Lancing
Infiltration Reduction Plan
June 2016
## Document Title: Lancing Infiltration Reduction Plan

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BACKGROUND

The Environment Agency’s (EA) Regulatory Position Statement (RPS) requires Water and Sewerage Companies (WaSC) which are aware of sewerage systems in their area which are vulnerable to infiltration, to submit Infiltration Reduction Plans (IRP) to the EA for approval. This document is produced in response to the RPS.

The IRP will be updated by Southern Water (SW) annually to show the latest information regarding the progress of work in the area to reduce infiltration. Therefore there will not be a ‘final issue’ of the plan; it is a working document, which will be updated as required.

Lancing is prone to flooding from many causes, including flooding from local water courses, coastal flooding, surface water flooding, ponding, capacity constraints in the Lancing Brooks and, as the parish occupies a low-lying coastal plain at the foot of the South Downs, particularly groundwater flooding. Groundwater from the Downs surfaces where it meets the flatter terrain and there are many natural springs beneath the catchment. Acknowledging that high seasonal groundwater is an issue particularly in North Lancing, Southern Water has been working to identify the locations of groundwater infiltration into sewers in North Lancing, and to repair them. The current infiltration reduction programme started in 2013.

The map on the following page shows that flows gravitate from Manor Close, Manor Way and Lewin Close WPS to Grinstead Lane WPS. Following this, flows are pumped from Grinstead Lane WPS to Old Salt WPS. The resultant flows are then pumped to East Worthing Wastewater Treatment Works (WTW) which is west of Lancing.

Southern Water has been active in communicating with other agencies to minimise the inconvenience to residents when groundwater infiltration of the sewer system occurs or is threatened.

The repairs carried out by SW improve the integrity of the sewerage system locally, however, despite the repairs completed, the current sewer flooding highlights that further investigation is required. Investigation is scheduled for spring 2016, as soon as groundwater levels reduce.

Southern Water 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,
- West Sussex County Council
- Adur District Council
- Lancing Parish Council
- Adur Floodwatch Group
Representation of the sewerage system serving Lancing catchment
EXECUTIVE SUMMARY

In the last three years Southern Water has invested more than £280,000 in surveying and repairing sources of infiltration in the local sewer network. The locations of the work are shown in Appendix A. Approximately 700m of sewer and 6 manholes have been repaired in North Lancing. The work formed an important part of the £14 million being invested by Southern Water during 2013 to 2016 to improve the performance of the sewers in many of the 60 towns and villages affected by high groundwater levels across the company’s region.

This Infiltration Reduction Plan (IRP) leads the reader through the steps taken by Southern Water (SW) to reduce infiltration and to explain the benefits of the work. The sections of the IRP follow the order of requirements of the current version of the Environment Agency’s Regulatory Position Statement - May 2014, (RPS)

Section 1 explains which IRP sections address which sections of the RPS. A significant number of unusually wet winters in recent years has caused a number of flooding events in the Lancing Catchment. During the winter of 2013/14, the wettest winter on record, flows in the sewers exceeded their capacity and unfortunately it was necessary to make discharges from the sewers into adjacent watercourses in order to maintain sewerage services to SW customers. The locations where discharges were required (over-pumping) are shown in Appendix C. The history of recent flooding is quantified in Section 2, together with an acknowledgement by SW that infiltration was sufficiently significant that action was required to reduce it.

The generic approach adopted by SW for its Infiltration Reduction Programme is explained in Section 3; also included is a table of key dates for surveys and repairs in Lancing.

Benefits of the sewer rehabilitation work are explained in Section 4, together with a description of the steps that SW is taking to prevent discharges needing to be made to the watercourse during high groundwater conditions. The pros and cons of tankering and over-pumping are included, as are the factors considered when having to decide whether over-pumping is required to avoid danger to health and to maintain sewerage services to customers. This section also summarises SW's plans for communications and arrangements for monitoring water quality, if over-pumping is required.

In Section 5, options to minimise infiltration, and the effects of it, are discussed. Since January 2015, SW has been running a winter groundwater monitoring programme. Weekly reports are shared with the EA and the information is used to help plan responses should sewer flooding occur. Taking a longer-term view, analysis of long-term data supports the view that infiltration to the sewerage system, and flows to Grinstead Lane WPS, have been reduced as a result of the repair work completed. Figure 5.2 shows that the completed repairs provide increased resilience against an additional 5 metres of groundwater as measured at Ladies Mile borehole, Patcham. However, whilst there is benefit from the repairs, the current sewer flooding demonstrates that further investigation is required. CCTV surveys will be carried out when the groundwater levels reduce sufficiently.

Section 6 includes a conclusion and a table of actions to reduce infiltration and the impact of remaining infiltration. SW is seeking to promote a multi-agency approach to
make improvements that will ultimately reduce the number of occasions when further over-pumping will be required.

The appendices include plans showing the extent of survey, locations of significant infiltration and extent of repairs undertaken (Appendix A), diagrams and photos of typical over-pumping arrangements where they are required (Appendix B), plans showing the locations of the over-pumping locations that have had to be used in recent years (Appendix C) and typical advisory signs (Appendix D).
1. REPORT STRUCTURE

Section 1 - Report Structure (this Section)

Southern Water has embarked on a programme to reduce the effects on customers and the environment of groundwater infiltration. Progress, and current and future activities are recorded in Infiltration Reduction Plans (IRPs) that SW is producing. This IRP covers the village of Lancing.

