Centre for Environment Fisheries & Aquaculture Science

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Southampton Water Sanitary Survey

Review

January 2015

Food Standards Agency

Cover photo: Cadland Port Channel Buoy, with Southampton Docks in the background.

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Statement of use

Under EC Regulation 854/2004 which lays down specific rules for official controls on products of animal origin intended for human consumption, a sanitary survey relevant to bivalve mollusc beds in Southampton Water was undertaken in 2009. This provided an appropriate hygiene classification zoning and monitoring plan based on the best available information with detailed supporting evidence. The Food Standards Agency (FSA) is committed to reviewing sanitary surveys every six years or sooner if significant changes in pollution sources or the fishery have occurred that may require revision of the sampling plan. This report provides a six year review of information and recommendations for a revised sampling plan. The Centre for Environment, Fisheries & Aquaculture Science (Cefas) undertook this work on behalf of the FSA.

Report prepared by

David Walker, Rachel Parks, Fiona Vogt, Owen Morgan.

Revision history

Version	Details	Approved by	Approval date
1	Draft for internal review	David Walker	09/03/2015
2	Draft for external review	Simon Kershaw	27/03/2015
Final	Final report post consultation	Simon Kershaw	18/06/2015

Consultation

Consultee	Date of consultation	Date of response
Environment Agency	01/04/2015	01/05/2015
Natural England	01/04/2015	01/05/2015
SAGB	01/04/2015	30/04/2015
Southampton Port Health Authority	01/04/2015	29/04/2015
Southern IFCA	01/04/2015	No response
Southern Water	01/04/2015	28/04/2015

Dissemination

Food Standards Agency, Southampton Port Health Authority. The report is available publicly via the Cefas website.

Recommended Bibliographic Reference

Cefas, 2015. Review of the Southampton Water 2009 Sanitary Survey. Cefas report on behalf of the Food Standards Agency, to demonstrate compliance with the requirements for classification of bivalve mollusc production areas in England and Wales under EC Regulation No. 854/2004.

Contents

1. Introduction

1.1. Background

The Centre for Environment, Fisheries & Aquaculture Science (Cefas) is performing sanitary surveys for new bivalve mollusc production areas (BMPAs) in England and Wales, on behalf of the Food Standards Agency (FSA). The purposes of the sanitary surveys are to demonstrate compliance with the requirements stated in Annex II (Chapter II paragraph 6) of EC Regulation 854/2004, whereby 'if the competent authority decides in principle to classify a production or relay area it must:

(a) make an inventory of the sources of pollution of human or animal origin likely to be a source of contamination for the production areas;
(b) examine the quantities of organic pollutants which are released during the different periods of the year, according to the seasonal variations of both human and animal populations in the catchment area, rainfall readings, waste-water treatment, etc.;
(c) determine the characteristics of the circulation of pollutants by virtue of current patterns, bathymetry and the tidal regime in the production area; and
(d) establish a sampling programme of bivalve molluscs in the production area which is based on the examination of established data, and with a number of samples, a geographical distribution of the sampling points and a sampling frequency which must ensure that the results of the analysis are as representative as possible for the area considered.'

In line with the EU Good Practice Guide Cefas is contracted to undertake reviews of sanitary surveys on behalf of the Food Standards Agency. Reviews are to be undertaken at six yearly intervals after the original sanitary survey or sooner where there are changes to the type and locations of the shellfisheries or significant changes in sources of pollution.

1.2. Southampton Water Review

This report reviews information and make recommendations for a revised sampling plan for existing native oyster, hard clam and Manila clam classification zones in Southampton Water (Figure 1.1). This review identifies changes to information presented in the sanitary survey through a desk based study, and shoreline survey and updates the assessment and sampling plan as necessary.

Specifically, the review considers:

(a) changes to the shellfishery
(b) changes in microbiological monitoring results
(c) changes in sources of pollution impacting the production area or new evidence relating to the actual or potential impact of sources
(d) changes in land use in the area
(e) change in environmental conditions

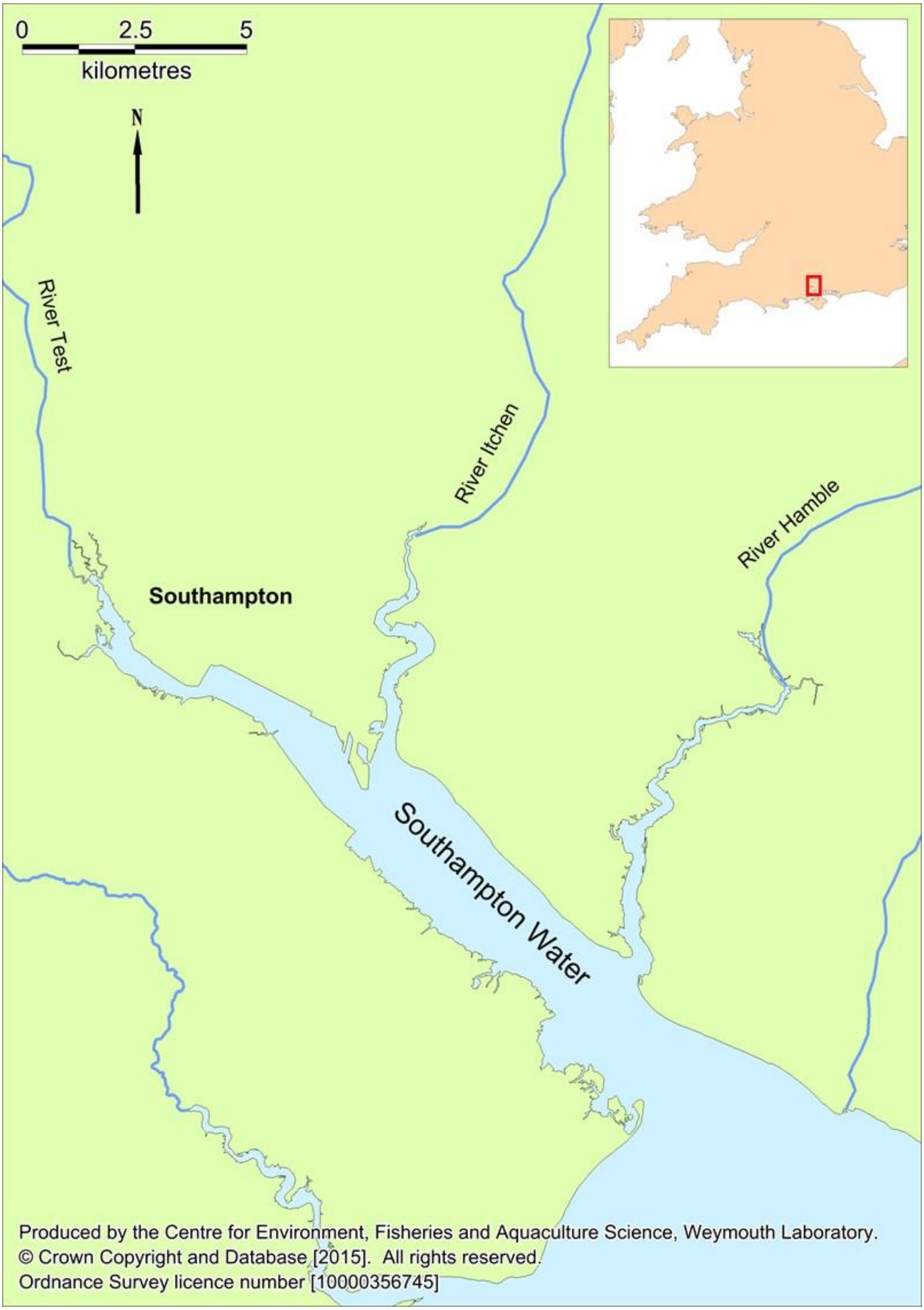


Figure 1.1: Location of Southampton Water

2. Shellfisheries

2.1. Description of shellfishery

There have been no reported changes to the geographical extents of any of the shellfish beds in Southampton Water since the 2009 sanitary survey report.

Currently there are only classifications in place for native oysters and hard clams at the southern end of Southampton Water. Both species have a long term B (B-LT) classification. However, a temporary closure of the Solent native oyster fishery, which includes Southampton Water, is currently in place due to low stock levels (Southern IFCA, 2013). This means that the only species that can legally be harvested from Southampton Water currently is hard clams; although stocks of this species are very low.

In the northern part of Southampton Water the classification zones are prohibited due to high *E. coli* levels in Manila clams. It is well known to the local authorities (Southampton PHA, Southern IFCA, MCA) that there is still a large amount of illegal harvesting of Manila clams occurring in Southampton Water despite the prohibition, and this is the subject of ongoing investigation.

Naturalised populations of Pacific oysters exist in Southampton Water and while there have been some observations of informal hand-gathering (Herbert *et al,* 2012), there has been no expression of interest in classifying this species for commercial exploitation.

Hard clams are harvested year round by dredge. Current byelaws state that the dredge size should be no smaller than 35 mm and the vessel should be no larger than 7 m. However, Cefas were informed by a source who requested to remain anonymous, that many of the harvesters are using smaller dredges and therefore harvesting undersized clams. Southern IFCA are aware of this.

In the past the majority of clams harvested in Southampton Water have been depurated at the facility operated by Viviers UK Ltd in Portsmouth. Others have been exported within Europe. There are currently no operational depuration facilities in the Southampton area, but a former harvester from the area owns the facilities for depuration near to Southampton Water, should the fishery be reopened.

The annual harvested yield from this public fishery is unknown.

2.2. Classification History

Table 2.1 lists all of the classifications within Southampton Water Since 2004 and Figure 2.1 shows the locations of the classification zones. The zone above the Itchen Bridge has never received a classification and initial sampling in this area yielded prohibited levels of *E. coli*. Following the 2009 sanitary survey, sampling in the Eastern Beds and Western Beds

(Appendix II, pages 54-55), was carried out at two RMPs within each zone. High results during initial sampling (exceeding class C) resulted in the zones being further subdivided, to allow part of the beds within them to remain open. Western Beds were split into Weston Shelf and Netley zones, and Eastern Beds was split into Hythe and Bird Pile zones. Initial samples taken at Hythe had prohibited levels of *E. coli*, while the other sites had C, B or B-LT classifications in 2011. However, by 2013 all of the beds in the upper portion of Southampton Water were prohibited. The only beds that remain not prohibited in Southampton Water are Hamble and Off Fawley, both of which have B-LT classifications for both hard clams and native oysters.

Table 2.1: Classification history for Southampton Water

Classification zone	Species	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Itchen River - Above Itchen Bridge	All species	-	-	-	P	P	P	P	P	P	P	P
Hythe		-	-	-	-	-			P	P	P	P
Dibden Bay	Cockles	-	C	C	-	-	-	-	-	-	-	-
All beds	Hard clam	B	B-LT	B-LT	B-LT	B-LT	B-LT	B-LT	-	-	-	-
Bird Pile		-	-	-	-	-	-	-	C	P	P	P
Hamble		-	-	-	-	-	-	-	B-LT	B-LT	B-LT	B-LT
Netley		-	-	-	-	-	-	-	B-LT	C	P	P
Off Fawley		-	-	-	-	-	-	-	B-LT	B-LT	B-LT	B-LT
Weston Shelf		-	-	-	-	-	-	-	B-LT	B-LT	P	P
Bird Pile	Manila clam	-	-	-	-	-	-	-	C	P	P	P
Netley		-	-	-	-	-	-	-	C	C	P	P
All beds	Native oyster	B	B-LT	B-LT	B-LT	B-LT	B-LT	B-LT	-	-	-	-
Hamble		-	-	-	-	-	-	-	B-LT	B-LT	B-LT	B-LT
Netley		-	-	-	-	-	-	-	B-LT	B	P	P
Off Fawley		-	-	-	-	-	-	-	B-LT	B-LT	B-LT	B-LT
Weston Shelf		-	-	-	-	-	-	-	B-LT	B-LT	P	P

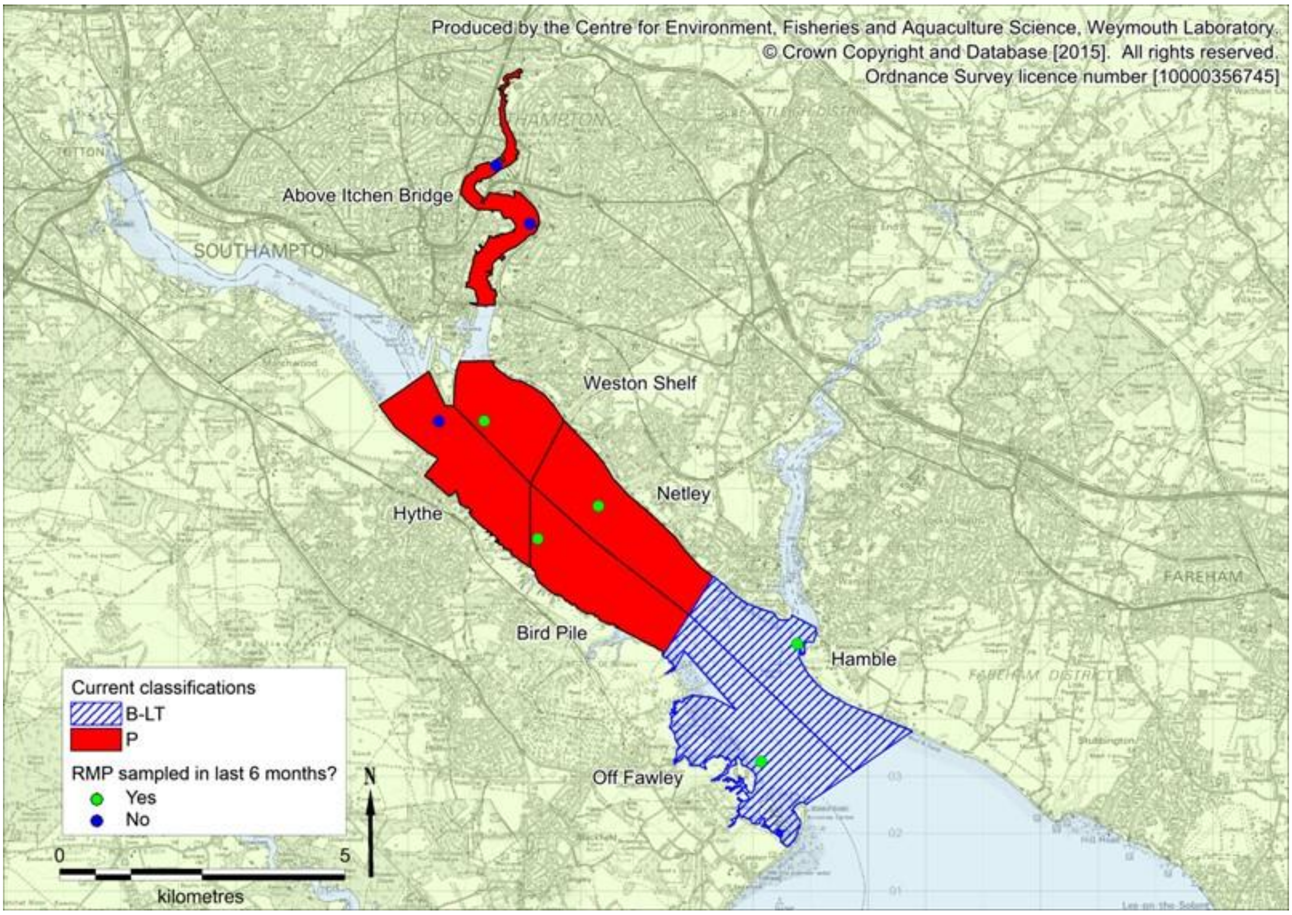


Figure 2.1: Locations of classification zones and their respective RMPs in Southampton Water

3. Overall Assessment

Since the 2009 sanitary survey, the fishery in Southampton Water has declined to the point where harvesting shellfish is currently illegal due to prohibition/IFCA closures (native oysters and Manila clams) or not economically viable due to low stock (hard clams).

While stocks of Manila clams may be dense enough for there to be a potential fishery, recent high sampling results shows that the harvesting of shellfish should remain prohibited in the northern part of Southampton Water. Below is a summary of the sources of contamination and their effects on shellfish in Southampton Water. This is further summarised in Figure 3.1.

The population in the catchment rose by 18.5% between the 2001 and 2011 censuses. Southampton, the largest settlement in the catchment, had the largest population increase. The volume of sewage discharged may have increased in response.

While the overall permitted dry weather flows (DWF) of water company owned continuous discharges reported in both the 2009 sanitary survey and this review have not changed significantly, there has been a 9% increase in the permitted DWF for Slowhill Copse WwTW in the River Test mouth (affecting the Hythe classification zone), and a 56% decrease in the permitted DWF for Ashlett Creek WwTW at the south-western end of Southampton Water (Off Fawley classification zone) although actual flows for the latter have not changed. The water quality of the south-eastern end of Southampton Water (Hamble classification zone) should be further improved in 2015 by the diversion of Bursledon STW to Peel Common (outside of Southampton Water). Woolston WwTW is being upgraded with a membrane bioreactor by May 2019, which should improve water quality in the north-eastern part of Southampton Water (Weston Shelf classification zone). It is recommended that shellfish and water samples should be taken following improvements to sewage works that may be causing prohibited results in some areas, to assess whether monitoring for shellfish classification should resume in the currently prohibited areas.

While there are planned improvements to some of the continuous sewage discharges in the Southampton Water catchment, many of the intermittent discharges in close proximity to shellfish beds have spilled frequently in recent years. These discharges are likely to impact the Hythe, Weston Shelf, Above Itchen Bridge and Hamble classification zones periodically.

The number of livestock in the Southampton water catchment declined between 2007 and 2010, but there still remains large numbers of livestock across the catchment (~1,300,000 animals). The majority of the land directly adjacent to Southampton Water is urbanised and so runoff from agricultural land is not likely to have a direct impact on shellfish water quality. However, agricultural practices in the upper catchment may contribute to the overall background contamination to shellfish growing waters.

No significant changes to wild bird populations & distributions have been reported for Southampton.

There may be a small number of new moorings in the Itchen River, but this is unlikely to impact shellfish hygiene. A new marina at Marchwood has received planning permission, but works have not yet started. This marina is unlikely to affect shellfish hygiene.

Since 2003, 20 representative monitoring points (RMPs) have been sampled in Southampton Water. Four of these RMPs were sampled both before and after the sanitary survey. There were no significant changes in *E. coli* levels at these sites before and after the sanitary survey. There is an overall trend of decreasing *E. coli* results when moving away from the northern end of Southampton Water, where there is a higher population and more sources of contamination.

There was very little seasonal effect on *E. coli* levels in shellfish flesh throughout Southampton Water. However, *E. coli* levels were shown to be significantly higher in the summer than in the winter in native oysters taken from Netley, and there were higher levels of *E. coli* in winter than in the autumn in Manila clams taken from Bird Pile. However, given the overall lack of season variation, it would not be appropriate to consider seasonal classifications in Southampton Water.

There were some tidal effects on *E. coli* levels in shellfish flesh, which showed that shellfish collected during the ebb tide had higher levels of contamination than those taken at other states of tide. This indicates that contamination from the north of Southampton Water is carried seawards during the ebb tide to affect shellfish down tide. This effect was not seen in the southern beds sampled since the sanitary survey, indicating that the contamination from the north of Southampton Water has less impact on these beds.

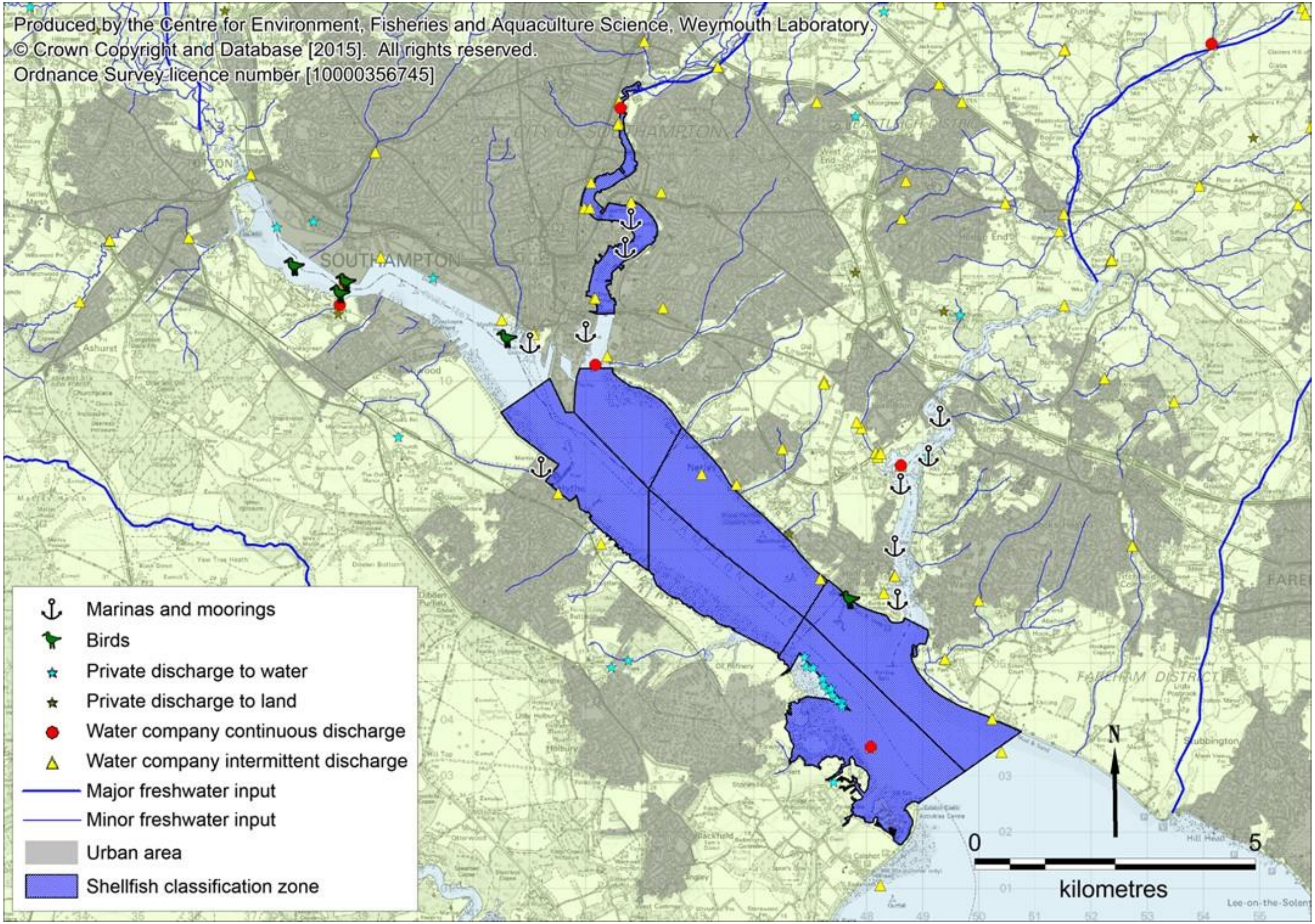


Figure 3.1: Summary of contamination sources to shellfish beds in Southampton Water

4. Sampling Plan

4.1. Recommendations

Native oysters (*O. edulis*)

The native oyster beds in Southampton Water are currently closed due to low population numbers. However, sampling for classification continues in order to maintain the classification for when the beds reopen. The extents of the classification zones for native oysters should remain unchanged from the current sampling plan. However, if shellfish hygiene improves for the northern beds, the sampling plan may be adjusted as described below

Hythe – This classification zone represents the north-western part of Southampton Water. Since the Eastern and Western bed classification zones were split into four classification zones in 2011, the Hythe zone has not been classified due to high *E. coli* results in initial samples. The monitoring point for this zone should be moved closer to the northern edge of the classification zone to better capture contamination from the River Test, and the Millbrook and Slowhill Copse WwTWs, which are likely to be the main sources of contamination to this area.

Bird Pile – This classification zone represents the beds in the middle-western part of Southampton Water and is currently prohibited. The RMP for this zone is sited to capture contamination coming from the River Test, and the Millbrook and Slowhill Copse WwTWs. These are likely to be the most significant contamination sources for this area and so the RMP should remain where it currently is. If shellfish hygiene improves in Southampton Water and both the Hythe and Bird Pile zones become un-prohibited, the Bird Pile classification zone could be joined with the Hythe classification zone, and a single RMP (that which is used for the Hythe classification zone) could be used to represent the entire area. This would be similar to the original recommendation from the 2009 sanitary survey.

Weston Shelf – This classification zone represents the north-eastern part of Southampton Water and is currently prohibited. The RMP for this classification zone should be moved to the northern most point of the classification zone to better account for contamination from the Woolston WwTW and the River Itchen. If it is not possible to take samples this far north, then the northern extent of the classification zone should be moved south and the RMP located at the northern most end of the new zone.

Netley - This classification zone represents the beds in the middle-eastern part of Southampton Water and is currently prohibited. The RMP for this classification zone should be moved to better account for contamination from the Woolston WwTW and the River Itchen. If shellfish hygiene improves in Southampton Water and both the Weston Shelf and Netley zones become un-prohibited, the Netley classification zone could be joined with the Weston Shelf classification zone, and a single RMP (that which is used for the Weston Shelf classification zone) could be used to represent the entire area. This would be similar to the original recommendation from the 2009 sanitary survey.

Off Fawley – This classification zone represents the beds in the south-western part of Southampton Water. The current RMP should be moved closer to the Ashlett Creek WwTW.

Hamble – This classification zone represents the beds in the south-eastern part of Southampton Water. The current RMP is sited to account for contamination from the River Hamble and the Bursledon STW and should remain where it currently is.

Hard clams (*M. mercenaria*)

Native oysters have been shown to be a suitable proxy for hard clams for the purposes of hygiene classification monitoring (Younger & Reese, 2011) and have historically been used in this way in Southampton Water. For this reason, all classification zones and RMPs for hard clams in Southampton Water should be identical to those for native oysters, and native oysters taken as a proxy for hygiene classification.

Manila clams (*Tapes* spp.)

All Manila clam beds are currently prohibited in Southampton Water, however, the following sampling plan should be used to inform any decision to lift or maintain the prohibition, and for any further sampling if a classification is granted. The classification zone above Itchen Bridge has never been classified due to high levels of *E. coli* in initial results. This area should be removed from the sampling plan.

Hythe – The extents of this zone and location of the RMP should be the same as for native oysters, but Manila clams should be sampled for hygiene classification.

Bird Pile – The extents of this zone and location of the RMP should be the same as for native oysters, but Manila clams should be sampled for hygiene classification.

Weston Shelf – The extents of this zone and location of the RMP should be the same as for native oysters, but Manila clams should be sampled for hygiene classification.

Netley – The extents of this zone and location of the RMP should be the same as for native oysters, but Manila clams should be sampled for hygiene classification.

4.2. General information

Location Reference

Production area	Southampton Water
Cefas main site reference	M021
Ordnance Survey 1:25,000 map	OL22 (New Forest), 119 (Meon Valley)
Admiralty charts	No. 2036 and 2041

Shellfishery

Species/culture	Native oysters (*Ostrea edulis)*	Wild
	Hard clams (*Mercenaria mercenaria*)	Wild
	Manila clams (*Tapes* spp.)	Wild
Seasonality of harvest	Year round	

Local Enforcement Authority

Name	Southampton Port Health Authority
Environmental health officer	Kelly Scott
Telephone number	02380 226631
Fax number	02380 233859
Email	port.health@southampton.gov.uk

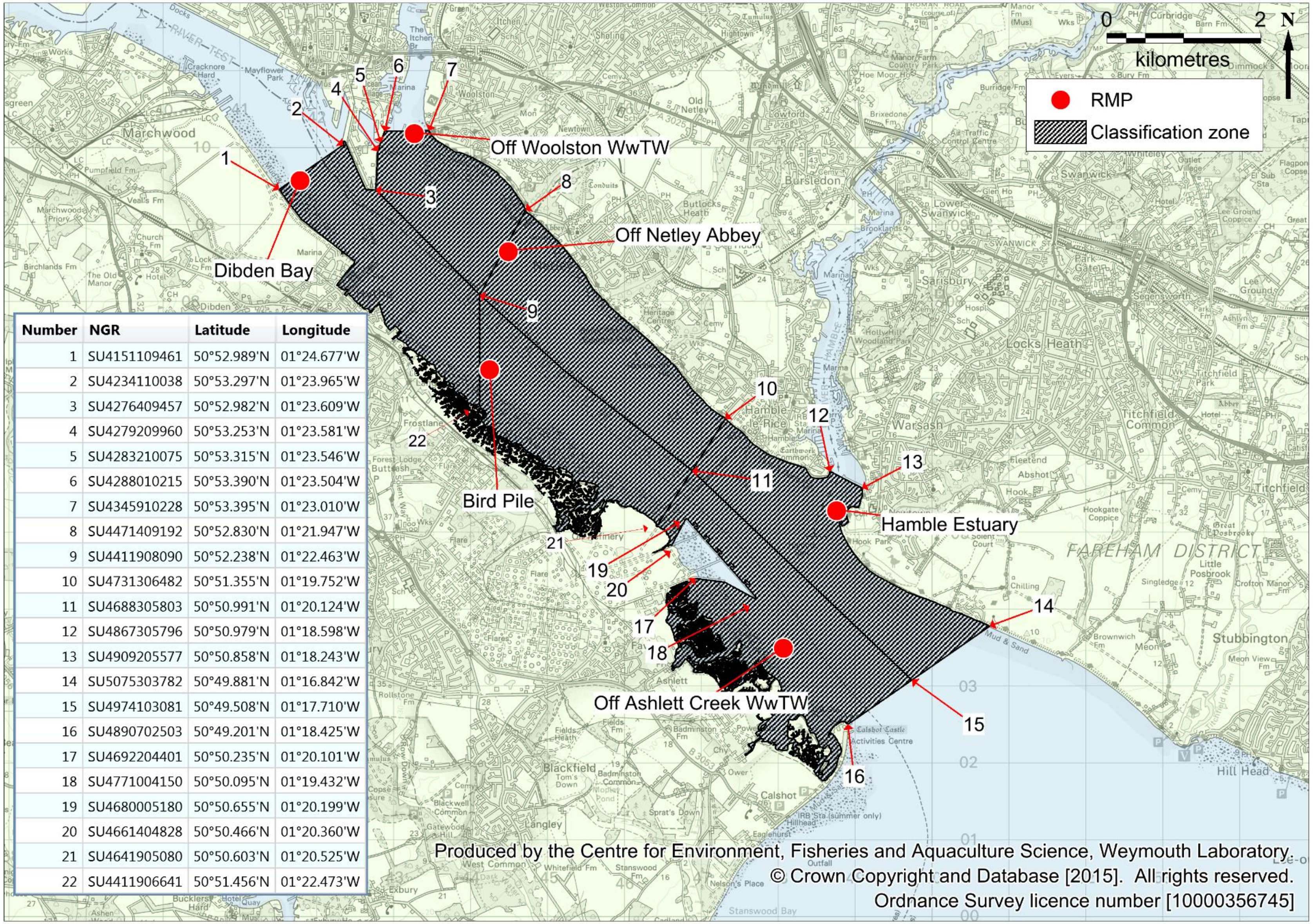
Requirement for review

The Guide to Good Practice for the Microbiological Monitoring of Bivalve Mollusc Harvesting Areas (EU Working Group on the Microbiological Monitoring of Bivalve Mollusc Harvesting Areas, 2014) indicates that sanitary assessments should be fully reviewed every six years. This assessment is therefore due for formal review in 2021. The assessment may require review in the interim should any significant changes in sources of contamination come to light or any changes to the shellfishery occur.

Table 4.1: Number and location of representative monitoring points (RMPs) and frequency of sampling for classification within Southampton Water

Classification zone	RMP†	RMP name	NGR	Latitude & longitude (WGS84)	Species represented	Growing method	Harvesting technique	Sampling method	Sampling species	Tolerance	Frequency
Bird Pile*	B21AF	Bird Pile	SU4424907130	50°51.720'N 01°22.359'W	Hard clams	Wild	Dredge	Dredge	Native oysters	100 m	Monthly
Hamble	B21AG	Hamble Estuary	SU4875905299	50°50.710'N 01°18.529'W	Hard clams	Wild	Dredge	Dredge	Native oysters	100 m	Monthly
Hythe*	B21AH	Dibden Bay	SU4178509592	50°53.059'N 01°24.443'W	Hard clams	Wild	Dredge	Dredge	Native oysters	100 m	Monthly
Netley*	B21AI	Off Netley Abbey	SU4449108666	50°52.547'N 01°22.141'W	Hard clams	Wild	Dredge	Dredge	Native oysters	100 m	Monthly
Off Fawley	B21AJ	Off Ashlett Creek WwTW	SU4807003509	50°49.748'N 01°19.130'W	Hard clams	Wild	Dredge	Dredge	Native oysters	100 m	Monthly
Weston Shelf*	B21AK	Off Woolston WwTW	SU4326810202	50°53.381'N 01°23.173'W	Hard clams	Wild	Dredge	Dredge	Native oysters	100 m	Monthly
Bird Pile*	B021W	Bird Pile	SU4424907130	50°51.720'N 01°22.359'W	Manila clams	Wild	Dredge	Dredge	Manila clams	100 m	Monthly
Hythe*	B21AL	Dibden Bay	SU4178509592	50°53.059'N 01°24.443'W	Manila clams	Wild	Dredge	Dredge	Manila clams	100 m	Monthly
Netley*	B21AM	Off Netley Abbey	SU4449108666	50°52.547'N 01°22.141'W	Manila clams	Wild	Dredge	Dredge	Manila clams	100 m	Monthly
Weston Shelf*	B21AN	Off Woolston WwTW	SU4326810202	50°53.381'N 01°23.173'W	Manila clams	Wild	Dredge	Dredge	Manila clams	100 m	Monthly
Bird Pile*	B21AO	Bird Pile	SU4424907130	50°51.720'N 01°22.359'W	Native oysters	Wild	Dredge	Dredge	Native oysters	100 m	Monthly
Hamble	B021Y	Hamble Estuary	SU4875905299	50°50.710'N 01°18.529'W	Native oysters	Wild	Dredge	Dredge	Native oysters	100 m	Monthly
Hythe*	B21AP	Dibden Bay	SU4178509592	50°53.059'N 01°24.443'W	Native oysters	Wild	Dredge	Dredge	Native oysters	100 m	Monthly
Netley*	B21AQ	Off Netley Abbey	SU4449108666	50°52.547'N 01°22.141'W	Native oysters	Wild	Dredge	Dredge	Native oysters	100 m	Monthly
Off Fawley	B21AR	Off Ashlett Creek WwTW	SU4807003509	50°49.748'N 01°19.130'W	Native oysters	Wild	Dredge	Dredge	Native oysters	100 m	Monthly
Weston Shelf*	B21AS	Off Woolston WwTW	SU4326810202	50°53.381'N 01°23.173'W	Native oysters	Wild	Dredge	Dredge	Native oysters	100 m	Monthly

**These beds are currently prohibited and the sampling plan should be used to inform any decision to lift or maintain the prohibition, and for any further sampling if a classification is granted.*



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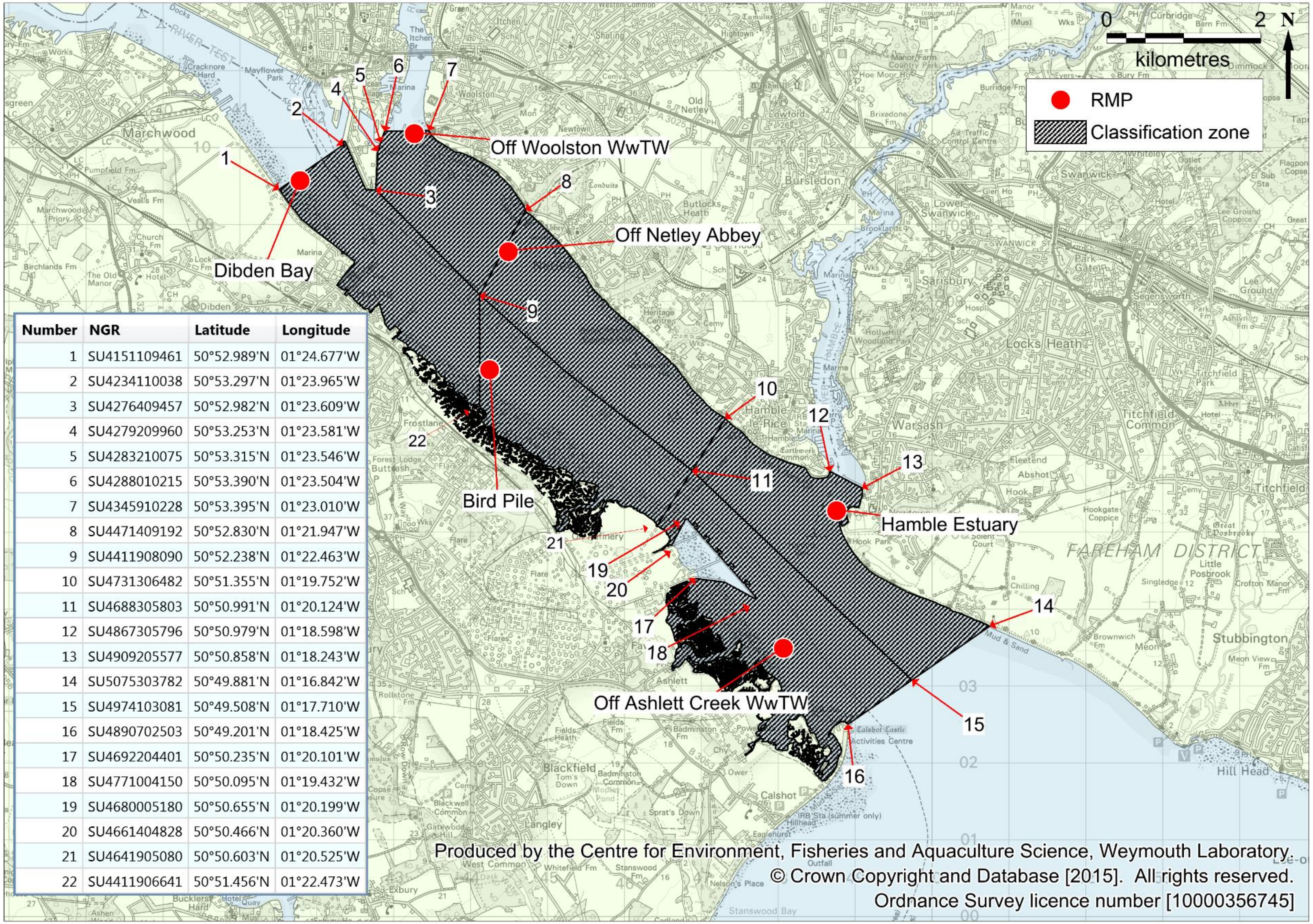
2	SU4234110038	50°53.297'N	01°23.965'W
3	SU4276409457	50°52.982'N	01°23.609'W
4	SU4279209960	50°53.253'N	01°23.581'W
5	SU4283210075	50°53.315'N	01°23.546'W
6	SU4288010215	50°53.390'N	01°23.504'W
7	SU4345910228	50°53.395'N	01°23.010'W
8	SU4471409192	50°52.830'N	01°21.947'W
9	SU4411908090	50°52.238'N	01°22.463'W
10	SU4731306482	50°51.355'N	01°19.752'W
11	SU4688305803	50°50.991'N	01°20.124'W
12	SU4867305796	50°50.979'N	01°18.598'W
13	SU4909205577	50°50.858'N	01°18.243'W
14	SU5075303782	50°49.881'N	01°16.842'W
15	SU4974103081	50°49.508'N	01°17.710'W
16	SU4890702503	50°49.201'N	01°18.425'W
17	SU4692204401	50°50.235'N	01°20.101'W
18	SU4771004150	50°50.095'N	01°19.432'W
19	SU4680005180	50°50.655'N	01°20.199'W
20	SU4661404828	50°50.466'N	01°20.360'W
21	SU4641905080	50°50.603'N	01°20.525'W
22	SU4411906641	50°51.456'N	01°22.473'W

Figure 4.1: Recommended zoning and monitoring arrangements (native oysters)



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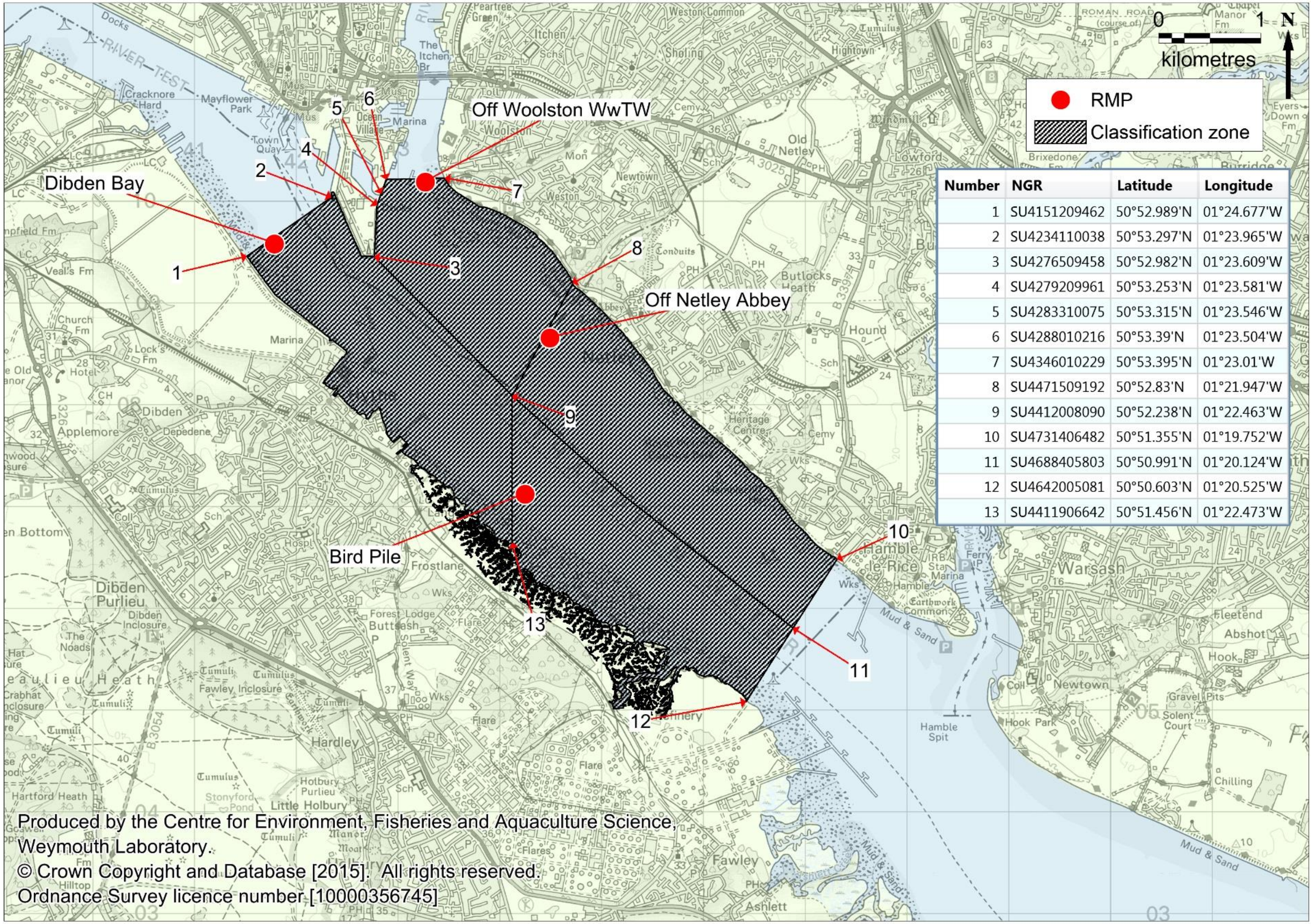
19	SU4680005180	50°50.655'N	01°20.199'W
20	SU4661404828	50°50.466'N	01°20.360'W
21	SU4641905080	50°50.603'N	01°20.525'W
22	SU4411906641	50°51.456'N	01°22.473'W

Figure 4.2: Recommended zoning and monitoring arrangements (hard clams)



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4	SU4279209961	50°53.253'N	01°23.581'W
5	SU4283310075	50°53.315'N	01°23.546'W
6	SU4288010216	50°53.39'N	01°23.504'W
7	SU4346010229	50°53.395'N	01°23.01'W
8	SU4471509192	50°52.83'N	01°21.947'W
9	SU4412008090	50°52.238'N	01°22.463'W
10	SU4731406482	50°51.355'N	01°19.752'W
11	SU4688405803	50°50.991'N	01°20.124'W
12	SU4642005081	50°50.603'N	01°20.525'W
13	SU4411906642	50°51.456'N	01°22.473'W

Figure 4.3: Recommended zoning and monitoring arrangements (Manila clams)

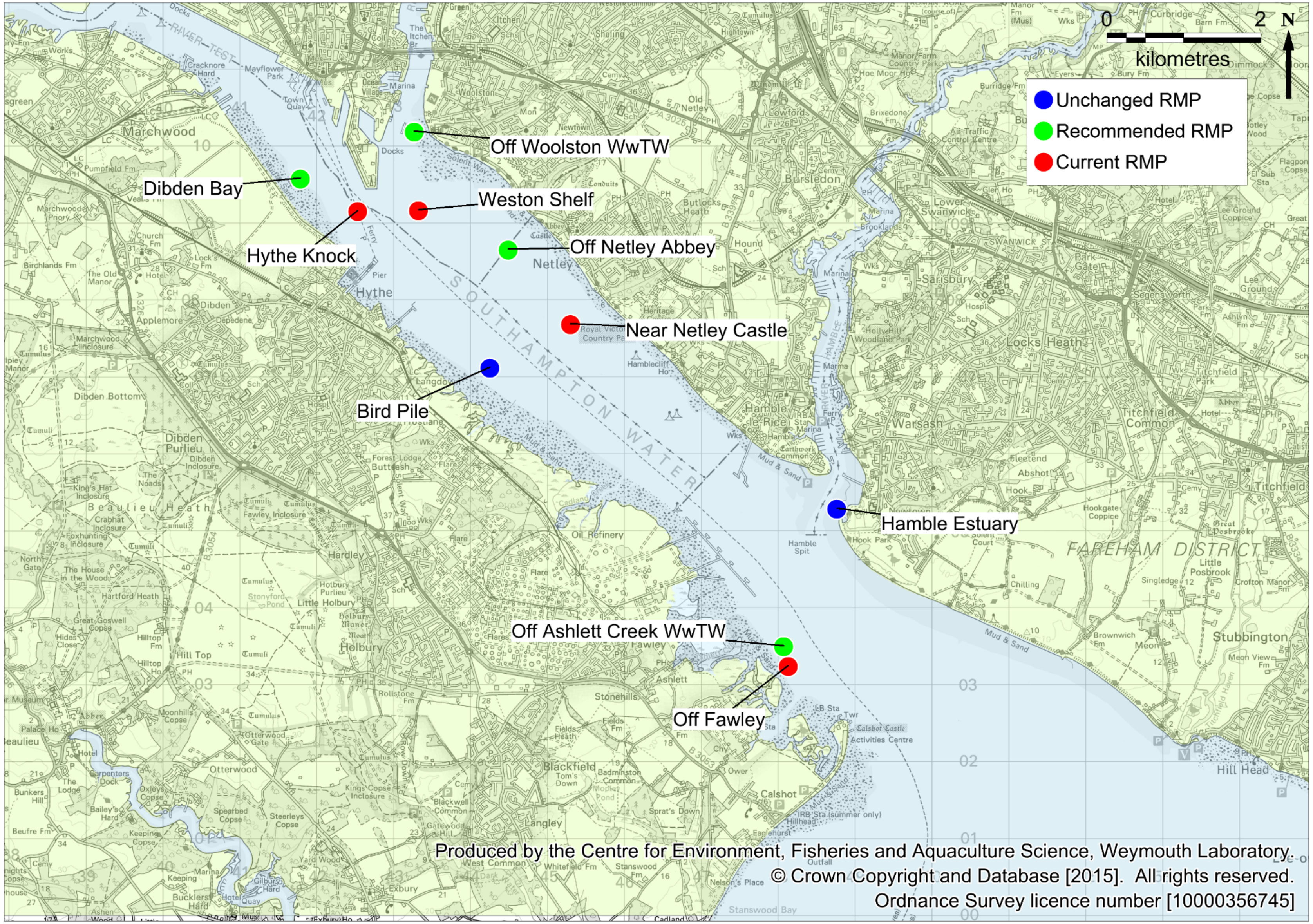

Figure 4.4: Current and recommended native oyster RMPs. Bird Pile and Hamble Estuary remain unchanged

