<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Description/Amendment</th>
<th>Prepared by (Author)</th>
<th>Checked by</th>
<th>Reviewed by</th>
</tr>
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<tr>
<td>D1</td>
<td>18 April 2013</td>
<td>IRP St Mary Bourne V2</td>
<td>MWH</td>
<td>Graham Purvis</td>
<td>Graham Purvis</td>
</tr>
<tr>
<td>D2</td>
<td>14 June 2013</td>
<td>IRP St Mary Bourne V3</td>
<td>MWH</td>
<td>Graham Purvis</td>
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<tr>
<td>D3</td>
<td>7 October 2013</td>
<td>Conditionally approved by EA</td>
<td>Richard Andrews</td>
<td>Graham Purvis</td>
<td>Martin Banks</td>
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<td>V1.0</td>
<td>28 March 2014</td>
<td>Updated</td>
<td>Sam Hodgson</td>
<td>Richard Andrews</td>
<td>Andy Adams</td>
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</table>

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File Location

U:\FLR\SHARED-FLR2-A\Pollution Initiative\Groundwater Infiltration To Sewers Project\GIRP\CATCHMENTS\BAST - Barton Stacey\ST MARYBOURNE\(d) IRP

Date: 28/3/14

OPTIONAL EXTRA IF REQUIRED BY PROJECT MANAGER:

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BACKGROUND

The EA’s Regulatory Position Statement (RPS) (October 2012), requires WaSCs which are aware of sewerage systems in their area which are vulnerable to infiltration, to submit to the EA for approval Infiltration Reduction Plans. This document is produced in response to the RPS.

The purpose and nature of the IRP is that it will be updated by Southern Water (SW) on a regular basis and 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.

Whilst the IRP is produced by SW, the success of the actions contained in it is dependent on the support and collective actions of the agencies listed below. Since 2013, SW and these authorities have been meeting regularly to review progress and planned activities and to agree activities to be implemented, as reducing infiltration into sewers is only one part of the work required to mitigate the effects of flooding.

Environment Agency
Hampshire County Council
St Mary Bourne Parish Council
Basingstoke & Deane Borough Council
Test Valley Borough Council
EXECUTIVE SUMMARY

In response to the Environment Agency’s publication of their Regulatory Position Statement in October 2012 on discharges made from groundwater surcharged sewers, (and subsequent additional guidance notes), and the consequence of several wet winters since the millennium, Southern Water has developed a strategy and action plan to manage the groundwater infiltration (GW infiltration) affecting St. Mary Bourne and the villages further upstream (i.e. as far as Ibthorpe). Refer Section 1 (p4).

The extent of the catchment covered by this IRP extends from Ibthorpe to St Mary Bourne. Due to the extreme weather events during the winter of 2013/14, Longparish was also affected by infiltration due to high groundwater levels, however, following discussion with the EA, the area currently covered by this IRP remains the original area. Separate investigations will be made regarding the infiltration at Longparish, but this is not included in this IRP.

This IRP includes:
1. The background to the current situation, (Appendix 1)
2. the process being followed and the actions being taken to investigate and rehabilitate the sewerage system to reduce infiltration to a manageable level, (Sections 1 & 2)
3. Long-term plans to monitor flows and investigate sources of flow increase beyond completion of the current phase of rehabilitation (Section 2)
4. Actions being taken by SW to identify sources of infiltration and to reduce the amount of infiltration (Section 4, Table 1)
5. Multi-Agency actions to mitigate conditions which give rise to the need for tankering and over-pumping (Section 4, Tables 2-5)
6. Plans to show the areas surveyed indicating areas of infiltration and the rehabilitation carried out, (Appendix 2) [some plans to be added when repairs are complete.]
7. Reasons why emergency discharges will continue to be required in extreme conditions. (Section 3)
8. Outline information about the emergency discharges - short-term (Section 3) and long-term, (Appendix 3).

Conclusions
1. The process set out in Section 1 is being followed; surveys have been completed and rehabilitation work commenced in October 2013.
2. The effectiveness of the rehabilitation work will be measured in Spring 2014, or when water levels permit. A 'Wet' Flow Monitoring exercise will be carried out after completion of the rehabilitation work. A limited amount of further CCTV survey and rehabilitation will be carried out if localised high levels of infiltration are identified.

However, the immediate benefit of £1 million worth of sewer survey and seal work conducted last year was evidenced by lower flows in the sewers for a given groundwater level. The bad weather caused Southern Water to halt work shortly before completion but we were able to repair 30 manholes and 12 major leaks. This meant we did not have to introduce tankers, because infiltration had become significant, until the groundwater level reached 119 m
AOD this year, compared to 104 metres last year (as measured at the borehole at Vernham Dean).

3. SW is engaging with other agencies through the Technical Steering Group to keep the stakeholders informed about planned activities and progress and to address multi-agency actions to build on the work being done by SW to reduce infiltration.