This IRP is arranged in five further sections: Situation, Investigation & Repairs, Over-pumping, Potential Actions and Conclusion. These headings have been used in order to cover, in a logical structure, the information required by the Regulatory Position Statement (RPS) published by the Environment Agency (EA). The descriptions in the bullet points below summarise the requirements of each section of the RPS. SW’s response to those requirements is provided in each section of the RPS, in the locations noted below.

Section 2 - Situation

- Acknowledgement that for Lancing, groundwater infiltration is significant enough to have necessitated the use of over-pumping to protect customers against sewer flooding (RPS Section 2.2)
- Explanation of what would happen if SW was not to actively prevent groundwater getting into the sewers or use mitigation measures to protect customers when flooding does occur, providing details and locations of infiltration and other likely impacts (RPS Section 2.3 i)

Section 3 – Investigation & Repairs

- Outline the plans for investigation of the problems caused by groundwater getting into the sewers (RPS Section 2.3 ii)
- Explanation of the techniques used to combat infiltration and a brief summary of the repairs carried out in Lancing.

Section 4 - Over-pumping

- Detail the circumstances and locations where over-pumping is expected to be required (RPS Section 2.3 iii)
- Include information about the over-pumping including typical flow rates and measures to minimise the effect on the watercourse of the discharge (RPS Section 2.3 iv)
- Explain what SW is doing to avoid the need for over-pumping (RPS Section 2.4 a.)
- Explain the steps SW takes to minimise how much is pumped (RPS Section 2.4 b)
- Describe the physical measures used to prevent and remove solid matter (RPS Section 2.4 c)
- In the event of needing to over-pump, explain SW’s procedures for notifying the EA and for communicating with people who might be affected by the pumping. (RPS Section 2.4 d)
• Describe what SW does to monitor the water quality of the downstream watercourse (RPS Section 2.4 e)

Section 5 – Future Actions
• What SW is doing to minimise the requirement for discharges. This is to include planned work to reduce groundwater getting into sewers and also work that could be considered in future if the work being carried out and the planned work are not adequate. (RPS Section 2.3 v)

Section 5 - Conclusion
• A commitment to review and update the IRP annually (RPS Section 2.3 vi)
2. SITUATION

2.1. The significance of groundwater infiltration in the Lancing catchment.

The Lancing catchment is exposed to surface water, groundwater, river and sea flooding. Excess groundwater which permeates through the ground from the South Downs to the north, surfaces in North Lancing. Groundwater which gets into the sewers prevents sewage from customers’ properties being able to be conveyed satisfactorily to the treatment works. During these conditions some customers suffer restriction in use of their facilities. Southern Water strives to maintain services for customers by a programme of investigation, repair, maintenance and mitigation measures that include use of tankers and over-pumping. Such measures are not popular, so during the last three years SW has invested over £280,000 carrying out significant improvements to the integrity of the sewers and manholes in North Lancing, in order to minimise the occasions on which over-pumping into the local watercourse will be required.

An investigation in 2013 by SW’s consultants showed a positive correlation between groundwater levels and sewer flows.

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

Flooding has been a major problem in Lancing for decades. The nature of the problem means that multi-agency groups need to successfully collaborate in order to mitigate flooding.

Table 2.1 and Figure 2.1 below show the number of recorded incidents of sewer flooding since April 2000. Average winter rainfall has also been included in Figure 2.1. Not surprisingly, it can be seen that the years with the most flooding incidents were also the wettest. See Section 3 for the summary of investigations and repairs carried out.

Sewers are designed to accommodate normal flows, which include an allowance for groundwater. However, during particularly wet winters, the capacity of the sewers is exceeded, resulting in spillages and sewer flooding. In addition to repairs to the sewers, Southern Water has a standard process which it follows each autumn/winter to ensure sewers are flowing freely. Consequently, it is difficult to assess what the effects of groundwater infiltration would be if no action were taken. It is likely that more customers would suffer loss of sanitation and more manholes would spill if SW did not carry out the pre-winter checks, regular jetting and rehabilitation of the sewers.

In some catchments, SW has hydraulic models of the sewers which can be used to predict the locations where the sewers are expected to flood during certain storm conditions. SW does not have a model of the Lancing catchment, but knows from experience which are the first areas to suffer from the effects of flooding. As such, an automatic alarm system has been installed to warn when sewer levels are high in the Manor area.
Table 2.1 shows that there have been 48 reported instances of external flooding, and 14 reported instances of restricted toilet use since 2000. Indeed, Figure 2.1 shows that there is a correlation between these reported incidents and the increasing rainfall trend over recent years. Incidents of Internal Flooding occurred less frequently; there has been only one reported incident of internal flooding since April 2000.

The rainfall figures are average winter rainfall figures. Records were not readily available before 2005. They are provided to show the influence of rainfall / high groundwater on incidences of sewer flooding.
Definitions of Categories of Flooding

**Internal Flooding** occurs when sewers either back-up to such an extent that dilute effluent floods inside dwellings from low connections to the drains (for example through WCs or shower drains) or when contaminated surface water enters the building where this is a direct consequence of sewer flooding.

**External flooding** at a property is defined as flooding to external areas within the curtilage of the property, due to sewers becoming surcharged. The flooding will normally be from a surcharged manhole or gully. External flooding can be contaminated surface water entering the grounds of the property. There are two other categories of external flooding: Highway flooding refers to flooding on roads or footpaths. ‘Other’ external flooding refers to non-residential buildings and public open spaces.