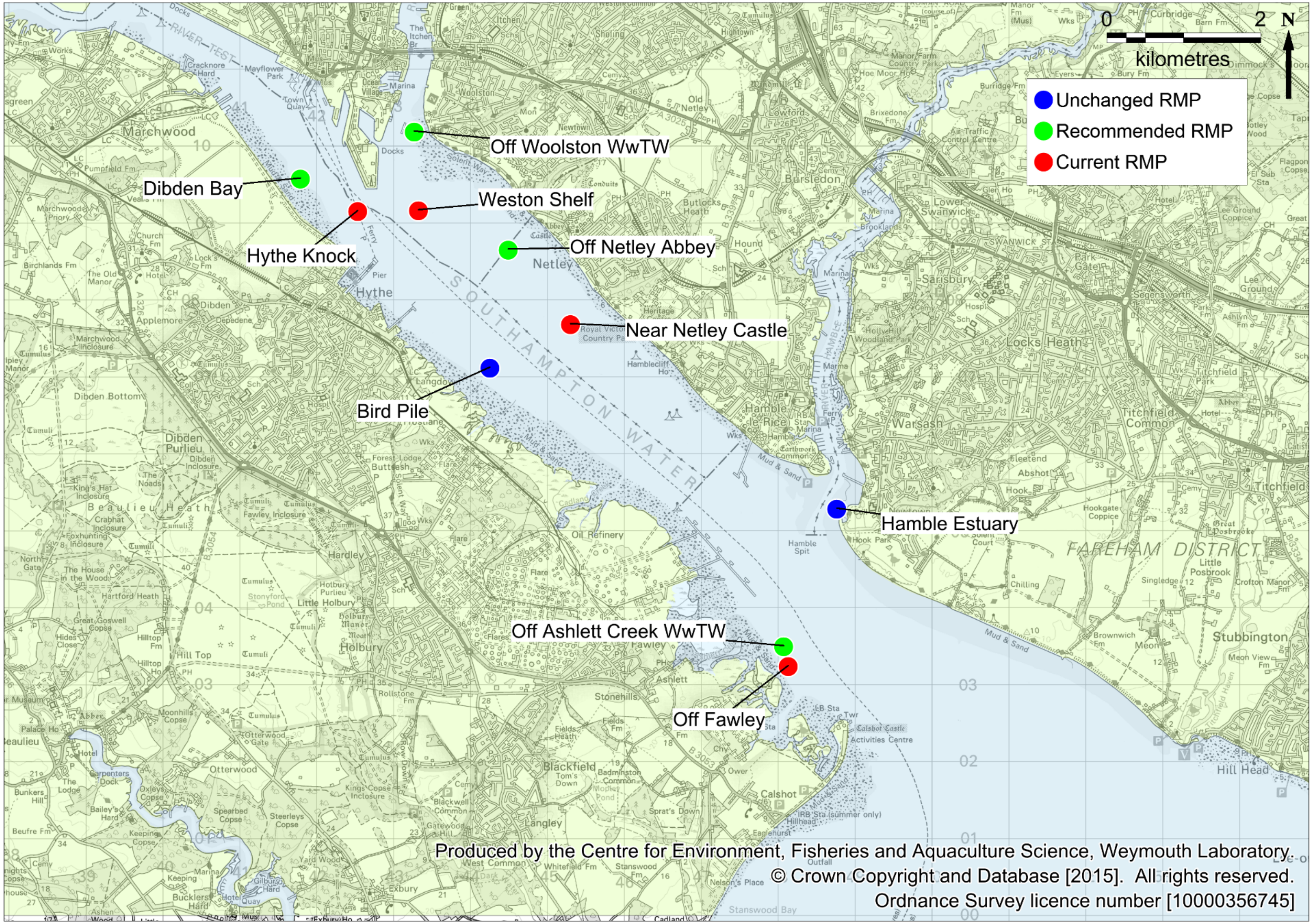

Figure 4.5: Current and recommended hard clams RMPs. Bird Pile and Hamble Estuary remain unchanged

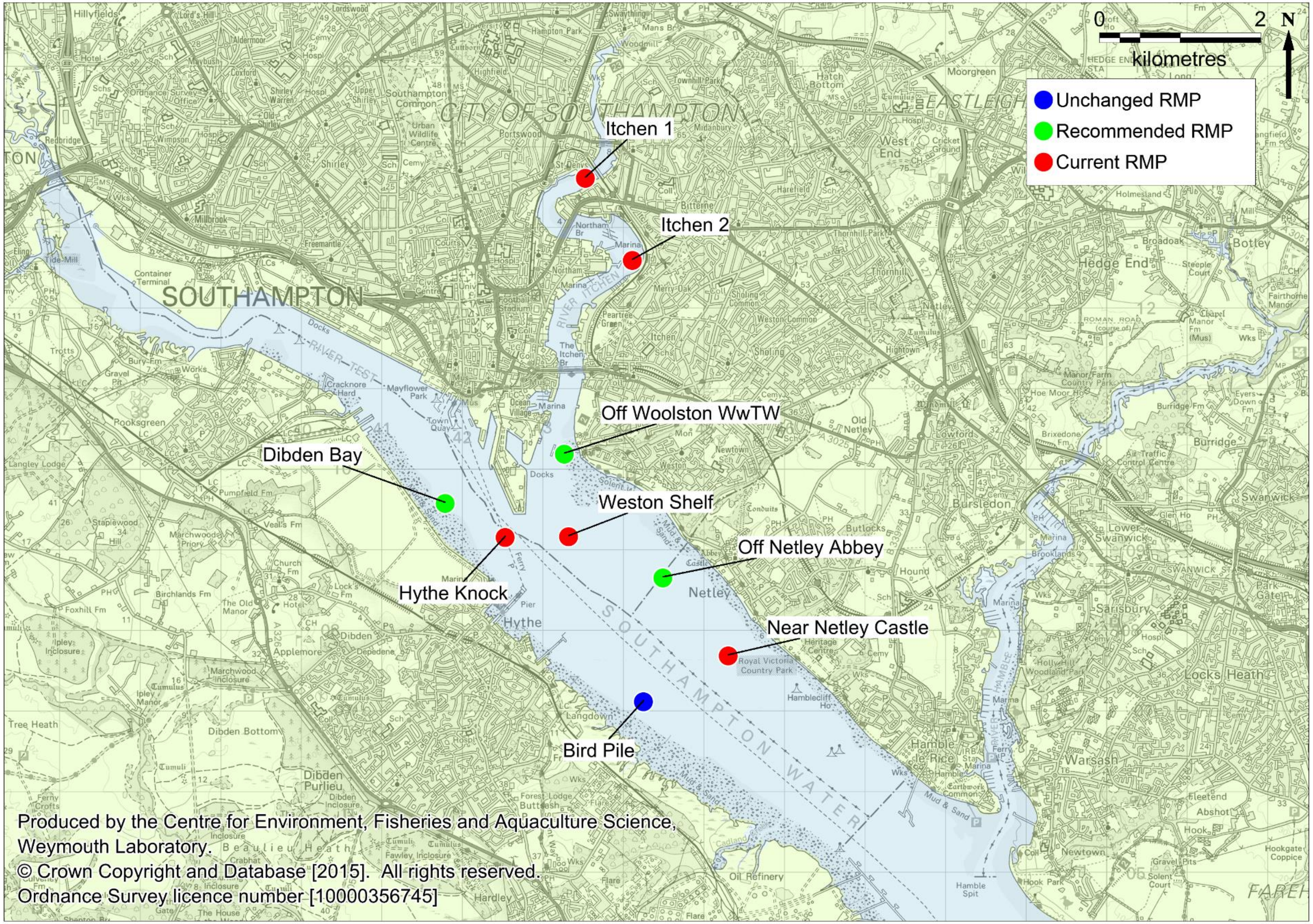

Figure 4.6: Current and recommended Manila clam RMPs. Bird Pile remains unchanged

5. Pollution sources

5.1. Human Population

In the 2009 Southampton Water Sanitary Survey Report, the population data presented were collected in the 2001 census. Another census in 2011 was conducted since the report was written, and so changes in the human population in the catchment are discussed here.

Figure 5.1 shows population densities in census Lower Layer Super Output Areas (LSOAs) within or partially within the Southampton Water catchment area, derived from data collected from the 2001 and 2011 censuses. An overall trend of increased population density is apparent. In particular, parts of Southampton saw large increases in population density between 2001 and 2011.

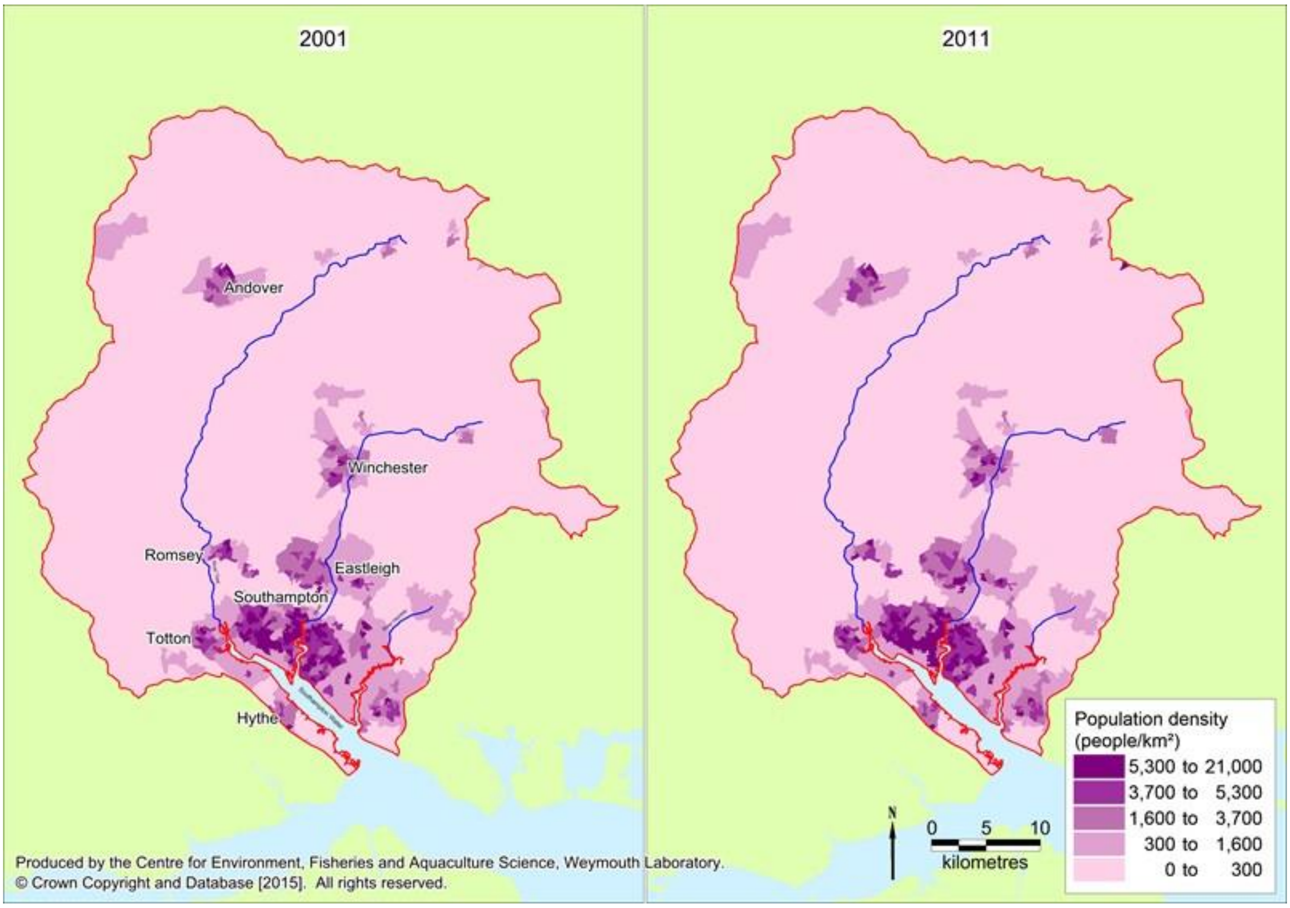

Figure 5.1: Human population density in 2001 and 2011 census LSOAs in the Southampton Water catchment.

Total resident population within the census areas contained within or partially within the catchment area was approximately 746,500 in 2001 and 884,400 in 2011. This is an increase of around 18.5% at the time of the 2011 census.

Table 5.1 shows the changes in the total populations and population densities for the wider census areas and Figure 5.2 shows the extents of the wider census areas. Test Valley had the largest proportional population increase, but Southampton had the largest absolute population increase. New Forest and West Berkshire had net decreases in population.

Table 5.1: Changes in populations in census areas in the Southampton Water catchment between 2001 and 2011.

	Total population				Population density (people/km²)		
Census area	**2001**	**2011**	**Absolute difference**	**% change**	**2001**	**2011**	**% change**
Test Valley	109,801	144,971	35,170	32.0	175.4	231.6	32.0
Winchester	97,948	128,027	30,079	30.7	163.9	214.3	30.7
Eastleigh	116,169	143,652	27,483	23.7	1,365.9	1,689.0	23.7
Wiltshire	31,183	37,466	6,283	20.1	81.7	98.2	20.1
Southampton	217,445	254,747	37,302	17.2	3,867.1	4,530.4	17.2
Fareham	37,915	41,004	3,089	8.1	1,167.3	1,262.4	8.1
Basingstoke and Deane	35,666	38,194	2,528	7.1	81.5	87.3	7.1
East Hampshire	14,552	14,583	31	0.2	66.1	66.3	0.2
New Forest	83,791	79,826	-3,965	-4.7	220.2	209.8	-4.7
West Berkshire	2,044	1,930	-114	-5.6	25.6	24.1	-5.6
Total	**746,514**	**884,400**	**137,886**	**18.5**	**721.5**	**841.3**	**12.9**

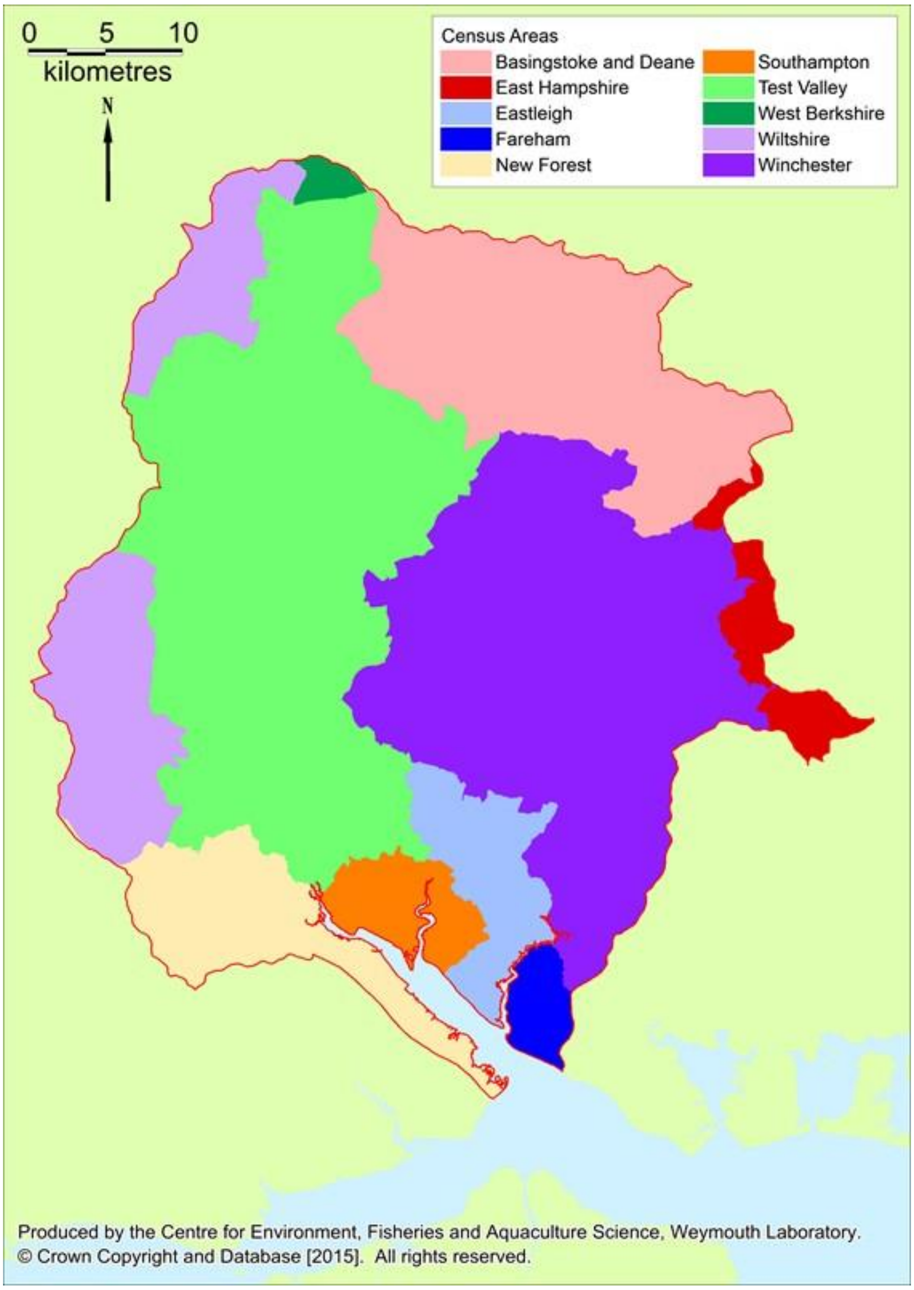

Figure 5.2: Wider 2011 census areas within or partially within the Southampton Water catchment.

5.2. Sewage

Details of all permitted discharges in the Southampton Water hydrological catchment were taken from the most recent update of the Environment Agency national permit database at the time of writing (October 2014). The locations of these discharges are shown in Figure 5.3, Figure 5.4 and Figure 5.6.

There are a total of 47, water company owned, continuous discharges in the catchment area, details of which are outlined in Figure 5.3 and Table 5.2. In the 2009 sanitary survey report, six continuous discharges were presented (Appendix I, page 13, Table 4.1). All six of these discharges still have discharge permits. The overall dry weather flow (DWF) from these six discharges collectively has not changed significantly, however the level of changes to DWFs at individual discharges are variable. The permitted DWF for Ashlett Creek WwTW has been reduced since the 2009 report, however actual flows have not changed. Bursledon STW and Slowhill Copse both have increased DWFs since the 2009 report and have had no change to their treatment levels, but in June 2014 the flow from Bursledon STW (now decommissioned) was transferred to Peel Common STW, which is outside the Southampton Water catchment (Southern Water, pers. comm. 2015). Both Millbrook WwTW and Portswood WwTW have similar DWF to the 2009 report. The treatment level for Millbrook WwTW has been upgraded to include nitrogen removal (tertiary treatment).

Following failing shellfish waters compliance, Southern Water modelled the impact of continuous discharges on the Southampton Water shellfish waters area and found that Woolston, Millbrook and Slowhill Copse WwTWs all have an impact on water quality (EA, 2014). Further modelling showed that Woolston WwTW requires tertiary treatment and both Millbrook and Slowhill Copse WwTW require improvements, however no improvements are currently planned. Woolston WwTW is being upgraded for nitrogen removal using a membrane bioreactor process, which will be completed in May 2019 (Southern Water, pers. comm, 2015).

There are 129 water company owned intermittent discharges in the Southampton Water catchment area details of which are outlined in Figure 5.4 and Table 5.3. In the 2009 sanitary survey, 38 intermittent discharges were reported, 32 of which still have current permits. Three of the six discharges that are no longer in operation (Cadland Park Hardley, Park Road CSO and Thomas Lewis Way CSO) did not discharge directly to shellfish production areas. Maritime Avenue Marchwood pumping station emergency overflow still exists but is not listed on the Permit database. This permit was surrendered by the original permit holder (Ryan of Wimbourne), as it is now a Southern Water asset (Sothern Water pers. comm. 2015).

Table 5.4 and Figure 5.5 detail the recorded spills from intermittent discharges in the Southampton Water catchment. Several of these discharges have spilled for more than 3% of the time in recent years and are therefore likely to be contributing a large amount of contamination to the shellfish waters. Of particular importance are the Bursledon STW storm overflow on the River Hamble; the Chickenhall Eastleigh WwTW storm overflow, Imperial Road Mount Pleasant CEO and Woolston WwTW storm overflow on the River Itchen; and the Millbrook and Slowhill Copse WwTWs storm overflow in the north west of Southampton Water. All of these discharges are in close proximity to shellfish classification zones and have spilled for more than 3% of the time in recent years.

There are several privately owned discharges in the Southampton Water catchment area. The locations of all of those with maximum daily flows of 5 m^3 or greater are shown in Figure 5.6 and the details of all those with maximum daily flows of 50 m^3 or greater are shown in Table 5.5. The Cadland Road and Fawley Generating Station discharges are the only large private discharges in close proximity to the shellfish production areas. There have been no significant reported changes to private discharges since 2009.

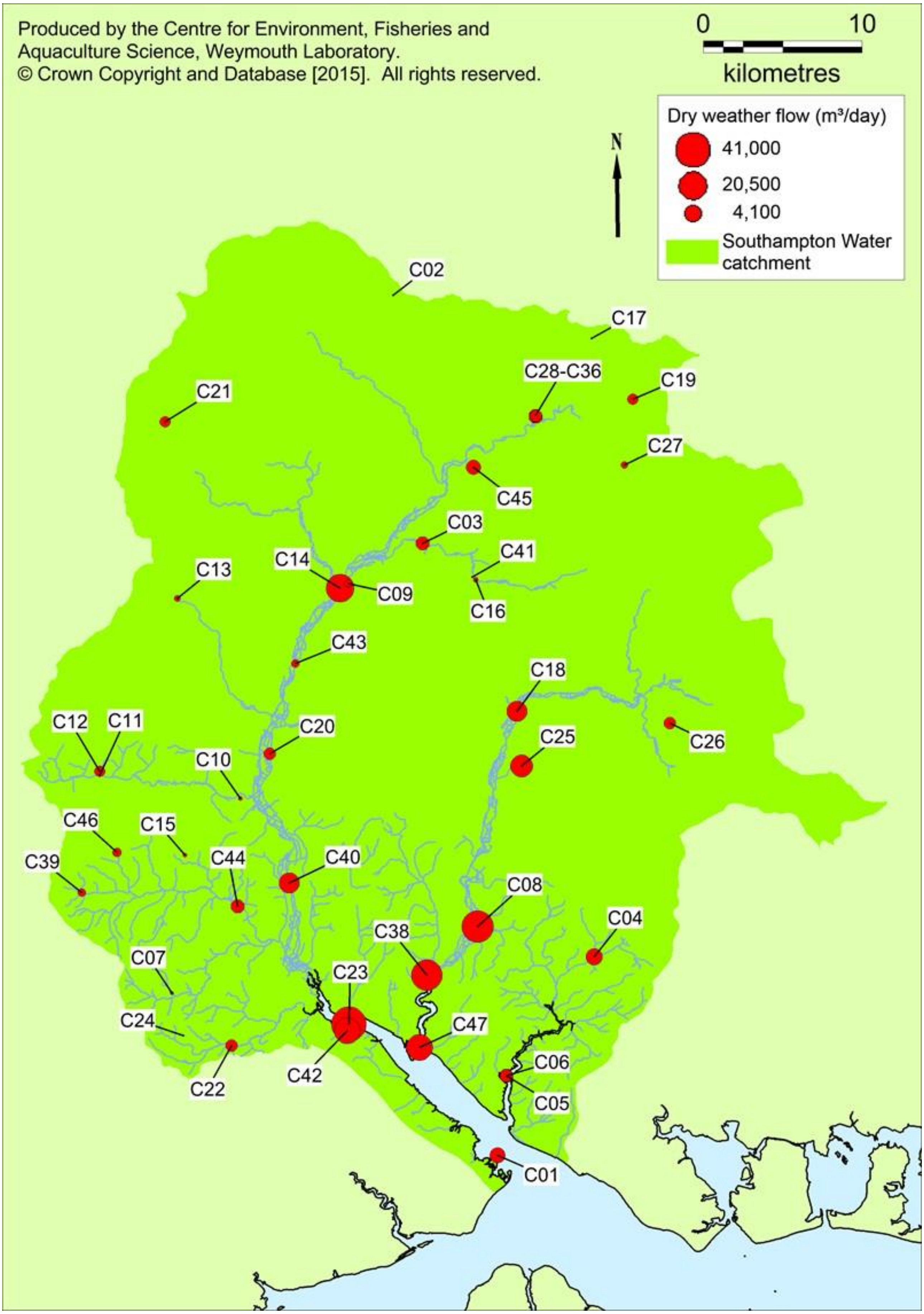

Figure 5.3: Locations and dry weather flows of the water company owned continuous discharges in the Southampton Water catchment (details in Table 5.2).

Table 5.2: Details of continuous water company sewage works permits within the survey area. Distances highlighted in yellow are less than 5 km.

Number on map	Name in current database (comment)	Name in 2009 sanitary survey	NGR	Treatment	DWF (m^3/day)	Previous DWF (m^3/day)	Receiving environ-ment	Nearest CZ (km)†	Calculated loading‡
C01	Ashlett Creek WwTW	Ashlett Creek STW	SU4807003510	2° (AS)	3,024	4,727	Estuary	0	-
C02	Barn Close Ashmansworth WwTW		SU4151057590	3° (SF)	5		Land	60	$1.4x10^{7}$
C03	Barton Stacey WwTW		SU4334541993	2° +CPS	1,746		River	43	$5.8x10^{12}$
C04	Bishops Waltham WwTW		SU5414015980	2° (CPS	3,100		River	14.5	$1.0x10^{13}$
C05	Bursledon STW (excluding April 2010 to February 2011)*	Bursledon STW	SU4861008500	2° (BF)	1,550	1,477	Estuary	3	$5.1x10^{12}$
C06	Bursledon STW (temporary April 2010 to February 2011).	Bursledon STW	SU4861008500	2° (BF)	1,720	1,477	Estuary	3	$5.7x10^{12}$
C07	Canterton Lane Brook WwTW		SU2758013690	2° (BF)	9		River	20.5	$3.0x10^{10}$
C08	Chickenhall Eastleigh WwTW		SU4681817888	2° +CPS	32,000		River	4.5	$1.1x10^{14}$
C09	Chilbolton WwTW		SU3865139466	2° +CPS	294		River	36.5	$9.7x10^{11}$
C10	Dunbridge WwTW		SU3188025945	2° (SAFF)	19		Soakaway	22.5	-
C11	East Grimstead WwTW		SU2303627419	2° (BF)	690		Soakaway	31.5	$2.3x10^{12}$
C12	East Grimstead WwTW		SU2303727650	2° (BF)	690		River	31.5	$2.3x10^{12}$
C13	Evans Close Over Wallop WwTW		SU2790038520	2° (BF)	86		River	38	$2.8x10^{11}$
C14	Fullerton (Andover) WwTW		SU3816039170	2°+ CPS	19,291		River	36.5	$6.4x10^{13}$
C15	Graemar Cottages S. English WwTW		SU2839022390	2° (PTP)	20		River	20.5	$6.6x10^{10}$
C16	Gratton Close Sutton Scotney WwTW		SU4670039690	2° (BF)	50		River	46.5	$1.7x10^{11}$
C17	Hannington S.T.W.		SU5397054870	2° (PTP)	NR		Land	60	-
C18	Harestock WwTW		SU4928031420	2° (CPS)	6,330		River	19.5	$2.1x10^{13}$
C19	Ivy Down Lane WwTW		SU5658051060	2° (BF)	722		Soakaway	60	$2.4x10^{12}$
C20	Kings Somborne WwTW		SU3373028750	2°+ CPS	972		River	25	$3.2x10^{12}$
C21	Ludgershall WwTW		SU2714049640	2° (BF)	887		Soakaway	52.5	$2.9x10^{12}$
C22	Lyndhurst WwTW		SU3131910397	3° (TB)	1,182		River	13	$3.3x10^{9}$
C23	Millbrook WwTW (Nitrogen removal from March 2015)	Millbrook STW	SU3871011760	3° (NitR)	40,007	40,000	Estuary	4	$1.3x10^{14}$
C24	Minstead WwTW		SU2830011030	2°+PTP	NR		River	16.5	-
C25	Morestead WwTW (CPS from December 2013)		SU4958027990	2°(AS) +CPS	9,933		Irrigation	17	$3.3x10^{13}$
C26	New Alresford WwTW		SU5892030690	2° (BF)	1,153		Soakaway	31.5	$3.8x10^{12}$
C27	North Waltham WwTW		SU5606046910	2° (BF)	167		Soakaway	61.5	$5.5x10^{11}$

Number on map	Name in current database (comment)	Name in 2009 sanitary survey	NGR	Treatment	DWF (m^3/day)	Previous DWF (m^3/day)	Receiving environ-ment	Nearest CZ (km)†	Calculated loading‡
C28	Overton WwTW (outfall 1) ††		SU5048050030	2° (BF)	1,160		Soakaway	52	$3.8x10^{12}$
C29	Overton WwTW (outfall 5) ††		SU5043049920	2° (BF)	1,160		Soakaway	52	$3.8x10^{12}$
C30	Overton WwTW (outfall 6) ††		SU5046049910	2° (BF)	1,160		Soakaway	52	$3.8x10^{12}$
C31	Overton WwTW (outfall 7) ††		SU5049049930	2° (BF)	1,160		Soakaway	52	$3.8x10^{12}$
C32	Overton WwTW (outfall 8) ††		SU5051049930	2° (BF)	1,160		Soakaway	52	$3.8x10^{12}$
C33	Overton WwTW (outfall 2) ††		SU5047050000	2° (BF)	1,160		Soakaway	52	$3.8x10^{12}$
C34	Overton WwTW (outfall 3) ††		SU5043050030	2° (BF)	1,160		Soakaway	52	$3.8x10^{12}$
C35	Overton WwTW (outfall 4) ††		SU5043049980	2° (BF)	1,160		Soakaway	52	$3.8x10^{12}$
C36	Overton WwTW (outfall 9) ††		SU5049050020	2° (BF)	1,160		Soakaway	52	$3.8x10^{12}$
C38	Portswood WwTW	Portswood STW	SU4362014840	2° (BF)	27,700	27,700	Estuary	0	$9.1x10^{13}$
C39	Redlynch STW		SU2189020030	2° (BF)	290		River	26	$9.6x10^{11}$
C40	Romsey WwTW		SU3495020620	2° +CPS	7,379		River	14	$2.4x10^{13}$
C41	Saddlers Close Sutton Scotney WTW		SU4648039870	2° (PTP)	NR		River	47	-
C42	Slowhill Copse WwTW (activated sludge NitR from	Slowhill Copse STW	SU3862011350	2° (BF/AS)	16,317	14,970	Estuary	4	$5.4x10^{13}$
C43	Stockbridge WwTW		SU3534034440	2°+ CPS	231		River	30	$7.6x10^{11}$
C44	West Wellow WwTW		SU3172019160	2° (DF)	1,834		River	16.5	-
C45	Whitchurch WwTW		SU4656046780	2° (BF)	2,336		Soakaway	49.5	$7.7x10^{12}$
C46	Whiteparish WwTW		SU2411022540	3° (TB)	367		River	26.5	$1.0x10^{9}$
C47	Woolston WwTW	Woolston STW	SU4317010290	2° (BF)	15,000	15,000	Estuary	0	$5.0x10^{13}$

STW=sewage treatment works, WwTW=wastewater treatment works

AS = activated sludge
BF = biological filtration
CPS = chemical phosphate stripping

DF = drum filter
LS = lagoon settlement
NitR = Nitrogen removal
NR = not reported

PTP = package treatment plant
TB = tertiary biological
SAFF = submerged aerated fixed films
SF =sand filtration

‡ *E. coli* cfu/day (data from Kay *et al.* 2008),
* decommissioned in June 2014,
** 2° (AS) +NitR from March 2015
† fluvial distance,
†† only one of these discharges operates at any one time and phosphorous removal from December 2012.

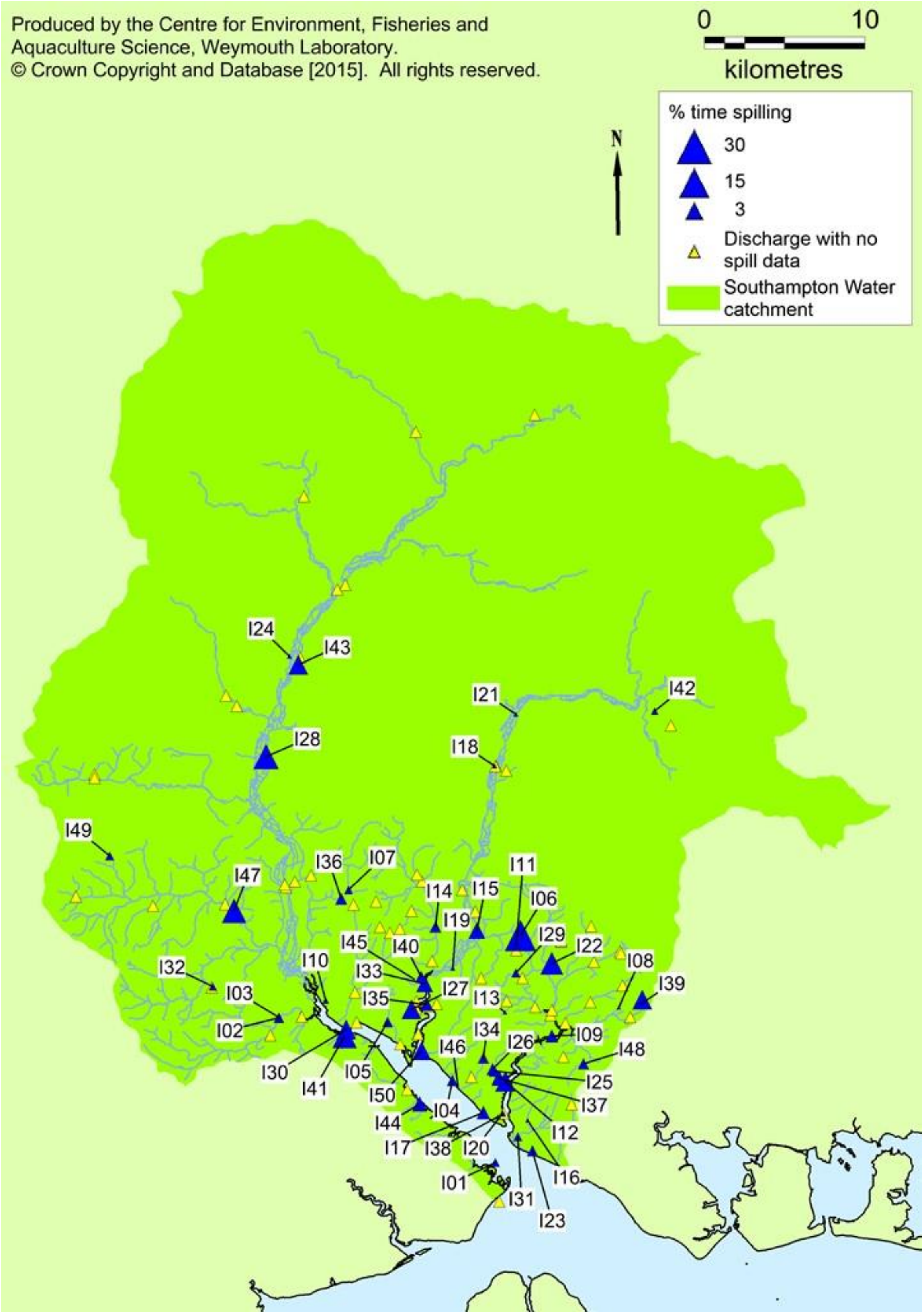

Figure 5.4: Locations and % time spilling for water company owned intermittent discharges in the Southampton water catchment (details in Table 5.3).

Table 5.3: Details of intermittent water company sewage works within the survey area. Spill information for those highlighted in grey is shown in Table 5.4 and Figure 5.5.

Number on map	Name in current database	Name in 2009 sanitary survey	NGR	Receiving environment	Type
	Alexandra Road CSO	Alexandra Road CSO	SU4250408013	Estuary	Sewer SO
	Anton Lane WPS		SU3609044980	River	PS & STW SO
	Ascot Road PS		SU4989017050	River	PS
	Ashdene Road Ashurst CSO		SU3399011410	River	Sewer SO
I01	Ashlett Creek WwTW	Ashlett Creek STW overflow	SU4807003510	Estuary	STW SO/ST
	Ashton Corner CEO		SU5397018190	River	Sewer SO
I02	Ashurst Bridge CEO		SU3451012490	River	Sewer SO
I03	Ashurst Bridge PS		SU3452012500	River	PS
I04	Beach Lane Netley CEO	Beach Lane SPS CSO/EO	SU4506008350	Estuary	Sewer SO
	Berrywood Gardens Hedge End CSO		SU4870013550	River	Sewer SO
	Bishops Waltham WwTW		SU5414015980	River	STW SO/ST
I05	Blechynden Terrace Southampton CSO	Blechynden Terrace CSO	SU4150011090	Estuary	Sewer SO
I06	Botley Road PS (Horton Heath)		SU4957017600	River	PS
I08	Botley Road PS (Shedfield)		SU5568013130	River	PS
I07	Botley Road WPS (North Baddesley)		SU3885020460	River	PS
	Broad Oak CSO		SU5047013160	River	Sewer SO
I09	Brook Lane PS		SU5152011340	Estuary	PS
I10	Brunel Road WPS	Brunel Road CEO	SU3703013670	Estuary	PS
I11	Burnetts Lane WPS		SU4927017020	River	PS
I12	Bursledon STW*	Bursledon STW storm	SU4861008500	Estuary	STW SO/ST
	Calshot Car Park CEO	Calshot Car Park SPS CSO/EO	SU4824001060	Estuary	Sewer SO
	Castle Lane North Baddesley EMO		SU4055019730	River	Sewer SO
	Cawte Road/Park Road CSO		SU3935012200	Estuary	Sewer SO
	Cedar Road Southampton CSO		SU4309013520	Estuary	Sewer SO
I13	Chalice Court		SU4862012890	River	Sewer SO
	Chapel Wharf WPS	Chapel Wharf CEO	SU4315011470	Estuary	Sewer SO
I14	Chestnut Avenue WPS		SU4427018170	River	PS
I15	Chickenhall Eastleigh WwTW		SU4681817888	River	STW SO/ST
	Chilbolton WwTW		SU3865139466	River	STW SO/ST
	Church Lane		SU5151012970	Estuary	Sewer SO
	Church Lane Botley CEO		SU5143012660	Estuary	Sewer SO
I16	Dibles Road Warsash PS	Dibles Road Warsash CSO	SU4999006110	River	Sewer SO
	Downs Park PS		SU3593012550	Estuary	PS
	Durley Lane Durley CEO		SU5209017260	River	Sewer SO
	Durley Main Pumping Station		SU5153015890	River	PS
	Durley Street Pumping Station		SU5209017270	River	PS
	East Grimstead WwTW		SU2303727650	Soakaway	STW SO/ST
	East Grimstead WwTW		SU2303627419	River	STW SO/ST
	Eight Acres Romsey CSO		SU3651021360	River	Sewer SO
I17	Ensign Park Hamble CEO	Ensign Park Hamble SPS	SU4717006490	Estuary	Sewer SO
	Fairthorne Manor CEO		SU5234012140	River	Sewer SO
	Fairthorne Manor PS		SU5236012150	River	PS
	Fullerton (Andover) WwTW		SU3816039170	River	STW SO/ST
	Garnier Road		SU4802028200	River	Sewer SO
	Garnier Road		SU4799028160	River	STW SO/ST
I18	Garnier Road Winchester CEO		SU4793028190	River	Sewer SO
I19	Gaters Mill		SU4535015580	River	Sewer SO
	Glenfield Avenue CSO	Glenfield Avenue CSO	SU4434013350	River	Sewer SO
	Green Lane Chilworth CEO		SU4204018020	River	Sewer SO
	Hamble Hard CEO, Green Lane, Hamble		SU4849006550	Estuary	Sewer SO
I20	Hamble Hard PS	Hamble Hard CEO	SU4850006550	Estuary	PS
	Hamble Lane Bursledon WPS		SU4815808733	Estuary	STW SO/ST
	Hamblewood Botley CSO		SU5151012970	Estuary	Sewer SO
I21	Harestock WwTW		SU4928031420	River	STW SO/ST

Number on map	Name in current database	Name in 2009 sanitary survey	NGR	Receiving environment	Type
I22	Heathen Lane Durley CEO		SU5152015880	River	Sewer SO
	High Street/Briton Street CSO	High Street CSO	SU4207010840	Estuary	Sewer SO
I23	Hook Park WPS	Hook Park CSO/EO SSO	SU5023004010	Estuary	PS
I23	Hook Park WPS	Hook Park CSO/EO SSO	SU5040003420	Estuary	PS
I24	Houghton Road Stockbridge CEO		SU3520034970	River	Sewer SO
I25	Hungerford Bottom Bursledon CEO	Hungerford Bottom SPS	SU4791009170	River	Sewer SO
I26	Hungerford Bottom PS		SU4782009270	Estuary	PS
I27	Imperial Road Mount Pleasant CEO	Imperial Rd Mount Pleasant SPS	SU4297013070	Estuary	Sewer SO
	Ingleside Pumping Station	Ingleside Netley	SU4650008800	River	PS
	Jct Titchfield Park Road/A27		SU5273007080	River	Sewer SO
	Kings Road		SU4342020980	River	Sewer SO
I28	Kings Somborne WwTW		SU3373028750	River	STW SO/ST
	Kitnocks PS		SU5392013470	River	PS
	Laurel Cottages		SU4930016700	River	Sewer SO
	Lawn Road/Osbourne Road	Lawn Road CSO	SU4309013520	Estuary	Sewer SO
	Little Bull Lane PS		SU5591014510	River	PS
	Manhole 190A Adj Waltham Mill PS		SU5575016630	River	Sewer SO
	Manhole No. 68		SU4711014950	River	Sewer SO
	Manor Road Chilworth Emo		SU4080018140	River	Sewer SO
	Marlborough Gardens		SU4969014950	River	Sewer SO
I29	Marlborough Gardens Hedge End CEO		SU4928015270	River	Sewer SO
	Memorial Park Romsey CEO		SU3487020780	River	Sewer SO
I30	Millbrook WwTW	Millbrook STW storm/CEO	SU3871011760	Estuary	STW SO/ST
	Morestead WwTW		SU4867027890	Irrigation	STW SO/ST
	New Alresford WwTW		SU5892030690	Soakaway	STW SO/ST
I31	Newtown Road Newtown CEO	Newtown Road SPS CSO/EO	SU4939005070	River	Sewer SO
	North Baddesley Village		SU3916019530	River	Sewer SO
	Overflow At Chestnut Avenue		SU4427018150	River	Sewer SO
	Overflow At Macnaughton Road	Macnaghten Road CSO	SU4381013180	Estuary	Sewer SO
	Overton WwTW		SU5046050050	Soakaway	STW SO/ST
	Percy Road		SU3925014060	Estuary	Sewer SO
I32	Pollards Moor Cadnam CEO		SU3031014370	River	Sewer SO
	Pollards Moor PS		SU3032014380	River	PS
I33	Portswood WwTW		SU4358014590	Estuary	STW SO/ST
	Pound Road Bursledon CEO	Pound Road SPS	SU4724010000	River	Sewer SO
I34	Pound Road PS		SU4724009960	River	PS
	Pumping Station At Maury'S Lane		SU2668019470	River	PS
	Rampart Road PS	Rampart Road Bitterne SPS	SU4437011300	Estuary	PS
	Redlynch STW		SU2189020030	River	STW SO/ST
	Ringwood Drive North Baddesley CEO		SU3839019890	River	Sewer SO
	Roake Farm PS		SU3190031900	River	PS
	Roman Road Chilworth Emo		SU4142017780	River	Sewer SO
	Romsey WwTW		SU3495020620	River	STW SO/ST
	Rookery Lane PS		SU3121032560	River	PS
	Saddlers Mill PS		SU3488020780	River	PS
I37	Salterns Lane Bursledon CEO	Salterns Lane SPS	SU4819008660	Estuary	Sewer SO
	Salterns Lane PS		SU4825008720	Estuary	PS
I38	School Lane Hamble CEO	School Lane Hamble SPS	SU4830006240	Estuary	Sewer SO
	Scotter Road		SU4675019100	River	Sewer SO
I39	Shirrell Heath PS		SU5715013620	River	PS
I40	Sirdar Road Southampton CSO		SU4359014960	Estuary	Sewer SO
I41	Slowhill Copse WwTW	Slowhill Copse STW overflow	SU3862011350	Estuary	STW SO/ST
	Southcliff Road/Liverpool Street		SU4307013070	Estuary	Sewer SO
I42	Spring Gardens PS		SU5788031620	River	PS
	St Mary Bourne PS		SU4303049000	River	PS
I43	Stockbridge WwTW		SU3534034440	River	STW SO/ST
I44	Tates Copse PS	Tates Copse SPS CSO/EO	SU4327007120	Estuary	PS

Number on map	Name in current database	Name in 2009 sanitary survey	NGR	Receiving environment	Type
	Templars Way Chandlers Ford CEO		SU4278019160	River	Sewer SO
	The Hundred Romsey CSO		SU3551020990	River	Sewer SO
	Trafalgar Way Stockbridge CEO		SU3584034940	River	Sewer SO
	Twyford/Consort Rd Area		SU4592020460	River	Sewer SO
I45	Upr Shaftesbury Ave Southampton CSO	Upper Shaftsbury Avenue CSO	SU4357014560	Estuary	Sewer SO
	Valley Road Chandlers Ford CSO		SU4312021410	River	Sewer SO
I46	Victoria Road Netley CEO	Victoria Road SPS CSO	SU4568008170	Estuary	PS
	Waltham Mill PS		SU5581016510	River	PS
	Wellow Mill WPS		SU3116019560	River	PS
	Wells Close Whiteley CEO		SU5223010050	River	Sewer SO
	Wessex Lane		SU4404016030	Estuary	Sewer SO
I47	West Wellow WwTW		SU3172019160	River	STW SO/ST
I48	Whiteley WPS		SU5347009630	River	PS
I49	Whiteparish WwTW		SU2411022540	River	STW SO/ST
	Winchester Road PS		SU5639012540	River	PS
I50	Woolston WwTW	Woolston STW outfall No 2	SU4338010440	Estuary	STW SO/ST

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CEO=combined emergency overflow, CSO=combined storm overflow, PS=pumping station, STW=sewage treatment works, WPS=waste pumping station, WwTW=wastewater treatment works, SO=Storm Overflow, ST=Storm tank

*Redirected to Hamble Lane Bursledon WPS in June 2014.

