TA 14.1 Cost Adjustment Claim 1 – Bathing Waters Technical Annex

September 2018
Version 1.0

Navigation: TA.14.1 Cost Adjustment Claim 1 – Bathing Waters

Purpose: This technical annex provides the evidence to support the Cost Adjustment Claims on Bathing Waters.

The table below summarises the Ofwat tests that are addressed by the evidence presented in this Annex.

Table: Relevant Ofwat tests

Ref	Ofwat test		Comment
Primary Focus Areas			
CE 4	To what extent are cost adjustment claims used only where prudent and appropriate, and where they are used, are cost adjustments well evidenced, efficient and challenging?	• High quality plan: The company will submit an efficient level of total expenditure in all areas. • High quality plan: The company will have an effective approach to managing and reducing doubtful debt and improving revenue recovery. • High quality plan: This will include identifying current barriers to revenue recovery, benchmarking with best practice outside the sector and how these barriers will be addressed in PR19 • High quality plan: The company will avoid cost adjustment claims where possible, including by taking account of offsetting favourable circumstances. Where the company raised claims, they are efficient and well evidenced • Ambitious and innovative plan: The company will present strong evidence of sector-leading cost efficiency.	We have developed and applied a consistent framework and process for reviewing and assessing all CACs and tested all claims against Ofwat's final methodology guidance. Using this approach we have submitted CACs that we think are prudent and appropriate and where we believe there are genuine gaps in the cost assessment process.

Contents

Executive Summary

This summary is written in the format outlined in the Information Notice (IN/1811 June 2018).

Name of claim	TA 14.1 PR19 CAC01 Bathing Water Schemes
Name and identifier of related claim submitted in May 2018	Bathing Water Schemes PR19SRN_CAC01
Business plan table lines where the totex value of this claim is reported.	WWS2 37, WWN8
Total value of claim for AMP7 £m	£32.4
Total opex of claim for AMP7	£Nil
Total capex of claim for AMP7	£32.4
Depreciation on capex in AMP7 (retail controls only)	n/a
Remaining capex required after AMP7 to complete construction	£0m
Cost benefit NPV (20yrs) £m	5 Bathing Waters “to Good” - £206.5m (positive net benefit) 2 Bathing Waters “to Excellent” - £21.3m (positive net benefit)
Do you consider that part of the claim should be covered by our cost baselines?	No
Materiality of claim for AMP7 as percentage of business plan (5 year) totex for the relevant controls.	1.4% of the totex value of the Wastewater Network Plus price control
Does the claim feature as a Direct Procurement for Customers (DPC) scheme? (please tick)	No

	Brief summary of evidence to support claim against relevant test	List of accompanying evidence, including document references, page or section numbers.
Need for investment/ expenditure	We have listened to our customers and having clean Bathing Water remains a priority service to the environment and their communities. Customers have consistently indicated that is an area where we should go beyond the statutory minimum. Our willingness to pay research in both AMP6 and in respect of AMP7 requirements support this, and we therefore propose to continue and extend our AMP6 programme into AMP7 by investing in further incremental improvements in bathing water quality beyond the statutory minimum at several additional sites. The proposal would improve five bathing waters from 'Poor' or 'Sufficient' to 'Good' status and a further two bathing waters to 'excellent' status (the latter to be chosen from 4 priority candidate sites following further investigations). We will not receive enforcement notices from the Environment Agency for these improvements, as they are customer driven and we will be going beyond the requirements of the Water Industry National Environment Programme. Bathing waters and the seaside economy are valuable economically, socially, and environmentally. Our operating area covers communities living in Southern coastal areas whose livelihoods depend on tourism income and in turn the quality of the region's bathing waters. Tourism contributes £8bn Total Direct Gross Value Added to the South East region, of which water related tourism, including day visits to beaches, contributes a large part. The improvements to bathing waters will therefore be a benefit to these communities.	Below, pages 10-11 Chapter 4 Customer and Stakeholder Engagement TA4.4 (11) Willingness to Pay TA4.4 (67) Feedback on Cost Adjustment Claims Southern Water Bathing Water Enhancement website EA Bathing Water Profiles
Need for the adjustment (if relevant)	The expenditure set out in this claim is neither base expenditure nor derived from statutory requirements. It is therefore clearly enhancement expenditure. We also believe that our proposed programme is unique among the water companies. Based on PR14 experience, therefore, and our understanding of Ofwat's PR19 modelling methodology, we do not anticipate the modelled allowances to	Below, pages 9-10

	reflect this customer-driven enhancement improvement and therefore consider that a cost adjustment claim is required rather than being treated as material enhancement expenditure.	
Outside management control (if relevant)	This claim is a customer-driven discretionary investment so is within management control. However, without this claim we will not be able to deliver against one of our customers' key priorities for AMP7 (as evidenced by a comprehensive study into customer's willingness to pay for improvements at bathing waters which also determined the amount customers are prepared to pay for these improvements). There are a wide range of external factors which influence bathing water quality. Whilst we do not control all these factors alone, our approach, enabled through this cost adjustment claim, to achieving 'Good' and 'Excellent' status gives us confidence we can have sufficient influence over them. We work collaboratively with a broad range of stakeholders to positively influence these factors and play a pro-active role in the community. Our AMP6 programme provides evidence that we can successfully deliver bathing water outcomes, manage stakeholder relations and third-party factors efficiently.	TA4.4 (11) Willingness to Pay TA4.4 (19) Bathing Water Enhancement Programme Below, page 10
Best option for customers (if relevant)	Customers are prepared to pay extra on their bills for bathing water improvements. We have assessed all 83 bathing waters in our region for improvement in AMP7. Of the 83, 46 sites were recorded as "Excellent" for 2016-2017, and a further 5 have had investment in AMP6 to reach "Excellent". We have performed cost benefit analysis on the remaining 32 sites and selected the most cost beneficial. Overall the scale of the proposed improvements does not exceed our customer's willingness to pay for them. The selection of the bathing waters for improvement was based on the same criteria applied in AMP6 and agreed with the CCG. The scale and pace of the work proposed has been supported by customers through recent engagement studies.	Below, pages 12-16 TA4.4 (67) Feedback on Cost Adjustment Claims
Robustness and efficiency of claim's costs	Cost estimates at this stage are based on best available information on the likely issues experienced at these sites and learning and examples from similar sites from AMP6. Where available, we have utilised information about the sites from existing AMP6 studies. At sites where no recent studies have been	Below, page 17 Detailed technical reports on 9 selected sites are found in the section titled Bathing

	undertaken, we jointly undertook an assessment with Stantec bathing water experts. The programme has been costed on a P10, P50 and P90 basis. We have high confidence in the costs associated with the sites that are being moved up to Good status, and although there is more uncertainty about the sites being moved to Excellent, we have adopted a structured approach to selecting and costing them. We have therefore proposed a balanced P50 cost position in our claim, with associated customer protections.	Water Investigations below
Customer protection (if relevant)	The business plan includes three performance commitments (PC) around this claim to protect customers: Maintain the number of bathing waters at 'Excellent' (PCX- Incentive type: Financial – Penalty only) Improve five bathing waters to at least 'Good', (PCX – Incentive Type: Financial – Reward and Penalty) Improve two bathing waters to 'Excellent' (PCX – Incentive Type: Financial – Reward and Penalty)	Below, page 16 TA06.2 Our Package of PCs and ODIs, Page 50-58 See Performance Commitment submission refs: PR19SRN_WWN11 PR19SRN_WWN12 PR19SRN_WWN13[RL 1]
Affordability (if relevant)	Overall affordability has been considered in the context of our wider plan. The total amount of this claim is £32.4m. This equates to approximately £1.30 annual increase to the average wastewater customer. Overall, we project customer bills will decrease by over 3% including our Cost Adjustment Claims.	Below, page 16 TA4.4 (67) Feedback on Cost Adjustment Claims
Board assurance (if relevant)	Our Board has reviewed and challenged all our Cost Adjustment Claims. The Board support the need for the investment at the named bathing waters to ensure that we continue to meet our customers' expectations and the specific elements of this claim. Additional internal and external technical assurance has been undertaken.	Below, page 18 TA 02.2 Board Engagement and Challenge TA 2.1 Statements of Board Assurance

Cost Adjustment Claim Summary

What is the claim for?

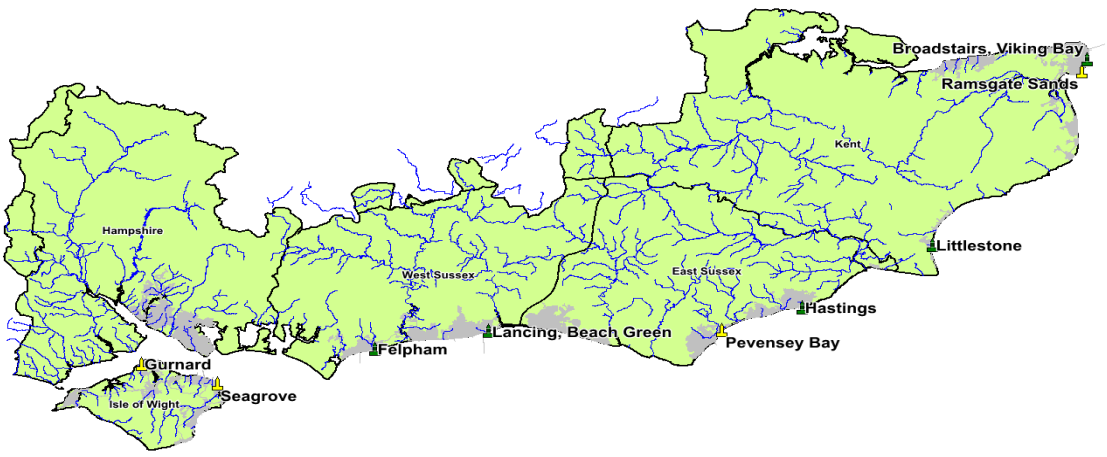
This claim relates to work to improve the bathing water quality and long-term resilience of seven bathing waters, enhancing the water quality, amenity value and economy in the local areas. This claim submission is based on the following:

- **Five bathing waters will be improved from 'Sufficient' or 'Poor' to 'Good' bathing water status;**
- **Two bathing waters will be improved from 'Good' to 'Excellent' bathing water status;**

Our customers consistently tell us that the quality of the bathing waters in our region is a key priority for them. We responded to this feedback as part of our AMP6 programme, going beyond the statutory minimum quality standard for bathing water ('Sufficient' bathing water quality) with our programme to improve an additional seven bathing waters to 'Excellent'. In our AMP6 strategy we set out our long term (multi-AMP) commitment to maintaining and improving the quality of bathing waters in the region for the benefit of our customers and communities and working towards bringing all coastal waters at bathing beaches up to the standard required to achieve Blue Flag status by 2040 (if there is continuing customer and regulators' support to do so). The results of a broad suite of research and engagement completed in support of the AMP7 plan demonstrate that it remains a priority for our customers and they are willing to continue to pay for the delivery of these enhancements. The average willingness to pay for each bathing water area to improve from less than 'Good' to 'Good' is £3.5 million, and from 'Good' to 'Excellent' is £0.9 million per year[1].

All 32 sites with bathing waters which are classified[2] as less than 'Excellent' status for either or both the 2016 and 2017 bathing seasons have been examined. Following a detailed selection process, it is envisaged that seven of these bathing waters (five less than 'Good' and two less than 'Excellent', the latter to be chosen from 4 priority candidate sites following further investigations) will be taken forward for enhancement, as a result of customer preference, as shown in Figure 1 on the .

Figure 1 - Geographical map of bathing waters to be improved



Yellow: Candidates for improvement to 'Excellent' (two will be selected)
Green: candidates for improvement to 'Good'

[1] Southern Water Willingness to Pay Main Stage Report Jan 2018, Accent, PJM Economics, Southern Water (p.19)
[2] Based on the four-year rolling methodology applied by the Environment Agency but including samples that has been discounted due to pollution risk forecasting (PRF). This is because PRF is only regarded as a temporary mitigation measure rather than a permanent solution.

Our proposed investment is also consistent with PR19 guidance from the Environment Agency around protecting and improving quality of England's bathing waters. Any overlap of investment between this claim and the Water Industry National Environment Programme (WINEP) has been removed.

Bathing waters for improvement in AMP7 have been selected based on certainty of outcome, deliverability, amenity, cost to deliver, environmental assessments and social capital criteria, as used in the AMP6 process. It is envisaged that the Customer Challenge Group (CCG) will have a similar role as in AMP6 to guide the investment in AMP7 and we will continually engage with customers throughout the delivery process.

Using the lessons learnt during delivery of the AMP6 programme we estimate that the total investment will be circa £32.4 million based on central estimates (P50) costs.

We have high confidence in the selection and costs associated with the sites that are being moved up to Good status, and although there is more uncertainty about the sites we propose to move to Excellent, we have adopted a structured approach to selecting and costing them. We have also learnt from the successful delivery of our AMP6 programme which improves our confidence in our ability to deliver in AMP7. We have therefore proposed a balanced P50 cost position in our claim, with associated customer protections.

Three performance commitments will incentivise delivery and protect customers in the event targeted improvements are not achieved. The first maintains the number of bathing waters at 'Excellent' and has an associated penalty only incentive mechanism. The second includes a penalty for not reaching 'Good' and a reward mechanism for stretching performance, beyond our committed level performance on the five to 'Good' status. The final performance commitment includes a penalty and reward for improving two bathing waters to 'Excellent'. These are similar to our AMP6 performance commitments.

Category of Claim

This claim is for improving the quality of bathing waters, around the Southern Water region, to 'Good' or to 'Excellent' status. Significantly improving the quality of bathing waters in our region was a key priority for our customers, with customers wanting us to go further than the minimum statutory duty ('Sufficient' bathing water quality) and they are willing to pay extra for delivery of these enhancements.

The category of the claim is customer-driven discretionary investment going beyond statutory environmental standards.

Which price control does the claim apply to?

All the costs associated with this claim apply to the Wastewater Network Plus price control.

What is the value of the claim?

The value of the claim is £32.4 million investment in AMP7. This is above the materiality threshold of 1% of projected totex (c.£20 million) for Wastewater Network Plus investment.

This investment is below the £100 million threshold for direct procurement. We also note that the proposed solutions are diverse in nature across broad geographies (e.g. identifying and remedying misconnections of small diameter sewers) resulting in the schemes frequently being non-discrete in nature.

The cost estimate breakdown is shown below.

Bathing Water Site	Improvement	"Should be" P50 cost
Broadstairs, Viking Bay	To "Good"	1,429,854
Littlestone	To "Good"	3,838,669
Lancing, Beach Green	To "Good"	5,343,519
Hastings, Pelham Beach	To "Good"	5,627,135
Felpham	To "Good"	10,643,494
To "Good" Sub-total		26,882,672
Gurnard	To "Excellent"	4,047,508
Seagrove	To "Excellent"	3,192,064
Ramsgate Sands	To "Excellent"	2,171,209
Pevensey Bay	To "Excellent"	1,579,903
*Average of "To Excellent" * 2*		5,495,342
Indicative cost of improvements		32,378,014

Two of four to be improved

Evidence for claim

Southern Water has 83 designated bathing waters and has continued to improve the quality of waters at these bathing sites through successive AMPs, as well as maintaining existing standards elsewhere. This proposal would improve five bathing waters from 'Poor' or 'Sufficient' to 'Good' status and a further two bathing waters to 'Excellent' status.

Improving the quality of bathing water is a priority area for our customers and our Business Plan therefore exceeds the statutory obligations of the Bathing Water Directive. There are multiple external factors that influence bathing water quality that are beyond management control, however despite these factors, the delivery of the AMP6 programme shows that we can successfully deliver Bathing Water outcomes, manage stakeholder relations and third-party factors whilst delivering efficiently.

The benefits of improving bathing waters are wide ranging, including improving seaside economies and reducing the health risk for bathers. This has been confirmed via our customer engagement survey[3] where customers stated that they wanted us to go further than the minimum statutory duty ('Sufficient' bathing water quality) and are willing to pay extra for delivery of these enhancements[4].

Need for cost adjustment

We have listened to our customers and it is apparent that it is part of our service to the environment and their communities which they consider a priority. We are confident that we can evidence this priority strongly because of our extensive and ongoing engagement. Customers have consistently indicated that it is an area where we should go beyond the statutory minimum. Our willingness to pay research in both AMP6 and with respect to AMP7 backs this up.

The expenditure set out in this claim is neither base expenditure nor derived from statutory requirements. It is therefore clearly enhancement expenditure. We also believe that our proposed programme is unique among the water companies.

[3] Breathe Report – Section 1
[4] Southern Water Willingness to Pay Main Stage Report Jan 2018, Accent, PJM Economics, Southern Water (Table 9)

We will not receive enforcement notices from the Environment Agency for these improvements, as they are customer driven. We will be going beyond the requirements of the Water Industry National Environment Programme.

Based on PR14 experience, therefore, and our understanding of Ofwat's PR19 modelling methodology, we do not anticipate that the models will make allowance for customer-driven enhancement improvements of this type and therefore consider that a cost adjustment is required rather than being treated as material enhancement expenditure.

Management control

This claim is a customer-driven discretionary investment so is within management control. However, without this claim we will not be able to deliver against one of our customers' key priorities for AMP7.

There are a wide range of external factors which influence bathing water quality such as litter, dog and bird waste, seaweed washed ashore and more indirect sources, such as marine traffic, or inputs to the natural estuaries and surface water systems that discharge into the bathing water. Whilst we do not control all these factors, our approach, enabled through this cost adjustment claim, to achieving 'Good' and 'Excellent' status gives us confidence we can have sufficient influence over them. We work collaboratively with a broad range of stakeholders to positively influence these factors and play a pro-active role in the community. Our AMP6 programme shows that we can successfully deliver bathing water outcomes, manage stakeholder relations and third-party factors efficiently. This gives us confidence that we can design and deliver a successful and efficient programme of further improvements in AMP7.

Need for investment

Our customers have consistently indicated that bathing waters are a priority area for investment. Our willingness to pay research in both AMP6 and AMP7 supports this with an increase in customers WtP in the latest research. A comprehensive study into customer's willingness to pay for improvements at bathing waters has been conducted by Southern Water in partnership with Accent and PJM economics [5]. This study establishes both a clear willingness to pay, and the amount customers are prepared to pay for these improvements. The study considered not only which services should be improved and which trade-offs with the resulting bill levels were acceptable, but also considered future benefits where the improvements would not be seen for several years.

The survey asked 921 dual-service customers and 699 wastewater only customers to identify which improvements they would like to see from a list of 12 issues. These were then ranked in terms of most and least preferred. Customers were then presented bill adjustments. Four options were presented in pairs and a total bill increase over the five years was presented alongside each option.

Bathing water improvements were ranked 5th for households and 4th for non-households. Although this was lower than renewable energy, fewer pollution incidents and river quality improvements, the amount customers are prepared to pay is 1.3 times that of renewable energy and five times that of pollution incidents[6].

Customer willingness to pay for bathing water improvements has increased since PR14 and during AMP6, where we are on the way to successfully improving seven bathing waters to 'Excellent' status. The increase in customer willingness to pay illustrates that this is still a key area for improvement for our customers.

The study used econometric analysis to derive willingness to pay values using the following steps:

[5] Southern Water Willingness to Pay Main Stage Report Jan 2018, Accent, PJM Economics, Southern Water.

[6] Southern Water Willingness to Pay Main Stage Report Jan 2018, Accent, PJM Economics, Southern Water (Figures 19 and 20)

1. Priority scores were estimated using econometric modelling of responses to the most and least preferred options.
2. “Package values” were estimated via econometric modelling of responses to the bill options. A package value was assigned to each bill option. It was found that of the four bill options presented the “better” option was preferred to the “best” option.
3. Individual “service measure weights” were then derived for each bill option presented (worse, current, better, best).
4. Each package value was then divided between each service measure change, in proportion to the service measure weights, to derive the main WTP estimates for changes in individual service levels.
5. £WTP per unit of change, (e.g. per improved bathing water to ‘Good’) were then calculated by dividing service measure values by the number of units of change represented.

Incremental improvement

We are investing c.£25 million in AMP6 to improve the quality of seven bathing waters to ‘Excellent’ following a cost adjustment claim in PR14 (known as ‘special cost factor’ claims). During AMP6, we have worked with partners to enable us to deliver improvement measures at seven bathing waters, gaining experience and insight as to how to make integrated working successful in respect to both the expenditure and the outcome.

Why this investment is required

As part of our work to identify which bathing waters to invest in during AMP6 we have carried out extensive investigation, utilising coastal models, field work and laboratory analysis to understand the factors which affect the quality of 21 bathing waters, enabling us to recognise that without investment they will remain below the standards that our customers want.

Bathing waters and the seaside economy are valuable economically, socially, and environmentally. The economic value of seaside tourism across England is estimated to be at least £3.3 billion. The quality of bathing waters makes a significant contribution towards this tourism offer and is key to the reputation of many seaside resorts[7]. Our operating area covers communities living in southern coastal areas whose livelihoods depend on tourism income and in turn the quality of the region’s bathing waters. The improvements to bathing waters will therefore be a benefit to these communities. For this reason, all but one of the bathing waters we have chosen for improvement in the proposed AMP7 programme support small or large resorts (as defined in EA guidance on bathing water improvement).

[7] PR19 Driver Guidance; Bathing Waters 2017.

Options

Following the analysis of a comprehensive study into customer's preferences, attitudes, priorities and willingness to pay for improvements at bathing waters, it was found that although customers are prepared to pay extra on their bills for bathing waters to be improved to 'Excellent' status, in fact improving bathing waters to 'Good' status is a higher priority for them, generating values which are more than three times greater. This Claim therefore reflects this priority with five bathing waters set to be improved to 'Good' status and a further two improved to 'Excellent' status.

A range of options and sites were identified, and a cost analysis undertaken on 32 sites, with the following bathing waters being earmarked for improvement measures:

Bathing Waters to be taken to 'Good' classification:
• Broadstairs, Viking Bay • Littlestone • Lancing, Beach Green • Hastings, Pelham Beach • Felpham
Bathing Waters to be taken to 'Excellent' (two from four)
• Gurnard • Seagrove • Ramsgate Sands • Pevensey Bay

We have high confidence in the selection of the sites that are being moved up to Good status. There is more uncertainty about the costs and benefits at the sites we propose to move to Excellent, which is why we have identified 4 potential priority sites at this stage which will be reduced to 2 for improvement in AMP7 following further investigations.

We have undertaken a cost benefit analysis for both of the proposed bathing water programmes (to "Good" to "Excellent"). The benefits have been based on the amount that our customers have told us they are willing to pay for each respective improvement (being £3.5m for each bathing water improved "to Good", and £0.9m for each bathing water improved "to Excellent"). Both programmes are highly cost beneficial as demonstrated below (negative NPV implies a positive cost-benefit).

(£m)	AMP7 Totex	Cost benefit NPV (20yrs)
5 "to Good"	26.9	-206.5
2 "to Excellent"	5.5	-21.3
Total	**32.4**	**-227.8**

In order to protect our customers, we have set out a number of performance commitments around this claim, including a penalty only and reward and penalty type financial incentive, as described further above.

Best option for customers

The scale and pace of the work proposed has been supported by customers through recent engagement studies.

Option Development

We have considered a range of options and sites with a combination of qualitative and quantitative analysis of the options in order to derive the details of the proposal.

The selection of the bathing waters for improvement was based on the same criteria applied in AMP6. More detail on the selection methodology is set out below and in the attached methodology appendix.

For improvement in AMP7, all 83 bathing waters were assessed based on their relevant assessment period classifications (4 years) for 2016 and 2017 without Pollution Risk Forecasting, and the number of bathing waters investigated has been reduced based on the following criteria:

- 46 sites have been recorded 'Excellent' for 2016 and 2017 (without taking PRF discounting into account);
- A further five[8] sites have had investment in AMP6 to reach 'Excellent'. (Seven sites were improved during AMP6 and two of these have already achieved 'Excellent' so were removed in stage 1 above).

Where sites have consistently achieved 'Excellent' status, they have been removed, reducing the number of sites from 83 to 37. Sites where considerable investment has been made to improve the classification to 'Excellent' were removed from the selection process reducing the number to 32.

Bathing waters that have been investigated as part of AMP6 and have not received improvement measures to reach 'Excellent' (although some improvements may have occurred) have remained within the selection group.

Bathing waters that are due to be investigated as part of the AMP7 programme via WINEP drivers have had the investigation cost element of the works subtracted from these total costs.

Additional criteria have been applied across all 32 sites, including:

- Amenity
- Certainty of root cause
- Deliverability
- Time scales
- Environmental assessments
- Social Capital

For example, where the bathing water provides an amenity to bathers and other recreational users, it has been ranked higher than a beach with only dog walking facilities. Customer engagement research undertaken in AMP6 has provided detailed information on the amenities and desirability of each bathing water investigated as part of our Bathing Water Enhancement Programme[9.]

The certainty of root cause and deliverability within time scales has influenced the weighting of cost data at bathing waters.

Cost Benefit Analysis (CBA) has also been undertaken on all 32 sites with ranking based on the criteria mentioned above with additional weighting on certainty of root cause, deliverability and timescales. The willingness to pay to improve from less than 'Good' to 'Good' is £3.5 million, and from 'Good' to 'Excellent' is £0.9 million per year[5].

The willingness to pay value represents a benefit per year and compared to the investment cost of the solutions for each bathing water across the AMP7 period. The cost of schemes are shown as total costs for AMP7.

[8] The five sites for further investment in AMP6 as part of the Bathing Water Enhancement Programme are: Selsey, Worthing, Shanklin, Leysdown and Minster Leas.

[9] Bathing Water Enhancement Programme Research Report November 2016, QA Research (available on request)

Bathing waters have then been ranked by their cost / benefit and are presented as less than 'Good' to 'Good' and less than 'Excellent' to 'Excellent' in Figure 2 and Figure 3 and below, with the grey shaded area depicting the sites determined to be cost beneficial.

Figure 2 - Cost Benefit Analysis to 'Good'

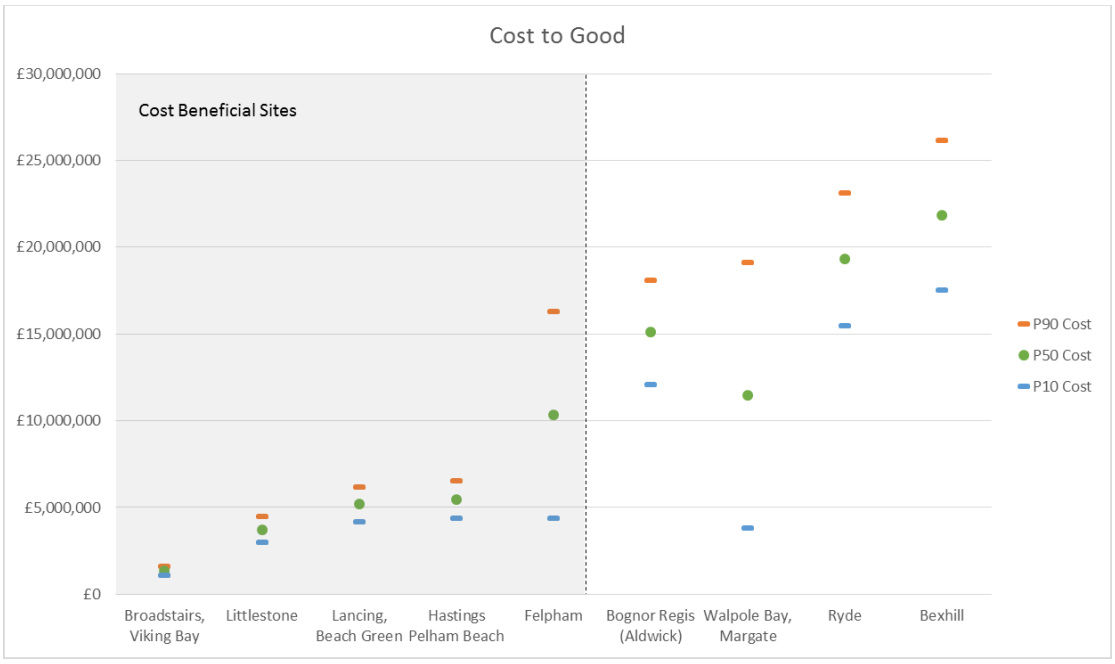
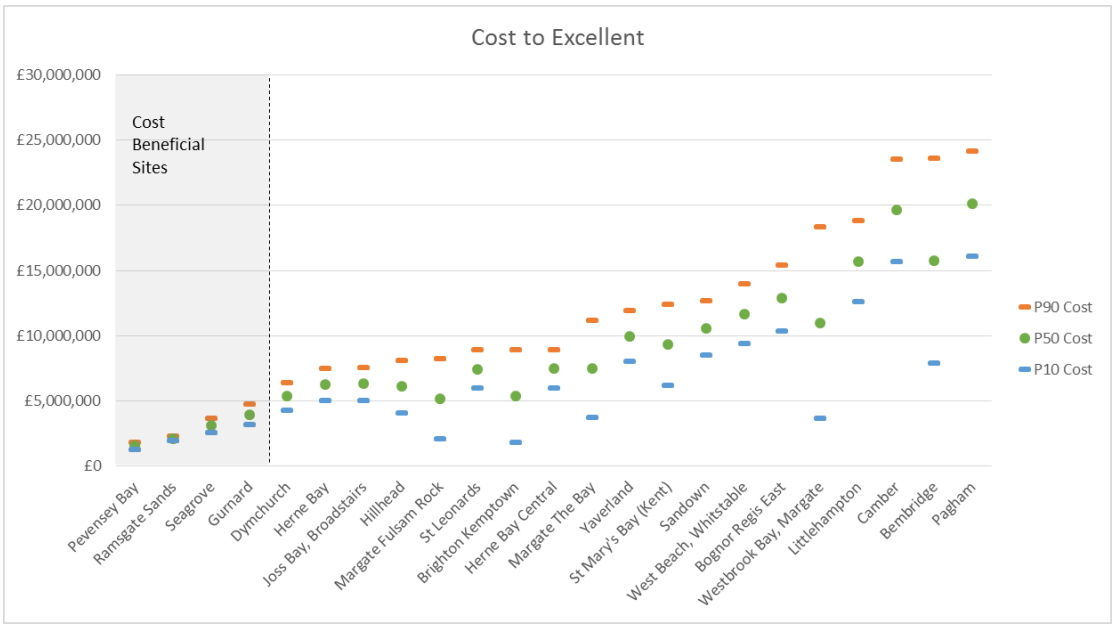


Figure 3 - Cost Benefit Analysis to 'Good' or to 'Excellent'



Based on this analysis, the following bathing waters are earmarked for improvement measures. It includes all five sites that are cost beneficial to improve to 'Good' and 2 out of the four sites that are cost beneficial to move to 'Excellent'.

Selection of the latter requires further investigation during AMP7, to ensure deliverability. To date, we have not carried out detailed investigations and our proposals are based on preliminary investigations and using what we have learnt from the AMP6 programme. For example, we haven't done a full investigation at Gurnard but are able to make assumptions from the bathing water next door where we have. The work to date is enough to provide us confidence to proceed but would be followed up by a detailed investigation (e.g. sampling, cage surveys, misconnection assessments) prior to finalising solutions and costs.

While we have reasonable certainty over the five beaches to improve to 'Good', we are continuing our investigations and customer engagement and we are proposing that, should an alternative beach to be moved to 'Good' be identified as providing better value for customers, a maximum one swap can be made. CCG would be consulted as part of the process.

Bathing Waters to be taken to 'Good' classification:
Broadstairs, Viking Bay Littlestone Lancing, Beach Green Hastings Pelham Beach Felpham
Bathing Waters to be taken to 'Excellent' (two from four)
Gurnard Seagrove Ramsgate Sands Pevensey Bay

Identification of the correct basket of interventions is essential to optimising the costs of delivery and understanding the most cost beneficial bathing waters to intervene at. Through our improvement programme in AMP6 we have developed a clear understanding of the suite of interventions available, the contribution that these interventions can have on the outcome and the cost of the interventions. Not every solution will be required at every bathing water, but during the investigation stage in AMP6 it was found this was a useful way to confirm faecal sources. Each bathing water has unique solutions and so a process chart of solutions can be applied. The list below summaries the approach at AMP6.

1. During investigations assets were occasionally found to have structural defects such as cracks. If any grade 4 or 5 structural or operational defects such as roots or silt were identified these were remedied. Many of these are associated with the recently transferred sewer assets. Some repairs were related to private systems (e.g. piers).
2. Misconnection studies were undertaken in co-operation with the local authorities. Dye tracing and connectivity surveys were used to identify where properties or parts of properties were connected incorrectly to the surface water system. Advice was then given to the property owner regarding reconnection to the foul system.
3. CSO surveys identified any changes in the operation of the overflow, and if the spill rate contained within models was accurate. If changes were required to the model or operation of the CSO these informed other solutions.
4. Bird waste has a substantial impact on the seashore and birds are attracted by litter, so we have created a beach campaign in conjunction with the Environment Agency to reduce the amount of litter present.
5. Dog waste also has an impact, and removal of waste is key to reducing faecal matter at some bathing waters.
6. Many bathing waters are impacted by the natural estuaries that flow to them. Tracing faecal matter back through the catchment has a significant impact at the bathing water. We are working with catchment sensitive farming officers and famers to reduce the impact farming has on the bathing water.

At PR14, we involved customers in an objective way and discussed the issues important to them. This gained strong support from the CCG. During AMP7 we want to improve on this and engage with customers to develop innovative ways for customer participation enabling behavioural change for the improvement of bathing waters alongside the capital improvements that we are proposing to make in this programme.

Co-delivery of schemes may be possible as many councils are already working to change customer behaviour towards litter collections. Councils and farmers may also be the delivery vehicle for some of the softer interventions proposed.

Customer protection

We have set out three of performance commitments (PC) around this claim to protect the customer:

- PR19SRN_WWN11: Maintain Bathing waters at 'Excellent'.
- PR19SRN_WWN12: To improve the number of Bathing waters to at least 'Good' (Cost Adjustment Claim).
- PR19SRN_WWN13: Improve the bathing waters at 'Excellent' quality (Cost Adjustment Claim).

The first performance commitment is to maintain 61 bathing waters at 'Excellent'. This will be based on their status over the relevant assessment period (four years) in 2020.

The second is to improve five bathing waters to 'Good' status (or better) from less than 'Good', customers will be protected by penalty and reward clauses linked to these improvements.

The third performance commitment is to improve a minimum of two bathing waters (from a choice of four) to 'Excellent' status from less than 'Excellent'. Again, customers will be protected by penalty and reward clauses linked to these improvements.

Affordability

The total amount of the claim is £32.4 million.

Affordability has been considered in the context of our plan overall. All current indications are that bills for our customers will be falling in AMP7 by >3% which is significantly more than the amount by which this claim (and our other cost adjustment claims) increases them.

Assurance

Costs estimates at this stage are based on best available information on the likely issues experienced at these sites and learning and examples from similar sites from AMP6.

The CCG have supported the basis for bathing water selection for the delivery of our AMP6 improvements, and we will continue to discuss the detail of our AMP7 proposals with them ahead of delivery. The Board support the need for the investment at bathing waters to deliver the improvements that are important to our customers and stakeholders.

Robustness and efficiency of costs

We have high confidence in the costs associated with the sites that are being moved up to Good status, and although there is more uncertainty about the sites being moved to Excellent, we have adopted a structured approach to selecting and costing them. We have therefore proposed a balanced P50 cost position in our claim, with associated customer protections. This represents a significant move from the AMP6 position, where P90 costs were used.

Costs estimates at this stage are based on best available information on the likely issues experienced at these sites and learning and examples from similar sites from AMP6. Where information is known about the sites due to existing AMP6 studies, this detailed information has been used to cost the delivery elements, through the application of our solution hierarchy.

At sites where no recent studies have been undertaken, an assessment by bathing water experts at both Southern Water and Stantec, has been undertaken. It is based on similar sites and learning from AMP6, again using the solution hierarchy to establish the optimum mix of interventions. The basis for the estimates for each of the bathing waters under consideration is set out in Table 1 below.

Table 1 - Status of bathing water investigations and cost maturity

Site Name	Investigation Status	Costing Approach
Broadstairs, Viking Bay	Area Investigations, not site specific	Internal assessment based on known issues
Littlestone	Bathing Water Enhancement Programme	Detailed Estimate
Lancing, Beach Green	Area Investigations, not site specific	Internal assessment based on known issues
Hastings Pelham Beach	Area Investigations, not site specific	Internal assessment based on known issues
Felpham	Bathing Water Enhancement Programme	Detailed Estimate
Gurnard	Area Investigations, not site specific	Internal assessment based on known issues
Seagrove	None available	Internal assessment
Ramsgate Sands	Area Investigations, not site specific	Internal assessment based on known issues
Pevensey Bay	Area Investigations, not site specific	Internal assessment based on known issues

Having developed a view of the options available to achieve the customer driven bathing water classification, we have utilised our Central Estimating Team (CET) to develop a view of the cost for each of the optimised solutions. They maintain a suite of cost curves, based on the outturn costs of projects completed to date. Ahead of using these curves to price solutions for AMP7, we conducted a review of all costs and adjusted the models to reflect our view of what would be needed to represent efficient costs for AMP7. We then used this information to select the lowest whole life cost solution.

Detailed technical and costing papers are attached to this claim for each of the 9 candidate bathing waters.

In order to allow for differences in estimation techniques, and that the programme of work may have different costs to carrying out the schemes individually, we did a Monte Carlo analysis of the programme of improvements. The costs included in this adjustment claim are the central estimate (P50) costs only, providing an additional level of challenge to the costs and to ensure that we take an appropriate level of risk. As noted above, this represents a significant move from the AMP6 position, where P90 costs were used.

Board assurance

Our Board has reviewed all our Cost Adjustment Claims. The Board support the need for, and the specific elements of, the proposed investment in bathing water improvement to ensure that we continue to meet our customer priorities, whilst at the same time exceeding our statutory obligation.

Costing Methodology

Nine bathing waters have been selected for improvements, during AMP7, to ensure bathing water quality achieves either Excellent or Good by 2025. The criteria used to select these nine bathing waters is described below.

Methodology

For improvement in AMP7, all 83 bathing waters were assessed based on their relevant assessment period classifications (4 years) for 2016 and 2017 without Pollution Risk Forecasting (PRF), and the number of bathing waters investigated has been reduced based on the following criteria:

- 46 sites have been recorded 'Excellent' for 2016 and 2017 (without taking PRF discounting into account);
- A further five sites have had investment in AMP6 to reach 'Excellent'. (Seven sites were improved during AMP6 and two of these have already achieved 'Excellent' so were removed in stage 1 above).

Where sites have consistently achieved 'Excellent' status, they have been removed, reducing the number of sites from 83 to 37. Sites where considerable investment has been made to improve the classification to 'Excellent' were removed from the selection process reducing the number to 32.

Bathing waters that have been investigated as part of AMP6 and have not received improvement measures to reach 'Excellent' (although some improvements may have occurred) have remained within the selection group.

Bathing waters that are due to be investigated as part of the AMP7 programme via WINEP drivers have had the investigation cost element of the works subtracted from these total costs.

The 32 bathing waters that have been assessed for improvement are shown in Table 2.

Table 2 - 32 Sites Considered for Improvement with Target Status

Bathing Water	Target Status	Bathing Water	Target Status
Bexhill	Good	Herne Bay Central	Excellent
Bognor Regis (Aldwick)	Good	Hillhead	Excellent
Broadstairs, Viking Bay	Good	Joss Bay, Broadstairs	Excellent
Felpham	Good	Littlehampton	Excellent
Hastings Pelham Beach	Good	Margate Fulsam Rock	Excellent
Lancing, Beach Green	Good	Margate The Bay	Excellent
Littlestone	Good	Pagham	Excellent
Ryde	Good	Pevensey Bay	Excellent
Walpole Bay, Margate	Good	Ramsgate Sands	Excellent
Bembridge	Excellent	Sandown	Excellent
Bognor Regis East	Excellent	Seagrove	Excellent
Brighton Kemptown	Excellent	St Leonards	Excellent
Camber	Excellent	St Mary's Bay (Kent)	Excellent
Dymchurch	Excellent	West Beach, Whitstable	Excellent
Gurnard	Excellent	Westbrook Bay, Margate	Excellent
Herne Bay	Excellent	Yaverland	Excellent

These 32 bathing water sites were given further consideration in order to reduce the number of bathing waters receiving improvement during AMP7. Further criteria are listed:

- The solution cost at each bathing water was assessed based on known information at each bathing water or catchment;
- The deliverability of each solution;
- The type of beach;
- The amenity, socio and economic value provided by each bathing water based on the type of beach.

These additional criteria are discussed in the following sections.

Costing and Deliverability

The type of scheme(s) required to meet either Good or Excellent at each bathing water was identified and costed. The certainty of that solution(s) being the correct solution(s) was also considered and a weighting applied, therefore the more certainty surrounding a scheme, the lower the weighting.

The certainty of delivering that scheme, during AMP7, was also assessed and again weighted to favour those that could be delivered within the time frame.

The P10, P50 and P90 costings generated take account of these weightings and give an indication of the certainty of the overall scheme at each bathing water. The greater the variability between P10 and P90, the greater the cost uncertainty.

P10, P50 and P90 costs for each of the remaining 32 bathing waters were derived and are shown in Figure 4 (bathing waters targeted to Good) and Figure 5 (bathing waters targeted to Excellent).

The nine bathing waters were selected for investment based on the P50 costs. A dotted line has been added to Figure 4 and Figure 5 to pictorially show the selected bathing waters.

Figure 4 – P10, P50 and P90 Costs of Bathing Waters to Good

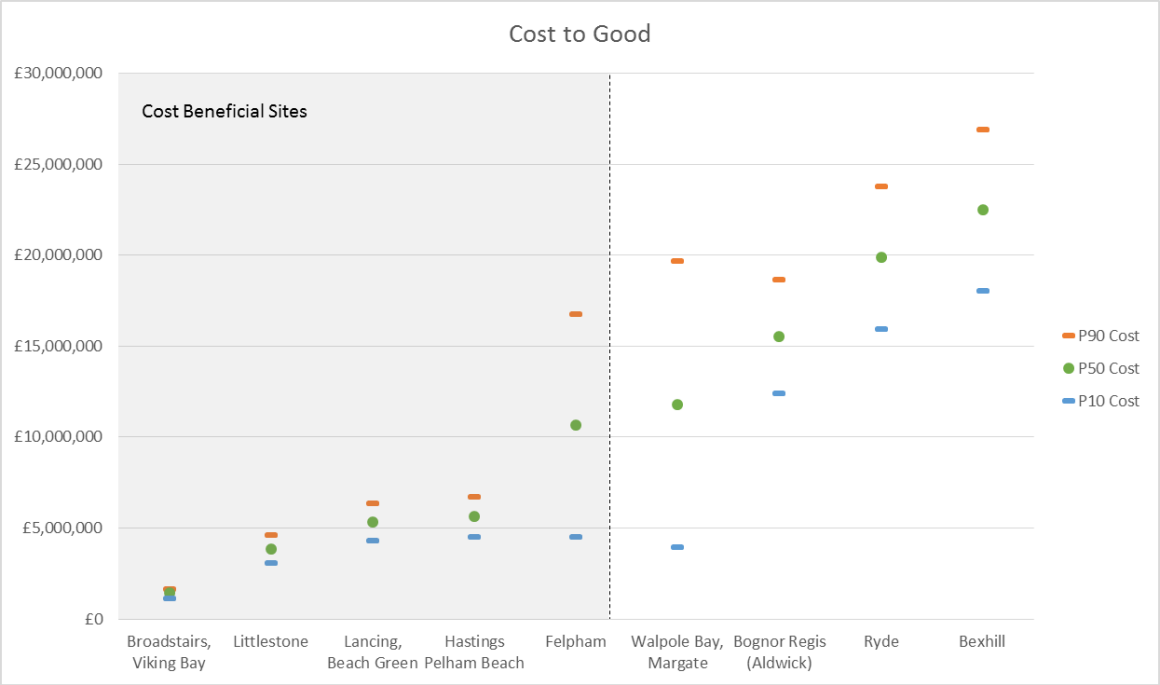


Table 3 – P10, P50 and P90 Costs of Bathing Waters to Good[10]

Site	P10 Cost	P90 Cost	P50 Cost
Broadstairs, Viking Bay	£1,129,623	£1,644,303	£1,429,854
Littlestone	£3,086,415	£4,590,923	£3,838,669
Lancing, Beach Green	£4,308,741	£6,378,297	£5,343,519
Hastings Pelham Beach	£4,524,016	£6,730,254	£5,627,135
Felpham	£4,532,332	£16,754,657	£10,643,494
Walpole Bay, Margate	£3,934,332	£19,671,661	£11,802,996
Bognor Regis (Aldwick)	£12,420,656	£18,630,984	£15,525,820
Ryde	£15,929,481	£23,775,345	£19,852,413
Bexhill	£18,034,948	£26,917,833	£22,476,391

[10] Bathing waters shown bold have been selected for investment.

Figure 5 - P10, P50 and P90 Costs of Bathing Waters to Excellent

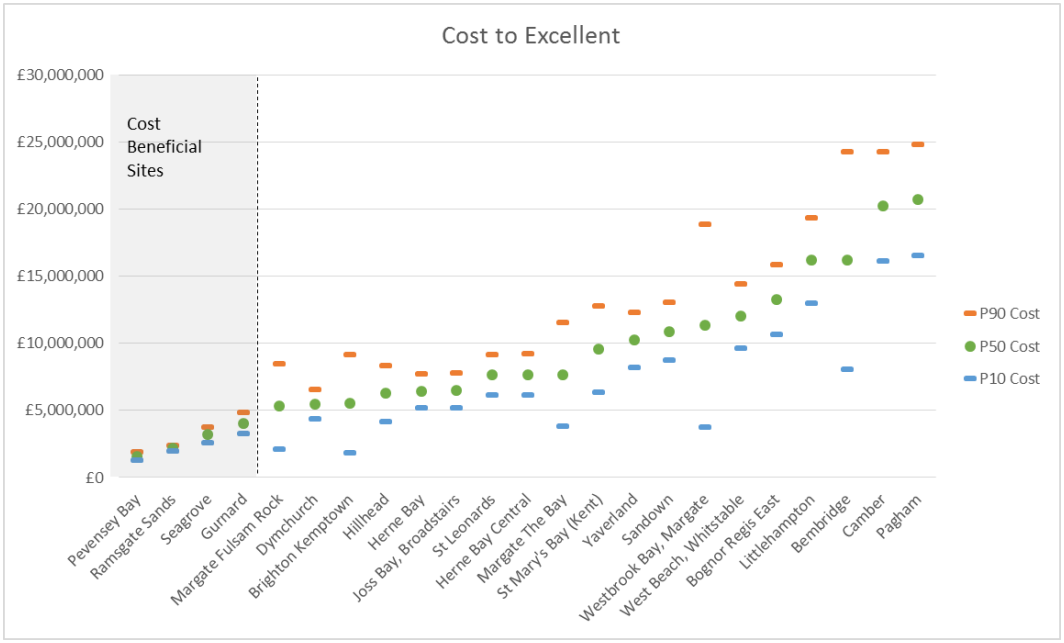


Table 4 - P10, P50 and P90 Costs of Bathing Waters to Excellent[11]

Site	P10 Cost	P90 Cost	P50 Cost
Gurnard	£3,246,756	£4,848,259	£4,047,508
Seagrove	£2,619,191	£3,764,936	£3,192,064
Ramsgate Sands	£1,978,252	£2,364,166	£2,171,209
Pevensey Bay	£1,273,189	£1,886,617	£1,579,903
Margate Fulsam Rock	£2,118,562	£8,474,249	£5,296,405
Dymchurch	£4,402,113	£6,570,318	£5,486,216
Brighton Kemptown	£1,835,031	£9,175,155	£5,505,093
Hillhead	£4,179,741	£8,359,482	£6,269,612
Herne Bay	£5,163,898	£7,707,311	£6,435,605
Joss Bay, Broadstairs	£5,197,509	£7,796,264	£6,496,886
St Leonards	£6,127,712	£9,145,839	£7,636,776
Herne Bay Central	£6,135,992	£9,203,987	£7,669,990
Margate The Bay	£3,838,708	£11,516,123	£7,677,416
St Mary's Bay (Kent)	£6,386,681	£12,773,362	£9,580,021
Yaverland	£8,224,370	£12,275,179	£10,249,775
Sandown	£8,736,652	£13,039,779	£10,888,215
Westbrook Bay, Margate	£3,771,356	£18,856,780	£11,314,068
West Beach, Whitstable	£9,642,298	£14,391,489	£12,016,893
Bognor Regis East	£10,630,763	£15,866,811	£13,248,787

[11] Bathing waters shown in bold have been selected for investment.

Littlehampton	£12,970,927	£19,359,593	£16,165,260
Bembridge	£8,087,497	£24,262,492	£16,174,995
Camber	£16,160,190	£24,240,285	£20,200,238
Pagham	£16,563,349	£24,845,024	£20,704,186

Based on the P10, P50 and P90 costs presented above, nine bathing waters were selected for further analysis to confirm their suitability for improvements; these bathing waters have been highlighted in bold in Table 3 and Table 4 above.