4. The IRP has been prepared by SW, but the success of ultimately eliminating the requirement for emergency discharges is dependent on a multi-agency commitment. [the current set of actions are included in Tables 2 – 5]

5. Reducing infiltration is a long term activity. The work identified from the CCTV surveys in the summer of 2013 is virtually complete, but due to the extreme heavy rainfall throughout the last two months, emergency discharges have been necessary during winter 2013/14 to ensure a minimum level of sewerage service is provided to residents. [Refer to Section 3.2]

6. SW is committed to detecting and repairing sources of infiltration to reduce groundwater infiltration into sewers in accordance with best technical knowledge not entailing excessive cost. (BTKNEEC).

7. Despite the significant investments being made by SW to reduce infiltration into sewers, due to circumstances outside its control (e.g. extreme weather), there may continue to be occasions when emergency discharges will be required. Analysis will be conducted in Spring/ Summer 2014 after completion of the current rehabilitation programme and when water levels have fallen, to determine the circumstances under which an overflow would be required, the location and expected flow rate. This information will then be included in Appendix 3.
1. REPORT REQUIREMENTS AND SOUTHERN WATER APPROACH

The scope and structure of this IRP is guided by the requirements in the Environment Agency’s publication of their Regulatory Position Statement in October 2012 on discharges made from groundwater surcharged sewers, (and the requests provided in subsequent additional guidance notes).

In response to the EA’s RPS and flooding that has occurred during several wet winters since the millennium, Southern Water has developed a strategy and action plan to manage the groundwater infiltration (GW infiltration) affecting the St Mary Bourne catchment.

The issues are complex and affect a long linear area over several villages. SW has engaged consultants to complete a technical review and provide the evidence showing the correlation between groundwater and the performance of the sewer network at St Mary Bourne. A copy of their report is in Appendix 1. As an example of the effect of rising groundwater levels, Figure B2 in the report shows pumping station wet well levels for corresponding groundwater levels. The pumping station, as noted above, is sized to pump flows within the range of normal operation. The figure shows that once the level of groundwater at the borehole at the Vitacress site (E442550, N149550) exceeds a level of 75.0m AOD, the pumps are not able to discharge the incoming flows because of high flows entering upstream of the pumps due to abnormally high groundwater levels.

Accepting that the infiltration needed to be reduced, SW adopted a standard process with the objective of reducing emergency discharges. The following steps are being taken:

1. Identification of infiltrating sewers by inspection of strategic manholes and tracing ‘clear flow’ upstream, followed by CCTV survey of the sewers showing signs of infiltration (completed).
2. Immediate repair of isolated points of significant infiltration (completed).
3. Review of the survey data and identification of the repairs required to seal sources of significant infiltration (completed) and follow contractual arrangements with SW’s framework contractors to carry out the rehabilitation (completed).
5. Flow monitoring surveys in ‘dry’ conditions, and also in ‘wet’ conditions when the groundwater has risen again to establish the success of the rehabilitation work. (Dry surveys are complete, wet surveys to be carried out during Spring/Summer 2014 when groundwater levels have fallen sufficiently).
6. Further CCTV and repairs (if required)
7. Ongoing monitoring

The timescale for these activities is set out in the table below.
**St Mary Bourne - Infiltration Reduction Plan**

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sewer and MH surveys</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Reactive Repairs</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Review survey data and scope repairs, and Contractual arrangements</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Rehabilitation work</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>‘dry’ and ‘wet’ flow monitoring.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Further CCTV (if required)</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Repairs (if required)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Ongoing monitoring</td>
<td></td>
</tr>
</tbody>
</table>

**NB:** Work shown in green has been completed. Work from January 2014 was halted due to high groundwater levels and will be reprogrammed later in the year once levels allow.

### 2. SURVEY, REHABILITATION AND MONITORING

Sewer systems are designed for normal ‘dry weather’ conditions but with an allowance for the effects of rainfall and infiltration. However, where the WaSC is aware of significant infiltration which impacts on the ability to provide effective drainage, steps are required to reduce infiltration to an acceptable level.

Within St Mary Bourne and other villages in the valley, the sewer is capable of accommodating dry weather flow, including allowance for peak demands on the system. Note: the dry weather flow figure includes the standard allowance of 40% of per capita discharge to allow for infiltration. Whilst the network is capable of accommodating the normal range of flows in dry weather and moderate storm events, in periods of heavy rainfall flooding is known to occur which shows there are parts of the drainage system with limited capacity.

Southern Water has undertaken infiltration reduction measures in 2005-6 and in 2007-8. However, acknowledging that infiltration needed to be reduced further during 2013, the process described above has been implemented.

During the summer of 2013, between St Mary Bourne and Ibthorpe, 119 manholes and 11km of sewers were surveyed and defects repaired. The sewers were surveyed using CCTV. A significant amount of sewer sealing had been undertaken in previous years (as noted above). Consequently, the majority of the repairs required and carried out in 2013 were at manholes (30 manholes sealed) and local repairs to sewers (repairs completed at 12 locations). Note: a few repairs which are dependent on scheduled road closures remain to be completed. These will be carried out in 2014 when levels allow. To repair the slump by Applegate, groundwater levels will need to be as low as possible and this is likely to be in late summer/ early autumn.

A plan of completed work is shown in Appendix 2. [survey results will be added].