**Restricted Toilet Use** may be experienced by customers as the sewers become surcharged. Toilet facilities still function, but effluent will be slow to drain away and sometimes facilities can only be used for limited periods – for instance after a tanker has removed dilute effluent from the local sewers.
3. INVESTIGATION & REPAIRS

3.1. Outline plans to investigate sources of infiltration

This section (3.1) describes the generic process to reduce infiltration, developed by Southern Water for the Infiltration Reduction Programme in 2013. The steps are shown in Figure 3.1 below. The specifics of the investigations and repairs at Lancing are in Section 3.2.

**SW Process to Reduce Infiltration**

1. Survey
2. Immediate Repairs
3. Review of Survey findings & scoping repairs
4. Repairs
5. Flow Monitoring
6. Targeted Follow-up Survey
7. Repairs as required
8. Long-term Monitoring

*Figure 3.1 – Infiltration Reduction Process*

1. survey (manhole lifting followed by CCTV)
2. immediate repairs of major points of infiltration.
3. review of data and commercial arrangements for repairs
4. carrying out repairs
5. flow monitoring in wet and dry weather conditions
6. targeted follow up survey
7. repairs as required
8. ongoing long-term monitoring

Steps 1 to 7 are described below. Step 8 is covered in Section 5.4.

Plans in Appendix A show the sewers identified for investigation, those surveyed, where infiltration was found, and where repairs were carried out. An example of a plan from another catchment is shown in Figure 3.2 below. The plan shows how the survey and repair steps follow a process of refining the area from where infiltration is...
thought to be, to the precise locations where groundwater is getting into the pipes, and the lengths of sewer and manholes repaired. The plans are generated from Southern Water’s updated records.

Figure 3.2 - Example of Plans showing Survey and Repairs.

3.1.1. Manhole inspections and CCTV surveys

Steps 1 to 4 follow a process of elimination. Initially SW identifies an area where infiltration is either known, or expected, to exist. This is generally based on local knowledge of the area. Then ‘strategic manholes’ within that area are identified. When the groundwater levels are high but falling and the sewers are no longer surcharged, flow in the strategic manholes is checked. Manholes at the downstream end of the run are inspected first, then the next manhole upstream, until the flow is down to normal. Any sewer runs where there is a reduction in flow from the downstream manhole to the upstream manhole are noted. The change in flow indicates infiltration. The manholes are also checked for infiltration. As soon as possible after this inspection, the sewer lengths are inspected using CCTV units which are moved through the sewers working upstream from manhole to manhole, as far as the manhole where the flow is normal. If significant flow is seen from lateral connections, these are also surveyed by CCTV (subject to gaining access from customers’ properties – where required).

The CCTV cameras are mounted on a wheeled unit which measures the distance along the pipe from the manhole. A report of the CCTV inspection is prepared noting...
the location of any defects (e.g. displaced joints), or leakage of groundwater into the pipe. Still photos of these are captured from the video and included in the report.

The report is reviewed by Southern Water, the most appropriate repair technique for each location is determined and specified and an order for the work is placed with the SW’s framework networks maintenance contractor.

3.1.2. Flow Monitoring Surveys

In addition to the surveys noted above, flow monitoring is another activity which can be used to aid in the identification of areas of infiltration. The activity does not fit sequentially between the other activities, hence it is shown to the side in Figure 3.1. Flows can be monitored in both dry weather, and in wet weather conditions. Flows are typically monitored for a period of four weeks. In some cases, comparison between the data from the wet weather and dry weather surveys can be used to assist with identifying areas of high levels of infiltration. Details of the flow monitoring in the Lancing catchment are given in Section 3.2 and dates are in Table 3.1.

3.1.3. Repairs

When the repairs are instructed, the contractor will then return to the site and prior to starting the repair, will rerun the CCTV inspection to ensure there are no material changes since the initial survey was done. This is particularly relevant if the repair is not carried out until a significant period of time after the initial inspection. The repairs specified by SW would be from the list below. After completing the repairs, a further CCTV survey of the pipes is carried out to demonstrate the effectiveness of the repairs. This information is retained by SW, which updates its sewer records. The lengths of sewers surveyed by CCTV and the results are also included in the sewer records database.

Where rehabilitation is required, the appropriate repair technique is selected from the following:

- Sewer lining – fitting a new lining to sewers from one manhole to another or to sections of sewer to repair several leaks, by forming a leak-tight pipe within the existing sewer.
- Excavations to repair leaking joints where no-dig techniques are not possible.
- Quick-Locks – metal ‘sleeves’ which are inserted remotely into damaged pipe sections and, once located correctly, are expanded via compressed air against the inner walls of the pipe to instantly seal leaks.
- Joint Test and Seal – each joint between sewer pipes is air tested and if it does not hold the pressure, the joint is injected with a gel to seal it. Sealed joints are retested.
- Capping of leaking un-used connections.
- Top Hats – fibreglass inserts which form a leak-tight bond at the point where a lateral sewer connects to the main pipe.
- Ground Stabilisation – an alternative technique which involves the injection of gel into the ground around a leak.
- Manhole chamber sealing – a non-exciavation method to repair manholes.
3.1.4. Follow-up survey and repairs

If there is evidence of remaining infiltration following repairs, further targeted investigation and repairs may be carried out if required.

3.2. Investigation and repairs at Lancing

As noted in Section 2, SW has acknowledged the significance of infiltration at Lancing and consequently included it in the company’s infiltration reduction programme from 2013 to 2015. The investigations and repairs followed the process set out in Section 3.1 above. The status of each step is summarised in Table 3.1 below.