Beach Type

The benefit or value of each bathing water can be measured by socio and economic factors. This report has considered these aspects based on the type of bathing water. Guidance[12] from the Environment Agency defines the Beach Resort Type as either a "small beach", "small resort" or "large resort" these definitions are provided below in Table 5. The beach resort type for the nine selected bathing waters are shown in Table 6 and Table 7.

Table 5 – EA Resort Type Definitions

Beach type	Distance visitors will travel
Small beach, little access, valued or peaceful and quiet	30km
Small Resort (village/town), good access, some beach facilities available	50km
Large Resort (town/city), long beach, facilities and entertainment available	130km

Table 6 – Beach Type Associated with Proposed Bathing Waters to Good

Bathing Water	Beach Type	Distance visitors will travel
Lancing, Beach Green	Small Beach	30km
Felpham	Small Resort	50km
Littlestone	Small Resort	50km
Broadstairs, Viking Bay	Large Resort	130km
Hastings Pelham Beach	Large Resort	130km

Table 7 – Beach Type Associated with Proposed Bathing Waters to Excellent

Bathing Water	Beach Type	Distance visitors will travel
Gurnard	Small Resort	50km
Seagrove	Small Resort	50km
Pevensey Bay	Small Resort	50km
Ramsgate Sands	Large Resort	130km

[12] Table 3.8 – Distances from which a Visitor may Travel to Visit a Particular Beach, Guidance Assessment of benefits for Water Quality and Water Resources Schemes in the PR04 Environment Programme (Part 4 Coastal Waters and Estuaries).

The nine selected bathing waters are associated with a mix of small beach, small resort and large resorts.

Socio and Economic Benefits

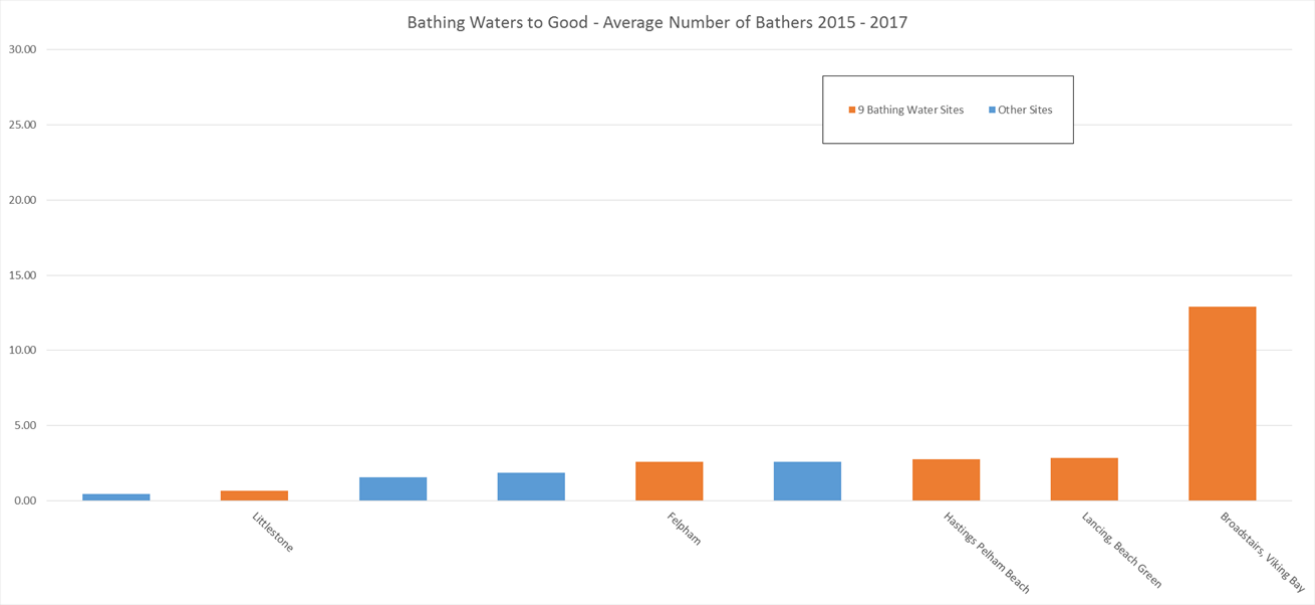
Guidance from the Environment Agency[13] identifies several socio and economic benefits; these were categorised into six sections; Health (immersive activities), Recreation, Angling, Shellfish, Tourism and Biodiversity. The benefit calculations identified by the EA in their guidance are based on assumptions and number of people with the potential to visit the bathing water in question on an annual basis.

However, the Environment Agency record the number of bathers and beach users at the time water quality samples are taken, this is weekly throughout the bathing season. These values are a useful indicator of the number of people who could benefit directly from improvements.

The recorded data from actual beach visits made by the EA have been analysed to identify the average number of bathers and beach users over the last three years during the bathing season. The number of bathers is a direct comparison to the Health category from the 2004 guidance. Recreation and tourism categories can be compared to the number of beach users recorded. The assumptions made in the guidance document with regard to Angling are that 3% of users will participate in the sport. The shellfish category is only relevant to Gurnard and Seagrove as the other bathing waters in question are not within shellfish waters.

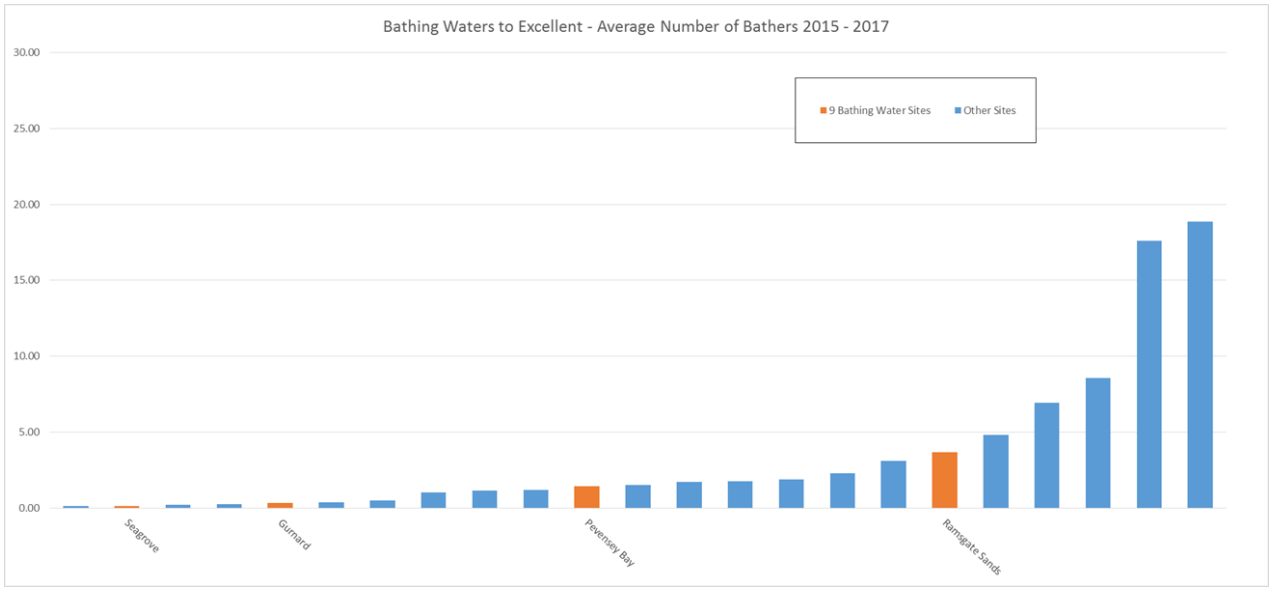
In order to establish the relative health benefit the amount of bathers have been graphed (in Figure 6 and Figure 7) to indicate the popularity of the bathing waters chosen for improvement alongside the other 32 bathing water sites considered for improvement within SWS region. These have been graphed by target status.

Figure 6 - Average Number of Bathers 2015 – 2017 for Bathing Waters to Good



[13] Environment Agency (2004) Guidance: Assessment of Benefits for Water Quality and Water Resources Schemes in the PR04 Environment Programme

Figure 7 – Average Number of Bathers 2015-2017 for Bathing Waters to Excellent



The benefit associated with recreation and tourism can be established using the recorded numbers of beach users, these have been graphed in Figure 8 and Figure 9 again these have been graphed by target status across the 32 bathing waters identified as not currently reaching Excellent.

Figure 8 - Average Number of Beach Users 2015 – 2017 for Bathing Waters to Good

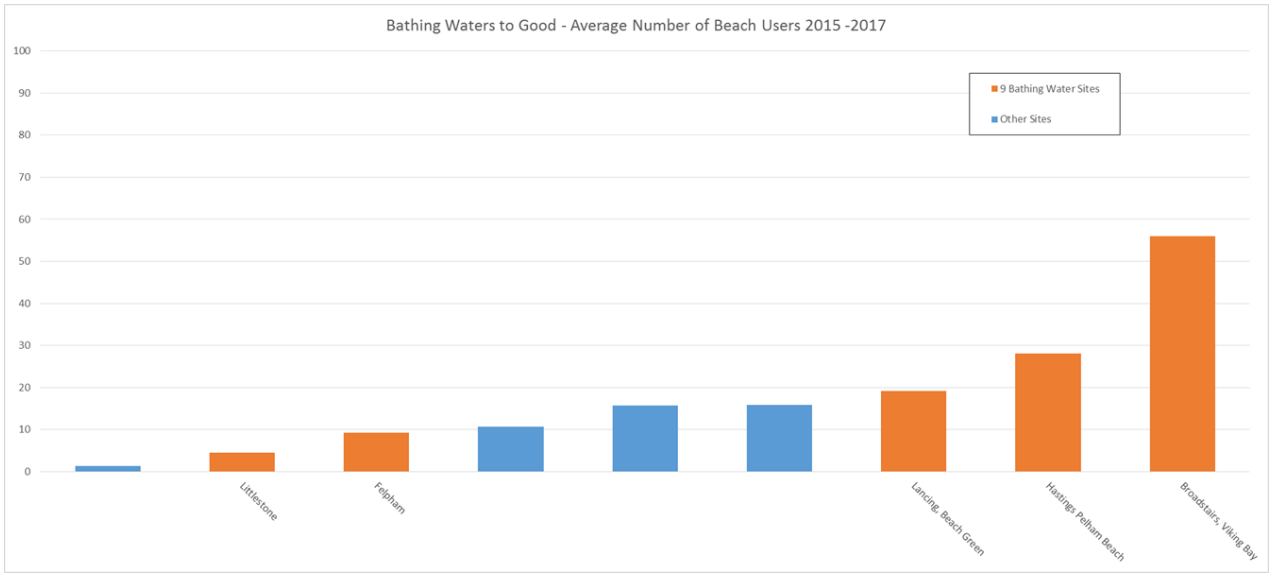
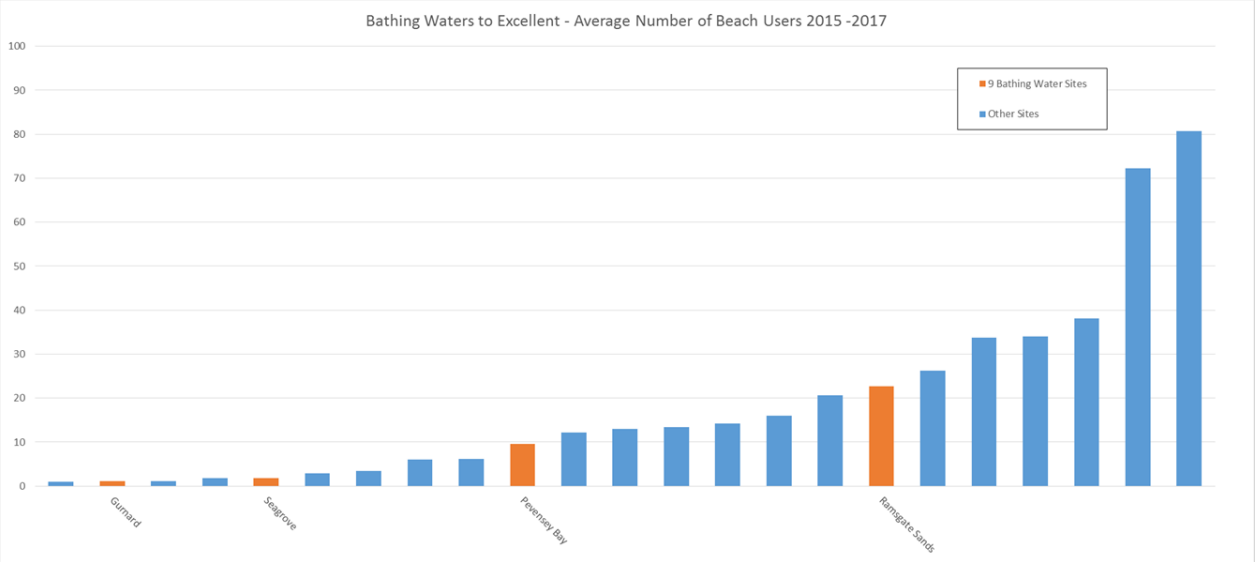


Figure 9 - Average Number of Beach Users 2015 – 2017 for Bathing Waters to Excellent



These graphs indicate the relative benefit associated with each of the chosen nine bathing waters. For the final selection of bathing waters to be improved to Excellent there is a choice of two from four, the benefit associated with these bathing waters will be considered during this selection process.

Bathing Water Investigations

In the following section we present the outputs from the nine individual bathing water investigations that we conducted in the process of creating the AMP7 bathing waters programme. Each investigation was conducted according to the broad principals previously set out in the Costing Methodology section above.

The following features of each bathing water have been considered in the assessments:

- Background;
- Bathing Water Quality;
- Catchment Features;
- Southern Water Assets including
    - continuous/intermittent discharges,
    - surface water network,
    - combined sewerage network,
    - agricultural diffuse,
    - urban and coastal diffuse,
    - private sewerage infrastructure etc.
- Historic Bathing Water Investigations;
- Bathing Water Analysis;
- Likely sources impacting the bathing water;
- Likely Solutions; and
- Deliverability of Proposals.

These features provide the subheadings for each individual bathing water investigation below.

Technical assessments, including cost breakdowns, for the following bathing waters are provided.

The contents page (page 3 above) is represented for ease of navigation.

Broadstairs, Viking Bay

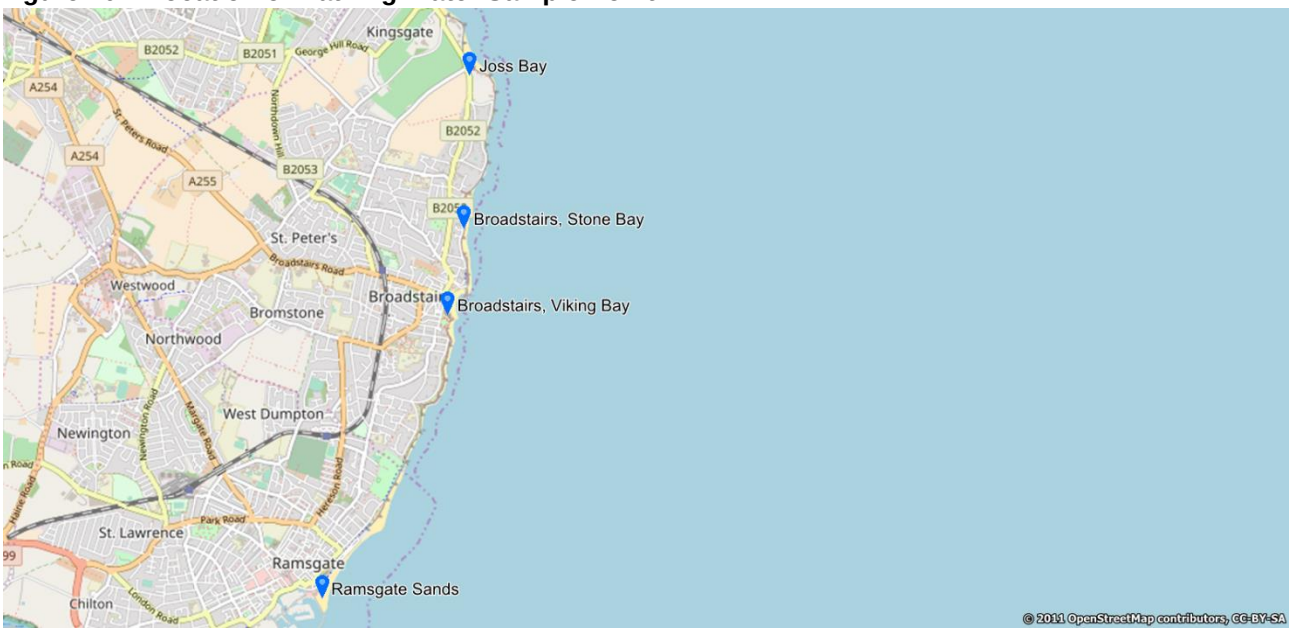
Background

Viking Bay in Broadstairs is a 300 metre sandy horse-shoe shaped bay, with cliff-top promenade, harbour pier and boardwalk. The small harbour is home to working boats, an active sailing club and resort facilities.

There are no natural surface water courses that flow to the coast from the local catchment of about 240 hectares. The Stour catchment of about 823 square kilometres drains into Pegwell Bay over 6 km to the south. The Stour catchment includes Ashford, Canterbury, Sandwich and much of Deal.

Figure 10 below shows location of Broadstairs Viking Bay Bathing Waters Sampling Point.

Figure 10 – Location of Bathing Water Sample Point



Bathing Water Quality

Table 8 below shows the annual and official four year rolling classifications at the bathing water.

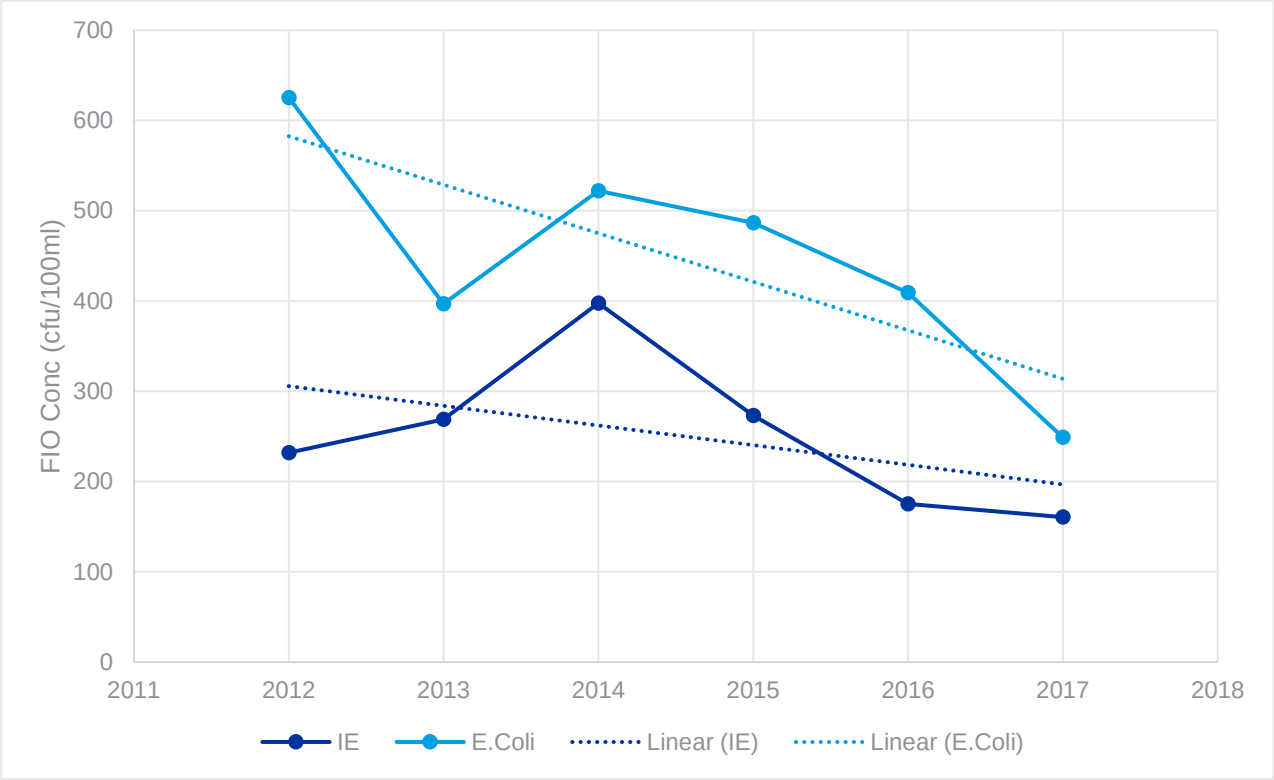
Table 8 – Historic Bathing Water Quality Classifications

	2013	2014	2015	2016	2017
Annual	Sufficient	Poor	Sufficient	Good	Good
Official	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient

Bathing Water quality at Broadstairs Viking Bay consistently falls below Good status for both the annual and four year rolling assessments.

Figure 11 below shows the 95%ile annual trending quality of the bathing water quality over the last five years.

Figure 11 – Historic Bathing Water Quality Trends

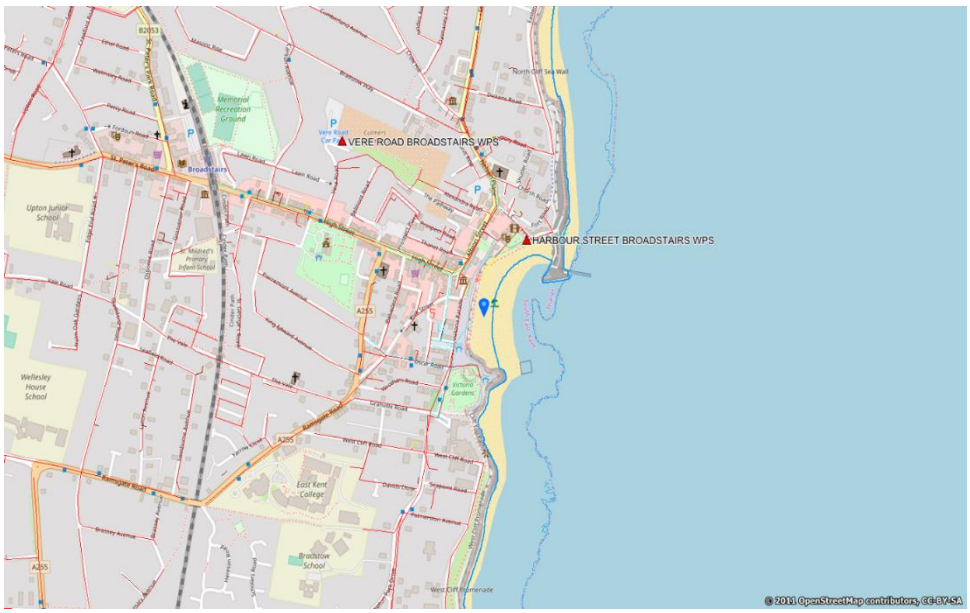


There would appear to be a slight improvement in bathing water quality on average within the last two years in particular. This may have been connected with a misconnection investigation undertaken within Broadstairs by the Southern Water Pollution Team in 2016.

Catchment Features

A brief desktop assessment has identified some key features and potential sources of the bathing water sampling results. This is shown in figure 12.

Figure 12 – Catchment Features



There is one surface water outfall discharging into the harbour at Viking Bay, this is likely to be an important pathway carrying multiple potential pollution sources to the bathing water.

Southern Water Assets

Continuous / Intermittent Discharges

Table 9 details the Southern Water continuous and intermittent assets which may impact the bathing waters. Environment Agency guidance on spill frequency from these assets are as follows:

Storm overflows that discharge directly into or impact on bathing waters with a target of good or sufficient status, must have no more than 3 significant spills per bathing season on average. Where more than one discharge affects the bathing water, you must aggregate the spills. The aggregated spills must be no more than 3 significant spills on average per bathing season. For storm overflows that discharge to bathing waters with a target of excellent status, the emission standard is for no more than 2 significant spills per bathing season on average. Whether a spill is significant will be considered on a site-specific basis. In general, for design purposes, a spill greater than 50m^3 is significant.

Table 9 – Continuous / Intermittent Discharges

Asset Name	Asset Type	Treatment Type	Average Bathing Season Spill Frequency[14]
Broadstairs	LSO	n/a	6.0
Broadstairs	SSO	n/a	0.0
Thanet Road Ramsgate	CSO	n/a	2.2

[14] Average spill frequency per bathing season based on 2012-2016 verified EDM records

Surface Water Network

Foul to surface water misconnections can have a significant impact on bathing water quality. 1490 properties and 1 surface water outfall has been identified which, if polluted, may have the ability to impact bathing water quality.

Misconnection surveys were undertaken around Viking Bay, trialling the 'hedgehog' system and the application of optical brighteners as tools for identifying misconnections. Neither were deemed as effective as traditional wire mesh caging by the Southern Water Pollution Team and retesting the SW system using cages was recommended.

Previous investigations have shown that:

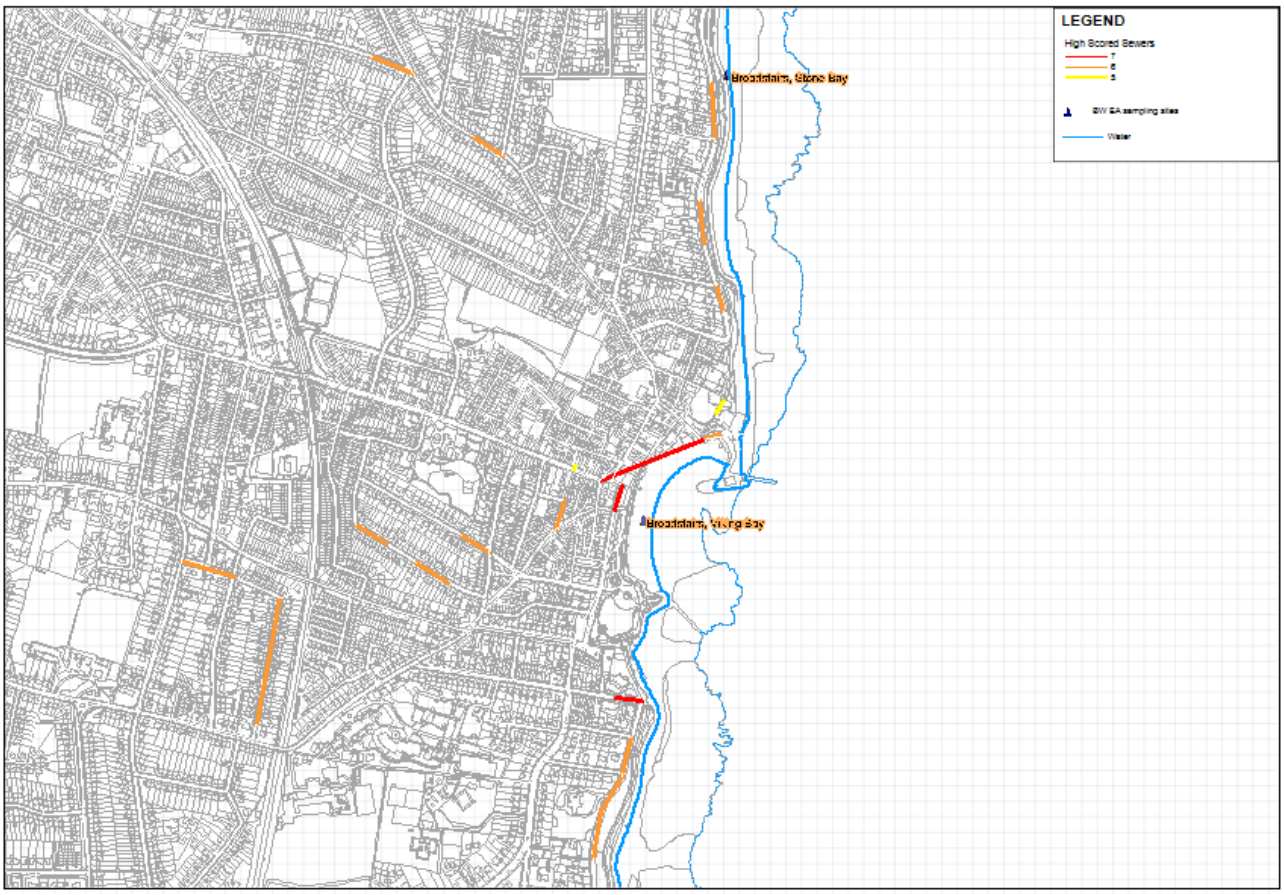
- Faecal coliform concentrations of between 10^5 and 10^6 cfu/100ml have been found both at the surface water discharge point north of the beach and throughout the system.
- Surveys have not identified one part of the system as being more contaminated than others.
- No evidence of foul solids was observed.
- No unknown connections were identified in the area around Harbour Street.
- A CCTV survey of potential misconnections from redeveloped older properties was abandoned due to the difficulty of access. The majority of the flats were in the area of Chandos Square where contamination was not particularly high.
- Dye tracing from the surface water sewer outfall showed that:
  - Surface water flows at TR399679 would be held back under high tidal conditions until the pipe is able to discharge under gravity (LW-3hrs), except under very high rainfall conditions.
  - Dye was observed to be opposite the entrance to the bay at low water.
  - The Environment Agency conjecture that this would bring the dye onto the beach on the rising tide.
  - The Environment Agency conjecture that this would bring the discharge from the surface water sewer onto the beach more often than might be expected.

Combined Sewerage Network

The integrity of the foul / combined sewerage network can have a significant impact on bathing water quality. The Southern Water Risk Scored Sewers (RSS) database shows 0.4 km of grades 5, 6 and 7 sewers which may be impacting the bathing water.

Exfiltration from the foul / combined network represents one of the few possible sources which could have the localised impact witnessed at Viking Bay.

Figure 13 – Risk Scored Sewers Grade 5 - 7



The RSS database is an internal Southern Water system of grading pipes based on structural integrity, frequency of inspections and maintenance and criticality. Scores are from 1 to 7 with 7 being the highest risk sewers.

Agricultural Diffuse

Agricultural diffuse pollution in the form of the storage or spreading of slurries and manures, or the keeping of grazing of livestock has the potential to contribute to reductions in bathing water quality. This can be from the direct excretion of waste from livestock or polluted runoff after rainfall.

There is unlikely to be a significant impact from agricultural diffuse pollution within this bathing water catchment.

No farms or watercourses have been identified with the potential to impact the bathing water at Viking Bay Broadstairs.

Urban and Coastal Diffuse

Faecal waste from dogs and birds, as well as polluted urban runoff, and sewage discharges from boats or houseboats have the potential to contribute to reductions in bathing water quality.

The impact from dogs and birds are common issues at every bathing water site. Dogs are banned from the beach between 1st May and 30th September.

Private Sewerage Infrastructure

There is unlikely to be a significant impact from private sewerage infrastructure although this is very hard to quantify at this stage given the lack of available information and the pathway through groundwaters.

There are currently no private pumping stations close to the bathing water, with the one remaining private pumping station having been transferred during the recent changeover. The EA consented discharges database does not highlight any private sewage discharge in the immediate vicinity of the bathing water.

Historic Bathing Water Investigations

A study into the efficacy of extending the current SWS outfall (TR399679) at Broadstairs was commissioned by Southern Water and carried out by Black and Veatch. This study found that: "An analysis of historical bathing water sampling data indicates that the Good and Excellent standards are not achieved even in dry weather when there should be no impact from the Viking Bay surface water outfall. This suggests that background levels of pollution in the bathing waters are high so it is not possible to ensure future compliance with the Excellent standard, irrespective of the outfall design".

Other analysis from Ann Saunders (Southern Water Bathing Water Technical Expert) has shown:

- Analysis shows a strong seasonal bias which indicates that increases in population due to holidaymakers or changes to beach use may have a significant impact on bathing water quality;
- Previous EA reports have mentioned a 'massive' accumulation of seaweed at the sampling point. This may have an impact on the bathing water as seaweed prolongs the length of time that the indicator species can survive on the beach;
- Toilets on the beach are frequently a source of contamination and would be worth investigating. Information provided by the public at an open meeting on 6th December 2004 suggested that toilets in High Street flooded regularly during the summer.

There have also been multiple investigations undertaken by the Environment Agency at Broadstairs Viking Bay. These have concluded:

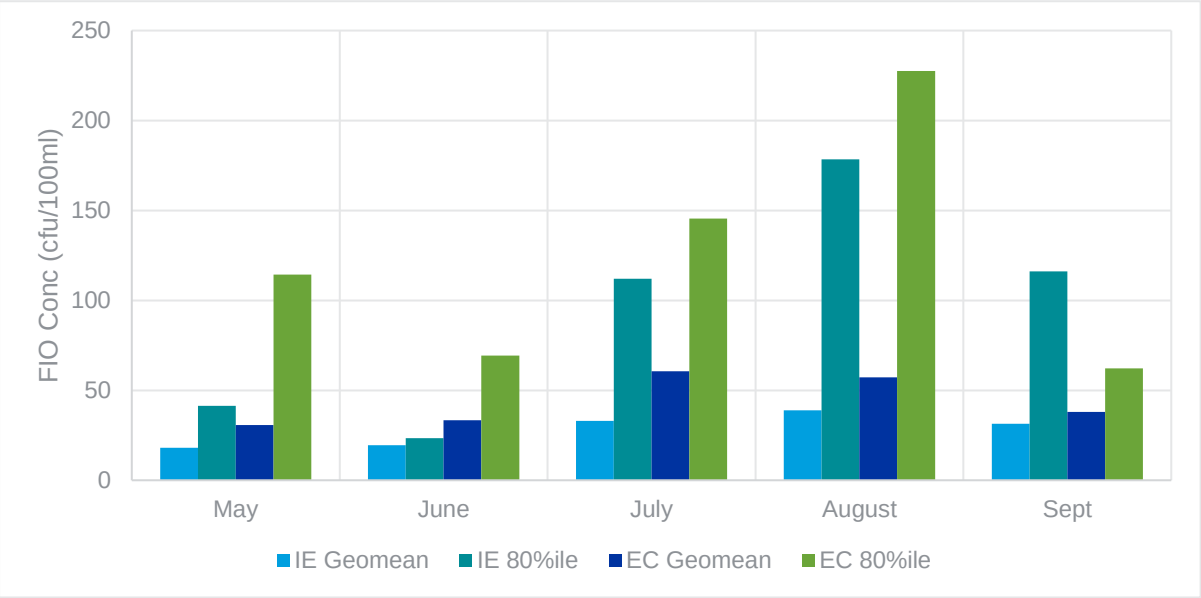
- This bathing water failed standards in 1996 and investigations identified and repaired two areas of collapsed and silted up foul sewer in Harbour Street.
- Following a failure in 2004, a series of investigations were carried out between 2004 and 2007 and more recently in 2015.
- Many potential sources of contamination were investigated which pointed to the fact that the surface water outfall is the source of contamination, although levels of contamination are comparable with other similar systems.
- It is likely that diffuse sources typical of an urban catchment all contribute to the contamination. Measures to reduce contamination in the surface water system are on-going.

Bathing Water Analysis

Correlations with Seasonality

Studies show there is a general increase in E.Coli and IE results throughout the summer peaking in late August. This may be due to increased population during the school summer holidays. Figure 14 below shows the monthly average results at Viking Bay, Broadstairs.

Figure 14 – Monthly Seasonality at Viking Bay, Broadstairs



Correlations with Rainfall

Table 10 shows the exceedance events recorded for the five bathing seasons 2013-2017. The exceedance values being shaded. Red text identifies samples where no rainfall data has been identified.

Table 10 – Exceedance Event Previous Rainfall

Event Date/Time	Previous 72 hours Rainfall (mm)	Viking Bay BW	
		E.Coli	IE
08/07/2013 14:50	0.0	220	310
24/07/2013 13:20	13.0	4200	800
08/09/2013 12:35	2.8	136	230
27/07/2014 12:41	0.0	670	630
12/08/2014 12:01	11.2	300	300
28/08/2014 14:18	27.6	230	230
09/09/2014 12:16	0.0	520	590
22/09/2014 12:37	0.8	530	270
05/05/2015 13:10	17.4	270	145
03/06/2015 12:37	0.4	760	1200
06/07/2015 10:55	23.4	173	136
27/08/2015 15:15	21.0	520	182
18/09/2015 11:33	27.4	36	127
02/06/2016 10:15	8.2	2800	2500
24/06/2016 13:28	25.6	220	115

10/08/2017 11:04	21.4	218	164
20/08/2017 14:08	1.2	400	250
05/09/2017 12:46	3.4	290	210

This data shows that of the 18 exceedance events between 2013 and 2017, 45% of these events occurred after periods of moderate to heavy rainfall (>5mm in 72 hours). A slight majority of exceedance events (55%) therefore occurred after periods of little to no rainfall (<5mm in 72 hours) however this analysis is insufficient to neither exclude nor conclude that rainfall is a significant influence in bathing water quality results at Broadstairs Viking Bay.

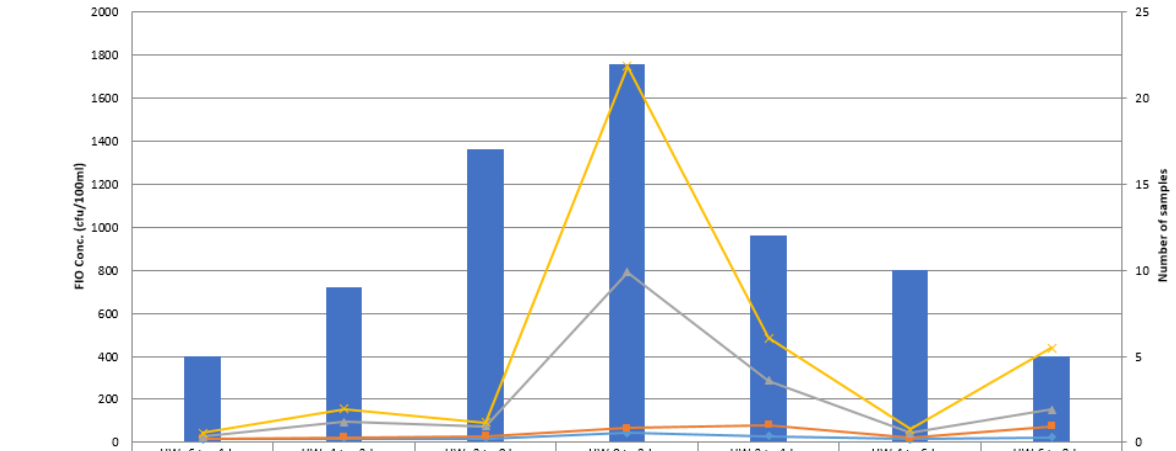
Correlations with Tide

Tidal data has been calculated from tidal constituents at Dover Harbour. HW Slack at Viking Bay occurs approximately two hours before HW at Dover. LW Slack occurs approximately four to five hours after HW. The tidal direction during the flood tide is towards the east.

Correlations with Tide Phase (Direction)

Analysis of bathing water quality results against high water (HW) times may indicate the direction from which pollution has travelled and therefore the location of its source. Figure 15 shows bathing water quality results against the time relative to HW.

Figure 15 – Bathing Water Quality Against Time Since High Tide



	HW -6 to -4 hrs Flood	HW -4 to -2 hrs Flood	HW -2 to 0 hrs HW Slack	HW 0 to 2 hrs Ebb	HW 2 to 4 hrs Ebb	HW 4 to 6 hrs LW Slack	HW 6 to 8 hrs Flood
No. of samples	5	9	17	22	12	10	5
Geomean IE	13.72	18.96	17.29	43.33	29.69	15.82	23.08
Geomean E.Coli	17.45	25.02	28.09	66.28	81.98	22.09	75.87
95%ile IE	25.20	96.00	76.60	791.50	288.00	45.00	152.80
95%ile E.Coli	43.20	154.60	92.80	1748.00	486.00	59.95	439.60

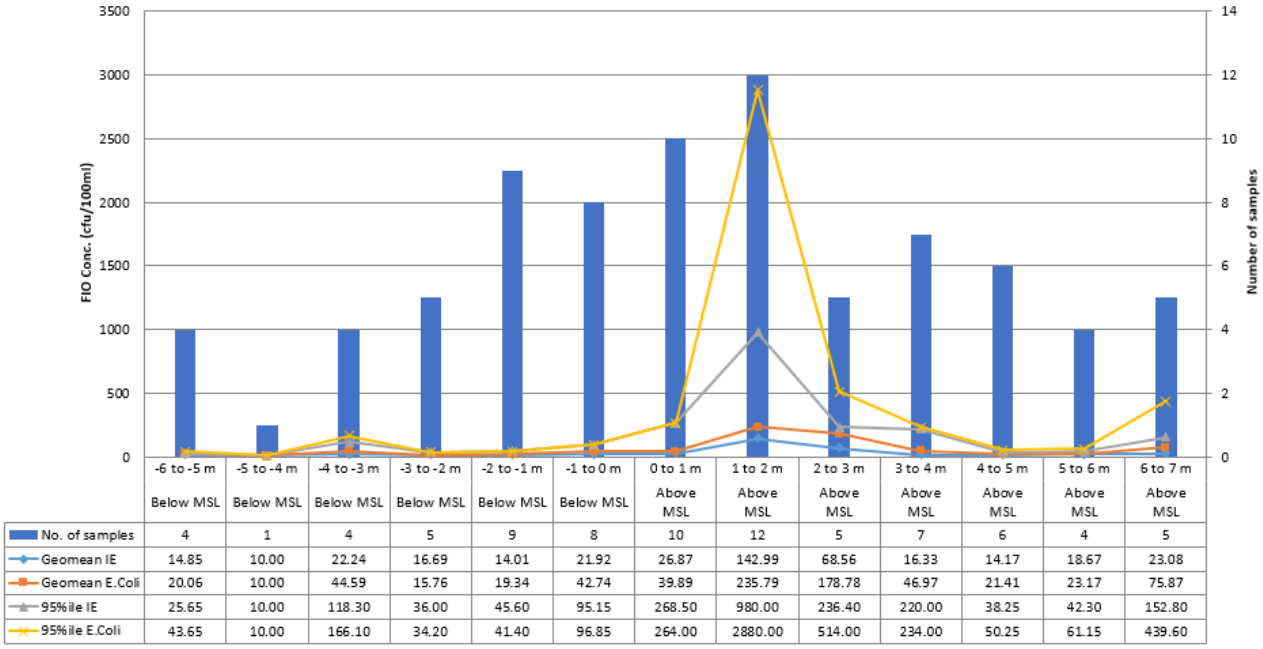
Samples were obtained from 5 hours before high tide to 7 hours after high tide. Samples taken more than 2 hours before high tide have been considered to occur during a flood tide (north east to south west) and samples taken up to 4 hours after high tide have been considered to occur on an ebb tide (South West to North East).

Figure 15 shows that between 2011 and 2015 peak 95%ile values for E.Coli and IE occur at HW 0 to 2 hour, just after slack water on the ebb flow. This is not replicated in the Geomean values. This suggests a key source impacting bathing water quality is localised. It should be noted however that bathing water exceedances occur across nearly all phases of the tide.

Correlations with Tide Level

Further analysis of bathing water quality results against tide level may provide an indication of problems with exfiltration from the foul sewer systems or problems with discharges from outfalls with flap valves.

Figure 16 – Bathing Water Quality Against Tide Levels



	-6 to -5 m Below MSL	-5 to -4 m Below MSL	-4 to -3 m Below MSL	-3 to -2 m Below MSL	-2 to -1 m Below MSL	-1 to 0 m Below MSL	0 to 1 m Above MSL	1 to 2 m Above MSL	2 to 3 m Above MSL	3 to 4 m Above MSL	4 to 5 m Above MSL	5 to 6 m Above MSL	6 to 7 m Above MSL
No. of samples	4	1	4	5	9	8	10	12	5	7	6	4	5
Geomean IE	14.85	10.00	22.24	16.69	14.01	21.92	26.87	142.99	68.56	16.33	14.17	18.67	23.08
Geomean E.Coli	20.06	10.00	44.59	15.76	19.34	42.74	39.89	235.79	178.78	46.97	21.41	23.17	75.87
95%ile IE	25.65	10.00	118.30	36.00	45.60	95.15	268.50	980.00	236.40	220.00	38.25	42.30	152.80
95%ile E.Coli	43.65	10.00	166.10	34.20	41.40	96.85	264.00	2880.00	514.00	234.00	50.25	61.15	439.60

Increasing E.Coli / IE ratios suggesting a human source which has a greater impact at after HW slack.

Likely Sources Impacting the Bathing Water

Table 11 shows the likely sources impacting the bathing water with regards to risk as a factor of likelihood and severity.

Table 11 – Key Sources Likely to be Impacting the Bathing Water

Source	Pathway	Risk	Justification
Dog Faeces	Direct to bathing water	Low – Med	The impact from dogs are common issues at every bathing water site. Dogs are banned from the beach between 1st May and 30th September.
Bird Faeces	Direct to bathing water	Low – Med	The impact from birds are common issues at most bathing water sites.
Thanet Road CSO	Sewer network	Low	The CSO only spills approx. twice per bathing season which is the guideline standard for Excellent bathing water quality
Broadstairs CSO / CEO	Direct to bathing water	Low	Broadstairs LSO is designed to protect bathing water compliance and there are no spills on average during the bathing season from the SSO.
Private Septic Tanks	Groundwater	Low – Med	Private septic tanks have the potential to spill/leak and impact bathing water quality
Surface Water Misconnections	Direct to bathing water	Med	Surface water outfalls, if polluted, may have the ability to impact bathing water quality. Previous water quality sampling has shown the SW outfall is contaminated although no misconnections were identified.
Foul Exfiltration	Groundwater	Med	0.4km of high risk sewers near to the bathing water have been identified as having the potential to impact the water quality. Exfiltration from the foul / combined network represents one of the few possible sources which could have the localised impact witnessed at Viking Bay.

Defining Likely Solutions

Based on the sources outlined in the previous section the following solutions have been defined and costed.

Table 12 – Solution Costing

	Cost (£)	Justification
Investigation Costs		
Analysis (Desktop)	34,000	Allowance based on AMP6 costs for little known sites
Ammonia Sondes	-	Not required
Asset Surveys	15,000	Allowance based on AMP6 costs
Catchment Flyovers	-	Not required
Coastal Modelling	5,000	Allowance for tidal excursion checks
Connectivity Survey	7,500	Allowance based on AMP6 costs
CCTV	15,000	Allowance based on AMP6 costs
Hydraulic Modelling	-	Not required
LSO / SSO Survey	-	Not required
Misconnections (to outfall)	-	Not required (previously sampled)
River Walkover	-	Not required
WQ Sampling	28,000	1 summers sampling
Solution Appraisal	15,000	Allowance for solution appraisal
Investigation Overhead	55,392	Contingency, project management, and overhead
Investigation Costs with SW Markup	**174,892**	
Delivery Phase Costs		
Additional WQ Sampling	112,000	4 summers sampling
Hydraulic Modelling & Flow Surveys	-	Not required
Misconnections (to property)	49,363	Based on unit rate for 1490 properties
Agricultural Measures	-	Not required
Bird and Dog Measures	20,000	Allowance to mitigate impact from dogs, birds and litter
Misconnection Rectification	157,854	Allowance based on AMP6 Hastings Costs
Sewer Rehab	23,620	Prices from CET based on lengths of Risk Scored Sewers
Enhanced Network Maintenance	9,134	Prices from CET based on lengths of Risk Scored Sewers
WPS / CSO Storage	-	Not required
WPS Refurb	155,665	Prices from CET
Private Infrastructure Allowance	70,000	Allowance for private infrastructure

WTW Upgrades	-	Not required
LSO / SSO Survey	-	Not required
Optioneering and Design	26,176	6% Allowance
Delivery Overhead	631,150	Contingency, project management, and overhead
Delivery Costs	**1,254,962**	
Total Project Cost (P50)	**1,429,854**	

Deliverability

Based on the information known about the bathing water to date the following comments can be made surrounding the confidence of delivery and an appropriate target standard.

