Infiltration Reduction Plan

Barnham

July 2024

Version 5.11

from Southern Water

Contents

Document Control

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Barnham Infiltration Reduction Plan	1.0	December 2014
Barnham Infiltration Reduction Plan	2.0	December 2015
Barnham Infiltration Reduction Plan	2.1	August 2021
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Barnham Infiltration Reduction Plan	3	January 2024
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Glossary

AMP – Asset Management Programme
CCTV - Closed-circuit television
CSO – Combined Sewer Overflow
EA - Environment Agency
GW – Ground Water
IRP - Infiltration Reduction Plans
l/s - litres per second
MH – Manhole
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

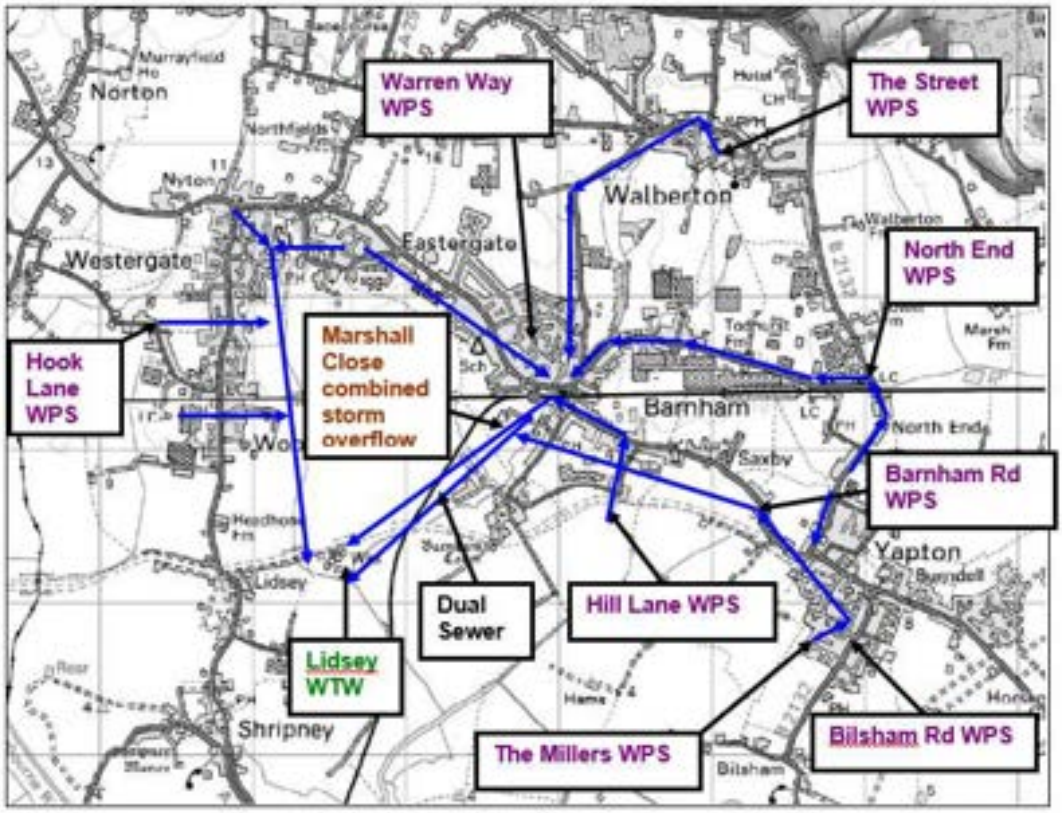
This Infiltration Reduction Plan (IRP) for Barnham in the Lidsey catchment has been prepared in response to the Environment Agency's (EA) Regulatory Position Statement (RPS). Southern Water has been carrying out work for many years to survey and repair sources of infiltration in the catchment for Lidsey Wastewater Treatment Works (WTW) in Sussex. This IRP covers the village of Barnham.

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
- Arun District Council
- West Sussex County Council
- Barnham Parish Council

Southern Water will continue to consult with representatives of these parties as part of the IRP development and implantation.