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<td>3.</td>
<td>Determination of required repairs</td>
<td>March 2013 and Summer 2014</td>
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<td>Further Targeted Repairs – Phase 3</td>
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Table 3.1 – Summary of Survey and Repairs at Lancing

Phase 1 of the major repairs was completed in May 2013. This work consisted of 387m of joint testing and sealing in the Manor Close and Manor Way area. The cost of this was approximately £135,000. Approximately £152,000 was invested in Phase 2 of the major repairs, which was completed in February 2015. This work extended the investigation into the housing development around Hayley Road/Lisher Road, resulting in 100m of sewer lining, 6 sealed manholes and 8 patch repairs. In total 316m of sewer was sealed from infiltration.
The current sewer flooding has highlighted the need for further investigation, which is being scheduled to be carried out when groundwater levels have fallen sufficiently. SW will survey the area south of the Phase 1 and Phase 2 works. Usually, there is only a short window in which surveys can be carried out. This is because optimum conditions in the sewers are required – when the groundwater level is just above the sewer and falling.

At Grinstead Lane WPS both pumps were replaced after the sewer flooding in 2012/13.

In addition to physical investigations on site, SW has instigated a long-term programme of monitoring flows in critical catchments, including the Lancing catchment. Details are given in Section 5.4.

Additionally, flow monitoring (Step 5 in Figure 3.1) was carried out in dry weather conditions (7th August to 18th September 2013) to establish baseline flows. Comparison of ‘wet and ‘dry’ flow monitoring data can, on occasions, help identify areas of infiltration if it has not been found by other survey methods. In the case of Lancing, this was not necessary as infiltration was located by CCTV survey.

Generally, Southern Water's £14 million investment during the past three years to survey and seal the sewer system in the many locations across its region which are prone to groundwater infiltration of the sewers is paying dividends. Nevertheless, there are never any guarantees as the unpredictable nature of groundwater is that sealing one part of the sewer network can increase the ground water table locally because it is no longer being drained via the sewers. The result is that it finds another way into the sewers, usually via the next highest joint which previously it may not have reached and therefore could not be identified during a sewer survey. It is a long term battle as points of ingress will continue to appear in different places, but if the ingress is significant, Southern Water’s intention is to conduct further survey work.
4. OVER-PUMPING

4.1. Where over-pumping may be required and under what circumstances

If flows continue to increase, as groundwater levels rise, mitigation measures at certain locations will be required. Using previous experience, areas likely to be the first affected are identified. The requirement for tankering or over-pumping will be driven by levels in the manholes locally. Based on experience in 2013 and 2014, over-pumping could be expected to be required when the groundwater level at Ladies Mile BH exceeds 40.1m AOD. However, conditions vary from year to year and to allow time for investigation and preparation, SW is using a ‘trigger level’ of 37.0m in the winter planning report. Whilst SW would not expect to start physical measures such as tankers or pumps at that level, the purpose of the ‘trigger level’ is to trigger actions to obtain more information and prepare for an appropriate response. Refer to Section 4.2 below - ‘Steps to prevent discharges and prior alternatives to over-pumping’.

Figure 4.1 shows the groundwater levels over the last four years at Ladies Mile BH, Patcham. The dates when pumping was required in 2012/13 and 2013/14 are also shown. The approximate timing of repair activities is also shown. Following the Phase 1 repairs, over-pumping was not required in 2014 until the groundwater level measured at Ladies Mile BH reached 43.7m AOD, compared to 40.1m AOD in February 2013. This supports the view that the Phase 1 repairs have been successful in reducing infiltration. However, whilst the groundwater levels at nearby boreholes are useful indicators, it is levels in the sewers that determine the response required by Southern Water.

![Figure 4.1 - Groundwater levels from 2012 to 2016](image-url)
Further analysis to quantitatively illustrate the effectiveness of the repairs are provided in Section 5.4. Overpumping was not required in winter 2014/15, however tankering did take place briefly in January 2015.

The locations where over-pumping has been necessary in the past are given in Appendix C. The repairs carried out, combined with the winter preparation checks, are expected to minimise the number of locations where over-pumping would be required. 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 over-pumps are required at other locations either in place of, or in addition to, the sites described in Appendix C.

4.2. Steps to prevent discharges and prior alternatives to over-pumping

In addition to the eight steps outlined above, SW also carries out other activities to minimise the requirement for discharges to watercourses. During the Winter 2014/15 SW followed the steps in the following list. These activities supplemented the rehabilitation programme. The approximate timescales for each step are included in brackets. The activities were:

1. carry out scheduled maintenance visits to key pumping stations prior to winter weather; this covers activities such as cleaning wet wells and checking that pumps are working at capacity, [Winter 2015/16]
2. ensure that sewers prone to silt deposition or fat build-up have been jetted as per SW’s Scheduled Maintenance Tasks, [Winter 2015/16]
3. monitor groundwater levels in relevant local boreholes, [from mid-September 2015]
4. when groundwater levels start to rise, monitor WPS performance as groundwater level approaches trigger levels based on previous flood events, [the frequency was increased to weekly from January 2016]
5. determine forecast dates for trigger levels based on previous dry, average and wet winters, [from mid-September 2015]
6. hold weekly calls with the EA and share forecasts for potential over-pumping, [commenced January 2016 - duration is dependent on groundwater levels]
7. as each trigger level is approached, check sewer levels at selected manholes in the catchment; continue to monitor and record sewer levels, [from January 2016, for Lancing]
8. if levels continue to rise, carry out manhole lifting and record sewer levels and share data with the EA, [following Step 7, data is being shared weekly]
9. monitor customer calls; seek to establish whether there is a common cause for the lack of capacity to maintain sewage disposal services, [ad-hoc analysis, as and when required during flood events]
10. respond to customer calls with targeted sewer jetting, tankering or over-pumping as appropriate, [as required]