Table 5.4: Spills from intermittent discharges in the Southampton Water catchment.

<table>
<tr><th rowspan="2">Number in Figure 5.5</th><th rowspan="2">Discharge name</th><th colspan="8">Number of spills</th><th colspan="8">% time spilling</th></tr>
<tr><th>2005</th><th>2006</th><th>2007</th><th>2008</th><th>2009</th><th>2010</th><th>2011</th><th>2012</th><th>2005</th><th>2006</th><th>2007</th><th>2008</th><th>2009</th><th>2010</th><th>2011</th><th>2012</th></tr>
<tr><td>1</td><td>Ashlett Creek WwTW</td><td colspan="6">NDP</td><td>1</td><td>5</td><td colspan="6">NDP</td><td>0.02</td><td>0.5</td></tr>
<tr><td>2</td><td>Ashurst Bridge CEO</td><td>3</td><td>9</td><td>6</td><td>12</td><td>9</td><td>2</td><td>2</td><td>NDP</td><td>0.2</td><td>1.1</td><td>0.1</td><td>0.7</td><td>0.5</td><td>0.06</td><td>0.08</td><td>NDP</td></tr>
<tr><td>3</td><td>Ashurst Bridge PS</td><td colspan="7">NDP</td><td>3</td><td colspan="7">NDP</td><td>0.2</td></tr>
<tr><td>4</td><td>Beach Lane Netley CEO</td><td colspan="6">NDP</td><td>3</td><td>8</td><td colspan="6">NDP</td><td>0.3</td><td>0.7</td></tr>
<tr><td>5</td><td>Blechynden Terrace Southampton CSO</td><td colspan="6">NDP</td><td>1</td><td>9</td><td colspan="6">NDP</td><td>0.02</td><td>0.8</td></tr>
<tr><td>6</td><td>Botley Road PS (Horton Heath)</td><td>1</td><td colspan="2">NDP</td><td>3</td><td>306</td><td>6</td><td colspan="2">NDP</td><td>0.003</td><td>NDP</td><td></td><td>0.06</td><td>83.1</td><td>0.2</td><td>NDP</td><td></td></tr>
<tr><td>7</td><td>Botley Road WPS (North Baddesley)</td><td>NDP</td><td>2</td><td>3</td><td>6</td><td>2</td><td>NDP</td><td>1</td><td>13</td><td>NDP</td><td>0.01</td><td>0.01</td><td>0.05</td><td>0.01</td><td>NDP</td><td>0.004</td><td>1.9</td></tr>
<tr><td>8</td><td>Botley Road PS (Shedfield)</td><td colspan="7">NDP</td><td>1</td><td colspan="7">NDP</td><td>0.02</td></tr>
<tr><td>9</td><td>Brook Lane PS</td><td>NDP</td><td>NDP</td><td>NDP</td><td>NDP</td><td>NDP</td><td>NDP</td><td>2</td><td>11</td><td colspan="6">NDP</td><td>0.2</td><td>1.8</td></tr>
<tr><td>10</td><td>Brunel Road WPS</td><td>NDP</td><td>2</td><td>24</td><td>5</td><td>5</td><td>2</td><td colspan="2">NDP</td><td>NDP</td><td>0.004</td><td>0.1</td><td>0.1</td><td>0.05</td><td>0.02</td><td colspan="2">NDP</td></tr>
<tr><td>11</td><td>Burnetts Lane WPS</td><td>NDP</td><td>5</td><td>1</td><td>NDP</td><td>2</td><td>1</td><td colspan="2">NDP</td><td>NDP</td><td>0.1</td><td>0.04</td><td>NDP</td><td>0.3</td><td>0.008</td><td colspan="2">NDP</td></tr>
<tr><td>12</td><td>Bursledon S.T.W.</td><td colspan="5">NDP</td><td>16</td><td>18</td><td>32</td><td colspan="5">NDP</td><td>3.7</td><td>4.0</td><td>8.0</td></tr>
<tr><td>13</td><td>Chalice Court</td><td>NDP</td><td>1</td><td>1</td><td>1</td><td colspan="4">NDP</td><td>NDP</td><td>0.02</td><td>0.0008</td><td>0.04</td><td colspan="4">NDP</td></tr>
<tr><td>14</td><td>Chestnut Avenue WPS</td><td colspan="3">NDP</td><td>4</td><td>15</td><td>7</td><td colspan="2">NDP</td><td colspan="3">NDP</td><td>0.1</td><td>1.0</td><td>0.4</td><td>NDP</td><td></td></tr>
<tr><td>15</td><td>Chickenhall Eastleigh WwTW</td><td colspan="6">NDP</td><td>1</td><td>21</td><td colspan="6">NDP</td><td>0.09</td><td>4.6</td></tr>
<tr><td>16</td><td>Dibles Road Warsash PS</td><td colspan="6">NDP</td><td>1</td><td>1</td><td colspan="6">NDP</td><td>0.02</td><td>0.02</td></tr>
<tr><td>17</td><td>Ensign Park Hamble CEO</td><td colspan="5">NDP</td><td>18</td><td>14</td><td>12</td><td colspan="5">NDP</td><td>2.3</td><td>1.3</td><td>0.7</td></tr>
<tr><td>18</td><td>Garnier Road Winchester CEO</td><td colspan="5">NDP</td><td>2</td><td>1</td><td>2</td><td colspan="5">NDP</td><td>0.04</td><td>0.03</td><td>0.03</td></tr>
<tr><td>19</td><td>Gaters Mill</td><td>1</td><td>3</td><td colspan="5">NDP</td><td>1</td><td>0.0004</td><td>0.03</td><td colspan="5">NDP</td><td>0.1</td></tr>
<tr><td>20</td><td>Hamble Hard PS</td><td colspan="6">NDP</td><td>1</td><td>2</td><td colspan="6">NDP</td><td>0.02</td><td>0.1</td></tr>
<tr><td>21</td><td>Harestock WwTW</td><td colspan="7">NDP</td><td>2</td><td colspan="7">NDP</td><td>0.04</td></tr>
<tr><td>22</td><td>Heathen Lane Durley CEO</td><td colspan="5">NDP</td><td>25</td><td>34</td><td>37</td><td colspan="5">NDP</td><td>6.1</td><td>6.8</td><td>8.7</td></tr>
<tr><td>23</td><td>Hook Park WPS</td><td colspan="6">NDP</td><td>2</td><td>9</td><td colspan="6">NDP</td><td>0.1</td><td>1.2</td></tr>
<tr><td>24</td><td>Houghton Road Stockbridge CEO</td><td colspan="5">NDP</td><td>3</td><td>NDP</td><td>1</td><td colspan="5">NDP</td><td>0.07</td><td>NDP</td><td>0.02</td></tr>
<tr><td>25</td><td>Hungerford Bottom Bursledon CEO</td><td colspan="5">NDP</td><td>7</td><td>NDP</td><td>NDP</td><td colspan="5">NDP</td><td>0.5</td><td colspan="2">NDP</td></tr>
<tr><td>26</td><td>Hungerford Bottom Pumping Station</td><td colspan="6">NDP</td><td>8</td><td>17</td><td colspan="6">NDP</td><td>0.4</td><td>1.0</td></tr>
<tr><td>27</td><td>Imperial Road Mount Pleasant CEO</td><td colspan="5">NDP</td><td>23</td><td>32</td><td>15</td><td colspan="5">NDP</td><td>4.3</td><td>6.9</td><td>1.8</td></tr>
</table>

Number in Figure 5.5	Discharge name	Number of spills								% time spilling							
		2005	2006	2007	2008	2009	2010	2011	2012	2005	2006	2007	2008	2009	2010	2011	2012
28	Kings Somborne WwTW	NDP						1	66	NDP						0.01	19.3
29	Marlborough Gardens Hedge End CEO	NDP					2	1	NDP	NDP					0.6	0.02	NDP
30	Millbrook WwTW	NDP						4	39	NDP						0.4	8.7
31	Newtown Road Newtown CEO	NDP						3	4	NDP						0.2	0.4
32	Pollards Moor Cadnam CEO	NDP					5	2	NDP	NDP					0.3	0.02	NDP
33	Portswood WwTW	NDP							14	NDP							2.6
34	Pound Road PS	NDP						4	11	NDP						0.2	0.6
35	Rampart Road PS	10	1	NDP						2.0	0.002	NDP					
36	Ringwood Drive North Baddesley CEO	NDP							8	NDP							0.8
37	Salterns Lane Bursledon CEO	NDP					9	9	25	NDP					1.2	1.0	2.7
38	School Lane Hamble CEO	NDP							1	NDP							0.04
39	Shirrell Heath PS	NDP							21	NDP							4.4
40	Sirdar Road Southampton CSO	NDP						2	19	NDP						0.005	1.7
41	Slowhill Copse WwTW	61	96	NDP				6	52	4.1	16.0	NDP				1.1	14.1
42	Spring Gardens PS	5	10	6	17	26	7	3	9	0.04	0.07	0.04	0.5	0.2	0.06	0.2	0.07
43	Stockbridge WwTW	NDP					1	3	42	NDP					0.04	0.3	12.2
44	Tates Copse PS	NDP							9	NDP							1.6
45	Upr Shaftesbury Ave Southampton CSO	NDP							1	NDP							0.001
46	Victoria Road Netley CEO	NDP							1	NDP							0.002
47	West Wellow WwTW	47	45	NDP						10.2	8.0	NDP					
48	Whiteley WPS	NDP					16	1	NDP	NDP					1.0	0.003	NDP
49	Whiteparish Wastewater Treatment Wk	NDP							3	NDP							0.3
50	Woolston WwTW	54	NDP				19	32	29	0.6	NDP				3.3	5.8	3.9

NDP=no data provided

Many discharges did not start event monitoring until 2011 & 2012

Figures highlighted are spills ≥3% time in year indicated

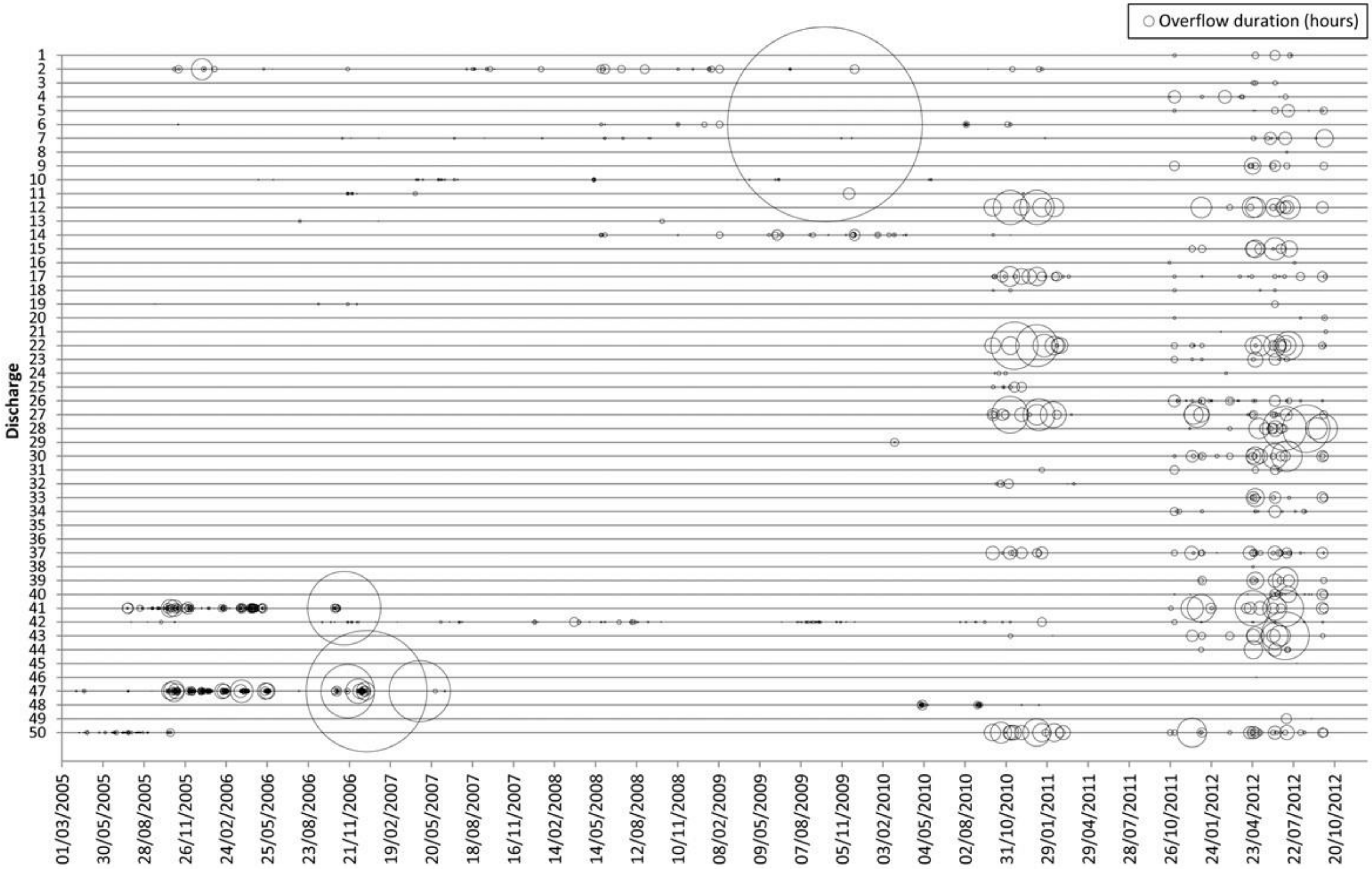

Figure 5.5: Bubble plot of spills from intermittent discharges in the Southampton Water catchment (details in Table 5.4).

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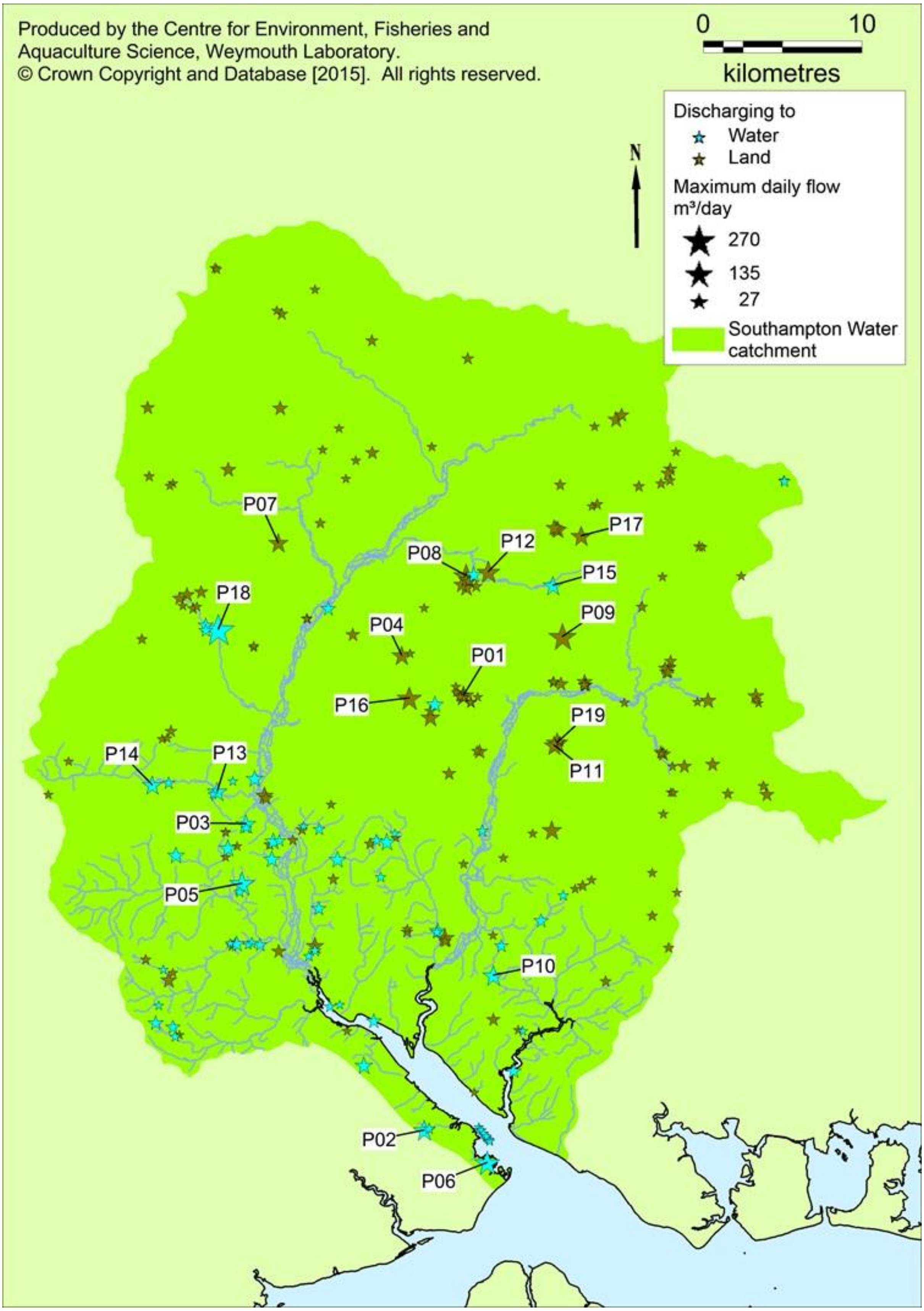

Figure 5.6: Locations and maximum daily flows for privately owned discharges in the Southampton water catchment with maximum daily flows greater than or equal to 5 m³/day (details in Table 5.5).

Table 5.5: Details of private sewage discharges within the survey area with maximum daily flows of 50 m³ or more.

Number on map	Name	NGR	Name in 2009 sanitary survey	Maximum daily flow (m³)	Receiving environment
P01	55 Houses & Caravan Pk	SU4593232336		60	Land
P02	Cadland Road	SU4345004930		73	Estuary
P03	Cowleas Sewage Works	SU3221024240		50	River
P04	Crawley Court	SU4203034870		50	Land
P05	Embley Park School STW	SU3197020490		104	River
P06	Fawley Generating Station	SU4741002890	Fawley Power Station	114	Estuary
P07	Land At Farleigh School	SU3425041970		50	Land
P08	Little Chef Sutton Scotney	SU4610039900		121	Land
P09	M3 Motorway Services Shroner Wood	SU5215336034		165	Land
P10	Moorgreen Hospital	SU4780014700		68	River
P11	Morn Hill, Telegraph Way	SU5162229198		52	Land
P12	Norton Park Hotel	SU4748840132		95	Soakaway
P13	Oval Road & Butlers Close STW	SU3042026270		52	River
P14	Royal Naval Armament Depot	SU2632726699		54	River
P15	Southbrook Cottages	SU5154739256		53	River
P16	Sparsholt College	SU4250032180		100	Land
P17	STP @ Black Wood Forest Hol. Lodges	SU5333042385		58	Land
P18	The School Of Army Aviation	SU3048036490		266	River
P19	The Wykeham Hotel	SU5182729353		73.5	Soakaway

5.3. Agriculture

Livestock data were not freely available for the same area assessed in the sanitary survey report (Test, Itchen, Hamble and New Forest catchments). However, the livestock numbers for the districts within the Southampton Water catchment were available for 2007 and 2013 (Defra, 2014). Ten districts that were included in the dataset from Defra (2014) are within or partially within the Southampton Water catchment. As several of these catchments made up only a small proportion of the total area of the catchment, the livestock numbers were adjusted to represent the percentage of land cover that the districts occupy in the catchment. The adjusted data are presented in Table 5.6 and the locations of the districts are shown in Figure 5.7. It should be noted that the adjustments for these data assume uniform distribution of livestock across the district and therefore there is some degree of inaccuracy within the adjusted data.

There has been an overall decline in livestock numbers across the catchment for all livestock types. The largest decline was for poultry (-27.0%). The Southampton and Eastleigh district, which is directly adjacent to the production area, had increases in both sheep and pig numbers.

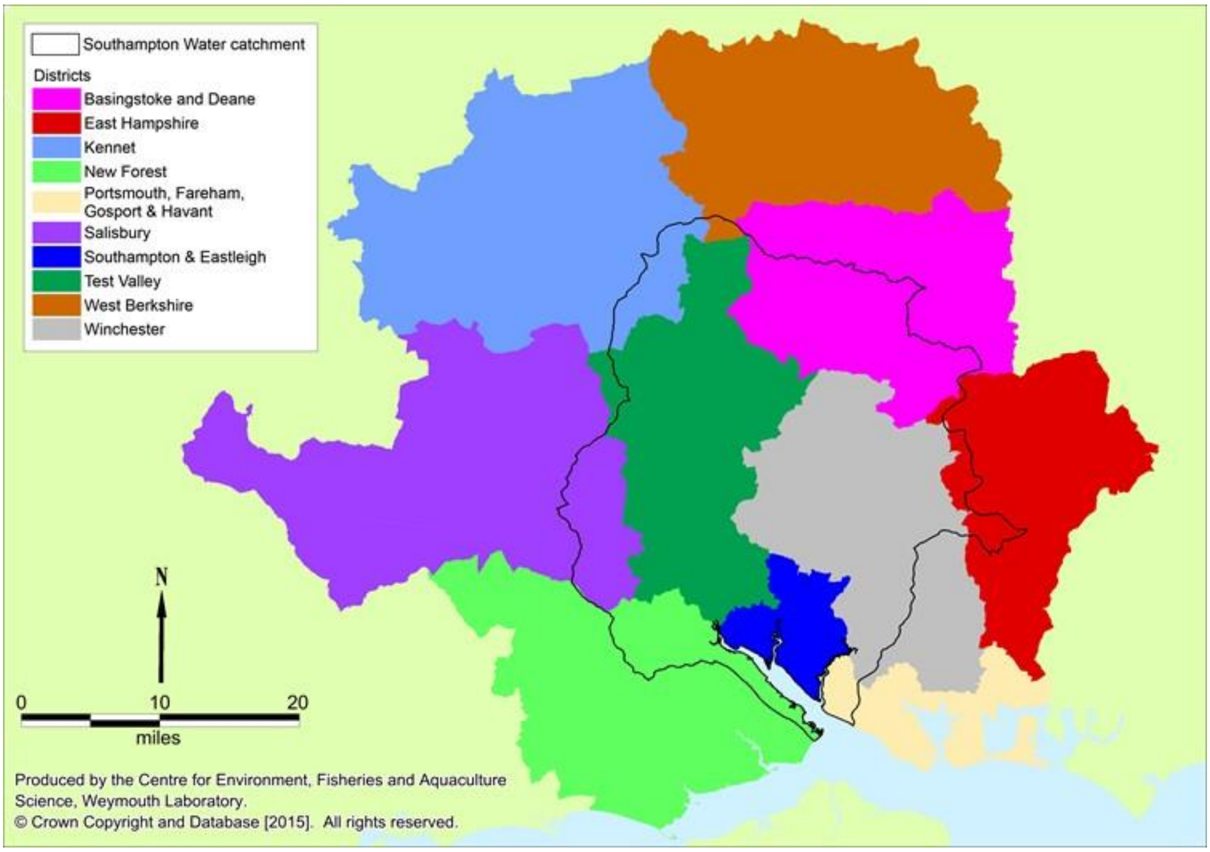

Figure 5.7: Livestock districts that lie within or partially within the Southampton Water catchment

Table 5.6: Livestock data for the Southampton Water catchment in 2007 and 2013.

District	District area (km²)	% district area within catchment	Adjusted cattle numbers 2007			Adjusted sheep numbers			Adjusted pig numbers			Adjusted poultry numbers		
			2007	2013	% change	2007	2013	% change	2007	2013	% change	2007	2013	% change
Basingstoke and Deane	632.0	47.5	5,446	3,938	-27.7	12,448	13,570	9.0	3,672	3,675	0.1	19,257	23,885	24.0
East Hampshire	513.0	9.4	1,323	951	-28.1	2,782	3,513	26.3	392	499	27.2	26,828	19,944	-25.7
Kennet	964.0	7.0	2,360	2,222	-5.9	3,179	2,608	-18.0	2,252	1,723	-23.5	45,117	38,729	-14.2
New Forest	751.2	15.8	2,618	2,268	-13.3	1,605	1,563	-2.6	3,072	1,829	-40.5	97,501	35,186	-63.9
Portsmouth, Fareham, Gosport & Havant	194.6	13.1	224	242	7.8	187	#	#	73	#	#	785	279	-64.5
Salisbury	1001.5	12.5	4,209	4,051	-3.7	7,411	9,055	22.2	4,225	4,176	-1.2	89,278	74,536	-16.5
Southampton and Eastleigh	129.2	100.0	2,837	2,324	-18.1	1,895	2,729	44.0	850	1,180	38.8	2,424	1,284	-47.0
Test Valley	625.9	97.2	13,334	12,343	-7.4	35,715	29,671	-16.9	16,421	10,950	-33.3	741,190	683,419	-7.8
West Berkshire	702.2	1.3	212	195	-7.8	493	550	11.7	312	138	-55.9	1,187	2,137	80.1
Winchester	659.2	77.1	13,827	13,922	0.7	11,306	9,557	-15.5	7,458	13,440	80.2	750,346	416,109	-44.5
Southampton Water Catchment	**1432.1**	**100.0**	**46,390**	**42,457**	**-8.5**	**77,022**	**72,816**	**-5.5**	**38,729**	**37,609**	**-2.9**	**1,773,912**	**1,295,507**	**-27.0**

Data from Defra (2014)
- Missing data

5.4. Wildlife

Figure 5.8 shows the peak counts for overwintering birds in Southampton Water from 2008 to 2013 (Austin *et al.*, 2014). Bird numbers have remained fairly stable since 2008, with a temporary increase in wild fowl numbers in 2011/12. The most numerous bird types in Southampton Water are waders and wild fowl.

No large flocks of birds were observed on the western shore during the shoreline survey, as would have been expected from previous distribution pattern data (Appendix II, Figure 4.6, page 22). However observations during the shoreline survey were spot sightings and are unlikely to reflect the true pattern of distribution throughout the year. No additional evidence could be found that would suggest the distributions of waders and wild fowl have changed since the 2009 sanitary survey (Appendix II, Figure 4.6, page 22).

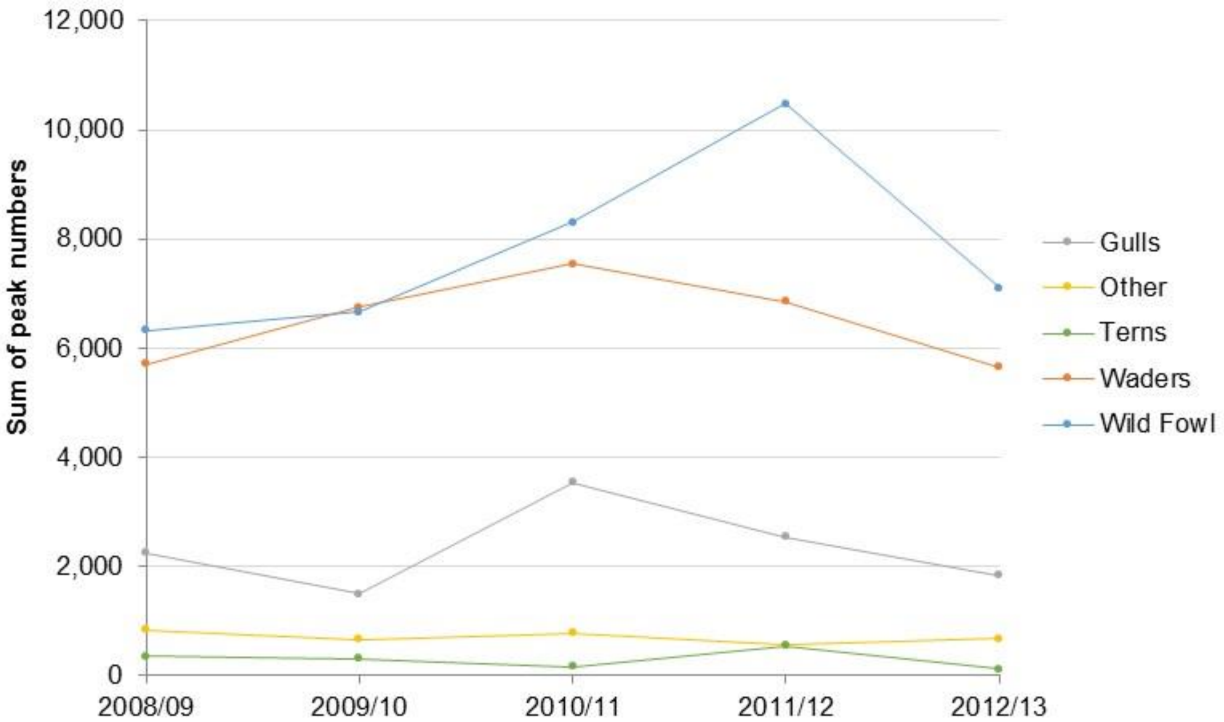

Figure 5.8: Annual peak bird counts in Southampton Water
Data from Austin et al. *(2014)*

5.5. Boats

There have been few changes to the number of moorings in Southampton water since the 2009 sanitary survey. There is a new pontoon off Bitterne in the River Itchen, but it is not clear whether this has altered the number of moorings.

A new marina in Marchwood has received planning permission, but building has not commenced (New Forest District Council planning number 05/85969). The extent of the proposed marina is shown in Figure 5.9. A recent application for renewal of planning permission (New Forest District Council planning number 14/11429) indicates that there is still interest in building the marina. If this marina was to be built, it would include pump out facilities for sewage from moored boats. However, there are currently no sewage facilities in the vicinity of the planning area, and so other arrangements would need to be made (such as a package treatment plant or septic tank). During construction there is the possibility of resuspension of bacteria, which may affect the shellfish beds. Additionally, once completed and in operation, there would be an increased level of runoff.

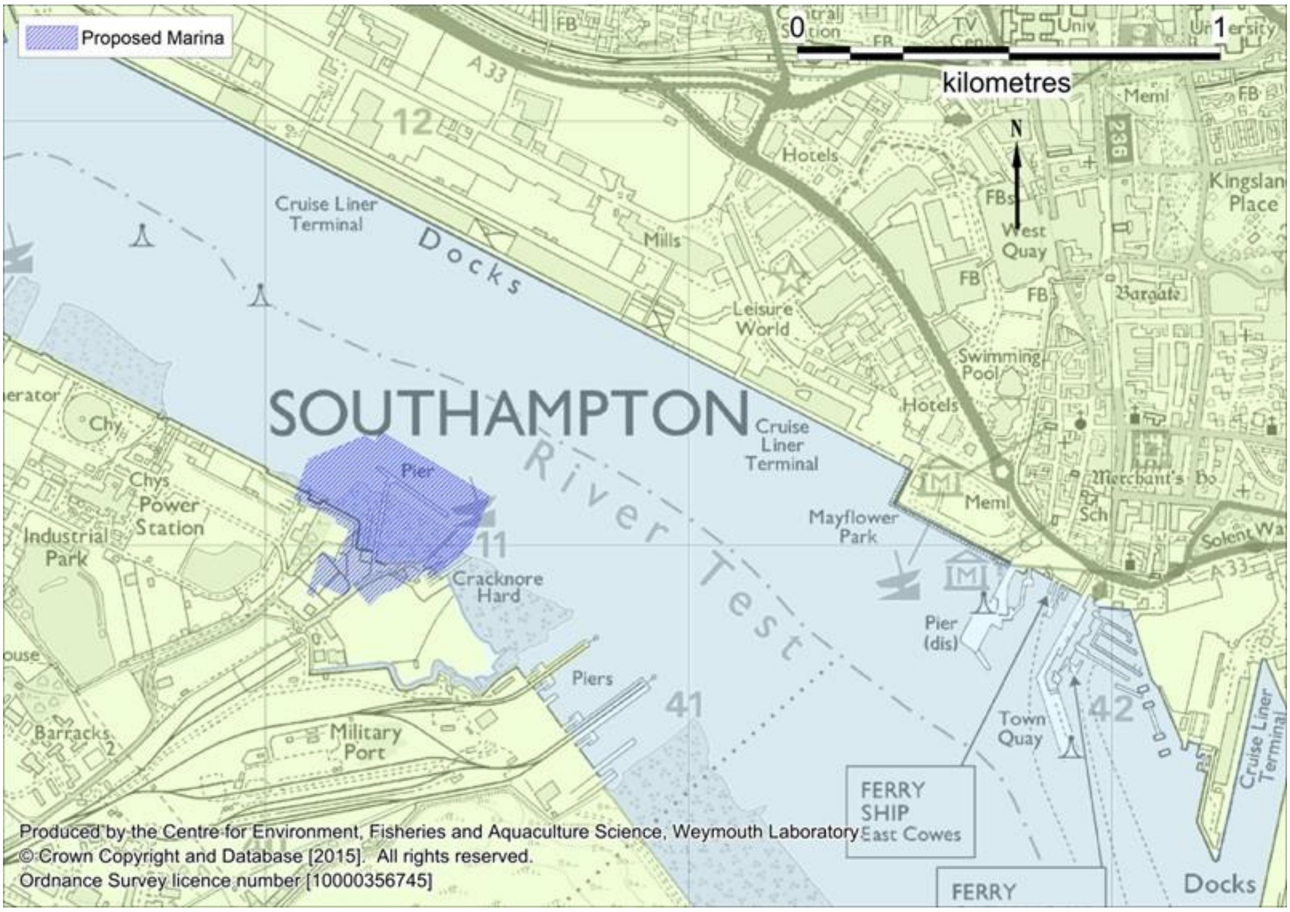

Figure 5.9: Location and extent of proposed marina at Marchwood

6. Hydrodynamics

The bathymetry within Southampton Water has remained largely unchanged since the sanitary survey. Comparisons of the 2009 and 2014 editions of Admiralty Charts No. 2036 and 2041 show there have been minor changes to the depths throughout the area. A small number of additional moorings have been created at Hythe and just off Bitterne in the River Itchen.

If built, the proposed Marchwood Marina (Section 0 for details) may have a small effect on local currents, but is not likely to have a significant impact on the movement of contamination.

7. Rainfall

There were no freely available rainfall data available that were relevant to this report.

8. Microbial Monitoring Results

8.1. Summary statistics and geographical variation

There are a total of 20 RMPs in the Southampton Water production area that have been sampled between January 2003 and December 2014. Four of these RMPs are for cockles, one is for hard clams, six are for native oysters and eight are for *Tapes* spp. Four of these RMPs have been sampled both before and after the original sanitary survey.

The geometric mean results of shellfish flesh monitoring from all RMPs sampled from 2003 onwards are presented in Figure 8.1 and summary statistics are presented in Table 8.1. Several RMPs have not been sampled on 10 or more occasions (Brown Reach and Lee on Solent cockles; Bramble native oysters; Itchen 1, Itchen 2 and Hythe Knock *Tapes* spp.) and so will not be considered further. Boxplots for sites with 10 or more samples are show in Figure 8.2 to Figure 8.4.

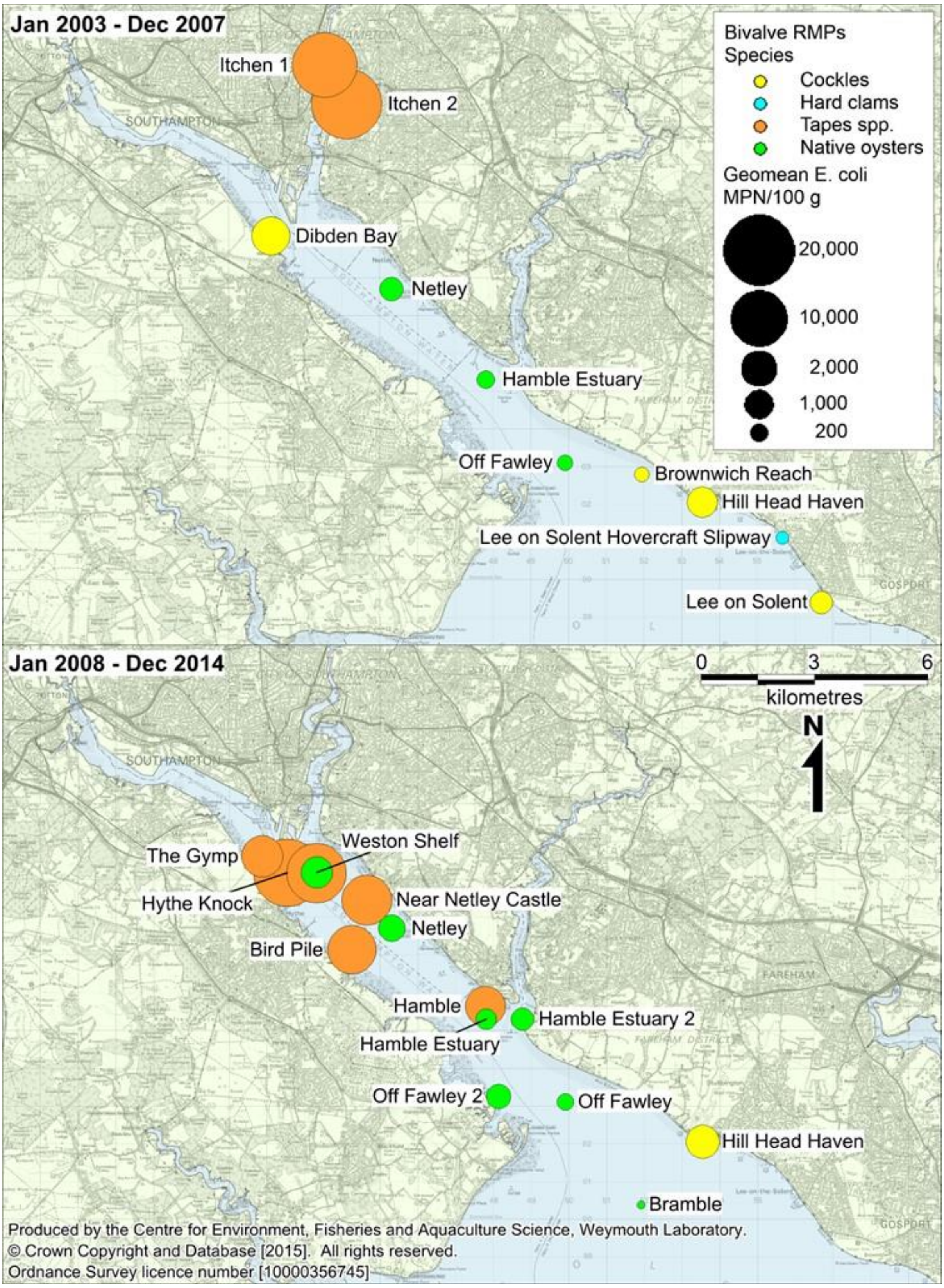

Figure 8.1: Bivalve RMPs active since 2003

Table 8.1: Summary statistics of *E. coli* results (MPN/100 g) from RMPs sampled from 2003 onwards

Site	Species	No.	Date of first sample	Date of last sample	Geometric mean	Min.	Max.	% over 230	% over 4,600	% over 46,000
Dibden Bay	Cockle	26	05/07/2004	10/04/2006	2,637.3	220	22,000	88.5	30.8	0.0
Brownwich Reach		3	20/04/2004	04/05/2004	115.5	20	1,100	33.3	0.0	0.0
Hill Head Haven (2003-2008)		39	20/04/2004	05/12/2007	1,211.0	90	>18,000	87.2	20.5	0.0
Hill Head Haven (2008-2014)		28	01/02/2008	13/05/2011	1,594.2	130	>18,000	89.3	17.9	0.0
Lee on Solent		5	06/04/2004	04/05/2004	436.8	160	1,400	60.0	0.0	0.0
Lee on Solent Hovercraft Slipway	Hard clam	2	06/01/2003	15/09/2003	74.2	50	110	0.0	0.0	0.0
Weston Shelf	Native oyster	35	21/07/2008	04/03/2013	1,343.0	50	16,000	91.4	17.1	0.0
Netley (2003-2008)		55	27/01/2003	11/12/2007	494.9	20	5,400	70.9	3.6	0.0
Netley (2008-2014)		34	22/01/2008	11/10/2010	793.2	130	9,200	85.3	11.8	0.0
Hamble Estuary (2003-2008)		60	27/01/2003	11/12/2007	209.5	<20	2,400	48.3	0.0	0.0
Hamble Estuary (2008-2014)		26	22/01/2008	02/03/2010	349.5	20	16,000	61.5	3.8	0.0
Hamble Estuary 2		54	12/04/2010	01/12/2014	472.0	20	24,000	63.0	3.7	0.0
Off Fawley 2		53	13/04/2010	01/12/2014	578.0	40	16,000	69.8	7.5	0.0
Off Fawley (2003-2008)		59	27/01/2003	11/12/2007	125.6	20	1,300	28.8	0.0	0.0
Off Fawley (2008-2014)		27	22/01/2008	01/03/2010	178.8	20	2,400	44.4	0.0	0.0
Bramble		8	22/01/2008	13/10/2009	14.9	1	330	12.5	0.0	0.0
Itchen 1	*Tapes* spp.	5	13/06/2006	16/08/2006	15,315.8	3,500	91,000	100.0	80.0	20.0
Itchen 2		3	20/06/2006	16/08/2006	30,079.8	5,400	>180,000	100.0	100.0	33.3
The Gymp		10	07/07/2010	09/05/2011	3,295.5	40	>180,000	80.0	50.0	30.0
Hythe Knock		3	03/03/2010	09/06/2010	17,614.0	9,200	54,000	100.0	100.0	33.3
Weston Shelf		5	07/07/2014	11/11/2014	11,480.5	1,400	1,600,000	100	60	20
Near Netley Castle		45	03/03/2010	11/11/2014	6490.7	490	540,000	100.0	57.8	11.1
Bird Pile		38	03/03/2010	11/11/2014	5,996.7	<20	920,000	94.7	63.2	10.5
Hamble		13	03/03/2010	09/05/2011	3,156.3	330	70,000	100.0	30.8	7.7

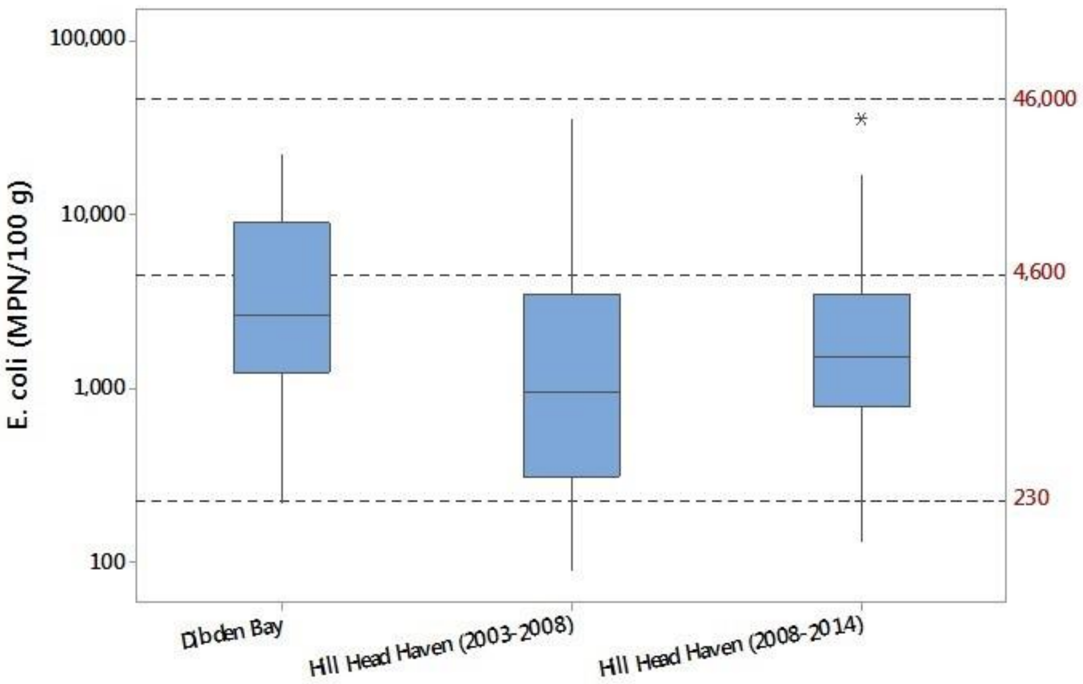

Figure 8.2: Boxplots of *E. coli* results from cockle RMPs from 2003 onwards.

E. coli levels exceeded 4,600 MPN/100 g at Dibden Bay and Hill Head Haven in more than 10% of samples. While the geometric mean for Dibden Bay was higher than for Hill Head Haven (both 2003-2008 and 2008-2014), one-way ANOVA tests revealed no significant differences in *E. coli* levels between the sites (p=0.109).

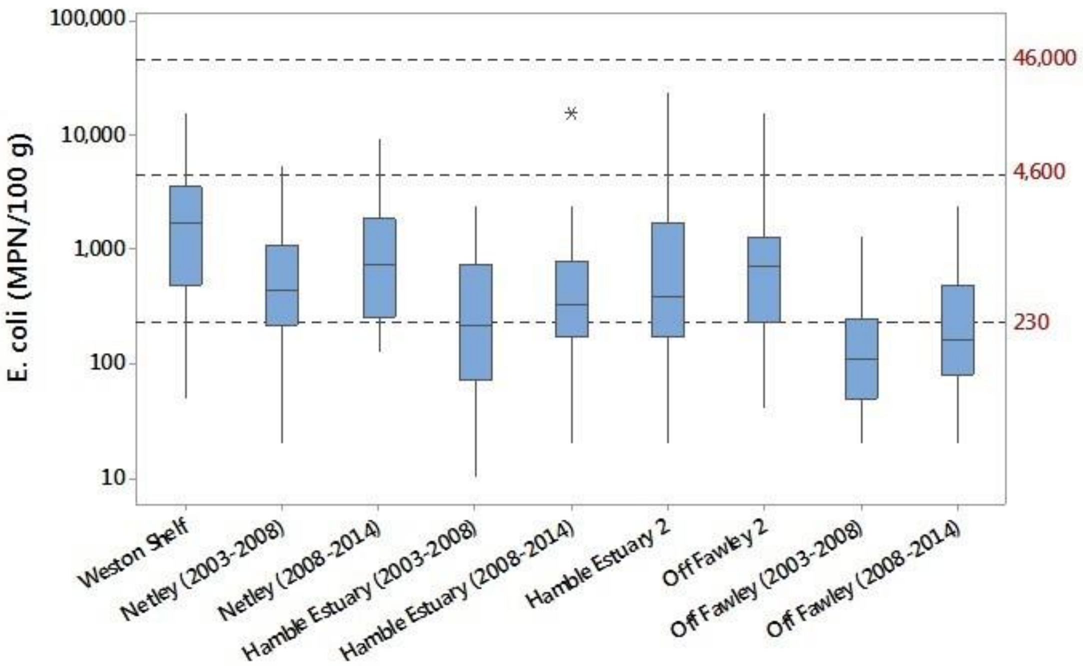

Figure 8.3: Boxplots of *E. coli* results from native oyster RMPs from 2003 onwards.

