THE ENVIRONMENTAL STATUS OF ST. AUBIN'S BAY, JERSEY ACCORDING TO THE REQUIREMENTS OF THE WATER FRAMEWORK DIRECTIVE

DATA MANAGEMENT AND ASSESSMENT FOR MONITORING PROGRAMMES

MONITORING PROGRAMME RESULTS AND STATUS ASSESSMENTS

FINAL REPORT TO STATES OF JERSEY (ENVIRONMENTAL PROTECTION SECTION) FROM WCA ENVIRONMENT LIMITED

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EXECUTIVE SUMMARY

The States of Jersey, Transport and Technical Services need to replace the Bellozanne sewage treatments works which discharges treated effluent into St. Aubin's Bay. In order to assess how the replacement of the Bellozanne works will affect the environmental status of St. Aubin's Bay, it is necessary to first establish the current environmental status of the bay and to provide a baseline against which any changes in environmental quality can be measured.

The States of Jersey, Environmental Protection Section have undertaken the first year of a long-term monitoring programme in St. Aubin's Bay (April 2012 to May 2013), which was designed by wca environment with the aim of generating the initial chemical and ecological information required to assess the interim environmental status of the bay according to the requirements of the Water Framework Directive (WFD).

The Water Framework Directive (WFD) is a holistic approach to managing the water environment in Europe and brings together objectives to protect the water environment from the effects of chemical pollution and broader ecological objectives, designed to protect the structure and function of aquatic ecosystems themselves.

Under the WFD, the overall environmental status of a waterbody (be it river, lake, estuary or coastal) is determined by the assessment of its ecological and chemical status. Ecological status refers to the quality of the structure and functioning of aquatic ecosystems while chemical status is based on the measured concentrations of specified substances in the waterbody.

This system of integrated chemical and ecological assessment provides a framework within which costs and benefits can be properly taken into account when setting environmental objectives, and proportionate and cost-effective combinations of measures to achieve the objectives (which consider a waterbody as a whole) can be designed and implemented.

Despite not being a member of the EU, small island jurisdictions, such as Jersey, may benefit from applying the WFD approach to environmental assessment since it provides an effective means of considering the combined effects of all identified chemical pressures on the island's waterbodies in an integrated manner while also delivering reliable information on which particular combinations of pressures may be driving potentially impoverished ecological status. It also allows for the effects of changes in the identified pressures on the local environment to be reliably measured against a baseline which considers each aquatic environment (freshwater or coastal) of the island as a whole. This means that limited resources can be focused on measures which are likely to result in the greatest benefit in terms of overall environmental improvement, rather than attempting to address individual chemical pollution issues (real or perceived) in isolation of considerations of the wider environmental impacts of combinations of different pressures.

Estimates of the status of a waterbody will inevitably improve over time, as the amount of monitoring data, on which the status assessment is based, accumulates. As a result, the

status of some water bodies will be re-classed as better, or worse, than originally estimated. Classification is therefore normally built up from the monitoring data over a number of stages, in which the data are collected using rolling programmes in which each site is monitored over a number of years. This means that initial status assessments for a particular element may change as the monitoring dataset increases. In general, the status of a particular element can be estimated as soon as enough data have been generated to allow the relevant assessments to be undertaken, however, there is a difference between having enough data to mechanistically undertake the assessment and having a sufficiently representative dataset to be confident of the final status of an element. For this reason, assessments made before monitoring has been carried out over a sufficiently representative period can only be considered to represent the 'interim' status of a particular metric or waterbody.

The initial monitoring programme for St. Aubin's Bay was split into three main phases of monitoring and assessment:

- a chemical screening assessment of the Bellozanne treated sewage effluent and environmental samples from the bay to identify substances of concern;
- longer term chemical/ physico-chemical monitoring of the bay to generate sufficient chemical data with which to estimate the chemical and ecological status of the bay, and
- a programme of ecological monitoring which comprised phytoplankton, macroalgae, seagrass, benthic invertebrate and imposex assessments.

The results of this monitoring programme have been used to assess the interim chemical and ecological status of St. Aubin's Bay. Monitoring for a further two to three years will be required (as planned by States of Jersey, Environmental Planning Section) to determine the final status of St. Aubin's Bay according to the requirements of the WFD.