Table 13 – Confidence in Deliverability

	Level	Comments
Confidence of Source	Medium to High	Whilst a particular source has not been identified there are only a few possible sources of pollution which could impact Viking Bay
Confidence of Delivery	High	All potential sources could be addressed within the project timescales and are within the control of Southern Water
Confidence of Outcome	High	The limited number of sources and localised nature of the pollution would give a high confidence in delivering the outcome
Confidence of Costs	High	Whilst costs cannot be fixed there is a high degree in confidence that all works will not exceed £2m due to the limited area involved and the number of sources.
Appropriate Target Standard	Excellent Status	May be appropriate for a PR19 scheme looking to improve bathing water quality to Excellent status

Littlestone

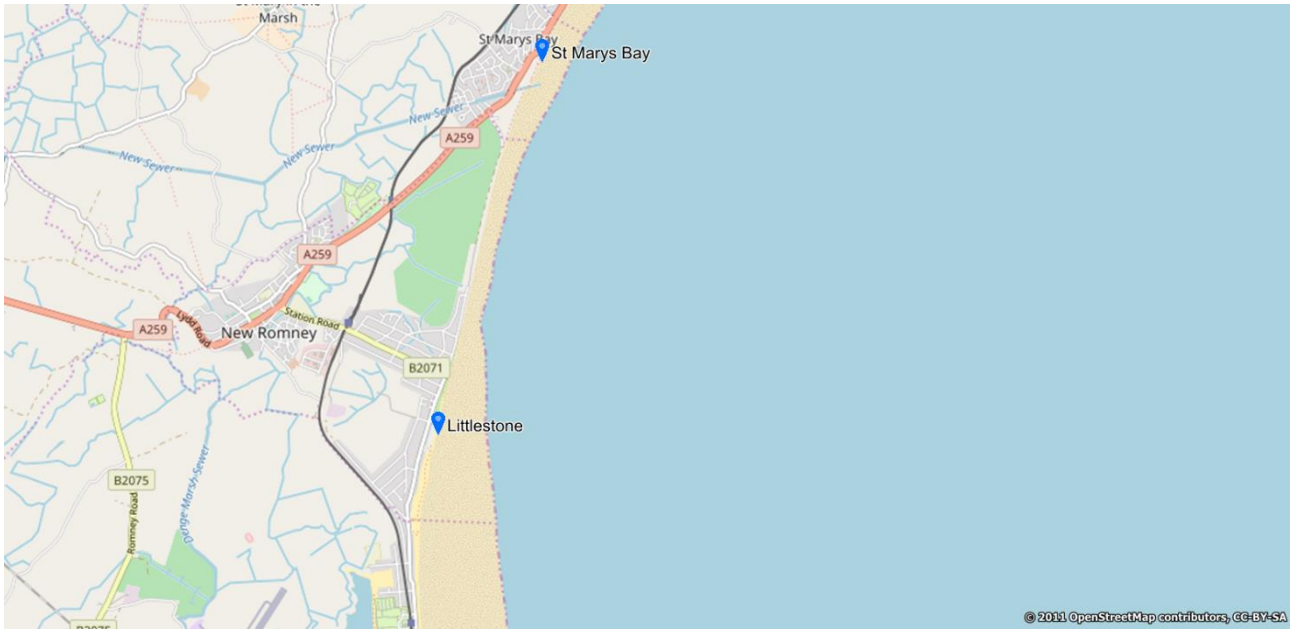
Background

Littlestone is a resort beach in the middle of a 20 kilometre stretch of beach in Hythe Bay, Kent. Hythe Bay stretches from Folkestone to the headland of Dungeness. The bathing water is a steeply shelved shingle bank with sand dunes at the southern edge. Wide shallow sand and mud flats are exposed at low tide, resulting in long distances to the sea. Fine sediments suspended in the water column leave the bathing water cloudy at times.

The drainage catchment surrounding the bathing water is part of the Romney Marsh, a large network of drainage ditches that includes the towns of New Romney, Littlestone-on-Sea and Greatstone-on-Sea. The New Romney Main Sewer drains through the marsh land and into the sea through an outfall pipe located to the north of the bathing water. The Littlestone Sewer, a 1 km long drainage ditch which receives effluent from New Romney WTW, discharges onto the beach via an outfall pipe 200 metres south of the bathing water sampling point.

Figure 17 below shows location of Littlestone Bathing Waters Sampling Point.

Figure 17 – Location of Bathing Water Sample Point



There is an ongoing bathing water enhancement scheme at Littlestone, looking at low-cost measures which may make an improvement to existing bathing water quality. This should be in place for the 2019 bathing season.

Bathing Water Quality

Table 8 below shows the annual and official four year rolling classifications at the bathing water.

Table 14 – Historic Bathing Water Quality Classifications

	2013	2014	2015	2016	2017
Annual	Sufficient	Sufficient	Good	Poor	Good
Official	Sufficient	Sufficient	Sufficient	Sufficient	Good

Bathing Water quality at Littlestone consistency falls below Good status for both the annual and four year rolling assessments.

Figure 11 below shows the 95%ile annual trending quality of the bathing water quality over the last five years.

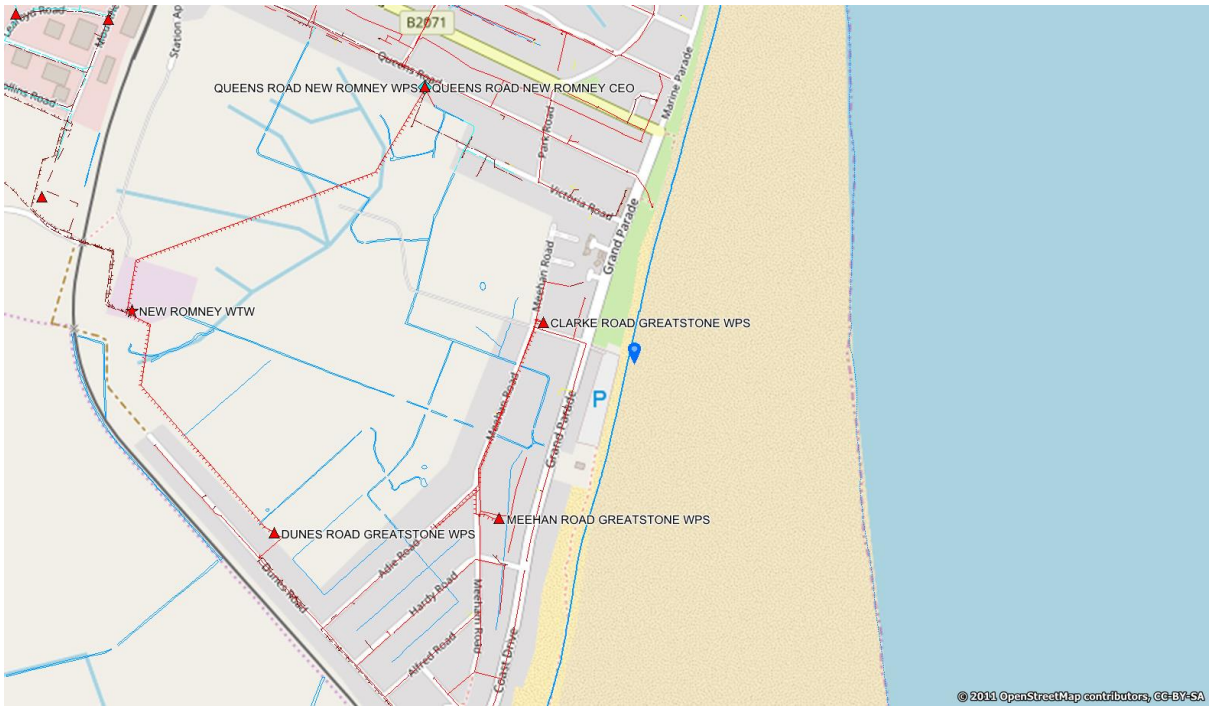
Figure 18 – Historic Bathing Water Quality Trends

There would appear to be a slight overall improvement in water quality at Littlestone over the previous years although this is offset by a Poor year in 2016. Southern Water and the Environment Agency has undertaken a number of small scale measures in the last few years, including sewer jetting and CCTV and manure management at a Stud Farm, which may explain this apparent improvement.

Catchment Features

A brief desktop assessment has identified some key features and potential sources of the bathing water sampling results. This is shown figure 19.

Figure 19 – Catchment Features



The Littlestone Sewer discharges onto the beach via an outfall pipe 200 metres south of the bathing water sampling point. The New Romney WTW discharges into the head of the Littlestone Sewer. There are no other surface water outfalls discharging to coast.

Southern Water Assets

Continuous / Intermittent Discharges

Table 15 details the Southern Water continuous and intermittent assets which may impact the bathing waters. Environment Agency guidance on spill frequency from these assets are as follows:

Storm overflows that discharge directly into or impact on bathing waters with a target of good or sufficient status, must have no more than 3 significant spills per bathing season on average. Where more than one discharge affects the bathing water, you must aggregate the spills. The aggregated spills must be no more than 3 significant spills on average per bathing season. For storm overflows that discharge to bathing waters with a target of excellent status, the emission standard is for no more than 2 significant spills per bathing season on average. Whether a spill is significant will be considered on a site-specific basis. In general, for design purposes, a spill greater than 50m^3 is significant.

Table 15 – Continuous / Intermittent Discharges

Asset Name	Asset Type	Treatment Type	Annual Average Bathing Season Spill Frequency
New Romney WTW	WTW	Tertiary (UV Disinfection)	N/A
New Romney WTW Storm Tanks	SST	N/A	0.3[15]
Queens Road New Romney WPS	CSO	N/A	0.4[16]

Surface Water Network

There are two surface water outfalls which discharge to drainage ditches leading to the Littlestone Sewer. During the summer months these ditches are usually dry and there is no pathway to the bathing water.

Both of these outfalls were caged during the AMP6 BWEP scheme at Littlestone and confirmed as clean and having no misconnections

Combined Sewerage Network

The integrity of the foul / combined sewerage network can have a significant impact on bathing water quality. The Southern Water Risk Scored Sewers (RSS) database shows 1.76 km of grades 5, 6 and 7 sewers which may be impacting the bathing water.

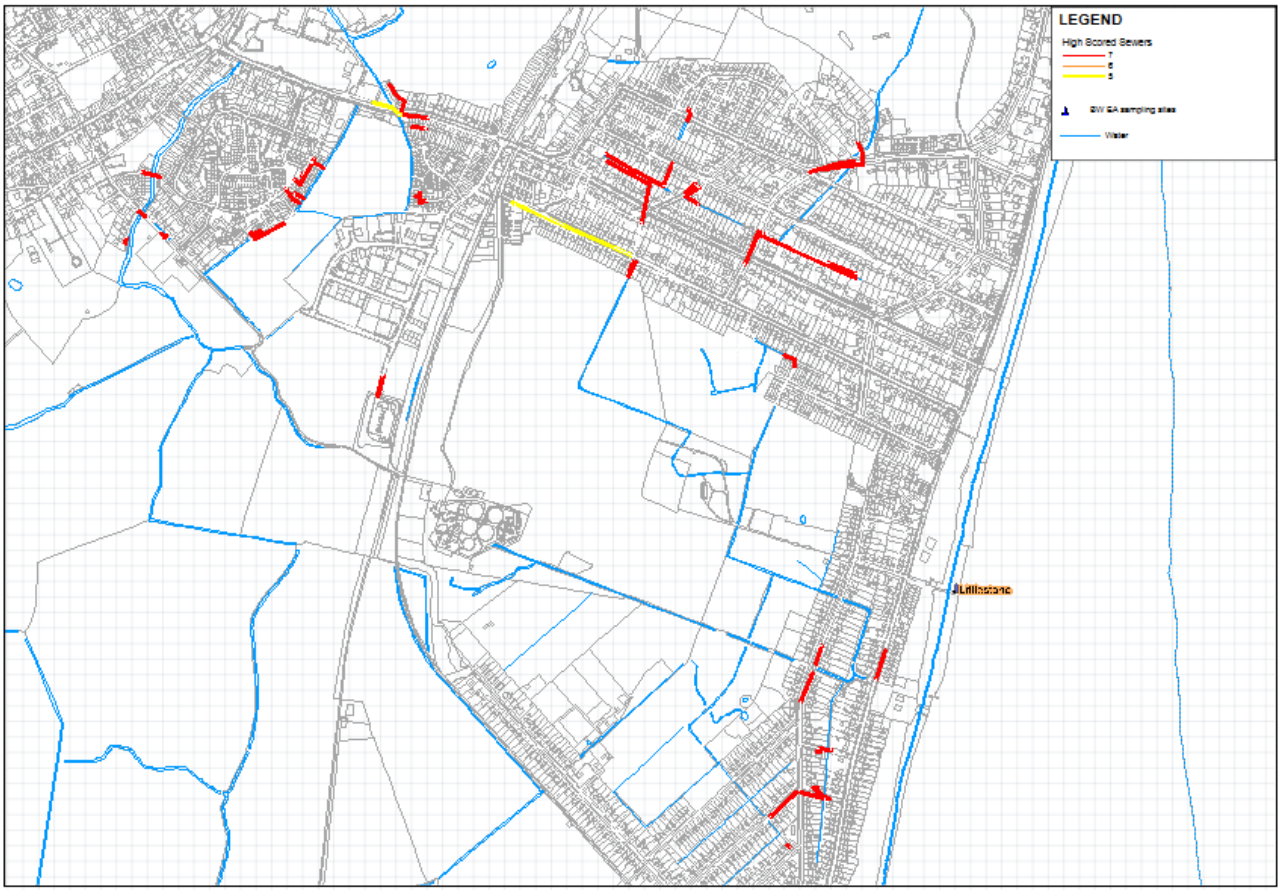
The RSS database is an internal Southern Water system of grading pipes based on structural integrity, frequency of inspections and maintenance and criticality. Scores are from 1 to 7 with 7 being the highest risk sewers.

Surveys undertaken as part of the AMP6 BWEP scheme identified several breaks and fractures of the pipeline along Madeira and St Andrews Road. This is not being addressed within the scope of delivery works for the 2019 bathing season.

It should also be noted that there may be a number of WPS in the Littlestone area which are likely to have insufficient emergency DWF storage provision in the event of the failure. This issue will need to be addressed as part of any AMP7 scheme to mitigate the impact from mechanical failures across the network.

[15] Based on modelled spill frequencies
[16] Based on reported EDM data between 2012 and 2016

Figure 20 – Risk Scored Sewers Grade 5-7



Agricultural Diffuse

Agricultural diffuse pollution in the form of the storage or spreading of slurries and manures, or the keeping of grazing of livestock has the potential to contribute to reductions in bathing water quality. This can be from the direct excretion of waste from livestock or polluted runoff after rainfall.

Potential issues with agricultural diffuse pollution at Littlestone are currently being investigated and addressed as part of the AMP6 BWEP scheme in time for the 2019 bathing season.

As part of this surveys evidenced Ruminant Bacteroidetes (2.84 lgN/0.1l) and low levels of Horse mitochondria (2.09 lgN/0.1l) in one of four samples which exceeded the threshold standards for MST testing.

Urban and Coastal Diffuse

Faecal waste from dogs and birds, as well as polluted urban runoff, and sewage discharges from boats or houseboats have the potential to contribute to reductions in bathing water quality.

The impact from dogs and birds are common issues at most bathing water sites. At Littlestone there are dog restrictions are in place during the bathing season.

Three coastal samples, taken on 20/06/2016, 28/07/2016 and 24/08/2016 didn't reveal any evidence of dog faeces. Surveys evidenced Seabird mitochondria (average 4.82 lgN/0.1l) in two of four samples which exceeded the threshold standards for MST testing.

Measures to reduce urban and coastal diffuse pollution from birds, dogs and litter are being implemented as part of the AMP6 BWEP scheme in time for the 2019 bathing season.

Private Sewerage Infrastructure

There is likely to be a significant impact from private sewerage infrastructure although this is very hard to quantify at this stage given the lack of available information and the pathway through groundwaters.

Previous surveys have confirmed that a large number of properties (33%) did not connect to the first-time sewerage scheme in Littlestone in 2007 meaning many properties are still served by privately owned septic tanks and cess pits of unknown condition. Of particular concern is the septic tank owned by the Sea Cadets, less than 30m away from the bathing water sample location. Actions are currently ongoing this AMP as part of the BWEP scheme to try and quantify and mitigate the impact of this asset.

There have been no private sewage pumping stations identified during the private pumping station transfer and the EA consented discharges database does not highlight any private sewage discharge in the immediate vicinity of the bathing water.

Historic Bathing Water Investigations

There have been previous SWS bathing water investigations carried out at this bathing water which are detailed below:

- New Romney and Littlestone Water Quality (2017)
- Littlestone BWEP Technical Appraisal v4 (2017)
- Littlestone NEP Bathing Water Final Report (2016)

These reports concluded that:

- Post UV samples at New Romney WTW have shown faecal streptococci (intestinal enterococci) concentrations above the permit concentration. The source of this contamination is unclear.
- The effluent from new Romney WTW typically dilutes the concentration of faecal indicator organisms in the Littlestone Sewer between 30 and 130 times. Surveys have shown that contamination enters the watercourse around Meehan Road.
- The microbial source tracking study showed that seabirds and humans contribute to contamination at the bathing water sampling point. The seabird marker was present in all samples.
- Approximately 67% of properties in the catchment are connected to the Southern Water network. A number of commercial properties also rely on cess pits and septic tanks. Surveys have found a 'hot spot' of contamination around Greatstone, which may be the result of un-sewered properties.
- The CCTV surveys in areas requested by the EA showed that the condition of the Southern Water sewerage system is good and that there are no areas identified where exfiltration or operational issues could be impacting on the bathing water quality.
- Levels and the pumping regime in the Littlestone Sewer affect water quality in the watercourse. When levels rise in the sewer, then the typical increase in concentrations from the outfall to Greatstone Pumping Station is sometimes reversed. However, initial analyses do not show that this impacts on high concentration samples taken at the Post-UV sample point.

There have also been multiple investigations undertaken by the Environment Agency over the last 20 years at Littlestone. The conclusions of these are detailed below:

- Regular occurrences of reduced water quality triggered a series of Environment Agency investigations into the sources of contamination in Littlestone from 1999 onwards.

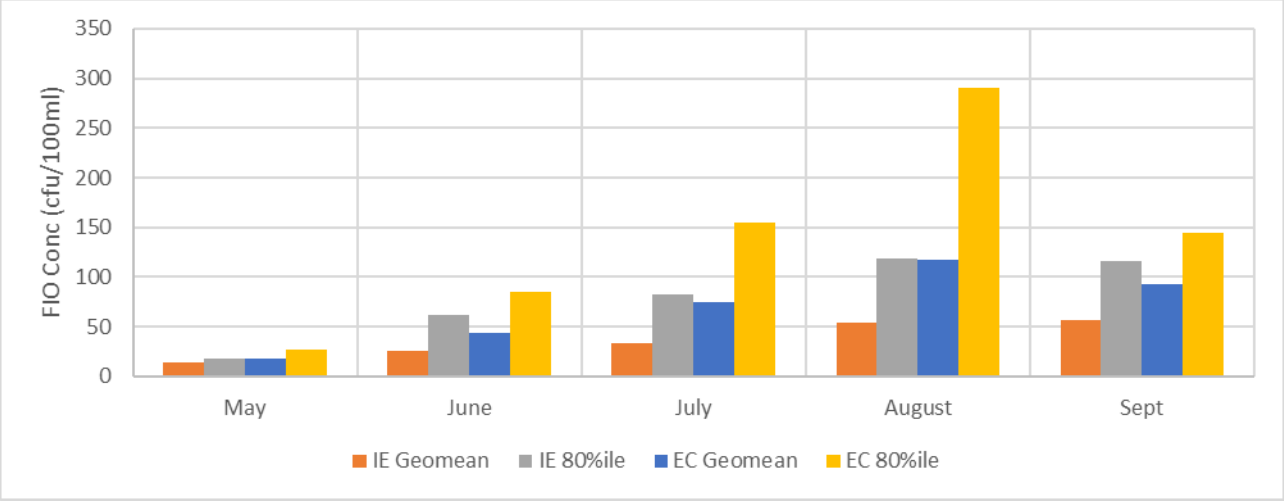
- Some exceedances have been attributed to storm overflow discharges and contamination from marsh drains.
- The reason for the frequent exceedance of guideline standards, which occur particularly during the holiday season, has not yet been identified.
- There is a drainage ditch, which receives the effluent from New Romney sewage treatment works and discharges onto the beach in regular intervals.
- Diffuse agricultural pollution from the marsh drainage may also affect bathing water quality.
- There also is a high number of private sewerage systems in place especially towards Greatstone.

Bathing Water Analysis

Correlations with Seasonality

Analysis shows there is a general increase in E. coli and IE results throughout the summer peaking in late August. This may be due to increased population during the school summer holidays. Figure 21 below shows the monthly average results at Littlestone.

Figure 21 – Monthly Seasonality at Littlestone



Correlations with Rainfall

The following table shows the exceedance events recorded for the five bathing seasons 2013-2017.

Table 16 – Exceedance Event Previous Rainfall

Event Date/Time	Previous 72 hours Rainfall (mm)	Littlestone BW	
		E.coli	IE
29/07/2013 15:31	15.4	400	109
05/08/2013 10:03	0.0	320	370
11/08/2013 11:57	0.4	280	91
22/08/2013 11:56	3.2	136	118
28/08/2013 16:00	0.0	290	55
18/09/2013 10:49	12.4	1200	64
27/07/2014 11:51	0.2	1173	18
27/08/2014 12:40	40.2	680	210
08/09/2014 11:39	0.0	300	100

17/05/2015 11:10	13.0	27	109
31/05/2015 10:55	17.8	91	164
15/06/2015 11:00	11.0	340	82
12/08/2015 10:56	4.0	530	290
28/08/2015 11:00	27.4	420	109
20/06/2016 12:28	14.2	173	360
24/07/2016 13:32	0.0	155	136
24/08/2016 14:30	0.4	290	73
30/08/2016 11:11	0.0	155	173
08/09/2016 14:09	0.0	164	182
14/09/2016 10:20	0.0	310	145
12/06/2017 14:11	0.0	27	109
21/07/2017 11:32	0.4	350	73
05/09/2017 11:14	5.4	145	127

This data shows that of the 30 exceedance events between 2013 and 2017, 40% of these events occurred after periods of moderate to heavy rainfall (>5mm in 72 hours). The other 60% of exceedance events therefore occurred after periods of little to no rainfall (<5mm in 72 hours).

This neither excludes nor concludes that rainfall is a significant influence in bathing water quality results at Littlestone.

Previous studies undertaken as part of the AMP6 BWEP scheme have shown of the 23 exceedance events between 2011 and 2015, only 30% of these events occurred after periods of moderate to heavy rainfall (>5mm in 72 hours). The majority of exceedance events (70%) therefore occurred after periods of little to no rainfall (<5mm in 72 hours) indicating rainfall is not a significant influence in bathing water quality results at Littlestone.

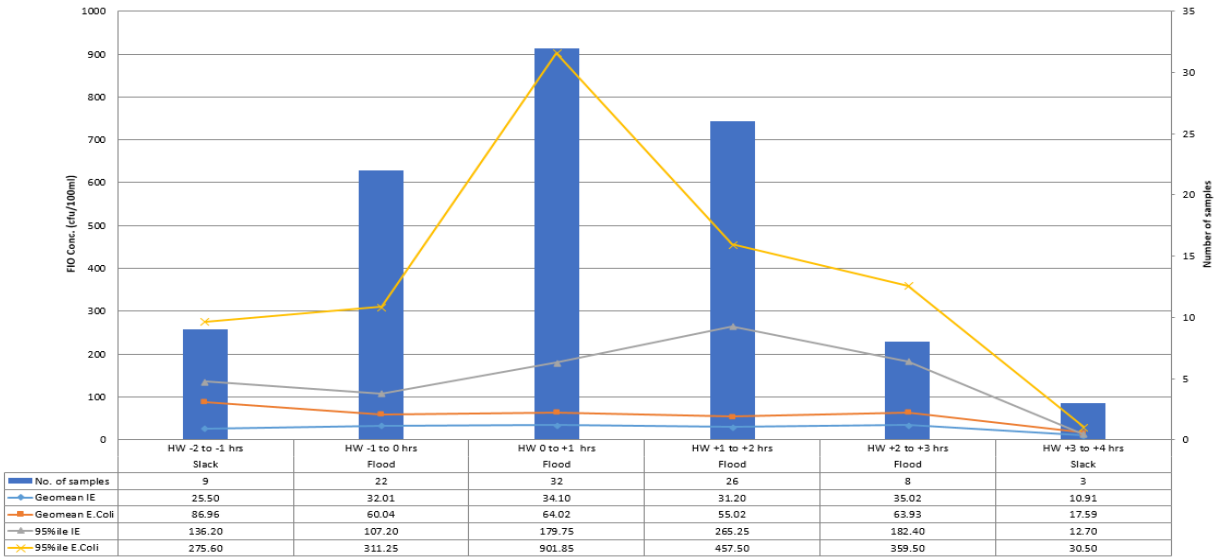
Correlations with Tide

Tidal data has been calculated from tidal constituents at Dover Harbour. HW Slack at Littlestone occurs approximately two hours before HW at Dover. LW Slack occurs approximately four to five hours after HW. The tidal direction during the flood tide is towards the east.

Correlations with Tide Phase (Direction)

Analysis of bathing water quality results against high water (HW) times may indicate the direction from which pollution has travelled and therefore the location of its source. Figure 22shows bathing water quality results against the time relative to HW.

Figure 22 - Bathing Water Quality Against Time Since High Tide



	HW -2 to -1 hrs Slack	HW -1 to 0 hrs Flood	HW 0 to +1 hrs Flood	HW +1 to +2 hrs Flood	HW +2 to +3 hrs Flood	HW +3 to +4 hrs Slack
No. of samples	9	22	32	26	8	3
Geomean IE	25.50	32.01	34.10	31.20	35.02	10.91
Geomean E.Coli	86.96	60.04	64.02	55.02	63.93	17.59
95%ile IE	136.20	107.20	179.75	265.25	182.40	12.70
95%ile E.Coli	275.60	311.25	901.85	457.50	359.50	30.50

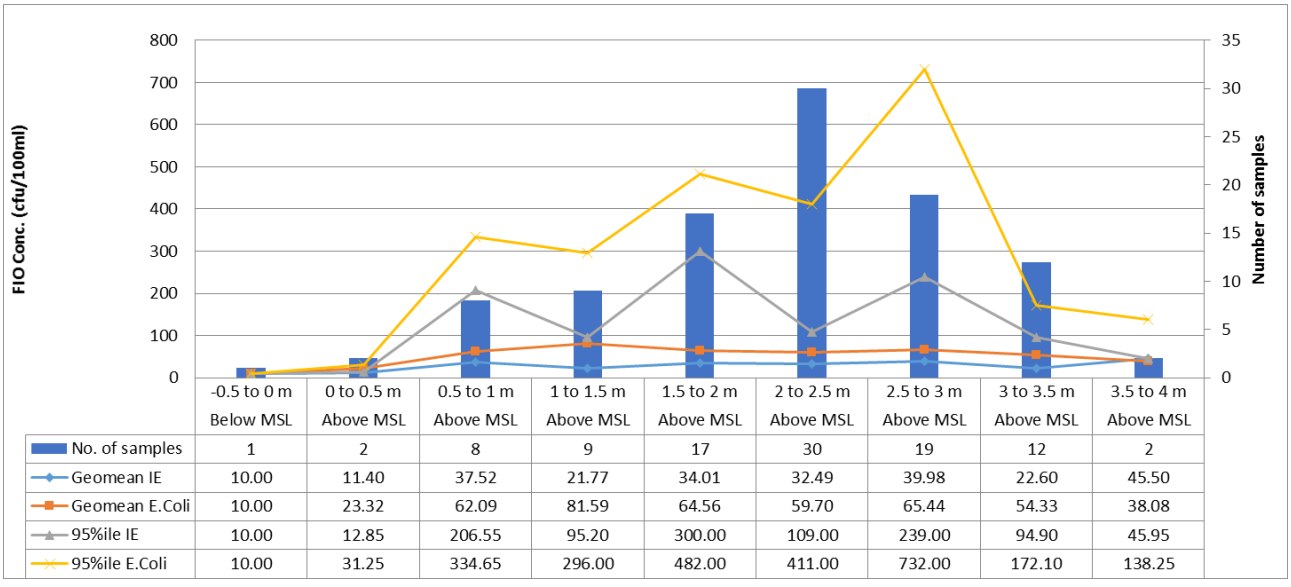
Samples were obtained from 3 hours before high tide to 4 hours after high tide. Samples taken more than 2 hours before high tide have been considered to occur during a flood tide (west to east) and samples taken up to 4 hours after high tide have been considered to occur on an ebb tide (east to west).

Figure 22 shows that between 2011 and 2015 peak 95%ile values for E. coli occur at HW 0 to +1 hours and for IE at HW +1 to +2 hours. This is not replicated in the geomean values. The peak occurring just after HW slack may indicate a localised source of pollution. Bathing water exceedances occur across nearly all phases of the tide with the number exceedance events highest between HW 0 to +2 hours in line with the higher number of samples during this period.

Correlations with Tide Level

Further analysis of bathing water quality results against tide level may provide an indication of problems with exfiltration from the foul sewer systems or problems with discharges from outfalls with poorly functioning (or no) flap valves.

Figure 23 Bathing Water Quality Against Tide Levels



	-0.5 to 0 m Below MSL	0 to 0.5 m Above MSL	0.5 to 1 m Above MSL	1 to 1.5 m Above MSL	1.5 to 2 m Above MSL	2 to 2.5 m Above MSL	2.5 to 3 m Above MSL	3 to 3.5 m Above MSL	3.5 to 4 m Above MSL
No. of samples	1	2	8	9	17	30	19	12	2
Geomean IE	10.00	11.40	37.52	21.77	34.01	32.49	39.98	22.60	45.50
Geomean E.Coli	10.00	23.32	62.09	81.59	64.56	59.70	65.44	54.33	38.08
95%ile IE	10.00	12.85	206.55	95.20	300.00	109.00	239.00	94.90	45.95
95%ile E.Coli	10.00	31.25	334.65	296.00	482.00	411.00	732.00	172.10	138.25

95%ile E. coli results increase to a peak concentration at 2 to 2.5m above Mean Sea Level (MSL). This is not replicated in the geomean values or the IE results. Although far from conclusive these graphs could be indicative of foul exfiltration with increasing E. coli / IE ratios suggesting a human source which has a greater impact at higher tidal levels.

Likely Sources Impacting the Bathing Water

Table 11, below, shows the likely sources impacting the bathing water with regards to risk as a factor of likelihood and severity.

Table 17 – Key Sources Likely to be Impacting the Bathing Water

Source	Pathway	Risk	Justification
Agricultural diffuse pollution	Runoff into the drainage ditches	Low	Agricultural issues being addressed as part of the AMP6 BWEP scheme
Dog Faeces	Direct to bathing water	Low – Med	Agricultural issues being addressed as part of the AMP6 BWEP scheme. Ongoing financial contributions may be required.
Bird Faeces	Direct to bathing water	Low – Med	Agricultural issues being addressed as part of the AMP6 BWEP scheme. Ongoing financial contributions may be required.
Queens Road CSO	Littlestone Sewer	Low	Spill frequency less than guideline standards for Excellent bathing waters
New Romney WTW	Littlestone Sewer	Low	Effluent from the WTW evidenced to dilute the FIO concentrations in the Littlestone Sewer. SST spill frequency is less than guideline standards for Excellent status.
Private Septic Tanks	Groundwater	High	Previous surveys have confirmed that a 33% of properties did not connect to the first-time sewerage scheme in Littlestone in 2007 meaning many properties are still served by privately owned septic tanks and cess pits of unknown condition.
Surface Water Misconnections	Direct to bathing water	Low	No evidence of surface water misconnections.
Foul Exfiltration	Groundwater	Med	1.75km of high risk sewers near to the bathing water have been identified as having the potential to impact the water quality. AMP6 BWEP surveys highlighted issues along Madeira and St Andrews Road.

Defining Likely Solutions

Based on the sources outlined in the previous section the following solutions have been defined and costed.

Table 18 – Solution Costing

	Cost (£)	Justification
Investigation Costs		
Analysis (Desktop)	17,000	Allowance based on AMP6 costs
Ammonia Sondes	30,000	3 sondes for 10 weeks
Asset Surveys	15,000	Allowance for asset surveys
Catchment Flyovers	-	Not required
Coastal Modelling	5,000	Allowance based on AMP6 costs
Connectivity Survey	7,500	Allowance based on AMP6 costs

CCTV	15,000	Allowance based on AMP6 costs
Hydraulic Modelling	-	Not required
LSO / SSO Survey	-	Not required
Misconnections (to outfall)	-	Not required
River Walkover	5,000	Allowance for 5km of walkovers
WQ Sampling	28,000	1 summers sampling
Solution Appraisal	15,000	Allowance for solution appraisal
Investigation Overhead	63,736	Contingency, project management, and overhead
Investigation Costs	**201,236**	
Delivery Phase Costs		
Additional WQ Sampling	112,000	Based on 4 seasons sampling
Hydraulic Modelling & Flow Surveys	-	Not required
Misconnections (to property)	-	Not required
Agricultural Measures	-	Not required
Bird and Dog Measures	20,000	Ongoing allowance to mitigate dog and bird impact
Misconnection Rectification	-	Not required
Sewer Rehab	79,104	No IMP3 scheme so cost from site with similar length of RSS
Enhanced Network Maintenance	11,500	No IMP3 scheme so cost from site with similar length of RSS
WPS / CSO Storage	-	Not required
WPS Refurb	1,279,478	No IMP3 scheme so St Marys Bay costs used (similar site)
Private Infrastructure Allowance	210,000	3x default allowance due to high no. of unsewered properties
WTW Upgrades	-	Not required
LSO / SSO Survey	-	Not required
Optioneering and Design	96,005	6% Allowance
Delivery Overhead	1,829,346	Contingency, project management, and overhead
Delivery Costs	**3,637,433**	
Total Project Cost (P50)	**3,838,669**	

Deliverability

Based on the information known about the bathing water to date the following comments can be made surrounding the confidence of delivery and an appropriate target standard.

Table 19 – Confidence in Deliverability

	Level	Comments
Confidence of Source	High	Multiple investigations and surveys have taken place over several years giving a high degree of confidence in the remaining sources
Confidence of Delivery	Low to Medium	Reliance on co-operation from private sewerage owners. Southern Water have no ability to incentivise connectivity to the sewerage network
Confidence of Outcome	Medium	Outcome reliant on co-operation from private sewerage owners.
Confidence of Costs	Medium	Significant unknowns related to private sewerage infrastructure but there will be no large cost items which haven't been unaccounted for.
Appropriate Target Standard	Good Status	May be appropriate for a PR19 scheme looking to improve bathing water quality to Good status. Issues with deliverability mean a scheme to Excellent status is not realistically possible.

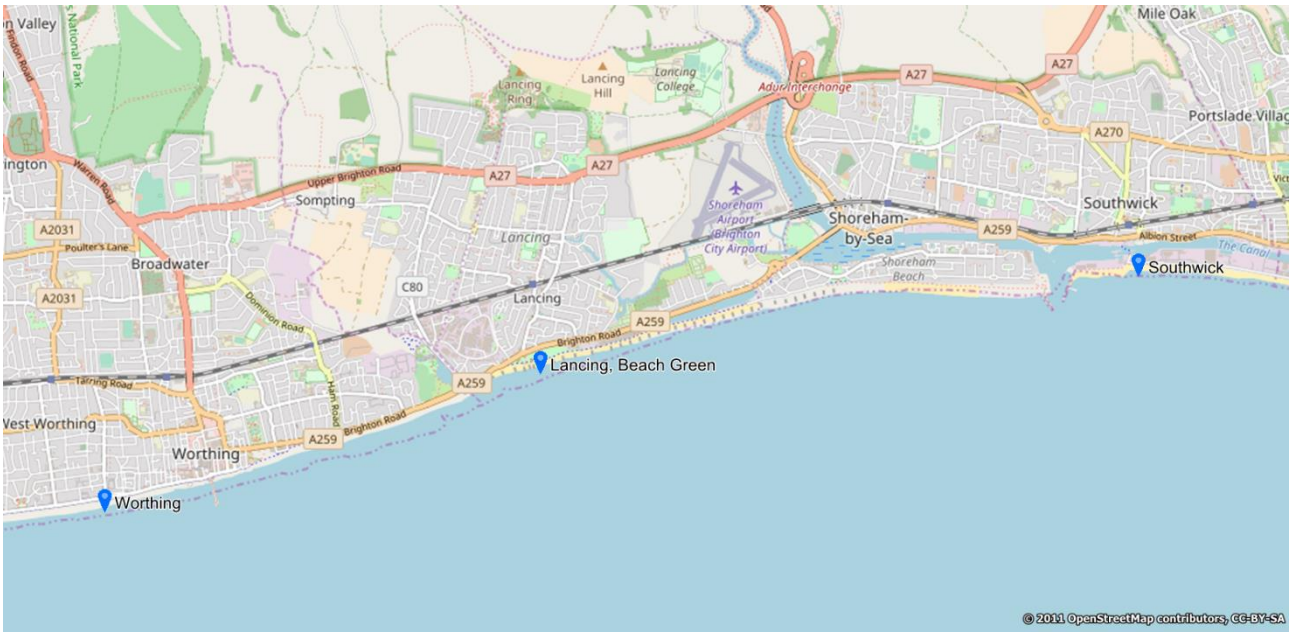
Lancing, Beach Green

Background

The bathing water is situated on the south coast in West Sussex, backed by an urban area. The bathing water is primarily a shingle beach but with gently shelving sand exposed at low water. Wooden groynes and boulder breakwaters protect the beach. Above the bathing water is a line of beach huts with a large grassed area behind.

The bathing water is situated in a low-lying area. The natural drainage (hydrological) catchment into the bathing water is approximately 50 hectares and comprises just the local urban area. There are no streams within the immediate beach vicinity but the entrance to Shoreham Harbour is situated 5 km to the east and the Teville Stream enters the sea nearly a km to the west. The wider surrounding area is predominantly rural (arable and managed grassland) and most drainage in this area either enters the harbour through the River Adur or flows westwards towards the Teville Stream.Figure 24 – Location of Bathing Water Sample Point shows location of Lancing, Beach Green Bathing Water Sampling Point.

Figure 24 – Location of Bathing Water Sample Point



Bathing Water Quality

Table 8 below shows the annual and official four year rolling classifications at the bathing water.

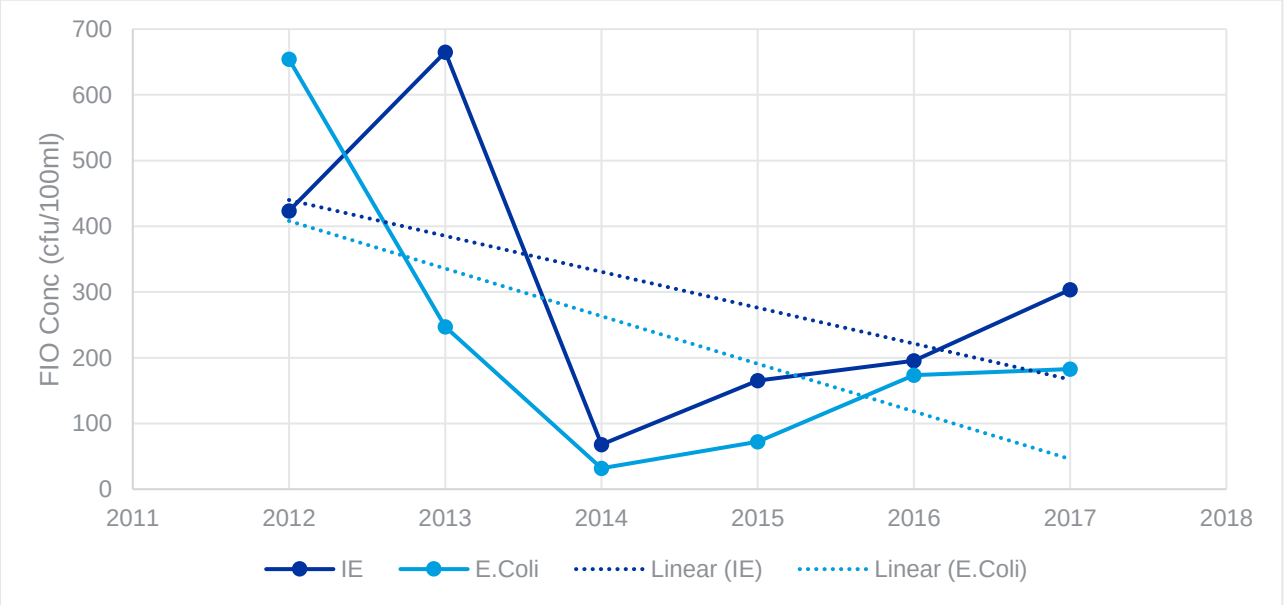
Table 20 – Historic Bathing Water Quality Classifications

	2013	2014	2015	2016	2017
Annual	Poor	Excellent	Good	Good	Sufficient
Official	Poor	Sufficient	Sufficient	Good	Good

Bathing Water quality at Lancing regularly falls below Good status for both the annual and four year rolling assessments.

Figure 11 below shows the 95%ile annual trending quality of the bathing water quality over the last five years.

Figure 25 – Historic Bathing Water Quality Trends

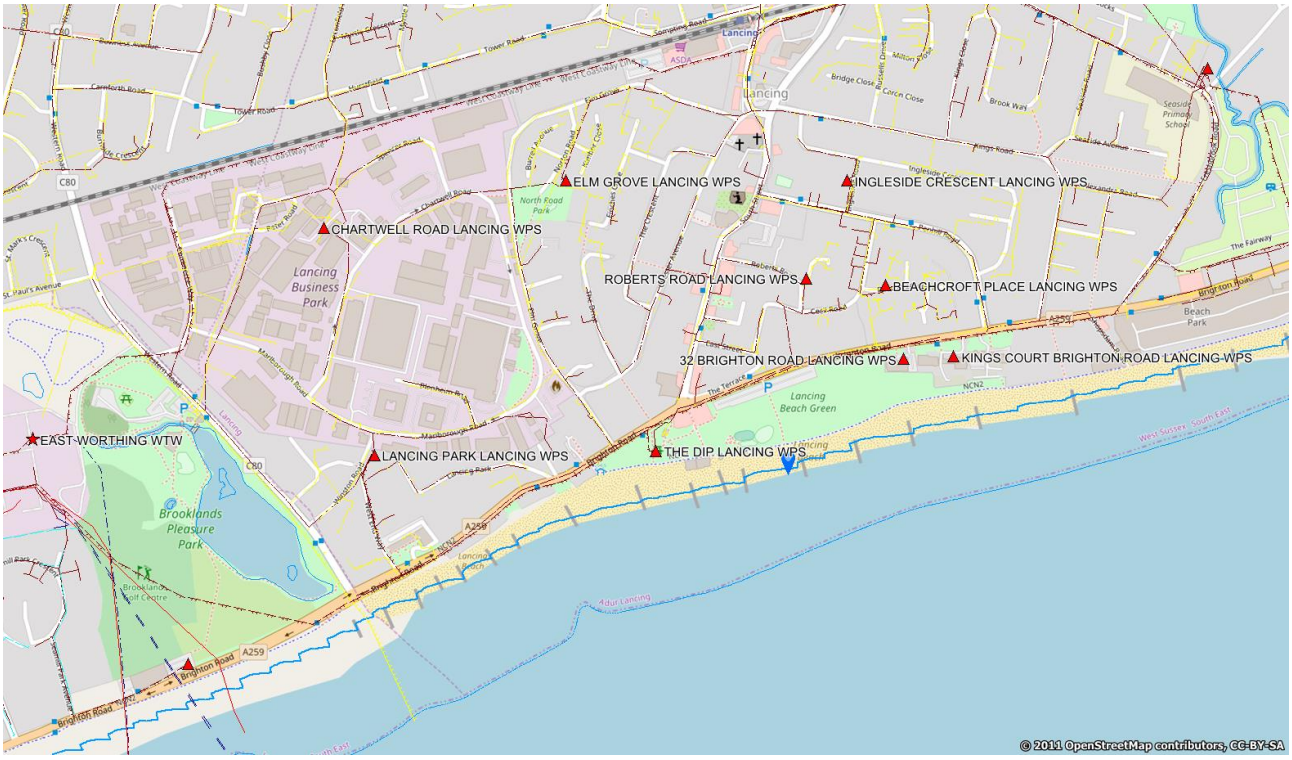


On the whole bathing water quality at Lancing Beach Green has improved significantly since 2013 however from 2015 onwards there has been a relatively consistent deterioration in quality.

Catchment Features

A brief desktop assessment has identified some key features and potential sources of the bathing water sampling results. This is shown in Figure 26

Figure 26 – Catchment Features



The majority of surface water sewerage in Lancing heads west towards Brooklands Park lake and the Teville Stream which discharges to the coast approximately 1 km to the south west of the bathing water sample location. There is only one other outfall along this section of beach which isn't mapped and appears redundant.

There is a short and long sea outfall from East Worthing WTW within several hundred meters to the south west of Brooklands Park lake outfall.

Southern Water Assets

Continuous / Intermittent Discharges

Table 15 details the Southern Water continuous and intermittent assets which may impact the bathing waters. Environment Agency guidance on spill frequency from these assets are as follows:

Storm overflows that discharge directly into or impact on bathing waters with a target of good or sufficient status, must have no more than 3 significant spills per bathing season on average. Where more than one discharge affects the bathing water, you must aggregate the spills. The aggregated spills must be no more than 3 significant spills on average per bathing season. For storm overflows that discharge to bathing waters with a target of excellent status, the emission standard is for no more than 2 significant spills per bathing season on average. Whether a spill is significant will be considered on a site-specific basis. In general, for design purposes, a spill greater than 50m3 is significant.

Table 21 – Continuous / Intermittent Discharges

Asset Name	Asset Type	Treatment Type	Spill Frequency[17]
East Worthing WTW – LSO	WTW	Secondary Treatment	12.4
East Worthing WTW – SSO	WTW SST	Settled Storm	1.0

Southern Water is currently proposing to replace existing pumps and screens at the East Worthing WTW inlet works. All flows from Worthing town centre are served by the Main Trunk Relief Sewer and the Old Main Foul Sewer into the inlet works, are initially screened then pumped to either to treatment / long sea outfall or to the short sea outfall.

East Worthing WTW has experienced longstanding problems with the inlet works. The band screens are exposed to high solids loadings, blind and frequently overtop resulting in unscreened flows reaching the inlet DWF and storm pumps. The inlet DWF and storm pumps suffer from frequent blockages and screenings are passed into the treatment process downstream.

Surface Water Network

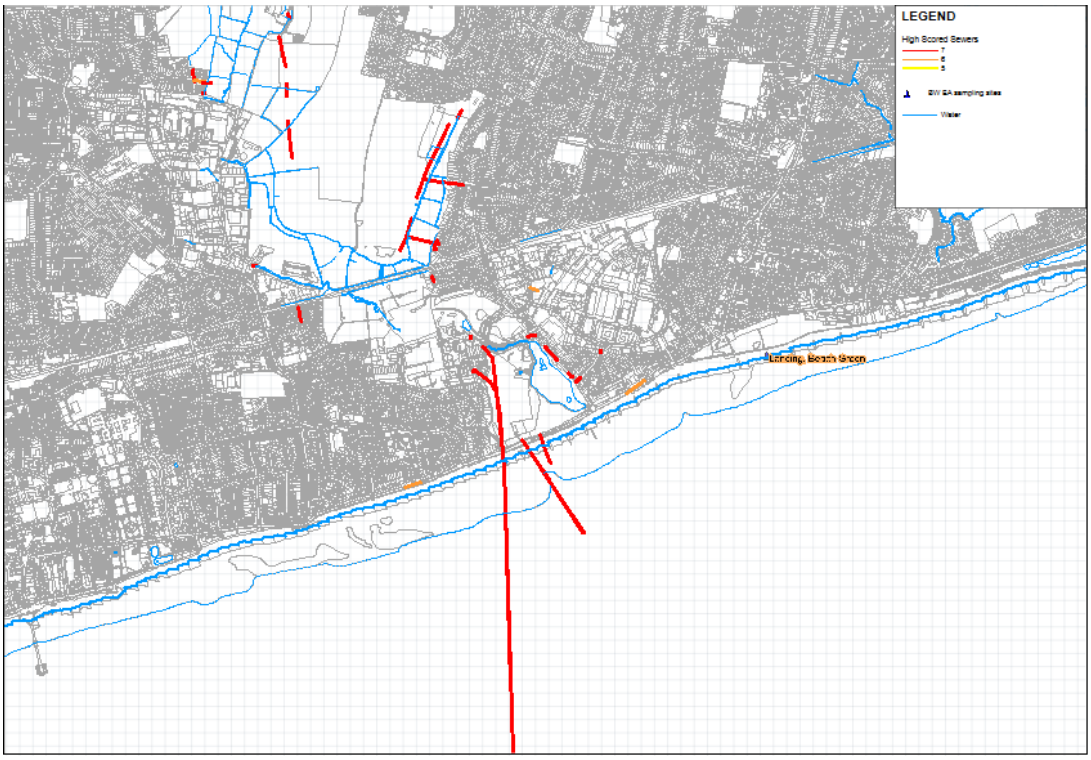
Foul to surface water misconnections can have a significant impact on bathing water quality. 4300 properties and 3 surface water outfalls have been identified which, if polluted, may have the ability to impact bathing water quality.

[17] Average spill frequency per bathing season based on 2012-2016 verified EDM records

Combined Sewerage Network

The integrity of the foul / combined sewerage network can have a significant impact on bathing water quality. The Southern Water Risk Scored Sewers (RSS) database shows 6.4 km of grades 5, 6 and 7 sewers which may be impacting the bathing water.

Figure 27 – Risk Scored Sewers Grade 5-7



The RSS database is an internal Southern Water system of grading pipes based on structural integrity, frequency of inspections and maintenance and criticality. Scores are from 1 to 7 with 7 being the highest risk sewers.

There are no mapped sewers along the seafront at Beach Green although there are café facilities with toilets on the beachfront.

Agricultural Diffuse

Agricultural diffuse pollution in the form of the storage or spreading of slurries and manures, or the keeping of grazing of livestock has the potential to contribute to reductions in bathing water quality. This can be from the direct excretion of waste from livestock or polluted runoff after rainfall.

There is unlikely to be an impact from agricultural diffuse pollution within this bathing water catchment.