E. coli levels in native oysters appear to show an overall decline towards the seaward end of Southampton Water. Only Weston Shelf and Netley (2008-2014) had >4,600 *E. coli* MPN/100 g in more than 10% of samples. No sites had >46,000 *E. coli* MPN/100 g. One-way ANOVA tests showed that there were significant differences in *E. coli* levels between sites (p<0.001). Post ANOVA Tukey tests revealed that there were significantly higher *E. coli* levels at Weston Shelf than at Netley (2003-2008), Hamble Estuary (2003-2008 and 2008-2014), Hamble Estuary 2 and Off Fawley (2003-2008 and 2008-2014). Additionally, Off Fawley (2003-2008 and 2008-2014) had significantly lower *E. coli* levels than most other sites. The exceptions to this were where Off Fawley had significantly lower *E. coli* levels than Hamble estuary between 2003 and 2008; this difference no long existed between 2008 and 2014.

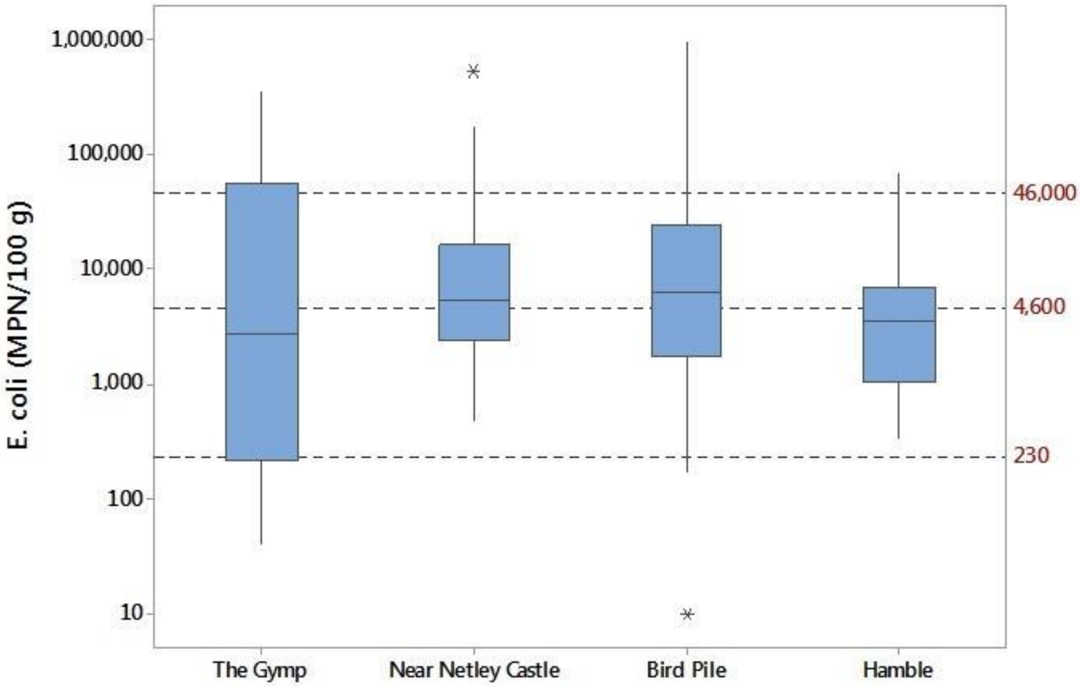

Figure 8.4: Boxplots of *E. coli* results from *Tapes* spp. RMPs from 2003 onwards.

With the exception of Hamble, all *Tapes* spp. sites had *E. coli* levels exceeding 4,600 MPN/100 g in at least 50% of samples and exceeding 46,000 MPN/100 g in at least 10% of samples. At Hamble, which is more seaward than the other RMPs, *E. coli* levels in *Tapes* spp. exceeded 4,600 MPN/100 g in 30.8% of samples and 46,000 MPN/100 g in 7.7% of samples. One-way ANOVA tests did not show any significant differences in *E. coli* levels between sites (p=0.529).

8.2. Overall temporal pattern in results

The overall temporal variation in E. coli levels found in bivalves is shown in Figure 8.5 to Figure 8.7.

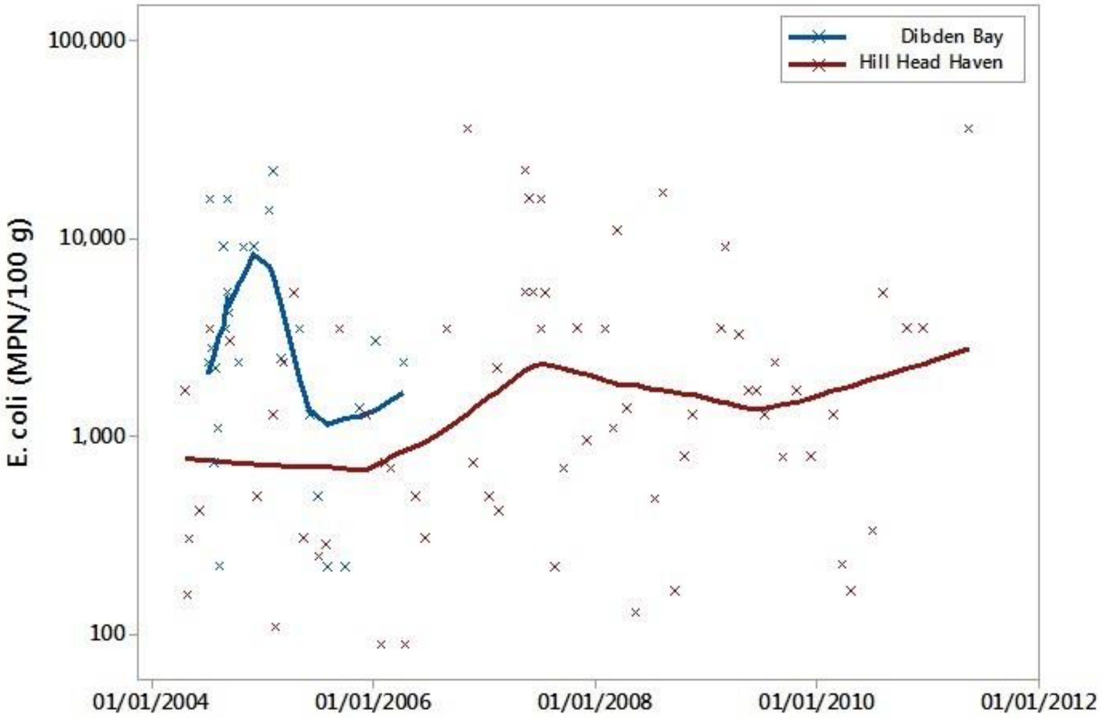

Figure 8.5: Scatterplot of *E. coli* results for cockles overlaid with loess line.

Cockle sampling was not carried out at Dibden Bay for long enough to show a trend in *E. coli* levels. At Hill Head Haven, *E. coli* levels appear to have increased from 2004 to 2012. However, a two-sample T-test showed that there were no significant differences in *E. coli* levels at Hill Head Haven before and after 2008 (p=0.451).

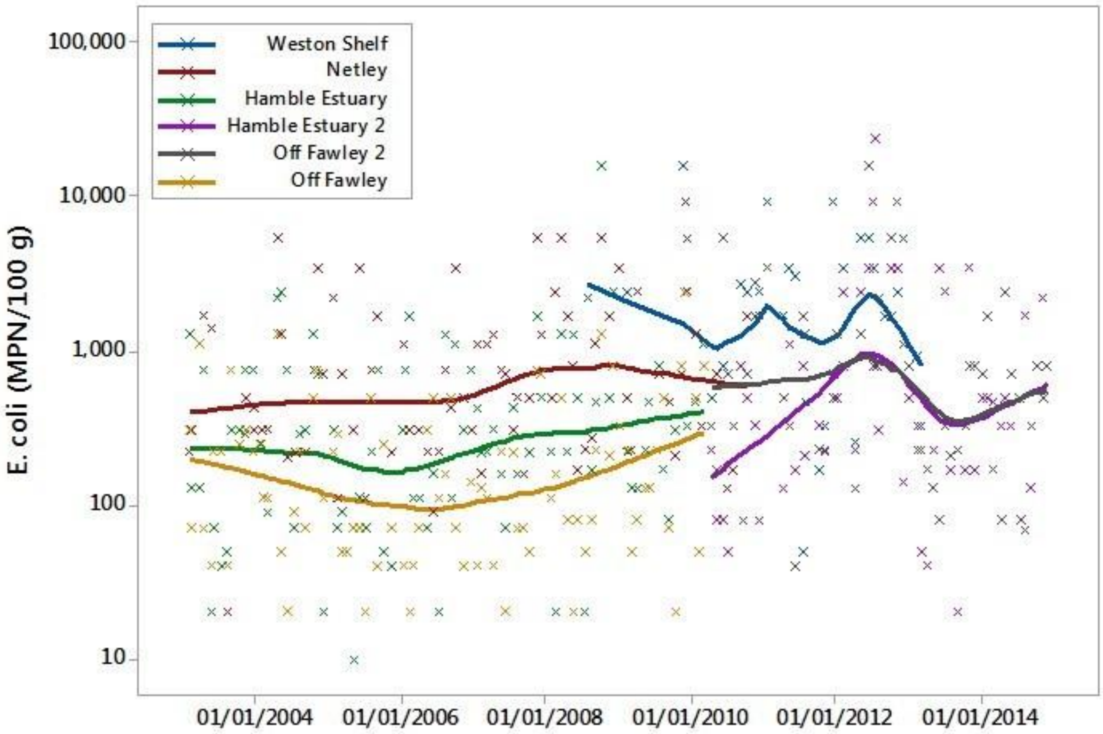

Figure 8.6: Scatterplot of *E. coli* results for native oysters overlaid with loess line.

E. coli levels have remained fairly stable at all native oyster RMPs. Two-sample T-tests showed that there were no significant differences in *E. coli* levels at Netley, Hamble Estuary or Off Fawley before and after 2008 (p=0.066, 0.115 and 0.207 respectively).

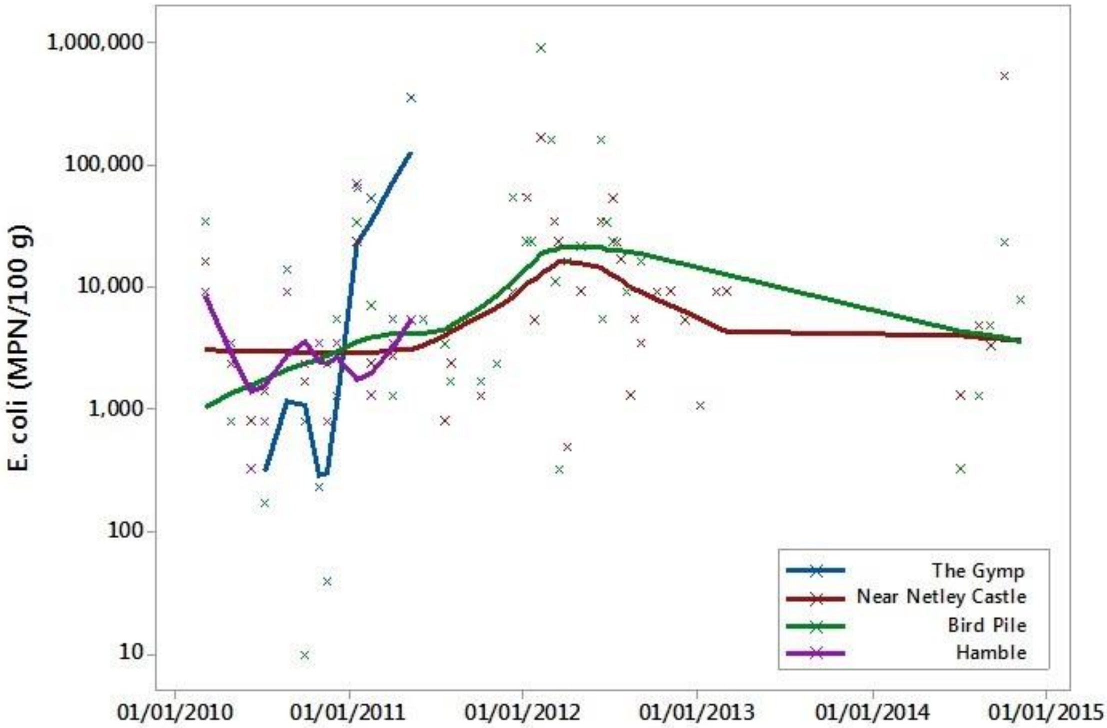

Figure 8.7: Scatterplot of *E. coli* results for *Tapes* spp. overlaid with loess line.

Sampling was not carried out at The Gymp or Hamble over a long enough period to show a trend in *E. coli* levels. At Near Netley Castle, *E. coli* levels in *Tapes* spp. increased from 2011 to 2012, but appeared to have reduced slightly throughout 2012 to 2013. At Bird Pile, *E. coli* levels increased from the start of sampling in 2010 up to the start of 2012. Recent sampling at Bird Pile and Near Netley Castle showed that *E. coli* levels still remain similar to previous samples taken at these points.

8.3. Seasonal patterns of results

The seasonal patterns of results from 2003 to 2013 were investigated by RMP. Figure 8.8 to Figure 8.10 show box plots of *E. coli* levels at each site by season.

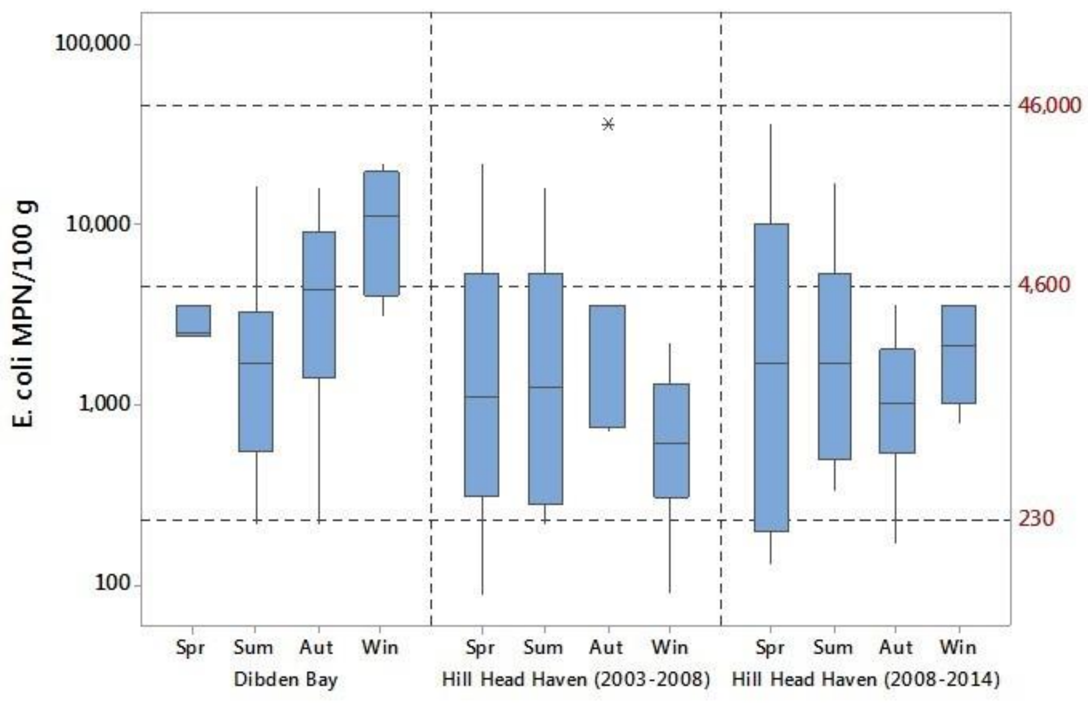

Figure 8.8: Boxplot of *E. coli* results for cockles by RMP and season

One-way ANOVAs showed that there were no significant variations in *E. coli* levels between seasons at any of the cockle RMPs (p=0.112 to 0.819).

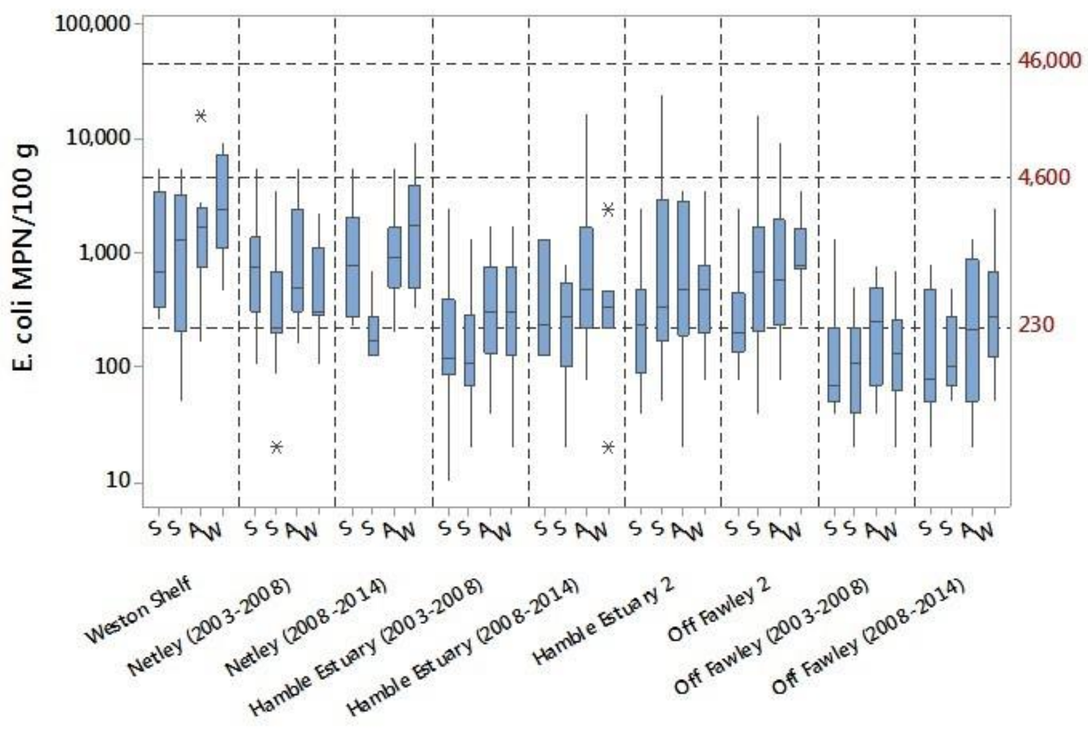

Figure 8.9: Boxplot of *E. coli* results for native oysters by RMP and season

One-way ANOVAs showed that there were no significant variations in *E. coli* levels between seasons at all but one of the native oyster RMP (p=0.063 to 0.560). At Netley, there was a significant variation in *E. coli* levels between 2008 and 2014 (p=0.003), but not between

2003 and 2008 (p=0.063). Post ANOVA Tukey tests showed that *E. coli* levels were lower in the summer than in any other season at Netley.

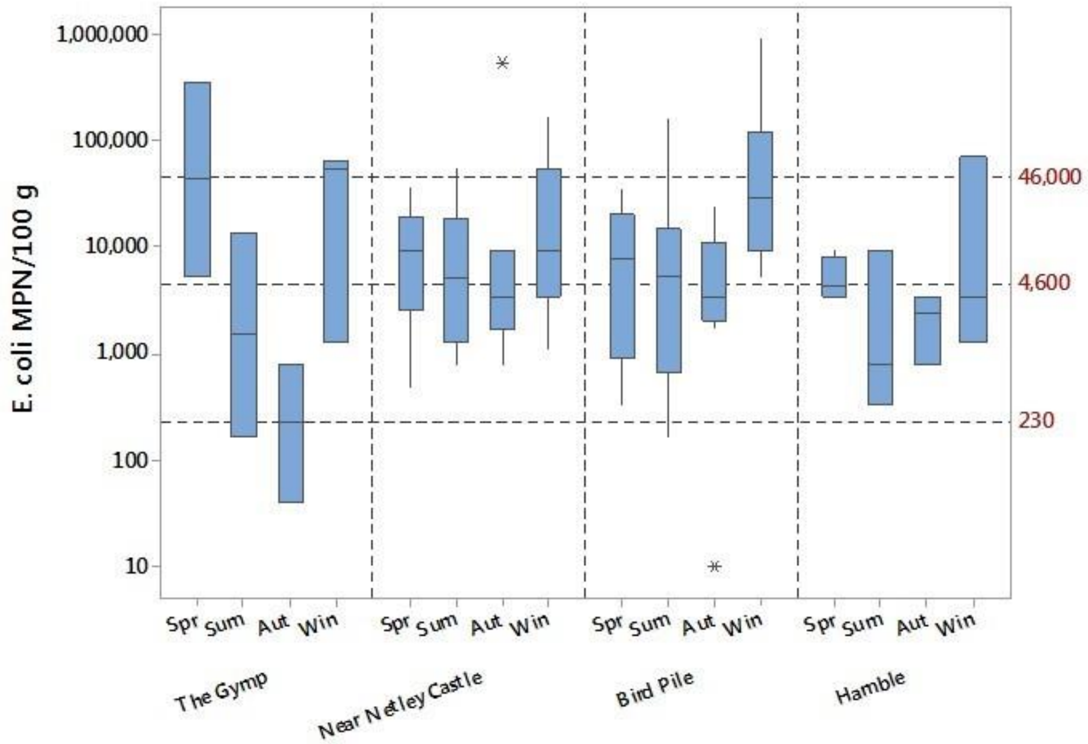

Figure 8.10: Boxplot of *E. coli* results for *Tapes* spp. by RMP and season

One-way ANOVAs showed that there were no significant variations in *E. coli* levels between seasons at all but one of native oyster RMP (p=0.128 to 0.425). At Bird Pile there were significant variations in *E. coli* levels between seasons (p=0.023). Post ANOVA Tukey tests showed that there were significantly higher levels of *E. coli* in winter than in the autumn.

8.4. Influence of tide

To investigate the effects of tidal state on *E. coli* results, circular-linear correlations were carried out against the high/low and spring/neap tidal cycles for each RMP where more than 30 samples had been taken. Results of these correlations are summarised in Table 8.2, and significant results are highlighted in yellow.

Table 8.2: Circular linear correlation coefficients (r) and associated p values for *E. coli* results against the high/low and spring/neap tidal cycles

Site Name	Species	High/low tides r	High/low tides p	Spring/neap tides r	Spring/neap tides p
Hill Head Haven (2003-2008)	Cockle	0.191	0.268	0.293	0.045
Weston Shelf	Native oyster	0.368	0.013	0.220	0.213
Netley (2003-2008)		0.050	0.879	0.164	0.246
Netley (2008-2014)		0.292	0.070	0.046	0.937
Hamble Estuary (2003-2008)		0.235	0.042	0.174	0.180
Hamble Estuary 2		0.238	0.087	0.141	0.423
Off Fawley 2		0.244	0.086	0.156	0.367
Off Fawley (2003-2008)	Native oyster	0.462	<0.001	0.393	0.000
Near Netley Castle	*Tapes* spp.	0.437	0.001	0.200	0.226
Bird Pile		0.111	0.692	0.067	0.874

Figure 8.11 and Figure 8.12 present polar plots of log10 *E. coli* results against tidal states on the high/low cycle for the correlations indicating a statistically significant effect. High water at Southampton is at 0° and low water is at 180°. Results of 230 *E. coli* MPN/100 g or less are plotted in green, those from 231 to 4,600 *E. coli* MPN/100 g are plotted in yellow, and those exceeding 4,600 *E. coli* MPN/100 g are plotted in red.

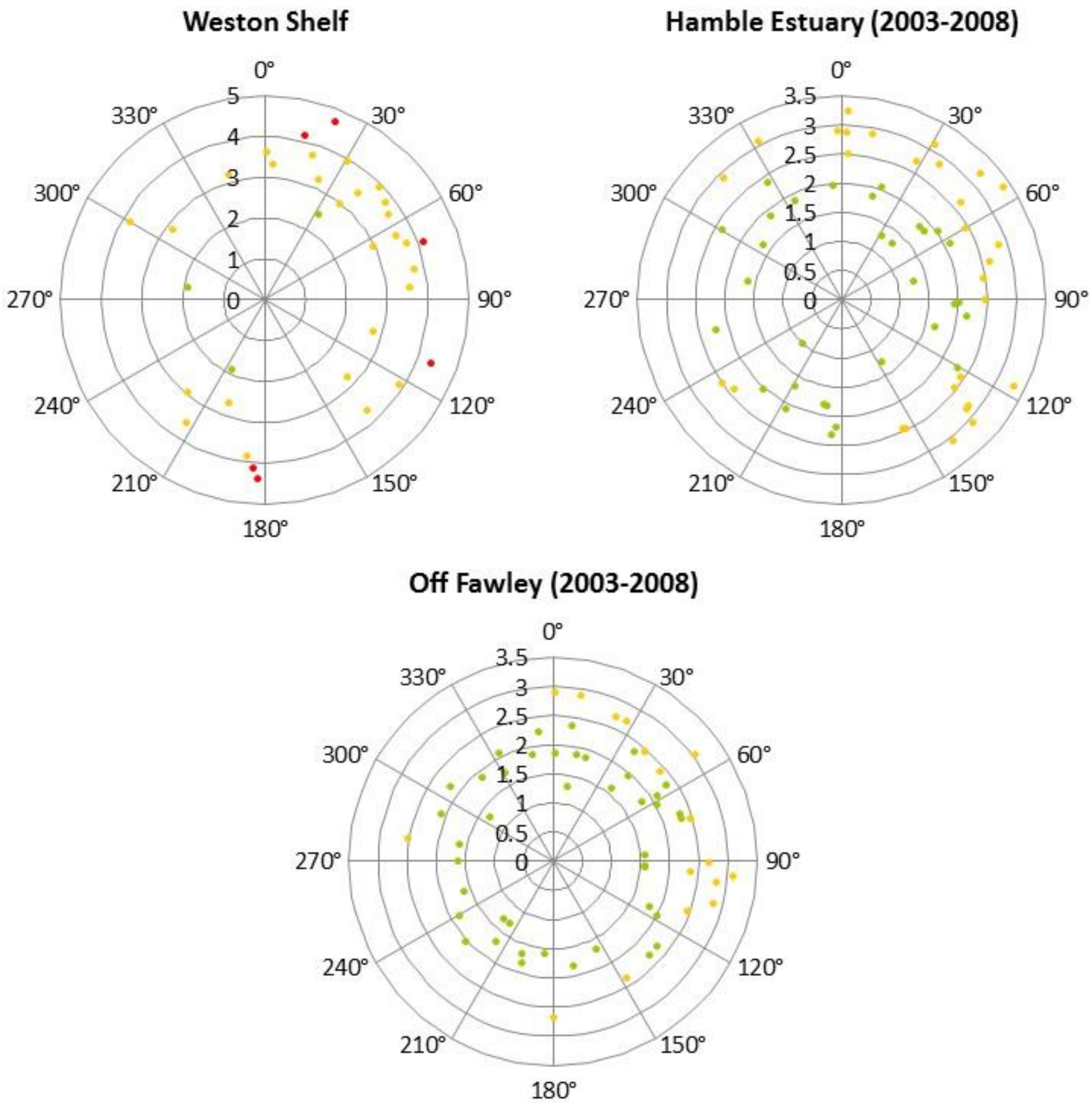

Figure 8.11: Polar plot of log$_{10}$ *E. coli* results (MPN/100 g) at native oyster RMPs against high/low tidal state

At all three native oyster sites that had significant correlations with the high/low tidal state, higher results tended to occur during the ebb tide. This suggests that there was a significant source of contamination towards the upper end of the estuary, and the contamination is transported to the sites as the tide recedes. However, this pattern did not exist at Hamble Estuary or Off Fawley after 2008.

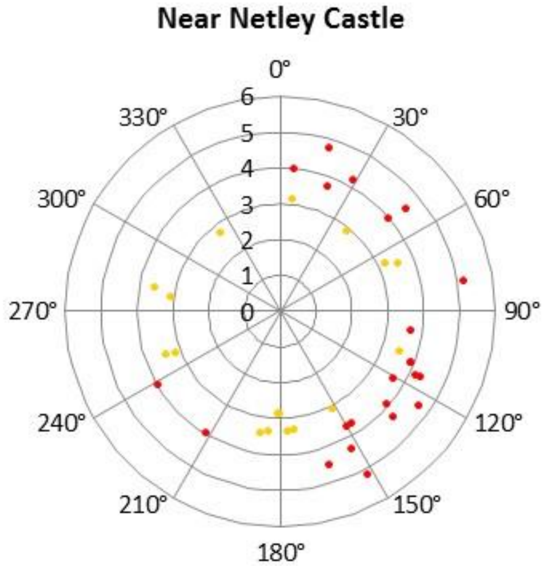

Figure 8.12: Polar plot of $\log_{10}$ *E. coli* results (MPN/100 g) at *Tapes* spp. RMPs against high/low tidal state

As with the native oysters, the majority of high results in the Near Netley Castle *Tapes* spp. RMP occurred during the ebb tide. However, most of the sampling effort took place during the ebb tide and so it is not possible to determine whether this pattern is truly representative of the contamination at this site.

Figure 8.13 and Figure 8.14 present polar plots of $\log_{10}$ *E. coli* results against the spring/ neap tidal cycle for each RMP. Full/new moons occur at 0º, and half moons occur at 180º, and the largest (spring) tides occur about 2 days after the full/new moon, or at about 45º, then decrease to the smallest (neap tides) at about 225º, then increase back to spring tides. Results of 230 *E. coli* MPN/100 g or less are plotted in green, those from 231 to 4,600 *E. coli* MPN/100 g are plotted in yellow, and those exceeding 4,600 *E. coli* MPN/100 g are plotted in red.

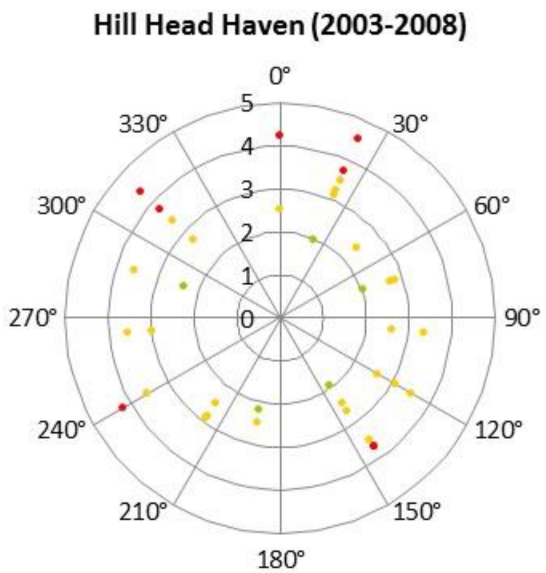

Figure 8.13: Polar plot of log10 *E. coli* results (MPN/100 g) at cockle RMPs against spring/neap tidal state

Despite significant correlations calculated between *E. coli* levels and the spring/neap tidal state, there is no pattern distinguishable pattern in Figure 8.13

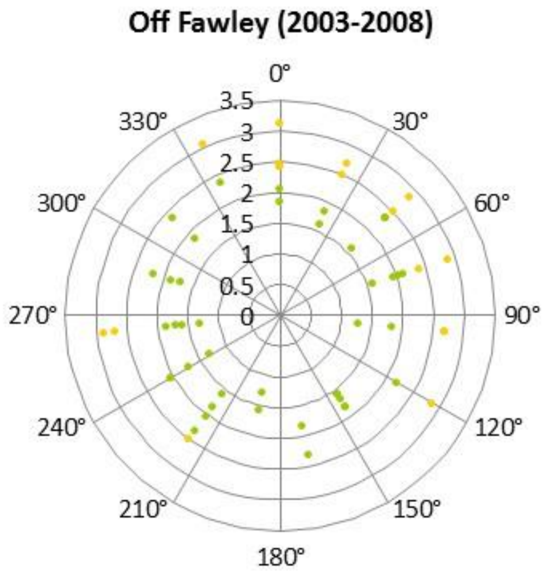

Figure 8.14: Polar plot of log10 *E. coli* results (MPN/100 g) at native oyster RMPs against spring/neap tidal state.

Despite significant correlations calculated between *E. coli* levels and the spring/neap tidal state, there is no pattern distinguishable pattern in Figure 8.14

9. References

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Appendices

Appendix I. Shoreline Survey

Date (time):
18/06/2014, 07.30 – 15:00
19/06/2014, 07.30 – 15:00

Cefas Officers:
Rachel Parks, Simon Kershaw, (Boat Survey)
David Walker (Foot Survey)

Survey Partners:
Cathy Rushworth, Chelsea Technology Group Ltd (19th only)
David Reed, Eastleigh BC (18th only)
Kelly Scott, Southampton PHA (18th only)
Karen Brett, Fareham BC (19th only)

Area surveyed:
River Itchen and along the east shoreline towards Redbridge. Calshot along the west shoreline towards Redbridge.
Itchen Bridge to Hamble-le-Rice. Warsash to Hill Head.

Weather:
18/06/2014 - overcast with sunny spells in the afternoon, 17.1°C, wind bearing/speed 012°/9.66 km/h.
19/06/2014 - sunny, 20.4°C, wind bearing/speed 330°/4.83 km/h

Tides:
Admiralty TotalTide© predictions for Southampton 50°53'N 1°24'W. All times in this report are BST.

18/06/2014			19/06/2014 Last Quarter		
High	03:16	4.5 m	High	04:17	4.3 m
High	15:58	4.5 m	High	18:39	4.5 m
Low	09:02	0.7 m	Low	09:57	1.0 m
Low	21:31	1.1 m	Low	22:29	1.3 m

Objectives:

The shoreline survey aims to confirm the location of previously identified sources of potential contamination; locate other potential sources of contamination that were previously unknown, obtain samples of freshwater inputs and pipeline discharges to the area for bacteriological testing, find out more information about the fishery and lend context to elements of the desk study. A full list of recorded observations is presented in Table I.1 and the locations of these observations are shown in Figure I.1 and Figure I.2.

I.1. Fishery

In the Southern end of the production area, there is a temporary closure of the Solent native oyster fishery due to low stock levels. In the northern part of Southampton Water, the classification zones are prohibited due to high levels of *E. coli* in Manila clams. It is well known to the local authorities (Southampton PHA, Southern IFCA, MCA) that there is still a large amount of illegal harvesting of Manila clams occurring in Southampton Water despite the prohibition, and this is the subject of ongoing investigation.

There is currently no interest in harvesting naturalised Pacific oysters in Southampton Water, mainly due to low stock densities.

Hard clams are harvested year round by dredge. The current legislation states that the dredge size should be no smaller than 35 mm and the vessel should be no larger than 7 m. However, Cefas were informed by a source who requested to remain anonymous, that many of the harvesters are using smaller dredges and therefore harvesting undersized clams. Southern IFCA are aware of this.

In the past the majority of clams have been depurated at the facility operated by Viviers UK Ltd in Portsmouth. Others have been exported within Europe. There are currently no operational depuration facilities in the Southampton area, but a former harvester from the area does own the facilities for depuration near to Southampton Water, should the fishery be opened again.

The annual harvested yield from this public fishery is unknown.

I.2. Sources of contamination

Sewage discharges

The locations of three continuous discharges, Slowhill Copse WwTW, Millbrook WwTW and Woolston WwTW (observations 32, 44 and 91 respectively) were confirmed. Slowhill Copse WwTW and Millbrook WwTW were submerged at the time of survey and Woolston WwTW was inaccessible; flow measurements could therefore not be made. *E. coli* concentrations in surface water samples taken in the plumes observed from the Slowhill Copse WwTW and Millbrook WwTW discharges were 2,400 and 16,000 cfu/100 ml respectively.

Intermittent sewage outfalls observed included Spitfire Quay (observation 1), Chapel Wharf WPS (observation 12), High Street/Briton Street CSO (observation 19), Cawte Road CSO (observation 24), Western Docks (observation 29), Beach Lane Pumping station (observation 69), Victoria Road CEO (observation 74), Ensign Park Hamble CEO (observations 81 and 82), School Lane Hamble Pumping Station (observation 88) and Hook Park WPS (observations 101 and 102). Only High Street/Briton Street CSO and Ensign Park Hamble CEO could be sampled and had *E. coli* concentrations of 1,600 and 1,200 cfu/100 ml respectively. Flow from Ensign Park Hamble CEO was very low and the *E. coli* loading was calculated as equivalent to $4.61x10^7$ cfu/day if this discharge were to run continuously, which is unlikely.

Five industrial discharges were also identified and sampled where possible, including from Marchwood waste to energy incinerator (observation 36, 30 cfu/100 ml), chemical plant (observation 53, 10 cfu/100 ml) and rubber plant (observation 59, not sampled), BP Hamble outfalls A and C (observations 83 and 84, not sampled).

Freshwater inputs

Access by boat in the upper estuaries was restricted due to shallow water. Consequently the rivers Test and Itchen were not sampled at their tidal limits.

Surface water samples were taken at regular intervals starting from Calshot Spit at the seaward end of Southampton Water to just north of Marchwood at the mouth of the River Test (samples WS09 to WS14 and WS16). No geographical pattern was apparent in *E. coli* concentrations from these samples but there was an increase in freshwater towards the River Test as would be expected (section I.3 for details).

Small stream inputs were observed at several locations throughout Southampton Water. Results of those sampled returned *E. coli* concentrations ranging between <20 and 2,500 cfu/100 ml. Observations 62 and 76 was had relatively high *E. coli* loadings of $3.1x10^{10}$ and $5.53x10^{10}$ cfu/day.

A sluice draining from Hook Lake into the mouth of the River Hamble (observation 106) had an *E. coli* loading of $7.7x10^{10}$ cfu/day.

There were also several pipes that were not listed in the EA permit database. It is therefore assumed that these are either surface or ground water drainage. However, Observation 80 had an *E. coli* concentration of 7,400 cfu/100 ml, indicating that it is probably contaminated with sewage. This pipe is marked on the OS maps and it appears to be flowing from the GE Aviation site in Hamble-le-Rice.

Livestock

No livestock was observed on the shoreline survey.

Wildlife

Birds were observed throughout the survey area (observations 21, 45, 46, 48 and 89). Dog walking was observed at observation 89 where dog faeces were left on the beach.

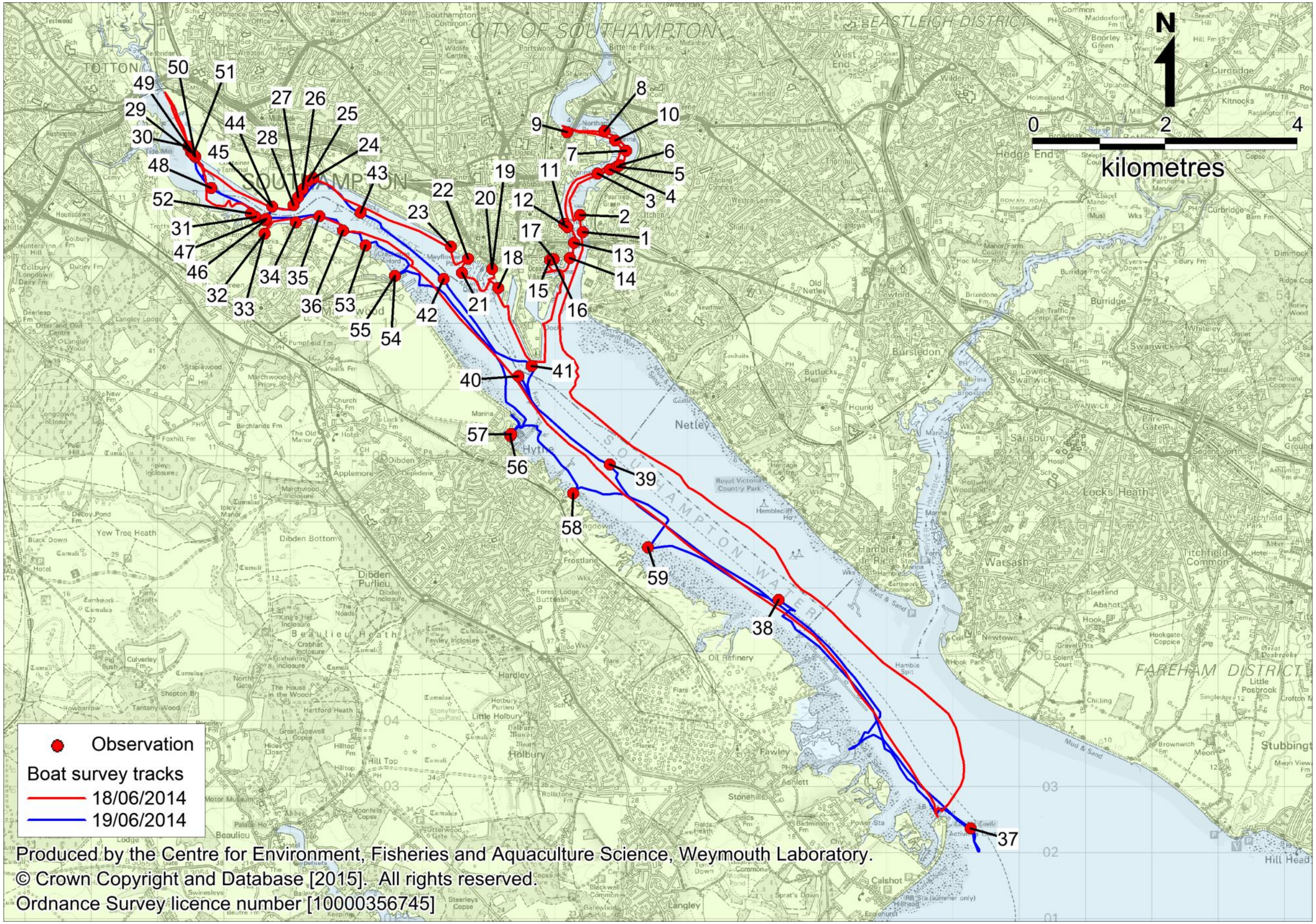

Figure I.1: Locations of boat based shoreline observations (Table I.1 for details).

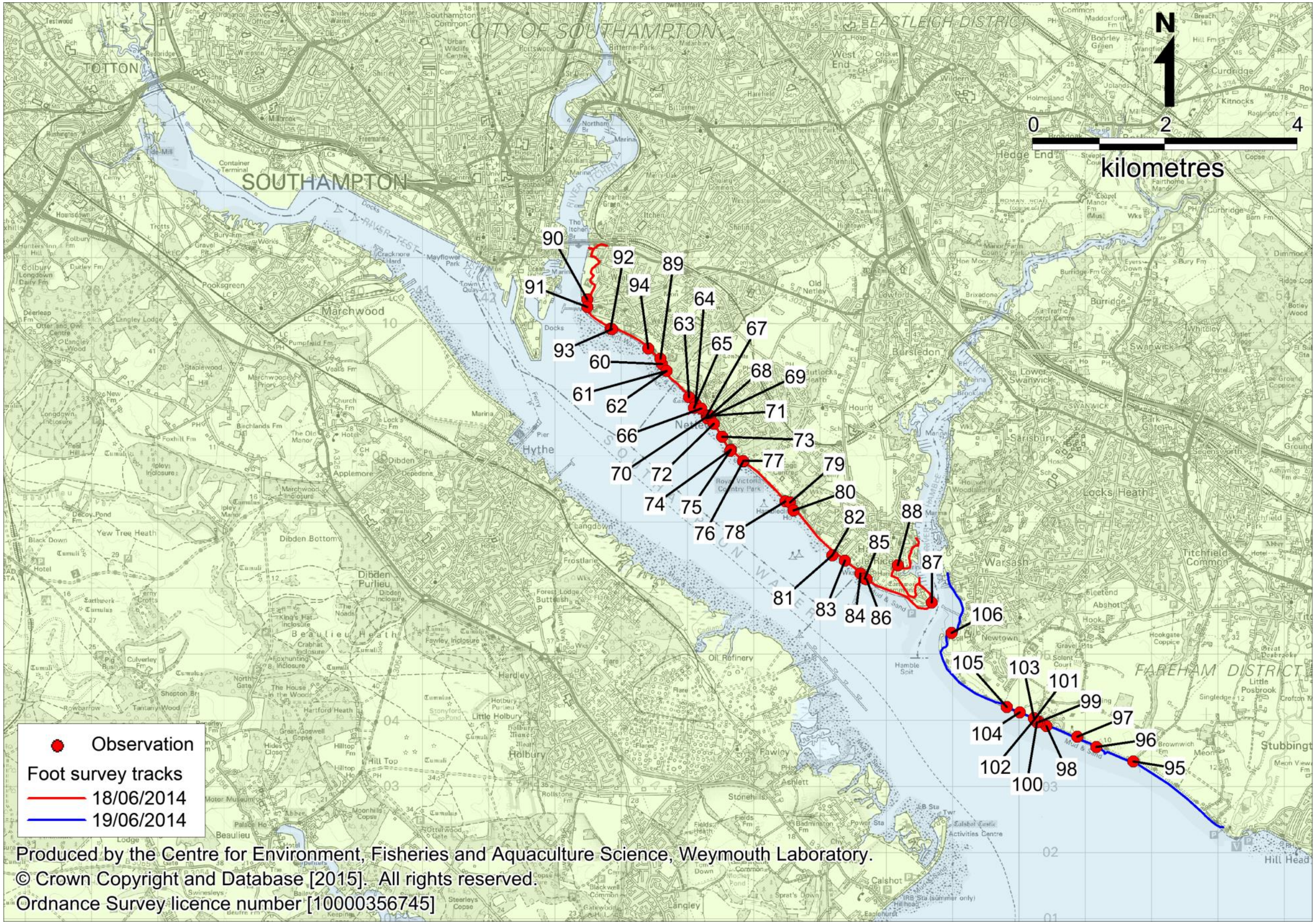

Figure I.2: Locations of foot based shoreline observations (Table I.1 and for details)

Table I.1: Details of Shoreline Observations

Observation no.	NGR	Date	Time	Description	Photo
1	SU4341011378	18/06/2014	07:19	Spitfire Quay, Hazel Road Intermittent. Not Flowing.	Figure I.16
2	SU4337011638	18/06/2014	07:25	Surface drainage flowing from wharf.	Figure I.17 & Figure I.18
3	SU4363612262	18/06/2014	07:30	Large pipe with valve. Not flowing.	Figure I.19 & Figure I.20
4	SU4382012327	18/06/2014	07:32	Pipe. Low flow.	Figure I.21
5	SU4393012365	18/06/2014	07:34	Pipe. Not Flowing.	
6	SU4397012390	18/06/2014	07:34	Pipe. Not Flowing.	
7	SU4406912611	18/06/2014	07:37	Bricked culvert - residual flow.	Figure I.22
8	SU4374112905	18/06/2014	07:51	Surface drainage channel flowing through mudflats in marina (SW01).	Figure I.23 & Figure I.24
9	SU4317812889	18/06/2014	08:09	Pipe with valve flowing under Northam Bridge (2.45s to fill 1l jug, SW03).	Figure I.25 & Figure I.26
10	SU4390212765	18/06/2014	08:24	Mussels attached to marina pier.	Figure I.27
11	SU4312911508	18/06/2014	08:51	Large pipe. Partially submerged in marina.	Figure I.28
12	SU4318111456	18/06/2014	08:53	Chapel Wharf WPS. 2 pipes. Not flowing.	Figure I.29 & Figure I.30
13	SU4328011216	18/06/2014	08:56	Large grid. Not flowing.	Figure I.31
14	SU4321610986	18/06/2014	08:58	Ocean Village surface water intermittent pipe. Not flowing.	Figure I.32 & Figure I.33
15	SU4292010958	18/06/2014	09:04	Pipe with metal valve. Not Flowing.	Figure I.34
16	SU4296410971	18/06/2014	09:06	Drainage into Marina. Flowing.	Figure I.35 & Figure I.36
17	SU4297810968	18/06/2014	09:07	Pipe with metal valve. Not Flowing.	
18	SU4213910532	18/06/2014	09:36	Large pipe. Not flowing. Downstream pipe submerged.	Figure I.37
19	SU4204710823	18/06/2014	09:41	High Street/Briton Street CSO. Scum on surface of the water. Submerged (SW04).	Figure I.38 & Figure I.39
20	SU4204710823	18/06/2014	09:41	Mussels and oysters.	
21	SU4159110765	18/06/2014	09:49	90 gulls on pontoons.	Figure I.40

22	SU4168310977	18/06/2014	09:53	Pipe with metal valve. Not flowing.	Figure I.41 & Figure I.42
23	SU4142111159	18/06/2014	10:00	ABP ground water Pumping Station Intermittent.3 large pipes. Not flowing.	Figure I.43
24	SU3935112196	18/06/2014	10:20	Cawte Road CSO. Down pipe. Low flow.	Figure I.44
25	SU3926612148	18/06/2014	10:26	Large pipe with metal grid. Not flowing.	Figure I.45
26	SU3918512026	18/06/2014	10:29	Large pipe with metal grid. Not flowing.	
27	SU3911811907	18/06/2014	10:29	Large pipe with metal grid. Not flowing.	
28	SU3904711785	18/06/2014	10:30	Large pipe with metal grid. Not flowing.	
29	SU3750512586	18/06/2014	10:38	Western Docks private discharge. Metal pipe. Not flowing.	Figure I.46 & Figure I.47
30	SU3746312672	18/06/2014	10:42	Small metal pipe. Flowing (SW05).	Figure I.48
31	SU3848011610	18/06/2014	11:19	Redbridge Channel (SW06).	Figure I.49
32	SU3861111358	18/06/2014	11:23	Slowhill Copse WwTW continuous discharge. Submerged and flowing (SW07).	
33	SU3861111358	18/06/2014	11:23	Culverted stream, drains past STW. Not flowing.	
34	SU3908611526	18/06/2014	11:35	Pipe with grid and head wall.	
35	SU3943811618	18/06/2014	11:38	Around 150 boats, moored/anchored.	
36	SU3979511404	18/06/2014	11:41	Industrial effluent discharge from Marchwood waste to energy incinerator (SW08).	Figure I.50
37	SU4926502365	19/06/2014	06:29	Water Sample & CTD measurement - Black Jack Buoy (WS09).	
38	SU4636605819	19/06/2014	06:58	Water Sample & CTD measurement - Cadland Buoy (WS10).	
39	SU4382307864	19/06/2014	07:15	Water Sample & CTD measurement - Deans Elbow (WS11).	
40	SU4244409199	19/06/2014	07:38	Water Sample & CTD measurement - Hythe Knock Buoy (WS12).	
41	SU4264209355	19/06/2014	07:50	CTD measurement - ABP Port of Southampton.	
42	SU4131310671	19/06/2014	08:05	Water Sample & CTD measurement - Gymp Elbow Buoy (WS13).	
43	SU4006311672	19/06/2014	08:20	Water Sample & CTD measurement - Swinging Ground 4 Buoy (WS14).	
44	SU3872611762	19/06/2014	08:45	Millbrook WwTW continuous discharge. Submerged and flowing (WS15).	
45	SU3872611762	19/06/2014	08:45	20 gulls.	
46	SU3862411559	19/06/2014	08:52	8 gulls on marsh.	
47	SU3863711577	19/06/2014	09:08	Water Sample & CTD measurement - Bury Buoy (WS16).	
48	SU3780712044	19/06/2014	09:25	70 gulls on shore.	
49	SU3756012527	19/06/2014	09:33	CTD measurement on edge of dredged channel.	
50	SU3756612515	19/06/2014	09:35	CTD measurement in dredged channel (16.0 m).	