Figure 1.1 - Representation of the sewerage system for the Lidsey WTW Catchment



2. Groundwater Infiltration at Barnham

2.1. The significance of groundwater infiltration.

Barnham 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. The mitigation measure used is the use of tankers to remove surplus groundwater, however such mitigation measures are not sustainable and disruptive to communities. During the period 2013 to 2018 SW has invested in carrying out major improvements to the integrity of the sewers and manholes in the vicinity of Barnham in order to minimise the occasions on which mitigation measures are required. The number incidents of flooding or restricted toilet use can be seen in Table 2.1.

Table 2.1- Reported Flooding Incidents by Category, in the Barnham Catchment.

Year	External Flooding (properties / gardens)	External Flooding (Highways/Other)	Restricted Toilet Use	Total
2011	3	0	1	4
2012	0	0	0	0
2013	18	0	0	18
2014	6	6	5	17
2015	3	3	2	8
2016	2	0	0	2
2017	0	0	0	0
2018	2	1	0	3
2019	0	0	0	0
2020	2	1	0	3
2021	3	0	1	4
2022	18	2	0	20
2023	3	13	0	16
2024	16	11	4	31
Totals	**76**	**37**	**13**	**126**

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

Despite the significant groundwater flow during these conditions, incidents of sewer flooding have been relatively infrequent this is due to the mitigation provided during times of high groundwater. Table 2.1 shows reported incidents of sewer flooding since April 2010. The villages worst affected are Barnham and Lidsey

For context, until the winter of 2023/24, 2012/13 was the wettest year on record and 2013/14 was wettest winter on record. Looking at the period 2013/14 to 2022/23 we can see that over time the number of incidents affecting our customers has reduced which demonstrates that the investment being made in terms of sewer sealing and mitigation is making a difference. However, due to the very high and prolonged groundwater event in 2023/24 the number of incidents increased significantly and we know from this that the issue is not fully resolved. If no action were taken then uncontrolled discharges of wastewater to the environment would occur at greater frequencies and in greater volumes.

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 Barnham 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 Barnham area

Groundwater infiltration into sewers has been a long-running issue in Barnham. SW has been making significant investments over many years to minimise infiltration and the need for interventions such as tankering, temporary network reinforcement.

SW recently completed a major programme of survey and repairs to the sewers in the Barnham catchment. However, at times of very high groundwater there are still significant challenges with the drainage system and there is more work to do. 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

Step	Description	Approx. Date	Status
1a.	CCTV Surveys	Spring 2013	Completed.

Step	Description	Approx. Date	Status
2.	4 manholes and approx. 50m of sewers sealed.	Summer 2013	Completed.
5a.	Dry Weather flow Monitoring.	17th July to 2nd September 2013	Completed.
N/A	Tankering at Elm Grove, Barnham (100+ Tanker days)	Dec 2013 – March 2014	Completed.
5d	Lidsey Inflow and Infiltration Investigation	March 2014	Completed.
N/A	Over-pumping at Barnham Lane/ Lake Lane Junction	19 March – 24 April 2014	Completed.
5b.	Wet Weather Flow Monitoring	8th May to 19th June 2014.	Completed.
1b.	CCTV Surveys	Spring 2014	Completed.
3.	Review of Survey findings.	Spring 2014	Completed.
4.	Sewer Rehabilitation in Elm Grove and Lake Lane areas approx. 840m of sewers sealed.	Summer / Autumn 2014	Completed.
5c.	Two additional Sewer Level Monitors installed.	Autumn 2014	Completed.
6.	Targeted CCTV Survey	Summer 2015	Completed.
8.	Winter monitoring exercise commenced.	October 2015	Ongoing
7.	Scheduled repair near Barnham Station	January 2016	
8.	CCTV Investigation	March 2016 – April 2018	Completed.
9.	Sewer Rehabilitation	March 2016 – October 2018	Completed.
10.	Further Surveys	Post 2024	Planned

Despite the repairs, significant mitigation measures were required in winter 2023/24 due to the highest groundwater levels recorded. The major interventions were to tanker excess from sewage system and take these to either Lidsey (after storm separation) or East Worthing Wastewater Treatment Works for treatment outside of the catchment.

4. Mitigation measures

4.1. Circumstances that lead to mitigation

Since 2013, SW has made significant investment to reduce infiltration into the public sewage system and protect specific properties at risk of flooding. The objective is to reduce the frequency of discharges to watercourses and the disruption caused by the need to tanker flows from the system to larger wastewater treatment centres.