Urban and Coastal Diffuse

Faecal waste from dogs and birds, as well as polluted urban runoff, and sewage discharges from boats or houseboats have the potential to contribute to reductions in bathing water quality.

The impact from dogs and birds are common issues at every bathing water site. Dog restrictions are currently unknown for the beach at Lancing.

Private Sewerage Infrastructure

There is likely to be a significant impact from private sewerage infrastructure although this is very hard to quantify at this stage given the lack of available information and the pathway through groundwaters.

There are currently no private pumping stations near the bathing water with one private pumping station having been transferred during the changeover. The EA consented discharges database highlight 6 private sewage discharge in the immediate vicinity of the bathing water. Details of the 6 private consented discharges can be found in Table 22.

Table 22 – Private Consented Discharges

Company Name	Discharge Site	Discharge Type	Discharge NGR
G.f.smith esq.	North barn kennels	TE	TQ1930004600
M.d. Goble, esq.	Minstrels gallery	ZZ	TQ1927004440
Ms k.l. Hay.	Septic tank @ old salts fm nursery	TF	TQ1916004560
Nursing & hygiene supplies	Nursing & hygielne dupplies	ZZ	TQ1588004370
Sibella coneley & sibella pannell	Minstrels gallery, lancing	TE	TQ1929004430
The community stadium limited	Irrigation @ bhfc training ground	TC	TQ1890504948

Historic Bathing Water Investigations

Southern Water has been carrying out a study using microbial source tracking to understand the sources of contamination at various bathing waters within the Southern Water region using Environment Agency laboratory skillsets and expert academic analysis from University of Surrey. Lancing Beach Green is one of these bathing waters. This study, undertaken by Ann Saunders (Southern Water Bathing Water Technical Expert) concluded:

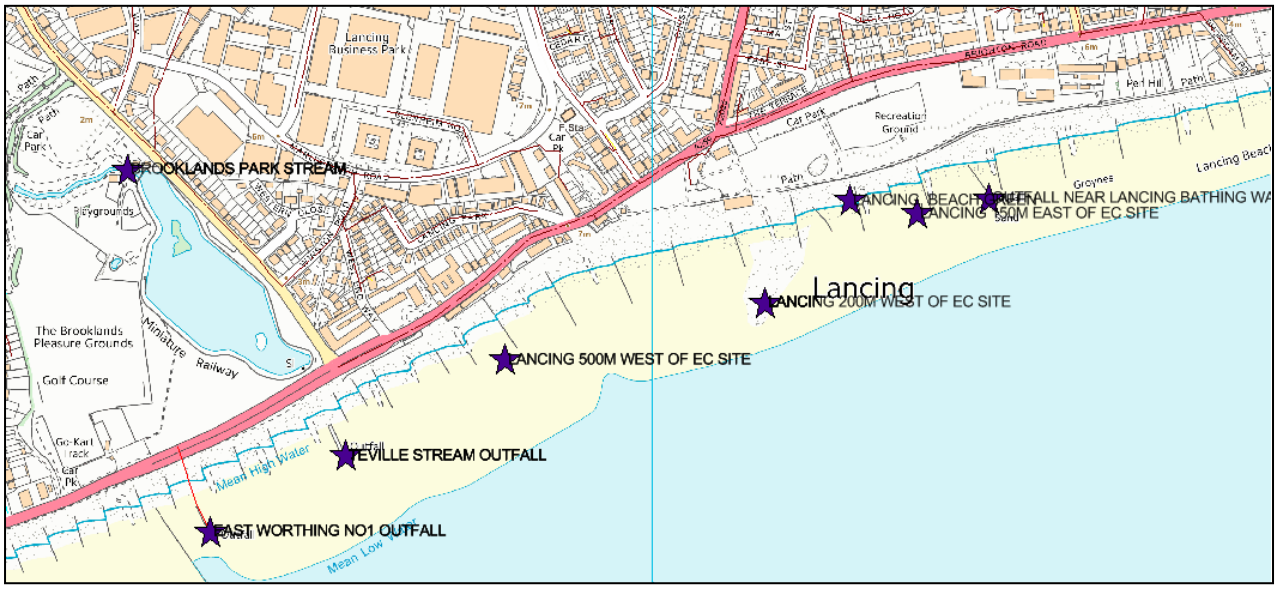
- Microbial Source Tracing indicated that while human DNA is consistently present, seabirds are a consistent significant source of bacteria and dog waste affected at least one of these samples;

Samples were taken by the Environment Agency in 2013 and 2014 at 5 additional locations. These locations are set out in Table 23 and show in map format in Figure 28.

Table 23 - Additional Sampling Locations around Lancing

Location	Easting	Northing
East Worthing No1 Outfall	517325	103095
Teville Stream Outfall	517530	103211
Brooklands Park Stream	517199	103646
Lancing 500m West Of Ec Site	517773	103357
Lancing 200m West Of Ec Site	518170	103444
Lancing 150m East Of Ec Site	518402	103580
Lancing, Beach Green	518300	103600
Outfall Near Lancing Bathing Water	518511	103602

Figure 28 - Additional Sampling Locations around Lancing



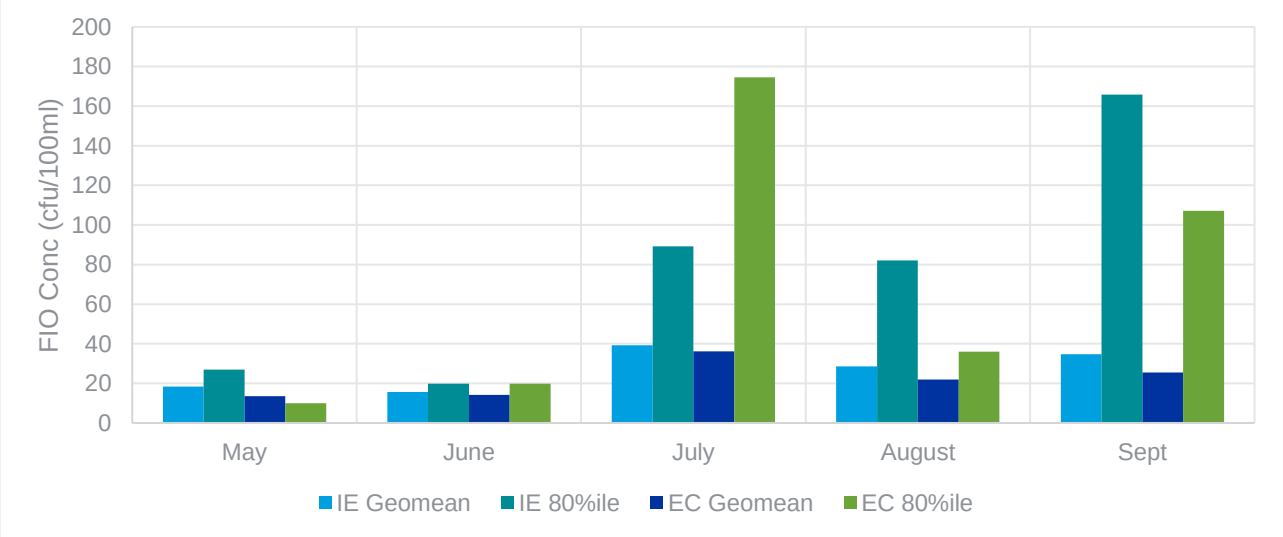
The results show that for coincident samples, high concentrations occur preferentially around low water slack at Lancing. The results also show that for these samples, high concentrations are associated with rainfall above 10mm either on the sample day or on the previous day.

Bathing Water Analysis

Correlations with Seasonality

Studies show no clear correlation with seasonality at Lancing, Green Beach. Figure 29 shows the monthly average results at Lancing.

Figure 29 – Monthly Seasonality at Pevensey Bay



Correlations with Rainfall

Table 24 shows the exceedance events recorded for the five bathing seasons 2013-2017. The exceedance values being shaded.

Table 24 – Exceedance Event Previous Rainfall

Event Date/Time	Previous 72 hours Rainfall (mm)	Lancing, Beach Green BW	
		E.coli	IE
15/05/2013 11:00	9.8	290	530
21/05/2013 10:57	3.8	10	100
07/08/2013 10:41	2.8	182	266
09/09/2013 10:59	22.4	2400	4900
20/09/2013 10:53	17.6	36	310
06/08/2014 13:20	8.2	118	270
23/06/2015 13:10	10.6	10	690
23/09/2015 12:35	21.2	118	155
11/05/2016 14:30	15.0	109	280
09/07/2016 12:59	0.2	610	540
19/07/2017 15:10	10.4	590	700
05/09/2017 14:48	9.4	91	173
11/09/2017 15:32	24.8	164	1100

This analysis shows that of the 13 exceedance events between 2013 and 2017, the majority (77%) of these events occurred after periods of moderate to heavy rainfall (>5mm in 72 hours). This shows that rainfall is a significant influence in bathing water quality results at Lancing.

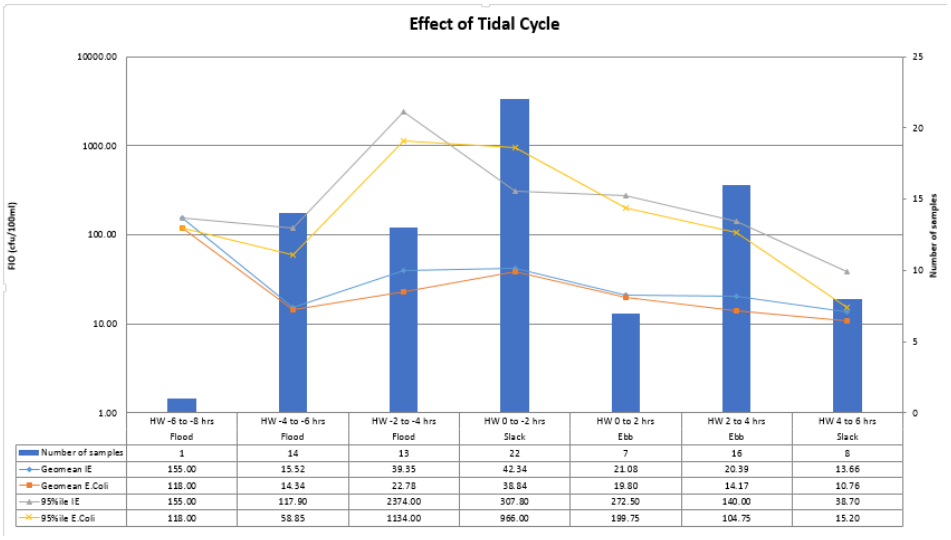
Correlations with Tide

Tidal data has been calculated from tidal constituents at Shoreham Harbour. HW Slack at Lancing occurs approximately two hours before HW. LW Slack occurs approximately four to five hours after HW. The tidal direction during the flood tide is towards the east.

Correlations with Tide Phase (Direction)

Analysis of bathing water quality results against high water (HW) times may indicate the direction from which pollution has travelled and therefore the location of its source. Figure 30 shows bathing water quality results against the time relative to HW.

Figure 30 – Bathing Water Quality Against Time Since High Tide



	HW -6 to -8 hrs Flood	HW -4 to -6 hrs Flood	HW -2 to -4 hrs Flood	HW 0 to -2 hrs Slack	HW 0 to 2 hrs Ebb	HW 2 to 4 hrs Ebb	HW 4 to 6 hrs Slack
Number of samples	1	14	13	22	7	16	8
Geomean IE	155.00	15.52	39.35	42.34	21.08	20.39	13.66
Geomean E.Coli	118.00	14.34	22.78	38.84	19.80	14.17	10.76
95%ile IE	155.00	117.90	2374.00	307.80	272.50	140.00	38.70
95%ile E.Coli	118.00	58.85	1134.00	966.00	199.75	104.75	15.20

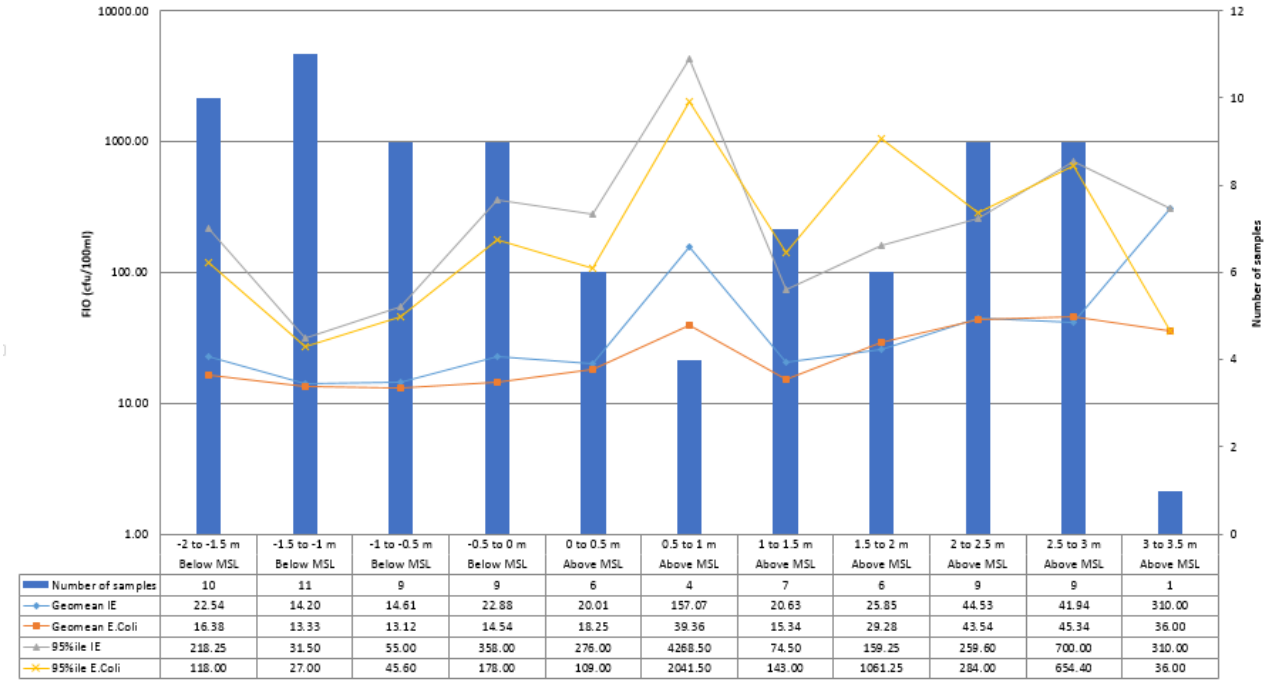
Samples were obtained from 7 hours before high tide to 5.5 hours after high tide. Samples taken more than 2 hours before high tide have been considered to occur during a flood tide (west to east) and samples taken up to 4 hours after high tide have been considered to occur on an ebb tide (east to west).

The analysis shows that between 2011 and 2015 peak 95%ile values for IE and E. coli and the largest number of exceedances occur at HW -2 to -4 hours. This suggests a key source impacting before slack water after the tide has been travelling from the south west.

Correlations with Tide Level

Further analysis of bathing water quality results against tide level may provide an indication of problems with exfiltration from the foul sewer systems or problems with discharges from outfalls with poorly functioning (or no) flap valves.

Figure 31 - Bathing Water Quality Against Time Since High Tide



	-2 to -1.5 m Below MSL	-1.5 to -1 m Below MSL	-1 to -0.5 m Below MSL	-0.5 to 0 m Below MSL	0 to 0.5 m Above MSL	0.5 to 1 m Above MSL	1 to 1.5 m Above MSL	1.5 to 2 m Above MSL	2 to 2.5 m Above MSL	2.5 to 3 m Above MSL	3 to 3.5 m Above MSL
Number of samples	10	11	9	9	6	4	7	6	9	9	1
Geomean IE	22.54	14.20	14.61	22.88	20.01	157.07	20.63	25.85	44.53	41.94	310.00
Geomean E.Coli	16.38	13.33	13.12	14.54	18.25	39.36	15.34	29.28	43.54	45.34	36.00
95%ile IE	218.25	31.50	55.00	358.00	276.00	4268.50	74.50	159.25	259.60	700.00	310.00
95%ile E.Coli	118.00	27.00	45.60	178.00	109.00	2041.50	143.00	1061.25	284.00	654.40	36.00

Figure 31 shows the bathing water quality results against tide level. The analysis shows the 95%ile IE and E. coli results increase to a peak concentration at 0.5 to 1m above Mean Sea Level (MSL).

Likely Sources Impacting the Bathing Water

Table 11 shows the likely sources impacting the bathing water with regards to risk as a factor of likelihood and severity.

Table 25 – Key Sources Likely to be Impacting the Bathing Water

Source	Pathway	Risk	Justification
Dog Faeces	Direct to bathing water	Low – Med	The impact from dogs are common issues at most bathing water sites.
Bird Faeces	Direct to bathing water	Low – Med	The impact from birds are common issues at most bathing water sites.
Surface Water Misconnections	Teville Stream	Med	Surface water outfalls, if polluted, may have the ability to impact bathing water quality.
Foul Exfiltration	Groundwater	Med	6.4km of high risk sewers near to the bathing water have been identified as having the potential to impact the water quality.
Private discharges	Via water courses	Med	The EA Consented Discharge Database indicates 6 private sewerage discharges near to the bathing water.
East Worthing WTW and LSO	Direct to bathing water	Low	The SSO spill frequency is less the guideline standards for Excellent bathing waters. The LSO is designed to protect bathing water quality.

Defining Likely Solutions

Based on the sources outlined in the previous section the following solutions have been defined and costed.

Table 26 – Solution Costing

	Cost (£)	Justification
Investigation Costs		
Analysis (Desktop)	34,000	Allowance based on AMP6 costs
Ammonia Sondes	30,000	3 sondes for 10 weeks
Asset Surveys	15,000	Allowance based on AMP6 costs
Catchment Flyovers	-	Not required
Coastal Modelling	5,000	Allowance for tidal excursion checks
Connectivity Survey	7,500	Allowance based on AMP6 costs
CCTV	15,000	Allowance based on AMP6 costs
Hydraulic Modelling	-	Not required
LSO / SSO Survey	10,000	Allowance for basic outfall survey
Misconnections (to outfall)	3,000	Based on unit rate for SW outfalls
River Walkover	5,000	Allowance for 5km of walkovers
WQ Sampling	28,000	1 summers sampling
Solution Appraisal	15,000	Allowance based on AMP6 costs
Investigation Overhead	77,642	Contingency, project management, and overhead
Investigation Costs	**245,142**	
Delivery Phase Costs		
Additional WQ Sampling	112,000	4 summers sampling
Hydraulic Modelling & Flow Surveys	-	Not required
Misconnections (to property)	110,156	Based on unit rate for 656 properties
Agricultural Measures	-	Not required
Bird and Dog Measures	20,000	Allowance to mitigate impact from dogs, birds and litter
Misconnection Rectification	430,139	Allowance based on AMP6 Hastings Costs
Sewer Rehab	304,082	Prices from CET based on lengths of Risk Scored Sewers
Enhanced Network Maintenance	134,537	Prices from CET based on lengths of Risk Scored Sewers
WPS / CSO Storage	-	Not required
WPS Refurb	1,222,500	Prices from CET
Private Infrastructure Allowance	70,000	Allowance for private infrastructure
WTW Upgrades	-	Not required
LSO / SSO Survey	-	Not required
Optioneering and Design	130,876	6% Allowance
Delivery Overhead	2,564,087	Contingency, project management, and overhead
Delivery Costs	**5,098,377**	
Total Project Cost (P50)	**5,343,519**	

Deliverability

Based on the information known about the bathing water to date the following comments can be made surrounding the confidence of delivery and an appropriate target standard.

Table 27 – Confidence in Deliverability

	Level	Comments
Confidence of Source	Low to Medium	There are no obvious sources which would explain the patterns witnessed by the analysis undertaken to date in this report and by others. More detailed investigations and surveys are required to confirm the potential sources.
Confidence of Delivery	Medium	Most of the potential sources would be in the control, or ability to influence, of Southern Water and deliverable within the timescale of the AMP
Confidence of Outcome	Medium	Given the uncertainty about the source(s) at this stage, no further confidences can be given.
Confidence of Costs	Medium	Unless the surveys reveal issues with East Worthing LSO there are no other high risk cost items. The scale of the surface water network makes costing misconnection interventions difficult.
Appropriate Target Standard	Good Status	May be appropriate for a PR19 scheme looking to improve bathing water quality to Good status

Hastings, Pelham Beach

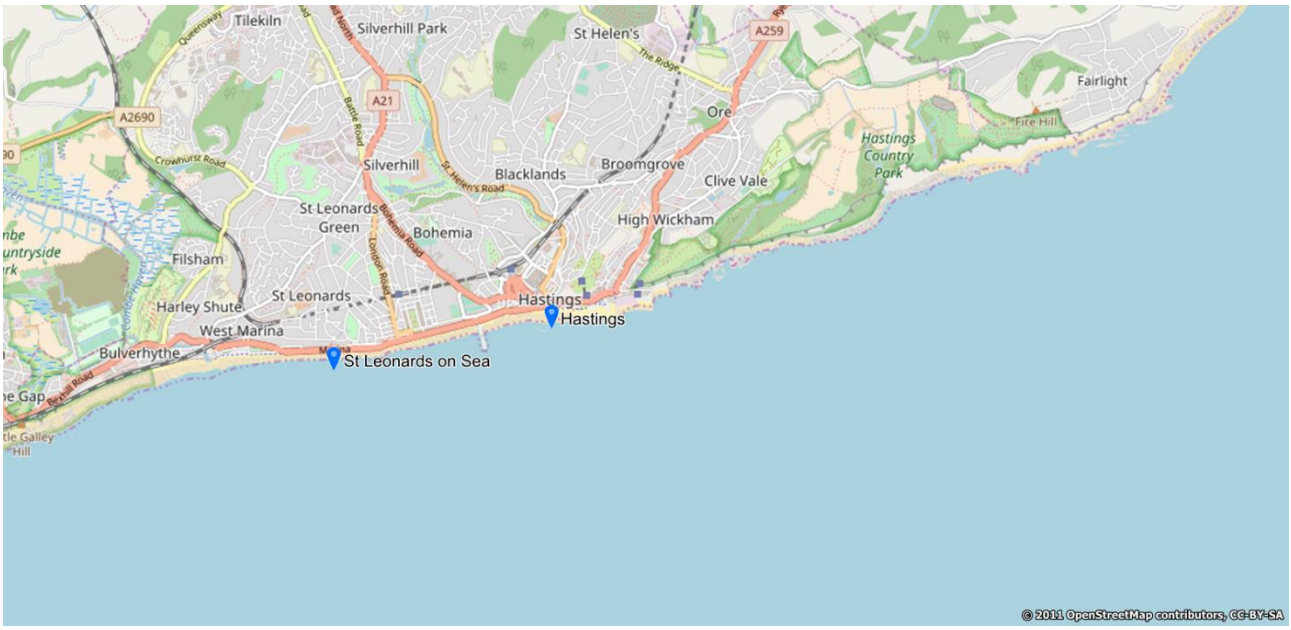
Background

Hastings Pelham Beach is a resort beach within the district of Hastings Pelham Beach in East Sussex. The beach is predominantly shingle, with shallow sand flats exposed at low water. Alexandra Park Stream drains into the sea via an outfall pipe across the beach, which also is exposed at low water. A promenade is above the beach with the urban backdrop of Hastings Pelham Beach.

The natural drainage (hydrological) catchment surrounding the bathing water is approximately 1100 hectares of urban area. The upper catchment slopes steeply. Alexandra Park Stream originates in the north of Silverhill Park and runs through Alexandra Park. It passes through the town of Hastings via a culvert, and drains into the sea through an outfall just west of the bathing water.

The Hastings drainage catchment is heavily urbanised with historic and modern developments/dwellings. It covers an area of approximately 1,350 hectares and has a population of approximately 56,000.Figure 32 below shows location of Hastings Pelham Beach Bathing Waters Sampling Point.

Figure 32 – Location of Bathing Water Sample Point



Bathing Water Quality

Table 8 below shows the annual and official four year rolling classifications at the bathing water.

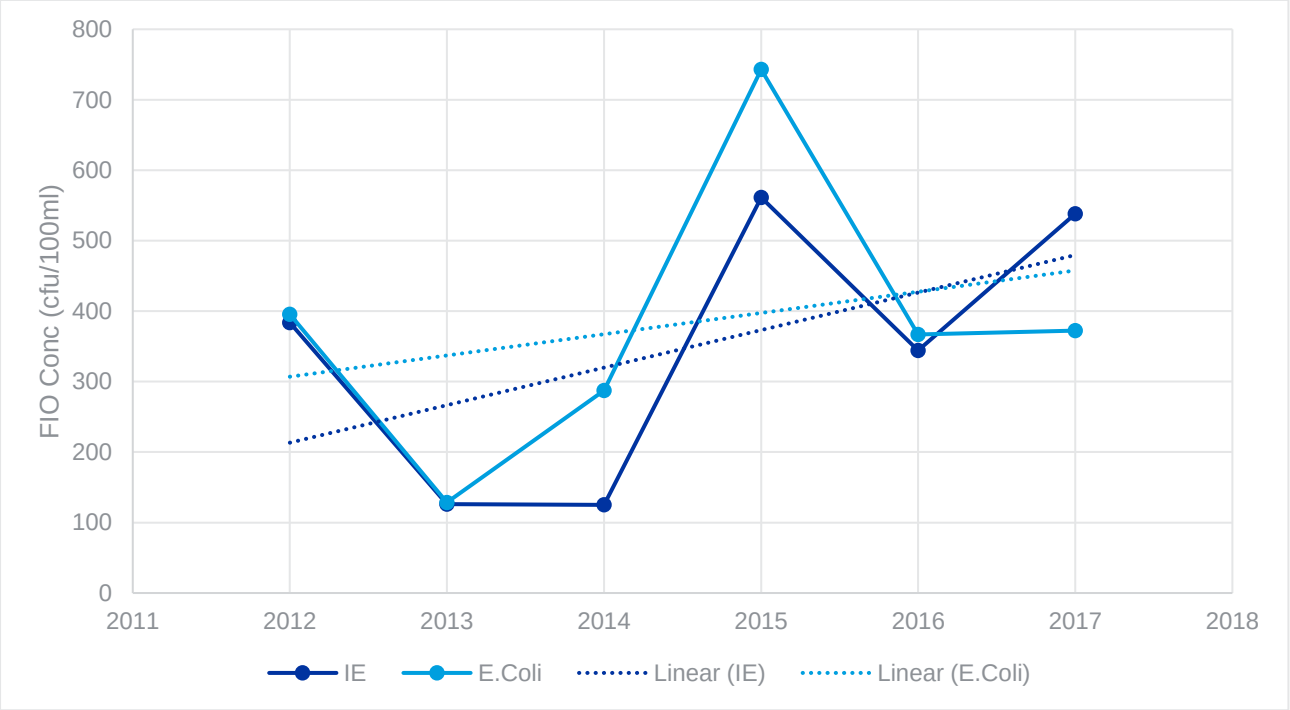
Table 28 – Historic Bathing Water Quality Classifications

	2013	2014	2015	2016	2017
Annual	Sufficient	Sufficient	Good	Poor	Good
Official	Poor	Poor	Good	Good	Good

Bathing Water quality at Hastings, Pelham Bay has been at Good status since the Southern Water misconnection programme in early 2015. However, remove the impact of pollution risk forecasting (PRF) on results and bathing water quality consistency falls below Good status for both the annual and four year rolling assessments.

Figure 11 shows the 95%ile annual trending quality of the bathing water quality over the last five years.

Figure 33 – Historic Bathing Water Quality Trends



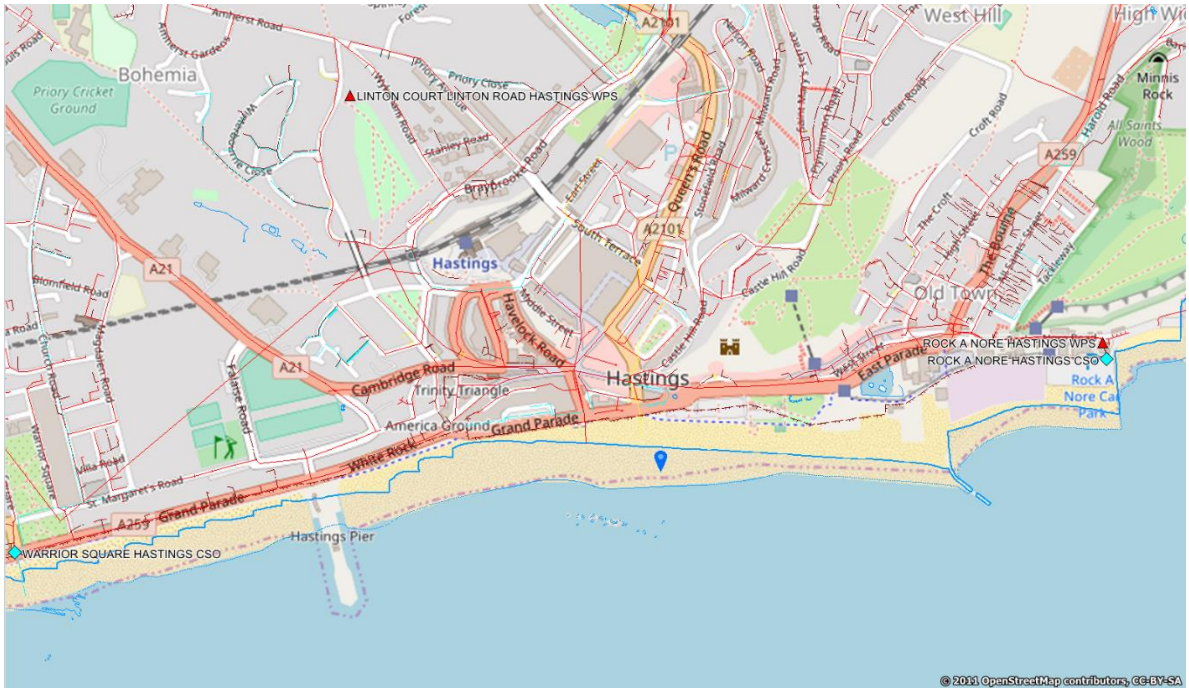
There has been a significant improvement in bathing water quality at Hastings since 2015 by looking at Table 8. However, Figure 113, which includes the results which have been discounted through the PRF process shows that Hastings is still failing to achieve Good status and may even still be deteriorating.

The AMP5 NEP Hastings scheme was focussed on the EA driver of addressing misconnections within the Alexandria Park Stream. In addition to this work, the EA moved the sample point was also moved 60m away from the outfall of the watercourse and PRF was introduced.

Catchment Features

A brief desktop assessment has identified some key features and potential sources of the bathing water sampling results. This is shown in Figure 34.

Figure 34

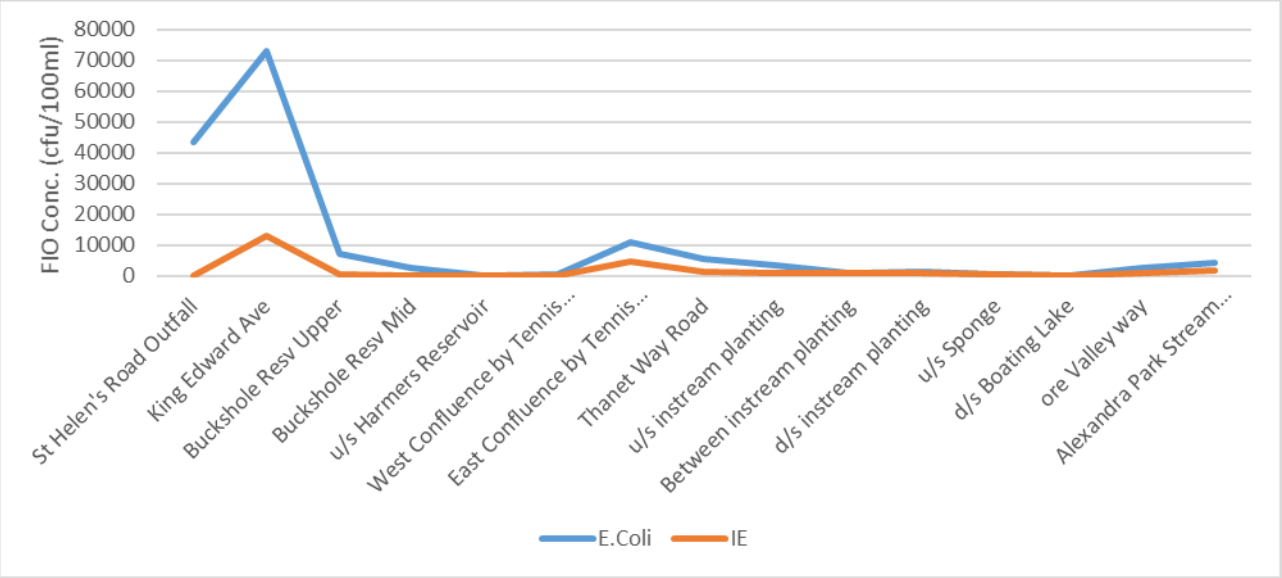


Alexandria Park Stream

Alexandra Park Stream is the largest surface water system in the Hastings catchment. The stream is an open channel from its source near Silverhill Park and discharges via a series of ponds located in Alexandra Park. The stream is culverted prior to discharging at an outfall located on the Hastings beach.

Water quality monitoring undertaken by the EA in spring 2016 shows there is still a considerable degree of pollution coming from the Alexandria Park Stream. Figure 35 shows that there are pollution spikes at King Edward Avenue, the East Confluence by the Tennis Courts and perhaps most importantly an further increase in pollution downstream of the Boating Lake in the culverted section of the watercourse.

Figure 35 – Water Quality Sampling along Alexandria Park Stream



Southern Water Assets

Continuous / Intermittent Discharges

Table 15 details the Southern Water continuous and intermittent assets which may impact the bathing waters. Environment Agency guidance on spill frequency from these assets are as follows:

Storm overflows that discharge directly into or impact on bathing waters with a target of good or sufficient status, must have no more than 3 significant spills per bathing season on average. Where more than one discharge affects the bathing water, you must aggregate the spills. The aggregated spills must be no more than 3 significant spills on average per bathing season. For storm overflows that discharge to bathing waters with a target of excellent status, the emission standard is for no more than 2 significant spills per bathing season on average. Whether a spill is significant will be considered on a site-specific basis. In general, for design purposes, a spill greater than 50m^3 is significant.

Table 29 – Continuous / Intermittent Discharges

Asset Name	Asset Type	Treatment Type	2012-2016 Average Annual Bathing Season Spill Frequency
COOMBS	WPS/CSO/CEO	N/A	0.6(CSO)/0.2(CEO)
ROCK A NORE	WPS/CSO	N/A	3.4
ST HELENS DOWN	CSO	N/A	2.6
WARRIOR SQUARE	CSO	N/A	No alarm data

Surface Water Network

In 2013 and 2014, Hastings Borough Council and the EA, commissioned three investigations to identify misconnected properties within the Hastings catchment. The investigations identified the following within nine surface water sub-catchments:

- 73 properties were confirmed to have a total of 162 misconnections (single misconnection being a hand basin, washing machine, toilet or kitchen sink) and a further 10 were identified as having an untested misconnection (access to the property not possible to confirm
- Of the 73 misconnected properties, 16 properties had one or more toilet/foul misconnections.

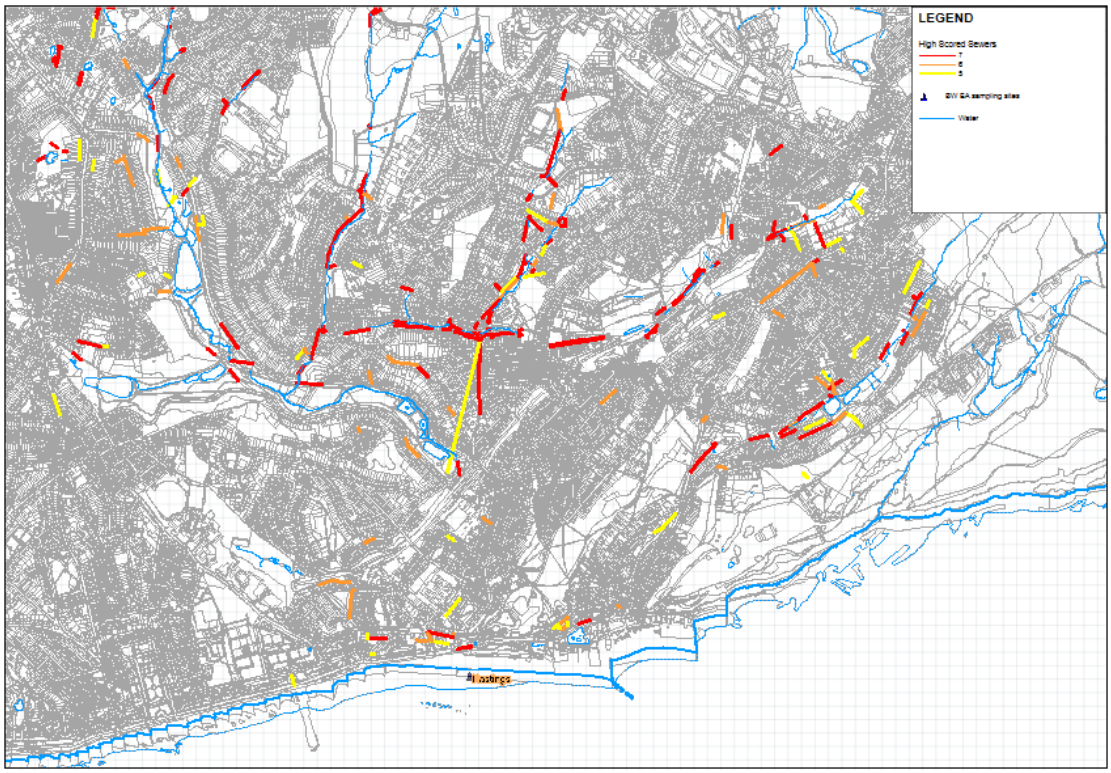
- A total of 69 open dual manholes were identified at 66 properties. 47 of the caps were rectified and permanently sealed by July 2014.

All these investigations however were all undertaken within the Alexandria Park Stream. The impact of the other surface water networks in Hastings should be investigated and quantified.

Combined Sewerage Network

The integrity of the foul / combined sewerage network can have a significant impact on bathing water quality. The Southern Water Risk Scored Sewers (RSS) database shows 7 km of grades 5, 6 and 7 sewers which may be impacting the bathing water. The impact of foul exfiltration was not considered as part of the AMP5 investigation.

Figure 36 – Risk Scored Sewers Grade 5-7



The RSS database is an internal Southern Water system of grading pipes based on structural integrity, frequency of inspections and maintenance and criticality. Scores are from 1 to 7 with 7 being the highest risk sewers.

Agricultural Diffuse

Agricultural diffuse pollution in the form of the storage or spreading of slurries and manures, or the keeping of grazing of livestock has the potential to contribute to reductions in bathing water quality. This can be from the direct excretion of waste from livestock or polluted runoff after rainfall.

There is unlikely to be a significant impact from agricultural diffuse pollution within this bathing water catchment. No farms or other agricultural activity has been identified as having the potential to effect the bathing water.

Urban and Coastal Diffuse

Faecal waste from dogs and birds, as well as polluted urban runoff, and sewage discharges from boats or houseboats have the potential to contribute to reductions in bathing water quality.

The impact from dogs and birds are common issues at most bathing water sites. There are zones along Pelham beach where dogs are restricted during the bathing season.

Private Sewerage Infrastructure

There is unlikely to be a significant impact from private sewerage infrastructure although this is very hard to quantify at this stage given the lack of available information and the pathway through groundwaters.

There have been no private pumping stations identified during the private pumping station transfer, however, the EA Consented Discharge database indicates three separate private domestic sewerage discharge. Hastings Pier is another factor that needs to be considered as having the potential to impact the bathing water.

Historic Bathing Water Investigations

There have been previous SWS bathing water investigations carried out at this bathing water.

- RT-CA-1506 Hasting Bathing Water Source Apportionment Report (2015)
- Hastings Bathing Waters Analysis (2016)

The conclusions from these studies have been used to complete this report.

There have also been multiple investigations undertaken by the Environment Agency over the last 10 years at Hastings Pelham Beach. The results of which are detailed below:

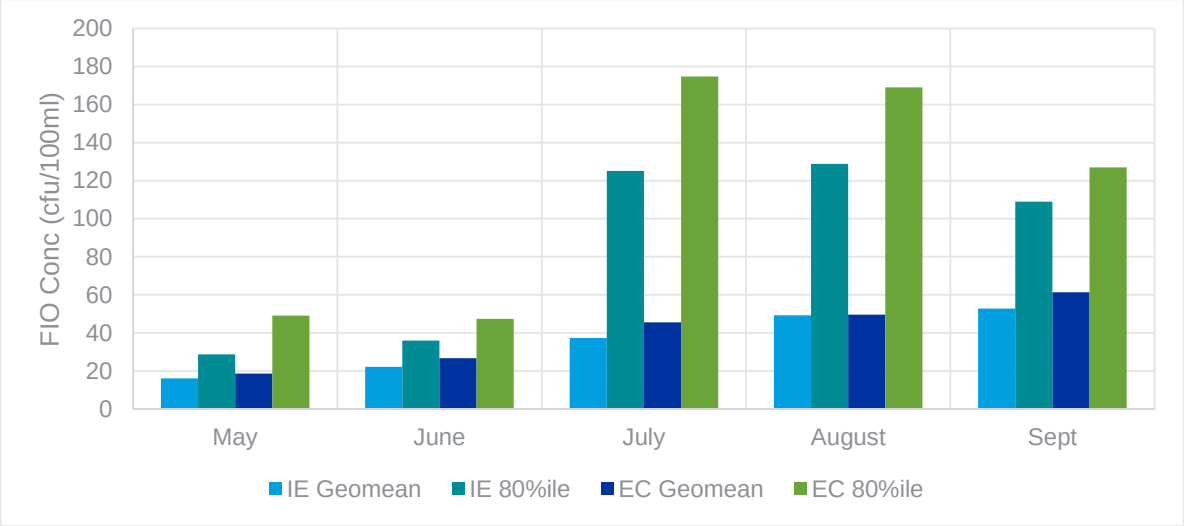
- The Environment Agency investigated the complex Hastings catchment in order to identify possible sources of pollution. Surveys were carried out between 2007 and 2010 focusing on the Alexandra Park Stream catchment.
- The Environment Agency introduced a DNA tracing technique that helped identify whether sources of faecal pollution are human or animal. Since 2009, the EA have been using this method at Hastings and the catchment of the Alexandra Park Stream.
- This means the EA can target further investigations and identify appropriate courses of corrective action.
- In 2013, the Environment Agency trialled innovative technology in Alexandra Park Stream to improve water quality.
- Since 2012 the EA have been taking samples in the stream throughout the park on a regular basis.
- In 2015 the EA deployed instruments that give us live data from around the park to identify times when pollution is higher and track pollution sources.

Bathing Water Analysis

Correlations with Seasonality

Studies show there is a general increase in E.Coli and IE results throughout the summer peaking in late August. This may be due to increased population during the school summer holidays. Figure 37 shows the monthly average results at Hastings Pelham Beach.

Figure 37 – Monthly Seasonality at Hastings Pelham Beach



Correlations with Rainfall

Table 30 shows the exceedance events recorded for the five bathing seasons 2013-2017. The exceedance values being shaded. Red text identifies samples where no rainfall data has been identified.

Table 30 – Exceedance Event Previous Rainfall

Event Date/Time	Previous 72 hours Rainfall (mm)	Hastings Pelham Beach BW	
		E.Coli	IE
16/07/2013 14:30	0.0	45	109
24/07/2013 14:22	7.4	191	250
22/08/2013 15:25	4.6	73	100
08/09/2013 14:00	6.4	73	109
16/07/2014 14:12	0.0	280	82
14/08/2014 14:05	15.8	200	136
22/06/2015 14:10	10.2	240	109
21/07/2015 11:15	2.6	145	118
04/08/2015 10:47	0.8	18	145
18/09/2015 11:46	29.2	3300	2800
22/09/2015 11:45	27.4	2500	1700
23/06/2016 11:37	19.6	620	670
24/07/2016 13:30	0.0	330	164
27/07/2016 10:00	0.0	164	106
09/08/2016 12:16	1.0	64	118
16/08/2016 14:25	0.0	118	182

09/09/2016 13:34	0.0	127	290
30/05/2017 14:28	3.6	127	145
12/06/2017 14:00	0.0	155	148
28/06/2017 10:25	17.6	1200	2000
12/07/2017 11:13	31.2	290	522
07/08/2017 10:45	3.0	191	400

The analysis shows that of the 22 exceedance events between 2013 and 2017, approximately 45% of these events occurred after periods of moderate to heavy rainfall (>5mm in 72 hours). The majority of exceedance events (55%) therefore occurred after periods of little to no rainfall (<5mm in 72 hours). This neither excludes nor concludes that rainfall has a significant impact on the Hastings Pelham Beach BW.

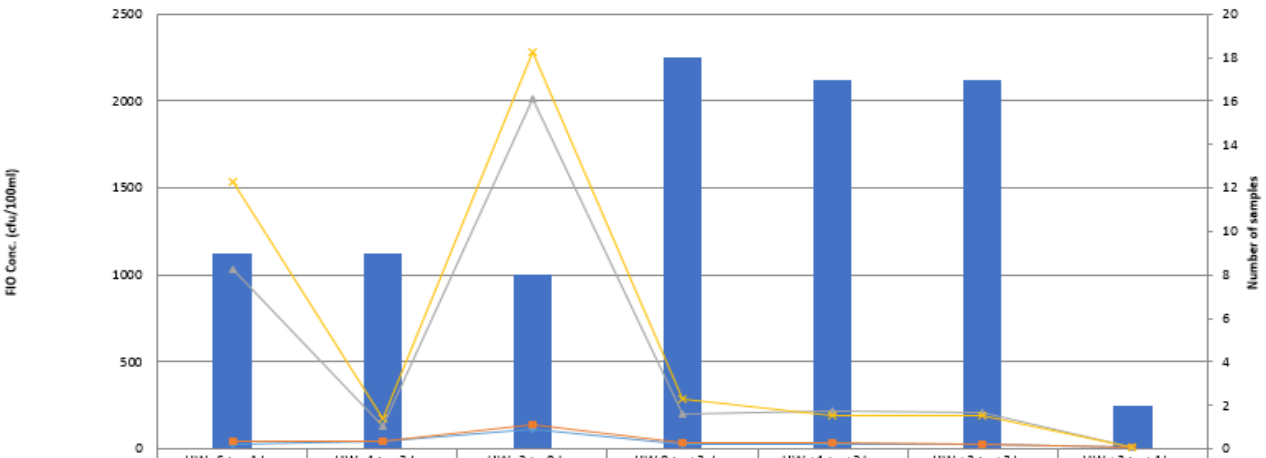
Correlations with Tide

Tidal data has been calculated from tidal constituents at Dover Harbour. HW Slack at Hastings occurs approximately two hours after HW at Dover. LW Slack occurs approximately four to five hours after HW. The tidal direction during the flood tide is towards the east.

Correlations with Tide Phase (Direction)

Analysis of bathing water quality results against high water (HW) times may indicate the direction from which pollution has travelled and therefore the location of its source. Figure 38 shows bathing water quality results against the time relative to HW.

Figure 38 - Bathing Water Quality Against Time Since High Tide



	HW -6 to -4 hrs LW Slack	HW -4 to -2 hrs Flood	HW -2 to 0 hrs Flood	HW 0 to +2 hrs HW Slack	HW +1 to +2 hrs Ebb	HW +2 to +3 hrs Ebb	HW +3 to +4 hrs Ebb
No. of samples	9	9	8	18	17	17	2
Geomean IE	25.44	47.43	114.82	29.19	25.78	25.35	10.00
Geomean E.Coli	40.01	42.90	138.00	38.93	38.48	27.01	10.00
95%ile IE	1034.40	134.20	2009.00	198.20	218.00	208.80	10.00
95%ile E.Coli	1532.80	172.60	2278.00	287.50	192.80	189.20	10.00

Samples were obtained from 6 hours before high tide to 4 hours after high tide. Samples taken more than 2 hours before high tide have been considered to occur during a flood tide (west to east) and samples taken up to 4 hours after high tide have been considered to occur on an ebb tide (east to west).