51	SU3753612554	19/06/2014	09:37	CTD measurement on north of dredged channel (1.7 m).	
52	SU3840711662	19/06/2014	09:52	Stream across Bury marsh (WS17).	Figure I.51 & Figure I.52
53	SU4013811178	19/06/2014	10:19	Large discharge from chemical plant (WS18).	Figure I.53
54	SU4057710718	19/06/2014	10:40	Stream - Surface drainage pipe with concrete headwall. Flowing (WS19).	Figure I.54
55	SU4057710718	19/06/2014	10:40	Oyster deadshell.	Figure I.54
56	SU4231808300	19/06/2014	11:19	Outfall inaccessible across mud. Flowing.	Figure I.55
57	SU4233308325	19/06/2014	11:19	Sluice from Hythe Marina. Too large and wide to measure.	Figure I.56
58	SU4327107432	19/06/2014	11:50	Stream flowing under bridge.	Figure I.57
59	SU4439406611	19/06/2014	12:02	Discharge from rubber plant - too difficult to access.	Figure I.58 & Figure I.59
60	SU4461009383	18/06/2014	07:55	Broken pipe across beach. Not flowing.	Figure I.60
61	SU4501708886	18/06/2014	08:13	Cockle deadshell.	
62	SU4501708886	18/06/2014	08:13	Stream (0.05 x 0.28 m x 0.545 m/s) (SE01).	Figure I.61
63	SU4501708885	18/06/2014	08:13	Iron pipe (~25 m to sea), broken so discharging at beach (0.2 m diameter, 0.01 m flow depth, 1.5 s to fill 250 ml container) (SE02).	Figure I.62
64	SU4511708785	18/06/2014	08:17	Buried iron pipe, 0.25 m diameter.	Figure I.63
65	SU4509208721	18/06/2014	08:19	Clam and oyster dead shell.	
66	SU4519808709	18/06/2014	08:26	Pipe in sea wall.	
67	SU4528208604	18/06/2014	08:31	Concrete pipe on beach, 0.45 m diameter. Not flowing.	Figure I.64
68	SU4529208565	18/06/2014	08:32	Iron pipe on beach, 0.3 m diameter. Not flowing.	Figure I.65
69	SU4529508563	18/06/2014	08:32	Outfall for Beach Lane pumping station. Iron pipe stretching around 100 m to sea (end below tide), 0.3 m diameter.	Figure I.66
70	SU4531608610	18/06/2014	08:35	Beach Lane pumping station (reportedly overflows often).	
71	SU4533908605	18/06/2014	08:37	Building site for 3 new houses. Buried tanks on site probably associated with Beach Lane pumping station.	
72	SU4538908482	18/06/2014	08:42	Old iron pipe under cliff, 0.15 m diameter. Not flowing.	Figure I.67
73	SU4551808286	18/06/2014	08:48	Old, broken iron pipe, 0.2 m outer diameter, 0.07 m internal diameter. Original pipe extending to sea but broken at beach.	Figure I.68
74	SU4564808089	18/06/2014	08:53	Victoria Road Netley CEO. Pipe encased in concrete, 0.5 m diameter. Not flowing.	Figure I.69
75	SU4563508075	18/06/2014	08:54	Old, broken iron pipe in beach. Mostly buried.	
76	SU4583407915	18/06/2014	09:02	Culvert surrounded by brickwork (0.04 m x 0.4 m x 1.6 m/s) (SE03).	Figure I.70

77	SU4583307916	18/06/2014	09:03	Oysters attached to embankment.	Figure I.71
78	SU4647007310	18/06/2014	09:18	Victoria Country Park discharge. Iron pipe covered with mussels, 1 m diameter extending around 100 m to sea. Cracked at beach, so will likely spill here. Not flowing but strong sewage smell.	Figure I.72 & Figure I.73
79	SU4654007293	18/06/2014	09:23	Buried culvert pipe, 0.8 m diameter into a stagnant pond. Not flowing.	Figure I.74
80	SU4659107171	18/06/2014	09:30	Iron pipe (0.6 m diameter, 0.01 m flow depth, 0.641 m/s). Surrounded by oyster, clams, mussel and cockle dead shell (SE04).	Figure I.75
81	SU4717606492	18/06/2014	09:47	Ensign Park Hamble CEO. Pipe, 0.4 m diameter. Covered with mussels. Extending 50 m to sea. Leaking at this point (4.5 s to fill pot) (SE05).	Figure I.76 & Figure I.77
82	SU4717606492	18/06/2014	09:47	Ensign Park Hamble CEO. Buried pipe, 0.3 m diameter. Extending 20 m to sea.	Figure I.76
83	SU4736606409	18/06/2014	09:53	Outfall A, BP Hamble (intermittent). Valved, iron pipe from works, 0.25 m diameter. Not flowing.	Figure I.78
84	SU4760306217	18/06/2014	09:58	Outfall C, BP Hamble (intermittent). Iron pipe from works with missing valve, 0.25 m diameter. Not flowing.	Figure I.79
85	SU4766506143	18/06/2014	10:00	Pipe extending under jetty, broken at beach, 0.45 m diameter. Not flowing.	Figure I.80 & Figure I.81
86	SU4769606131	18/06/2014	10:02	Grated pipe, partially buried.	Figure I.82
87	SU4867905780	18/06/2014	10:20	Cockle dead shell.	
88	SU4816506341	18/06/2014	10:43	School Lane Hamble Pumping station (strong smell).	Figure I.83
89	SU4458309467	18/06/2014	11:49	Around 100 crows on beach. Dog walker (did not clean up mess).	
90	SU4348010360	18/06/2014	12:42	Woolston WwTW. Strong smell. Reportedly spills often.	
91	SU4348210249	18/06/2014	12:45	Woolston WwTW outfall pipe extending along jetty.	Figure I.84
92	SU4383509921	18/06/2014	13:00	Half buried iron pipe.	Figure I.85
93	SU4385509912	18/06/2014	13:04	Grated and valved pipe (mostly closed and buried) coming from field/housing estate, 1.2 m diameter. Flow reading taken in front (0.02 m x 0.3 m x 0.298 m/s) (SE06).	Figure I.86
94	SU4440409620	18/06/2014	13:17	Concrete pipe extending around 15 m to sea (under tide).	Figure I.87
95	SU5172203378	19/06/2014	07:59	Stream (0.12 m x 1.85 m x 0.039 m/s) (SE07).	Figure I.88
96	SU5116203595	19/06/2014	08:14	Cockle & clam dead shell.	
97	SU5087503749	19/06/2014	08:19	Blue corrugated plastic pipes in cliff face. Scattered around by land slide/subsidence).	Figure I.89
98	SU5041303913	19/06/2014	08:31	Cockle dead shell.	
99	SU5030303971	19/06/2014	08:35	Sewer pipe going nowhere from underneath chalet. No evidence of sewage under pipe.	Figure I.90
100	SU5026703966	19/06/2014	08:36	Solent Breezes short outfall (0.5 m diameter, 0.01 m flow depth, 0.770 m/s) (SE08).	Figure I.91
101	SU5023404012	19/06/2014	08:43	Hook Park WPS long outfall.	Figure I.92

102	SU5023004013	19/06/2014	08:44	Hook Park WPS pipe next to long outfall and beach, 0.6 m diameter.	Figure I.93
103	SU5022204033	19/06/2014	08:46	Old fibre glass pipe, buried and filled with concrete. Possibly old discharge from nearby pumping station.	Figure I.94
104	SU5000504115	19/06/2014	08:52	Old, broken pipes filled with gravel.	
105	SU4981504197	19/06/2014	08:56	Buried corrugated pipe.	
106	SU4898005320	19/06/2014	09:21	Sluice from marsh towards the Hamble. Two pipes (0.103 flow depth x 1.6 m diameter x 0.281) (SE09).	Figure I.95

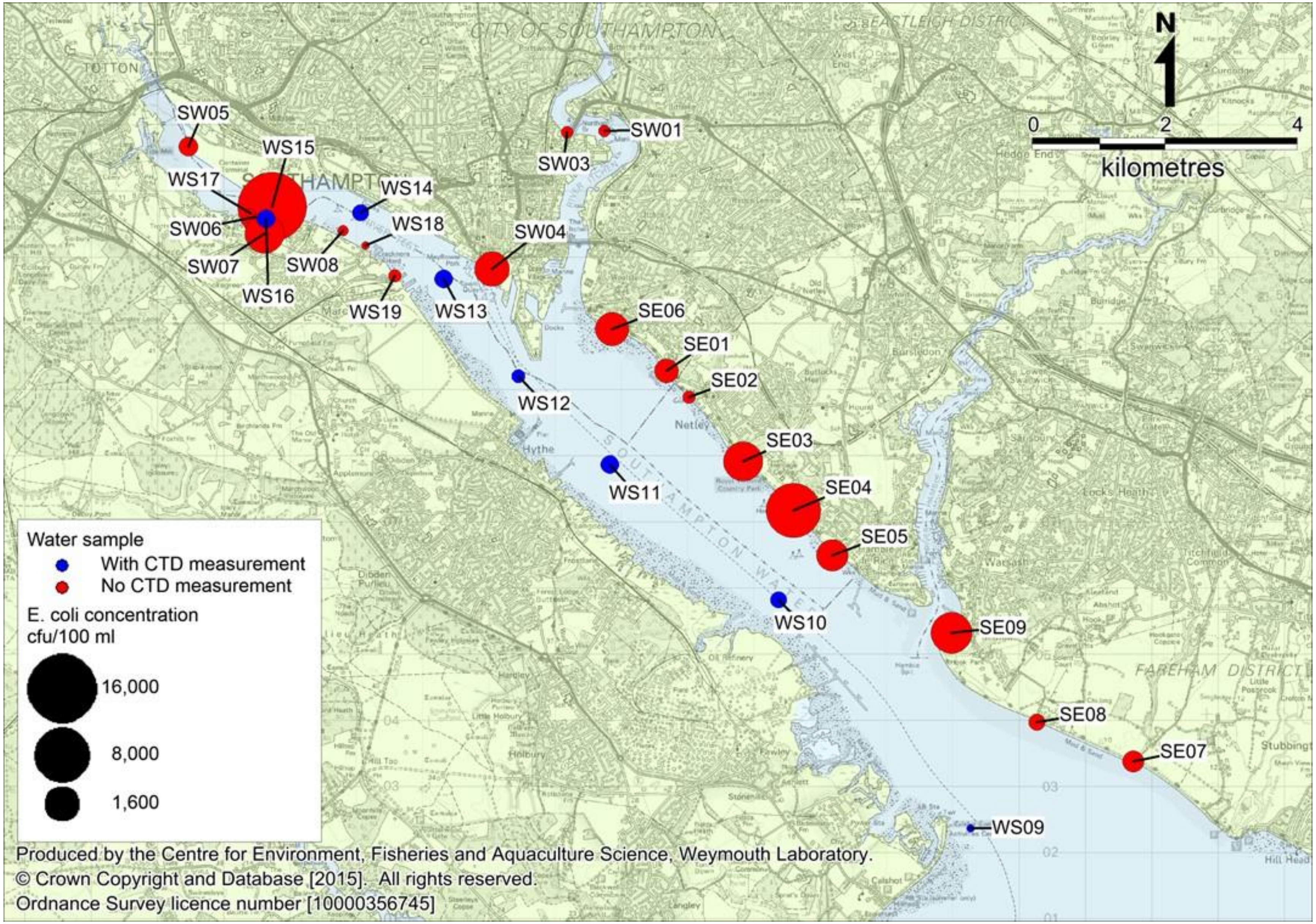

Figure I.3: Water sample results (Table I.2 for details).

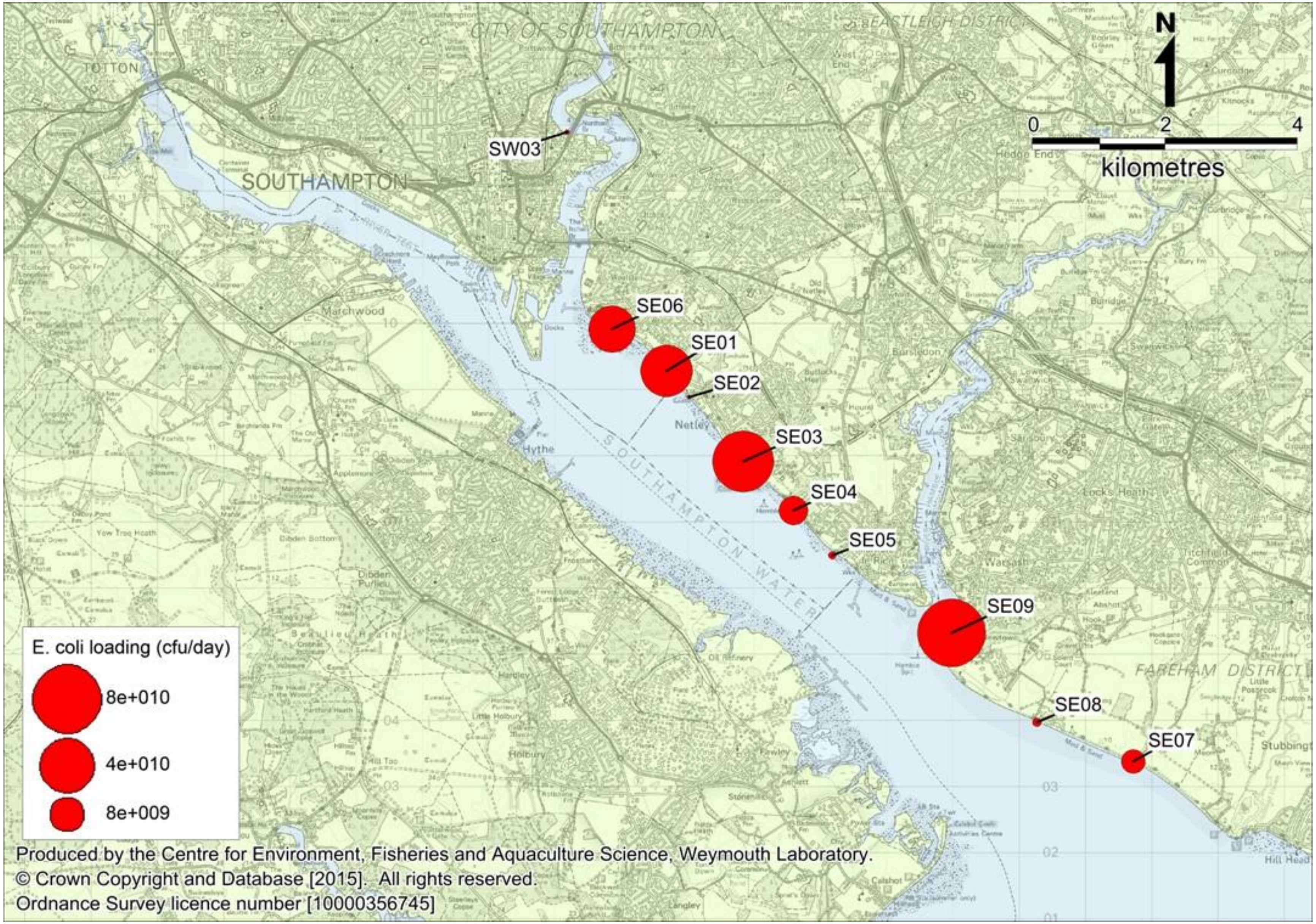

Figure I.4: *E. coli* stream loadings (Table I.2 for details).

Table I.2: Water sample *E. coli* results, spot flow gauging results and estimated equivalent daily loadings.

Sample ID	Observation number	Date and time	Description	Flow (l/s)	*E. coli* concentration (cfu/100 ml)	*E. coli* loading (cfu/day)	NGR
SW01	8	18/06/2014 07:51	Surface drainage		40		SU4374112905
SW03	9	18/06/2014 08:09	Pipe	0.4	40	$1.41x10^{7}$	SU4317812889
SW04	19	18/06/2014 09:41	CSO		1,600		SU4204710823
SW05	30	18/06/2014 10:42	Pipe		210		SU3746312672
SW06	31	18/06/2014 11:19	Redbridge Channel		<10		SU3848011610
SW07	32	18/06/2014 11:23	Continuous discharge		2,400		SU3861111358
SW08	36	18/06/2014 11:41	Industrial effluent		30		SU3979511404
WS09	37	19/06/2014 06:29	Water Sample & CTD measurement - Black Jack Buoy		10		SU4926502365
WS10	38	19/06/2014 06:58	Water Sample & CTD measurement - Cadland Buoy		120		SU4636605819
WS11	39	19/06/2014 07:15	Water Sample & CTD measurement - Deans Elbow		180		SU4382307864
WS12	40	19/06/2014 07:38	Water Sample & CTD measurement - Hythe Knock Buoy		70		SU4244409199
WS13	42	19/06/2014 08:05	Water Sample & CTD measurement - Gymp Elbow Buoy		200		SU4131310671
WS14	43	19/06/2014 08:20	Water Sample & CTD measurement - Swinging Ground 4 Buoy		130		SU4006311672
WS15	44	19/06/2014 08:45	Continuous discharge		16,000		SU3872611762
WS16	47	19/06/2014 09:08	Water Sample & CTD measurement - Bury Buoy		180		SU3863711577
WS17	52	19/06/2014 09:52	Stream		20		SU3840711662
WS18	53	19/06/2014 10:19	Discharge from chemical plant		10		SU4013811178
WS19	54	19/06/2014 10:40	Stream		60		SU4057710718
SE01	62	18/06/2014 08:13	Stream	76.3	470	$3.10 x10^{10}$	SU4501708886
SE02	63	18/06/2014 08:13	Pipe	0.1	50	$5.76 x10^{6}$	SU4501708885
SE03	76	18/06/2014 09:02	Culvert	25.6	2,500	$5.53 x10^{10}$	SU4583407915
SE04	80	18/06/2014 09:30	Pipe	0.7	7,400	$4.21 x10^{9}$	SU4659107171
SE05	81	18/06/2014 09:47	Pipe	<0.1	1,200	$4.61 x10^{7}$	SU4717606492
SE06	93	18/06/2014 13:04	Pipe	17.9	1,400	$2.16 x10^{10}$	SU4385509912
SE07	95	19/06/2014 07:59	Stream	8.7	310	$2.32 x10^{9}$	SU5172203378
SE08	100	19/06/2014 08:36	Solent Breezes short outfall	0.7	120	$7.48 x10^{7}$	SU5026703966
SE09	106	19/06/2014 09:21	Sluice	30.7	2,900	$7.70 x10^{10}$	SU4898005320

I.3. Conductivity, temperature and depth (CTD) measurements

Conductivity (practical salinity scale), temperature (°C) and depth (m) [CTD] measurements were taken at seven locations within Southampton Water shown in Figure I.1. Temperature and salinity profiles for these locations are shown in Figures I.5 to I.15.

All CTD measurements were taken on an ebb tide, starting at the mouth of the estuary measurement stations were spaced at intervals working up the estuary as far as the north western limit of Prince Charles Container Port, their locations are illustrated in Figure I.1 (observations 36 – 49,). Measurements were predominantly taken in the main navigation channel close to the navigational buoys with the exception of observation 49 which was taken above the main navigational channel.

In the lower estuary CTD 1 and CTD 2 the salinity and temperature measurements were approximately constant [>30 practical salinity scale (PSS) and 17.5°C – 18.1°C] throughout the water column in comparison to further up the channel where it becomes apparent that there is freshwater influence with incomplete mixing, lower salinities being recorded in the surface waters and higher salinities at depth. This is most pronounced in the upper estuary, adjacent to the north western limit of Prince Charles Container Port (Figure I.13) the salinity ranges from <15 PSS increasing to >30 PSS in the first 2 metres and remains around 30 PSS at depth, the temperature is fairly constant around 18°C.

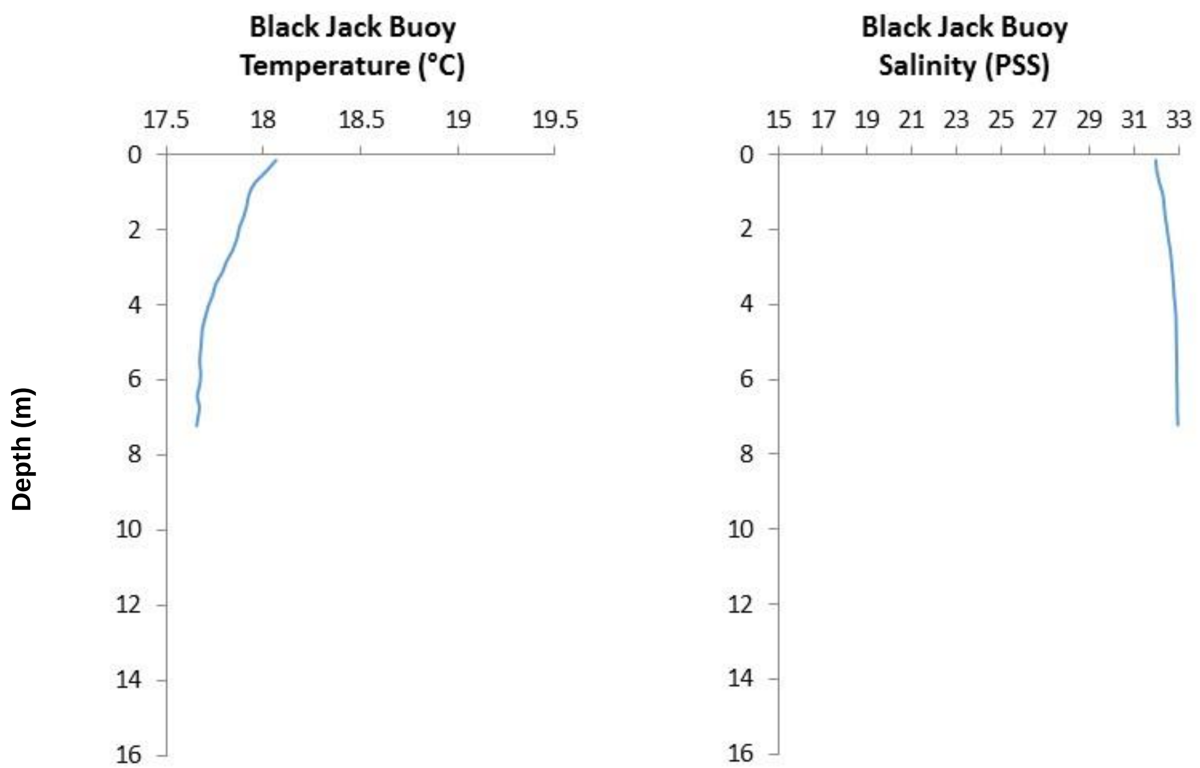

Figure I.5 CTD 1 (observation 36)

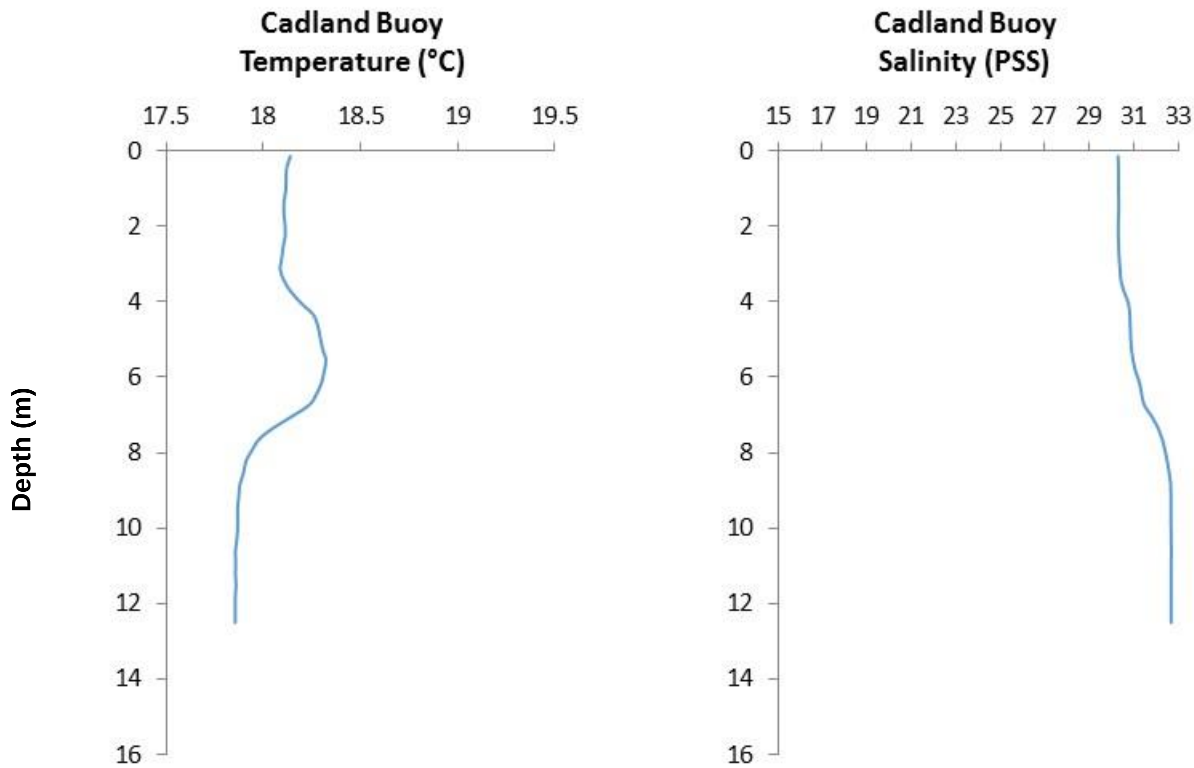

Figure I.6 CTD 2 (observation 37)

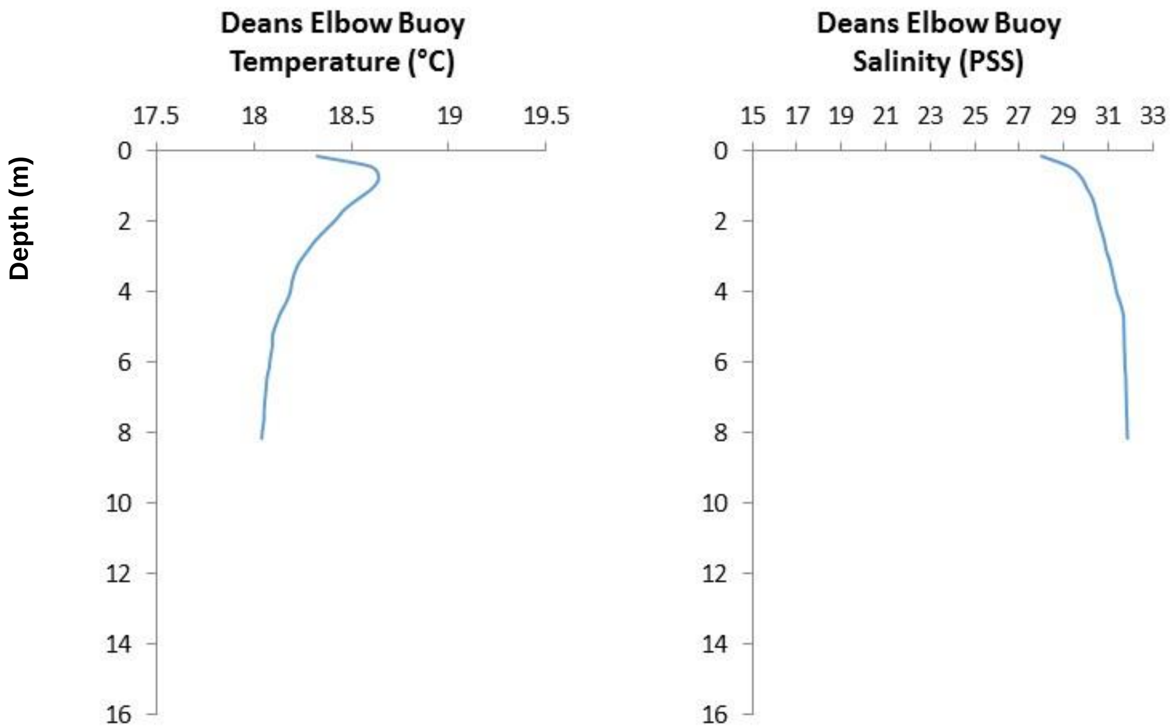

Figure I.7 CTD 3 (observation 38)

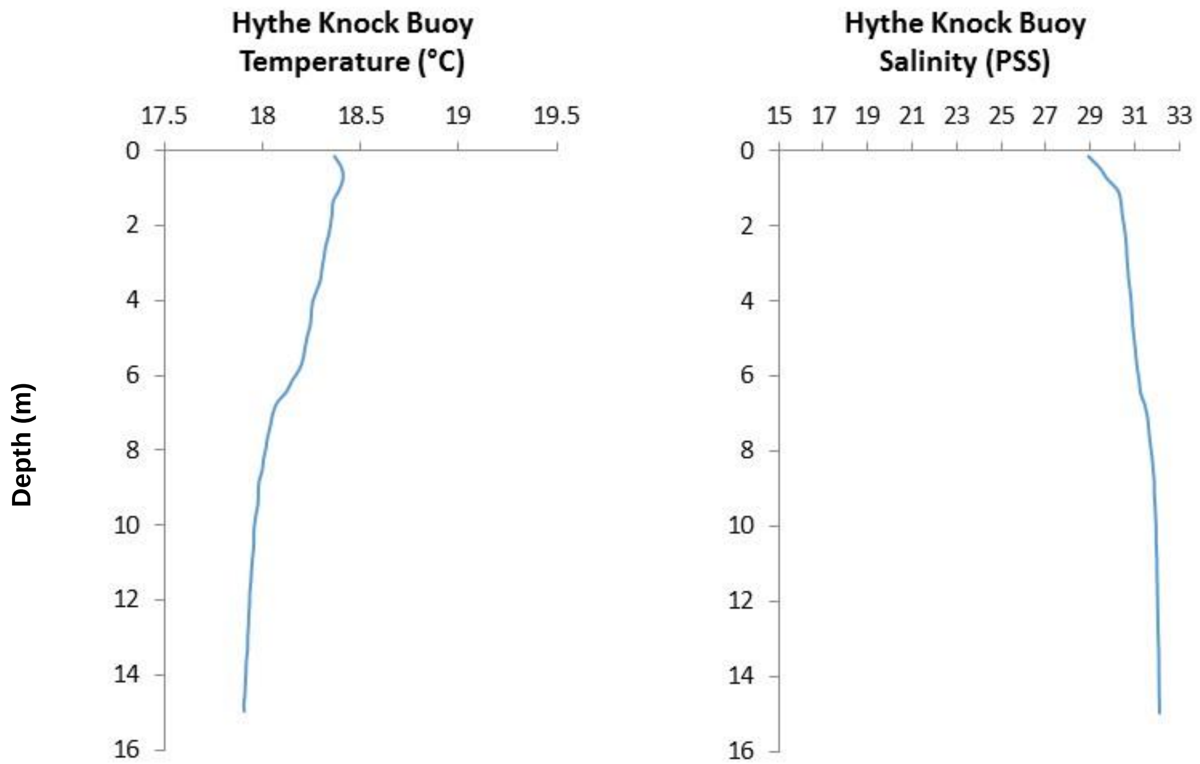

Figure I.8 CTD 4 (observation 39)

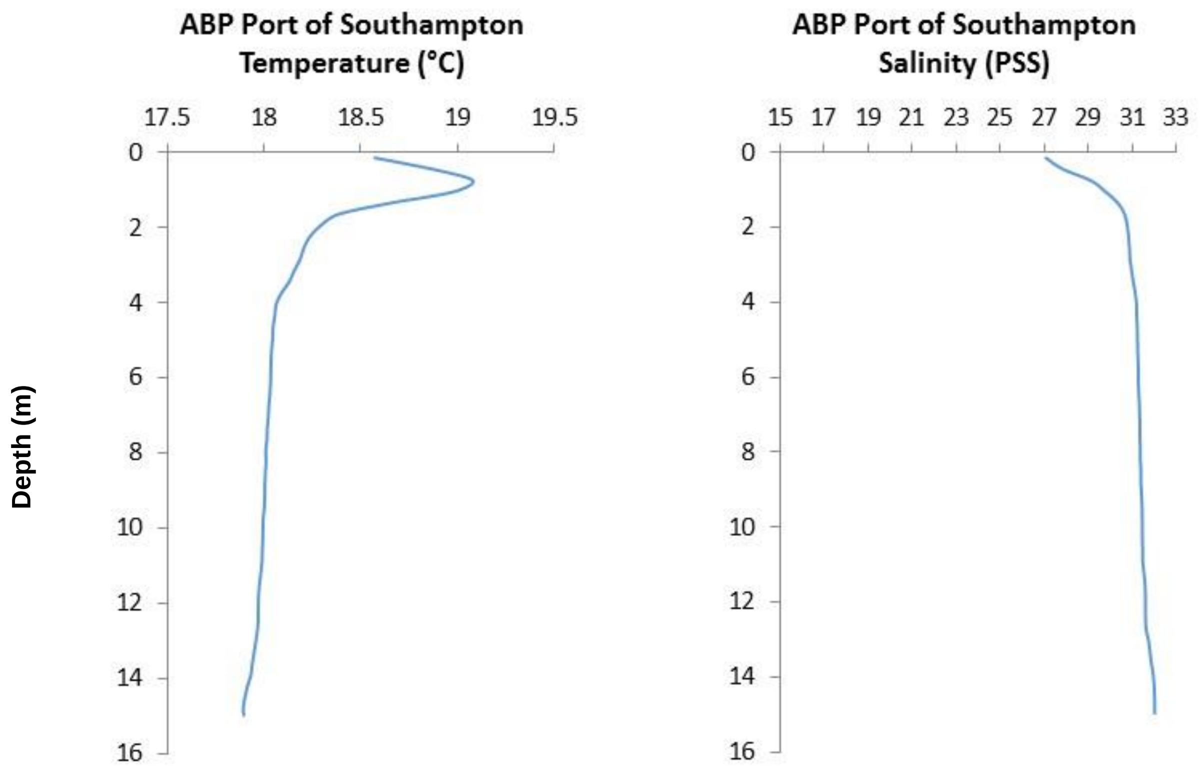

Figure I.9 CTD 5 (observation 40)

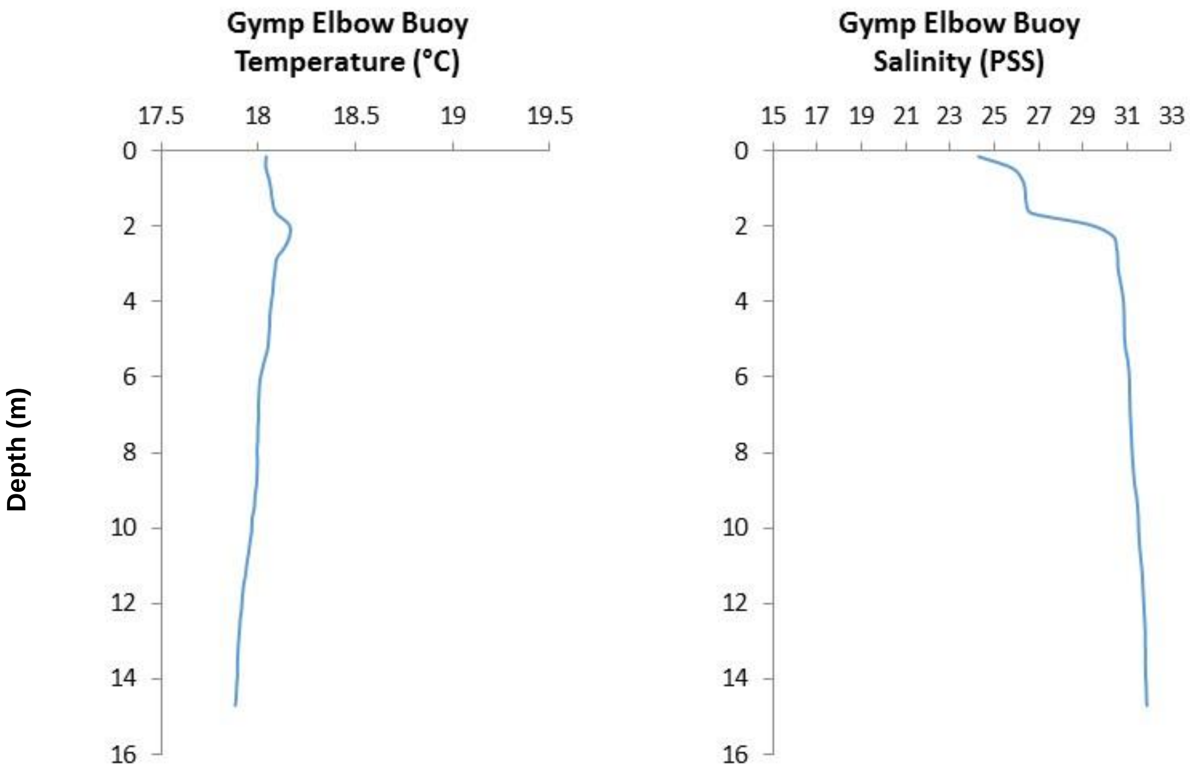

Figure I.10 CTD 6 (observation 41)

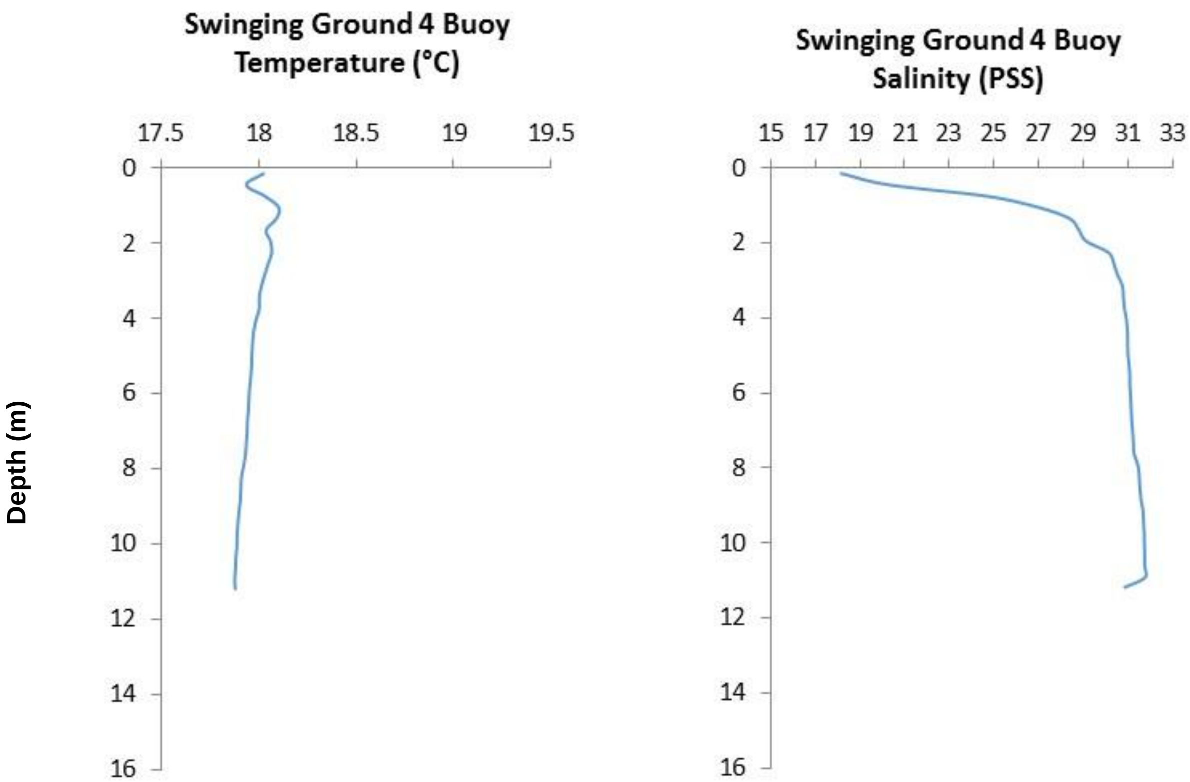

Figure I.11 CTD 7 (observation 42)

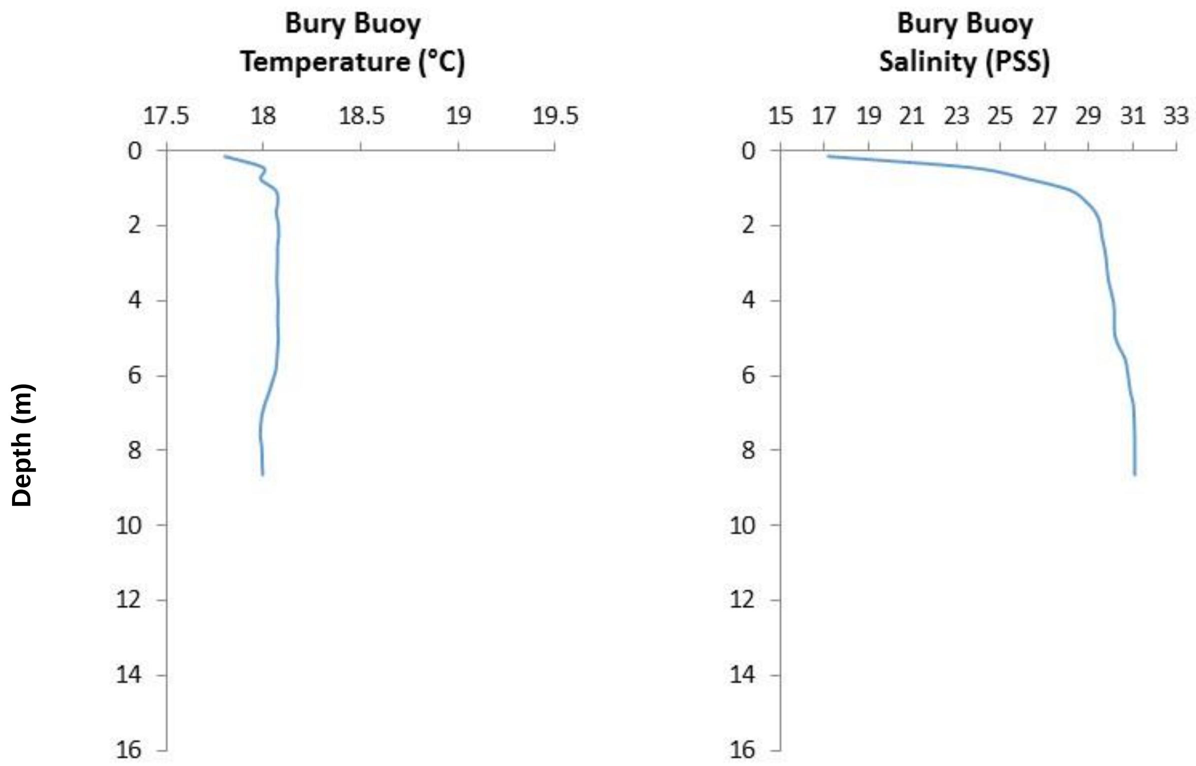

Figure I.12 CTD 8 (observation 45)

