabilitation work	Use various techniques to seal infiltration points in manholes and sewers	Barham to Bekesbourne Autumn 2013 – Complete Bishopsbourne Spring 2017 - Complete	Structural integrity of sewers restored.
1.6	Further surveys (CCTV or alternative techniques), if required, where 'wet weather' flow surveys show areas of high infiltration remaining	Further surveys in areas where high infiltration flows remain.	2015 – Completed Spring 2015 after Tankering at Bishopsbourne	Determine scope and carry out further rehabilitation if identified as required from the survey results.
1.7	Further sewer rehabilitation work, if required, in areas where surveys carried out.	As above, use various techniques to seal infiltration points in manholes and sewers	Summer/Autumn 2015 - Completed work in Bishopsbourne. and Bridge. - [Refer Section 3.2]	Reduced infiltration, leading to reduced requirement for tankers.
1.8	Maintain IRP as a live document	Review text of the IRP and update if appropriate to describe work carried out and/or developments	Annually	To be issued prior to winter each year
1.8a	Maintain IRP as a live document	Review Tables 6.1 to 6.5 and as appropriate amend to show progress on individual activities.	Annually	Up to date tables of Actions.
1.9	Consider alternative solutions that involve some risk	Investigate unconventional options such as vacuum sewers or consider conventional combined sewer overflows	Complete	No options identified other than to reduce infiltration at source whether this is in the public sewers or in the private sewer system.

Ref.	Item	Actions	Timescale and Status	Outcomes
1.10	Install Property Level Protection to Vulnerable properties.	Survey and install NRVs at vulnerable properties.	Autumn 2014 - Complete	The aim is that protection to vulnerable properties restricts tankering to those properties only as opposed to more significant sewer pumping.
1.11	Groundwater treatment Sites: improve effluent quality	Investigate potential for improved screening and basic treatment at points of discharge into watercourse.	SW, Summer/Autumn 2014	Improved arrangements for discharges when required.
1.12	Groundwater treatment Sites: minimise flow	Add level control to pumps to reduce durations for pumping	SW, 2014, Complete	Establish whether seasonal discharge (s) will be necessary in order to maintain use of sewerage services for customers during periods of very high groundwater levels.
1.12	Standards for emergency discharges	SW to discuss with EA about best practice set up for groundwater treatment arrangements.	SW, 2014, no longer required	Agree with EA acceptable treatment for discharges and acceptable flow rates.
1.13	Flow, location, screening arrangements for emergency discharges	Determine potential flow rates and screening arrangements and most appropriate locations,	SW, no longer required	Agree with EA, Canterbury CC, Shepway DC and local Parish Councils acceptable arrangements for future emergency discharges.
1.14	Action Plans	Develop SW action plans documenting set up of pumps, tankers, etc. for emergency situations.	SW, Summer 2014- Complete	Action Plan available for planning sessions with other authorities in preparation for repeat flooding events. Engagement with the local community about the potential arrangements for dealing with excess flows into sewers to mitigate disruption to customers.

Ref.	Item	Actions	Timescale and Status	Outcomes
1.15	Further survey and sealing work proposed for the public sewerage system	SW to gain approval to undertake necessary work	July 2021	Complete
1.16	Identification of lengths of sewer to survey or resurvey in the period 2021-25	Review sewer records with available groundwater profile date	Summer 2021	Complete
1.17	Surveys by cctv or electroscan lengths of sewer potentially at risk	Compare historical survey coverage with results of 1.15 and produce a survey schedule.	Summer/Autumn 2021	Complete
1.18	Survey result review	Review results of surveys undertaken in 1.16 to determine sewer sealing work.	Autumn/winter 2021	Complete
1.19	Undertake required sewer sealing	Continue to seal sewers and manholes by most appropriate technique	From Autumn 2024 as conditions allow, completed in 2025	Complete
1.20	Review effectiveness of any sealing work	Analyse monitoring data and groundwater data to determine benefit of investment	From spring 2026	Ongoing and to be further reviewed on completion of 1.19, will require high groundwater to quantify benefit
1.21	Seal private drains and public sewers in the approved AMP8 Pilot scheme	Identify, communicate and deliver sewer sealing work to create a watertight system	SW – 2025 - 2027	Planned