11. keep EA informed about potential and current tankering and jetting activities and agree course of action where over-pumping is required, [from late January 2016 for Lancing (as for Step 7) through weekly reports and calls]

12. continue to monitor levels, [weekly through the winter/ spring]

13. where over-pumping is required, ensure duration and quantity of discharges are minimised (e.g. by use of level control on pumps); also ensure use of the over-pumping components (settlement tanks etc) as agreed – refer Appendix B of the IRP,

14. following the flooding event, as levels in the sewers return to normal, lift manhole covers in catchments where there has been over-pumping to identify sudden increases in flow, [Spring 2016]

15. instigate survey and repairs if required [CCTV: Spring/ Repairs: Autumn 2016 – repairs will be dependent on the findings of the surveys].

4.3. Over-pumping arrangements (flow rates and minimisation of effect on watercourse)

Typical Over-pumping Arrangements
Depending on local conditions, a typical over-pumping site consists of a pump located at ground level adjacent to a sewer manhole near the watercourse into which it will discharge. The pump lifts dilute effluent from a surcharged manhole. The suction hose is positioned as near as practical to the top of the flow so that it is mostly liquid rather than solids which is pumped. The solids tend to remain in the sewer. A barrel filter is attached to the end of the suction hose. The barrel filter has 10mm holes in it, so it holds back larger material in the manhole. (Refer Figure B1 in Appendix B.)

The size of pump will be chosen to remove only the necessary flow from the sewer. To minimise the flow that is pumped out of the sewers, ‘level control’ sensors are used to ensure that the pump only operates when the level in the manhole is high. When the level drops, the pump stops and only starts again when the water level in the manhole rises above the level at which it is necessary to pump to protect properties. As explained above, SW monitors levels in the manholes as the levels rise, so has a fairly good idea of the maximum level in the manhole that can be tolerated before properties experience flooding or restricted toilet use.

Flow rates depend on the size of pump and the length of hose through which the pump delivers the flow. Typical discharge rates for pumps with short discharge pipes are:

- 75mm (3”) pump 10-20 l/s
- 100mm (4”) pump 30 l/s
Longer suction and/or delivery hoses reduce the flow rate significantly. The objective is to remove the minimum flow that is necessary to maintain services to customers.

For the 75mm and 100mm pumps, a combined unit is used which contains a Silent Pack generator and a pump.

Maintenance of the over pumping units is carried out regularly; daily checks include checking the flow and cleaning/replacement of filtration sacks and the barrel filter on the suction hose. The settlement tanks are cleaned each week.

The locations where tankering and over-pumping were used in winter 2013/14 are shown in App C.

Physical measures used to remove solid matter
When the pump operates, flow is pumped into a settlement tank. In the tank, the flow passes under a settlement weir, which traps much of the floating material. Finally, at the end of the discharge hose, before the flow is discharged into the receiving watercourse, it passes through a filtration sack located on the end of the hose.

Further details on a typical over-pumping arrangement are provided in Appendix B and the locations where over-pumping has been used in recent years is given in Appendix C.

River quality monitoring to check ammonia levels and bacteria content is carried out when over-pumping is required. More information on monitoring the quality of the downstream watercourses is given in Section 4.6.

4.4. Steps to minimise the volume and duration of over-pumping

4.4.1. Factors considered prior to over-pumping

As explained in Section 4.2 above, SW follows a set of steps to ensure that its assets operate correctly. The steps also identify how the company deals with high flows when they occur. SW endeavours not to use over-pumping into water-courses as this is an emergency, short-term solution to protect customers’ bathroom, toilet and kitchen facilities. However, on occasions it cannot be avoided if customers’ wastewater facilities are to be protected. Generally, tankering is used prior to over-pumping. Tankering is the initial emergency response, which is suitable for small-scale sewer flooding. But if the flooding becomes more widespread, over-pumping will need to be used to maintain sewerage services to customers.

There is no clear rule for the exact point to change from tankering to over-pumping. However, the following factors are taken into account:

1. Use of the appropriate equipment to maintain services to customers (e.g. minimising restricted toilet use).
2. Avoidance of imminent internal or external sewer flooding to protect public health.
3. Forecast of sudden increase in groundwater levels due to severe or prolonged rainfall that would significantly increase risk of sewer flooding.
4. Minimising health and safety risks or disruption to residents due to tanker movements, particularly where tankers are required at night or where tankers restrict access to properties.

5. Whether there are isolated properties suffering restricted toilet use/ flooding or whether the disruption is more widespread.

6. Traffic congestion caused by tankers.

7. As flood conditions worsen, determining whether tankers remain a practical and economically viable solution.

8. The availability and proximity of a suitable receiving watercourse with sufficient flow.

9. Noise and exhaust fumes pollution of tankers versus the potential impact of over-pumping on the receiving watercourse.

10. Demand for tankers elsewhere. During the exceptional high rainfall experienced in 2014, in responding to sewer flooding events, the available supply of tankers was exhausted.