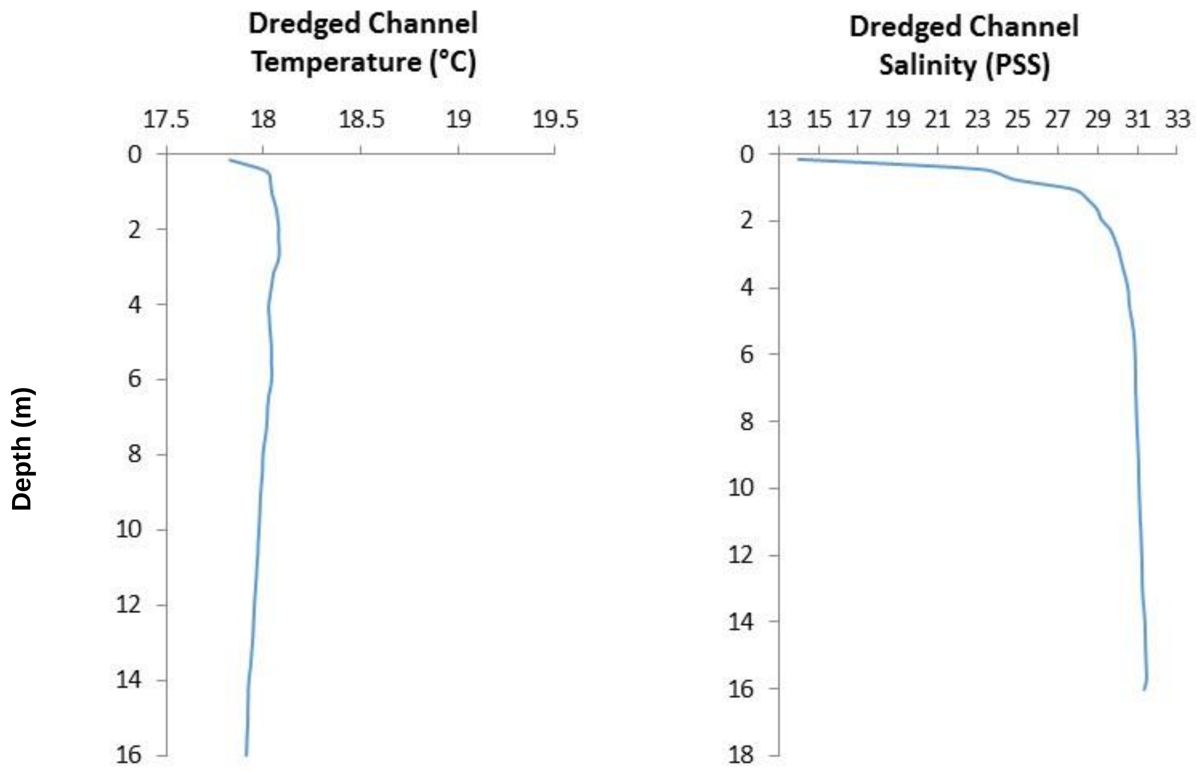

Figure I.13 CTD 9 (observation 47)

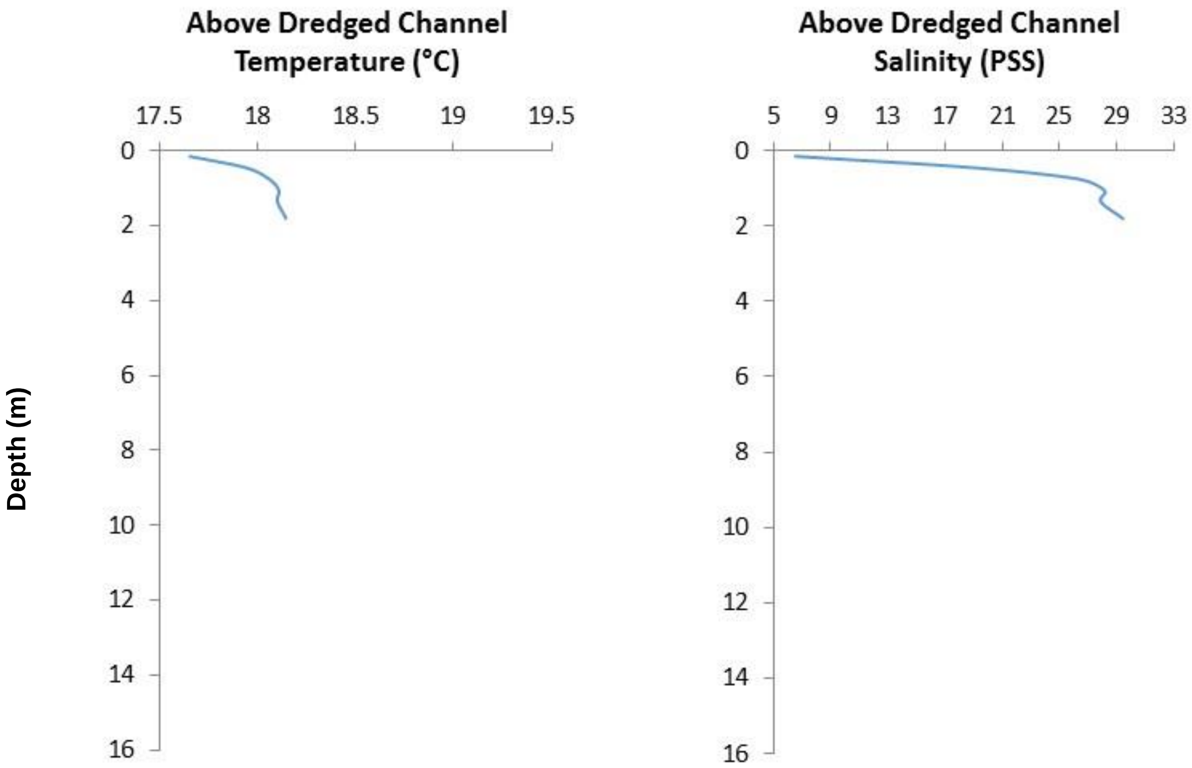

Figure I.14 CTD 10 (observation 48)

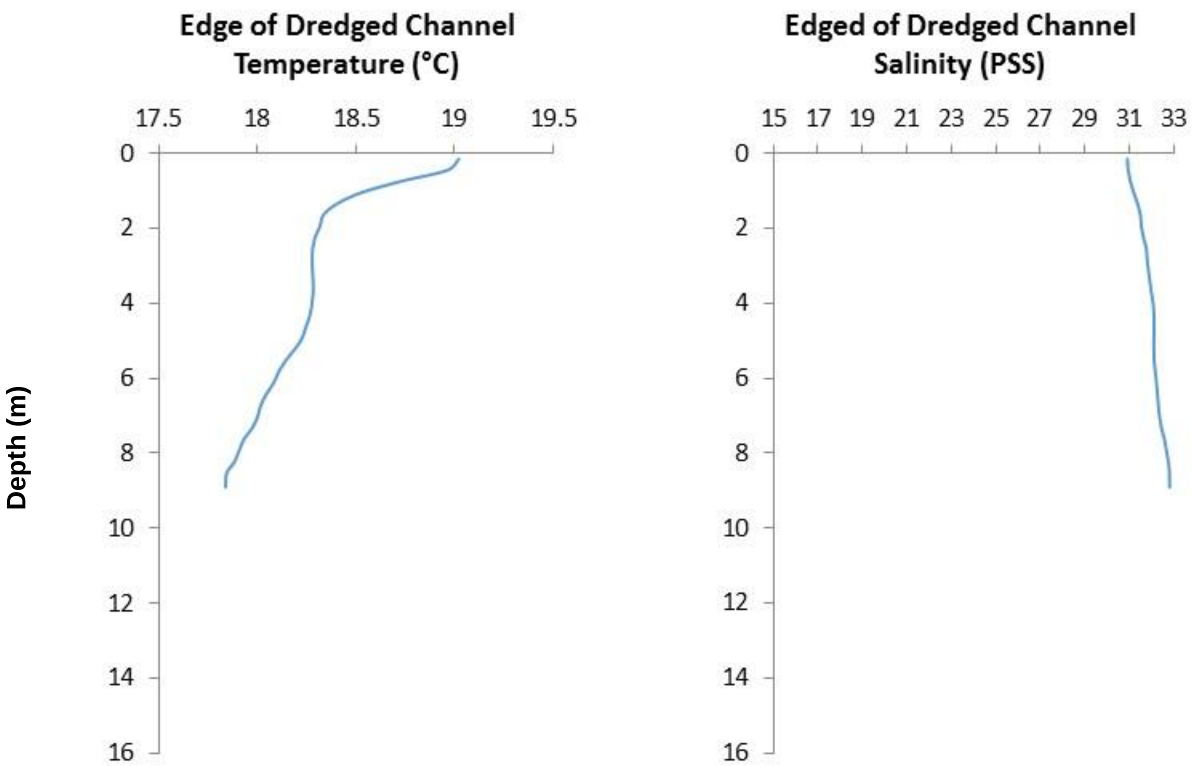

Figure I.15 CTD 11 (observation 49)

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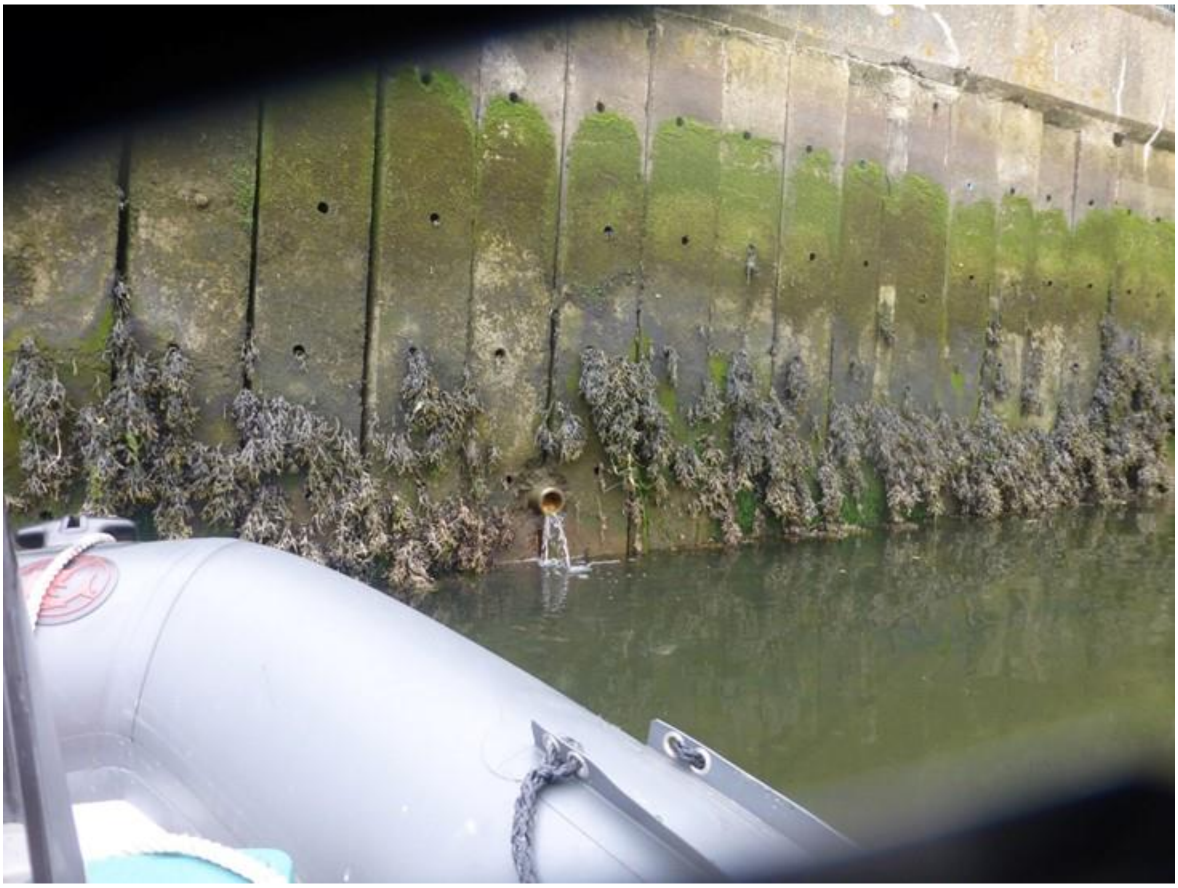

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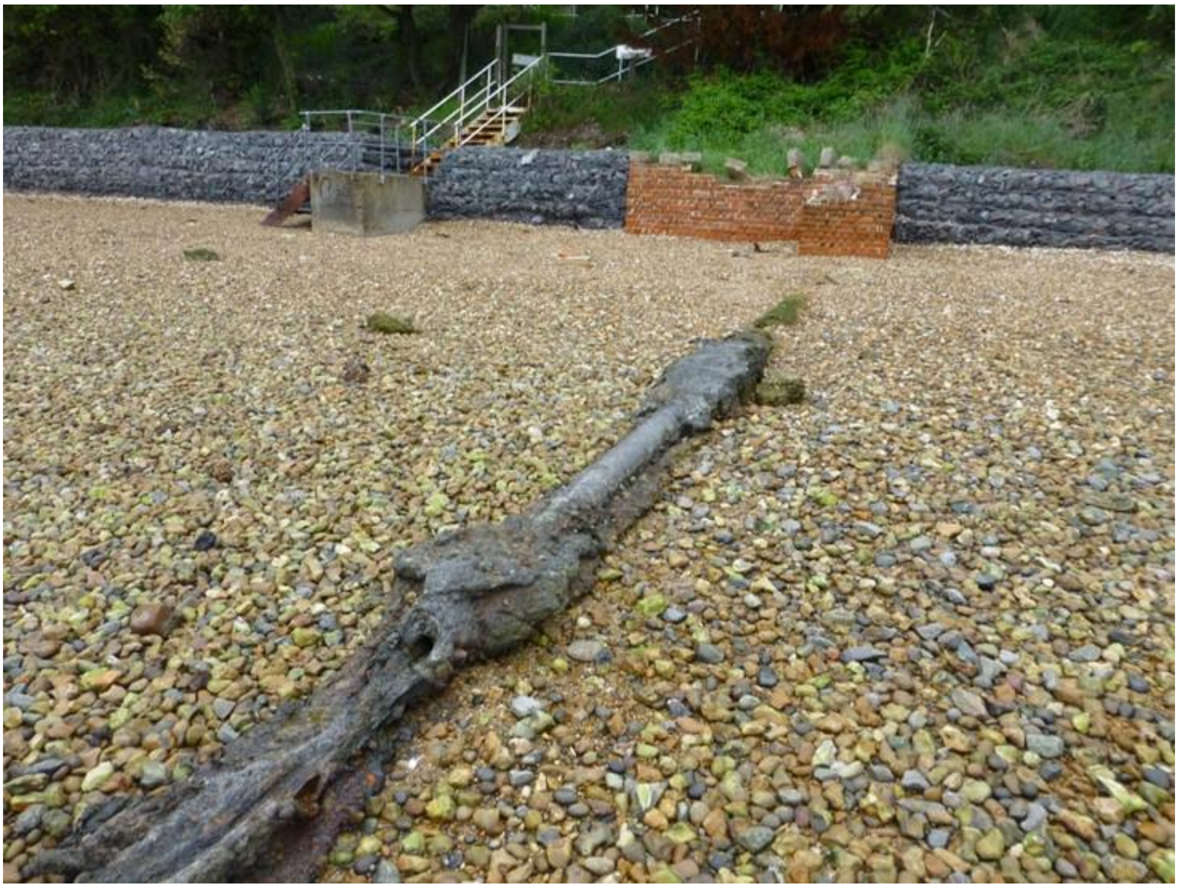

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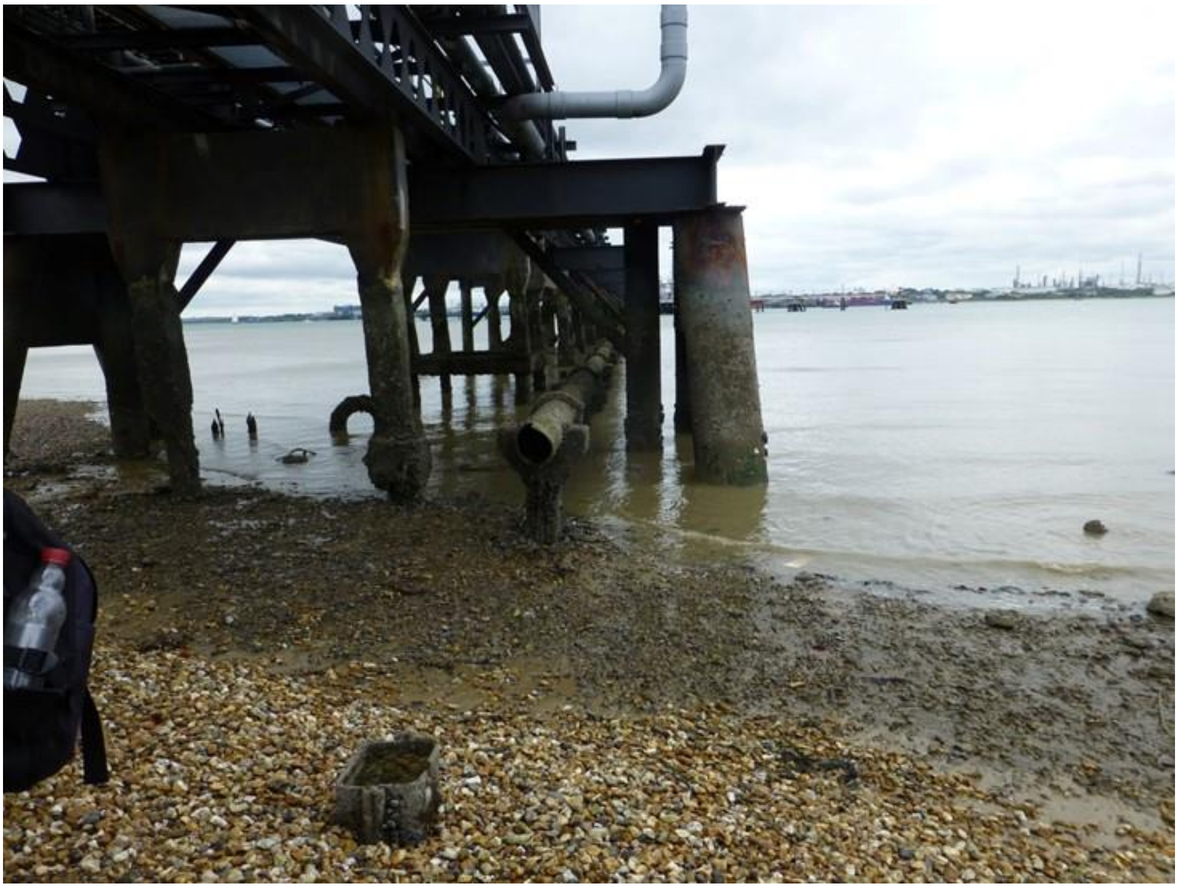

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Appendix II. Southampton Water Sanitary Survey Report 2009

EC Regulation 854/2004

CLASSIFICATION OF BIVALVE MOLLUSC PRODUCTION AREAS IN ENGLAND AND WALES

SANITARY SURVEY REPORT

Southampton Water

2009

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STATEMENT OF USE: This report provides information from a desk study and a practical survey evaluation of the information available relevant to perform a sanitary survey of bivalve mollusc production areas in Southampton Water. Its primary purpose is to demonstrate compliance with the requirements for classification of bivalve production areas, laid down in EC Regulation 854/2004, laying down specific rules for the organisation of official controls on products of animal origin intended for human consumption. The Centre for Environment, Fisheries and Aquaculture Science (Cefas) undertook this work on behalf of the Food Standards Agency (FSA).

DISSEMINATION: Food Standards Agency, Southampton Port Health Authority, Environment Agency.

ACKNOWLEDGMENTS: Cefas would like to thank the following for their assistance with this report: Ian Udal, Hana Abdul-Wahab and John Massie (Environment Agency); Ged Burden (Southampton Port Health Authority); Bill Bain (WEMS); Mike McKeown (Southern Water Services Ltd.); Peter Whitehead (ABP Marine Environment Research); Sioned Nuttgens (Esso Refinery, Fawley); Alison Fowler (River Hamble Harbour Authority); Anthony Jenson (National Oceanography Centre, Southampton); Simon Pengelly (Southern Sea Fisheries Committee).

CONTENTS

EXECUTIVE SUMMARY

1. This sanitary survey was triggered by a request from Southampton Port Health Authority for classification of the naturalised Manila clam (*Tapes philippinarum*) beds within Southampton Water. Southampton Water is already classified for the harvesting of native oysters (*Ostrea edulis*) and hard clams (*Mercenaria mercenaria*).

2. Southampton Water is situated on the south coast of England and connects the estuaries of the Rivers Test and Itchen with the Solent. These rivers have a large catchment (>1,750km^2) with significant urban and rural areas. The Port of Southampton is one of the most important and busiest ports in the UK.

3. Four large sewage treatment works (STWs) discharge treated sewage effluent to the upper reaches of Southampton Water. These discharges are likely to be the most significant sources of microbiological contamination of shellfisheries in the estuary. In addition, storm sewage overflows from STWs and CSOs are likely to be significant sources of contamination during periods of wet weather.

4. The estuary supports very large numbers of waterbirds (waders and wildfowl) during the winter. Droppings from these birds may be an important source of microbiological contamination during the winter.

5. The estuary is very popular for recreational water sports and there are several large yacht marinas and numerous yacht moorings in the vicinity of the shellfishery. The discharge of sewage from boats may be an important source of contamination during the summer.

6. Analysis of existing microbiological data indicates that levels of contamination of water and shellfish are highest in the upper reaches of Southampton Water. Seasonal variation in levels of contamination of shellfish is not marked, although significant relationships were detected between levels of contamination and antecedent rainfall and river flow.

7. It is recommended that changes are made to both the boundaries of the existing classified harvesting zones and the locations of monitoring points used to classify beds within these zones. Recommended monitoring points for new and existing fisheries are detailed in the sampling plan in Appendix II.

1. INTRODUCTION

Filter-feeding bivalve shellfish can accumulate bacterial and viral pathogens from sewage-contaminated waters. The consumption of raw or insufficiently cooked shellfish harvested from such waters can cause illness and lead to outbreaks of infectious disease (e.g. Norovirus-associated gastroenteritis, Hepatitis A and Salmonellosis). In order to protect public health, under EC Regulation 854/2004[1], shellfish harvesting and relaying areas are classified on the basis of monitoring of levels of faecal indicator organisms (*Escherichia coli* in the EU) in shellfish. This classification determines the level of treatment required (e.g. purification, relaying or cooking) before human consumption, or may prohibit harvesting.

Annex II (Chapter II paragraph 6) of EC Regulation 854/2004, states that 'if the competent authority decides in principle to classify a production or relay area it must:

i) make an inventory of the sources of pollution of human or animal origin likely to be a source of contamination for the production area;

ii) examine the quantities of organic pollutants which are released during the different periods of the year, according to the seasonal variations of both human and animal populations in the catchment area, rainfall readings, waste-water treatment, etc.;

iii) determine the characteristics of the circulation of pollutants by virtue of current patterns, bathymetry and the tidal cycle in the production area; and

iv) establish a sampling programme of bivalve molluscs in the production area which is based on the examination of established data, and with a number of samples, a geographical distribution of the sampling points and a sampling frequency which must ensure that the results of the analysis are as representative as possible for the area considered'.

In England and Wales, these activities are collectively known as a 'sanitary survey' (Cefas, 2007). The Centre for Environment Fisheries and Aquaculture Science (Cefas) is performing sanitary surveys for new bivalve mollusc production areas (BMPAs) in England and Wales on behalf of the Food Standards Agency (FSA). This report documents information arising from a sanitary survey relevant to new and existing BMPAs in Southampton Water, England. The sanitary survey was prompted by applications for classification of the estuary for the harvesting of Manila clams (*Tapes philippinarum*). The estuary contains existing BMPAs for native oysters (*Ostrea edulis*) and hard clams (*Mercenaria mercenaria*).

[1] EC Regulation 854/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific rules for the organization of official controls on products of animal origin intended for human consumption.

2. SITE DESCRIPTION

2.1 General description of the production area

Southampton Water is situated on the south coast of England and connects the estuaries of the Rivers Test and Itchen with the Solent (Figure 2.1). The estuary is approximately 20km long, with a shoreline of 110km and an area of 3,975ha at high water (ABPmer 2008a). For much of its length the estuary has an artificially deepened channel, maintained by dredging at 12.6m below chart datum (LAT)[2]. Depths elsewhere are generally shallow (<10m) although there are naturally deep (>15m) areas in the outer estuary off Fawley. Intertidal areas are extensive, covering an area of approximately 1,376ha at low water springs (ABPmer 2008a). Southampton Water is mesotidal, with a tide range of around 4m on springs and 2m on neaps. Despite significant freshwater inputs, Southampton Water is essentially marine in character, with upper estuary salinities rarely less than 20psu at the surface and 30 to 33psu at mid-depth, and lower estuary salinities typically 30 to 35 psu (Lucas *et al.*, 1997).

The city of Southampton (population approximately 225,000[3]) lies at the head of Southampton Water. Southampton is one of the UK's busiest and most important ports, handling in excess of 42 million tonnes of cargo and over 76,000 commercial vessel movements per year (ABP website). Exxon Mobile operates a major oil refinery at Fawley on the western shore of Southampton Water. The associated marine terminal handles around 2,000 ship movements and 22 million tonnes of crude oil and other products every year. (Exxon Mobil website). BP operates a smaller oil terminal on the opposite shore of the estuary at Hamble-le-Rice. There is also a very high level of recreational vessel activity within Southampton Water.

Southampton Water and the Approaches to Southampton Water are designated shellfish waters under the EC Shellfish Waters Directive (Environment Agency, 2008a; 2008b). In addition, parts of Southampton Water lie within the Solent Maritime Special Area of Conservation and the Solent and Southampton Water Special Protection Area and Ramsar site (JNCC website).

The hydrological catchment of Southampton Water has an area of approximately 1,750km^2. A land cover map for the catchment is shown in Figure 2.2 and a map showing population density in the catchment is shown in Figure 2.3. The main urban developments are located at Southampton and along the north and south shores of the estuary. The majority of the remainder of the catchment has been given over to agriculture.

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[2] ABP propose to undertake a deepening and widening of the navigation channel at various sites in Southampton Water in order to improve vessel accessibility (ABPmer, 2007a).

[3] 2009 small area population forecast, Hampshire County Council (2008)

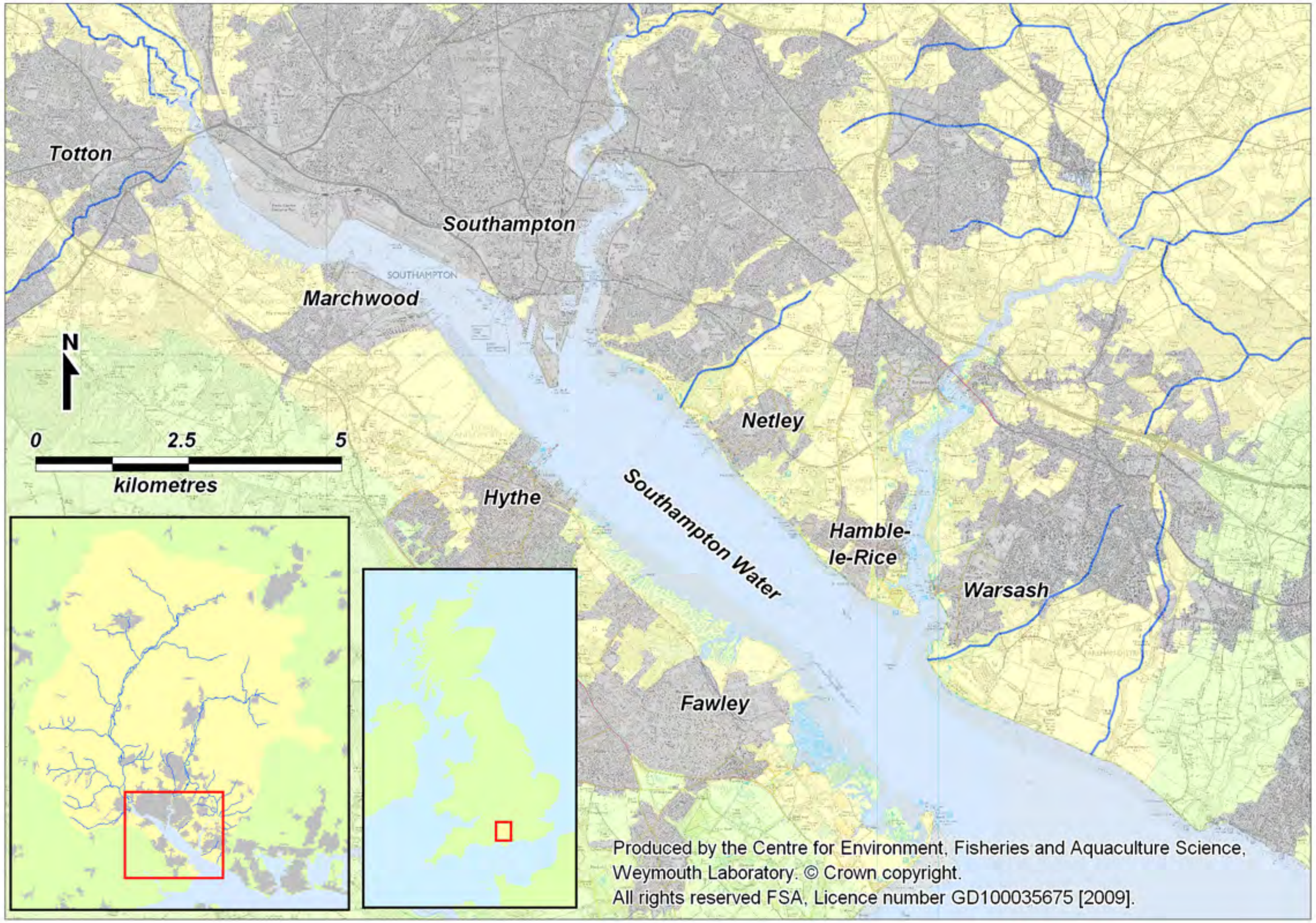


Figure 2.1: *Southampton Water location map*

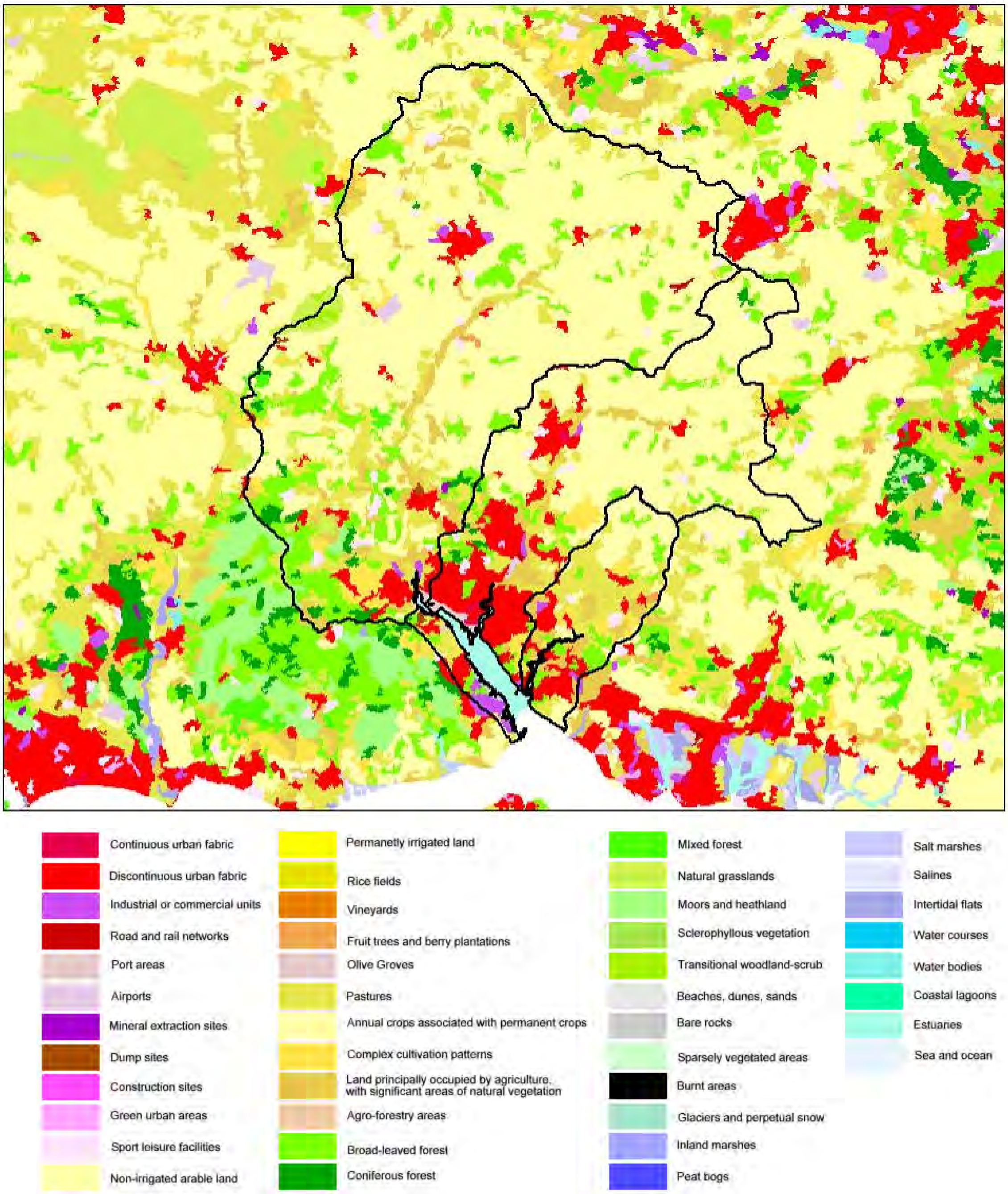


Figure 2.2: *Corine Land Cover (CLC 2000) map of the Southampton Water catchment. © EEA, Copenhagen, 2007, (http://www.eea.europa.eu)*

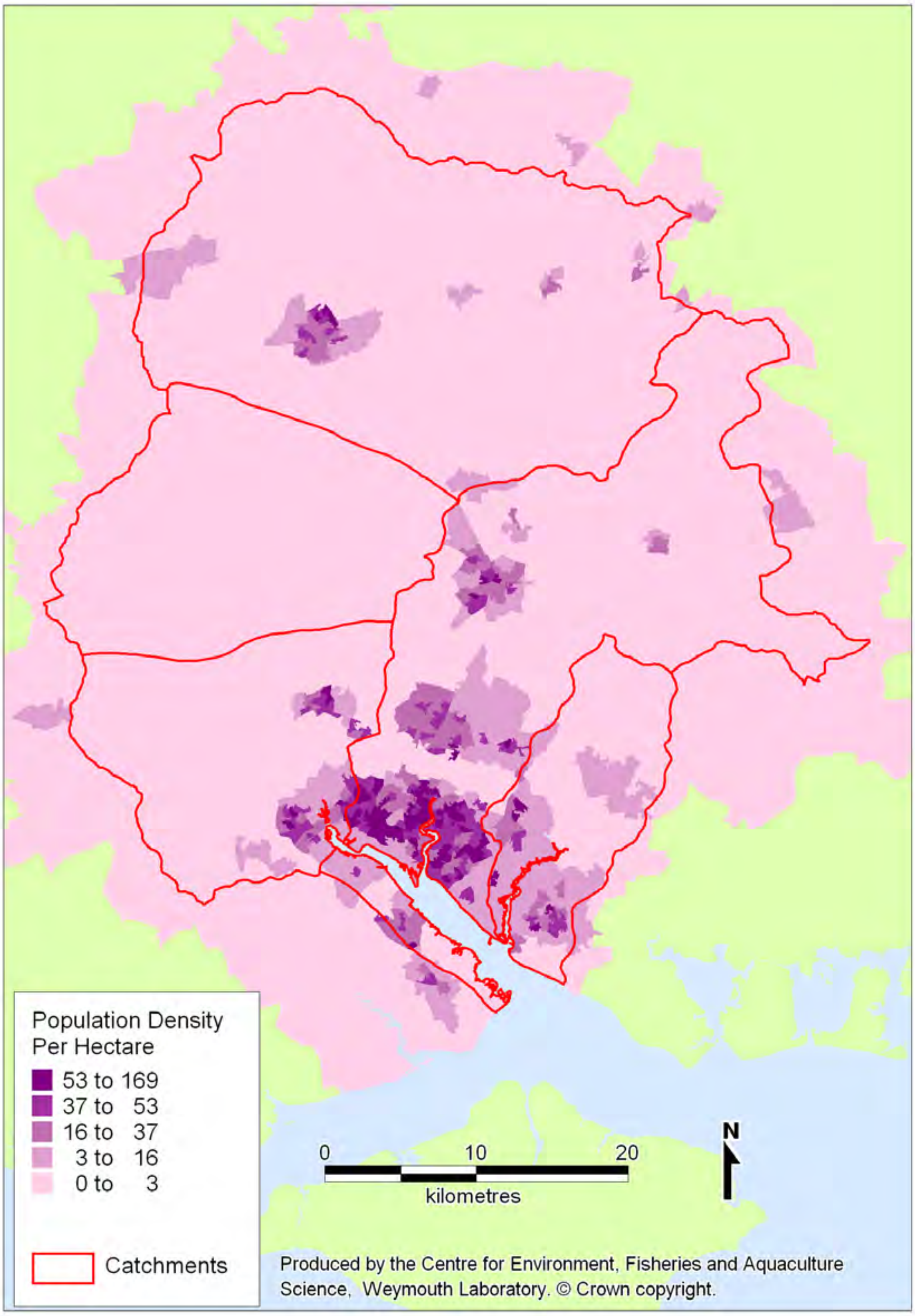


Figure 2.3: *Population density in the Southampton Water catchment (2001 census data from the Office of National Statistics)*

3. SHELLFISHERIES IN SOUTHAMPTON WATER

Southampton Water is currently classified for the production of native oysters (*Ostrea edulis*) and hard shell clams (*Mercenaria mercenaria*). All beds for these species downstream of the Itchen Bridge are currently classified as B long term under EC Regulation 854/2004 (Figure 3.1).

3.1 Native oysters (*Ostrea edulis*)

Native oyster beds are located along the eastern shore of Southampton Water and around the entrance to the River Hamble. The River Hamble Harbour Authority issues licenses for oyster dredging within the mouth of the River Hamble (from the Harbour Limit to Hamble Point Marina). Four boats are currently licensed although no more than two fish at one time (Alison Fowler, River Hamble Harbour Authority, personal communication). The oyster beds between Weston Shelf and Netley are considered to be of poorer quality and are of lower importance for commercial harvesting (ABPmer, 2008b). Native oysters are harvested by dredging, the harvesting season running from 1st November to the last day of February. No information is available on annual production.

3.2 Hard shell clams (*Mercenaria mercenaria*)

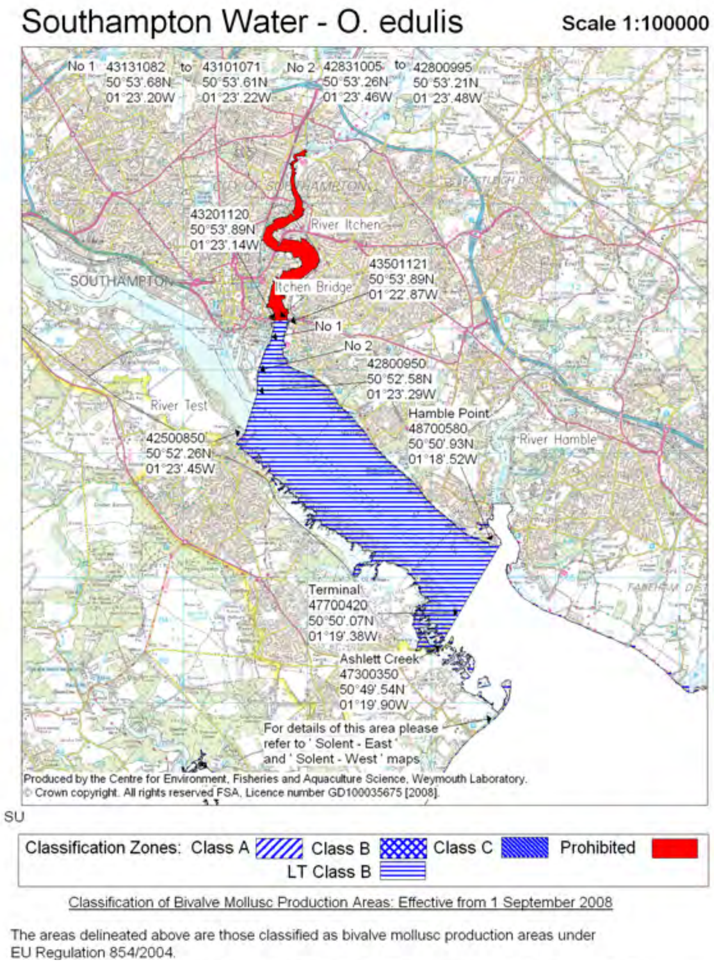
The American hard shell clam (*Mercenaria mercenaria*) became established in Southampton Water in the 1930s, and in the late 1970s and early 1980s the area supported a very productive dredge fishery (Jensen, 2000). A combination of poor recruitment and overfishing has left the stock much reduced and it is now only occasionally exploited (Walmsley and Pawson, 2007). Hard shell clams are patchily distributed in Southampton Water and are mainly found along the western shore (ABPmer, 2008b). There is no close season for clams although Southern Sea Fisheries Committee (SSFC) may temporarily close the beds for stock management purposes.

3.3 Manila clams (*Tapes philippinarum*)

Manila clams (*Tapes philippinarum*) have also become established in Southampton Water and an application for classification has been made in order to bring harvesting of this species under regulatory control. The area for which classification is being sought extends from the Dock Head to the BP Terminal at Hamble-le-Rice (Figure 3.2). The main fishing area is at Deans Lake south of Hythe (Simon Pengelly, SSFC, personal communication). Clams are harvested by dredge and there is currently no close season. The annual production of clams from Southampton Water is not known.

3.4 Cockles (*Cerastoderma edule*)

Cockles (*Cerastoderma edule*) are found within Southampton Water but are not commercially important within the estuary. There are classified cockle beds at Brownwich Reach and Hillhead Haven but these beds are outside of the estuary and are not considered further in this report.



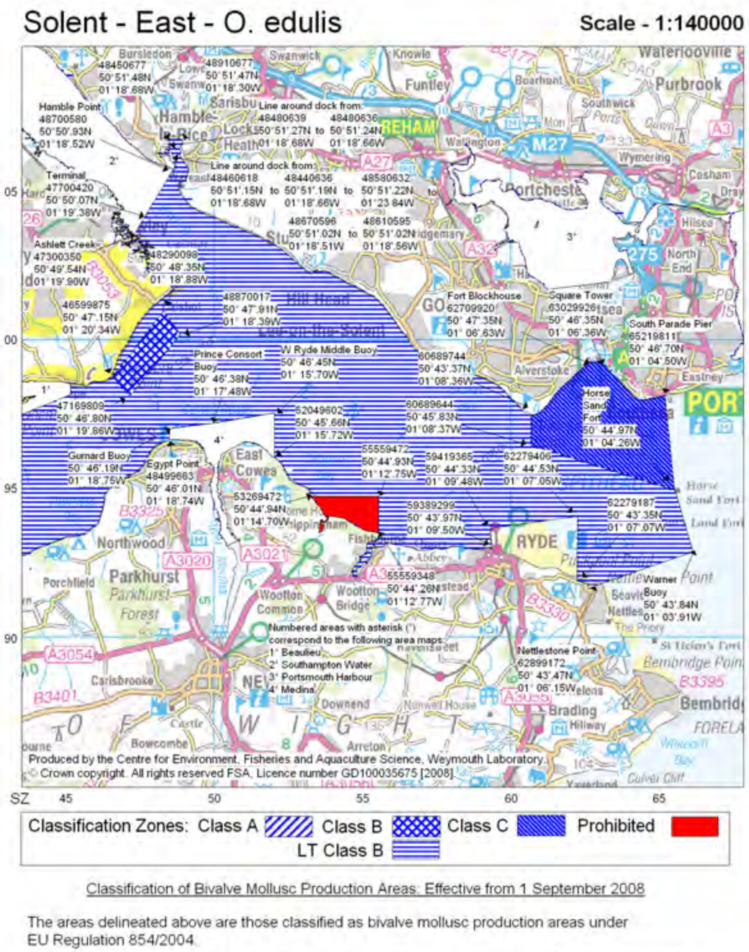


Figure 3.1: *Classification maps for native oysters in Southampton Water and Solent East. Monitoring results for oysters are used to classify the Mercenaria beds and the classification zones for Mercenaria are identical to those shown above*

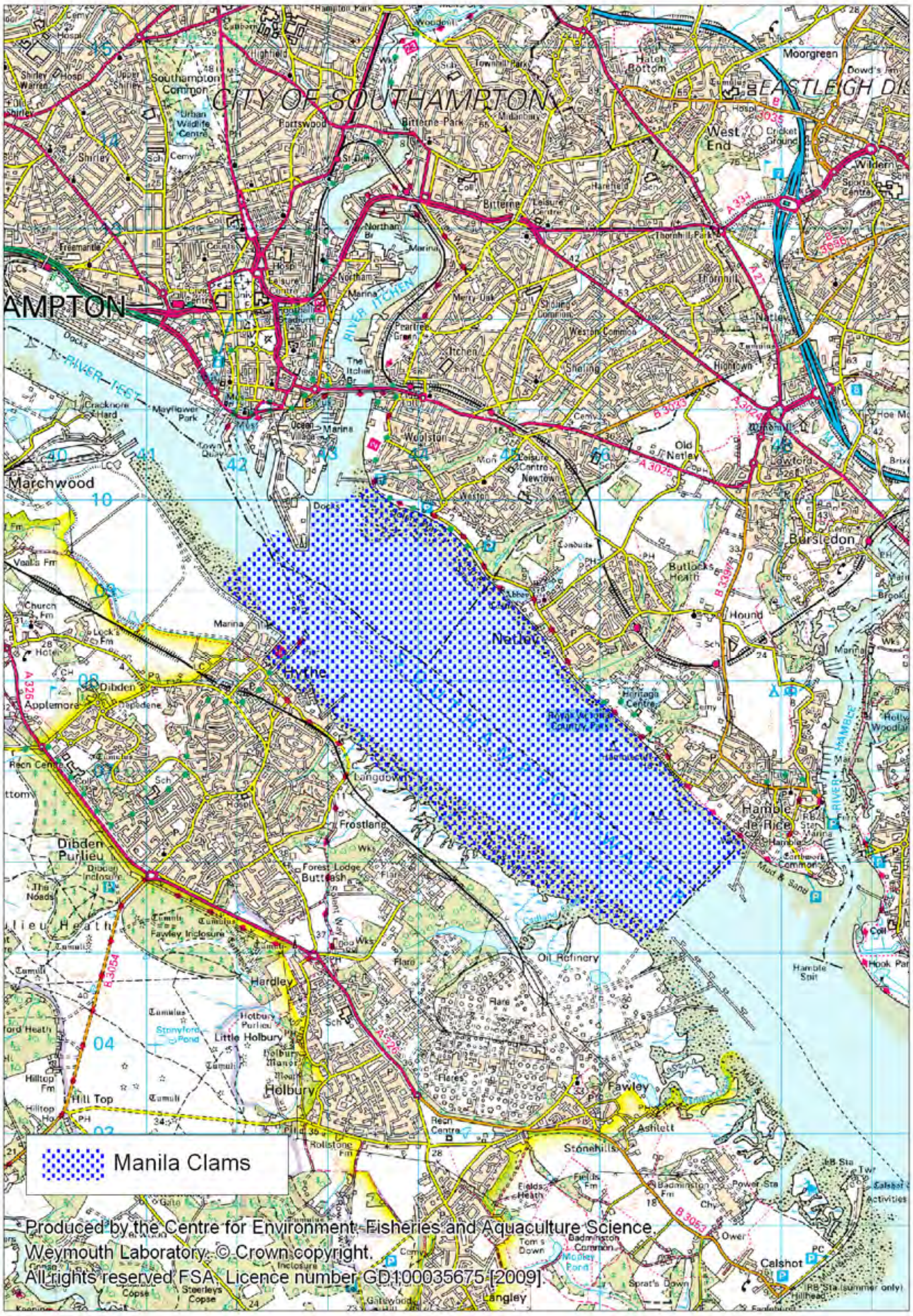


Figure 3.2: *Area of Southampton Water for which classification has been requested for harvesting of Manila clams*

4. SOURCES OF MICROBIOLOGICAL POLLUTION

4.1 Sewage discharges

4.1.1 Water company sewage discharges

Sewage discharges often pose the greatest potential contamination risk to shellfisheries. Sewage treatment facilities in the Southampton area are provided and maintained by Southern Water Services Ltd. The majority of the population in the area is connected to the public sewerage network, and Southern Water operate six sewage treatment works (STWs) that discharge secondary treated sewage effluent to Southampton Water (Table 4.1 and Figure 4.1).