Once groundwater levels have risen to a point where the sewerage system is below the water table groundwater will enter the system through leaking joints in both the public and private pipes and manholes. To ensure the sewerage system continues to function this excess flow must be removed from the network. This is done by deploying tankers to extract flow and to transport this, primarily groundwater, to larger WTW sites with capacity to treat the flow.

The locations for tankers are given in Appendix B.

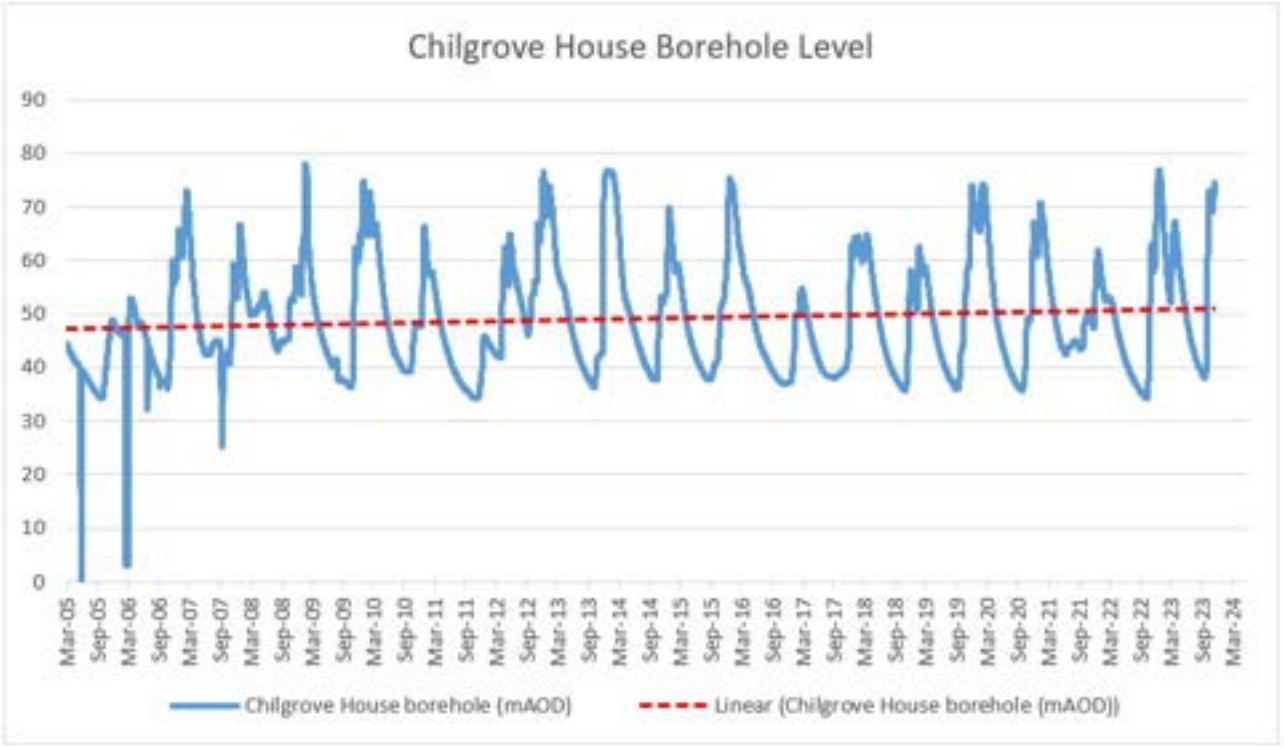


Figure 4.1 - Groundwater levels at Chilgrove House from 2005 to 2024

The Chilgrove House borehole is located on the south side of the South Downs, some 15km northwest of Barnham. Figure 4.1 shows groundwater levels recorded at the borehole since 2005. (Note: The readings are water level elevations rather than depths below ground level.) Whilst there is no positive correlation between the groundwater level and full flow to treatment at Lidsey Works, a correlation between rainfall and flow to Lidsey Works has been identified (Bernard Poole, WaPUG Spring Meeting 2002, 'Estimation of Infiltration from Long Term Flow Records'). The correlation between rainfall and flow, but not between groundwater and flow, aligns with SW's experiences. The mechanism by which the effect of heavy rain results in rapid increases in sewer flows, is not entirely understood, but it appears that groundwater levels rise rapidly during rain because the ground is very permeable.