Analysis to determine the benefit delivered by the programme of sealing work to date has been undertaken. It is observed that during 2012/13 it was necessary to begin tankering operations when groundwater levels at Vernham Dean on Dene borehole reached 104m AOD. In the winter of 2013/14, tankering was not necessary until groundwater levels rose beyond 119m AOD.
Table 1: Vernham Dean borehole levels January and February 2014

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

- Sewer lining – fitting a new lining to entire manhole to manhole 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.
- Capping of leaking un-used connections.
- Top Hats – fibre glass inserts which form a leak-tight bond at the point where a lateral sewer connects to the main pipe.
- Ground Stabilisation – an innovative technique which involves the injection of gel into the ground around a leak.
- Manhole chamber sealing – a non excavation method to repair manholes.

Following the completion of the rehabilitation, and the ‘Wet’ flow monitoring, SW will set up a regular review programme to monitor and seek correlation between groundwater levels, sewer flows, and rainfall. This will be used to detect flow increases. Repairs will then be carried out as appropriate. [The monitoring programme is still being developed but the principle will be to set up a simple monitoring programme that will give advance warning of increases in infiltration.]
3. EMERGENCY DISCHARGES

3.1. Requirements

The rehabilitation work being undertaken by SW will improve the integrity of the sewerage system thus reducing groundwater infiltration. SW is committed to detecting and repairing sources of infiltration to reduce groundwater infiltration into sewers in accordance with best technical knowledge not entailing excessive cost (BTKNEEC). Nevertheless, in extreme conditions emergency discharges are expected to continue to be required. Section 2.3 ii) and iii) of the RPS (reproduced below) anticipates this. After completion of the current rehabilitation programme, and the ‘Wet’ flow monitoring exercise, SW intends to carry out further analysis in Spring/Summer 2014, to assess the circumstances under which future overflows would be required, the locations and expected flow rates.

Excerpt from regulatory position statement - Section 2.3 ii) and iii)

ii) Indicate the location of anticipated unavoidable discharges (resulting from GW infiltration), and describe the circumstances under which they would need to be made

iii) Provide details of the screening and discharge rates that might result from these unavoidable discharges

3.2. Short-Term Discharges

It is imperative that the sewerage system and wastewater pumping stations in the Barton Stacey catchment operate at all times and to maximum capacity to ensure that residents and customers do not have to suffer from restricted use of their facilities, or that the sewer system becomes overloaded to the point that uncontrolled discharges occur which causes disruption and pollution incidents to the environment. If the hydraulic capacity of the sewers and wastewater pumping stations is exceeded due to additional flows from groundwater, the first response of Southern Water is to deploy tankers at strategic locations to remove excess flows. These tankers then transfer flows out of the catchment to Portway Industrial Estate, Andover.

The recent exceptionally high rainfall has necessitated the use of both tankers and pumping. Tankers have limited capacity, can only draw off liquid at a relatively low rate and cause disturbance by their presence and noise associated with the work.

As at March 2014:

Tankers are operating at:

- St Mary Bourne WPS
- St Mary Bourne village

Pumping units are operating at:

- Holdaway Cottages, St Mary Bourne
- Gangbridge Lane, St Mary Bourne
- Stoke

Details of historic over-pumping are included in Appendix 1, Section 3.3 and on the map below. (Figure 1)

![Figure 1: Map showing tankering and pumping locations in 2014](image)

Over pumping is seen as the last resort option. Southern Water has, and will continue to invest in sewer, manhole and wastewater pumping station improvement works to ensure the ingress of groundwater into the sewers is kept to a practicable minimum. However, in the short-term pumping is currently required and may be required in the future if extreme weather conditions continue.

Depending on local conditions, a typical over-pumping site consists of a submersible pump located in a suitable manhole at a level which captures liquid flows rather than solids (which settle out on the bottom of the sewer). This pump lifts flows through a Copa Sac solid screening bag, into a settlement tank where flows pass under settlement weirs, before discharging via a hose with a further Copa Sac screening bag located on the end. Power is supplied either by local access point or Silent Pack diesel generators on site. Maintenance of the units is daily or twice daily depending on conditions. Typical discharge rates are between 10 l/s and 30 l/s. In-situ river sampling is undertaken regularly to check ammonia levels.
3.3. Long-Term Discharges

SW is investigating the circumstances under which emergency discharges would be required after completion of the current phase of rehabilitation. This study will not be concluded until late spring / summer 2014 after the results of the ‘Wet’ flow monitoring exercise are available. Details will be provided in Appendix 3.

4. ACTION PLANS

The current rehabilitation work will reduce infiltration into sewers at the locations where repairs have been carried out. However, it is expected that during periods of high groundwater, infiltration will occur at new locations. The process being followed by SW to reduce infiltration into sewers anticipates this and an allowance has been made for further CCTV surveys on a percentage of the sewers if the ‘Wet’ flow monitoring surveys show higher than expected localised flows. Experience gained during the current phase of the study will be used to help identify areas of high infiltration.

Activities being carried out by SW to reduce infiltration into sewers are given in Table 1 below. This table also includes timescales and expected outcomes.