4.4.2. Pros and cons of tankers and pumps

Tankers and over-pumping are both appropriate solutions, each suiting different scenarios. The key benefits and disadvantages are noted below.

Tankering

Benefits:

- Dilute sewage is discharged at a treatment works for treatment.
- Quicker response time.
- No impact to watercourse.
- Convenience – suitable for response to short duration localised flooding.

Disadvantages

- The flow rate is low (approx. 2l/s per tanker over a 24 hour period).
- There are traffic issues associated with large vehicles using narrow roads.
- Rural roads are not designed to take the load of repeated visits by tankers – potentially resulting in damage to the road.
- Tankers are noisy causing disturbance to local residents, particularly at night.
- High cost and carbon footprint compared to over-pumping.

Over-pumping

Benefits:

- Typical pump fuel consumption is 20% of the fuel that one tanker would use in a day.
- The discharge rate is significantly greater. A 75mm (3") pump will discharge typically 10 to 15 l/s; the equivalent of a fleet of 7 tankers.
- Pumps are quieter than tankers.
• The pumps run on level control so only operate when required.
• Located off the highway.
• Lower cost and carbon footprint compared to tankering.

Disadvantages

• Temporary environmental impact of discharging dilute effluent to the watercourse.
• Pumps are less noisy than tankers but may still cause disturbance to the local residents, particularly at night.

The graph in Figure 4.2 shows the estimated carbon emission per m$^3$ of dilute effluent removed by tanker and by pump. Averaged data have been used for the tankers and pumps deployed in 2014.

![Figure 4.2 – Carbon footprint figures for tankers and overpumps per m$^3$ of effluent removed.](image)

Irrespective of the method of removing excess infiltration, it is clearly preferable to prevent it entering the system in the first place, which is why SW has been investing in finding and repairing points of infiltration and in installing targeted property level protection.

**4.5. 3rd Party communications about over-pumping**

Since the start of the Infiltration Reduction Programme in 2013, Southern Water has been proactive in communicating with stakeholders about planned and completed work to improve the integrity of the sewerage system. Stakeholders have been kept informed of progress on survey and sealing work via emails and face-to-face meetings. In addition, customers have also been kept informed via meetings with residents’ associations, letters to their homes and reports in their local media.

A draft of the IRP is to be shared with stakeholders to capture their views and, when approved by the EA, a copy will be published on SW’s website for all to see.

Despite the work being undertaken, if over-pumping is required, prior to commencing over-pumping, SW will liaise with the EA in order to agree the requirement and to discuss proposed locations for the emergency discharges to watercourses.
Immediately prior to commencing over-pumping, SW will notify the EA National Incident Communication Service (Tel. 0800 807 060).

Stakeholders, including local authorities and the EA, would also be kept informed of discharges to watercourses (over-pumping) before and during the operation.

Immediately prior to over-pumping being operated, Southern Water will put up advisory signs at the over-pumping discharge location(s) and at the appropriate location(s) downstream along the receiving watercourse, advising the public that over-pumping is in operation. The wording on the signs will be as, or similar to, the example in Appendix D. The location of advisory signs is also provided in Appendix C. Prior to the cessation of over-pumping, SW will also liaise with the EA and also inform the EA National Incident Communication Service following cessation.

During the winters of 2014/15 and 2015/16, SW and the EA held weekly conference calls to discuss locations where total flows in the sewers were reaching the point where SW would need to respond imminently with tankering or over-pumping.

4.6. Monitoring quality of the downstream watercourse

If over-pumping is required, Southern Water will undertake regular water quality monitoring, as it has on the occasions when over-pumping has had to be carried out in the past. For each site, SW will require sampling/measurement at each of the following points:

1. 15m upstream* of the effluent discharge
2. The effluent discharge
3. Downstream of the effluent discharge

*subject to pipework configuration.

The upstream/downstream points provided above are typical positions and may vary depending on the watercourse depth, width or flow.

When over-pumping is in operation a laboratory sample would be taken at each of the above points once a week for:

- E. coli
- Enterococci
- Total coliforms
- COD
- BOD
- Suspended solids

In addition, Southern Water will discuss the requirement for sondes with the Environment Agency and if required, the locations for them. Sondes are instrument probes which are immersed in the receiving watercourses upstream and downstream of the discharge point. They automatically transmit information about the surrounding water. Where sondes are deployed, they provide half-hourly measurements of:

- Ammonium (NH4+)/ ammonia(NH3)
- Dissolved oxygen
• Turbidity
• Oxidation reduction potential
• Additional standard parameters that come with sondes (pH, temperature, conductivity, total dissolved solids etc)
5. OPTIONS TO REDUCE INFILTRATION AND MINIMISE THE REQUIREMENT FOR DISCHARGES TO WATERCOURSES

5.1. Sewer Rehabilitation Programme

SW acknowledges that infiltration reduction is an ongoing process. Since 2013, SW has invested £280,000 in surveys and repairs at Lancing. The work was carried out in two phases as noted in Section 3; that work has been completed. In response to the current sewer flooding, SW will conduct further investigation work in spring 2016 in the Lancing catchment.

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 with a proposed investment of a further £10m across its region for AMP6 (2015 – 2020).

5.2. Property Level Protection

Non-return valves (NRVs) have always been part of Southern Water’s armoury for preventing infiltration affecting vulnerable properties. NRVs are only effective if infiltration is under control on both the lateral and the main sewer. Whilst there are no plans currently to install non-return valves in the Lancing catchment, the potential benefit of further property level protection will be investigated, if it is considered appropriate, when the planned repairs have been completed.