4.2. Steps to prevent discharges to environment

The Generic Plan details the typical activities that Southern Water undertakes to minimise the requirement for discharges to watercourses. 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). This built on the repairs that had been carried out in previous years (listed at the end of Appendix A).

5. Steps to minimise the volume and duration of tankering

5.1. 3rd Party Communications about wastewater treatment

Since the start of the Infiltration Reduction Programme in 2013, Southern Water has been active in communicating with stakeholders and customers about planned and completed work to improve the integrity of the sewage system. Stakeholders have been kept informed of progress on survey and sealing work via both emails and face-to-face meetings. However, we recognise there is more to do in this area to keep everyone informed of mitigation measures that maybe required and informing when we deployed the measures.

SW will attend and convene meetings with local groups to ensure progress against the plan and the on-site mitigation activity is clearly communicated. Meetings that have been held over the last 10 years with local council and EA representatives have been influential in helping to shape the IRP. The latest version of the IRP approved by the EA, will be published on SW's website.

For time to time, SW updates stakeholders about completed and planned work, as part of the stakeholder meetings with local councils.

5.2. Monitoring quality of the downstream watercourse

The Generic Plan provides details of water quality monitoring that will be undertaken if required.

6. Options to Reduce Infiltration

6.1. Sewer Rehabilitation Programme

SW acknowledges that infiltration reduction is an on-going process. Since 2013, SW has undertaken surveys and repairs at Barnham. The major repair work was completed in 2013. In the Spring of 2014 further CCTV investigations were carried out. SW completed all the identified repair work except for a repair near to the station; modifications to the sewerage system in Marshall Close were made to improve the level of service for some properties in the area; redistribution of flows was carried out between the two sewers to Lidsey WTW; and changes to the flow rate from one pumping station were made to reduce the peak flow. Further CCTV Investigations were carried out from March 2016 to April 2018, which led to Sewer rehabilitations from March 2016 to October 2018. Appendix A contains details of all sewer inspection and remedial work undertaken to date.

Table 6.1. below summarises the work undertaken in the system since 2014.

Action	Km of sewer
Length Surveyed	10.86
Length with no work required	6.91
Length Sealed	1.81
Length to be sealed	2.14
Manholes sealed	6
Manholes to be sealed	0

Table 6.2. below details the work undertaken in the system since 2014.

Reporting Year	Surveyed (km)	Sewers Sealed (km)	Manholes Sealed
2014	3.3	0	0
2015	0.22	0.16	1
2016	1.04	0.67	5
2017	2.89	0.18	0
2018	3.41	0.190	0
2019	0	0.55	0
2020	0	0	0
2021	0	0	0
2022	0	0	0
2023	0	0	0
2024	0	0.06	0
Post 2024	0	0	0
Total	10.86	1.81	6

6.2. Property Level Protection

Non-return valves and pumped anti-flood devices have always been part of our method for dealing with consequences of infiltration, but they are only effective if infiltration is under control on both the lateral and the main sewer. Having completed the current phase of rehabilitation work, which has improved the integrity of the sewers, the potential for using more NRVs to isolate individual properties or groups of properties is being investigated, with the objective of reducing the requirement for over-pumping.

6.3. Local Flow Control

As noted in Section 4.1, in the winter 2013/14 SW used tankering at 2 locations. Tankering has been required on selected dates during all winters where groundwater levels have impacted levels of service. Full details are given in Appendix B.

6.4. Pumping Stations

In order to minimise infiltration, SW is continuing to ensure that design discharges are maintained at pumping stations. This will help to ensure that the design discharge continues to be readily delivered.

6.5. Monitoring

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

The graph in Figure 4.1, is used to predict the timing of an operational mitigation activity to reduce the risk of flooding and pollution incidents.

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.

7. Action Plans

A significant amount has been achieved in the Barnham catchment in the last 10 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 7.1 and 7.2 cover the actions by SW and by other parties, respectively, to reduce infiltration. Tables 7.3 and 7.4 cover mitigation of the effects of flooding (Communication and other activities).