The EA notes that it is not seeking the complete elimination of groundwater surcharging, but requires improvements to be made in line with BTKNEEC. SW is spending £700,000 on rehabilitation work in the SMB area, benefiting a population of 1,500 people. The work being carried out by SW will improve the situation. The ‘Wet’ flow survey will be carried out during a period of high groundwater levels and after the repairs have been completed, will give an indication of the level of success achieved by the rehabilitation programme. A summary of the information will be added to the IRP.

For a given groundwater level, the rehabilitation work will reduce the frequency and duration when tankers and over-pumping will be needed. However, in addition to the steps being taken by SW set out in Table 1, actions to be taken by other agencies that will further reduce the infiltration into sewers are set out in Table 2 – 5 below.
Table 1. Southern Water Current Activities to Reduce Groundwater Infiltration

<table>
<thead>
<tr>
<th>Number</th>
<th>Item</th>
<th>Actions</th>
<th>Timescale and Status</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (i)</td>
<td>Develop an approach for reduction of infiltration and maintenance of reduced levels of infiltration.</td>
<td>Refer Section 1 above.</td>
<td>Summer 2013, Complete</td>
<td>The steps are being followed to deliver results.</td>
</tr>
<tr>
<td>1 (ii)</td>
<td>‘Dry’ flow surveys (to measure background levels of infiltration during low groundwater periods)</td>
<td>Identify suitable measurement points, carry out survey over four week period in Summer, match rainfall records with flow data.</td>
<td>July/ August 2013 - complete</td>
<td>At the top of the catchment, infiltration flows were low, but just upstream of St Mary Bourne WPS, higher rates of infiltration are still evident due to the higher than average groundwater levels in the valley.</td>
</tr>
<tr>
<td>1 (iii)</td>
<td>‘Wet’ flow surveys (to identify remaining areas of infiltration following initial sewer rehabilitation/repair)</td>
<td>Identify suitable measurement points, carry out survey over four week period in Winter, match rainfall records with flow data.</td>
<td>Winter 2013/14 after repairs are completed.</td>
<td>When complete, review comparison between wet and dry surveys to identify if further survey is required in localised areas.</td>
</tr>
<tr>
<td>1 (iv)</td>
<td>CCTV etc survey of sewers</td>
<td>Identify Strategic Manholes, survey MHs to identify clear flow and infiltration. Carry out CCTV survey where clear flow was identified.</td>
<td>Summer 2013 - complete</td>
<td>All survey data has been reviewed by SW, the rehabilitation work has been scoped and an order placed with the Contractor.</td>
</tr>
<tr>
<td>1 (v)</td>
<td>Carry out sewer rehab work</td>
<td>Use various techniques to seal infiltration points in manholes and sewers</td>
<td>Start 21 October 2013 for approx 4 months.</td>
<td>Reduced infiltration.</td>
</tr>
<tr>
<td>1 (vi)</td>
<td>CCTV surveys, if required, where Wet Surveys show areas of high infiltration</td>
<td>CCTV surveys in areas where ‘Wet’ flow surveys show high level of clear flow.</td>
<td>Spring / Summer 2014 – if reqd. after the ‘wet’ survey.</td>
<td>Determine scope and carry out further rehabilitation if identified as required from the CCTV survey results.</td>
</tr>
<tr>
<td>1 (vii)</td>
<td>Further sewer rehab work, if required, in areas where further CCTV carried out.</td>
<td>As above, use various techniques to seal infiltration points in manholes and sewers</td>
<td>Summer/ Autumn 2014</td>
<td>Reduced infiltration.</td>
</tr>
<tr>
<td></td>
<td>Consider innovative solutions that involve some risk</td>
<td>Investigate unconventional options. e.g. ground stabilisation techniques.</td>
<td>SW, Ongoing</td>
<td>Quicker or cheaper, or allowing repairs that could otherwise not be performed economically.</td>
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Table 2. Multi-Agency Activities to Reduce Groundwater Infiltration

<table>
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<th>Actions</th>
<th>Owner, Timescale and Status</th>
<th>Outcomes</th>
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</thead>
<tbody>
<tr>
<td>2 (i)</td>
<td>Strategy for inflows via private drains</td>
<td>Southern Water to propose a strategy for dealing with infiltration via private drains*</td>
<td>SW supported by EA and Parish Councils, Summer/ Autumn 2014.</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SW will monitor sewer flow to identify significant increases in inflows.</td>
<td>SW, Autumn 2014 onwards</td>
<td>Early identification of areas where infiltration has increased.</td>
</tr>
<tr>
<td>2 (ii)</td>
<td>Consider effects of proposed new developments on infiltration.</td>
<td>District Councils to continue to consult with SW on development applications.</td>
<td>Basingstoke &amp; Deane Borough Council, Test Valley Borough Council, St Mary Bourne Parish Council, Ongoing</td>
<td>Developments in areas which would be detrimental to sewer flooding, to have conditions recommended by SW and applied, as appropriate, by the District Councils.</td>
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<td></td>
<td>SW to determine threshold above which they require to be consulted.</td>
<td>SW</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Sewerage materials for new developments</td>
<td>SW, Basingstoke &amp; Deane Borough Council, Test Valley Borough Council</td>
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</table>

*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 3. Publicity / Communication Activities to Reduce / Mitigate the Effects of Groundwater Infiltration.