Table 4.1: *Major continuous sewage discharges to Southampton Water*

Name	Treatment level	Dry weather flow (m^3/day)	National Grid Reference of outfall	Population Equivalent*
Woolston STW	Secondary	15,000	SU 4317 1029	62,235
Ashlett Creek STW	Secondary	4,727	SU 4807 0351	14,533
Millbrook STW	Secondary	40,000	SU 3871 1176	132,139
Bursledon STW	Secondary	1,477	SU 4861 0850	6,764
Slowhill Copse STW	Secondary	14,970	SU 3862 1135	76,359
Portswood STW	Secondary	27,700	SU 4358 1493	72,882

*June Return 2008 figures supplied by Southern Water Services Ltd.

Secondary treated sewage effluent typically has an *E. coli* concentration of around 10^6 per 100 ml, and the large continuous discharges from Slowhill Copse and Millbrook STW, which discharge to the tidal reaches of the Test, and Portswood and Woolston STW, which discharge to the tidal reaches of the Itchen, are likely to be the major sources of faecal bacteria to Southampton Water (Lowthian, 2000).

Population equivalent data provided by Southern Water Services Ltd. indicates that the holiday population served by the sewage works listed above is small in comparison with the resident population (holiday population less than 10% of resident population). This suggests that seasonal variation in microbial load from these works is unlikely to be significant. Inspection of flow data provided by Southern Water confirms that there is little seasonal variation in flow, although flows at the four large sewage works serving Southampton do increase markedly in response to rainfall (Figure 4.2).

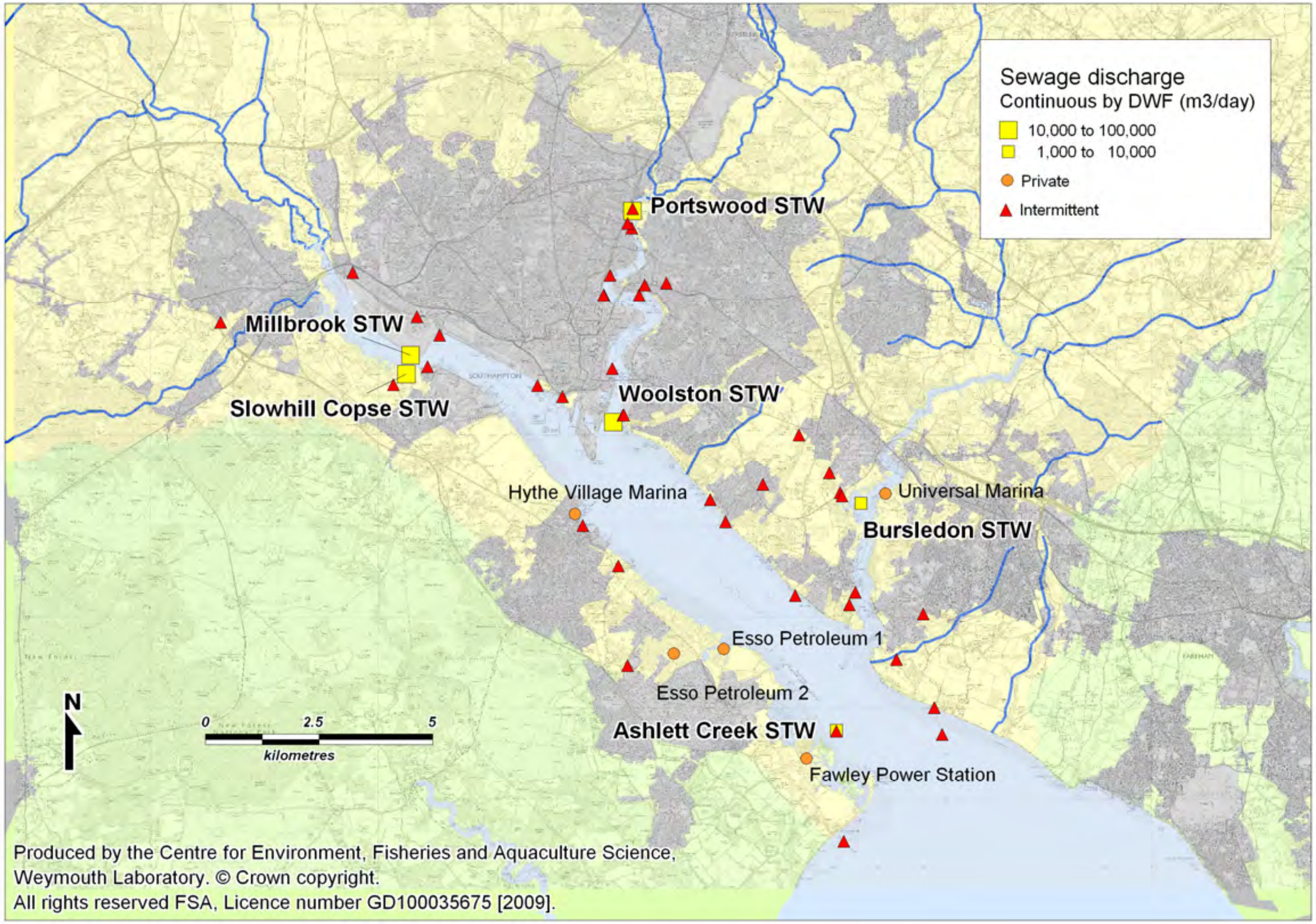


Figure 4.1: *Sewage discharges to Southampton Water*

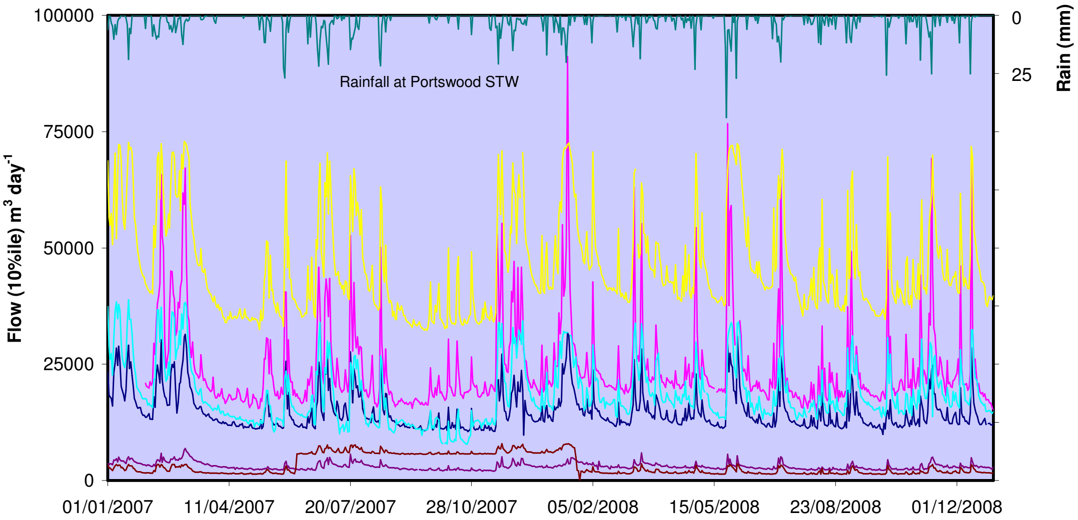


Figure 4.2: *Flows for STWs discharging to Southampton Water, 2007-2008 (STW flow data provided by Southern Water, rainfall data provided by the Environment Agency).*

In addition to the continuous sewage discharges listed above, there are numerous intermittent sewage discharges (storm and emergency overflows) that discharge directly or indirectly to Southampton Water (Table 4.2 and shown on the map in Figure 4.1). Storm overflows are likely to be a significant source of faecal bacteria during periods of wet weather. The storm overflow from Woolston STW discharges directly into the area that is currently classified for the production of clams and native oysters. The overflow is equipped with a spill recording device (event-duration logger), and analysis of the spill data indicates that it discharges frequently.

The overflows on the south shore at Alexandra Road Hythe CSO and Tates Copse Hythe SPS, and on the north shore at Ensign Park Hamble SPS, Victoria Road Netley SPS and Beach Lane Netley SPS, discharge directly to the fishery and are likely to have a significant effect on levels of contamination in the event of a storm or emergency sewage spill. Unfortunately, no information is available on the spill frequency of these discharges.

The locations of storm and emergency overflows in close proximity to the clam fishery in Southampton Water were verified during the shoreline survey (see Appendix I). The storm overflow from Woolston STW was discharging during heavy rain at the time of the survey (see photograph in Appendix I).

Table 4.2: *Intermittent sewage discharges to Southampton Water*

Name	Outfall NGR	Type
Marchwood		
Maritime Avenue Marchwood	SU 39080 11510	Storm
Slowhill Copse STW overflow	SU 38330 11108	Storm
Hythe		
Alexandra Road CSO	SU 42500 08010	Storm
Tates Copse SPS CSO/EO	SU 43280 07125	Storm and Emergency
Netley		
Beach Lane SPS CSO/EO	SU 45060 08350	Storm and Emergency
Ingleside Netley	SU 46460 08920	Storm
Victoria Road SPS CSO	SU 45640 08090	Storm
Fawley		
Ashlett Creek STW overflow	SU 48070 03490	Storm
Cadland Park Hardley	SU 43482 04935	Storm
Calshot		
Calshot Car Park SPS CSO/EO	SU 48241 01060	Storm and Emergency
Southampton		
Blechynden Terrace CSO	SU 41500 11090	Storm
Brunel Road CEO	SU 37440 13580	Storm
Chapel Wharf CEO	SU 43150 11470	Storm and Emergency
Glenfield Avenue CSO	SU 44336 13349	Storm
High Street CSO	SU 42050 10850	Storm
Imperial Rd Mount Pleasant SPS	SU 42960 13080	Storm
Lawn Road CSO	SU 43094 13520	Storm
Liverpool Street CSO	SU 42950 13080	Storm
Macnaghten Road CSO	SU 43860 13310	Storm
Millbrook STW storm/CEO	SU 38854 12607	Storm and Emergency
Park Road CSO	SU 39350 12200	Storm
Portswood STW storm/CEO	SU 43487 14655	Storm and Emergency
Rampart Road Bitterne SPS	SU 43740 13080	Storm and Emergency
Thomas Lewis Way CSO	SU 43590 14980	Storm
Upper Shaftsbury Avenue CSO	SU 43570 14560	Storm
Woolston STW outfall No 2	SU 43380 10440	Storm
Woolston STW outfall No 3	SU 43400 10440	Storm
Bursledon		
Bursledon STW storm	SU 48158 08733	Storm
Hungerford Bottom SPS	SU 47919 09177	Storm
Pound Road SPS	SU 47249 10007	Storm
Salterns Lane SPS	SU 48196 08666	Emergency
Hamble		
Ensign Park Hamble SPS	SU 47167 06483	Storm and Emergency
Hamble Hard CEO	SU 48452 06547	Storm and Emergency
School Lane Hamble SPS	SU 48360 06280	Storm and Emergency
Warsash		
Dibles Road Warsash CSO	SU 49990 06070	Storm
Hook Park CSO/EO LSO	SU 50400 03420	Storm and Emergency
Hook Park CSO/EO SSO	SU 50230 04010	Storm and Emergency
Newtown Road SPS CSO/EO	SU 49400 05068	Storm and Emergency

CEO-combined emergency overflow; CSO-combined sewer overflow; STW-sewage treatment works; SPS-sewage pumping station; SSO-short sea outfall; LSO-long sea outfall

In 2006, the outfall at Ashlett Creek STW was extended into deeper water. This improvement may have contributed somewhat to reducing coliform concentrations in the Shellfish Water (Environment Agency, 2008a). No specific improvements (targeted at Shellfish Waters) to the water company assets listed above have been identified in the AMP5 (PR09) investment round. Southern Water is planning to ultimately transfer flows from Woolston STW to Peel Common, although this work is unlikely to be completed before 2015 (Mike McKeown, Southern Water Services Ltd., personal communication).

4.1.2 Industrial and commercial sewage discharges

Industrial and commercial sewage discharges to Southampton Water are listed in Table 4.3. The sewage discharge from Universal and Hythe Village Yacht Marina are likely to be highly seasonal in nature (see Section 4.4).

The Esso Petroleum refinery at Fawley has an STW on site that discharges effluent via a pipeline to Cadland Creek. Although designed for 3,000 people it currently serves less than half this number. A second newer STW at Newton Copse also serves the site (John Massie, Environment Agency, Personal Communication).

In addition to the discharges listed in Table 4.3, there are sewage facilities that discharge macerated sewage directly into the sea on each of the 12 Fawley marine terminal berths, but these are little used (John Massie, Environment Agency, Personal Communication).

Table 4.3: *Industrial and commercial sewage discharges to Southampton Water*

Name	Treatment level	Dry weather flow (m^3/day)	National Grid Reference of outfall
Hythe Village Marina	Secondary	38	SU 4232 0827
Universal Marina	Secondary	24 (max)	SU 4915 0871
Fawley Refinery 2	Secondary	60[b]	SU 4450 0520
Fawley Refinery 1	Secondary	200[a]	SU 4560 0530
Fawley Power Station	Secondary	114	SU 4741 0289

a Estimated from population served (1000)
b Estimated mean flow

4.1.4 Summary

The shellfisheries at most significant risk of microbiological contamination from sewage discharges are the clam and oyster beds in the upper reaches of the estuary that are closest to the major sewage inputs from Southampton. The effluent discharge from Woolston STW represents the most significant risk due to its proximity to the shellfishery. Background levels of contamination are also likely to be elevated at the mouth of the Hamble Estuary, due to the inputs from Bursledon STW, and in the vicinity of Ashlett Creek STW. During and following rainfall, shellfisheries throughout the production area are at risk of contamination from storm overflows from CSOs and STW storm tanks.

4.2 Freshwater inputs

The main freshwater inputs to Southampton Water are the River Test, River Itchen and River Hamble which have a combined catchment area of over 1,500 km^2. These rivers will receive microbiological pollution from a variety of point and diffuse sources, including STW discharges and urban and agricultural run-off, and are potentially significant sources of microbiological contamination of shellfisheries in the estuary. Summary statistics for flow gauges on these rivers are presented in Table 4.4.

Table 4.4: *Summary flow statistics for rivers draining to Southampton Water*

River	Catchment area (km^2)	Av. Ann. rainfall 1961-90 (mm)	Mean flow (m^3/s)	Q95[1] (m^3/s)	Q10[2] (m^3/s)
Test (Longbridge)	1040.0	790	11.1	4.87	19.0
Itchen (Riverside Park)	415.0	829	5.28	2.70	8.34
Hamble (Frogmill)	56.6	838	0.43	0.10	0.87

[1]Q95 is the flow that is exceeded 95% of the time (i.e. low flow). [2]Q10 is the flow that is exceeded 10% of the time (i.e. high flow). Data from National River Flow Archive website.

Seasonal patterns of river flow in the Rivers Test and Itchen are shown in Figure 4.3. Groundwater from chalk aquifers makes up a significant proportion of the flow in both rivers and consequently they have highly seasonal flow regimes. Flows are typically maximal from January to February and minimal from August to September, although this does not necessarily imply that loads of microbiological contaminants follow a similar pattern. Unfortunately, no data were available on levels of faecal bacteria in the major freshwater inputs, although it is likely that concentrations of faecal bacteria in the rivers will be elevated following heavy rainfall due to urban and agricultural run-off and discharges from storm overflows.

In addition to the major rivers, there are several small streams and surface water discharges that drain to Southampton Water along the east and west shores. Although these streams discharge close to the shellfishery, the results of limited microbiological sampling of these streams during the shoreline survey (see Appendix I) suggest that they are unlikely to be significant sources of microbiological contamination of shellfish.

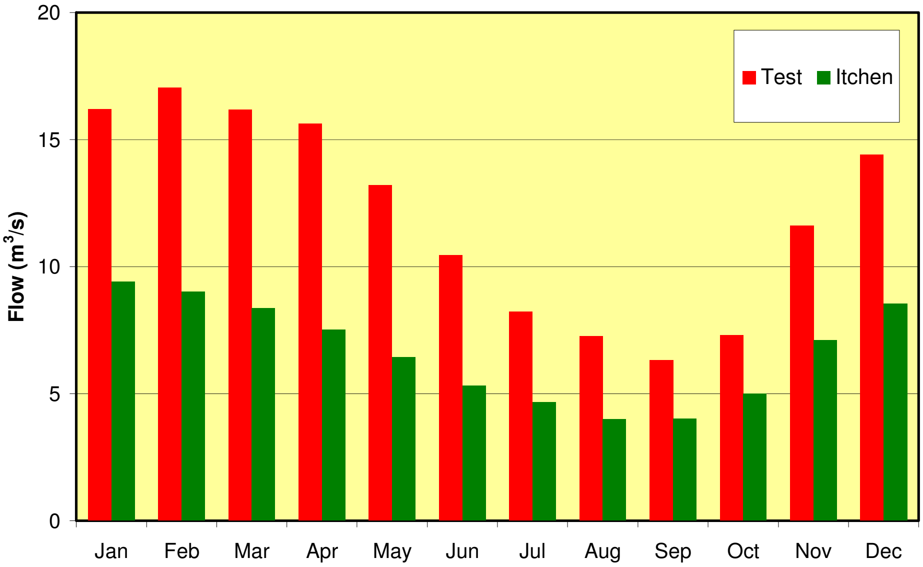


***Figure 4.3:** Mean monthly flow in the River Test at Longbridge and the River Itchen at Riverside Park, 2000-2007 (Data source Environment Agency)*

The shellfisheries at most significant risk of microbiological contamination from the freshwater inputs will be the clam and oyster beds in the upper reaches of the estuary that are closest to the tidal limits of the Rivers Test and Itchen and the oyster beds in the mouth of the River Hamble. The risk of contamination from this source is likely to be greatest following rainfall.

4.3 Livestock

Although livestock do not have direct access to the shoreline, faecal material from livestock may be a source of microbiological contamination of the main freshwater inputs to Southampton Water and may ultimately impact on shellfisheries in the estuary. Details of livestock numbers on agricultural holdings in the sub-catchments are given in Table 4.5. Excluding poultry, sheep are the predominant livestock on agricultural holdings in the Southampton Water catchment. There is some spatial variation in livestock types, with sheep dominant in the Test and Itchen catchments, and cattle dominant in the Hamble and New Forest catchments. No information on seasonal variation in animal numbers is available.

***Table 4.5:** Livestock numbers on agricultural holdings (June 2006 survey, Defra)*

Catchment	Cattle	Pigs	Sheep	Poultry
Test	24 958	32 144	60 312	1 308 559
Itchen	10 486	6 010	14 354	712 446
Hamble	5 148	662	1 831	159 468
New Forest	351	0	#	929
Southampton Water Total	40 943	38 816	76 497	2 181 402

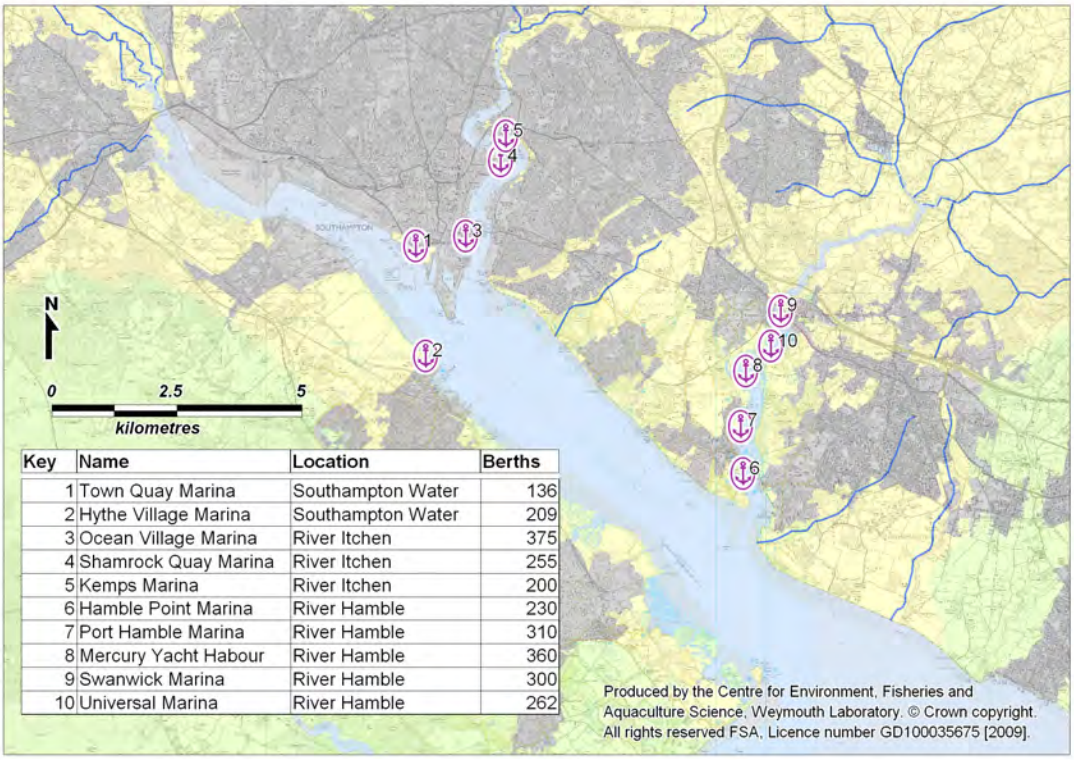
 # - Suppressed by Defra to prevent disclosure of information about individual holdings

Although the significance of agricultural pollution on levels of microbiological contamination of shellfish in Southampton Water is not clear, because any contamination from this source will be delivered to the estuary via the freshwater inputs, the shellfisheries at most significant risk are those impacted by the freshwater inputs as noted above.

4.4 Boats and marinas

Levels of sewage inputs from recreational craft are generally thought to be small compared to direct inputs from sewage treatment works (The Green Blue, 2008). However, given that Southampton Water is exceptionally popular for sailing and other forms of recreational boating, the discharge of sewage from sea toilets or from the holding tanks of recreational craft could be an important source of microbiological contamination. The risk of contamination from this source will vary in response to the seasonal variation in recreational activity. The key sailing period in the area is April to October, with June, July and August being the peak months (Tourism South East, 2004).

The locations of yacht marinas in the Southampton Water area are shown on the map in Figure 4.4. The main concentrations of moored recreational boats are in the River Itchen and River Hamble and shellfisheries close to these areas are likely to be at the most risk of contamination from sewage inputs. It is estimated that there can be between 4,000 to 4,500 boats moored in the Hamble Estuary, almost all of which are recreational craft (Hampshire County Council, 2003). In addition, there are small craft moorings off Hythe and Netley that are occupied during the summer months (i.e. April to October).



Key	Name	Location	Berths
1	Town Quay Marina	Southampton Water	136
2	Hythe Village Marina	Southampton Water	209
3	Ocean Village Marina	River Itchen	375
4	Shamrock Quay Marina	River Itchen	255
5	Kemps Marina	River Itchen	200
6	Hamble Point Marina	River Hamble	230
7	Port Hamble Marina	River Hamble	310
8	Mercury Yacht Habour	River Hamble	360
9	Swanwick Marina	River Hamble	300
10	Universal Marina	River Hamble	262

Figure 4.4: *Yacht marinas in Southampton Water*

Sewage pump-out facilities for boats with holding tanks are provided at Hythe Village and Swanick Marinas. The River Hamble Harbour Authority also provides pump-out facilities in the Hamble River (The Green Blue website).

Hythe Village Marina is adjacent to the proposed new Manila clam harvesting area and Hamble Point Marina and associated mooring pontoons are within that part of the Hamble Estuary that is currently classified for oyster production. Areas within harbours and marinas should not be used for the harvesting of bivalve moulluscs due to the potential of chemical and microbiological contamination (Cefas, 2007).

4.5 Birds

Faecal material from birds can be a significant source of microbiological contamination of coastal waters (Jones, 2005).

Southampton Water supports large numbers of birds during the winter. These birds feed on the intertidal mudflats in the estuary and their droppings may be a significant source of faecal bacteria. The total number of waterbirds (waders and wildfowl) in the estuary over the period 2002/03 to 2006/07 averaged 14,247 (range 11,510 to 16,684) (Wetland Bird Survey (WeBS) core count data from Austin *et al*., 2008). Key species in terms of numbers are brent geese (*Branta bernicla*), teal (*Anas crecca*), wigeon (*Anas penelope*), oystercatcher (*Haemotopus ostralgeus*), lapwing (*Vanellus vanellus*) and dunlin (*Calidris alpina*). The highest numbers of birds were recorded between November and March (ABPmer, 2008b).

The WeBS core count totals given above do not include gulls. Peak counts of 400 black headed gulls (*Larus ridibundus*) and 54 herring gulls (*Larus argentus*) were recorded during bird counts undertaken at three sites in Southampton Water between October 2007 and March 2008 (ABPmer, 2008b). Total numbers of gulls present in the estuary are likely to be much greater.

Information on the distribution of waterbirds in Southampton Water has been summarised by Pollitt *et al*. (2003) and AMPmer (2008). Large numbers of waterbirds are found on the western shore of Southampton Water. The River Itchen and River Hamble estuaries are also important. The highest concentrations of feeding brent geese occur in the mouth of estuary between Titchfield Haven and the confluence with the Hamble. In contrast, the highest concentrations of wigeon and teal are off Eling and Bury Marshes and off Hythe and Fawley. Oystercatchers are widely distributed, with the greatest densities off Fawley and around Dibden Bay. Lapwing are found principally around Eling and Bury Marshes, between Cadland Creek and Fawley and along the lower reaches of the Hamble. Dunlin are widely distributed over much of the estuary. The locations of areas where highest densities of birds have been recorded are shown in the map in Figure 4.6.

The shellfisheries at greatest risk of microbiological contamination from faecal material from birds will be those situated nearest to the feeding areas on the western shore of the estuary and near the mouth of the River Hamble. The risk of contamination from this source is likely to be much higher during the winter due the seasonal variation in bird numbers.

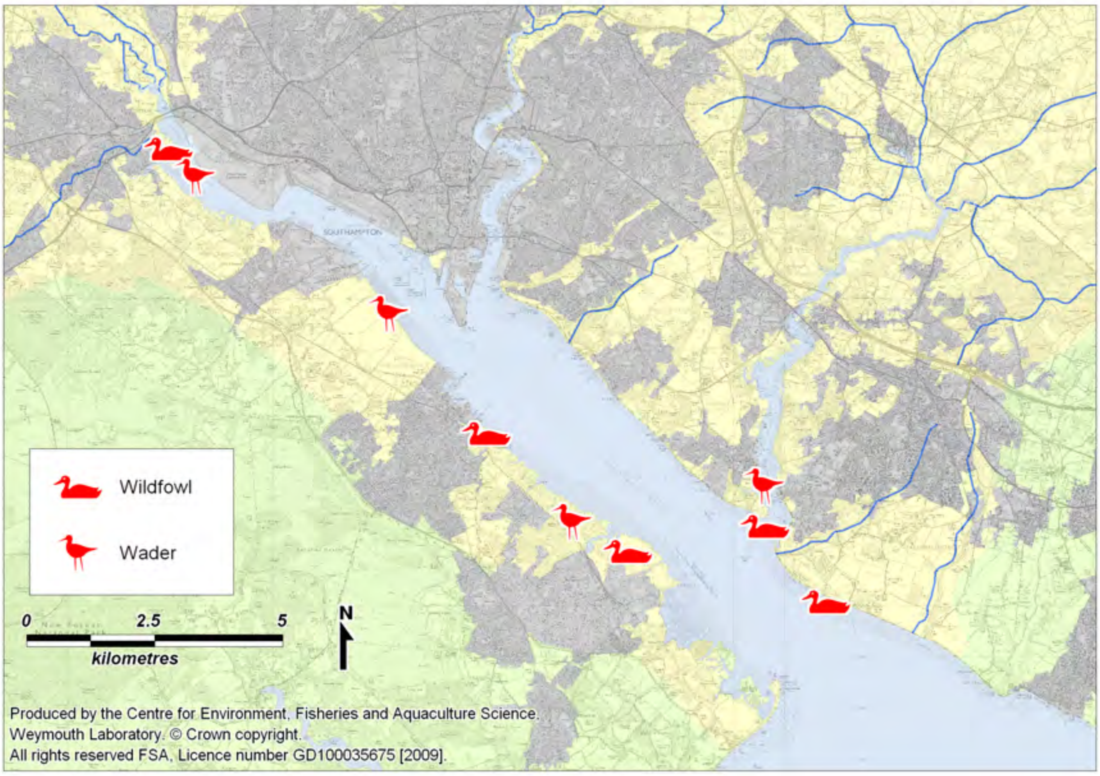


Figure 4.6: *Key feeding areas for birds in Southampton Water*

5. CIRCULATION OF POLLUTANTS IN THE PRODUCTION AREA

5.1 Current patterns

Tidal currents in Southampton Water can be very strong (>1m/s on spring tides) and advection of pollutants by tidal currents is likely to be the main mode of contaminant transport in the estuary. The tidal curve for Southampton Water is asymmetrical, with the ebb phase of the tide lasting for less than four hours, compared to nearly nine hours for the flood (Figure 5.1). This results in faster currents on the ebb tide than on the corresponding flood because the estuary has a shorter time over which to release its water on the ebb tide than it does to fill up on the flood tide (Price and Townend, 2000).

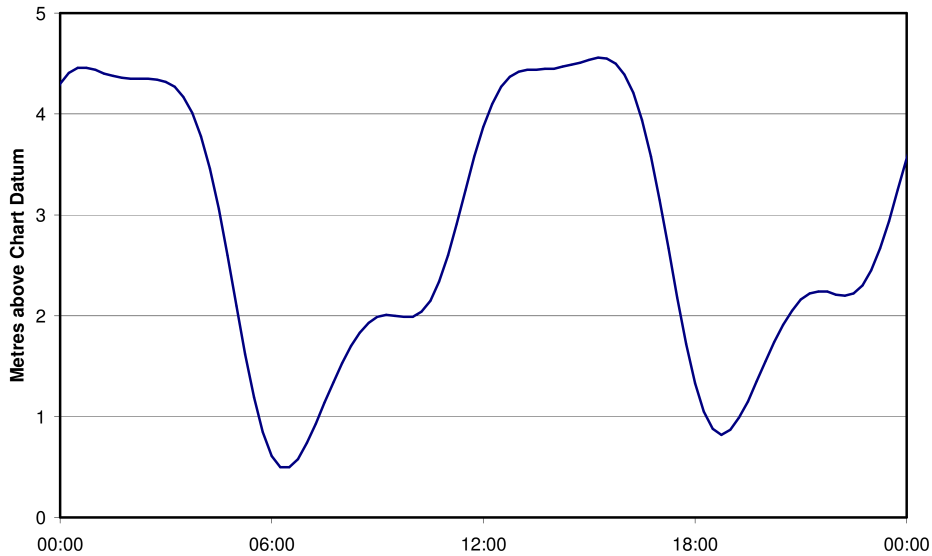


Figure 5.1: *Exemplary tidal curve for Southampton (predictions from POLTIPS)*

The tidal excursion in Southampton Water is typically in the range 5 to 8km (Sharples, 2000), indicating that sources of microbiological contamination within this distance of the shellfish beds have the potential to impact on the fishery within one tidal cycle.

Modelled peak ebb and flood flow vector plots for Southampton Water (ABPmer, 2008b) are shown in Figures 5.2 to 5.4. The plots demonstrate that between the Dock Head and the River Hamble, flows at peak ebb and peak flood are approximately parallel to the shore on both sides of the channel, with the fastest currents occurring through the main navigation channel. There is no evidence of any significant eddies or cross channel currents suggesting that advection of contaminants across the estuary is likely to be very limited.

In the outer estuary, flood flows from the West Solent split around and over Bramble Bank, with flows entering Southampton Water passing through the Thorn Channel (Figure 5.4). This suggests that sources of contamination in the West Solent could impact on shellfisheries in the estuary, although sources of contamination in the East Solent are unlikely to do so. Ebb flows from the estuary tend to pass around the Calshot turn approximately parallel to the channel.

Analysis of wind data undertaken by ABPmer for the Solent Maritime Rescue Co-ordination Centre (MRCC) at Lee on Solent indicates that winds blow most frequently over the south western to westerly quadrants (ABPmer 2008b). Wind speeds in excess of 27 knots are almost exclusively confined to the southwest quadrant, which can be considered to be the prevailing wind direction. Southampton Water is relatively sheltered from the prevailing south westerly winds due to the orientation of the estuary (ABPmer, 2007b) suggesting that wind-generated currents are unlikely to be significant in the transport of pollutants.

5.2 Bathymetry

An extract from Admiralty Chart 2036 (Southampton Water and Approaches) showing the bathymetry of Southampton Water in the vicinity of the Manila clam fishery is shown in Figure 5.5. The oyster and clam beds extend across both inter- and sub-tidal areas of the estuary, and there is the potential for differential exposure of shellfish in these areas to microbiological contamination over the tidal cycle, particularly if contamination is predominantly from upstream (e.g. freshwater) sources.

5.3 Salinity

Salinity provides an indication of the amount of freshwater in the estuary[4] and hence the potential influence of microbiological contamination derived from freshwater sources. A summary of near-surface salinity data for sites monitored by the Environment Agency is presented in Table 5.1. The lowest salinities occur in the upper reaches of the estuary and microbiological contamination from freshwater sources will be highest in this area. An analysis of the relationships between river flow, salinity and levels of microbiological contamination is presented in section 6.3.

Table 5.1: *Near-surface salinity (PSU) at sites in Southampton Water and approaches monitored by the Environment Agency, 2000-2008*

Site	Mean salinity	Range
Test Estuary	27.0	9.9-33.2
Southampton Water (Dock Head)	30.1	18.1-34.2
Approaches to Southampton Water (Off Fawley)	32.0	17.3-34.8
Calshot/Stanswood	33.3	30.8-34.9
Lepe Middle Bank	33.5	30.6-34.8

The estuary is generally well mixed although some stratification with respect to salinity occurs in the upper reaches of the estuary where the freshwater influence is greatest (ABPmer, 2007b). Where stratification does occur, contaminants derived from freshwater sources will tend to be concentrated in the upper layers of the water column.

[4] Fully marine waters have a salinity of approximately 35, and freshwater has a salinity of 0

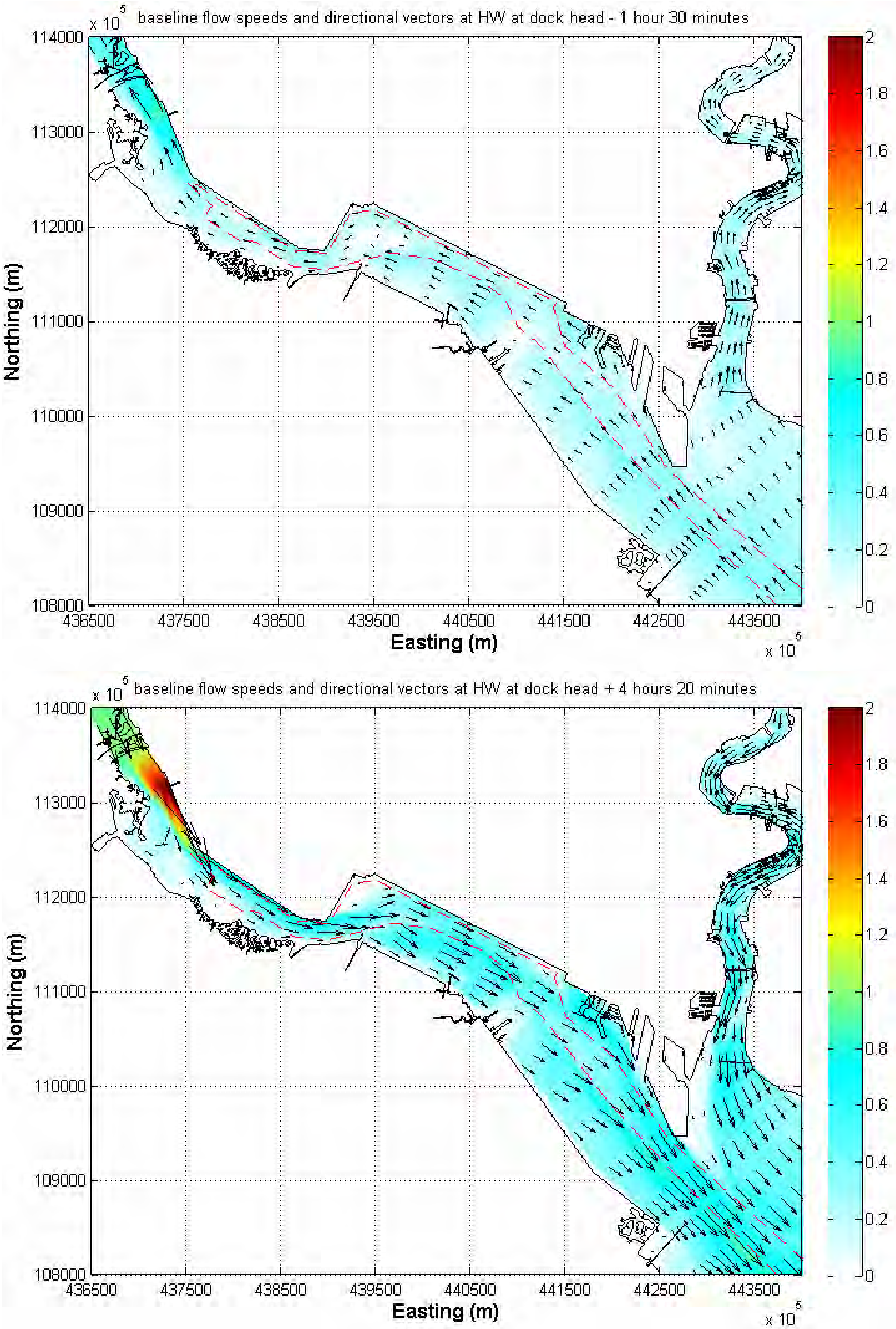


Figure 5.2: *Peak ebb (bottom) and flood (top) flow vector plots for Southampton Water: Container Terminal to Dock Head (ABPmer, 2008b). Reproduced with permission of ABPmer*

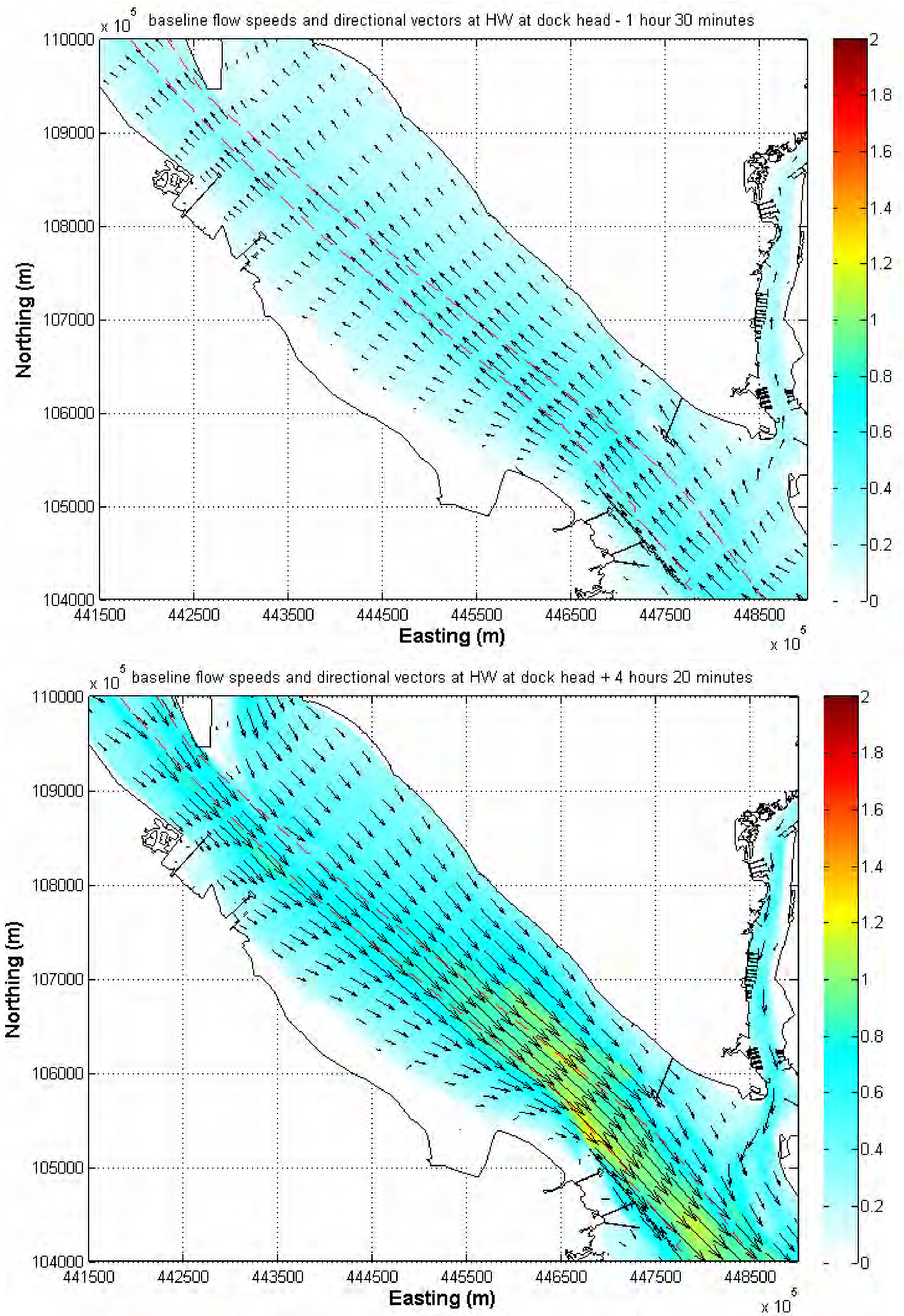


Figure 5.3: *Peak ebb (bottom) and flood (top) flow vector plots for Southampton Water: Dock Head to the entrance to the River Hamble (ABPmer, 2008b). Reproduced with permission of ABPmer*

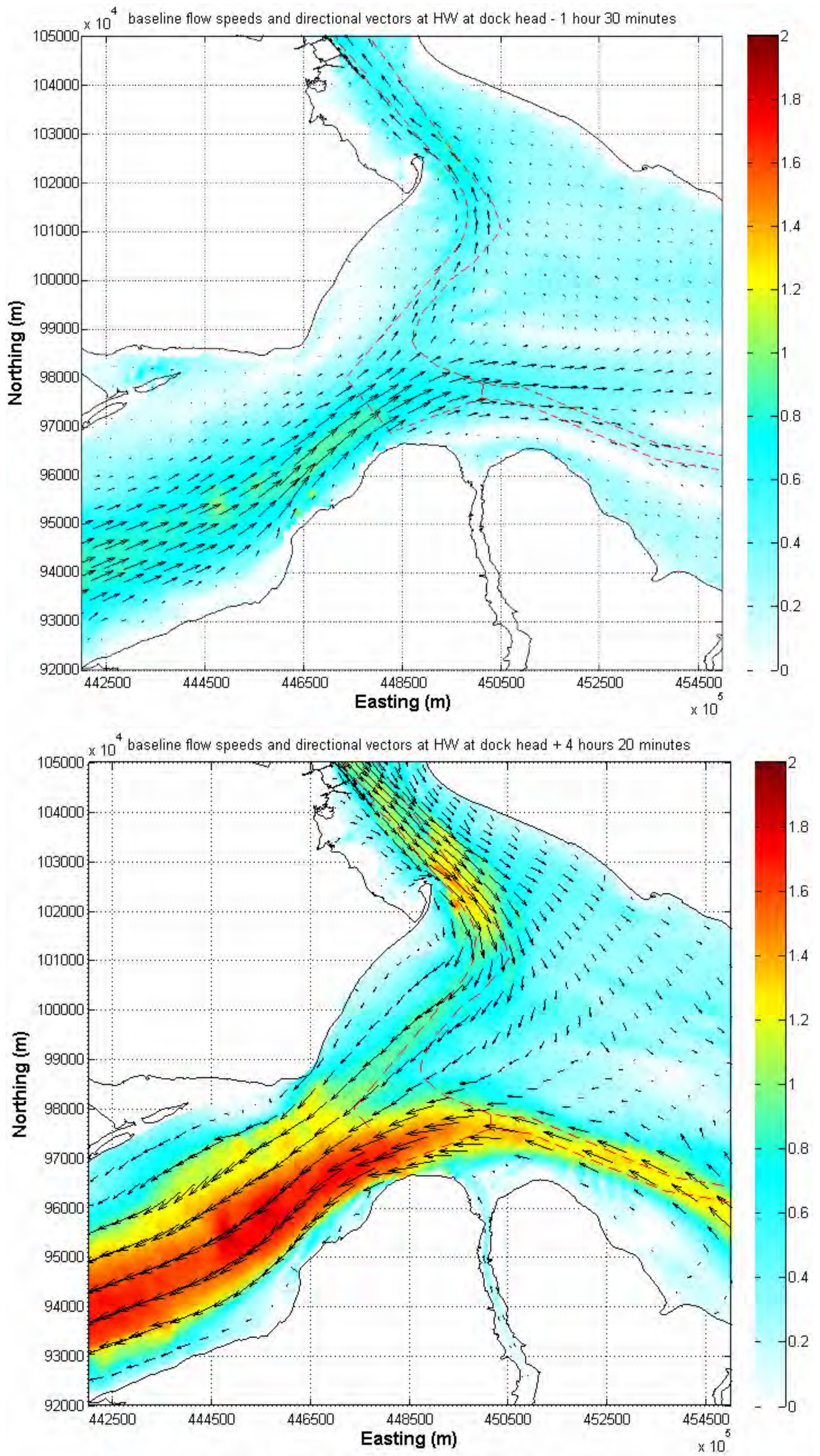


Figure 5.4: *Peak ebb (bottom) and flood (top) flow vector plots for Southampton Water: Outer estuary from Fawley and the central Solent (ABPmer, 2008b). Reproduced with permission of ABPmer*

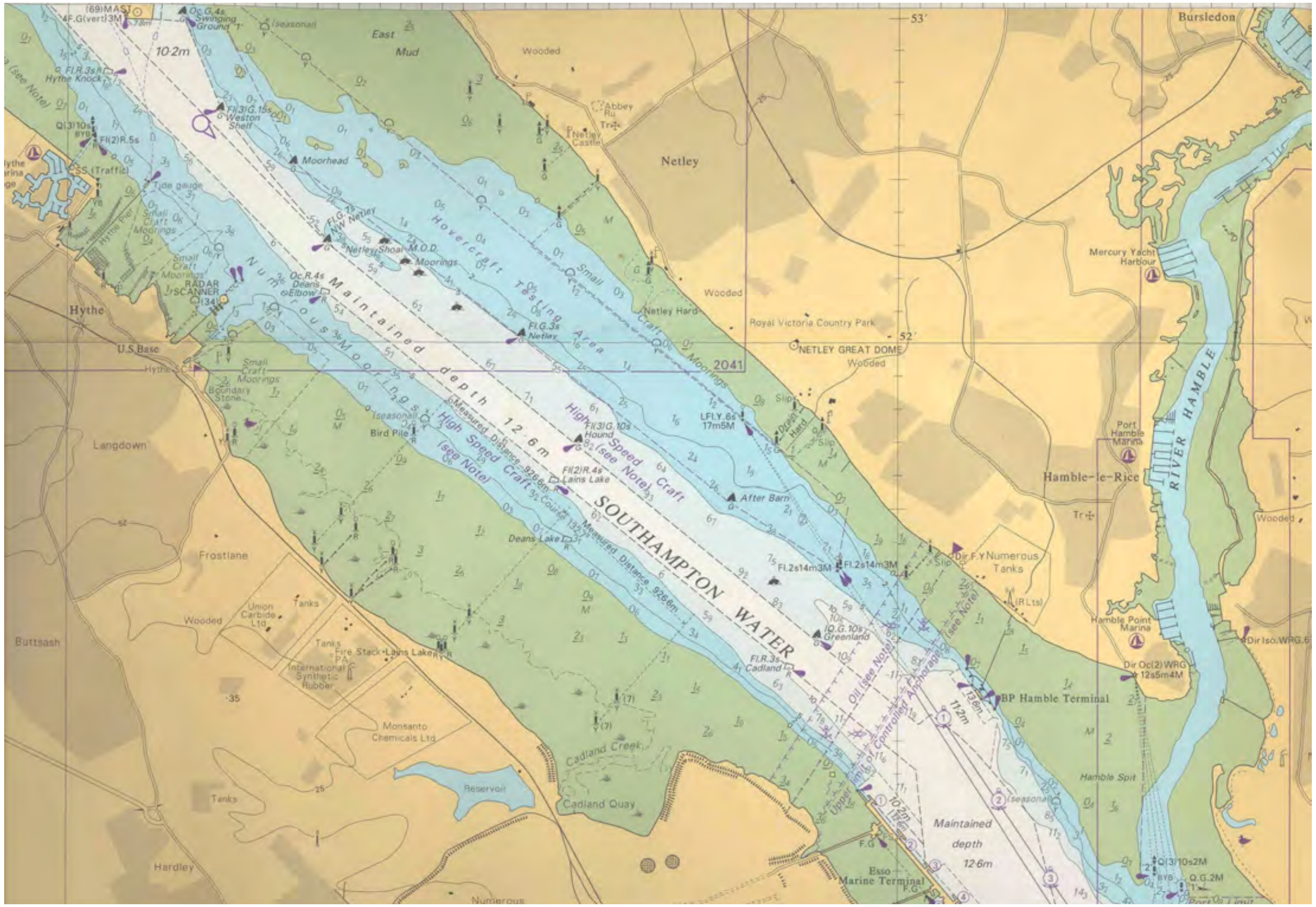


Figure 5.5: *Chart of part of Southampton Water © Crown Copyright and/or database rights. Reproduced by permission of the Controller of Her Majesty's Stationery Office and the UK Hydrographic Office (www.ukho.gov.uk)*

6. ANALYSIS OF EXISTING BACTERIOLOGICAL DATA

6.1 Shellfish hygiene data

Routine bacteriological monitoring of shellfish in the Southampton Water production area is undertaken by Wessex Environmental Microbiology Services (WEMS) on behalf of Southampton Port Health Authority. The results of bacteriological analysis of dredged samples of native oysters (*Ostrea edulis*) collected from Netley, Hamble Estuary and Off Fawley[5] are used to classify both the oyster and *Mercenaria* beds in Southampton Water (The sampling point at Weston Shelf was established recently and is not currently used for classification purposes). The locations of monitoring points are shown in Figure 6.1 below.