SW is committed to continuing to pursue infiltration to reduce the frequency of service impacts and mitigation measures. This IRP describes the work that has been done by SW to improve the situation. In addition, it also 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 7.1 - 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 3 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 - September 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 - Complete	The wet and dry weather flow survey results were compared to identify potential areas of infiltration.
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.	Spring 2013 and Spring 2014 - Complete March 2016 – April 2018 – Completed.	Sources of infiltration were identified 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	Summer/Autumn 2014: - Completed in 2014/15, April 2016 – October 2018: Completed	Rehabilitation will restore structural integrity of sewers restored
1.6	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	As required dependent on survey results; none currently scheduled.	Rehabilitation will restore structural integrity of sewers restored
1.7A	Maintain IRP as a live document	Update IRP as appropriate to describe work carried out and/or developments	Annually – on anniversary of submission to EA for approval	Up to date IRP
1.7B	Quarterly progress reports	A progress report on infiltration reduction work related to this catchment will be submitted to the Environment Agency	Quarterly (December, March, June, September)	Keep the Environment Agency informed of progress on a regular basis
1.8	Strategy for inflows via private drains	Southern Water to propose a strategy for dealing with infiltration via private drains*	SW 2014. Complete	Southern Water's 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.

Ref.	Item	Actions	Timescale and Status	Outcomes
1.9	Long-term monitoring	SW will monitor sewer flow to identify significant increases in inflows.	SW, Autumn 2014 onwards	Early identification of areas where infiltration has increased.
1.10	Over-pumping Sites: improve effluent quality	Investigate potential for improved screening and biological treatment at points of discharge into watercourse.	SW, 2014, Complete	Improved arrangements for discharges when required.
1.11	Over-pumping 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 over-pumping arrangements.	SW, 2014, Complete	Agree with EA acceptable standards for discharges and acceptable flow rates.
1.13	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.
1.14	Consider alternative solutions that involve some risk	Investigate unconventional options such as vacuum sewers or consider conventional combined sewer overflows	2020	Ongoing.
1.15	Sewer sealing	Sealing of sewers identified in Appendix A as requiring sealing	2025	Planned

Ref.	Item	Actions	Timescale and Status	Outcomes
1.15	Identification of lengths of sewer to survey or resurvey in the period Post 2024	Review sewer records with available ground water profile date	Post April 2025	Planned
1.16	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.	Post April 2025	Planned
1.17	Survey result review	Review results of surveys undertaken in 1.16 to determine sewer sealing work.	Post April 2025	Planned
1.18	Undertake required sewer sealing	Seal sewers and manholes by most appropriate technique	Post April 2025	Planned, no detailed program of work avaliable
1.19	Review effectiveness of any sealing work	Analyse monitoring data and groundwater data to determine benefit of investment	Post April 2025	Planned
1.20	Review further options for property protection and alternative tanker points	Consider other improvements	Post April 2025	Planned

Table 7.2 - Multi-Agency Activities to Reduce Groundwater Infiltration

Ref.	Item	Actions	Owner, Timescale and Status	Outcomes
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 'misconnections'	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	Local councils 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 local councils, 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 7.3 - 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.	Regular meetings are not planned, but SW will attend with other agencies as required.	Inform the local population of progress and planned activities and receive feedback.
3.2	Liaise with other agencies as appropriate.	Discuss and agree actions to reduce requirements for tankering and emergency discharges to watercourses.	On-going – further liaison as required	Improved understanding of issues and appreciation of issues. Agreement to actions to help reduce the need for tankering and emergency discharges to watercourses

** 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 7.4 - 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, Commenced and on-going. [SW use EA borehole data.]	Develop trigger levels by comparing historic customer complaints and tankering with BH levels (or other reference). Note trigger levels should vary as a consequence of rehabilitation. Also they will need to reflect groundwater reaction times.
4.2	Tankering arrangements	Investigate options for improving location of tankers and over-pump units for future events. e.g. by use of longer hoses/ pumping	SW, Spring/Summer 2014, done	Potentially less disruption to residents when tankering / pumping is essential.
4.3	Integrated Flood Risk Management	Develop a multi-agency approach to the management of flood risk within catchments as it relates to the impact on public sewers.	West Sussex County Council/Arun District Council, with inputs from SW, EA, Parish Councils and local flood action groups.	Actions for participating authorities that in unison will reduce the extent of flooding and the impact of flooding.

Appendix

A Survey Findings and Completed and Planned Rehabilitation

B Mitigation measures