<table>
<thead>
<tr>
<th>Number</th>
<th>Item</th>
<th>Actions</th>
<th>Owner, Timescale and Status</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 (i)</td>
<td>Public meetings about reducing groundwater infiltration into sewerage system</td>
<td>Hold public meetings as appropriate</td>
<td>SW, as required</td>
<td>Inform local population of progress and planned activities and receive feedback.</td>
</tr>
<tr>
<td>3 (ii)</td>
<td>Letters from SW to stakeholders and residents about reducing groundwater infiltration into sewerage system</td>
<td>Send letters at regular intervals to communicate progress and planned activities</td>
<td>SW, as required</td>
<td>Inform local population of progress and planned activities</td>
</tr>
<tr>
<td>3 (iii)</td>
<td>Technical Steering Group meetings</td>
<td>Discuss and agree actions to reduce requirements for tankering and over-pumping.</td>
<td>All Parties, alternate months until further notice.</td>
<td>Improved understanding of issues and appreciation of issues. Agreement to actions to help reduce the need for tankering and over-pumping.</td>
</tr>
<tr>
<td>3 (iv)</td>
<td>Implement local campaign to discourage mis-connections</td>
<td>Publicise through parish councils. Include article in parish magazines.**</td>
<td>Basingstoke &amp; Deane District Council, Test Valley District Council, Summer 2014</td>
<td>Publicise the role that everyone has to play in reducing non-sewage flows in sewers.</td>
</tr>
<tr>
<td>3 (v)</td>
<td>Ditto</td>
<td>Publicise through builders merchants and trade colleges the importance of rainwater drainage not being connected to sewers</td>
<td>SW, from Spring/Summer 2014</td>
<td>Publicise the role that builders have to play in reducing non-sewage flows in sewers.</td>
</tr>
</tbody>
</table>

** 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 4. Multi-Agency Activities to Mitigate the Effects of Groundwater Infiltration.

<table>
<thead>
<tr>
<th>Number</th>
<th>Item</th>
<th>Actions</th>
<th>Owner, Timescale and Status</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 (i)</td>
<td>Early Warning system</td>
<td>Joint continuous monitoring of groundwater levels and sewer levels/flows.</td>
<td>SW, EA, by May 2014</td>
<td>Develop 2012/13 trigger levels by comparing historic customer complaints and tankering with BH levels. Note trigger levels should vary as a consequence of rehab. Also they will need to reflect groundwater reaction times.</td>
</tr>
<tr>
<td>4 (ii)</td>
<td>Tankering arrangements</td>
<td>Investigate options for relocating tankers e.g. by use of longer hoses/pumping</td>
<td>SW, Winter 2013</td>
<td>Potentially less disruption to residents when tankering is essential.</td>
</tr>
</tbody>
</table>
Table 5. Activities required for Seasonal Emergency Discharge if Groundwater Infiltration cannot be adequately reduced at reasonable cost (BTKNEEC)/ interim arrangements.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Item</th>
<th>Actions</th>
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<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.0</td>
<td>Emergency Discharge Points</td>
<td>Identify location of anticipated unavoidable discharges (resulting from GW infiltration), and describe the circumstances under which they would need to be made. Provide details of the screening and discharge rates that might result from these unavoidable discharges</td>
<td>SW, Summer / Autumn 2014</td>
<td>Appropriate arrangements for discharges in the event that they are required, as set out in items 5.1 to 5.6 below.</td>
</tr>
<tr>
<td>5.1</td>
<td>Investigation</td>
<td>Modelling to compare sewer capacity with forecast remaining flow rates following rehabilitation and 'wet' flow survey.</td>
<td>SW, commence Spring 2014</td>
<td>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.</td>
</tr>
<tr>
<td>5.2</td>
<td>Standards</td>
<td>SW to discuss with EA about consent standards and flow rates</td>
<td>SW, spring 2014, to follow 5.1</td>
<td>Agree standards for discharge and acceptable flow rates.</td>
</tr>
<tr>
<td>Ref.</td>
<td>Item</td>
<td>Actions</td>
<td>Owner, Timescale and Status</td>
<td>Outcomes</td>
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<tr>
<td>5.3</td>
<td>Flow, location, screening arrangements.</td>
<td>Determine potential flow rates and screening arrangements (if discharges are appropriate) and most appropriate locations, including options for pumped discharges (if required)</td>
<td>SW, concurrent with 5.2</td>
<td>Concept design for discharge points and options for treatment e.g. reed beds. Groundwater level trigger points at which discharge would be expected; indicative flow rates relative to groundwater levels.</td>
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<td>5.4</td>
<td>Planning Consents</td>
<td>Discuss options with planning authorities</td>
<td>SW, Hampshire County Council, Summer 2014</td>
<td>Agreement of potential sites for seasonal discharges</td>
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<td>5.5</td>
<td>Community and Stakeholder Engagement</td>
<td>Engage with the local community about the requirement, potential locations, expected benefits and associated impacts of seasonal discharges.</td>
<td>SW, Autumn 2014</td>
<td>Stakeholder acceptance of the need for local action to implement precautions to minimise the impact of groundwater flooding</td>
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<td>5.6</td>
<td>Land Requirements</td>
<td>Investigate amount of land required, potential locations and likely availability</td>
<td>SW, Winter 2014</td>
<td>Land requirements and potential availability would be established.</td>
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APPENDIX 1