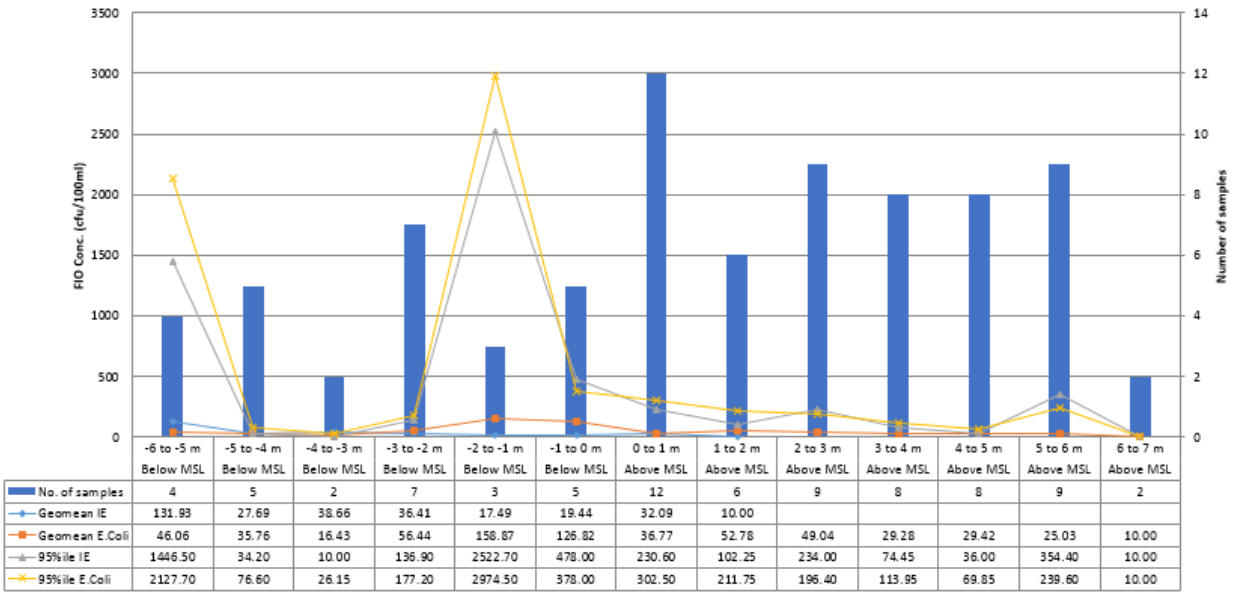
Figure 38 shows that between 2011 and 2015 peak geomean and 95%ile values for IE and E.Coli occur at HW -2 to 0 hours. This would suggest the primary source of pollution is reaching the bathing water on the flood tide, therefore pollution may be coming from the west.

The Alexander Park Stream is located to the west of the bathing water sample point and has previously been identified as being significant pollutant pathway.

Correlations with Tide Level

Further analysis of bathing water quality results against tide level may provide an indication of problems with exfiltration from the foul sewer systems or problems with discharges from outfalls with poorly functioning (or no) flap valves.

Figure 39 - Bathing Water Quality Against Tide Levels



	-6 to -5 m Below MSL	-5 to -4 m Below MSL	-4 to -3 m Below MSL	-3 to -2 m Below MSL	-2 to -1 m Below MSL	-1 to 0 m Below MSL	0 to 1 m Above MSL	1 to 2 m Above MSL	2 to 3 m Above MSL	3 to 4 m Above MSL	4 to 5 m Above MSL	5 to 6 m Above MSL	6 to 7 m Above MSL
No. of samples	4	5	2	7	3	5	12	6	9	8	8	9	2
Geomean IE	131.93	27.69	38.66	36.41	17.49	19.44	32.09	10.00					
Geomean E.Coli	46.06	35.76	16.43	56.44	158.87	126.82	36.77	52.78	49.04	29.28	29.42	25.03	10.00
95%ile IE	1446.50	34.20	10.00	136.90	2522.70	478.00	230.60	102.25	234.00	74.45	36.00	354.40	10.00
95%ile E.Coli	2127.70	76.60	26.15	177.20	2974.50	378.00	302.50	211.75	196.40	113.95	69.85	239.60	10.00

Figure 39 shows the bathing water quality results against tide level. The analysis shows that the 95%ile IE and E.Coli results increase to a peak concentration at -2 to -1m below Mean Sea Level (MSL). This may suggest that the tidal impact is based on direction and not level. Due to a low number of samples at -2 to -1 below MSL there is low confidence that there is a relationship between water quality and tide height.

Likely Sources Impacting the Bathing Water

Table 31 – Key Sources Likely to be Impacting the Bathing Water shows the likely sources impacting the bathing water with regards to risk as a factor of likelihood and severity.

Table 31 – Key Sources Likely to be Impacting the Bathing Water

Source	Pathway	Risk	Justification
Dog Faeces	Direct to bathing water	Low – Med	The impact from dogs are common issues at every bathing water site. There are zones along Pelham beach where dogs are restricted during the bathing season.
Bird Faeces	Direct to bathing water	Low – Med	The impact from birds are common issues at every bathing water site.
St Helens Down CSO	Alexandria Park Stream	Low - Med	Rectifying issues with the hydrobrake can reduce spill frequencies from St Helens Down CSO.
Warrior Square CSO	Direct to bathing water	Low – Med	No available telemetry from Warrior Square to quantify any impact

Coombs CSO	Direct to bathing water	Low – Med	Spill frequencies are less than the guideline standards for Excellent BW quality.
Rock a Nore CSO	Direct to bathing water	Low – Med	Spill frequencies are approx. at that the guideline standards for Good BW quality.
Private Septic Tanks	Groundwater	Low – Med	Private septic tanks have the potential to spill and impact bathing water quality
Surface Water Misconnections	Direct to bathing water	Med - High	Extensive misconnection investigations took place during AMP5 so it would be surprising if there was still a considerable impact from direct misconnections within the Alexandria Park Stream catchment However, indirect misconnections in the form of dual manholes are not as easy to detect and are known to be prevalent across Hastings. Additional misconnection investigations should be undertaken within the other surface water catchments.
Foul Exfiltration	Groundwater	Med - High	7km of high risk sewers near the bathing water have been identified as having the potential to impact the water quality.
Private Discharges	Via water courses	Low – Med	The EA Consented Discharge Database indicates 3 consented private sewerage discharges near to the bathing waters.

Defining Likely Solutions

Based on the sources outlined in the previous section the following solutions have been defined and costed.

Table 32 – Solution Costing

	Cost (£)	Justification
Investigation Costs		
Analysis (Desktop)	17,000	Allowance based on AMP6 costs for
Ammonia Sondes	30,000	3 sondes for 10 weeks
Asset Surveys	15,000	Allowance based on AMP6 costs
Catchment Flyovers	-	Not required
Coastal Modelling	5,000	Allowance based on AMP6 costs
Connectivity Survey	7,500	Allowance based on AMP6 costs
CCTV	15,000	Allowance based on AMP6 costs
Hydraulic Modelling	-	Not required
LSO / SSO Survey	10,000	Bexhill and Hastings WTW LSO survey
Misconnections (to outfall)	8,000	8 surface water outfalls based on AMP6 costs
River Walkover	5,000	Allowance for 5km of walkovers
WQ Sampling	28,000	1 summers sampling

Solution Appraisal	15,000	Allowance based on AMP6 costs
Investigation Overhead	72,079	Contingency, project management, and overhead
Investigation Costs	**227,579**	
Delivery Phase Costs		
Additional WQ Sampling	112,000	4 summers sampling
Hydraulic Modelling & Flow Surveys	60,000	Allowance based on AMP6 costs
Misconnections (to property)	101,166	540 properties based on AMP6 costs
Agricultural Measures		Not required
Bird and Dog Measures	20,000	Allowance based on AMP6 costs
Misconnection Rectification	115,834	8 outfalls and 540 properties based on AMP5 Hastings costs
Sewer Rehab	668,553	Prices from CET based of lengths of Risk Scored Sewers
Enhanced Network Maintenance	173,546	Prices from CET based of lengths of Risk Scored Sewers
WPS / CSO Storage	100,000	Price for removing the hydrobrake from St Helens Down CSO
WPS Refurb	1,126,438	Prices from CET to mitigate MEICA based failures
Private Infrastructure Allowance	70,000	Allowance for private infrastructure
WTW Upgrades	-	Not required
LSO / SSO	-	Not likely to be required
Optioneering and Design	136,462	6% Allowance
Delivery Overhead	2,715,557	Contingency, project management, and overhead
Delivery Costs	**5,399,556**	
Total Project Cost (P50)	**5,627,135**	

Deliverability

Based on the information known about the bathing water to date the following comments can be made surrounding the confidence of delivery and an appropriate target standard.

Table 33 – Confidence in Deliverability

	Level	Comments
Confidence of Source	Low	Multiple investigations and surveys have taken place over several years which have failed to address the underlying pollution issues at Hastings. Extensive investigations should be undertaken before any solutions are assessed in order that the underlying issue is correctly addressed.
Confidence of Delivery	Low to Medium	Confidence is cannot be high due to the difficulty of any investigations and subsequent schemes associated with the culverted section of Alexandria Park Stream
Confidence of Outcome	Medium	Given the extensive works already undertaken at Hastings and the wealth of information available it should be possible to correctly identify and mitigate the issues.
Confidence of Costs	Medium	Significant unknowns related to the complexity and size of the catchment
Appropriate Target Standard	Good Status	May be appropriate for a PR19 scheme looking to improve bathing water quality to Good status

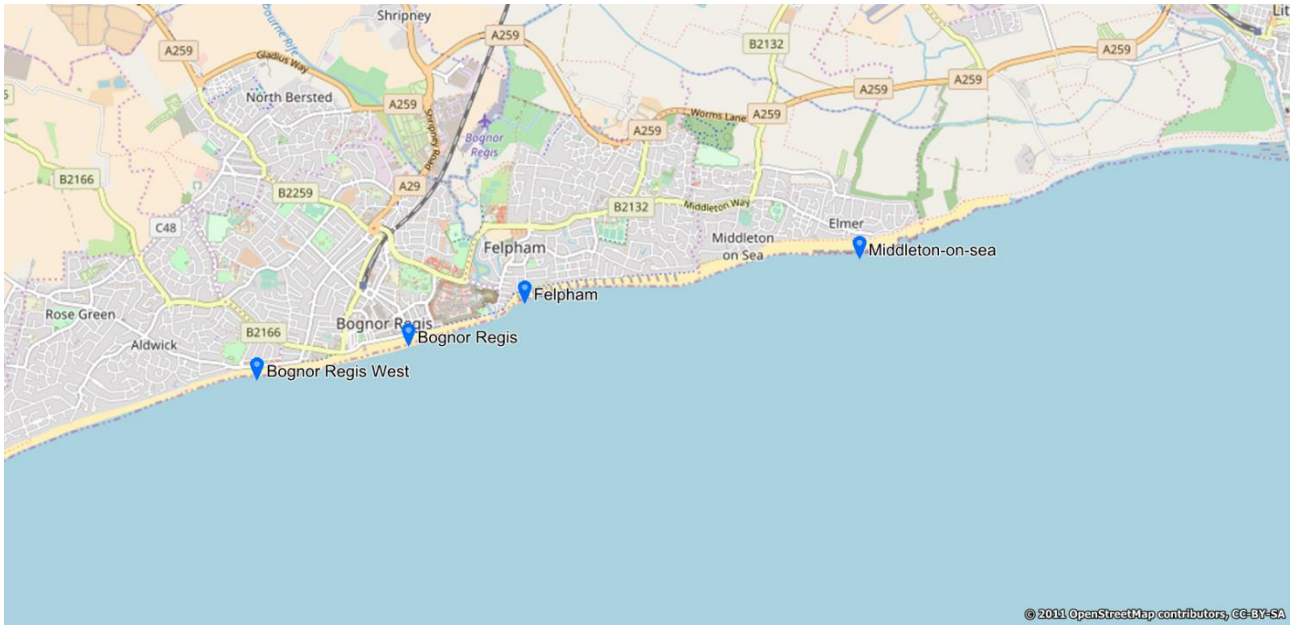
Felpham

Background

The bathing water is situated on the south coast in West Sussex, adjacent to the town of Felpham. The bathing water is predominantly a groyned, shingle beach with sand and rock pools exposed at low water. A footpath sits above the beach. The Aldingborne Rife crosses the beach at the western end of the bathing water.

The bathing water is situated in a low-lying area. The natural drainage (hydrological) catchment surrounding the bathing water is approximately 9000 hectares. This includes the catchment of the Aldingbourne Rife that drains most of the wider surrounding area which is predominantly rural (arable and managed grassland). There are several surface water outfalls onto the beach which drain the urban area immediately behind the bathing water. Figure 11 below shows location of Felpham Bathing Waters Sampling Point.

Figure 40 – Location of Bathing Water Sample Point



Bathing Water Quality

Table 8 below shows the annual and official four year rolling classifications at the bathing water.

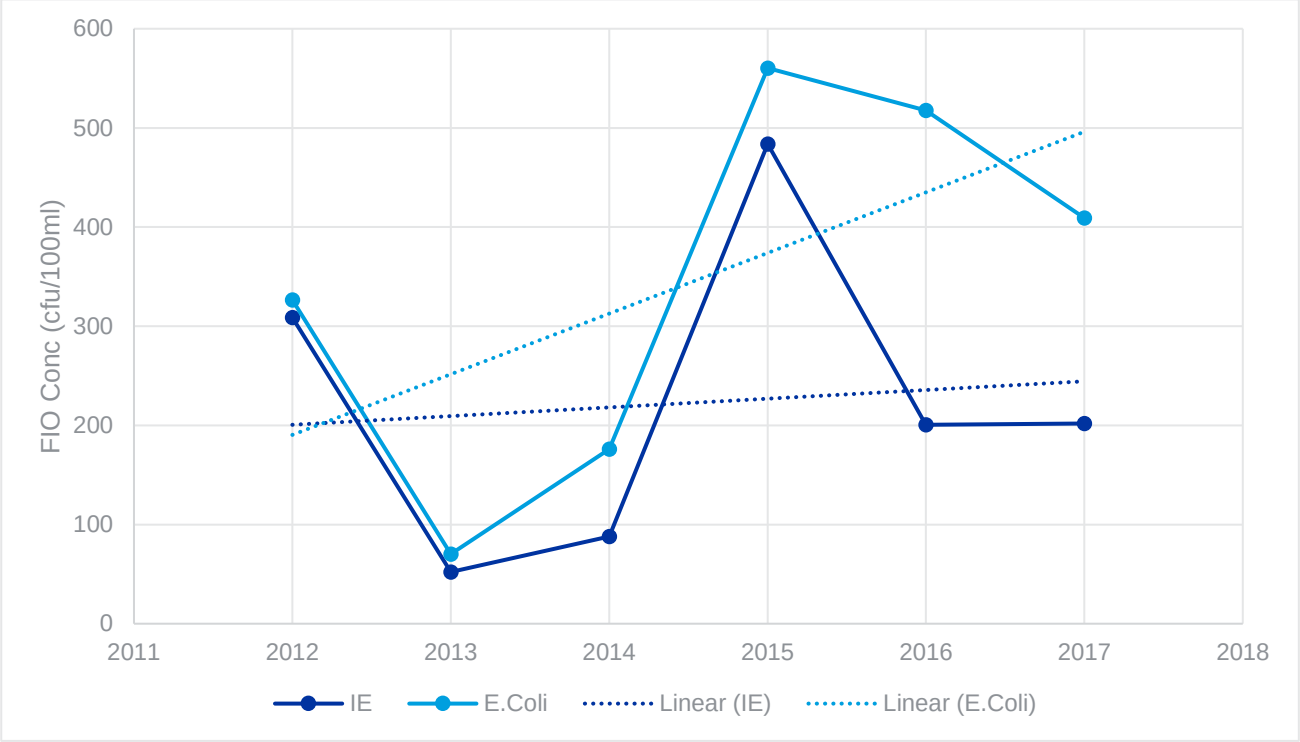
Table 34 – Historic Bathing Water Quality Classifications

	2013	2014	2015	2016	2017
Annual	Excellent	Excellent	Poor	Sufficient	Sufficient
Official	Good	Good	Good	Good	Sufficient

Since the end of 2014 bathing water quality at Felpham regularly falls below the threshold standards for Good bathing water quality.

Figure 11 below shows the 95%ile annual trending quality of the bathing water quality over the last five years.

Figure 41 – Historic Bathing Water Quality Trends

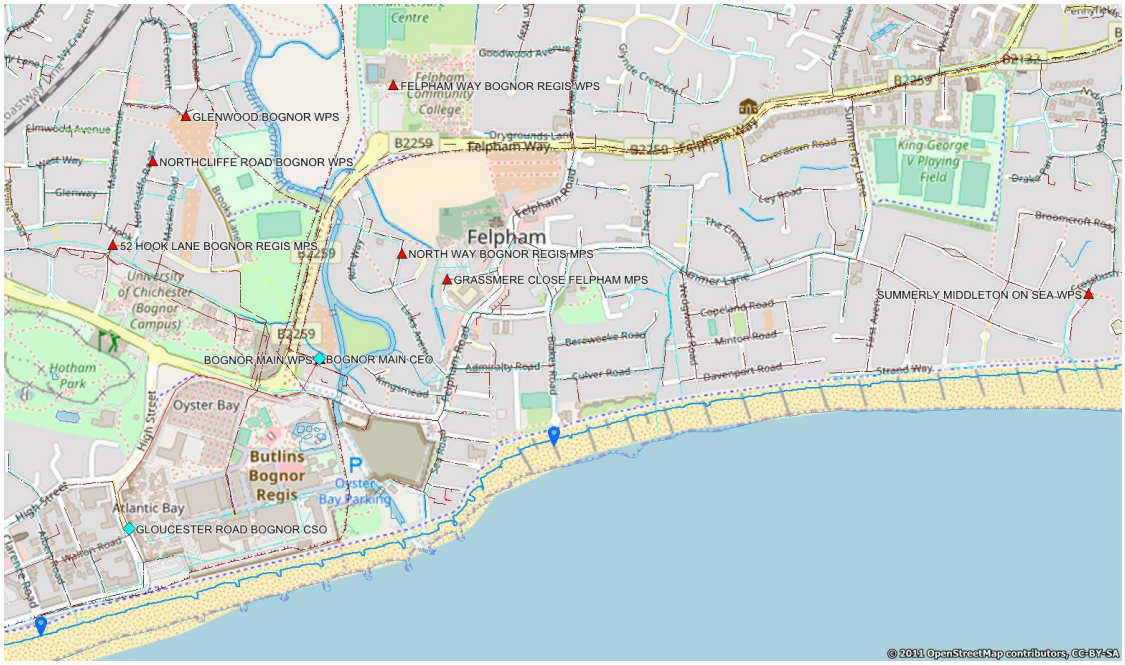


There would appear to be an overall deterioration in water quality since 2012. The deteriorating trend becomes more evident when looking from 2014 onwards where annual classifications have gone from Excellent to Sufficient status or worse.

Catchment Features

A brief desktop assessment has identified some key features and potential sources of the bathing water sampling results. This is shown in Figure 42.

Figure 42 – Catchment Features



The Aldingbourne Rife

The Aldingbourne Rife discharges over the beach to the west of the bathing water sample point. Flow in the Aldingbourne Rife is regulated by a tidal flap at the downstream point. The purpose of the flap is to prevent tidal (saline) ingress to the rife. The flap opens to release river water to the sea when the head of water in the river is higher than the tidal level. Conversely, the flap is closed as the tide rises to prevent saline ingress.The operation of the tidal flap has the effect of storing effluent and then releasing it in the period towards low water. The tide carries the river water towards Felpham under these conditions.

Investigations undertaken as part of the AMP6 BWEP scheme at Felpham showed that pollution coming from the Aldingbourne Rife was the single biggest influence on bathing water quality at Felpham.

Water quality sampling of the Aldingbourne Rife shows varying degrees of pollution with a step change in quality downstream of the confluence with the Lidsey Rife and again and the confluence with College Ditch. Microbial source tracing (MST) of these samples showed the pollution ranged from a variety of sources including humans, cattle, sheep, horses, birds and dogs. The predominant pollutant source, as shown in Table 35, is of human origins.

Figure 43 – Water Quality Sampling Along the Aldingbourne Rife

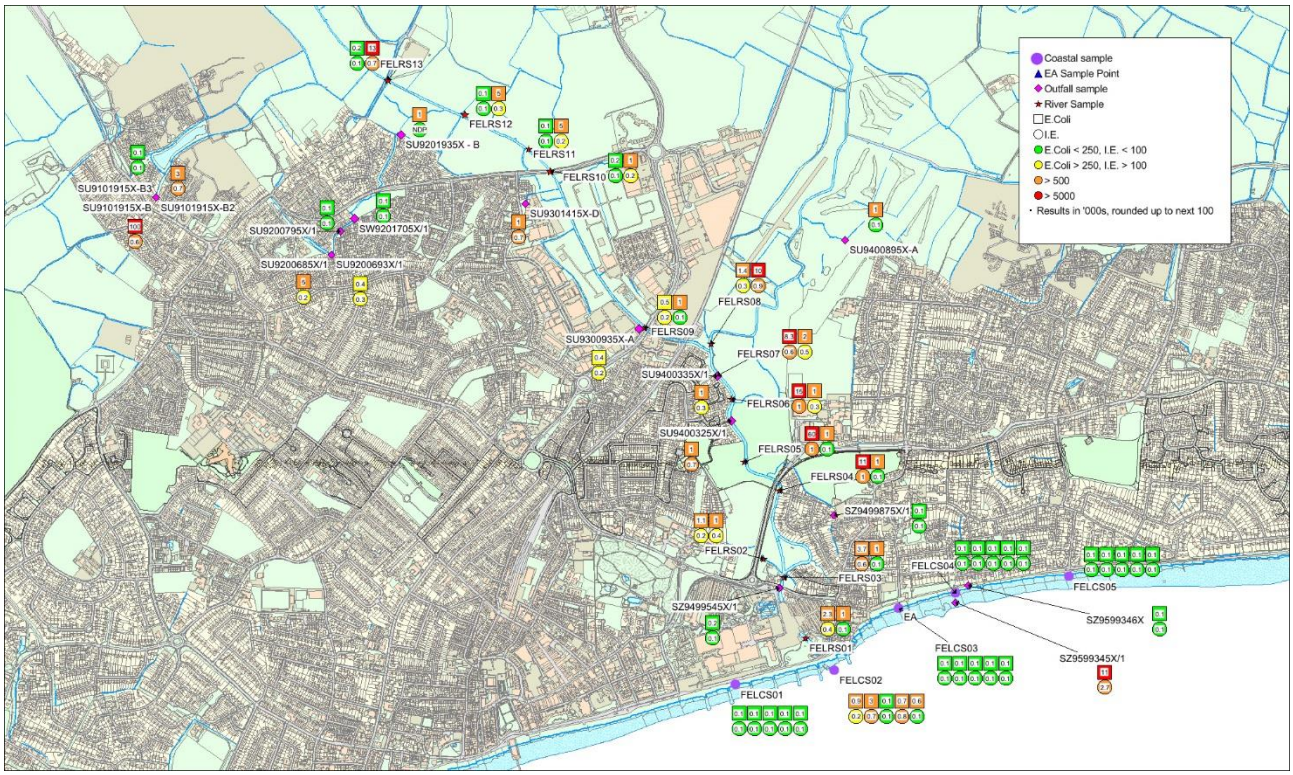


Table 35 – Mitochondria Sample Results for the Aldingbourne Rife

Sample Location	Avian	Canine	Bovine	Human	Ovine	Equine
FELCS02	0%	0%	6%	93%	0%	0%
FELRS01	3%	0%	5%	92%	0%	0%
FELRS02	3%	23%	0%	74%	0%	0%
FELRS03	1%	1%	8%	87%	0%	1%
FELRS04	3%	0%	3%	90%	3%	0%
FELRS05	1%	5%	5%	89%	0%	0%
FELRS06	4%	2%	19%	73%	2%	0%

FELRS07	2%	2%	9%	88%	1%	0%
FELRS08	0%	6%	15%	77%	3%	0%
FELRS09	0%	0%	6%	94%	0%	0%
FELRS10	0%	0%	0%	100%	0%	0%
FELRS11	6%	0%	6%	88%	0%	0%
FELRS12	0%	4%	8%	85%	0%	4%
FELRS13	1%	1%	1%	95%	1%	1%

Southern Water Assets

Continuous / Intermittent Discharges

Table 15 details the Southern Water continuous and intermittent assets which may impact the bathing waters. Environment Agency guidance on spill frequency from these assets are as follows:

Storm overflows that discharge directly into or impact on bathing waters with a target of good or sufficient status, must have no more than 3 significant spills per bathing season on average. Where more than one discharge affects the bathing water, you must aggregate the spills. The aggregated spills must be no more than 3 significant spills on average per bathing season. For storm overflows that discharge to bathing waters with a target of excellent status, the emission standard is for no more than 2 significant spills per bathing season on average. Whether a spill is significant will be considered on a site-specific basis. In general, for design purposes, a spill greater than 50m^3 is significant.

Table 36 – Continuous / Intermittent Discharges

Asset Name	Asset Type	Treatment Type	Average Annual Bathing Season Spills[18]
Bognor Main	WPS with CEO	N/A	2.4
Chichester Rd Bognor[19]	CSO	N/A	-
Gloucester Rd Bognor	CSO	N/A	1.0
Shripney Road South Bersted*	WPS with CEO	N/A	-
Tangmere WTW[20]	WTW	Filter Works	3.2
Lidsey WTW[21]	WTW	Filter Works with Reed Beds	2.5

We have modelled the impact from Tangmere and Lidsey WTWs[22] due to concerns on the impact to bathing water quality from significant growth in the Tangmere WTW catchment. An increase in base load of faecal indicator organisms (FIO) of approximately 9% is expected which is likely to lead to a slight deterioration to existing bathing water quality.

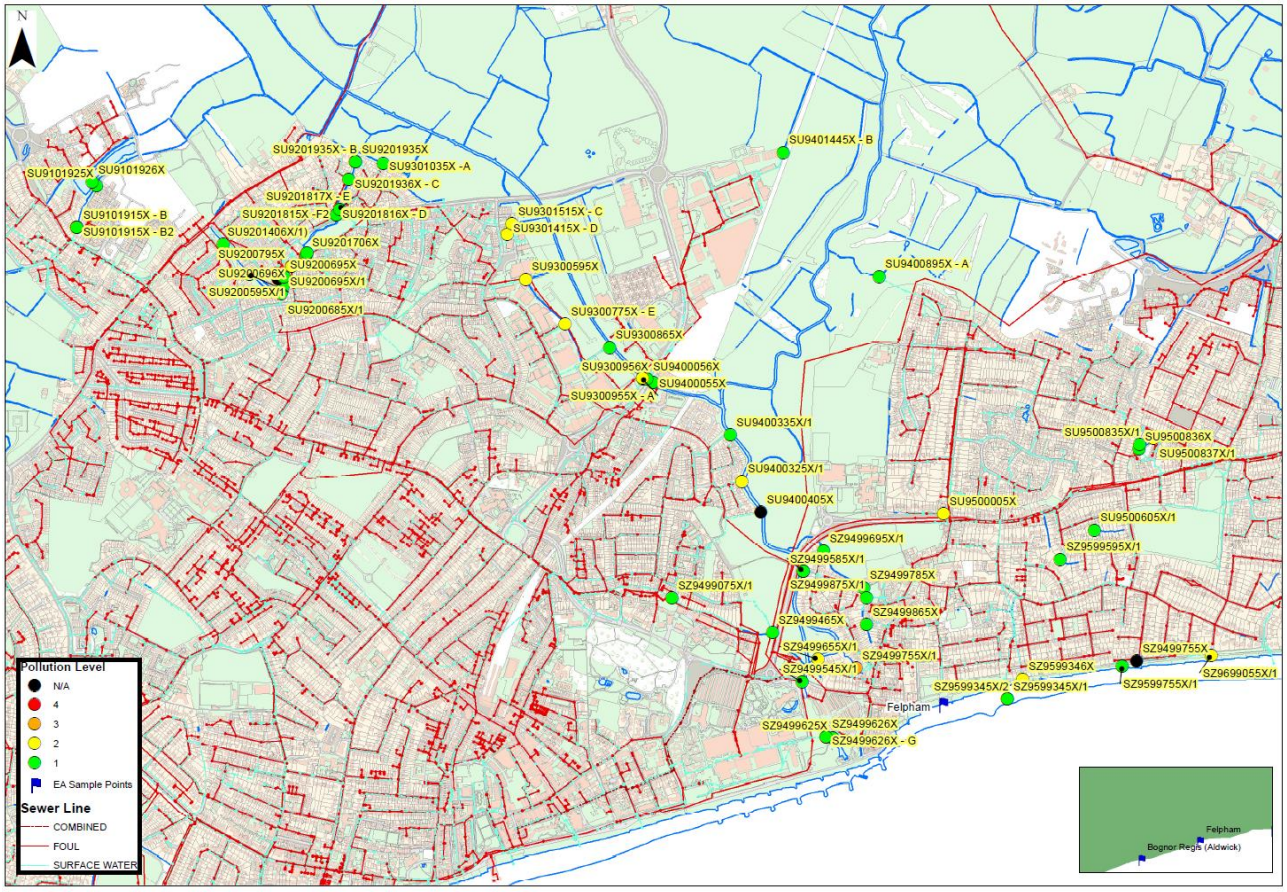
[18] Verified EDM spills reported to the 2012-2016
[19] No EDM record available
[20] EDM unreliable so spill frequency taken from models
[21] EDM unreliable so spill frequency taken from models
[22] Southern Water Initial Assessment of Tangmere and Lidsey WTWs on Bathing Water Quality at Felpham

Surface Water Network

The surface water network at Felpham has been investigated to outfall level as part of the AMP6 BWEP scheme at Felpham.

The investigation showed evidence of contamination, not necessarily from direct misconnections (level 2 pollution), at ten SW outfalls. The sampling highlighted two outfalls in particular with very high levels of faecal contamination, SZ9101915X and SZ9599345X. This shown below in Figure 44.

Figure 44 – Results of caging surveys from the AMP6 BWEP Scheme



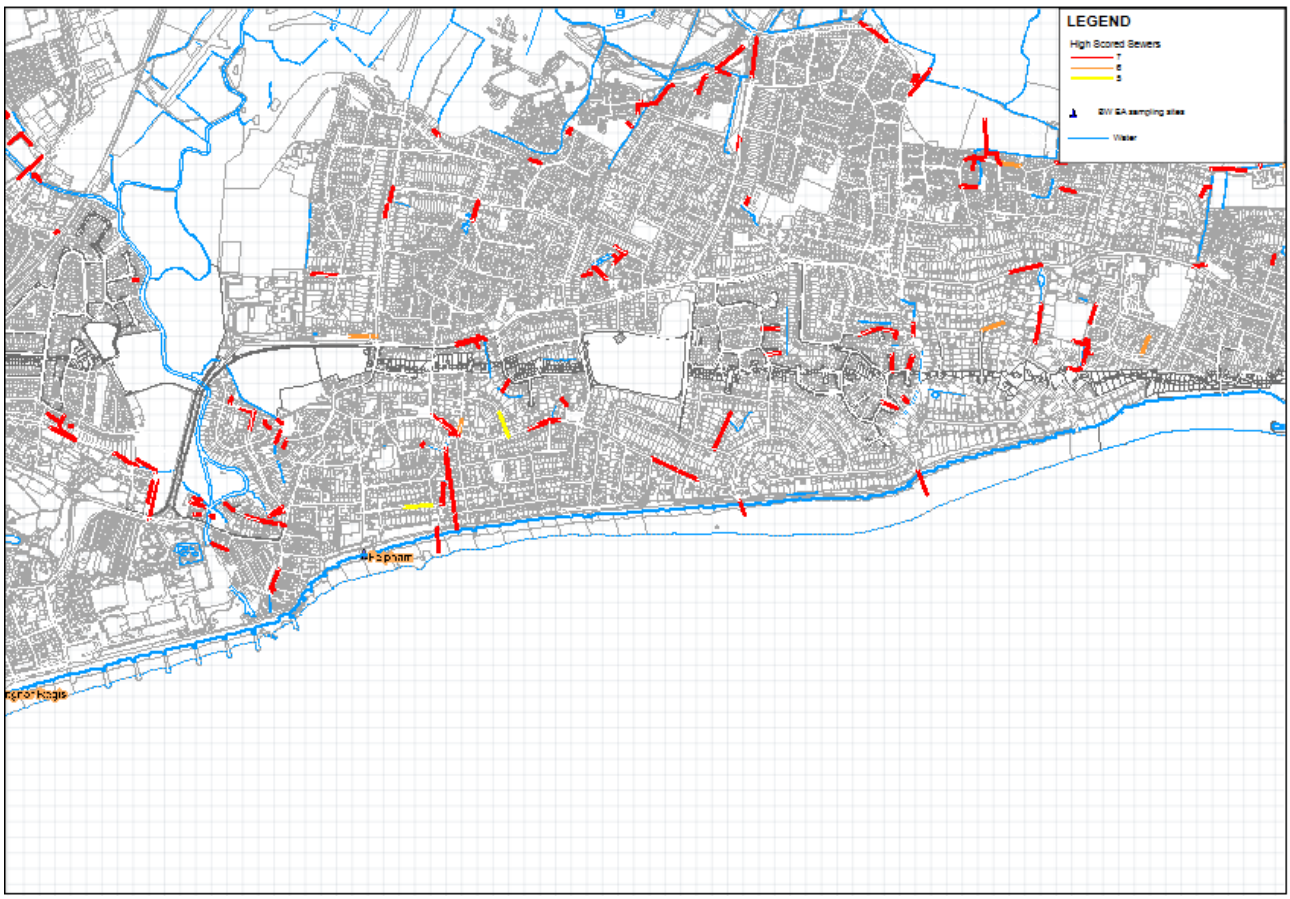
Associated water quality sampling of these outfalls found high levels of sewage contamination at two SW outfalls; SU9101915X (100,000 cfu/100ml) and SZ9599345X (11,000 cfu/100ml). A further eight SW outfalls had levels of IE or E.Coli of greater than 500 cfu/100ml.

Combined Sewerage Network

The integrity of the foul / combined sewerage network can have a significant impact on bathing water quality. The Southern Water Risk Scored Sewers (RSS) database shows 0.6 km of grades 5, 6 and 7 sewers which may be impacting the bathing water.

In addition to this, AMP6 BWEP survey identified pipe breaks and fractures at Davenport Road near to the bathing water which should also be considered as a potential source of urban pollution.

Figure 45 – Risk Scored Sewers Grade 5-7



The RSS database is an internal Southern Water system of grading pipes based on structural integrity, frequency of inspections and maintenance and criticality. Scores are from 1 to 7 with 7 being the highest risk sewers.

Agricultural Diffuse

Agricultural diffuse pollution in the form of the storage or spreading of slurries and manures, or the keeping of grazing of livestock has the potential to contribute to reductions in bathing water quality. This can be from the direct excretion of waste from livestock or polluted runoff after rainfall.

There is likely to be a significant impact from agricultural diffuse pollution within this bathing water catchment.

The Aldingbourne Rife catchment, inclusive of the Lidsey Rife, is largely agricultural north of the town of Bognor Regis. Previous river walkovers and satellite imagery suggests these areas are used for both arable purposes and the keeping and grazing of livestock and there are areas where the animals have direct access to the watercourse; 16 farms have been identified as having the potential to impact the bathing waters.

Table 35 shows evidence of agricultural pollution from cattle, sheep and horses contributing up to approximately 20% of the overall load in various places along the river reach.

Urban and Coastal Diffuse

Faecal waste from dogs and birds, as well as polluted urban runoff, and sewage discharges from boats or houseboats have the potential to contribute to reductions in bathing water quality.

The impact from dogs and birds are common issues at every bathing water site. Felpham beach has a ban on dogs during the bathing season.

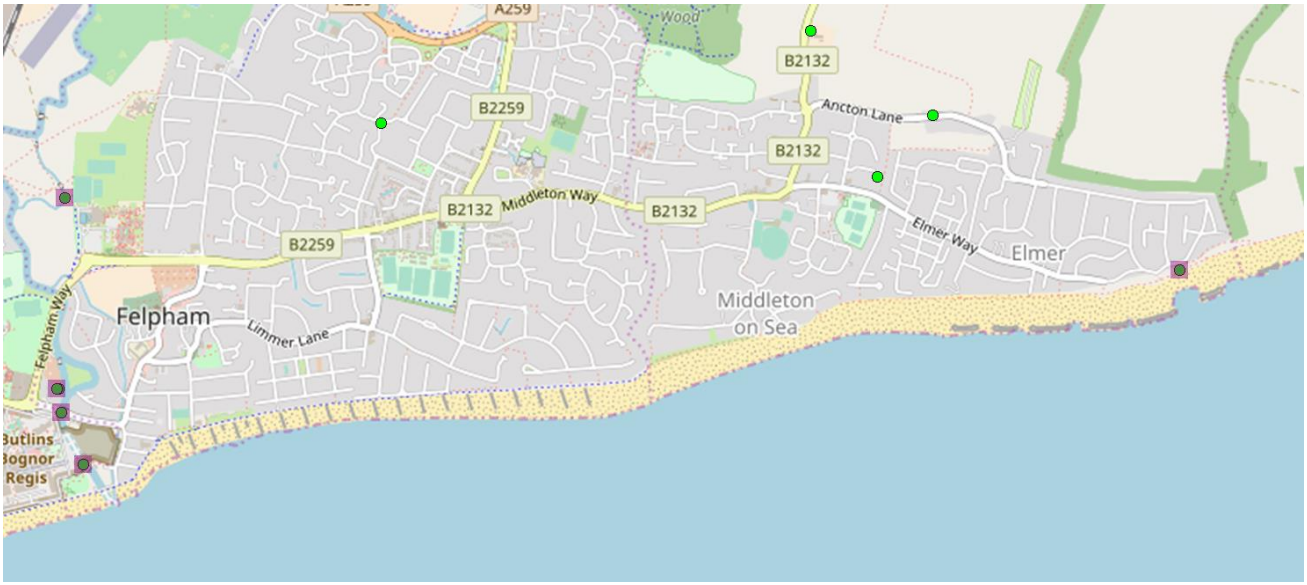
Table 35 shows evidence of pollution from dogs and birds contributing up to approximately 26% of the overall load in various places along the river reach.

Private Sewerage Infrastructure

There is unlikely to be a significant impact from private sewerage infrastructure although this is very hard to quantify at this stage given the lack of available information and the pathway through groundwaters.

There are 6 EA consented discharges of sewage within vicinity of Felpham and the Aldingbourne Rife river catchment. This includes three package treatment works serving both single domestic properties and larger commercial units. Figure 46 shows the locations of the private consented discharges.

Figure 46 – Location of EA private consented discharges



Historically issues at Felpham bathing water have also been connected with private sewerage issues at the Butlins Resort in Bognor Regis.

There have been no private pumping stations identified during the private pumping station transfer legislative changeover and the EA consented discharges database has not highlight any private sewage discharge in the immediate vicinity of the bathing water.

Historic Bathing Water Investigations

There have been previous SWS bathing water investigations carried out at this bathing water.

- Felpham BWEP Technical Appraisal v4 (2017)
- Initial Assessment of Tangmere and Lidsey WTWs on Bathing Water Quality at Felpham (2017)

There have also been multiple investigations undertaken by the Environment Agency.

An EA investigation was carried out in 2000 and the reports into the water quality at Felpham are listed below:

- Non-Compliant Bathing Water Investigation Felpham 1998-1999
- Non-Compliant Bathing Water Investigation Felpham 2000

These investigations into the water quality results at Felpham have identified several key findings:

1. Previous work has highlighted the link between contamination at Felpham and Bognor Regis East bathing water sampling site and Bognor Pier. It also appeared that contamination from the Aldingbourne Rife was impacting Felpham on tides moving west to east.

2. An environmental tracer survey was carried out in July 2000. Bacteria Bacillus Globigii (since recognised as Bacillus Atrophaeus) was dosed into the Aldingbourne Rife at Ladybrook Bridge for five hours and samples were taken every hour from the Rife, the bathing water sample points at Felpham and Bognor Regis East and also at Gloucester Road slipway and Bognor Regis Pier. The survey concluded that pollution from the Aldingbourne Rife affects the adjacent bathing water sites at Felpham and Bognor Regis East.

3. A surface water catchment survey illustrates that College Ditch is a significant pollution source, although the impact upon Aldingbourne Rife remains intermittent. The surface water sewer line running along Hook Lane appeared to be highly polluted and is likely to be the significant source of faecal contamination to the College Ditch. The College Ditch receives surface water from much of the centre of Bognor. In addition to the detailed SW system investigation, routine samples were taken at seven locations from the bathing water up to the Aldingbourne Rife and Lidsey Rife confluence over the course of two bathing seasons (2000, 2001). This data is presented in graphical format in Appendix B4. The high coliform concentrations at College Ditch triggered the more detailed investigation into the catchment feeding the Ditch. It can be seen that the faecal coliform concentrations appear much lower in 2001 than in 2000 (although not the case for total coliforms). Although this may be due to several reasons such as rainfall, it could also indicate the benefits achieved when corrective actions were carried out from issues identified in the College Ditch survey.

4. Historic investigations have concentrated on the large number of unsatisfactory CSOs, foul connections and leaks to surface water drainage in the catchment. Misconnections that were located have been rectified.

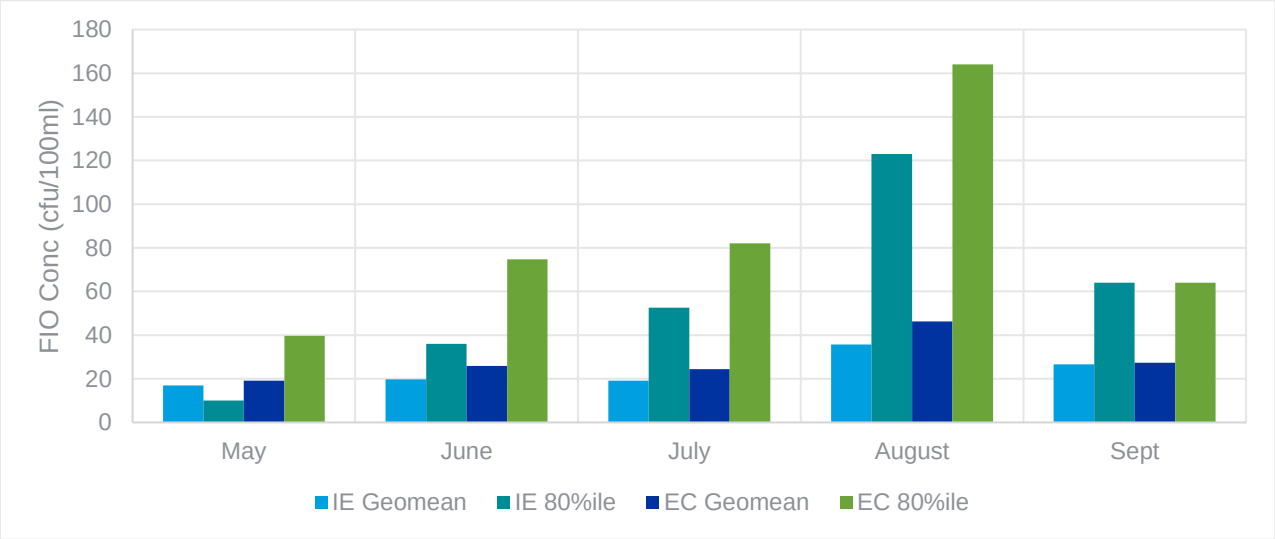
5. Previous exceedance of mandatory standards at Felpham (Spring 1999) were attributed to incidents reported at the Lidsey WTW. Lidsey WTW discharges to the Aldingbourne Rife, 5km upstream of Felpham bathing water. Treatment at the WTW does not receive disinfection (UV treatment).

Bathing Water Analysis

Correlations with Seasonality

Studies show there is a general increase in E.Coli and IE results throughout the summer peaking in late August. This may be due to increased population during the school summer holidays. Figure 47 shows the monthly average results at Pevensey Bay.

Figure 47 – Monthly Seasonality at Felpham



Correlations with Rainfall

The following table shows the exceedance events recorded for the five bathing seasons 2013-2017, and the rainfall occurring in the preceding 72 hours.

Table 37 – Exceedance Event Previous Rainfall

Event Date	Rainfall (72 hrs.)	Felpham BW	
		IE	E.Coli
17/08/2014 11:51	0.0	955	123
27/08/2014 11:10	44.4	164	164
01/07/2015 10:48	0.0	91	100
15/07/2015 10:45	3.6	10	136
20/07/2015 11:05	1.4	270	37
24/08/2015 11:38	37.8	10000	10000
21/06/2016 11:20	21.6	570	36
10/07/2016 11:35	1.2	882	64
08/08/2016 11:12	0.0	300	36
17/08/2016 10:50	0.0	10	164
22/08/2016 11:20	7.8	155	164
05/09/2016 11:30	16.0	420	744
17/05/2017 14:00	26.2	720	2300
29/08/2017 12:19	0.0	280	10

This analysis shows that of the 14 exceedance events between 2013 – 2017, 60% of these events occurred during periods of low (<5mm in 72 hours) or no rainfall. Half of the remaining samples occurred after periods of heavy or intense rainfall (>30mm in 72 hours). This would suggest multiple sources impacting the bathing water, some of which are wet weather driven.

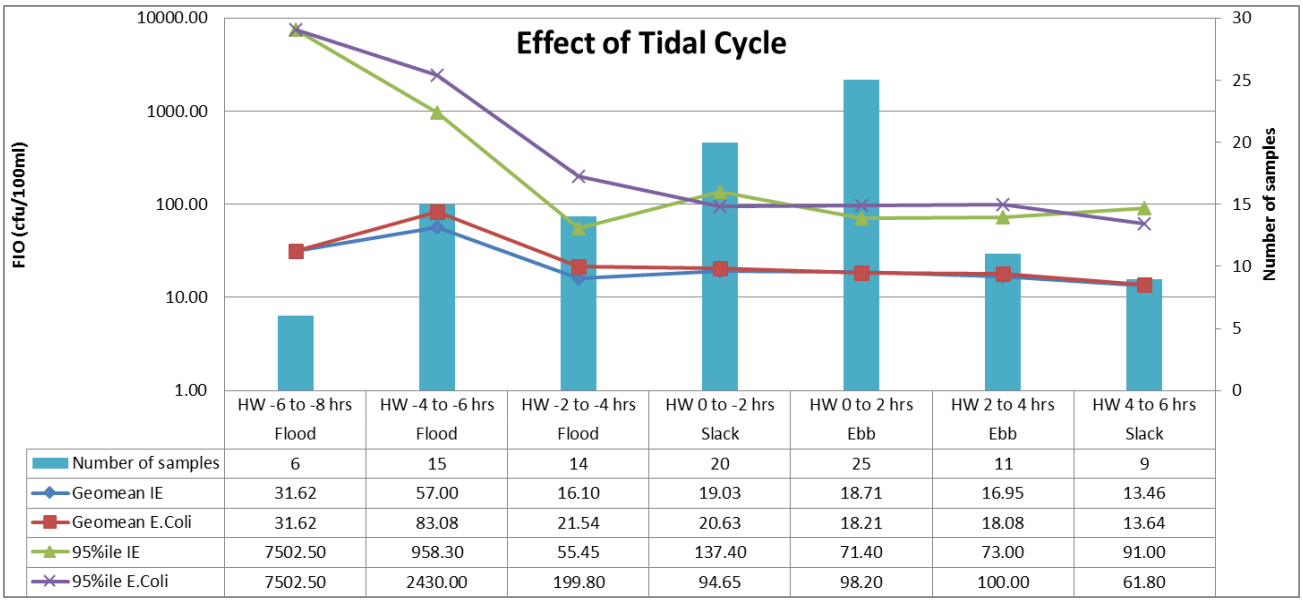
Correlations with Tide

Tidal data has been calculated from tidal constituents at Chichester Harbour. HW Slack at Felpham occurs approximately two hours before HW. LW Slack occurs approximately four to five hours after HW. The tidal direction during the flood tide is towards the east.

Correlations with Tide Phase (Direction)

Analysis of bathing water quality results against high water (HW) times may indicate the direction from which pollution has travelled and therefore the location of its source. Figure 48 shows bathing water quality results against the time relative to HW.

Figure 48 – Bathing Water Quality Against Time Since High Tide



	HW -6 to -8 hrs Flood	HW -4 to -6 hrs Flood	HW -2 to -4 hrs Flood	HW 0 to -2 hrs Slack	HW 0 to 2 hrs Ebb	HW 2 to 4 hrs Ebb	HW 4 to 6 hrs Slack
Number of samples	6	15	14	20	25	11	9
Geomean IE	31.62	57.00	16.10	19.03	18.71	16.95	13.46
Geomean E.Coli	31.62	83.08	21.54	20.63	18.21	18.08	13.64
95%ile IE	7502.50	958.30	55.45	137.40	71.40	73.00	91.00
95%ile E.Coli	7502.50	2430.00	199.80	94.65	98.20	100.00	61.80

Samples were obtained from 7 hours before high tide to 5.5 hours after high tide. Samples taken more than 2 hours before high tide have been considered to occur during a flood tide (west to east) and samples taken up to 4 hours after high tide have been considered to occur on an ebb tide (east to west).

Figure 48 shows that there is an increase in E.Coli and IE results between 8 and 4 hours before HW. This is particularly evident in the 95-percentiles of the results. Analysis shows that 50% of breaches of Excellent status occur between 6 and 4 hours before HW. 86% of exceedance events occur during a flood tide. The tidal direction during the flood tide is towards the east, indicating that the source of pollution is predominantly from west of the sample point.