Table 6.2. Multi-Agency Activities to Reduce Groundwater Infiltration

Ref.	Item	Actions	Owner, Timescale and Status	Outcomes
2.1	Strategy for infiltration via private drains	Southern Water to propose a strategy for dealing with infiltration via private drains*	SW supported by EA and local Parish Councils, Summer/ Autumn 2014. Completed 2014.	Southern Water objective is to improve awareness of the significance of infiltration into private drains and the importance for customers to ensure infiltration is repaired when it is discovered.
2.1a	Long-term Monitoring	SW will monitor sewer flow to identify significant increases in inflows.	Ongoing	Early identification of areas where infiltration has increased
2.2a	Investigate highway 'mis-connections'	Where non-sewage flow is identified, check highway drainage relative to sewers to ensure road drainage is not a source of flow into the SW sewers	Kent County Council with support from SW, 2014 onwards. To be pursued as and when required.	Reduced flow of surface water (if connections are found).
2.2b	Investigate groundwater infiltration on domestic drains	Where non-sewage flow is identified from domestic properties, investigate to identify source of flow into SW sewers	SW, with assistance from Canterbury City Council where required, 2014 onwards. To be pursued as and when required.	Reduced flow of surface water (if connections are found).
2.3	Consider effects of proposed new developments on infiltration.	District Council to continue to consult with SW on development applications.	District Council, Ongoing.	Developments in areas which would be detrimental to sewer flooding, to have conditions recommended by SW and applied, as appropriate, by the City and District Councils.
		SW to determine threshold above which they require to be consulted.	District Council, Ongoing. SW wish to be consulted on all proposed development.	
		Sewerage materials for new developments	SW & District Council, when developments are at planning approval stage. Ongoing.	

*Note: Southern Water does not have powers to require residents to repair private drains. Hence the support of the other agencies is required. It is acknowledged that customers may not be aware of infiltration in their private drains, so SW will consider ways of obtaining information to demonstrate the presence of infiltration. District Councils would only be able to instigate action under Section 59 of the Building Act where proof/evidence is provided of the defect.

Table 6.3. Publicity / Communication Activities to Reduce / Mitigate the Effects of Groundwater Infiltration.

Ref.	Item	Actions	Owner, Timescale and Status	Outcomes
3.1	Public meetings about reducing groundwater infiltration into sewerage system	Attend public meetings with other agencies as appropriate.	SW, as required	Inform stakeholders of progress and planned activities and receive feedback.
3.2	Letters from SW to stakeholders about reducing groundwater infiltration into the sewerage system	Send letters at regular intervals to communicate progress and planned activities	SW, as required	Inform stakeholders of progress and planned activities
3.3	Multi-Agency Group meetings	Discuss and agree actions to reduce requirements for tankering and emergency discharges to watercourses.	All Parties, Discussed and actions agreed in 2013 and 2014. To be discussed in future as required.	Improved understanding and appreciation of issues. Agreement to actions to help reduce the need for tankering and emergency discharges to watercourses
3.4	Implement local campaign to discourage misconnections	Publicise through parish councils. Include article in Parish magazines. **	District and Parish Councils, Summer 2014 Complete	Article included in Canterbury City Council magazine.

** SW can provide base information to councils to include in articles publicising the role that everyone can play in minimising non-sewage flows into sewers, and the importance of doing so to reduce the incidence of restricted toilet use during periods of high groundwater.

Table 6.4. Activities to Mitigate the Effects of Groundwater Infiltration/ Other Flood Protection Mechanisms

Ref.	Item	Actions	Owner, Timescale and Status	Outcomes
4.1	Early Warning system	Joint continuous monitoring of groundwater levels and sewer levels/flows.	SW, EA, 2014. Ongoing. Commenced Jan 2015. Re-commenced annually	Develop trigger levels by comparing historic customer complaints and tankering with BH levels (or other reference). Note: due to the success of the rehabilitation work, the trigger level has been raised from 78.5m to 80.0m at Little Bucket borehole.
4.2	Tankering arrangements	Investigate options for improving location of tankers for future events. e.g. by use of longer hoses/ pumping	SW, Spring 2014, Complete	Potentially less disruption to residents when tankering / pumping is essential.
4.3	Maximise the capacity of the sewerage system and pumping stations	Investigate the carrying capacity of the sewerage system north of Littlebourne	SW, July 2014 for capacity determination. Trial - if and when - the sewers are surcharged	Potential to increase output from the pumping station at School Lane, Bekesbourne.
4.4	Flooding Management Plan	Develop plan to address the flooding issues caused by high groundwater. Implement recommendations. This is being addressed by the Little Stour, Nailbourne and Petham Bourne Flood Management Group Action Plan.	Kent County Council & Canterbury City Council, Shepway District Council with inputs from SW, EA, and Parish Councils	Plan including actions for participating authorities, that in unison will reduce the extent of flooding and the impact of flooding.
4.5	Maintenance of watercourses	Riparian owners to carry out their responsibilities to maintain adequate flow through watercourses by clearing vegetation, desilting, etc	Riparian owners with input from District and Parish Councils – ongoing responsibility	Maximise the flow along watercourses in order to minimise surface flooding, which results in inundation of manholes to the sewerage system.
4.6	Review of utilisation of a control structure	Investigate the possible use of a fixed control structure to relieve hydraulic overloading of sewers.	SW	No current plans to progress this option.

Appendix