Technical Report
## MWH Project Code: 41520490

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<td>First Draft</td>
<td>Jody Cockcroft</td>
<td>Robert McTaggart</td>
<td>Rob Perrett</td>
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<td>02</td>
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<td>Second Draft</td>
<td>Jody Cockcroft</td>
<td>Kate Harris</td>
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APPENDIX A
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APPENDIX B
Evidence of Groundwater Infiltration
St Mary Bourne Infiltration Reduction Plan

1. INTRODUCTION

This Infiltration Reduction Plan covers the villages of St Mary Bourne, Hurstbourne Tarrant and Stoke, Hampshire which lie within the Barton Stacey Wastewater Treatment Works (WWTW) catchment.

The WWTW catchment is made up of the villages and settlements of Ibthorpe, Hurstbourne Tarrant, Stoke, St Mary Bourne, Hurstbourne Priors, Longparish, Forton and Barton Stacey that lie to the east of Andover. Figure A1 in Appendix A shows the location and extents of the WWTW catchment.

The Barton Stacey catchment is an extended linear catchment following the course of the Bourne Rivulet, a tributary of the River Test. The Bourne Rivulet is a chalk stream that rises and falls with local groundwater levels. It joins the River Test near Tufton.

2. STATEMENT OF PROBLEMS

The catchment of St Mary Bourne has a long history of problems associated groundwater infiltration into the sewerage system. Historically, properties have suffered from flooding, surcharge and restricted toilet use as a result of groundwater inundation.

As a result Southern Water uses both over-pumping and tankering of sewer flows to alleviate high surcharge levels and minimise the public health risk to customers.

High groundwater levels normally occur in January or February and recede in April or May, but in 2012 additional flows were apparent in the sewer system from early in Autumn, and it became necessary to protect properties in mid-December. This was caused by the rainfall in late 2012 which was significantly above average levels. Prior to this over-pumping was last necessary in 2006/07.

Southern Water’s DG5 flooding database shows four properties or locations at risk of external flooding on the 1 in 20 year register, one in Stoke and three in St Mary Bourne.

3. BACKGROUND INFORMATION

3.1. Sewerage System

Table 1 below summarises the basic information on the sewerage system and catchment upstream of St Mary Bourne Wastewater Pumping Station (WPS).

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<td>Catchment population</td>
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<td>Catchment elevations (mAOD)</td>
<td>73 - 122.4</td>
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<tr>
<td>No. of pumping stations</td>
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<tr>
<td>No. of overflows (see comment below)</td>
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<tr>
<td>Length of foul/combined sewers (km)</td>
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<td>Diameters of foul/combined sewers (mm)</td>
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<td>Length of surface water sewers (km)</td>
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Table 1: Summary of St Mary Bourne sewerage network

The sewerage system serving the catchment upstream of St Mary Bourne WPS is comprised of both a gravity and pumped foul system. There are four pumping stations, three of which are ‘micro’ pumping stations serving a single or a small number of properties, and one permitted emergency overflow (EMO) located at St Mary Bourne WPS. However, a survey of the pumping station in 2006 showed no evidence of an overflow pipe from the wet well.

All flows from the north of the catchment flow by gravity to St Mary Bourne WPS, which pumps flow southwards towards Longparish.

Gravity flows from Forton and Longparish drain to Longparish WPS which then pumps into a small gravity system and then gravitates into the WWTW. Flows from Barton Stacey in the far south of the catchment are conveyed by gravity and pumped forward to the works by Roberts Road WPS.

Figure A2 in Appendix A shows the topography of the WWTW catchment and the main watercourses in the area. The St Mary Bourne catchment is located entirely within the valley of the Bourne Rivulet.

3.2. Evidence of Groundwater infiltration

The catchment suffers from flooding problems mostly due to overloaded sewers during prolonged periods of wet weather when groundwater levels are high. Groundwater infiltration can account for up to 95% of the sewer flow during these periods. The survey and CCTV work have identified a number of infiltration points in both the public and private drainage systems. We are hopeful that the sealing work to be carried out this summer during dry conditions will have a significant effect on the infiltration levels.

A series of graphs have been presented in Appendix B showing the relationship between groundwater levels and incidents within the sewerage network up to 2008. Borehole data was provided by the Environment Agency for a borehole located at the Vitacress site just upstream of St Mary Bourne WPS.

Figure B1 shows borehole levels plotted against recorded incidents of surcharge, flooding, tankering and over-pumping of flows. The graph clearly indicates a correlation between the incidents and high groundwater levels.

Figures B2 and B3 show comparisons of measured wet well levels at St Mary Bourne WPS and measured groundwater levels. When borehole levels are below 74.6 metres above Ordnance Datum (mAOd) the pumping station operates at normal levels. When groundwater levels rise above 74.8 mAOd the wet well level rises and the WPS no longer has the capacity to pump the received flows.