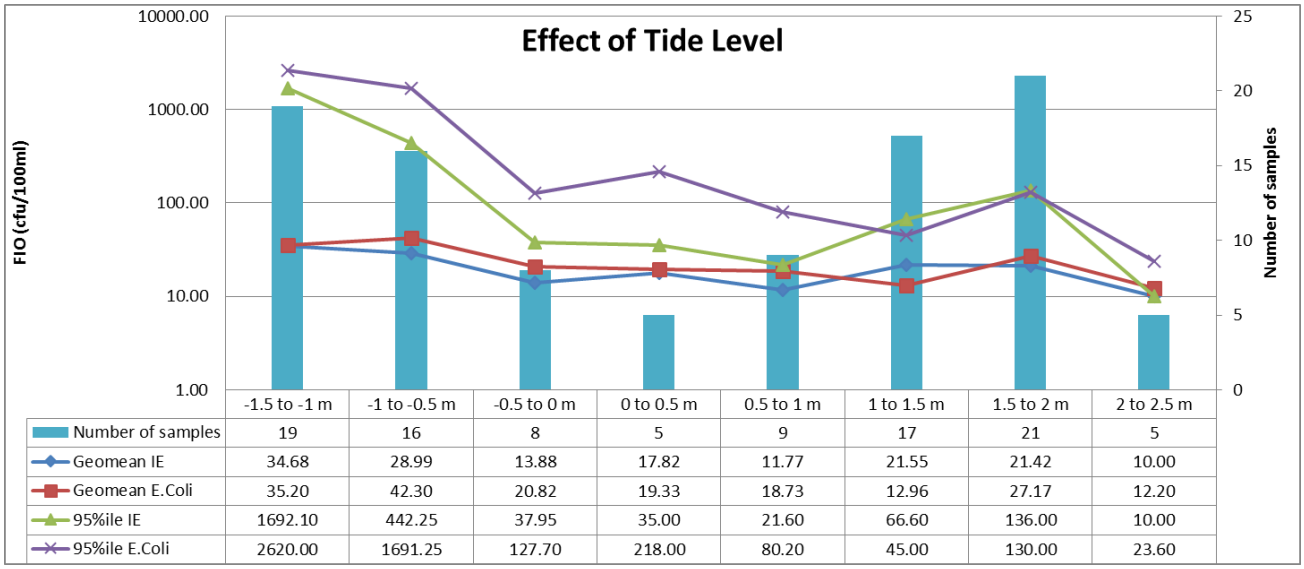
The Aldingbourne Rife is located to the west of the sample point and has previously been identified as being the predominant pathway for pollution to reach the sample point. The sample point is at a bearing of between 48° and 58° from the outfall of the Aldingbourne Rife, depending on the tide level. The tidal current direction between 8 and 4 hours before high water varies between a bearing of 58° and 80°23. This analysis supports the information about Aldingbourne Rife.

[23] Tidal directions are based on admiralty data from the tidal diamond location E: 492434, N: 094193.

Correlations with Tide Level

Further analysis of bathing water quality results against tide level may provide an indication of problems with exfiltration from the foul sewer systems or problems with discharges from outfalls with flap valves.

Figure 49 – Bathing Water Quality Against Tide Levels



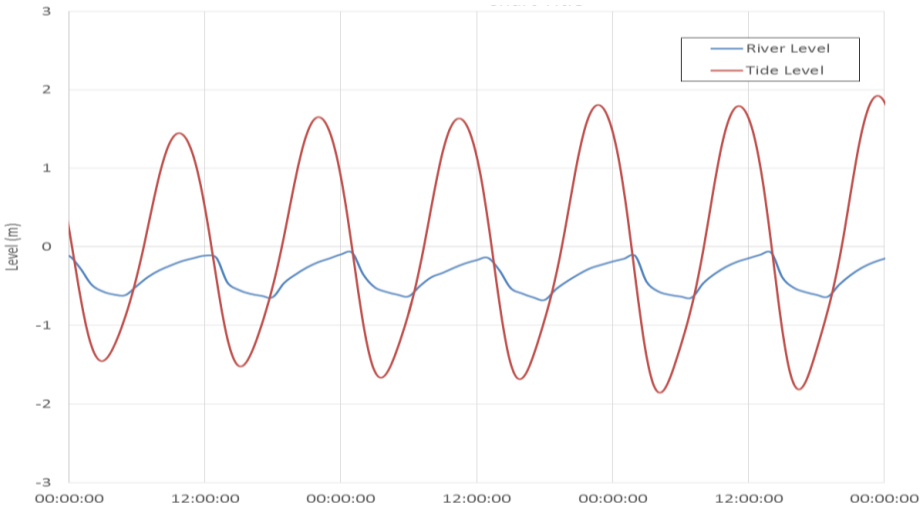
	-1.5 to -1 m	-1 to -0.5 m	-0.5 to 0 m	0 to 0.5 m	0.5 to 1 m	1 to 1.5 m	1.5 to 2 m	2 to 2.5 m
Number of samples	19	16	8	5	9	17	21	5
Geomean IE	34.68	28.99	13.88	17.82	11.77	21.55	21.42	10.00
Geomean E.Coli	35.20	42.30	20.82	19.33	18.73	12.96	27.17	12.20
95%ile IE	1692.10	442.25	37.95	35.00	21.60	66.60	136.00	10.00
95%ile E.Coli	2620.00	1691.25	127.70	218.00	80.20	45.00	130.00	23.60

Figure 49 shows the bathing water quality results against tide levels. The analysis shows that there is an increase in sample results when the tide level is greater than 0.5 m below Mean Sea Level (MSL). Between -0.5 to 0 m MSL and -1 to -0.5 m MSL, the 95-percentiles increase by more than a factor of 10 and the geomeans increase by a factor of 2.

The trend of higher samples occuring during low tides could be explained by the fact that the Aldingbourne Rife generally discharges freely by gravity when the sea level drops below a certain level and is tide-locked by flap valves when the sea is above this level. Felpham Pumping Station, owned and operated by the EA, can pump flows to sea through high level pipes during high tide in order to reduce levels in the river and prevent flooding. The pumps are controlled by a level gauge, though the level at which they activate is not known.

Figure 50 shows the water levels in the Aldingbourne Rife at the pumping station and the tide levels during a three day dry weather period under typical operating conditions. Note that the reference datum levels are arbitrary therefore this should only be used to give an indication of scale and timing.

Figure 50 – Aldingbourne Rife Levels at Felpham Pumping Station and Tide Levels



Summary of Tidal Correlations

Tidal analysis indicates that:

- Higher sample results largely occur when the direction of the tidal current is from west to east which supports the hypothesis that the Aldingbourne Rife is the predominant pathway for pollution to reach the sample point;
- Higher sample results largely occur during low tide when the Aldingbourne Rife discharges to sea, further indicating that it is the predominant pathway.

Likely Sources Impacting the Bathing Water

Table 38, below, shows the likely sources impacting the bathing water with regards to risk as a factor of likelihood and severity.

Table 38 – Key Sources Likely to be Impacting the Bathing Water

Source	Pathway	Risk	Justification
Agricultural diffuse pollution	Runoff into the drainage ditches	Med	Given the agricultural nature of the upper Aldingbourne Rife catchment it is highly likely that slurry stores or slurry spreading may present a risk of FIO pollution. There is a spike in 95%ile pollutant counts in late August that correlate with the "closed" period for use of some fertilizers on various receiving soils or crop types. MST has also confirmed that agricultural diffuse can contribute ~21% of the overall pollution along certain stretches of the river.
Dog Faeces	Direct to bathing water	Low – Med	The impact from dogs are common issues at most bathing water sites. Evidenced during microbial source tracing tests.
Bird Faeces	Direct to bathing water	Low – Med	The impact from birds are common issues at most bathing water sites. Evidenced during microbial source tracing tests.
Bognor Main CEO	Aldingbourne Rife	Med	CEO spills on average 2.4 times per bathing season according to EDM data. Proximity to end of Aldingbourne Rife suggests on the occasions it does spill, releases would impact the BW. Flooding events at Limmer Lane have been attributed to the incapacity of Bognor Main WPS. There have also been numerous pollution events at the WPS including a Category 4 event the day before a large exceedance of threshold standards, attributed to pump failure.
Gloucester Road Bognor CSO	Aldingbourne Rife	Low	CSO spills on average 1.0 times per bathing season according to EDM data. Proximity to end of Aldingbourne Rife suggests on the occasions it does spill, releases would impact the BW.
Lidsey and Tangmere WTW	Aldingbourne Rife	Med-High	Water quality sampling and MST results show considerable levels of human pollution coming from both the Aldingbourne and Lidsey Rife. The main cause of this is likely to be the continuous discharges from the WTWs. Growth within the Tangmere catchment is likely to increase this contribution by ~9%. The impact from storm discharges from these assets have not been quantified at this time. There was a proposal to install UV treatment in AMP3 but it did not go ahead.
Surface Water Misconnections	Direct to bathing water	Med	Caging surveys, WQ sampling of SW outfalls and visual inspections during river walkovers have evidenced a number of polluted surface water outfalls in and around Felpham. It is highly likely that polluted surface water outfalls contribute to reductions in BW quality.
Foul Exfiltration	Groundwater	Med	0.6km of high risk sewers near to the bathing water have been identified as having the potential to impact the water quality.

The complexity of issues at Felpham should be noted. In addition to these regularly evidenced sources there are a significant number of other sources at Felpham which appear to have been responsible for singular or occasional historic exceedance events but do not occur frequently enough to be addressed within this project. The number and scale of these sources however should be noted here.

Additional sources include:

- Numerous SIRF and PIRF hotspots including the foul flooding of Limmer Lane;
- Issues with the private sewerage from Butlins Holiday Park;
- Intermittent storm discharges from Chichester Road and Shripney Road CSOs;
- Multiple domestic and commercial non-SWS consented sewage discharges to the Aldingbourne Rife.
- Historical information (Southern Water DAP studies and information provided by the EA) indicates that the College Ditch is susceptible to pollution from the adjacent surface water catchment.

Defining Likely Solutions

Based on the sources outlined in the previous section the following solutions have been defined and costed.

Table 39 – Solution Costing

	Cost (£)	Justification
Investigation Costs		
Analysis (Desktop)	17,000	Allowance for known sites
Ammonia Sondes	30,000	3 sondes for 10 weeks
Asset Surveys	15,000	Allowance based on AMP6 BWEP costs
Catchment Flyovers	-	Not required
Coastal Modelling	25,000	Allowance based on AMP6 BWEP costs
Connectivity Survey	7,500	Allowance based on AMP6 BWEP costs
CCTV	15,000	Allowance based on AMP6 BWEP costs
Hydraulic Modelling	-	Not required
LSO / SSO Survey	10,000	Allowance based on AMP6 BWEP costs
Misconnections (to outfall)	7,000	Allowance based on AMP6 BWEP costs
River Walkover	5,000	Allowance for 5km of walkovers
WQ Sampling	28,000	1 summers sampling
Solution Appraisal	15,000	Allowance based on AMP6 costs
Investigation Overhead	80,886	Contingency, project management, and overhead
Investigation Costs	**255,386**	
Delivery Phase Costs		
Additional WQ Sampling	112,000	4 summers sampling
Hydraulic Modelling & Flow Surveys	60,000	Allowance based on AMP6 BWEP costs
Misconnections (to property)	242,728	Based on unit rate for 656 properties
Agricultural Measures	400,000	Based on 16 farms and AMP6 BWEP costs
Bird and Dog Measures	20,000	Allowance to mitigate impact from dogs, birds and litter
Misconnection Rectification	235,036	Allowance based on AMP6 Hastings Costs
Sewer Rehab	79,104	Prices from CET based on lengths of Risk Scored Sewers
Enhanced Network Maintenance	11,451	Prices from CET based on lengths of Risk Scored Sewers

WPS / CSO Storage	754,662	Prices from CET to provide 333m^3 storage[24]
WPS Refurb	541,222	Prices from CET
Private Infrastructure Allowance	70,000	Allowance for private infrastructure
WTW Upgrades	2,368,684	Allowance for Tertiary UV treatment at Lidsey[25]
LSO / SSO Survey	-	Not required
Optioneering and Design	268,810	6% Allowance
Delivery Overhead	5,224,411	Contingency, project management, and overhead
Delivery Costs	**10,388,108**	
Total Project Cost (P50)	**10,643,494**	

Deliverability

Based on the information known about the bathing water to date the following comments can be made surrounding the confidence of delivery and an appropriate target standard.

Table 40 – Confidence in Deliverability

	Level	Comments
Confidence of Source	Medium	Multiple investigations and surveys have taken place over a number of years which have highlighted several key pollution sources
Confidence of Delivery	Medium	Reliance on co-operation from agricultural land owners and space at the WTWs for installation of UV treatments
Confidence of Outcome	Medium	The large number of potential sources and complexities of issues mean a high confidence of achieving the outcome cannot be given.
Confidence of Costs	Low	The number and nature of sources means there is not a high confidence in cost certainty. Extensive work is required for example before detailed costs can be provided for the appropriate provision of UV treatment at the WTWs. The stated costs in this provide a realistic risk profile for a site of this complexity.
Appropriate Target Standard	Good Status	May be appropriate for a PR19 scheme looking to improve bathing water quality to Good status. Guaranteeing Excellent status on an annual basis however would be very difficult given the number of potential sources.

[24] In the Felpham BW IMP3 scheme that has been priced this cost has been shared with the Bognor East BW IMP3.
[25] This cost has not been verified by CET

Gurnard

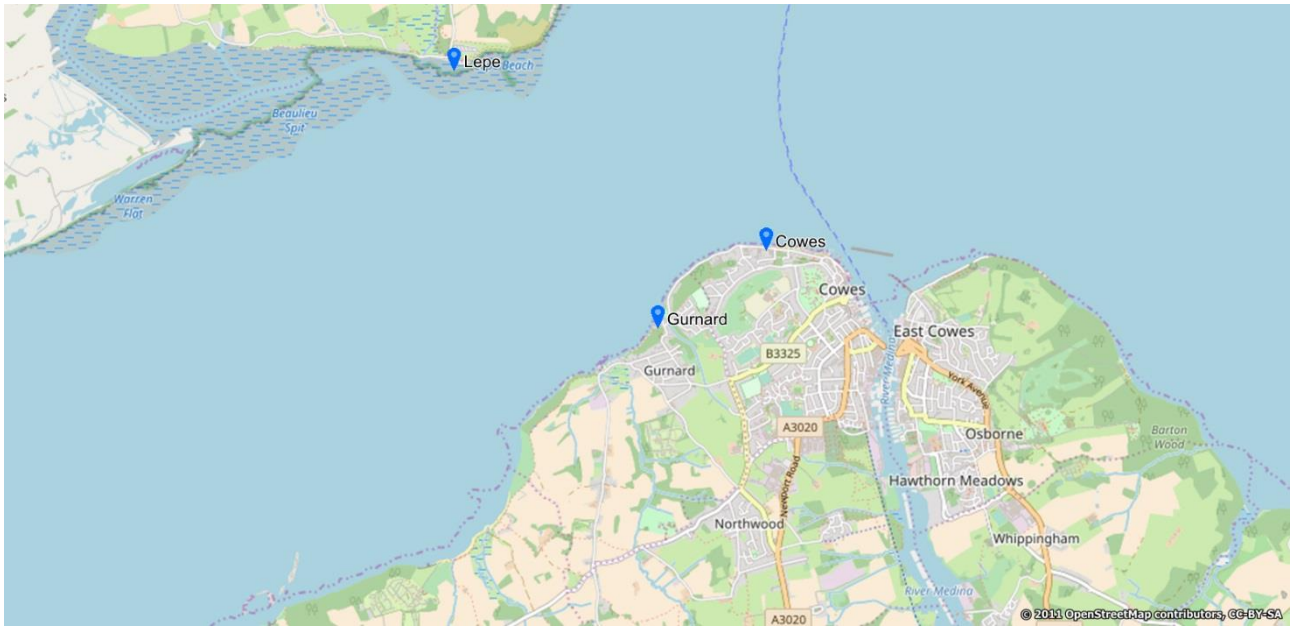
Background

Gurnard is a small resort situated on the Isle of Wight, west of Cowes, facing across the Solent to the New Forest shore. The gravel beach slopes gently into deep water where the currents can be strong. There are various facilities along the esplanade. The Gurnard Luck and River Jordan flows to the sea in the vicinity of the beach and there are two storm outfalls.

The natural drainage (hydrological) catchment surrounding the bathing water is about 900 hectares. The catchment is mostly farmland with some housing and part of Parkhurst Forest.

Figure 11 below shows location of Gurnard Bathing Water Sampling Point.

Figure 51 – Location of Bathing Water Sample Point



Bathing Water Quality

Table 8 below shows the annual and official four year rolling classifications at the bathing water.

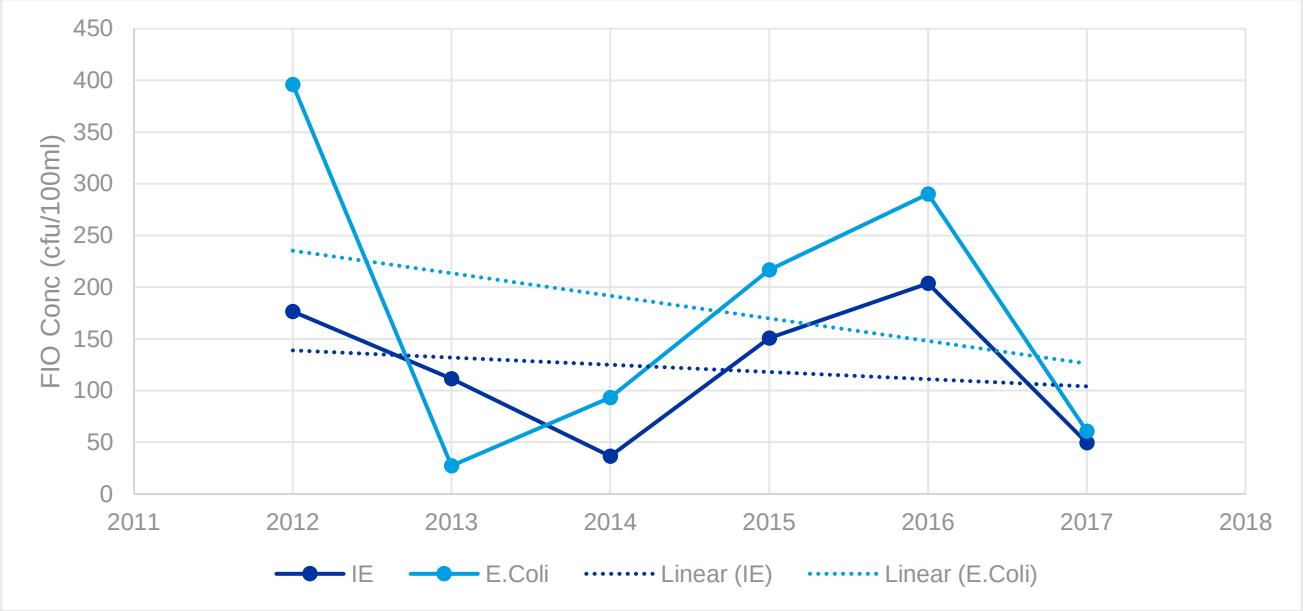
Table 41 – Historic Bathing Water Quality Classifications

	2013	2014	2015	2016	2017
Annual	Good	Excellent	Good	Sufficient	Excellent
Official	Good	Good	Good	Good	Excellent

Bathing Water quality at Gurnard regularly falls below Excellent status for both the official and annual assessments.

Figure 11 below shows the 95%ile annual trending quality of the bathing water quality over the last five years.

Figure 52 – Historic Bathing Water Quality Trends (Based on the Annual Assessment)

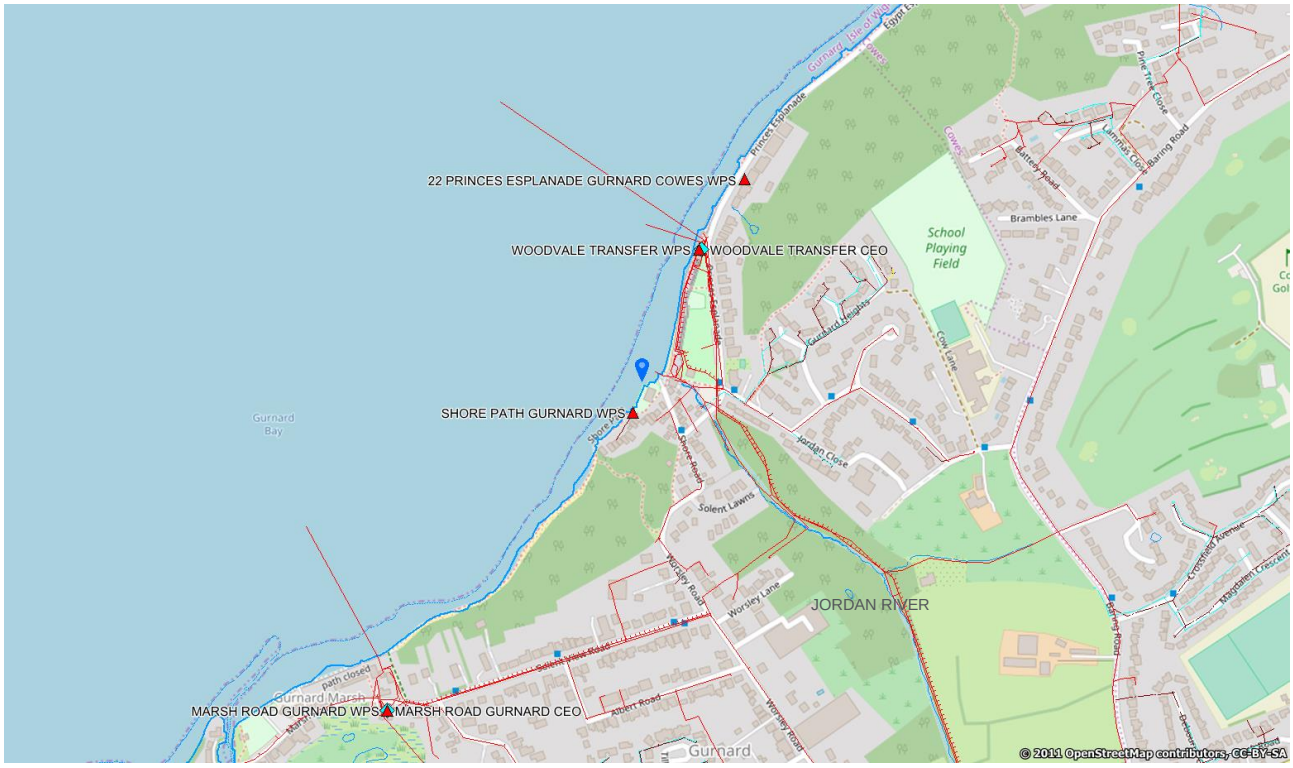


There would appear to be a slight increase in bathing water quality over the last five years. Annual results however are still variable and there is little obvious reason for an improving trend at this location.

Catchment Features

A brief desktop assessment has identified some key features and potential sources of the bathing water sampling results. This is shown in Figure 53.

Figure 53 – Catchment Features



The River Jordan discharges onto the beach via an outfall pipe less than 50m from the bathing water sample point making this a significant pollutant pathway. The Gurnard Luck discharges to the coast approx. 800m to the south east.

Southern Water Assets

Continuous / Intermittent Discharges

Table 1542 details the Southern Water continuous and intermittent assets which may impact the bathing waters. Environment Agency guidance on spill frequency from these assets are as follows:

Storm overflows that discharge directly into or impact on bathing waters with a target of good or sufficient status, must have no more than 3 significant spills per bathing season on average. Where more than one discharge affects the bathing water, you must aggregate the spills. The aggregated spills must be no more than 3 significant spills on average per bathing season. For storm overflows that discharge to bathing waters with a target of excellent status, the emission standard is for no more than 2 significant spills per bathing season on average. Whether a spill is significant will be considered on a site-specific basis. In general, for design purposes, a spill greater than 50m3 is significant.

Table 42 – Continuous / Intermittent Discharges

Asset Name	Asset Type	Treatment Type	2012-2016 Average Bathing Season Spill Frequency
Marsh Road WPS	CEO	N/A	3.6
Woodvale Transfer WPS	CEO	N/A	1.8
Woodvale Transfer WPS	CSO	N/A	11.6

It should be noted that overflows from both Marsh Road WPS CEO and Woodvale Transfer CSO are discharged along sea outfalls both of which have been designed to protect bathing water quality. Woodvale Transfer CEO, for emergency discharges only, is the only outfall which discharges direct to the near shore.

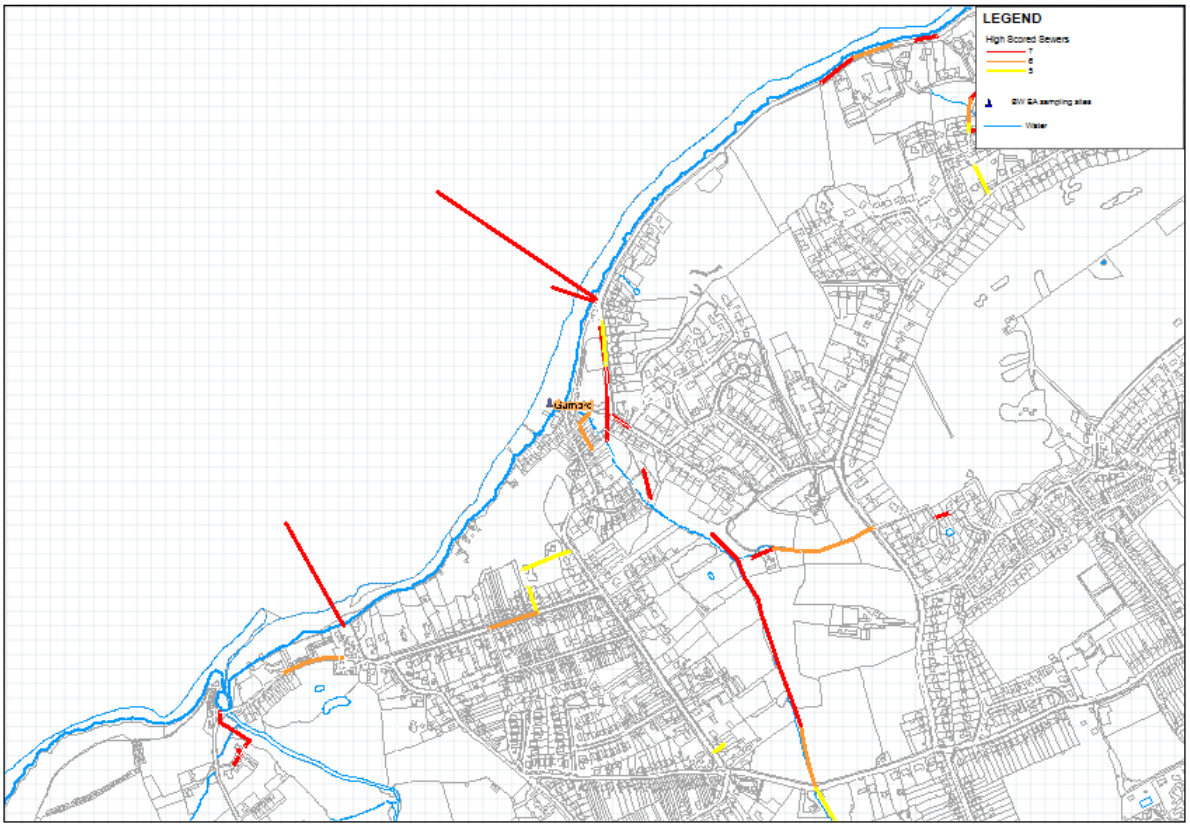
Surface Water Network

Foul to surface water misconnections can have a significant impact on bathing water quality. 728 properties and 1 surface water outfall have been identified which, if polluted, may have the ability to impact bathing water quality.

Combined Sewerage Network

The integrity of the foul / combined sewerage network can have a significant impact on bathing water quality. The Southern Water Risk Scored Sewers (RSS) database shows 2.8 km of grades 5, 6 and 7 sewers which may be impacting the bathing water.

Figure 54 – Risk Scored Sewers Grade 5-7



The RSS database is an internal Southern Water system of grading pipes based on structural integrity, frequency of inspections and maintenance and criticality. Scores are from 1 to 7 with 7 being the highest risk sewers.

Agricultural Diffuse

Agricultural diffuse pollution in the form of the storage or spreading of slurries and manures, or the keeping of grazing of livestock has the potential to contribute to reductions in bathing water quality. This can be from the direct excretion of waste from livestock or polluted runoff after rainfall.

There is likely to be an impact from agricultural diffuse pollution within this bathing water catchment. The rivers Gurnard Luck and Jordan flow through areas of agricultural farmland and 5 farms have been identified as having the potential to impact the bathing waters.

Urban and Coastal Diffuse

Faecal waste from dogs and birds, as well as polluted urban runoff, and sewage discharges from boats or houseboats have the potential to contribute to reductions in bathing water quality.

The impact from dogs and birds are common issues at most bathing water sites. There is a ban on dogs between the 1st May and 30 September at Gurnard beach.

Private Sewerage Infrastructure

There is likely to be an impact from private sewerage infrastructure although this is very hard to quantify at this stage given the lack of available information and the pathway through groundwaters.

There is anecdotal evidence from operations of a private WPS adjacent to the River Jordan which is believed to regularly surcharge and flow into the river during periods of high rainfall. No further information on this asset or its location is available at this time.

One private pumping station has been identified during the private pumping station transfer as being under the control of the EA.

The EA Consented Discharges database indicates two separate private domestic sewerage discharges within 200m of the Gurnard Luck, registered to Mr C & Mrs R Bish and Mr and Mrs R E King.

Figure 55 – EA Consented Discharges

Historic Bathing Water Investigations

There have not been previous SWS bathing water investigations carried out at this bathing water

There have been sporadic investigations undertaken by the Environment Agency at Gurnard. These have concluded:

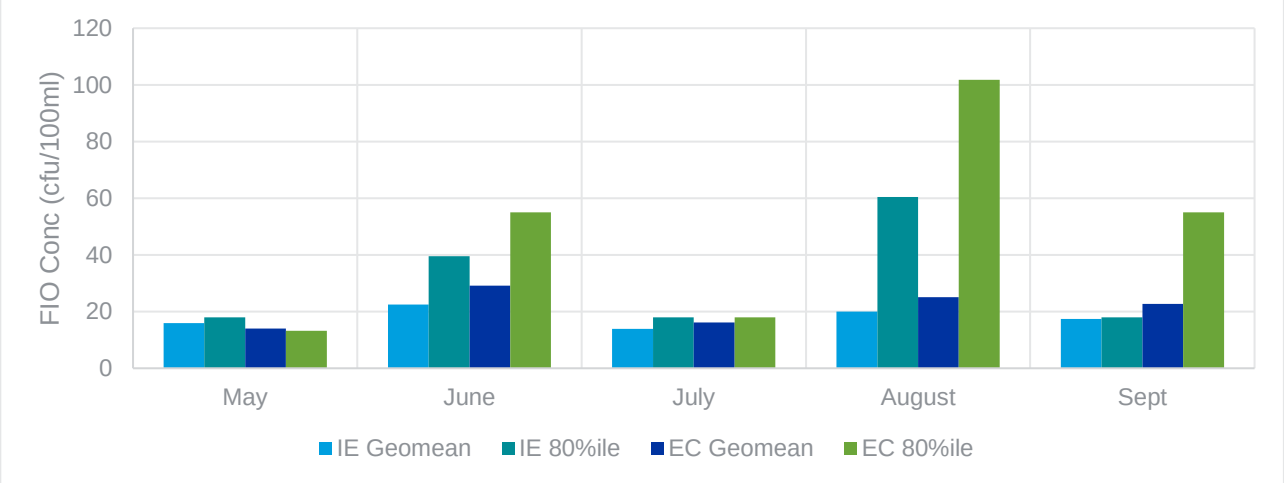
- In 1998 the River Jordan was shown to discharge contaminated surface water within 50 metres of the sampling point. Leaking public and private sewers were sealed and this eliminated the contamination.
- A single breach of standards during the 2000 bathing season was caused by a pumping station emergency overflow. The pumping station has since been rebuilt and should prevent recurrence.
- Another single breach in May 2001 was due to heavy rainfall which caused a storm water discharge from the Woodvale storm overflow. At the time the overall Woodvale scheme (diversion to Sandown sewage treatment works) was not completed and all of the storm capacity was used up.

Bathing Water Analysis

Correlations with Seasonality

Studies show no clear correlation with seasonality although results appear to peak in August. Figure 56 below shows the monthly average results at Gurnard.

Figure 56 – Monthly Seasonality at Gurnard



Correlations with Rainfall

This bathing water is subject to short term pollution. Short term pollution is caused when heavy rainfall washes faecal material into the sea from livestock, sewage and urban drainage via rivers and streams. At this site the risk of encountering reduced water quality increases after rainfall and typically returns to normal after 1-3 days.

The following table shows the exceedance events recorded for the five bathing seasons 2013-2017. The exceedance values being shaded.

Table 43 – Exceedance Event Previous Rainfall

Event Date/Time	Previous 72 hours Rainfall (mm)	Gurnard BW	
		E.Coli	IE
08/05/2013 13:13	5.6	10	630
22/06/2013 14:20	5.4	55	100
27/08/2014 11:10	40.0	100	100
22/06/2015 10:31	8.9	320	240
23/08/2015 12:50	11.8	220	340
22/09/2015 13:45	10.7	100	100
20/06/2016 10:26	27.8	1600	1800
02/08/2016 10:22	24.1	540	260
30/07/2017 10:30	22.1	310	300

This shows that of the nine exceedance events between 2013 and 2017, all events occurred after periods of moderate to heavy rainfall (>5mm in 72 hours), suggesting that rainfall is a significant influence in bathing water quality results at Gurnard.

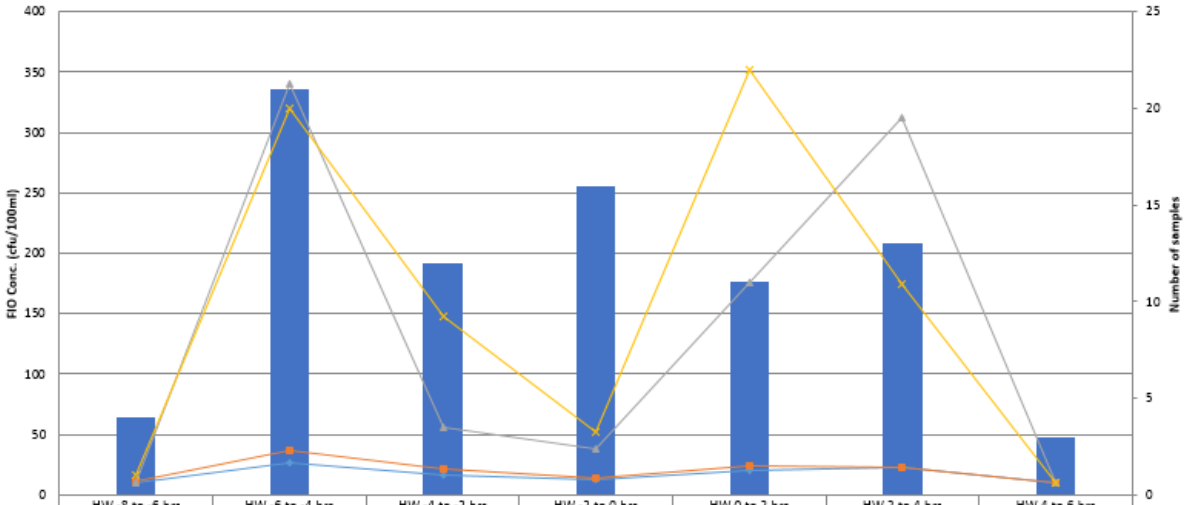
Correlations with Tide

Tidal data has been calculated from tidal constituents at Portsmouth Harbour. HW Slack at Gurnard occurs approximately two hours before HW. LW Slack occurs approximately four to five hours after HW. The tidal direction during the flood tide is towards the east.

Correlations with Tide Phase (Direction)

Analysis of bathing water quality results against high water (HW) times may indicate the direction from which pollution has travelled and therefore the location of its source. Figure 57 shows bathing water quality results against the time relative to HW.

Figure 57 – Bathing Water Quality Against Time Since High Tide



	HW -8 to -6 hrs Ebb	HW -6 to -4 hrs Ebb	HW -4 to -2 hrs Slack	HW -2 to 0 hrs Flood	HW 0 to 2 hrs Flood	HW 2 to 4 hrs Flood	HW 4 to 6 hrs Slack
No. of samples	4	21	12	16	11	13	3
Geomean IE	10.00	26.21	15.88	11.98	20.62	22.66	10.00
Geomean E.Coli	11.58	36.22	21.61	14.33	23.83	23.09	10.00
95%ile IE	10.00	340.00	55.80	38.50	175.50	312.00	10.00
95%ile E.Coli	16.80	320.00	148.15	52.00	352.00	174.80	10.00

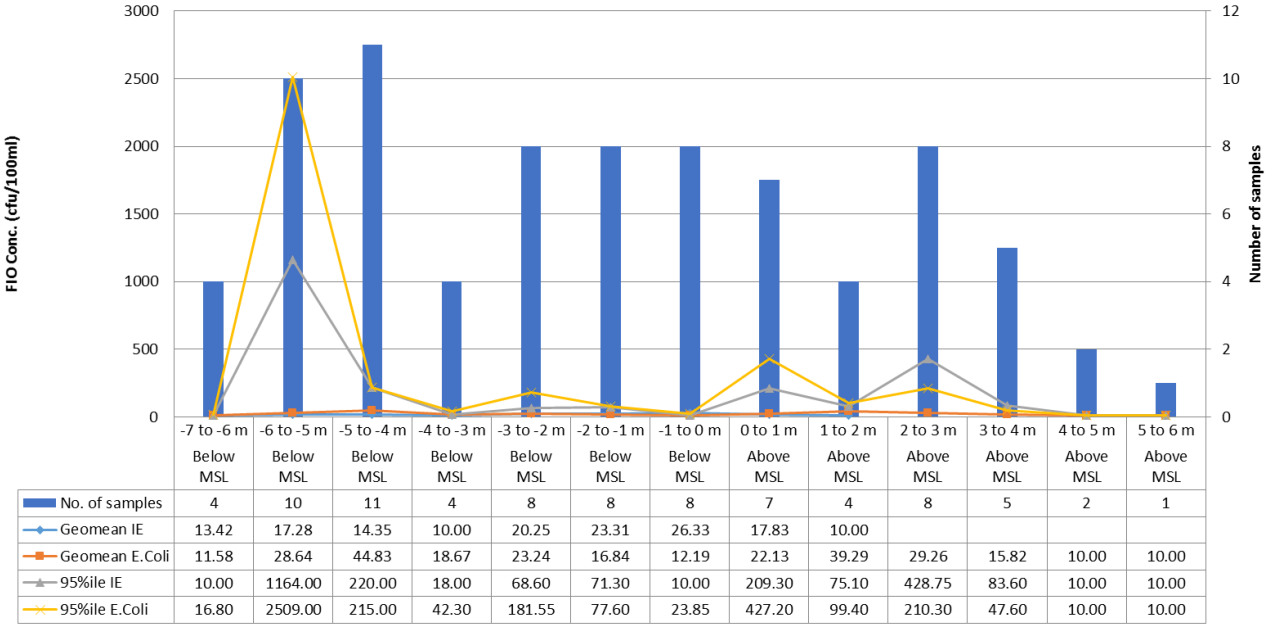
Samples were obtained from 7 hours before high tide to 5.5 hours after high tide. Samples taken more than 2 hours before high tide have been considered to occur during a flood tide (west to east) and samples taken up to 4 hours after high tide have been considered to occur on an ebb tide (east to west).

Figure 13 shows that between 2011 and 2015 there are two significant 95%ile peaks for both E.coli (HW -6 to -4 hrs and 0 to 2 hrs) and IE (HW-6 to -4 hrs and 2 to 4 hrs). Although this is not replicated in the geomean values. The analysis also shows the lowest concentrations of FIOs occur at both low and high-water slack. Further coastal modelling would be required in order to determine if the water quality is affected by the tide.

Correlations with Tide Level

Further analysis of bathing water quality results against tide level may provide an indication of problems with exfiltration from the foul sewer systems or problems with discharges from outfalls with poorly functioning (or no) flap valves.

Figure 58 – Bathing Water Quality Against Tide Levels



	-7 to -6 m Below MSL	-6 to -5 m Below MSL	-5 to -4 m Below MSL	-4 to -3 m Below MSL	-3 to -2 m Below MSL	-2 to -1 m Below MSL	-1 to 0 m Below MSL	0 to 1 m Above MSL	1 to 2 m Above MSL	2 to 3 m Above MSL	3 to 4 m Above MSL	4 to 5 m Above MSL	5 to 6 m Above MSL
No. of samples	4	10	11	4	8	8	8	7	4	8	5	2	1
Geomean IE	13.42	17.28	14.35	10.00	20.25	23.31	26.33	17.83	10.00				
Geomean E.Coli	11.58	28.64	44.83	18.67	23.24	16.84	12.19	22.13	39.29	29.26	15.82	10.00	10.00
95%ile IE	10.00	1164.00	220.00	18.00	68.60	71.30	10.00	209.30	75.10	428.75	83.60	10.00	10.00
95%ile E.Coli	16.80	2509.00	215.00	42.30	181.55	77.60	23.85	427.20	99.40	210.30	47.60	10.00	10.00

Figure 58 shows the bathing water quality results against tide levels. The analysis shows the 95%ile E.Coli and IE results increase to a peak concentration at -6 to -5m below Mean Sea Level (MSL). This is not replicated in the geomean values.

Likely Sources Impacting the Bathing Water

Table 44, below, shows the likely sources impacting the bathing water with regards to risk as a factor of likelihood and severity.

Table 44 – Key Sources Likely to be Impacting the Bathing Water

Source	Pathway	Risk	Justification
Agricultural diffuse pollution	Via Watercourses	Med	The rivers Gurnard Luck and Jordan flow through areas of agricultural farmland and 5 farms have been identified as having the potential to impact the bathing waters
Dog Faeces	Direct to bathing water	Low – Med	The impact from dogs are common issues at every bathing water site.
Bird Faeces	Direct to bathing water	Low – Med	The impact from birds are common issues at every bathing water site.
Woodvale Transfer CEO	Via SSO direct to BW	Low – Med	Spills on average 1.8 times per bathing season which is less than the guideline standards for Excellent bathing water quality.
Woodvale Transfer CSO	Via LSO direct to BW	Low – Med	Spills on average 11.6 times per bathing season which is greater than the guideline standards for Good bathing water quality. However, flows are discharged down a sea outfall designed to protect bathing water quality.
Marsh Road Gurnard CEO	Via LSO direct to BW	Low – Med	Spills on average 3.6 times per bathing season which is greater than the guideline standards for Good bathing water quality. However, flows are discharged down a sea outfall designed to protect bathing water quality.

Private Sewerage	Various	High	The EA Consented Discharge database indicates two separate private domestic sewerage discharges within 200m of the Gurnard Luck. Anecdotal evidence also indicated issues with a private WPS adjacent to the River Jordan.
Surface Water Misconnections	Direct to bathing water	Med	Surface water outfalls, if polluted, may have the ability to impact bathing water quality.
Foul Exfiltration	Groundwater	Med	2.8km of high risk sewers near to the bathing waters have been identified as having which have the potential to impact water quality

Defining Likely Solutions

Based on the sources outlined in the previous section the following solutions have been defined and costed.

Table 45 – Solution Costing

	Cost (£)	Justification
Investigation Costs		
Analysis (Desktop)	34,000	Allowance for desktop assessment for little known sites
Ammonia Sondes	30,000	3 sondes for 10 weeks
Asset Surveys	15,000	Allowance for asset surveys
Catchment Flyovers	-	Not required
Coastal Modelling	25,000	Allowance made for coastal impact assessment
Connectivity Survey	7,500	Allowance for connectivity surveys
CCTV	15,000	Allowance for CCTV surveys
Hydraulic Modelling	-	Not required
LSO / SSO Survey	10,000	Allowance for basic outfall surveys
Misconnections (to outfall)	2,000	Based on 2 outfalls
River Walkover	5,000	Allowance for 5km of walkovers
WQ Sampling	28,000	1 summers sampling
Solution Appraisal	15,000	Allowance for solution appraisal
Investigation Overhead	86,449	Contingency, project management, and overhead
Investigation Costs	**272,949**	
Delivery Phase Costs		
Additional WQ Sampling	112,000	4 summers sampling
Hydraulic Modelling & Flow Surveys	60,000	To check the impact from CSOs
Misconnections (to property)	35,745	Based on 728 properties
Agricultural Measures	125,000	Based on farms and AMP6 BWEP costs
Bird and Dog Measures	20,000	Allowance based on AMP6 BWEP costs
Misconnection Rectification	84,923	2 outfalls and 728 properties based on Hastings AMP5 costs
Sewer Rehab	406,139	Prices from CET based on lengths of risk scored sewers
Enhanced Network Maintenance	68,000	Prices from CET based on lengths of risk scored sewers

WPS / CSO Storage	-	Not required as CSOs designed to protect BW quality
WPS Refurb	800,000	High level estimate taken from CET cost curves
Private Infrastructure Allowance	70,000	Allowance for private infrastructure
WTW Upgrades	-	Not required
LSO / SSO Works	-	Unlikely to be required, costs covered in contingency budget
Optioneering and Design	94,444	6% Allowance
Delivery Overhead	1,898,308	Contingency, project management, and overhead
Delivery Costs	**3,774,559**	
Total Project Cost (P50)	**4,047,508**	

Deliverability

Based on the information known about the bathing water to date the following comments can be made surrounding the confidence of delivery and an appropriate target standard.

Table 46 – Confidence in Deliverability

	Level	Comments
Confidence of Source	Low - Medium	Whilst the contamination from the River Jordan would perhaps be the obvious source of pollution, this is not reflected in the desktop tidal analysis undertaken within this report.
Confidence of Delivery	High	None of the potential sources identified within this report would represent a high-risk delivery item as the majority are within the control, or ability of Southern Water to influence.
Confidence of Outcome	Medium	Understanding the complexities of the tides around Gurnard are crucial to getting confirmation of the source. Until this is undertaken confidence of outcome cannot be high.
Confidence of Costs	Low	No allowance has been made for improvements to Woodvale Transfer and Marsh Road CSOs based on the assumption these were designed to protect bathing water quality. Similarly, no allowance has been made for CSOs in Cowes which are believed to be directed by tides away from Gurnard. However, detailed coastal modelling may alter these assumptions bringing significant costs.
Appropriate Target Standard	Excellent Status	If tidal analysis proves the assumptions within this report this site may be appropriate for a PR19 scheme looking to improve bathing water quality to Excellent status

Seagrove

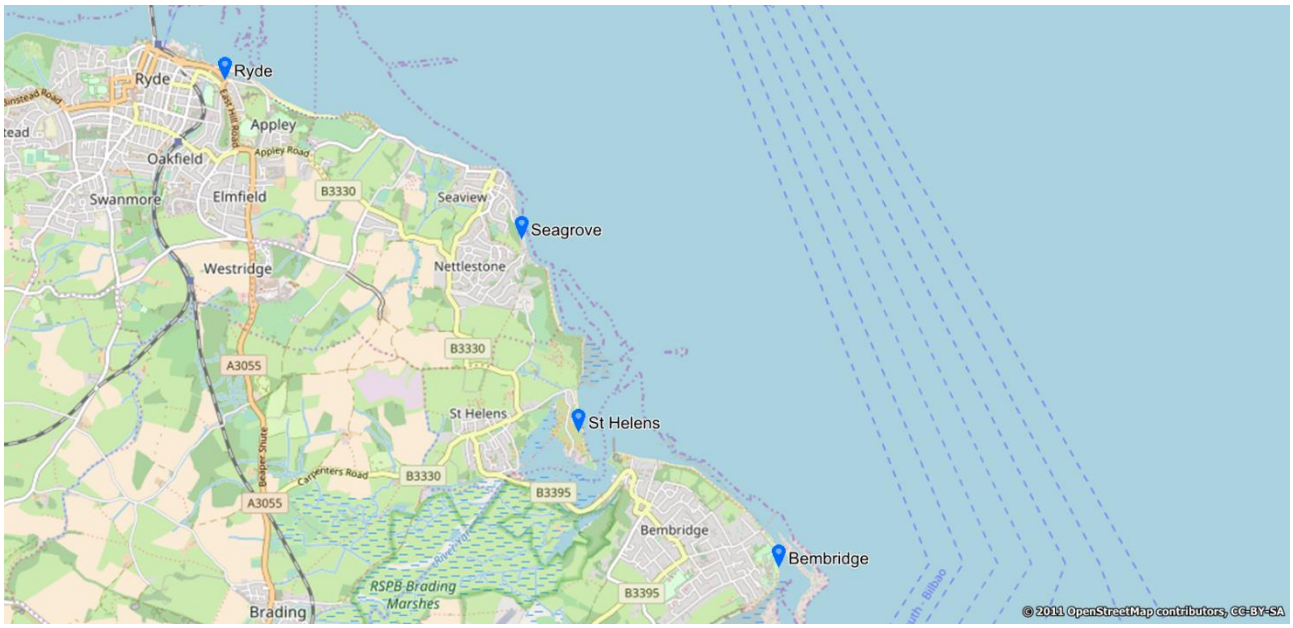
Background

Seagrove is a small bay situated on the east coast of the Isle of Wight. Measuring less than 1km in length, the bay slopes gently, with channels and sandbanks at low tide. The beach is mainly sand. Two streams cross the beach and there is a sewage overflow just offshore at the north end that could operate in response to significant rainfall.