5.3. Pumping Stations

In order to minimise infiltration, SW continues to ensure that design discharges are maintained at pumping stations. Both pumps at Grinstead Lane WPS were replaced after the 2012/13 sewer flooding. Maintaining the pumps ensures that the design flow is reliably discharged.

5.4. Monitoring

SW has set up a monitoring programme using current electronic data. (e.g. EA borehole level data via telemetry links). In January 2015, SW commenced a weekly review of the ten locations in its region which are most prone to sewer flooding. Lancing was not included in the 2015 monitoring as locally groundwater levels remained relatively low. However, this year Lancing has been included in the weekly review of sites vulnerable to groundwater flooding.

The monitoring uses ‘real time’ groundwater levels from local boreholes to predict when it might be necessary to respond to mitigate the effects of flooding. The trigger levels are not the levels at which tankering or over-pumping started historically. When a trigger level is breached SW increase activity to ensure that the sewers are running clearly. Levels in the manholes are also checked, as it is this, not groundwater levels that determine when surplus effluent needs to be removed from the sewers.

The graph below, 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.
SW is repeating this monitoring each winter. In 2015, the reporting commenced mid-September, running reports at monthly intervals initially, increasing to fortnightly, then weekly to suit the rise of groundwater levels. The forecast dates for reaching trigger levels is shared with the EA when it is produced.

The above approach can only be used during periods of rising groundwater. However it is important for SW to continue to monitor the integrity of the sewers through the dryer months of the year.

Figure 5.1 – Forecasting of Trigger Dates

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.
Figure 5.2 shows the groundwater levels at Ladies Mile BH plotted against estimated flows at Grinstead Lane WPS. Line A represents data for 01/01/2010 – 07/04/2013, which was before Phase 1 repairs at Lancing. Line B represents data for 10/02/2015 – 26/01/2016 which is after completion of the Phase 2 repairs.

It can be seen from Figure 5.2 that there is limited data for the period following repairs (Line B). Nevertheless, the trend lines (Lines A and B) suggest that generally the repairs have reduced infiltration. For a given groundwater level, the flows are lower after the repairs than before the repairs. For example, at a groundwater level of 30.0m AOD, it can be seen that Line B indicates the corresponding flow to be approximately 1,400m$^3$/day. However, using Line A, the flow can be estimated to be approximately 4,000m$^3$/day.

Figure 5.2 suggests that at average flows (approximately 200 – 1,500m$^3$/day), phase 1 and 2 repairs provide resilience against an additional 5m of groundwater as measured at Ladies Mile borehole. The figure also suggests that for higher groundwater levels the benefit of the repairs is even greater.

However, further data, particularly at higher groundwater levels is required in order to confirm the benefit of the repair work. SW will continue to carry out further analysis and include updates in future updates of the IRP.
6. CONCLUSIONS / ACTION PLANS

6.1. Conclusions

SW has carried out significant survey and repair work in the Lancing catchment since spring 2013. Following the repair works carried out in 2013 over-pumping was not required until higher groundwater levels than was the case in 2013. In the winter of 2014/15, groundwater levels were slightly lower and over-pumping was not required.

As noted in Section 5.4, analysis of long-term data supports the view that infiltration to the sewage network has decreased since the repair work was carried out.

As noted previously, reducing infiltration is an ongoing journey. In 2013, SW prioritised 17 areas – including Lancing – which were identified as priority sites for reducing infiltration. Having reduced infiltration in those priority catchments – including Lancing - SW is now focusing on improving other catchments that have significant infiltration. However, the Lancing catchment is not being ignored. SW is currently monitoring the flows (see Figure 5.2), and continuing with ‘winter preparation’ work. Also further investigations will be carried out in spring 2016 as groundwater levels start to fall. If further repair work is identified as being required, this will be scheduled into the infiltration reduction programme, taking account of the needs of other catchments.

6.2. Actions Plans

A significant benefit has been achieved in the Lancing catchment in the last three years, but some actions are incomplete or on-going. To make it easy to track progress the following table summarises the actions to reduce infiltration and also to mitigate the effects of it, if the infiltration cannot be controlled at economic cost (in line with BTKNEEC see below).
### SW Actions

<table>
<thead>
<tr>
<th></th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Infiltration Reduction</strong></td>
<td></td>
</tr>
<tr>
<td>Activities to investigate infiltration and carry out repairs</td>
<td>Refer Table 3.1 in Section 3.2 for completed and planned activities</td>
</tr>
<tr>
<td>Annual IRP updates and quarterly reporting to EA</td>
<td>In 2016, Q1 and Q2 reports submitted and discussed with EA.</td>
</tr>
<tr>
<td>Winter Preparations</td>
<td>Preparation as Section 4.2 and monthly/weekly forecasting.</td>
</tr>
<tr>
<td>Preparation and making suitable arrangements for emergency discharges if required</td>
<td>Arrangements discussed with EA during Winter weekly calls.</td>
</tr>
<tr>
<td>Developments</td>
<td>Respond to planning applications as required</td>
</tr>
<tr>
<td><strong>Flood Mitigation</strong></td>
<td></td>
</tr>
<tr>
<td>Forecasting</td>
<td>Wet weather monitoring of groundwater levels and sewer levels/flows relative to trigger levels</td>
</tr>
<tr>
<td>EA communications</td>
<td>Monitoring groundwater levels and communicate with EA</td>
</tr>
<tr>
<td>Stakeholder Engagement</td>
<td>Communications with stakeholders and the public as appropriate.</td>
</tr>
</tbody>
</table>

Colour coding of actions in tables: Green – completed, Yellow – imminent action required, Red – overdue, White – on-going actions with no specific end dates.