Figures B4 and B5 demonstrate that when high level alarms are triggered at the pumping station the borehole level is generally above 74.74 mAOd.

Recent groundwater level data from 2008 to 2012 was also provided by the EA for the Vitacress site (E442550, N149550). This data was plotted against both daily flows from St Mary Bourne WPS and daily Flow to Full Treatment (FFT) flows measured at the WWTW. The graphs are presented in Appendix B as Figures B6 and B7.
Both graphs show strong relationships between groundwater levels and flows at St Mary Bourne WPS and the WWTW. Statistically, there is a correlation coefficient of 0.3 between the pumping station flows and groundwater indicating a reasonable correlation.

It should be noted though that the pumping station flow data appears to contain a number of dubious high readings that could be caused by errors in the flow measurement equipment. The ‘y’ axis of the graph in Figure B6 has therefore been reduced to a maximum of 5000 m$^3$/d to better show the variations in daily flows. Figure B6 shows that the overall trends in daily flows closely follow the trends in groundwater levels suggesting a link between the two variables.

The correlation between WWTW FFT data and groundwater is statistically very strong with a coefficient of 0.69. The better correlation observed with the WWTW data is likely to be due to the better quality of flow measured data at the works, rather than higher levels of infiltration.

Figure B8 in Appendix B shows the percentile curves for both WWTW FFT flows and groundwater.

The graph shows the percentile curves for both FFT and groundwater levels for the period 2008 to 2013. The percentile curve for a typical wastewater catchment with minimal infiltration is normally relatively flat up to around the 97$^{th}$ percentile indicating minor variations in flow for the majority of the time. Above the 97$^{th}$ percentile there is often a sharp rise in the curve indicating the influence of rainfall and storm response affecting the flows for a small percentage of the time.

The percentile graph for Barton Stacey WWTW shows a steadily rising percentile curve up to the 99$^{th}$ percentile when there is a sharp rise in flow. This indicates the presence of an unplanned inflow into the system (in this case groundwater) causing highly variable flows to the WWTW.

### 3.3. Unavoidable discharges – location, options and reasons why necessary

A number of measures have been used to protect Southern Water’s customers and to avoid danger to public health, to prevent flooding, surcharge and restricted toilet use in the St Mary Bourne catchment. Over-pumping of flows to the environment and tankering have both been used historically and are in place currently upstream of St Mary Bourne WPS to maintain a level of service.

**Over-pumping** is carried out at the following locations shown in Figure A3 in Appendix A:

- Manhole SU40514603 - south of ‘Garston’, Stoke, discharges to the watercourse,
- Manhole SU41506801 - Bourne Farm, Gangbridge Lane, discharges to watercourse (this site is currently turned off pending a drop in ammonia levels before it can be reinstated),
- Manhole SU42501410 – next to No.1 Holdaway Cottages, discharges to ford,
- Manhole SU42501325 – rear of Little Brook House, Church Street, discharges to watercourse.

The over pump units are fed by a small pump sited mid way in the affected manhole. This is float level controlled and switches on and off as the levels change. Flows then pass through a 6mm 2D mesh Copa Sac to catch any large solids, before draining the open cell Copa Foam, which removes further fine...
particles. Flows then pass under two weir boards before being discharged by gravity out the discharge hose which has another Copa Sac mesh bag attached. The units are attended to daily, sometimes twice daily, to change the Copa Sacs and ensure the system is working satisfactorily. Discharge rates vary due to the change in head and levels, but are between 20 – 30 litres per second when operational.

Over pumping is viewed as a last resort action to prevent the backup of sewerage into customers’ properties and uncontrolled spilling from the sewer system into the environment. Each unit is carefully sited where they will have the greatest benefit in reducing the levels upstream, they are placed so that any noise or disturbance from daily maintenance activities is kept to a practical minimum, and they discharge into a high volume of stream water to maximise the dilution effect. Individual units are only activated when strictly necessary and an ongoing assessment to the need for over pumping is carried out by staff to ensure minimum impact.

**Tankers** have been used as the first response to rising sewer levels, and as an ongoing assistance when the over pumping is not sufficient. Unfortunately they are not the most effective way to remove large volumes of water and cause considerable disturbance and noise to residents and traffic congestion problems. They can remove flows at an average rate of between 5 – 10 litres per second, but with fixed capacity, the connecting and un-connecting of hose pipes, and travel time to discharge the liquids elsewhere, means their efficiency as a controlling factor is not great. Tankers have been maintained at the site throughout the duration of this winters flooding at the insistence of the Environment Agency. Tankers used to remove sewer flows have been in operation in St Mary Bourne Village, the pumping station and further points towards Stoke. Currently (June 2013) there is one over pump unit active in the village and a rota of 3 tankers operating at the St Mary Bourne WPS.

Water quality testing of ammonia levels in the watercourse is currently carried out daily to monitor the effect on the environment. In addition, formal sampling has been carried out and the results have been sent to the Environment Agency on a regular weekly basis. The sampling parameters include E.Coli (confirmed) CFU; Enterococci species CFU / 100mg/l; ammonia as Nitrogen; BOD and DO.