The natural drainage (hydrological) catchment surrounding the bathing water is about 100 hectares. The catchment is mainly urban, but with a few fields.

Figure 59 below shows the location of Seagrove Bathing Waters Sampling Point.

Figure 59 – Location of Bathing Water Sample Point



Bathing Water Quality

Table 8 below shows the annual and official four year rolling classifications at the bathing water.

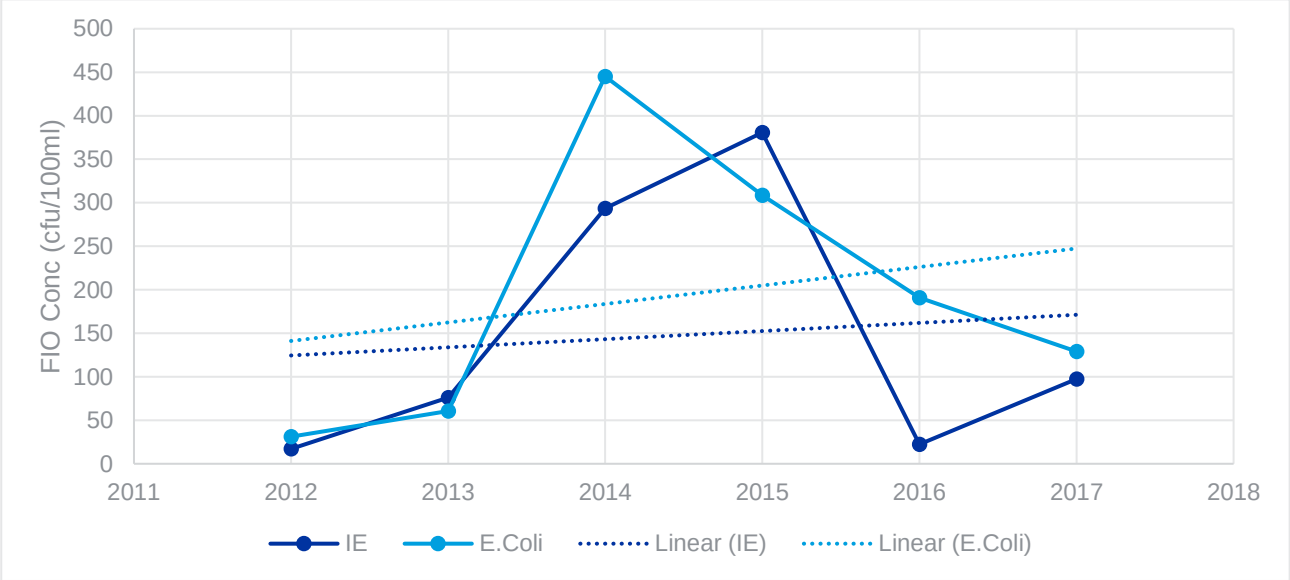
Table 47 – Historic Bathing Water Quality Classifications

	2013	2014	2015	2016	2017
Annual	Excellent	Sufficient	Poor	Excellent	Excellent
Official	Excellent	Good	Good	Good	Good

Bathing Water quality at Seagrove often falls below Excellent status for both the annual and four year rolling assessments.

Figure 11 shows the 95%ile annual trending quality of the bathing water quality over the last five years.

Figure 60 – Historic Bathing Water Quality Trends



There was significant deterioration in water quality in 2014 and 2015 which highlights the variability of results at Seagrove on an annual basis. There is no obvious reason for a reduction in bathing water quality during this period, at this site.

Catchment Features

A brief desktop assessment has identified some key features and potential sources of the bathing water sampling results. This is shown in Figure 61.

Figure 61 – Catchment Features

There are two small streams which discharge to the coast 250 and 350m south of the sample location which could be pollutant pathways. The history of ground movement and the presence of a local fault line also suggests pollution travelling through groundwater is quite likely.

Southern Water Assets

Continuous / Intermittent Discharges

Table 15 details the Southern Water continuous and intermittent assets which may impact the bathing waters. Environment Agency guidance on spill frequency from these assets are as follows:

Storm overflows that discharge directly into or impact on bathing waters with a target of good or sufficient status, must have no more than 3 significant spills per bathing season on average. Where more than one discharge affects the bathing water, you must aggregate the spills. The aggregated spills must be no more than 3 significant spills on average per bathing season. For storm overflows that discharge to bathing waters with a target of excellent status, the emission standard is for no more than 2 significant spills per bathing season on average. Whether a spill is significant will be considered on a site-specific basis. In general, for design purposes, a spill greater than 50m3 is significant.

Table 48 – Continuous / Intermittent Discharges

Asset Name	Asset Type	Treatment Type	Average Bathing Season Spill Frequency[26]
Esplanade Seaview	WPS/CEO	N/A	0.2
High Salterns Ryde	CSO	N/A	No EDM data
Latimer Road St Helens	WPS/CEO	N/A	0.6
Salterns Road Seaview	WPS/CEO/EMO	N/A	1.0
Seagrove Bay	WPS/CEO	N/A	0.0
Spring Vale	WPS/CEO	N/A	2.2
Springvale Road Ryde	EMO	N/A	No EDM data
The Duver St Helens	WPS/CEO	N/A	2.8

Surface Water Network

Foul to surface water misconnections can have a significant impact on bathing water quality. 656 properties and 10 surface water outfalls have been identified which, if polluted, may have the ability to impact bathing water quality.

Combined Sewerage Network

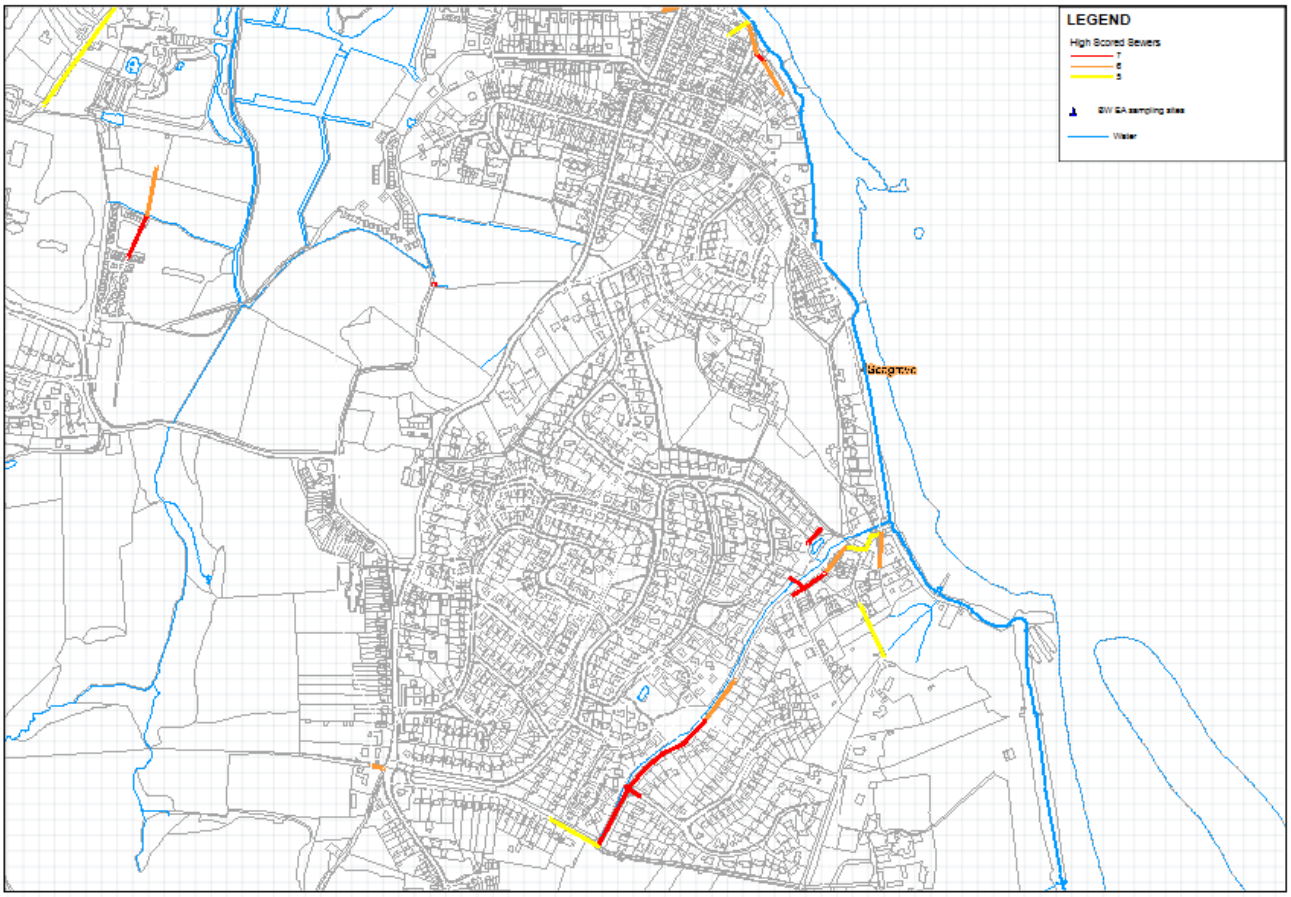
The integrity of the foul / combined sewerage network can have a significant impact on bathing water quality. The Southern Water Risk Scored Sewers (RSS) database shows 0.63 km of grades 5, 6 and 7 sewers which may be impacting the bathing water.

The RSS database is an internal Southern Water system of grading pipes based on structural integrity, frequency of inspections and maintenance and criticality. Scores are from 1 to 7 with 7 being the highest risk sewers.

The foul sewer that runs along the sea front has a history of collapse, attributed to subsidence/ground movement. A collapse occurred at Bonny Blink in 2001. A section of sewer was replaced by Southern Water in 2008 (PRN: 14810).

[26] Average spill frequency per bathing season based on 2012-2016 verified EDM records

Figure 62 **– Risk Scored Sewers Grade 5-7**



The RSS database is an internal Southern Water system of grading pipes based on structural integrity, frequency of inspections and maintenance and criticality. Scores are from 1 to 7 with 7 being the highest risk sewers.

Agricultural Diffuse

Agricultural diffuse pollution in the form of the storage or spreading of slurries and manures, or the keeping of grazing of livestock has the potential to contribute to reductions in bathing water quality. This can be from the direct excretion of waste from livestock or polluted runoff after rainfall.

There is unlikely to be a significant impact from agricultural diffuse pollution within this bathing water catchment. Two small streams run through an urban setting has been identified with no farms within immediate area.

Urban and Coastal Diffuse

Faecal waste from dogs and birds, as well as polluted urban runoff, and sewage discharges from boats or houseboats have the potential to contribute to reductions in bathing water quality.

The impact from dogs and birds are common issues at every bathing water site. There are no dog restrictions in place at Seagrove beach.

Private Sewerage Infrastructure

There is unlikely to be a significant impact from private sewerage infrastructure although this is very hard to quantify at this stage given the lack of available information and the pathway through groundwaters.

There have been no private pumping stations identified during the private pumping station transfer changeover and the EA consented discharges database has not highlight any private sewage discharge in the immediate vicinity of the bathing water.

Historic Bathing Water Investigations

There have not been any previous SWS bathing water investigations carried out at this bathing water.

There have been multiple investigations undertaken by the Environment Agency. These have concluded:

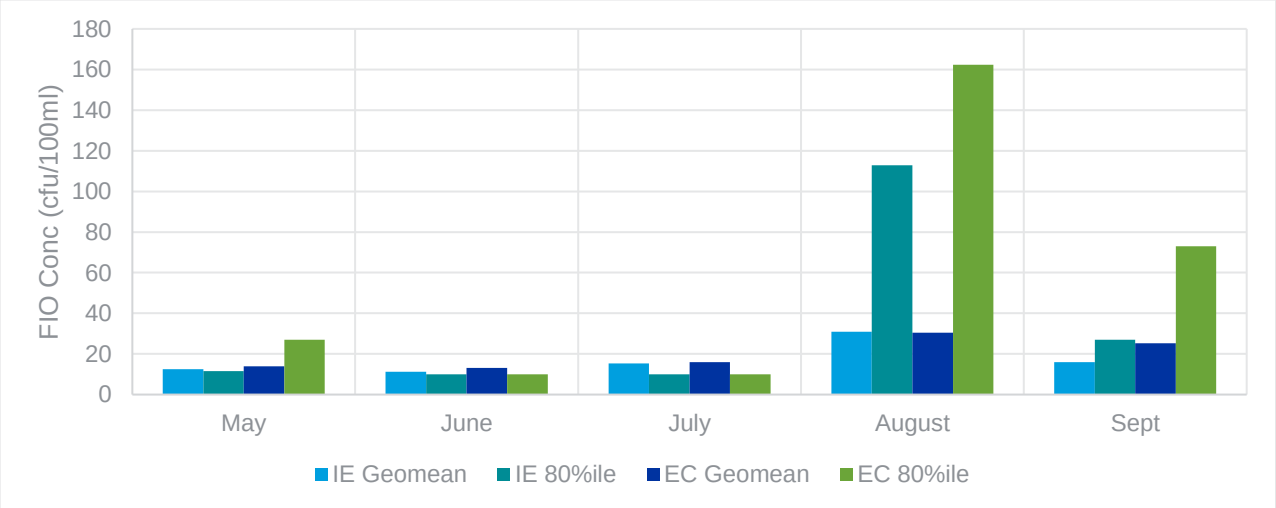
- A length of suspect sewer was sealed in June 1999 and follow-up tracer studies by the Environment Agency confirmed that the work was effective in preventing leakage to the surface water system.
- The foul sewer that runs along the sea front has a history of collapse, attributed to subsidence/ground movement. A collapse occurred at Bonny Blink in 2001. A section of sewer was replaced by Southern Water in 2008.
- Substantial improvements were made to the sewerage system during 1990-1993 when local sewage discharges were diverted to the Ryde Sea Outfall, the Seagrove storm outfall was repaired and direct foul connections to it were connected to mains sewerage. Improvements at three storm overflows in the area were completed during 2000-2005. Diversion of flows from Ryde Sea Outfall to Sandown sewage treatment works for treatment and discharge via a new long sea outfall was completed prior to the 2001 bathing season.
- The Seagrove storm overflow is just offshore and the Seaview Esplanade storm overflow is at the north end of the beach. These outfalls are designed to a once in five year standard. These outfalls can discharge when heavy rainfall overwhelms the sewerage system but are designed to ensure that bathing water compliance is not affected.

Bathing Water Analysis

Correlations with Seasonality

Plotting bathing water quality results from 2012-2017 by month shows a significant decrease in bathing water quality for both geomean and 80%ile values in August indicating a potential link with tourism. The Cowes Week sailing regatta also occurs during August and has had previous links with causing bathing water pollution incidents in nearby Cowes.

Figure 63 – Seasonality Analysis



Correlations with Rainfall

According to the EA, Seagrove is not impacted by short term pollution after rainfall.

Table 49 shows the exceedance events recorded for the five bathing seasons 2013-2017. The exceedance values being shaded.

Table 49 – Exceedance Event Previous Rainfall

Event Date/Time	Previous 72 hours Rainfall (mm)	Seagrove BW	
		E.Coli	IE
05/08/2013 12:26	10.0	440	560
10/08/2014 13:05	30.2	570	1100
26/08/2014 13:45	0.0	1500	2000
22/09/2014 11:17	0.0	620	10
26/07/2015 12:20	44.6	220	460
03/08/2015 12:16	0.0	340	420
24/08/2015 12:52	40.9	3300	3600
19/06/2016 13:45	7.0	540	27
05/09/2016 14:45	13.0	1200	27
24/07/2017 14:05	38.7	1500	320
11/09/2017 14:30	10.6	36	145

This analysis data shows that of the 11 exceedance events between 2013 and 2017, the majority (70%) of these events occurred after periods of moderate to heavy rainfall (>5mm in 72 hours). The remaining of the exceedance events therefore occurred after periods of little to no rainfall (<5mm in 72 hours). This shows that rainfall is a potential influence in bathing water quality results at Seagrove BW.

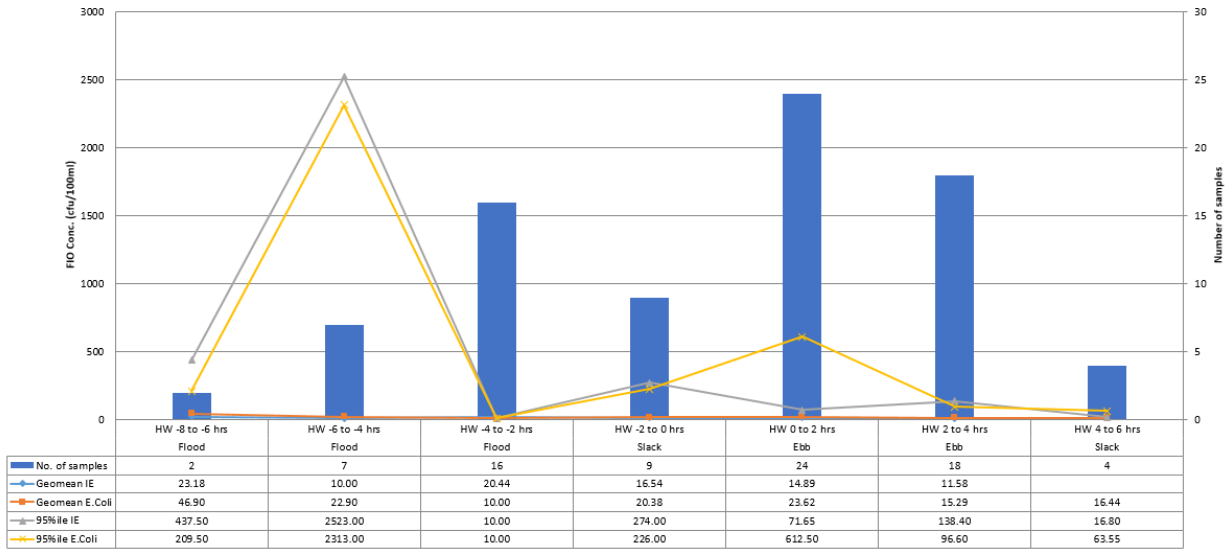
Correlations with Tide

Tidal data has been calculated from tidal constituents at Sandown Harbour. HW Slack at Seagrove occurs approximately two hours before HW. LW Slack occurs approximately four to five hours after HW. The tidal direction during the flood tide is towards the east.

Correlations with Tide Phase (Direction)

Analysis of bathing water quality results against high water (HW) times may indicate the direction from which pollution has travelled and therefore the location of its source. Figure 64 shows bathing water quality results against the time relative to HW.

Figure 64 – Bathing Water Quality Against Time Since High Tide



	HW -8 to -6 hrs Flood	HW -6 to -4 hrs Flood	HW -4 to -2 hrs Flood	HW -2 to 0 hrs Slack	HW 0 to 2 hrs Ebb	HW 2 to 4 hrs Ebb	HW 4 to 6 hrs Slack
No. of samples	2	7	16	9	24	18	4
Geomean IE	23.18	10.00	20.44	16.54	14.89	11.58	
Geomean E.Coli	46.90	22.90	10.00	20.38	23.62	15.29	16.44
95%ile IE	437.50	2523.00	10.00	274.00	71.65	138.40	16.80
95%ile E.Coli	209.50	2313.00	10.00	226.00	612.50	96.60	63.55

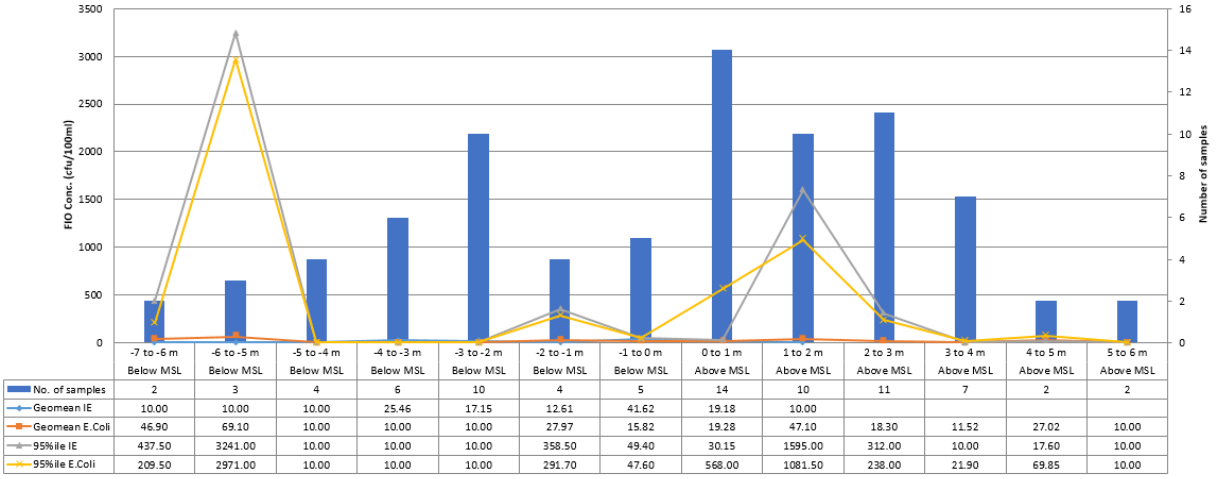
Samples were obtained from 7 hours before high tide to 5.5 hours after high tide. Samples taken more than 2 hours before high tide have been considered to occur during a flood tide (west to east) and samples taken up to 4 hours after high tide have been considered to occur on an ebb tide (east to west).

Figure 64 shows that between 2011 and 2015 peak 95%ile values for E.Coli and IE occur just after at HW -6 to -4, during the flood tide. This suggests a key source impacting bathing water quality may be from the east.

Correlations with Tide Level

Further analysis of bathing water quality results against tide level may provide an indication of problems with exfiltration from the foul sewer systems or problems with discharges from outfalls with flap valves.

Figure 65 – Bathing Water Quality Against Tide Levels



	-7 to -6 m Below MSL	-6 to -5 m Below MSL	-5 to -4 m Below MSL	-4 to -3 m Below MSL	-3 to -2 m Below MSL	-2 to -1 m Below MSL	-1 to 0 m Below MSL	0 to 1 m Above MSL	1 to 2 m Above MSL	2 to 3 m Above MSL	3 to 4 m Above MSL	4 to 5 m Above MSL	5 to 6 m Above MSL
No. of samples	2	3	4	6	10	4	5	14	10	11	7	2	2
Geomean IE	10.00	10.00	10.00	25.46	17.15	12.61	41.62	19.18	10.00				
Geomean E.Coli	46.90	69.10	10.00	10.00	10.00	27.97	15.82	19.28	47.10	18.30	11.52	27.02	10.00
95%ile IE	437.50	3241.00	10.00	10.00	10.00	358.50	49.40	30.15	1595.00	312.00	10.00	17.60	10.00
95%ile E.Coli	209.50	2971.00	10.00	10.00	10.00	291.70	47.60	568.00	1081.50	238.00	21.90	69.85	10.00

Figure 65 shows the bathing quality results against tide level. The analysis shows the highest IE and E.coli geomeans, 95%iles and the greatest number of exceedances all occur when the tide level is between -6 to -5m below Mean Sea Level (MSL), with a second peak at 1 to 2 m above MSL. At this stage it is difficult to assess whether this is a factor of tide level or tidal phase.

Likely Sources Impacting the Bathing Water

Table 50 – Key Sources Likely to be Impacting the Bathing Watershows the likely sources impacting the bathing water with regards to risk as a factor of likelihood and severity.

Table 50 – Key Sources Likely to be Impacting the Bathing Water

Source	Pathway	Risk	Justification
Dog Faeces	Direct to bathing water	Low – Med	The impact from dogs are common issues at most bathing water sites. There are no dog restrictions in place at Seagrove beach.
Bird Faeces	Direct to bathing water	Low – Med	The impact from birds are common issues at most bathing water sites.
Emergency Overflows	Sewer network	Low - Med	Spring Vale and The Dulver CSOs are the only overflows to marginally exceed the guideline spill frequency standards for Excellent status. However due their distance from the sample point its highly unlikely that works would be required these locations. The nearest CSO, Seagrove Bay was not shown to spill at all during the 2010-2015 bathing seasons.

Private Sewerage	Groundwater	Low – Med	Private sewerage, including septic tanks, cess pits, sewerage and pumping station all have the potential to impact bathing water quality
Surface Water Misconnections	Direct to bathing water	Med	Surface water outfalls, if polluted, may have the ability to impact bathing water quality.
Foul Exfiltration	Groundwater	Med	0.63km of high risk sewers near to the bathing water have been identified as having the potential to impact the water quality.

Defining Likely Solutions

Based on the sources outlined in the previous section the following solutions have been defined and costed.

Table 51 – Solution Costing

	Cost (£)	Justification
Investigation Costs	-	
Analysis (Desktop)	34,000	Allowance based on AMP6 costs
Ammonia Sondes	-	Not required
Asset Surveys	15,000	Allowance based on AMP6 costs
Catchment Flyovers	-	Not required
Coastal Modelling	5,000	Allowance for tidal excursion checks
Connectivity Survey	7,500	Allowance based on AMP6 costs
CCTV	15,000	Allowance based on AMP6 costs
Hydraulic Modelling	-	Not required
LSO / SSO Survey	-	Not required
Misconnections (to outfall)	10,000	Based on unit rate for SW outfalls
River Walkover	-	Not required
WQ Sampling	28,000	1 summers sampling
Solution Appraisal	15,000	Allowance based on AMP6 costs
Investigation Overhead	60,028	Contingency, project management, and overhead
Investigation Costs	**189,528**	
Delivery Phase Costs		
Additional WQ Sampling	112,000	4 summers sampling
Hydraulic Modelling & Flow Surveys	-	Not required
Misconnections (to property)	126,123	Based on unit rate for 656 properties

Agricultural Measures	-	Not required
Bird and Dog Measures	20,000	Allowance to mitigate impact from dogs, birds and litter
Misconnection Rectification	142,999	Allowance based on AMP6 Hastings Costs
Sewer Rehab	47,240	Prices from CET based on lengths of Risk Scored Sewers
Enhanced Network Maintenance	12,185	Prices from CET based on lengths of Risk Scored Sewers
WPS / CSO Storage	-	Not required
WPS Refurb	890,944	Prices from CET to mitigate impact of MEICA failures
Private Infrastructure Allowance	70,000	Allowance for private infrastructure
WTW Upgrades	-	Not required
LSO / SSO Survey	-	Not required
Optioneering and Design	71,002	6% Allowance
Delivery Overhead	1,510,043	Contingency, project management, and overhead
Delivery Costs	**3,002,536**	
Total Project Cost (P50)	**3,192,064**	

Deliverability

Based on the information known about the bathing water to date the following comments can be made surrounding the confidence of delivery and an appropriate target standard.

Table 52 – Confidence in Deliverability

	Level	Comments
Confidence of Source	Medium	Surveys should be able to confirm the source(s) impacting the bathing water
Confidence of Delivery	Medium	Most of the sources are within the control, or ability to influence, of Southern Water and are deliverable within the timeframe of the AMP.
Confidence of Outcome	Medium	Given the nature of the site and the potential source there is a reasonable confidence that the outcome can be achieved.
Confidence of Costs	Medium	There are no obvious high risk cost items and total project costs are likely to remain at around £3m.
Appropriate Target Standard	Excellent Status	May be appropriate for a PR19 scheme looking to improve bathing water quality to Excellent status

Ramsgate Sands

Background

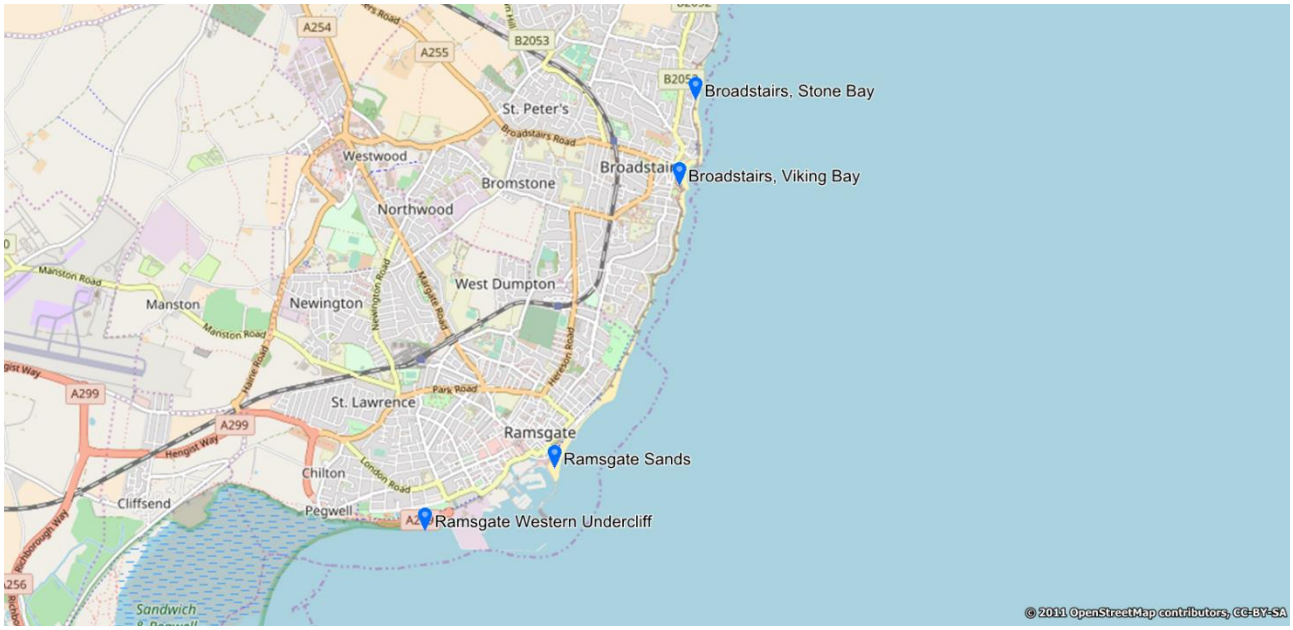
Ramsgate Sands is a sandy resort beach with a promenade between the Royal Harbour and marina at the south and the white chalk cliffs to the north. Along the seafront promenade there are a range of resort facilities.

There are no natural surface water courses that flow to the coast from the local catchment of about 640 hectares, though the Stour catchment of about 823 square kilometres drains into Pegwell Bay about 3 km to the west. The Stour catchment includes Ashford, Canterbury, Sandwich and much of Deal.

Water from the Stour Estuary circulates in Pegwell Bay and can reach the beach. Within the Stour's catchment there are inputs from storm overflows that can occur when heavy rainfall overwhelms the sewerage system. These outfalls are designed to protect bathing water compliance. In response to heavy rainfall runoff from agricultural land could also affect the water quality in the Stour estuary.

Figure 66 below shows location of Ramsgate Sands Bathing Waters Sampling Point.

Figure 66 – Historic Bathing Water Quality Trends



Bathing Water Quality

Table 53 below shows the annual and official four year rolling classifications at the bathing water.

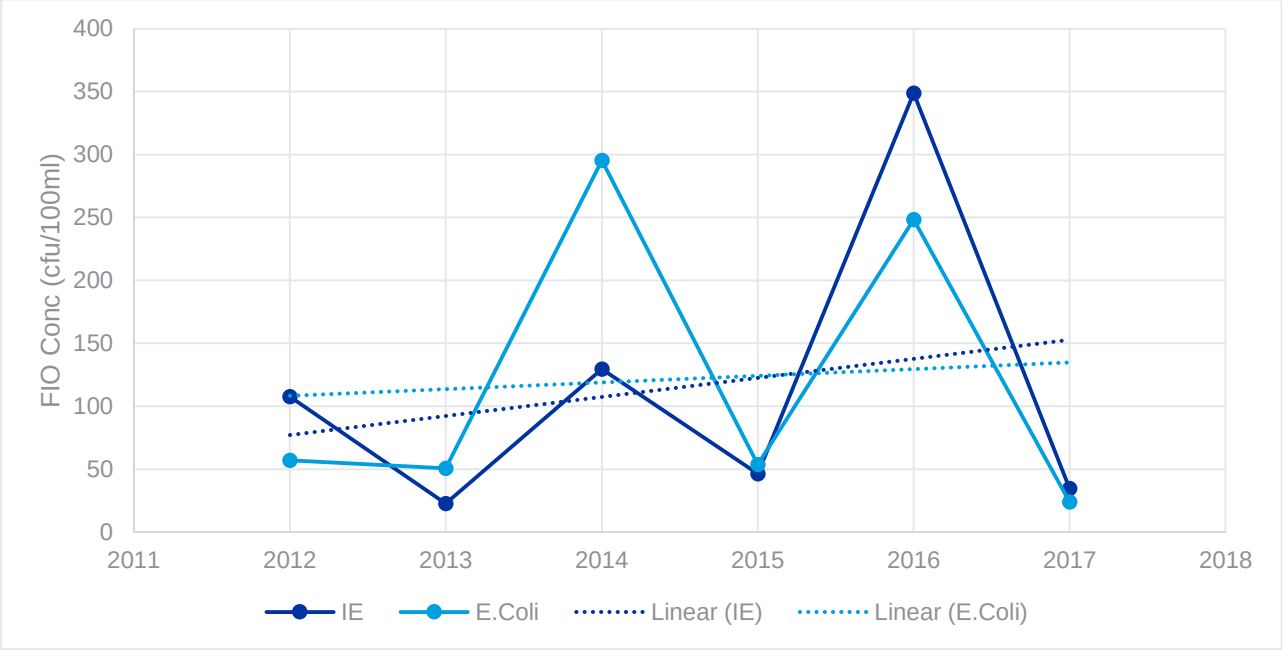
Table 53 – Historic Bathing Water Quality Classifications

	2013	2014	2015	2016	2017
Annual	Excellent	Good	Excellent	Poor	Excellent
Official	Good	Excellent	Excellent	Good	Good

Bathing Water quality at Ramsgate Sands often falls below Excellent status for both the annual and four year rolling assessments.

Figure 67 shows the 95%ile annual trending quality of the bathing water quality over the last five years.

Figure 67 – Historic Bathing Water Quality Trends

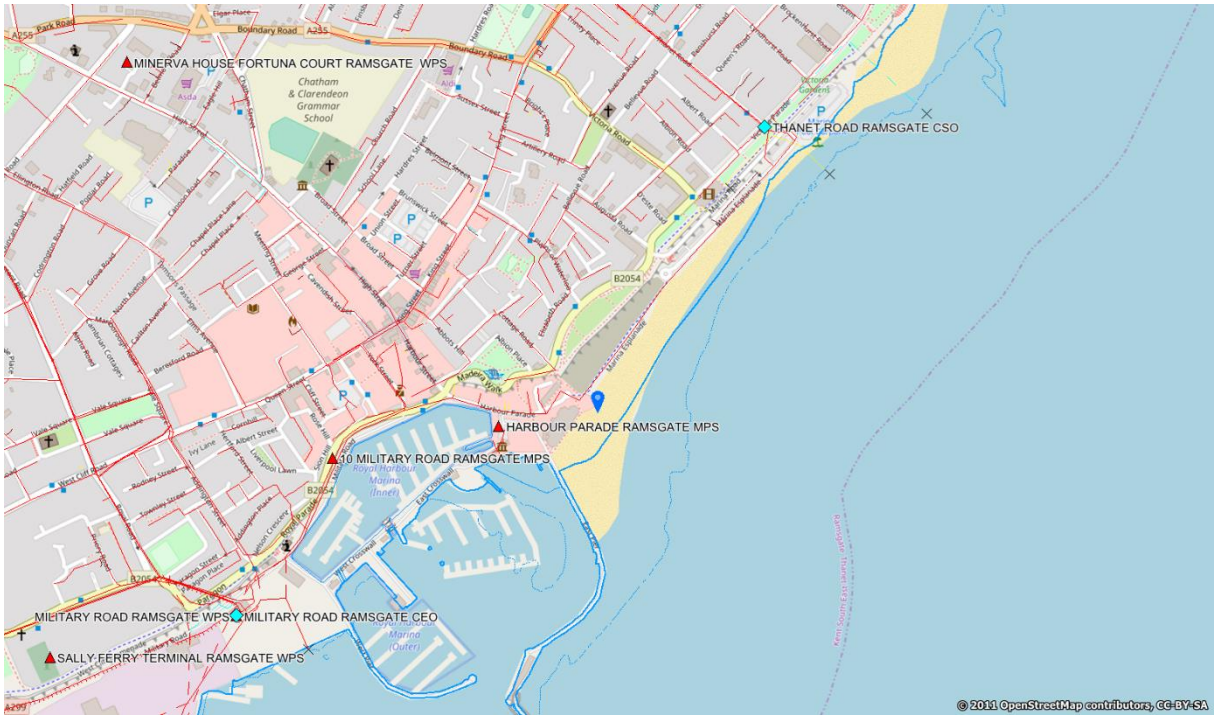


Annual results at Ramsgate appear highly variable which is contributing to an apparent trend of deteriorating water quality. There is no obvious reason for this deterioration based on changes in the catchment.

Catchment Features

A brief desktop assessment has identified some key features and potential sources of the bathing water sampling results. This is shown in Figure 68.

Figure 68 – Catchment Features



There are no watercourses draining to coast in the immediate vicinity of the Bathing Water. The surrounding area is generally urban with a marina to the South West of the sample location

Southern Water Assets

Continuous / Intermittent Discharges

Table 154 details the Southern Water continuous and intermittent assets which may impact the bathing waters. Environment Agency guidance on spill frequency from these assets are as follows:

Storm overflows that discharge directly into or impact on bathing waters with a target of good or sufficient status, must have no more than 3 significant spills per bathing season on average. Where more than one discharge affects the bathing water, you must aggregate the spills. The aggregated spills must be no more than 3 significant spills on average per bathing season. For storm overflows that discharge to bathing waters with a target of excellent status, the emission standard is for no more than 2 significant spills per bathing season on average. Whether a spill is significant will be considered on a site-specific basis. In general, for design purposes, a spill greater than 50m3 is significant.

Table 54 – Continuous / Intermittent Discharges

Asset Name	Asset Type	Treatment Type	2012-2016 Average Annual Bathing Water Season Spills
Military Road, Ramsgate	WPS/CEO	N/A	1.6
Thanet Road, Ramsgate	CSO	N/A	2.2

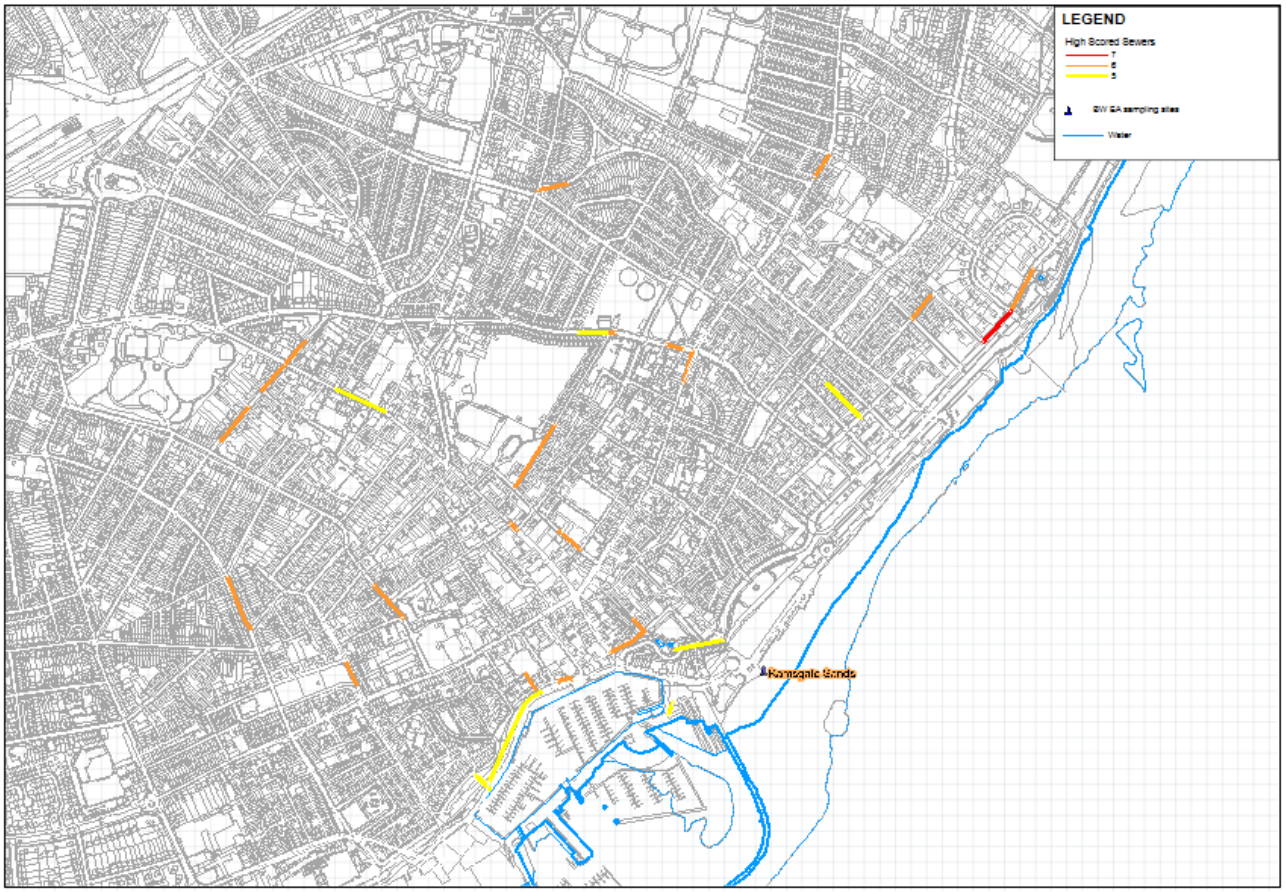
Surface Water Network

Foul to surface water misconnections can have a significant impact on bathing water quality. 3 surface water outfalls have been identified which, if polluted, may have the ability to impact bathing water quality.

Combined Sewerage Network

The integrity of the foul / combined sewerage network can have a significant impact on bathing water quality. The Southern Water Risk Scored Sewers (RSS) database shows 0.3 km of grades 5, 6 and 7 sewers which may be impacting the bathing water.

Figure 69 – Risk Scored Sewers Grade 5-7



The RSS database is an internal Southern Water system of grading pipes based on structural integrity, frequency of inspections and maintenance and criticality. Scores are from 1 to 7 with 7 being the highest risk sewers.

Agricultural Diffuse

Agricultural diffuse pollution in the form of the storage or spreading of slurries and manures, or the keeping of grazing of livestock has the potential to contribute to reductions in bathing water quality. This can be from the direct excretion of waste from livestock or polluted runoff after rainfall.

There is unlikely to be a significant impact from agricultural diffuse pollution within this bathing water catchment. No farms have been identified as having the potation to impact the bathing water.

Urban and Coastal Diffuse

Faecal waste from dogs and birds, as well as polluted urban runoff, and sewage discharges from boats or houseboats have the potential to contribute to reductions in bathing water quality.

The impact from dogs and birds are common issues at every bathing water site. There is a dog ban in place between 1st May through to the 30th September.

Private Sewerage Infrastructure

There is unlikely to be a significant impact from private sewerage infrastructure although this is very hard to quantify at this stage given the lack of available information and the pathway through groundwaters.

There have been no private pumping stations identified during the private pumping station transfer and the EA consented discharges database has not highlight any private sewage discharge in the immediate vicinity of the bathing water.

Historic Bathing Water Investigations

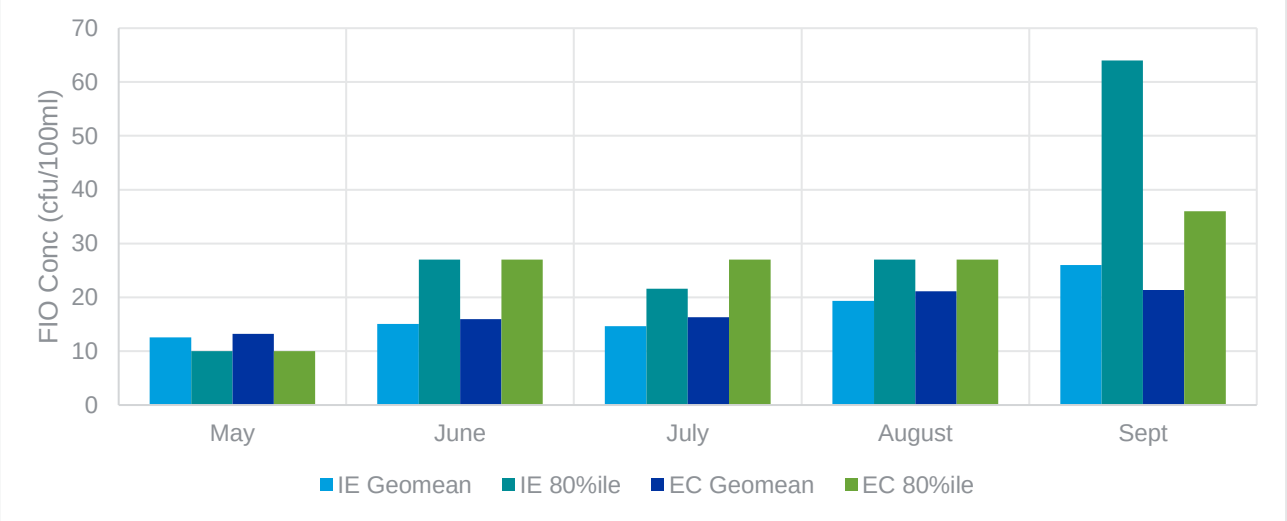
There have not previous SWS nor Environment Agency bathing water investigations carried out at this bathing water.

Bathing Water Analysis

Correlations with Seasonality

Studies show there is a general increase in E.Coli and IE results throughout the summer peaking in September. No obvious reason can be concluded for this increase. Figure 70 below shows the monthly average results at Ramsgate Sands.

Figure 70 – Monthly Seasonality at Pevensey Bay



Correlations with Rainfall

Table 55 shows the exceedance events recorded for the five bathing seasons 2013-2017.

Table 55 – Exceedance Event Previous Rainfall

Event Date/Time	Previous 72 hours Rainfall (mm)	Ramsgate Sands BW	
		E.Coli	IE
09/09/2014 12:40	0.0	2600	1800
04/08/2016 13:55	10.6	1400	1400
07/09/2016 13:01	1.2	10	420
15/09/2016 13:47	0.0	470	410

This analysis shows that of the 4 exceedance events between 2013 and 2017, all but one occurred after a period of no rainfall (<5mm in 72 hours) suggesting that rainfall is probably not a significant influence in bathing water quality results at Ramsgate Sands BW.

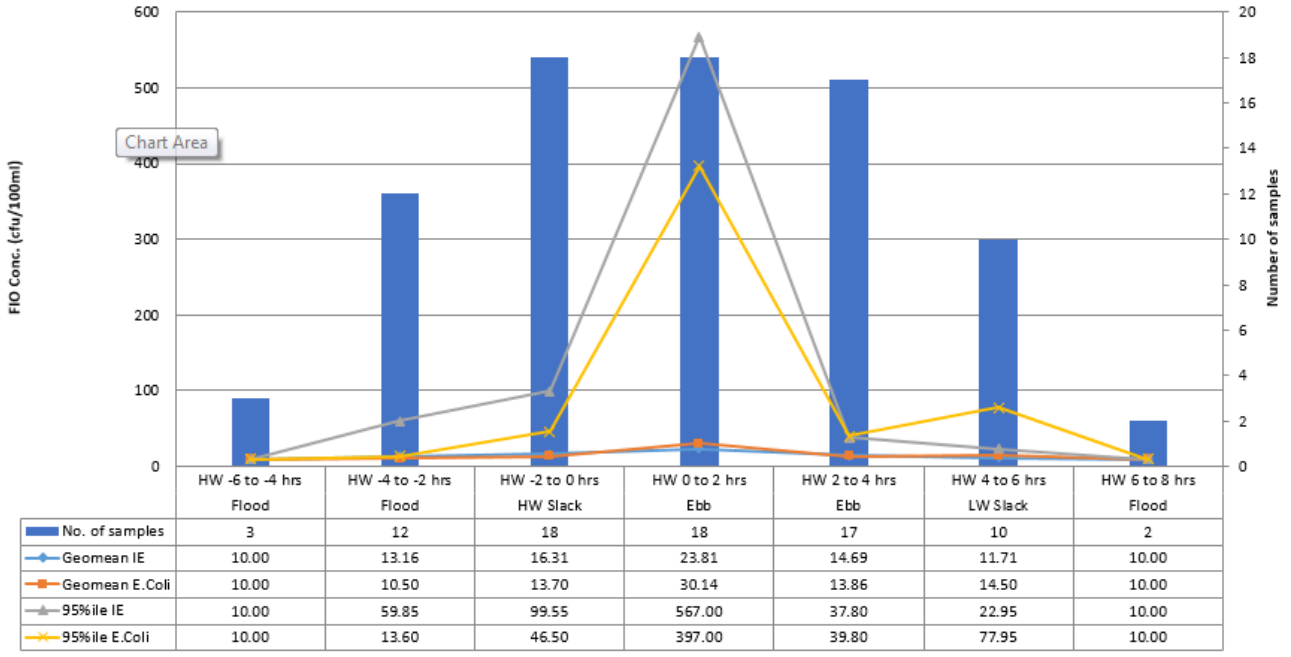
Correlations with Tide

Tidal data has been calculated from tidal constituents at Dover Harbour. HW Slack at Ramsgate Sands occurs approximately two hours before HW. LW Slack occurs approximately four to five hours after HW. The tidal direction during the flood tide is towards the east.