**Multi-agency activities**

**Infiltration Reduction**

- Misconnections - WSCC (for highways) and Adur District Council (for domestic connections) to investigate and pursue as required.
- Groundwater Flooding Strategy - WSCC with input by other agencies as appropriate

SW is committed to continuing to pursue infiltration to reduce the frequency of over-pumping. In the RPS, the EA notes that it is not seeking the complete elimination of groundwater surcharging, but requires improvements to be made in line with “best technical knowledge not entailing excessive cost” (BTKNEEC).
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 our assets are operating correctly, and the work to be developed with other agencies to improve an integrated plan to address flooding.

6.3. IRP Updates

The IRP records SW's commitment to strive continuously for the long-term objective of eliminating the need to over-pump. As required by the RPS, SW will report progress quarterly to the EA and will update the IRP annually (RPS Section 2.3 vi). The approved IRP will be published on SW's website.
APPENDIX A

Survey Findings and Rehabilitation Scope Plans

[Refer Section 3.1 for an explanation of the steps in identifying and repairing sources of infiltration.]
Surveys and Repairs completed 2013 - 2015
Surveys completed in 2016

Map obtained from Google

WOEA01

WOEA02

WOEA03
APPENDIX B

Typical Over-pumping Arrangements
FIGURE B1
SCHEMATIC OF TYPICAL OVER-PUMPING ARRANGEMENT
Pump drawing excess flows from sewer and discharging into a settlement tank. See Figure B4

Settlement tanks. See Figures A5 to B7

Pump hose drawing excess flows from sewer. See Figure B3

Hose discharges to watercourse via filtration sacks. See Figure B8

Figure B2 – Photograph of Typical Overpumping Arrangement
Figure B3 – Pump lifts flow through a barrel filter from a level in the sewer which captures liquid flows rather than solids

Figure B4 – Pump extracts flows from the sewer and discharges to a settlement tank
Figure B5 - Diagram of a large settlement tank showing the direction of flow beneath and above baffle plates which results in suspended fine solids dropping to the bottom of the tank. The dimensions shown (2.44m x 1.83m x 1.52m = 8ft x 6ft x 5ft) are suitable for use with 150mm (6 inch) hoses.

Figure B6 - Photograph of a small settlement tank usually fed by 75mm (3 inch) or 100mm (4 inch) hoses. The dimensions of the tank are 1.0m wide x 1.5m long x 1.4m high.
Figure B7 - Photograph of a typical settlement tank showing the hose at the entry point to the tank and the baffle plates. The blue foam shown can be added to the tank to capture solids at the entry point for flows. This size tank is supplied by 75mm and 100mm pump sets only.

Figure B8 - Discharge of treated flow to the watercourse through a filtration sack which is replaced regularly.
APPENDIX C

Emergency Discharge Sites

See notes in Section 4.1 regarding the potential need to modify / augment over-pumping sites to deal with future flood events. Over-pumping sites will be selected to provide the most effective arrangements to maintain services, whilst minimising environmental effects. Where practical, sites that have been used previously are expected to be re-used (when necessary), but the use of different locations cannot be ruled out, if hydraulic conditions dictate.
Lancing, West Sussex - Overpumping and Tankering Sites in the Winter of 2013-14 (Sheet 1 of 3)
Lancing, West Sussex - Overpumping and Tankering Sites in the Winter of 2013-14 (Sheet 2 of 3)

Overpump from council surface water system (not shown on SW mapping system) to ditch
Lancing, West Sussex - Overpumping and Tankering Sites in the Winter of 2013-14 (Sheet 3 of 3)

Tanker Point from surface water gullies (council owned, not shown on SW mapping system)
Lancing, West Sussex - Overpumping and Tankering Sites in the Winter of 2015-16 (Sheet 1 of 2)

Over-pump from manhole 8502 to ditch
Lancing, West Sussex - Overpumping and Tankering Sites in the Winter of 2015-16 (Sheet 2 of 2)

Over-pump from manhole 5204 to manhole 5201
Timing for Deployment of Tankers and Overpumps

<table>
<thead>
<tr>
<th>Location</th>
<th>Tankering</th>
<th>Overpumping</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Start Date</td>
<td>Stop Date</td>
</tr>
<tr>
<td>Grinstead Lane</td>
<td>19/02/14</td>
<td>21/02/14</td>
</tr>
<tr>
<td>Manor Close</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Note: tankering also took place in January 2015 at Manor Close, and in January/February 2016 at Manor Close, Shoreham Road and Grinstead Lane. The IRP will be updated as and when details are finalised.
APPENDIX D

Signage
Typical Advisory Sign - Reference Number and Village Name to be Amended

VILLAGE NAME

EMERGENCY OVERPUMPING

Please note over-pumping of dilute screened sewage to the [TBC] being undertaken to protect customers from flooding and lack of drainage.

It is advised to keep children & pets from the watercourse in the vicinity of this discharge. If you have contact with the water please ensure you wash your hands before eating or drinking.

If you have any concerns please contact:

Southern Water 0845 278 0845 Quoting Ref: [TBC]