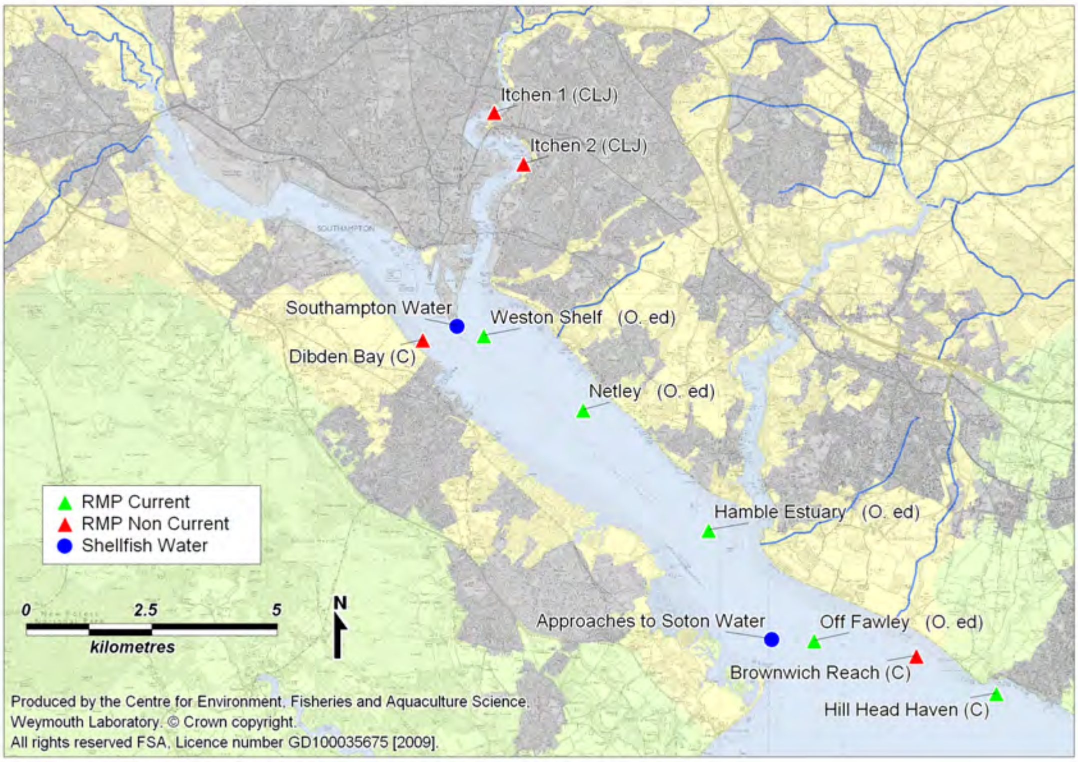


Figure 6.1: *EC Shellfish Waters Directive monitoring sites and shellfish hygiene representative monitoring points (RMPs) in Southampton Water*

A summary of existing bacteriological data for shellfish hygiene monitoring points in Southampton Water for the period 2004 to 2008 is presented in Table 6.1. Average (geometric mean) levels of *E. coli* contamination in oysters decrease in a seaward direction from Netley to Off Fawley. This can be attributed to the fact that the main point sources of contamination (i.e. the major continuous sewage discharges and freshwater inputs from the Test and Itchen) are located at the head of the estuary. Sporadic results above the B/C class limit (>4,600MPN per 100g) have been recorded at the Netley and Hamble Estuary monitoring points (Figure 6.2).

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[5] The RMP Off Fawley (B021H) is outside of the zone that is classified for harvesting of native oysters and *Mercenaria* in Southampton Water.

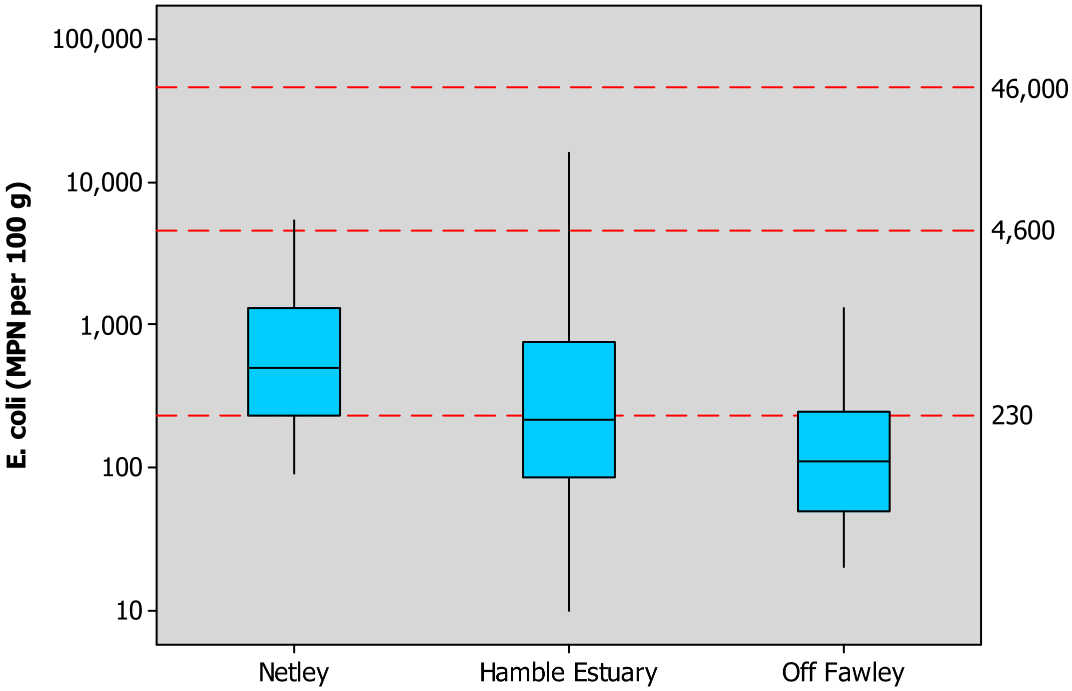

Figure 6.2: *Boxplot of E. coli data for native oysters from hygiene monitoring points in Southampton Water, 2004 to 2008*

Seasonal variation in levels of *E. coli* contamination of oysters from Southampton Water is not particularly marked (Figure 6.3). The highest average (geometric mean) levels of contamination at the Netley and Hamble Estuary monitoring points were recorded in October.

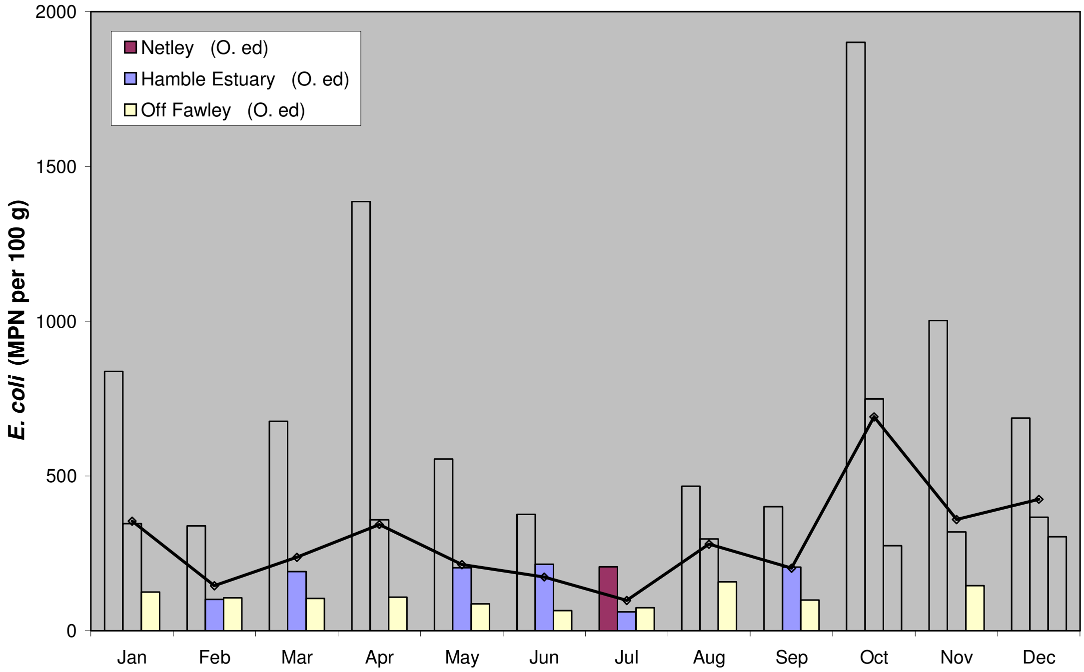

Figure 6.3: *Variation in geometric mean E. coli result by month for native oysters from hygiene monitoring points in Southampton Water, 2004 to 2008. The solid line is the grand (geometric) mean for all three sites combined*

Limited monitoring of Manila clams (*Tapes philippinarum*) at two sites in the River Itchen has revealed high levels of bacteriological contamination, with levels of *E. coli* exceeding 46,000MPN per 100g on occasions at both sites. Consequently, the beds upstream of the Itchen Bridge are prohibited for shellfish harvesting (Figure 3.1). It should be noted that the prohibited area is adjacent to the class B area that is classified for the production of native oysters and that there is currently no routine hygiene monitoring for any species upstream of Netley. A single sample of oysters collected by WEMS from Weston Shelf in 2008 gave an *E. coli* result of 2,200MPN per 100g.

The *E. coli* result for a single sample of Manila clams collected by a dredge between Bird Pile and Deans Lake on 20th November 2008 was 1,700MPN per 100g. (Sample collected from RV Bill Conway operated by Southampton Oceanography Centre, and analysed by WEMS).

6.2 Shellfish Waters data

The Environment Agency routinely monitors levels of faecal coliforms in the water column at two designated EC Shellfish Waters Directive monitoring points in Southampton Water (Figure 6.1). Note that the sampling frequency was monthly prior to 2003, and quarterly from 2003 to 2008.

Faecal coliform data for Southampton Water for the period 2000 to 2008 are summarised in Table 6.2.

Levels of faecal coliforms are broadly equivalent to levels of *E. coli*, the indicator organism used for shellfish hygiene classification purposes (Environment Agency, 2003). Average (geometric mean) levels of contamination are higher at the Shellfish Waters monitoring point off Southampton Port dock head than off Fawley in the approaches to Southampton Water. This confirms the results of the shellfish hygiene monitoring and indicates that shellfish in the upper reaches of Southampton Water are at greater risk of contamination than those in the outer estuary.

6.3 Relationships with rainfall and river flow

Correlation between levels of *E. coli* or faecal coliforms and rain fall or river flow was undertaken in order to determine if there were any statistically significant relationships between levels of bacterial contamination of the shellfisheries in Southampton Water and environmental variables. The *E. coli* data used were for native oysters from the monitoring points at Netley, Hamble Estuary and Off Fawley for the period 2000 to 2008. The faecal coliform data used were water column data from Southampton Water and Approaches to Southampton Water shellfish waters monitoring points for the period 2000 to 2008.

Flow, rainfall and salinity data were obtained from the Environment Agency (EA). The river flow records used were mean daily flows for the EA flow gauging stations on River Test at Longbridge and the River Itchen at Riverside. The rainfall record came from daily totals from the EA storage gauge at Portswood STW. Although the record for this station is unlikely to be representative of rainfall across the entire Southampton Water catchment, it was considered to be representative of conditions in the urban areas of Southampton and that most likely to record rainfall events that could lead to storm sewage overflows. Salinity at shellfish waters monitoring sites was measured *in situ* using a conductivity meter coincident with collection of the faecal coliform sample.

The *E. coli*, faecal coliform and flow data were log-transformed in order to increase normality of the data. Pearson correlation coefficients (r) were calculated for microbiological data paired with mean river flow data or total rainfall data for the preceding 1 to 7 days prior to sampling, and with salinity at the time of sampling (Table 6.3 and 6.4). Note that rainfall totals are for the period starting and ending at 0900 hours, whereas mean river flows are for the period starting and ending at midnight.

E. coli concentrations in oysters at all three sites were significantly positively correlated with both rainfall and river flow in the period prior to sampling. Rainfall accounted for up to 32.5% of the variation in *E. coli* results, the strongest correlation being between *E. coli* levels at Netley and rainfall in the 96 hours prior to sampling. River flow accounted for up to 16.0% of the variation in *E. coli* results, in this case the strongest correlation was between *E. coli* results at Hamble Estuary and mean flow in the River Itchen on the second day prior to sampling.

Faecal coliform concentrations in the water column were significantly positively correlated with both rainfall and river flow. Rainfall accounted for up to 36.2% of the variation in faecal coliform results, the strongest correlation being between faecal coliform concentrations at Approaches to Southampton Water and total rainfall in the 7 days prior to sampling. River flow accounted for up to 33.8% of the variation in faecal coliform results, with the strongest correlation being between faecal coliform concentrations at Southampton Water and mean flow in the River Itchen over the two days prior to sampling.

Faecal coliform concentrations in the water column were negatively correlated with salinity at the time of sampling at both sites.

The above results suggest that rainfall, and to a lesser extent river flow, have an influence on levels of bacterial contamination throughout the shellfishery. This can be attributed to increased inputs from storm discharges and contaminated urban or agricultural run off in the catchment following rain. Although the Test and Itchen are predominantly groundwater fed, both rivers respond to rainfall in their lower reaches. It should be noted that rainfall, river flow and salinity are not independent of each other and that correlation does not necessarily indicate a causative relationship.

Table 6.1: *Summary of E. coli data (MPN per 100g) for shellfish hygiene monitoring points in Southampton Water, 2004 to 2008*

Bed ID	Name	Species	Number of samples	Geometric mean	Minimum	Maximum	Compliance with 4,600 *E. coli* /100g (%)	Monitoring point in use
B021T	Bramble	Native oysters	4	49	<20	330	100.0	Yes
B021N	Brownwich Reach	Cockles	3	120	20	1,100	100.0	No
B021P	Dibden Bay	Cockles	26	2,600	220	22,000	69.2	No
B021L	Hamble Estuary	Native oysters	58	240	<20	16,000	98.3	Yes
B021M	Hill Head Haven	Cockles	41	1,200	90	22,000	80.5	Yes
B021Q	Itchen 1	Manila clams	5	15,000	3,500	91,000	20.0	No
B021R	Itchen 2	Manila clams	3	30,000	5,400	>180,000	0.0	No
B021O	Lee on Solent	Cockles	5	440	160	1,400	100.0	No
B021D	Netley	Native oysters	55	610	90	5,400	92.7	Yes
B021H	Off Fawley	Native oysters	57	120	20	1300	100.0	Yes
B021S	Weston Shelf	Native oysters	1	2,200	2,200	2,200	100.0	No

Table 6.2: *Summary of faecal coliform data (number per 100ml) from EC Shellfish Waters Directive monitoring points in Southampton Water, 2000 to 2008 (Data supplied by the Environment Agency)*

Shellfish Water	Number of results	Number of results below limit of detection*	Geometric mean	Minimum	Maximum
Approaches to Southampton Water	58	24	34	<2	4,860
Southampton Water	54	4	159	<2	3,330

* From 2000 to 2004 the limit of detection was 10 per 100ml. From 2004 to 2008 the limit of detection was 2 per 100ml

Table: 6.3: *Pearson's correlation coefficients (r) for E. coli shellfish hygiene data and rainfall/river flow*

		Portswood STW Total rainfall (mm)												
Site	n	24 hr	48 hr	72 hr	96 hr	120 hr	144 hr	7 day	-2 days	-3 days	-4 days	-5 days	-6 days	-7 days
Netley	88	**0.443**	**0.383**	**0.492**	**0.570**	**0.569**	**0.510**	**0.480**	**0.434**	**0.383**	0.195	0.161	0.044	-0.122
Hamble Estuary	93	**0.291**	0.232	**0.284**	**0.362**	**0.392**	**0.375**	**0.396**	0.216	**0.320**	0.265	0.162	0.234	-0.029
Off Fawley	91	0.265	0.197	**0.295**	**0.451**	**0.472**	**0.361**	**0.348**	**0.338**	**0.419**	0.267	-0.088	0.055	0.129

		River Test at Longbridge mean flow (m^3 day^{-1})												
Site	n	24 hr	48 hr	72 hr	96 hr	120 hr	144 hr	7 day	-2 days	-3 days	-4 days	-5 days	-6 days	-7 days
Netley	80	0.201	0.198	0.189	0.180	0.170	0.161	N/A	0.170	0.150	0.129	0.108	0.111	N/A
Hamble Estuary	84	0.252	0.237	0.236	0.226	0.218	0.212	N/A	0.234	0.187	0.183	0.177	0.187	N/A
Off Fawley	82	0.216	0.213	0.209	0.204	0.197	0.189	N/A	0.199	0.183	0.163	0.147	0.133	N/A

		River Itchen at Riverside mean flow (m^3 day^{-1})												
Site	n	24 hr	48 hr	72 hr	96 hr	120 hr	144 hr	7 day	-2 days	-3 days	-4 days	-5 days	-6 days	-7 days
Netley	83	0.267	0.250	0.254	0.247	0.229	0.209	N/A	0.253	0.213	0.145	0.127	0.108	N/A
Hamble Estuary	85	**0.389**	**0.368**	**0.382**	**0.371**	**0.365**	**0.361**	N/A	**0.400**	**0.321**	**0.326**	**0.309**	**0.302**	N/A
Off Fawley	84	0.261	0.242	0.258	0.263	0.249	0.240	N/A	0.280	0.266	0.181	0.163	0.143	N/A

N.B. Underlined values are significant at <0.05 level. Values in **bold** are significant at <0.01 level. n = number of samples.

Table: 6.4: *Pearson's correlation coefficients (r) for faecal coliform shellfish waters data and environmental variables*

		Portswood STW Total rainfall (mm)												
Site	n	24 hr	48 hr	72 hr	96 hr	120 hr	144 hr	7 day	-2 days	-3 days	-4 days	-5 days	-6 days	-7 days
Soton Water	53	0.312	0.314	0.301	0.287	0.309	0.359	**0.368**	0.185	0.034	0.278	**0.369**	0.161	0.112
App. to Soton Water	53	**0.410**	**0.372**	**0.526**	**0.546**	**0.537**	**0.572**	**0.602**	**0.484**	0.341	0.176	**0.367**	0.315	0.080

		River Test at Longbridge mean flow (m^3 day^{-1})												
Site	n	24 hr	48 hr	72 hr	96 hr	120 hr	144 hr	7 day	-2 days	-3 days	-4 days	-5 days	-6 days	-7 days
Soton Water	51	**0.496**	**0.498**	**0.497**	**0.488**	**0.481**	**0.473**	N/A	**0.488**	**0.457**	**0.450**	**0.418**	**0.408**	N/A
App. to Soton Water	53	**0.383**	**0.388**	**0.386**	**0.368**	0.355	0.345	N/A	**0.379**	0.301	0.290	0.271	0.256	N/A

		River Itchen at Riverside mean flow (m^3 day^{-1})												
Site	n	24 hr	48 hr	72 hr	96 hr	120 hr	144 hr	7 day	-2 days	-3 days	-4 days	-5 days	-6 days	-7 days
Soton Water	50	**0.575**	**0.582**	**0.571**	**0.564**	**0.558**	**0.552**	N/A	**0.529**	**0.520**	**0.514**	**0.500**	**0.4880**	N/A
App. to Soton Water	53	**0.561**	**0.549**	**0.561**	**0.543**	**0.525**	**0.511**	N/A	**0.559**	**0.451**	**0.406**	**0.409**	**0.3746**	N/A

		Salinity
Site	n	-
Soton Water	53	**-0.539**
App. to Soton Water	56	**-0.555**

N.B. Underlined values are significant at <0.05 level. Values in **bold** are significant. n = number of samples.

7. OVERALL ASSESSMENT

The main sources of microbiological contamination of the Southampton Water production area are shown in Figure 7.1.

The most significant continuous sources of microbiological contamination are the sewage effluents from Slowhill Copse, Portswood, Woolston, Millbrook STWs. These sources, and the large freshwater inputs from the River Test and Itchen, are located at the head of the estuary, and background levels of contamination are likely to be highest on the north-western limit of the clam and oyster fisheries, particularly near to Woolston STW. Analysis of microbiological data has confirmed that average (geometric mean) levels of contamination in water and shellfish are highest in the upper reaches of the estuary. Monitoring points for classification purposes should therefore be located in the upper reaches of the estuary on both the east and west sides of the navigation channel.

Levels of microbiological contamination are also likely to be elevated at the mouth of the Hamble Estuary, due to the sewage inputs from Bursledon STW (and potentially from moored boats) and the freshwater input from the River Hamble, and in the vicinity of Ashlett Creek STW. Monitoring points should therefore also be located in these areas.

Numerous intermittent sewage discharges (storm and emergency overflows) are located within a tidal excursion (5 to 8km) of the oyster and clam fisheries in Southampton Water, The overflows from Woolston STW, Alexandra Road CSO, Beach Lane SPS, Victoria Road SPS, Tates Copse SPS and Ensign Park SPS are in close proximity to the shellfishery. These discharges represent a significant contamination risk to shellfisheries in the estuary in the event of a storm or emergency spill, and are particularly important in this context given that classification status is dependent on peak rather than average levels of contamination. The precise impact of storm and emergency spills on shellfisheries in the estuary is difficult to predict and will depend on the location of the discharge and the state of tide at the time of the spill. However, it can be concluded from an examination of the current patterns in the estuary that the impact of storm or emergency sewage spills is likely to be restricted to the shore of the estuary on which the spill occurred. The east and west shores of the estuary can therefore be considered to be hydrologically distinct zones separated by the navigation channel.

Due to the size of the Southampton Water production area and the number of potential sources of contamination it is recommended that the production area is split into four zones for classification purposes. Each of these zones should have associated monitoring points (See section 8).

There is little seasonal variation in the population served by the sewage works that discharge to Southampton Water indicating that seasonal variation in levels of contamination from this source is unlikely to be significant. In contrast, faecal inputs from birds and sewage inputs from boats are likely to be much more seasonal in nature. Faecal inputs from birds are likely to be highest during the winter months, whereas sewage inputs from boats are likely to be highest during the summer. Despite this, no marked seasonal variation in levels of contamination of shellfish from the production area was observed.

Rainfall-related sources of microbiological contamination, including discharges from storm overflows and urban and/or agricultural run off, are likely to be important sources of contamination in Southampton Water, and statistically significant relationships between antecedent rainfall and *E. coli* levels in oysters from the estuary were detected.

Although no microbiological data were available on levels of faecal bacteria in the River Test and Itchen, analysis of existing data indicates that levels of faecal bacteria in the water column tend to be elevated during periods of high river flow and low salinity, demonstrating the importance of contaminants derived from freshwater sources. Levels of faecal bacteria in rivers and streams are often elevated during wet weather due to urban and/or agricultural run off, although sampling undertaken during wet weather indicated that *E. coli* levels in several of the small streams that drain to the eastern shore of Southampton Water were low indicating that they are unlikely to be major sources of contamination.

It is beyond the scope of this report to consider chemical contamination. However, given the proximity of the shellfisheries in Southampton Water to the chemical industrial complex and oil refinery at Fawley, this issue may warrant further investigation.

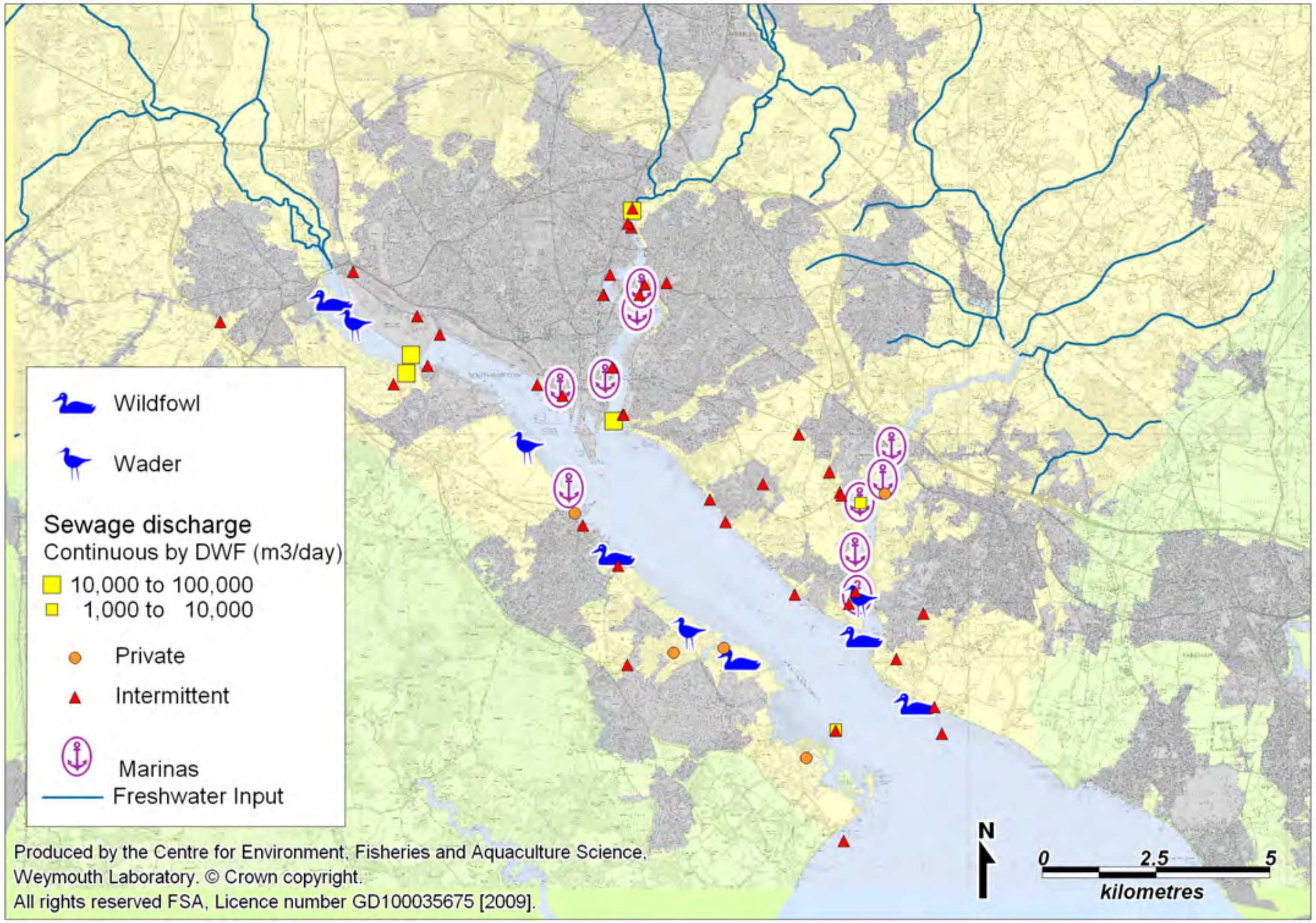

Figure 7.1: *Sources of microbiological contamination of the Southampton Water production area*

8. RECOMMENDATIONS

Recommended sampling points and classification zones for the Southampton Water production area are shown in sampling plan in Appendix II. Specific recommendations are:

1. The seaward limit of the Southampton Water production area should be moved to the lower limit of controlled anchorage (a line between Calshot and Hook) in order to encompass the beds in the outer estuary.

2. The upper limit of the production area on the River Itchen should be moved to Woolston Jetty. This would provide a buffer zone between the classified area and the prohibited zone above Itchen Bridge.

3. The upper limit of the production area on the River Hamble should be moved to Warsash Jetty due to the risk of contamination from marinas and moorings in the Hamble River.[6]

4. The production area should be split into four hydrologically distinct zones for classification purposes (Southampton Water eastern beds, Southampton Water western beds, Hamble Estuary and Off Fawley) in order to reflect the different potential sources of contamination impacting each zone. Each of these zones should have associated monitoring points for clams and/or oysters.

5. A new monitoring point for native oysters should be established at Weston Shelf. This monitoring point is closer to Woolston STW and the freshwater inputs from the River Itchen than the existing monitoring point at Netley. This monitoring point would be used to classify the oyster beds in the eastern beds. Monitoring at Netley could be discontinued after a period of parallel monitoring.

6. Two monitoring points should be established for Manila clams in each of the eastern and western zones (See sampling plan in Appendix II). After a period of parallel monitoring, the monitoring points in each zone showing the highest level of contamination should be used to classify the zone. Monitoring at the other points could be discontinued[7].

7. The monitoring point at Hamble Estuary should be moved into the estuary mouth. This would be more representative of levels of contamination in the vicinity of the marinas and moorings (and wintering bird populations) within the Hamble River. This point would be used to classify the oyster beds in the Hamble estuary.

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[6] Oyster dredging traditionally occurs above this mark. If classification of the River Hamble upstream of Warsash Jetty is required, it is recommended that a monitoring point is located at the upstream end of the B pontoon at Hamble Point Marina.

[7] If initial monitoring indicates that the beds have a different class (e.g. B and C), further revision of the classification zone boundaries will be required.

8. The monitoring point at Off Fawley should be moved to a point off the western shore closer to the discharges from Ashlett Creek STW and Fawley Power Station. This point would be used to classify the oyster beds off Fawley.

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ABBREVIATIONS

ABP	Associated British Ports
ABPmer	Associated British Ports Marine Environmental Research
BMPA	Bivalve Mollusc Production Area
BST	British Summer Time
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CEO	Combined emergency overflow
CFU	Colony forming units
CSO	Combined Sewer Overflow
Defra	Department for Environment, Food and Rural Affairs
DWF	Dry Weather Flow
EA	Environment Agency
E. coli	*Escherichia coli*
EC	European Community
EU	European Union
FSA	Food Standards Agency
g	gram
GMT	Greenwich Mean Time
HW	High Water
ha	Hecatre
km	Kilometre
LAT	Lowest Astronomical Tide
LSO	Long sea outfall
LW	Low water
MDF	Mean daily flow
m	Metre
m^3/day	Cubic metres per day
m^3/s	Cubic metres per second
m/s	Metres per second
ml	Millilitres
MHWN	Mean high water neap
MHWS	Mean high water spring
MLWN	Mean low water neap
MLWS	Mean low water spring
MPN	Most probable number
NGR	National Grid Reference
OS	Ordnance Survey
p.e.	Population Equivalent
psu	Practical salinity units
Q_{10}	10 percentile flow
Q_{95}	95 percentile flow
RMP	Representative Monitoring Point
SPS	Sewage pumping station
SSFC	Southern Sea Fisheries Committee
SSO	Short sea outfall
STW	Sewage treatment works
UKHO	United Kingdom Hydrographic Office
WEMS	Wessex Environmental Microbiology Service

GLOSSARY

Bivalve mollusc	Any marine or freshwater mollusc of the class Pelecypoda (formerly Bivalvia or Lamellibranchia), having a laterally compressed body, a shell consisting of two hinged valves, and gills for respiration. The group includes clams, cockles, oysters and mussels.
Classification of bivalve mollusc production or relay areas	A system for grading harvesting areas based on levels of bacterial indicator organisms (usually E. coli or faecal coliforms) in shellfish (in European Union).
Coliform	Gram negative, facultatively anaerobic rod-shaped bacteria which ferment lactose to produce acid and gas at 37℃. Members of this group normally inhabit the intestine of warm-blooded animals but may also be found in the environment (e.g. on plant material and soil).
Combined Sewer Overflow	A system for allowing the discharge of sewage (usually dilute crude) from a sewer system following heavy rainfall. This diverts high flows away from the sewers or treatment works further down the sewerage system.
Discharge	Flow of effluent into the environment.
Dry Weather Flow (DWF)	The average daily flow to the treatment works during seven consecutive days without rain following seven days during which rainfall did not exceed 0.25 mm on any one day (excludes public or local holidays). With a significant industrial input the dry weather flow is based on the flows during five working days if production is limited to that period.
EC Directive	Community legislation as set out in Article 189 of the Treaty of Rome. Directives are binding but set out only the results to be achieved leaving the methods of implementation to Member States, although a Directive will specify a date by which formal implementation is required.
Emergency Overflow	A system for allowing the discharge of sewage (usually crude) from a sewer system or sewage treatment works in the case of equipment failure.
***Escherichia coli* (*E. coli*)**	A species of bacterium that is a member of the faecal coliform group (see below). It is more specifically associated with the intestines of warm-blooded animals and birds than other members of the faecal coliform group.
Faecal Coliforms	A group of bacteria found in faeces and used as a parameter in the Hygiene Regulations, Shellfish and Bathing Water Directives, E. coli is the most common example of faecal coliform. Coliforms (see above) which can produce their characteristic reactions (e.g. production of acid from lactose) at 44℃ as well as at 37℃. Usually, but not exclusively, associated with the intestines of warm-blooded animals and birds.
Geometric Mean	The geometric mean of a series of N numbers is the Nth root of the product of those numbers. It is more usually calculated by

obtaining the mean of the logarithms of the numbers and then taking the anti-log of that mean. It is often used to describe the typical values of a skewed data such as one following a lognormal distribution.

Mesotidal Area with a moderate tidal range of between 2 and 4 metres.

Norovirus Small, 27-to 32-nm, structured RNA viruses classified as caliciviruses which have been implicated as the most common cause of non-bacterial gastroenteritis outbreaks. Previously known as Norwalk-like viruses and Small round structured viruses.

Salmonellosis Illness caused by Salmonella, a genus of Gram-negative, usually motile, rod-shaped bacteria found in the intestines of humans, other animals and birds.

Secondary Treatment Treatment to applied to breakdown and reduce the amount of solids by helping bacteria and other microorganisms consume the organic material in the sewage. OR Further treatment of settled sewage, generally by biological oxidation.

Sewage Sewage can be defined as liquid, of whatever quality that is or has been in a sewer. It consists of waterborne waste from domestic, trade and industrial sources together with rainfall from subsoil and surface water.

Sewage Treatment Works (STW) Facility for treating the waste water from predominantly domestic and trade premises.

Sewerage A system of connected sewers, often incorporating inter-stage pumping stations and overflows.

Storm Water Rainfall which runs off roofs, roads, gulleys, etc. In some areas storm water is collected and discharged to separate sewers, whilst in combined sewers it forms a dilute sewage.

Tidal excursion The net horizontal distance over which a water particle moves during one tidal cycle of flood and ebb.

Waste water Any waste water but see also “sewage”.

APPENDIX I: SOUTHAMPTON WATER SHORELINE SURVEY

SURVEY

The aim of the shoreline survey was to confirm the presence of potential sources of microbiological pollution previously identified in a desk study and to identify any additional sources of contamination. Two separate shoreline surveys were undertaken. The eastern shore was surveyed on 9th July 2008 during heavy rain. The western shore was surveyed on 24th July 2008 during dry weather. The survey of the western shore was incomplete because it was not possible to access the shoreline in the vicinity of Fawley Oil Refinery.

Details of both surveys are given below:

Survey:	Southampton Water Eastern Shore		
Start Point:	Hamble Common	Start NGR:	SU 484 059
End Point:	Woolston STW	End NGR:	SU 435 104
Date:	9th July 2008		
Start time:	09:00 BST		
End time:	14:00 BST		
Weather:	Heavy rain	Wind:	S F4-5
Tidal state:	Low water		
Time of LW:	08:45 GMT	Height of LW:	1.1 m
Time of HW:	15:22 GMT	Height of HW:	4.2 m
Surveyed by:	Richard Acornley (Cefas)		

Survey:	Southampton Water Western Shore		
Start Point:	Hythe Village Marina	Start NGR:	SU 423 086
End Point:	Langdown	End NGR:	SU 432 070
Date:	24th July 2008		
Start time:	09:00 BST		
End time:	14:00 BST		
Weather:	Dry	Wind:	ESE F4-5
Tidal state:	Low water		
Time of LW:	09:04 GMT	Height of LW:	1.5 m
Time of HW:	15:43 GMT	Height of HW:	4.0 m
Surveyed by:	Richard Acornley (Cefas)		

Notes
Wind data from Sotonmet Station at Southampton Dock Head (www.sotonmet.co.uk).
Tidal predictions from UKHO for Southampton

The areas covered by each survey are shown in the map in Figure 1.

Stream and pipeline discharges were sampled in order to determine if they were contaminated. The locations of sampled discharges are shown in the map in Figure 1. Water samples were analysed for *E. coli* by WEMS. All counts were presumptive.

Figure 1: *Southampton Water Shoreline survey*

RESULTS

Potential sources of contamination observed during the shoreline surveys are listed below in Tables 1 and 2.

Table 1: *Potential sources of contamination –East shore***.**

Location/Notes	NGR	Water sample	Photo. Ref.
Stream near BP terminal (Ensign Way) running onto beach. Unturbid.	SU 47343 06451	E2	-
Ensign Way Pumping Station	SU 47322 06631	-	-
Stream running onto beach at Netley Hard (Spear Pond Gulley). Downstream of duck pond. Unturbid.	SU 45740 08034	E1	9
Victoria Road Pumping Station outfall (presumed). Not flowing.	SU 45300 08580	-	-
Beach Lane Pumping Station. Discharge point submerged.	SU 45340 08630	-	-
Stream running onto beach (Tickleford Gulley). Unturbid.	SU 44750 09180	E4	10
Outfall at Canberra Towers. Screened with triangular green channel mark. Flowing. Unturbid.	SU 44380 09600	E3	-
Outfall at Weston Hard with triangular green channel mark. Flowing. Unturbid.	SU 43860 09930	E5	-
Stream flowing onto beach at Woolston STW (Jurd's Lake). Unturbid.	SU 43439 10304	E6	11
Woolston STW. Storm water discharging. Grey.	SU 43390 10440	E7	12

Table 2*: Potential sources of contamination –West shore***.**

Location/Notes	NGR	Water sample	Photo. Ref.
Hythe Village Marina. Sampled from overflow sluice. Salinity 31.0	SU 42337 08332	W2	4,6
Stream at Hythe flowing onto beach. Salinity 11.8. Low flow. Clear.	SU 42283 08231	W1	2
Pipe with flap missing under Hythe Beacon. Trickle only.	SU 42306 08227	-	8
Large pipe at Hythe slipway. Very low flow. Salinity 8.2.	SU 42400 08159	W3	7
Large Outfall at The Promenade, Hythe (Alexandra Rd outfall). Flow of surface water. Salinity 2.0.	SU 42504 08018	W4	1
Small outfall adjacent to above. Port marker. Not flowing.	SU 42519 08002	-	1
Stream at flowing onto beach at Langdown. Low flow. Salinity 0.4.	SU 43114 07371	W5	3
Tates Copse outfall. Not flowing.	SU 43286 07112	-	5

Results of microbiological analysis are given in Table 3 and 4 below. The *E. coli* results for the samples collected from streams and outfalls on the eastern shore during heavy rainfall were, with one exception, very low. This indicates that the discharges were of uncontaminated surface water and suggests that they would not be a significant source of contamination, at least during the conditions under which the survey was undertaken. The one exception was the storm discharge from Woolston STW, which was discharging at the time of the survey. The *E. coli* result for the discharge was typical of that for stormwater (i.e. diluted sewage effluent). This discharge is directly into the classified oyster/clam fishery and is likely to be a significant source of contamination.

The *E. coli* results for the streams and outfalls sampled near Hythe during dry weather were indicative of moderate levels of contamination (500-1800cfu per 100ml). However, given that the flows from these discharges were very low, they are unlikely to be significant sources of contamination. The *E. coli* result for the sample collected from the overflow from Hythe Village Marina was below the limit of detection indicating that the marina is not polluted and is unlikely to be a significant source of contamination.

Table 3: *Microbiological results for water samples collected on 9th July 2008*

Sample	Location	Time	NGR	***E. coli*** / **100ml**
E1	Stream at Netley Hard (Spear Pond Gulley).	10:25	SU 45740 08034	<10
E2	Stream at Ensign Way	10:35	SU 47343 06451	<10
E3	Outfall at Canberra Towers	11:00	SU 44380 09600	<10
E4	Tickleford Gulley at beach	11:10	SU 44750 09180	460
E5	Outfall at Weston Hard	11:20	SU 43860 09930	<10
E6	Stream at Woolston STW (Jurd's Lake)	11:30	SU 43439 10304	140
E7	Woolston STW storm discharge	11:40	SU 43390 10440	410,000

Table 4: *Microbiological results for water samples collected on 24th July 2008*

Sample	Location	Time	NGR	***E. coli*** / **100ml**
W1	Stream at Hythe	09:15	SU 42283 08231	1,800
W2	Outfall from Hythe Village Marina	09:30	SU 42337 08332	<10
W3	Pipe at Hythe slipway	09:35	SU 42400 08159	500
W4	Outfall at The Promenade, Hythe	09:50	SU 42504 08018	1,500
W5	Stream at Langdown	10:30	SU 43114 07371	1,700

PHOTOGRAPHS

1: Alexandra Rd CSO outfall, Hythe

2: Stream at Hythe

3: Stream at Langdown

4: Hythe Village Marina sluice

5: Tates Copse outfall

6: Hythe Village Marina

7: Pipe at Hythe slipway

8: Pipe at Hythe Beacon E1:

9: Stream at Netley Hard

10: Tickleford Gulley at beach

11: Stream at Weston Point

12: Woolston STW storm overflow

EC Regulation 854/2004

CLASSIFICATION OF BIVALVE MOLLUSC PRODUCTION AREAS IN ENGLAND AND WALES

SAMPLING PLAN

Southampton Water

2009

General Information

Production area	Southampton Water
Cefas Main Site reference	M021
Cefas Area Reference	FDR 2843
Ordnance survey 1:25,000 map	Explorer OL22 New Forest
Admiralty Chart	2036 Southampton Water and Approaches

Shellfishery

Native oysters (*Ostrea edulis*)
Hard clams (*Mercenaria mercenaria*)
Manila clams (*Tapes philippinarum*)

Local Food Authority

Southampton Port Heath Authority
Meridians House
7 Ocean Way
Ocean Village
Southampton
SO14 3TJ

Telephone: 02380 226631

Monitoring points

See Figure 1 and Table 1 below.

Requirement for review

The competent authority will review this sampling plan within six years or in light of any obvious known changes in sources of pollution of human or animal origin (e.g. following a sewerage improvement scheme).

Table 1: *Recommended monitoring points in Southampton Water production area*

Zone	Species	RMP Name	National Grid Reference		Lat/Long (WGS 84)		Notes
			Easting	Northing	Latitude	Longitude	
Soton Water East	Manila clam	Weston Point	443001	109784	50° 53'.15 N	1° 23'.40 W	Green (starboard) channel marker with conical topmark. 500m d/s Woolston STW outfall.
Soton Water East	Manila clam	Netley Castle	444647	108450	50° 52'.43 N	1° 22'.01 W	Yellow marker buoy off Netley Castle
Soton Water West	Manila clam	Hythe Knock	442531	109177	50° 52'.83 N	1° 23'.81 W	Off Hythe Village Marina
Soton Water West	Manila clam	Bird Pile	444259	107130	50° 51'.72 N	1° 22'.35 W	Red (port) channel marker with can topmark. Near main clam fishing area.
Soton Water (all beds)	Native oyster	Netley	445300	107700	50° 51'.99 N	1° 21'.37 W	Existing RMP B021D. Dredged.
Soton Water (all beds)	Native oyster	Hamble Estuary	448762	105300	50° 50'.71 N	1° 18'.53 W	Existing RMP B021L. Dredged. *Move to mouth of Hamble Estuary.*
Soton Water (all beds)	Native oyster	Off Fawley	448136	103259	50° 49'.74 N	1° 19'.08 W	Existing RMP B021H. Dredged. *Move to inside Soton. Water near outfall from Ashlett Creek STW*
Soton Water (all beds)	Native oyster	Weston Shelf	443320	109180	50° 52'.82 N	1° 23'.14 W	New RMP B021S. Dredged. *Recommended if classification of oyster beds in this area is to be maintained. Could replace RMP B021D (Netley)*

Notes

1. If dredged samples of Manila clams are difficult to obtain it would be acceptable to use bagged mussels after a period of parallel monitoring.
2. The tolerance for dredged samples is 250m
3. Depending on the results of preliminary monitoring, the number of clam sampling points could be reduced from two to one in either zone

Figure 1: *Classification zones and recommended monitoring points*