Correlations with Tide Phase (Direction)

Analysis of bathing water quality results against high water (HW) times may indicate the direction from which pollution has travelled and therefore the location of its source. Figure 71 shows bathing water quality results against the time relative to HW.

Figure 71 – Bathing Water Quality Against Time Since High Tide



	HW -6 to -4 hrs Flood	HW -4 to -2 hrs Flood	HW -2 to 0 hrs HW Slack	HW 0 to 2 hrs Ebb	HW 2 to 4 hrs Ebb	HW 4 to 6 hrs LW Slack	HW 6 to 8 hrs Flood
No. of samples	3	12	18	18	17	10	2
Geomean IE	10.00	13.16	16.31	23.81	14.69	11.71	10.00
Geomean E.Coli	10.00	10.50	13.70	30.14	13.86	14.50	10.00
95%ile IE	10.00	59.85	99.55	567.00	37.80	22.95	10.00
95%ile E.Coli	10.00	13.60	46.50	397.00	39.80	77.95	10.00

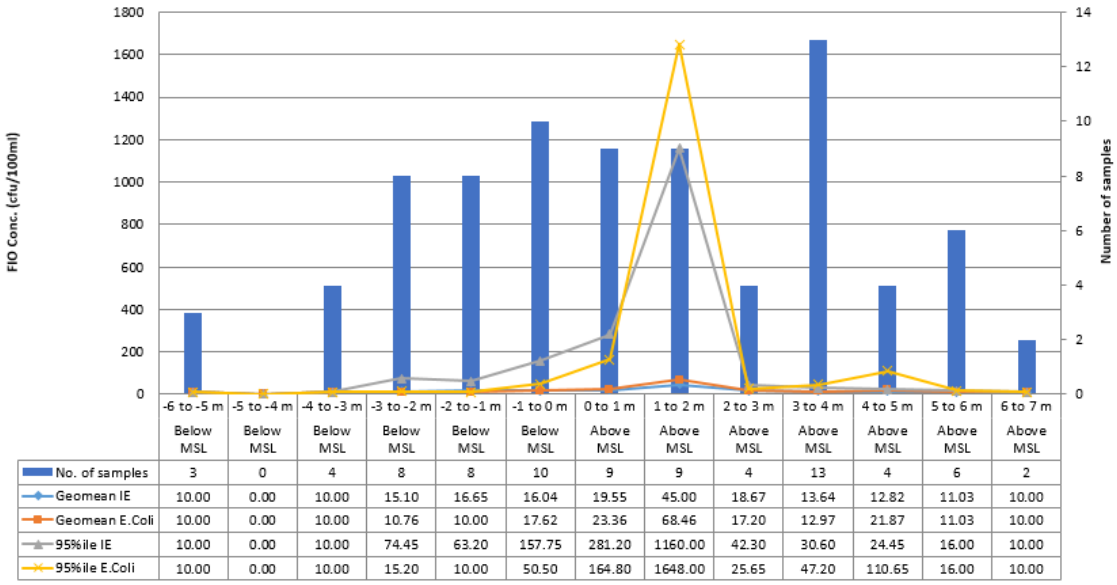
Samples were obtained from 7 hours before high tide to 5.5 hours after high tide. Samples taken more than 2 hours before high tide have been considered to occur during a flood tide (west to east) and samples taken up to 4 hours after high tide have been considered to occur on an ebb tide (east to west).

Figure 71 show that between 2011 and 2015 peak geomean and 95%ile values for IE and E.Coli occur at HW 0 to +2 hours, just after slack water on the ebb tide. This suggests a key source impacting bathing water quality is localised.

Correlations with Tide Level

Further analysis of bathing water quality results against tide level may provide an indication of problems with exfiltration from the foul sewer systems or problems with discharges from outfalls with flap valves.

Figure 72 – Bathing Water Quality Against Tide Levels



	-6 to -5 m Below MSL	-5 to -4 m Below MSL	-4 to -3 m Below MSL	-3 to -2 m Below MSL	-2 to -1 m Below MSL	-1 to 0 m Below MSL	0 to 1 m Above MSL	1 to 2 m Above MSL	2 to 3 m Above MSL	3 to 4 m Above MSL	4 to 5 m Above MSL	5 to 6 m Above MSL	6 to 7 m Above MSL
No. of samples	3	0	4	8	8	10	9	9	4	13	4	6	2
Geomean IE	10.00	0.00	10.00	15.10	16.65	16.04	19.55	45.00	18.67	13.64	12.82	11.03	10.00
Geomean E.Coli	10.00	0.00	10.00	10.76	10.00	17.62	23.36	68.46	17.20	12.97	21.87	11.03	10.00
95%ile IE	10.00	0.00	10.00	74.45	63.20	157.75	281.20	1160.00	42.30	30.60	24.45	16.00	10.00
95%ile E.Coli	10.00	0.00	10.00	15.20	10.00	50.50	164.80	1648.00	25.65	47.20	110.65	16.00	10.00

Figure 72 shows the bathing water quality results against tide level. The analysis shows that the Geomean and 95%ile values for IE and E.Coli increase to a peak concentration at 1.5 to 2m above Mean Sea Level (MSL). Given the lack of exceedances above +2m MSL this would suggest the apparent trend is based on tide direction rather than tide level.

Likely Sources Impacting the Bathing Water

Table 11, below, shows the likely sources impacting the bathing water with regards to risk as a factor of likelihood and severity.

Table 56 – Key Sources Likely to be Impacting the Bathing Water

Source	Pathway	Risk	Justification
Dog Faeces	Direct to bathing water	Low – Med	The impact from dogs and birds are common issues at most bathing water sites. There is a dog ban in place between the 1st May through to the 30th September.
Bird Faeces	Direct to bathing water	Low – Med	The impact from birds are common issues at most bathing water sites.
Foul Exfiltration	Groundwater	Med	0.3km of high risk sewers near to the bathing waters have been identified as having the potential to impact the bathing water.
Ramsgate Marina	Direct to bathing water	Low – Med	Discharges from marine vessels and the adequacy of pump away facilities both have the potential to contribute to reductions in bathing water quality
Military Road CSO	Direct to bathing water	Low – Med	The CSO only spills on average approx. twice per bathing season, which is the guideline standard for Excellent bathing water quality.
Thanet Road CSO	Direct to bathing water	Low – Med	The CSO only spills on average approx. twice per bathing season, which is the guideline standard for Excellent bathing water quality.

Defining Likely Solutions

Based on the sources outlined in the previous section the following solutions have been defined and costed.

Table 57 – Solution Costing

	Cost (£)	Justification
Investigation Costs		
Analysis (Desktop)	34,000	Allowance based on AMP6 costs
Ammonia Sondes	-	Not required
Asset Surveys	15,000	Allowance based on AMP6 costs
Catchment Flyovers	-	
Coastal Modelling	5,000	Allowance based on AMP6 costs
Connectivity Survey	7,500	Allowance based on AMP6 costs
CCTV	15,000	Allowance based on AMP6 costs
Hydraulic Modelling	-	Not required
LSO / SSO Survey	-	Not required
Misconnections (to outfall)	3,000	Based on unit rate for SW outfalls
River Walkover	-	Not required
WQ Sampling	28,000	1 summers sampling
Solution Appraisal	15,000	Allowance based on AMP6 costs
Investigation Overhead	56,783	Contingency, project management, and overhead
Investigation Costs	**179,283**	
Delivery Phase Costs		
Additional WQ Sampling	112,000	4 summers sampling
Hydraulic Modelling & Flow Surveys	-	
Misconnections (to property)	59,149	Based on unit rate for 1406 properties
Agricultural Measures	-	
Bird and Dog Measures	20,000	Allowance to mitigate impact from dogs, birds and litter
Misconnection Rectification	157,018	Allowance based on AMP6 Hastings Costs
Sewer Rehab	19,260	Prices from CET based on lengths of Risk Scored Sewers
Enhanced Network Maintenance	10,731	Prices from CET based on lengths of Risk Scored Sewers
WPS / CSO Storage	-	Not required
WPS Refurb	495,626	Prices from CET

Private Infrastructure Allowance	70,000	Allowance for private infrastructure
WTW Upgrades	-	Not required
LSO / SSO Survey	-	Not required
Optioneering and Design	46,358	6% Allowance
Delivery Overhead	1,001,784	Contingency, project management, and overhead
Delivery Costs	**1,991,926**	
Total Project Cost (P50)	**2,171,209**	

Deliverability

Based on the information known about the bathing water to date the following comments can be made surrounding the confidence of delivery and an appropriate target standard.

Table 58 – Confidence in Deliverability

	Level	Comments
Confidence of Source	Medium	Although the source(s) has not yet been confirmed there is only a limited account of sources within the vicinity.
Confidence of Delivery	High	Most of the potential sources are within the ownership, or ability to influence, of Southern Water
Confidence of Outcome	Medium to High	Outcome reliant on co-operation from private sewerage owners
Confidence of Costs	Medium to High	There are no obvious high-risk cost items or potential scope items that may get added at a later date.
Appropriate Target Standard	Excellent Status	May be appropriate for a PR19 scheme looking to improve bathing water quality to Excellent status

Pevensey Bay

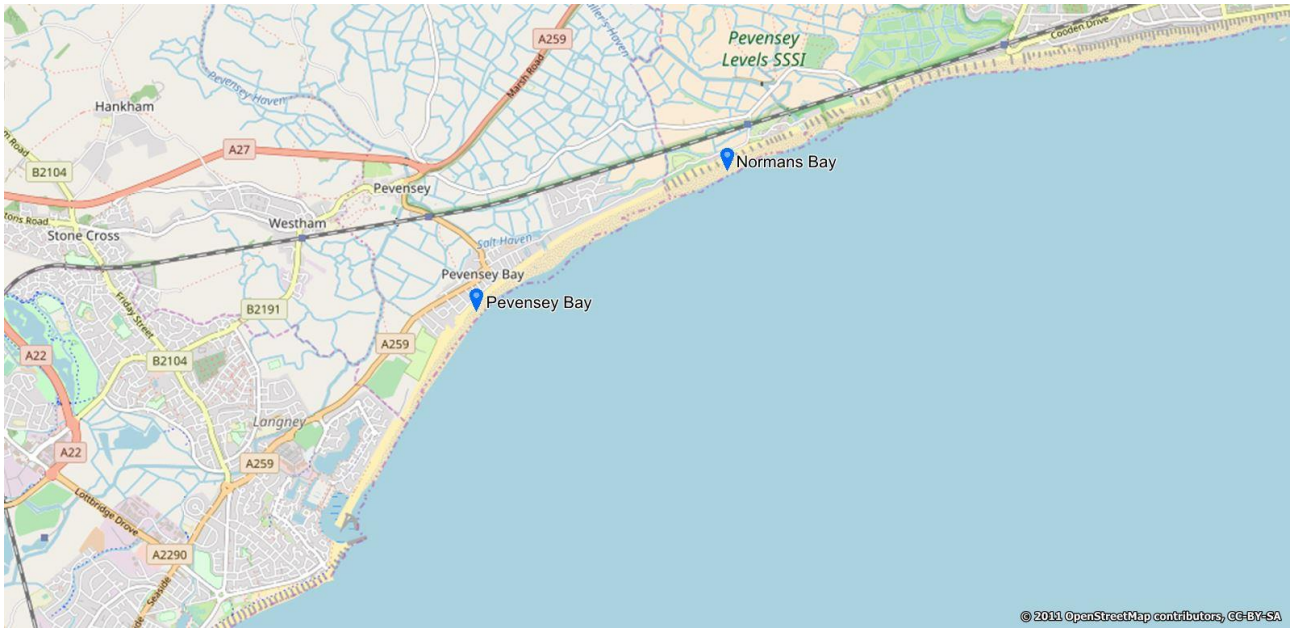
Background

Pevensey Bay is a resort beach on the Sussex coast between Eastbourne and Hastings. The small town of Pevensey backs on to the beach. The beach is predominantly shingle, with shallow sand flats exposed at low water.

The natural drainage (hydrological) catchment surrounding the bathing water is approximately 7400 hectares. It comprises the Pevensey Levels, a wide agricultural plane with a complex network of streams and ditches. There are small forested areas and some villages within the catchment, and the urban areas of Pevensey, Hailsham and parts of Eastbourne. The main river is Pevensey Haven. After a series of confluences with Chilley Stream, Old Haven and the Langney Sewer, it changes into Salt Haven and drains into the sea through three outfalls to the east of Pevensey Bay.

Figure 11 below shows location of Pevensey Bay Bathing Waters Sampling Point.

Figure 73 – Location of Bathing Water Sample Point



Bathing Water Quality

Table 8 below shows the annual and official four year rolling classifications at the bathing water.

Table 59 – Historic Bathing Water Quality Classifications

	2013	2014	2015	2016	2017
Annual	Excellent	Excellent	Excellent	Poor	Good
Official	Good	Good	Excellent	Good	Good

Bathing Water quality at Pevensey Bay in 2016 has fallen below “Excellent” status for the annual assessments.

Figure 11 below shows the 95%ile annual trending quality of the bathing water quality over the last five years.

Figure 74 – Historic Bathing Water Quality Trends

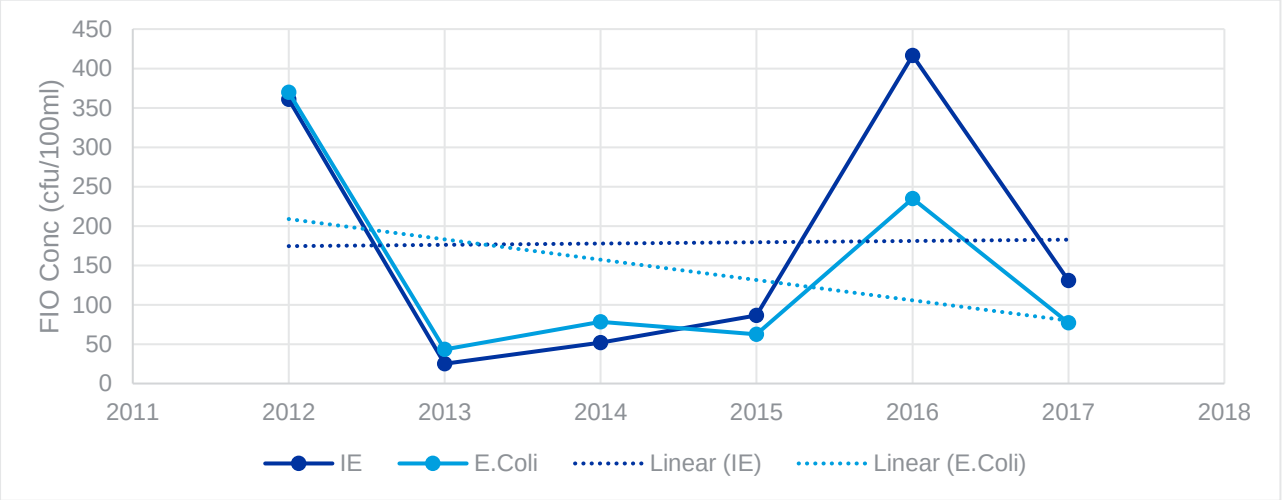


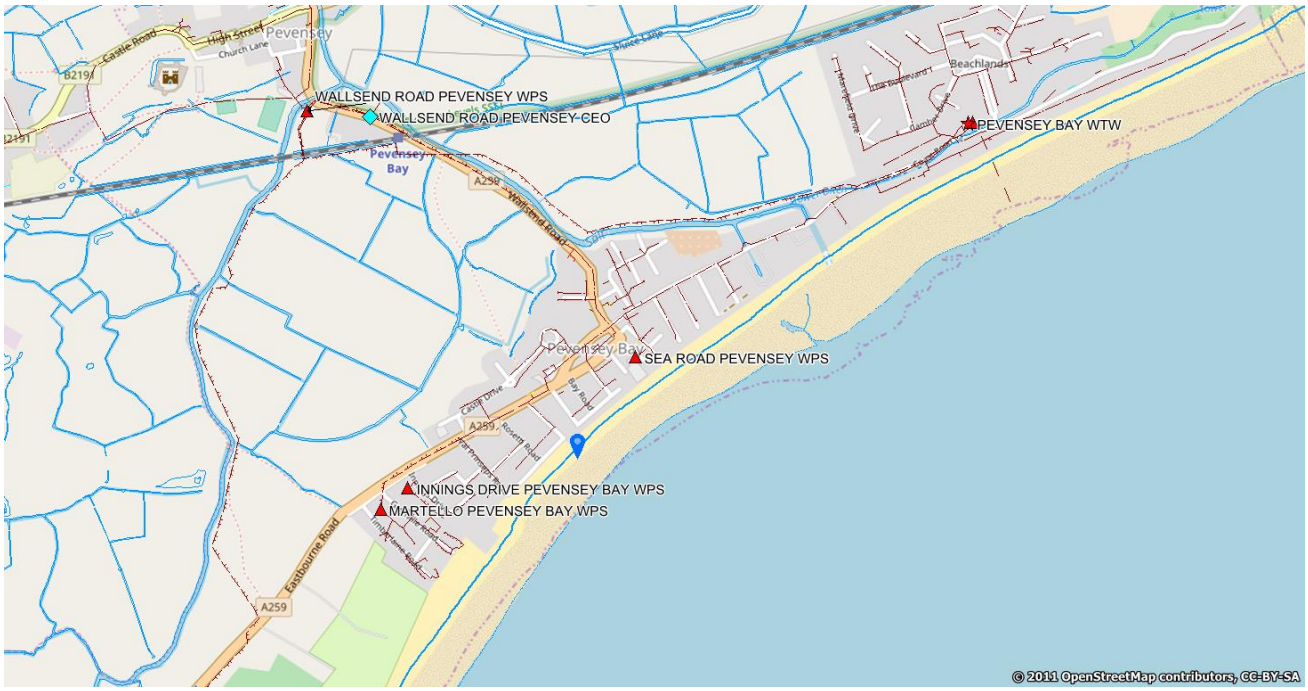
Figure 74 shows significant variability within the bathing water quality with high FIO concentrations in 2012 and 2016 in particular.

Previous analysis undertaken by Ann Saunders (Southern Water Bathing Water Expert) done on the median concentrations of the last 20 samples between 2013 and 2016 appeared to show a significant decrease in bathing water quality after 2015. However, this pattern is not as conclusive when looking at a longer data set.

Catchment Features

Figure 75 below shows the key catchment features and potential sources, derived from a brief desktop assessment of the bathing water.

Figure 75 – Catchment features



Pevensey Bay is close to the discharge point of the Salt or Pevensey Haven. The Haven is a managed river, with the Pevensey Levels being pumped over the coastal flood defences to the bathing waters. The operation of the pumped discharge has changed since October 2014, with the Environmental Agency maintaining lower river levels within the watercourse. This increase in riverine flows entering the sea may have an impact on bathing water quality. The Pevensey Bay WTW shown on the above plan is decommissioned and pumps away to Eastbourne WTW.

Southern Water Assets

Continuous / Intermittent Discharges

Table 15 details the Southern Water continuous and intermittent assets which may impact the bathing waters. Environment Agency guidance on spill frequency from these assets are as follows:

Storm overflows that discharge directly into or impact on bathing waters with a target of good or sufficient status, must have no more than 3 significant spills per bathing season on average. Where more than one discharge affects the bathing water, you must aggregate the spills. The aggregated spills must be no more than 3 significant spills on average per bathing season. For storm overflows that discharge to bathing waters with a target of excellent status, the emission standard is for no more than 2 significant spills per bathing season on average. Whether a spill is significant will be considered on a site-specific basis. In general, for design purposes, a spill greater than 50m3 is significant.

Table 60 – Continuous / Intermittent Discharges

Asset Name	Asset Type	Treatment Type	2012-2015 Average Annual Spill Frequency[27]	2012-2015 Average Annual Bathing Season Spill Frequency[28]
Montague Way, Westham	WPS/CEO	N/A	17	No Data
Wallsend Road, Pevensey	CEO	N/A	No Data	No Data

Surface Water Network

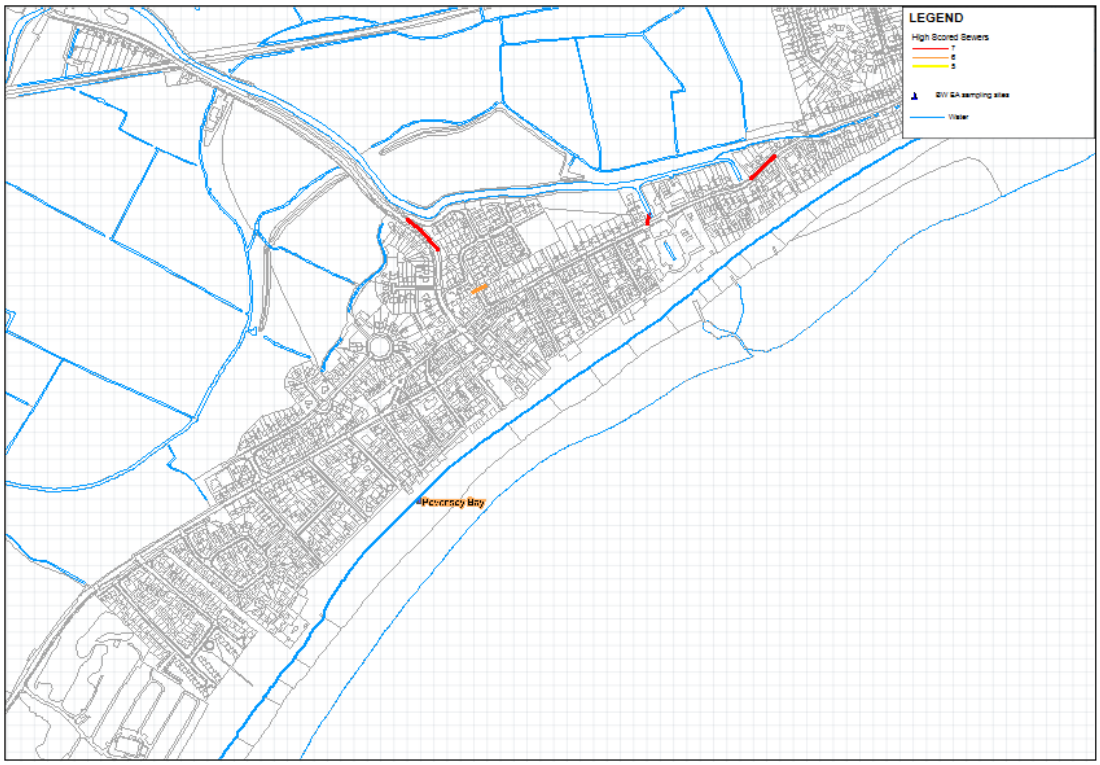
Foul to surface water misconnections can have a significant impact on bathing water quality. There are no mapped surface water outfalls which, if polluted, may have the ability to impact bathing water quality.

[27] Average spill frequency per bathing season based on 2013-2017 verified EDM records
[28] Average spill frequency per bathing season based on 2013-2017 verified EDM records

Combined Sewerage Network

The integrity of the foul / combined sewerage network can have a significant impact on bathing water quality. The Southern Water Risk Scored Sewers (RSS) database shows 0.7 km of grades 5, 6 and 7 sewers which may be impacting the bathing water.

Figure 76 – Risk Scored Sewers Grade 5-7



Agricultural Diffuse

There is likely to be a significant impact from agricultural diffuse pollution within this bathing water catchment. Six farms and numerous streams / ditches draining agricultural land have been identified as having the potential to impact the bathing water.

Urban and Coastal Diffuse

The impact from dogs and birds are common issues at every bathing water site. There are currently no dog restrictions at Pevensey Bay.

Private Sewerage Infrastructure

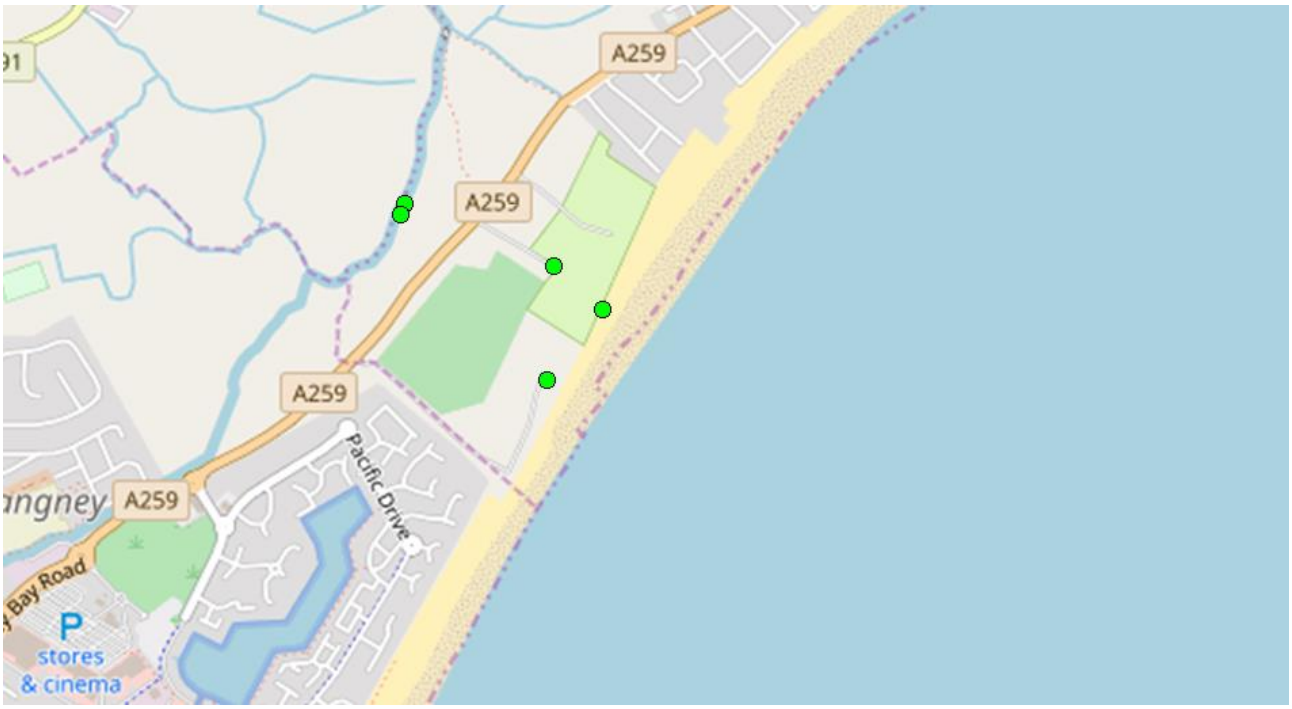
There is likely to be a significant impact from private sewerage infrastructure although this is very hard to quantify at this stage given the lack of available information and the pathway through groundwaters.

There have been no private pumping stations identified, however, the EA consented discharges database highlights 5 private sewage discharges in the immediate vicinity of the bathing water. Table 61 shows that both Pevensey Sailing Club and a nearby caravan site have two consents each with the fifth belonging to a private septic tank. Figure 3 shows the private discharge locations.

Table 61 – Private Consented Discharges

COMPANY NAME	DISCHARGE SITE NAME	DISCHARGE SITE TYPE CODE	DISCHARGE NGR
CARAVAN SITES DEVELOPMENT LTD.	CASTLE VIEW CARAVAN SITE	QF	TQ6462003310
CARAVAN SITES DEVELOPMENT LTD.	CASTLE VIEW CARAVAN SITE	QF	TQ6461003280
MRS CARSON PRATT	STP AT GREY TOWER CARAVAN PARK	QF	TQ6501903157
PEVENSEY BAY SAILING CLUB	NEW OUTLET FROM SEPTIC TANK	TC	TQ6515003050
PEVENSEY BAY SAILING CLUB	PEVENSEY BAY SAILING CLUB	TC	TQ6501002860

Figure 77 – Locations of 5 Private Consented Discharges.



Historic Bathing Water Investigations

There have been no previous SWS bathing water investigations carried out at this bathing water.

There have also been multiple investigations undertaken by the Environment Agency over the last 20 years at Pevensey Bay. The conclusions of these investigations are described below:

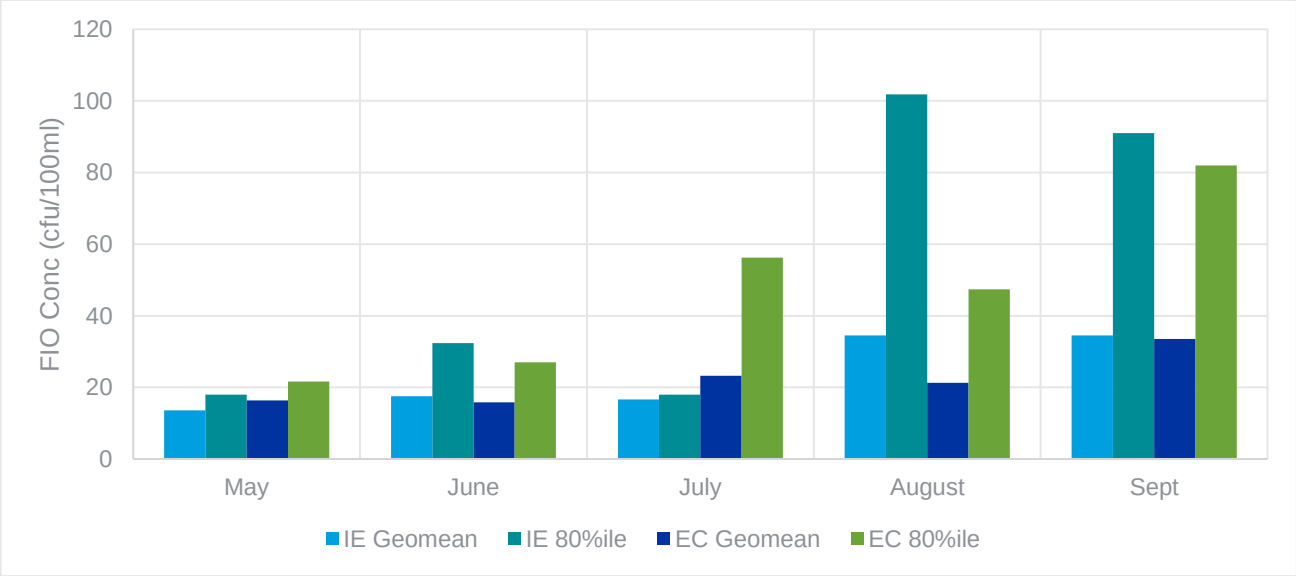
- The Environment Agency carried out investigations into local sewerage arrangements and found high levels of contamination around Val Princeps Road. A survey confirmed that sewers around this area were leaking. Further CCTV investigations by SWS identified a defect in a private lateral sewer, which was repaired by 2001.
- Since water quality did not improve significantly, the Environment Agency carried out a series of surveys across the catchment in 2008 and 2009. However, the sources of contamination remain unclear.

Bathing Water Analysis

Correlations with Seasonality

Studies show there is a general increase in E.Coli and IE results throughout the summer peaking in August and September. Figure 11 below shows the monthly average results at Pevensey Bay.

Figure 78 – Monthly Seasonality at Pevensey Bay



Correlations with Rainfall

The following table shows the exceedance events recorded for the five bathing seasons 2013-2017. The exceedance values being shaded.

Table 62 – Exceedance Event Previous Rainfall

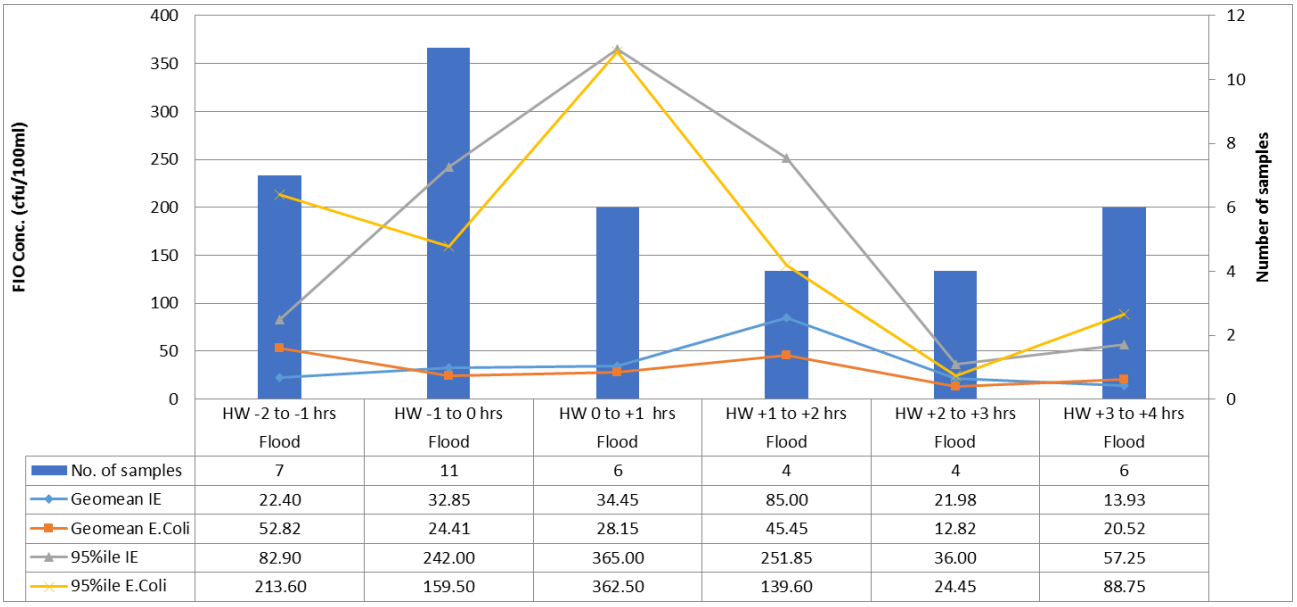
Event Date/Time	Previous 72 hours Rainfall (mm)	Pevensey Bay BW	
		E.Coli	IE
08/07/2013 10:01	0.0	270	18
12/09/2014 14:12	0.0	145	100
23/08/2015 11:40	3.0	27	127
24/07/2016 12:00	0.0	410	320
16/08/2016 10:15	0.0	610	164
21/09/2016 14:41	0.2	136	2880
07/08/2017 12:20	4.2	91	370
22/08/2017 12:31	11.4	55	173

This shows that of the 8 exceedance events between 2013 and 2017, only 12% of these events occurred after periods of moderate to heavy rainfall (>5mm in 72 hours). The majority of exceedance events (88%) therefore occurred after periods of little to no rainfall (<5mm in 72 hours) indicating rainfall is not a significant influence in bathing water quality results at Pevensey Bay.

Correlations with Tide

Between 2011 and 2015 peak 95%ile values for E.Coli occur at HW 0 to +1 hours and for IE also. This is not replicated in the geomean values. Bathing water exceedances occur across nearly all phases of the tide with the number exceedance events highest between HW -1 to 0 hours in line with the higher number of samples during this period.

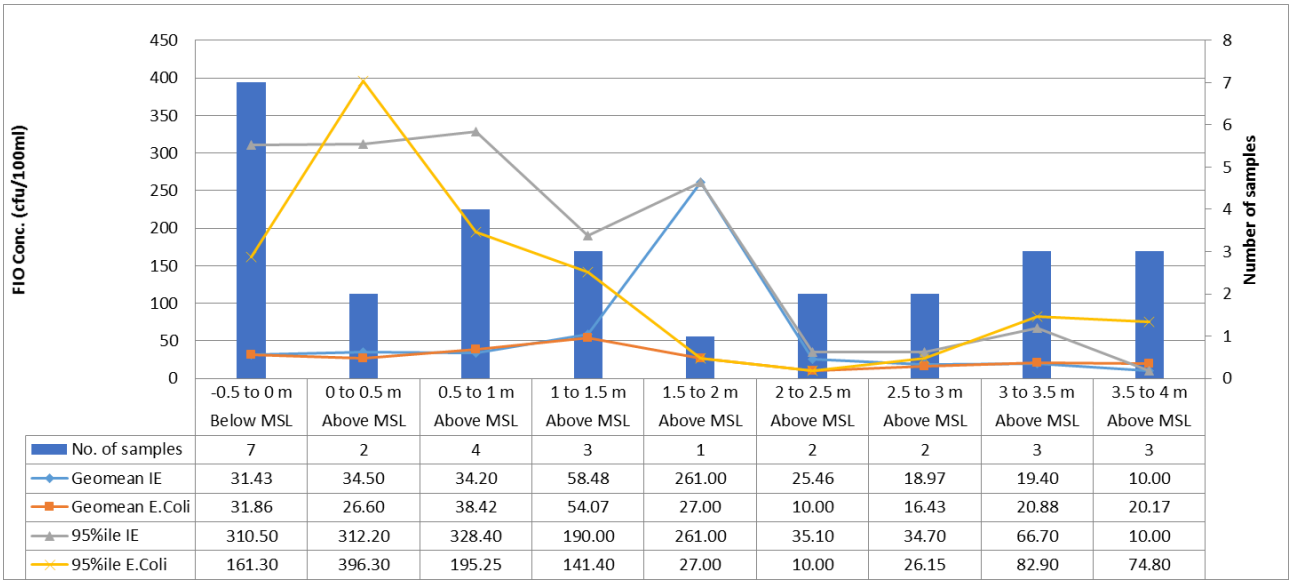
Figure 79 - Effect of Rainfall in the Previous 24hrs on IE and E.Coli Concentrations, 2011-15



	HW -2 to -1 hrs Flood	HW -1 to 0 hrs Flood	HW 0 to +1 hrs Flood	HW +1 to +2 hrs Flood	HW +2 to +3 hrs Flood	HW +3 to +4 hrs Flood
No. of samples	7	11	6	4	4	6
Geomean IE	22.40	32.85	34.45	85.00	21.98	13.93
Geomean E.Coli	52.82	24.41	28.15	45.45	12.82	20.52
95%ile IE	82.90	242.00	365.00	251.85	36.00	57.25
95%ile E.Coli	213.60	159.50	362.50	139.60	24.45	88.75

95%ile E.Coli results increase to a peak concentration at -0.5 to 0m above Mean Sea Level (MSL). This is not replicated in the geomean values or the IE results. Although far from conclusive this graph could be indicative of foul exfiltration with increasing E.Coli / IE ratios suggesting a human source which has a greater impact at higher tidal levels

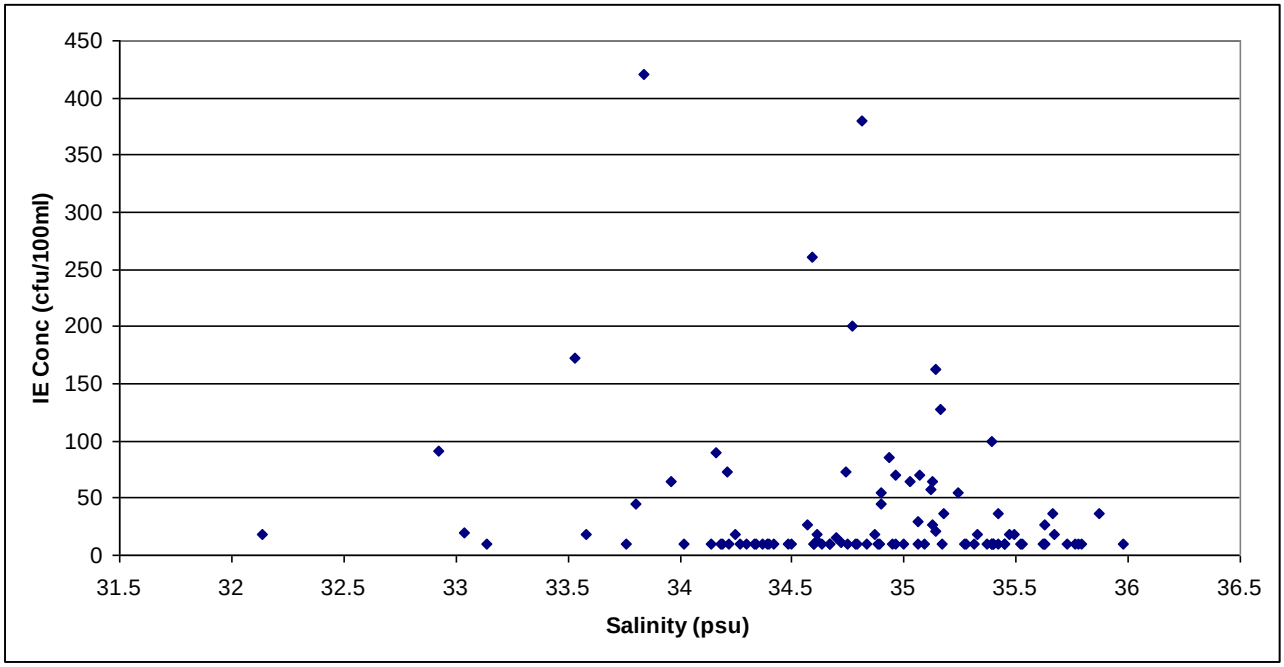
Figure 80 – Bathing Water Quality Against Time Since High Tide



	-0.5 to 0 m Below MSL	0 to 0.5 m Above MSL	0.5 to 1 m Above MSL	1 to 1.5 m Above MSL	1.5 to 2 m Above MSL	2 to 2.5 m Above MSL	2.5 to 3 m Above MSL	3 to 3.5 m Above MSL	3.5 to 4 m Above MSL
No. of samples	7	2	4	3	1	2	2	3	3
Geomean IE	31.43	34.50	34.20	58.48	261.00	25.46	18.97	19.40	10.00
Geomean E.Coli	31.86	26.60	38.42	54.07	27.00	10.00	16.43	20.88	20.17
95%ile IE	310.50	312.20	328.40	190.00	261.00	35.10	34.70	66.70	10.00
95%ile E.Coli	161.30	396.30	195.25	141.40	27.00	10.00	26.15	82.90	74.80

Plotting the intestinal enterococci against salinity would suggest higher IE concentrations in times of low salinity for example when the contribution from riverine inputs is higher (average seawater is 35 psu).

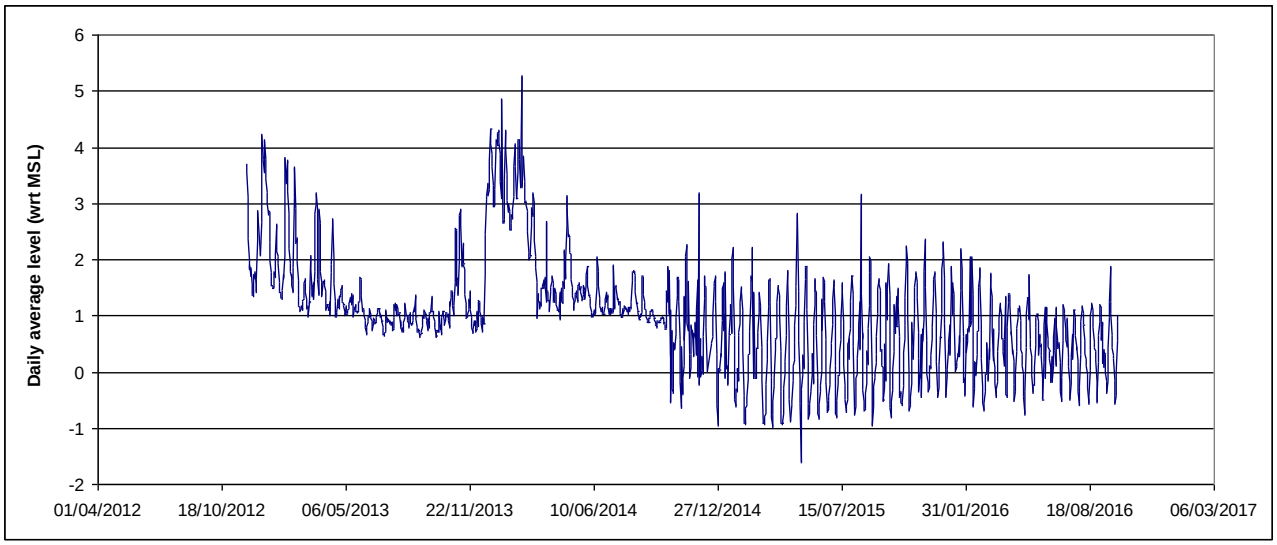
Figure 81 – Comparison of Salinity against Intestinal Enterococci concentrations



Correlations with River Levels

Level gauge data is available for the Salt Haven between 2012 and 2016; this is plotted below in Figure 82. It can be seen that the pumping regime changed at the discharge pumping station after October 2014. In addition to the findings of the tidal and salinity analysis this would appear to suggest the primary source of pollution at Pevensey Bay originates from the Salt Haven.

Figure 82 – River Levels within the Salt Haven



Likely Sources Impacting the Bathing Water

Table 11, below, shows the likely sources impacting the bathing water with regards to risk as a factor of likelihood and severity.

Table 63 – Key Sources Likely to be Impacting the Bathing Water

Source	Pathway	Risk	Justification
Agricultural diffuse pollution	Salt Haven	Med - High	There are large areas of land arable and livestock farming which may contribute to agricultural diffuse pollution. Six farms and numerous streams/ditches draining agricultural land have been identified as having the potential to impact the bathing water
Dog Faeces	Direct to bathing water	Low – Med	The impact from dogs are common issues at every bathing water site. There are no dog restrictions at this beach.
Bird Faeces	Direct to bathing water	Low – Med	The impact from birds are common issues at every bathing water site.
CSOs	Sewer network	Low	The lack of correlation with rainfall and distance to the nearest overflows suggests CSOs are not likely to be the primary causes of bathing water reductions
Surface Water Misconnections	Salt Haven	Low	There are no mapped surface water outfalls discharging directly to the bathing water or within 2km of the discharge point of the Salt Haven
Foul Exfiltration	Groundwater / Salt Haven	Med	0.7 km of high risk sewers near to the bathing water have been identified as having the potential to impact the water quality.
Private Sewerage	Groundwater / Salt Haven	Med	The EA Consented Discharge database indicates 5 private sewerage discharges at three locations near the bathing water.

Defining Likely Solutions

Based on the sources outlined in the previous section the following solutions have been defined and costed.

Table 64 – Solution Costing

	Cost (£)	Justification
Investigation Costs		
Analysis (Desktop)	34,000	Allowance based on AMP6 costs
Ammonia Sondes	30,000	3 sondes for 10 weeks
Asset Surveys	15,000	Allowance based on AMP6 costs
Catchment Flyovers	7,500	Allowance based on AMP6 costs
Coastal Modelling	5,000	Allowance for tidal excursion checks
Connectivity Survey	7,500	Allowance based on AMP6 costs
CCTV	15,000	Allowance based on AMP6 costs
Hydraulic Modelling	-	Not required
LSO / SSO Survey	-	Not required

Misconnections (to outfall)	-	Not required
River Walkover	5,000	Allowance for 5km of walkovers
WQ Sampling	28,000	1 summers sampling
Solution Appraisal	15,000	Allowance based on AMP6 costs
Investigation Overhead	75,092	Contingency, project management, and overhead
Investigation Costs	**237,092**	
Delivery Phase Costs		
Additional WQ Sampling	112,000	4 summers sampling
Hydraulic Modelling & Flow Surveys	-	Not required
Misconnections (to property)	-	Not required
Agricultural Measures	150,000	Based on works at 6 farms
Bird and Dog Measures	20,000	Allowance to mitigate impact from dogs, birds and litter
Misconnection Rectification	-	Not required
Sewer Rehab	10,702	Prices from CET based on lengths of Risk Scored Sewers
Enhanced Network Maintenance	1,104	Prices from CET based on lengths of Risk Scored Sewers
WPS / CSO Storage	-	Not required
WPS Refurb	272,234	Prices from CET to mitigate the impact of MEICA failures
Private Infrastructure Allowance	70,000	Allowance for private infrastructure
WTW Upgrades	-	Not required
LSO / SSO Survey	-	Not required
Optioneering and Design	31,442	6% Allowance
Delivery Overhead	675,329	Contingency, project management, and overhead
Delivery Costs	**1,342,811**	
Total Project Cost (P50)	**1,579,903**	

Deliverability

Based on the information known about the bathing water to date the following comments can be made surrounding the confidence of delivery and an appropriate target standard.

Table 65 – Confidence in Deliverability

	Level	Comments
Confidence of Source	Medium to High	Whilst a particular source has not been identified there is a high degree of confidence that it originates from the Salt Haven. There are only limited sources of pollution which could impact the lower reaches of the Salt Haven.
Confidence of Delivery	Medium	Reliance on co-operation from agricultural landowners and co-operation from private sewerage owners
Confidence of Outcome	Medium	Reliance on co-operation from agricultural landowners and co-operation from private sewerage owners
Confidence of Costs	Medium	Whilst costs cannot be fixed there is a high degree in confidence that all works will not exceed £2m due to the nature of the potential sources.
Appropriate Target Standard	Excellent Status	May be appropriate for a PR19 scheme looking to improve bathing water quality to Excellent status