3.4. **Work to Date**

In 2010 a number of properties in St Mary Bourne and Stoke were protected from sewer flooding through sewer improvements works. The solutions involved sewer diversions and small single or multi-property pumping stations lifting local drainage into the main sewer. However, these had no impact on the overall level of groundwater in the system.

In addition, an extensive CCTV investigation was carried out in 2007 in Stoke and St Mary Bourne which revealed groundwater infiltration in the network. At the time of the CCTV survey, a comprehensive set of maps showing lateral connections joining the main sewer was created.

Work was then progressed to seal manholes, the main trunk sewer and lateral connections points in these areas. Sealing was carried out using the Cured In Place Pipe (CIPP) lining technique and covered around 7 km of pipeline in 150 mm and 225 mm diameter.

The section of sewer between Church Road downstream of St Mary Bourne and St Mary Bourne WPS was not sealed, as there was no evidence of infiltration in this section of sewer. The extent of sewer lining has been presented in Figure A4 in Appendix A.
At the time of this scheme, Southern Water had no authority to carry out repairs to the lateral connections to the main sewer where significant infiltration was evident, as these were under private ownership.

A CCTV survey was carried out in 2008 (post-lining) downstream of Hurstbourne Tarrant to check that the lining had no defects. The results showed that the lining works had been successful at eliminating any infiltration directly to the public sewerage system. The survey also revealed a number of locations where significant inflows were entering the sewers through private lateral connections.

More recently on 18th March 2013, sewer jetting work has been carried out at Gangbridge Lane and the frequency of sewer jetting has been increased to minimise the risk of blockages during the current period of high groundwater levels. Blockages occur because whilst the sewers and manholes are surcharged, pipe flow velocities drop below the self cleansing velocities necessary and settlement of solids takes place.

On going routine maintenance at St Mary Bourne WPS includes replacing the wear rings and impellers in the pumps to ensure that they continue to operate at their design efficiency. The St Mary Bourne WPS has an output capacity of approximately 20 – 24 l/s. The two pumps operate on a duty /standby basis. The WPS cannot pass forward additional flows due to the limitations of the rising main from the WPS down to Longparish, which has had previous bursts recorded, and the sewer network capacity in Longparish where additional flows would cause flooding downstream.

An extensive investigation into the sewerage system is currently underway involving manhole, CCTV and connectivity surveys of the drainage.

3.5. Consultation and customer liaison

A number of methods are used to consult with and inform the local residents of the issues with groundwater infiltration including:

- A technical steering group (TSG) attended by Southern Water, the Environment Agency, Hampshire County Council, Test Valley Borough Council, Basingstoke and Deane Borough Council and the St Mary Bourne Parish Council.

- Weekly drop-in sessions attended by a member of Southern Water staff.

- Letter drops to residents.

- Public meetings attended by Southern Water.

- Information boards in the vicinity of the four over-pumping sites to explain the purpose and need for the equipment.

- Updates and briefs to the Member of Parliament
APPENDIX A

Figures
Figure A1: Location of Barton Stacey WWTW catchment
Figure A2 – Topography of the catchment

- Bourne Rivulet
- River Test
- River Dever
Figure A3 - Locations of over-pumping to Bourne Rivulet
Figure A4 – Extent of Sewer Lining carried out in 2007/08
Figure A5 - Strategic MHs for survey
Figure A6: Properties and laterals for survey
APPENDIX B

Evidence of Groundwater Infiltration
Figure B1: Comparison of Borehole levels with CSMS incidents
Figure B2: Comparison of Borehole levels with Wet Well levels

74.6m AOD - BH Level at which infiltration starts to occur.

74.8m AOD - BH Level at which GSMS Incidents occur and tankering/overpumping required.

75.0m AOD - BH Level at which CSMS Incidents occur and tankering/overpumping not able to maintain water level below 75m AOD.
Figure B3: Comparison of Borehole levels with Wet well levels (Feb 2007 to Aug 2008)

- 74.8m AOD - BH Level at which infiltration starts to occur.
- 74.8m AOD - BH Level at which CSMS Incidents occur and Tankering / overpumping required.
- 75.0m AOD - BH Level at which CSMS Incidents occur and overpumping not able to maintain water level below 75m AOD.
Figure B4: Comparison of Borehole levels with High Level Alarms triggered

% of Days WPS High level Alarm Triggered (1998-2008)

- 75.0+
- 74.75 to 75.0
- 74.50 to 74.75
- 74.25 to 74.5
- 74.0 to 74.25
- < 74.0

% of Days Alarm Triggered
Figure B5: Comparison of Borehole levels with Wet well high level alarms (1998 to 2007)
Figure B6 – St Mary Bourne WPS Daily Flows and groundwater levels
Figure B7 – Barton Stacey WWTW Daily FFT and groundwater levels
Figure B8 – Barton Stacey WWTW Daily FFT and groundwater levels
APPENDIX 2

Survey Findings and Rehabilitation Scope Plans
APPENDIX 3

Emergency Seasonal Discharge Proposal (to follow)
Southern Water wishes to thank the Environment Agency, Hampshire County Council, St Mary Bourne Parish Council, Basingstoke & Deane Borough Council and Test Valley Borough Council for their support in achieving the objectives set out in the IRP.