The interim status assessments undertaken indicate that St. Aubin's Bay should be initially classified as being at 'Good' chemical status and 'Moderate' ecological status. The overall interim status classification of St. Aubin's Bay, according to the requirements of the WFD, is therefore 'Moderate'.

The ecological quality elements driving the 'Moderate' status are the macroalgae assessments (rocky shore and opportunistic macroalgae) and these indicate that the bay is currently moderately impacted by nutrient enrichment.

The primary point source of this nutrient enrichment is the Bellozanne sewage treatment works effluent, which discharges to the bay. While there are other (diffuse) sources of nutrients entering the bay, a reduction in the point source inputs of inorganic nitrogen to the bay, would be expected to go some way to improving the overall status of the bay. We would recommend that efficient nitrification, followed by de-nitrification, of the effluent prior to release to the bay would be the most effective way of improving the quality of the treated effluent and reducing point source nitrogenous inputs to the bay.

In order to confirm the initial baseline environmental status of St. Aubins Bay suggested by this assessment, undertake an evaluation of any trends or changes in the status of the various chemical and ecological quality elements (both during and following the replacement of the sewage works), and finalise the overall WFD status assessment, the planned future monitoring programme should continue for at least two, and possibly three, further years.

It is recommended that theongoing monitoring programme should include, at least:

- Chemical monitoring of seawater for ammonia, arsenic, copper, lead, zinc and nonylphenol at the central bay site. Benzo (g,h,i) perylene should also be monitored at the central bay site, if an analytical laboratory can be sourced which can achieve a limit of detection which is less than the EQS value for this substance.

- Chemical monitoring of seawater and sediment at the port site. Seawater analysis should include at least tributyl tin (TBT). Sediment monitoring should include TBT tin, mercury and PAHs.

- Physico-chemical monitoring of dissolved inorganic nitrogen (limit of detection at least 50 μgL^{-1}), salinity and turbidity (as mgL^{-1} suspended solids) at three sites in the bay.

- Ecological monitoring of phytoplankton and chlorophyll-a concentrations in seawater at three sites within the bay, for at least a further 12 months. The methods applied for taking, preserving and filtering seawater samples for the analysis of phytoplankton assemblages and chlorophyll-a concentration should be reviewed and optimised prior to embarking on this element of the new monitoring programme.

- Ecological monitoring of rocky shore macroalgae and opportunistic macroalgae assessment. At least one further assessment of each of these quality elements should be undertaken following completion of the replacement of the Bellozanne sewage treatment works.

- Ecological monitoring of seagrass beds - one survey should be undertaken in 2013.

- Ecological monitoring of benthic invertebrates at the central bay site. Benthic invertebrate surveys should be timed to be undertaken both during and after the replacement of the Bellozane sewage treatment works.

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1 INTRODUCTION

The States of Jersey, Transport and Technical Services need to replace the Bellozanne sewage treatments works which discharges treated effluent into St. Aubin's Bay. In order to assess how the replacement of the Bellozanne works will affect the environmental status of St. Aubin's Bay, it is necessary to first establish the current environmental status of the bay and to provide a baseline against which any changes in environmental quality can be measured.

The States of Jersey, Environmental Protection Section have undertaken the first year of a long-term monitoring programme in St. Aubin's Bay, which was designed by wca environment (wca) with the aim of generating the chemical and ecological information that is required to assess the interim environmental status of the bay according to the requirements of the Water Framework Directive (WFD).

The initial monitoring programme was split into three main phases of monitoring and assessment:

- a chemical screening assessment of the Bellozanne treated sewage effluent and environmental samples from the bay to identify substances of concern;
- longer term chemical/ physico-chemical monitoring of the bay to generate sufficient chemical data with which to estimate the chemical and ecological status of the bay, and
- a programme of ecological monitoring which comprised phytoplankton, macroalgae, seagrass, benthic invertebrate and imposex assessments.

This report presents the results of each element of the monitoring programme, corresponding estimates of the interim chemical or ecological status of the bay according to the monitoring results for each element, and the overall interim outcome of the assessment according to the requirements of the Water Framework Directive (WFD). The monitoring programme Technical Specification[1] document fully details the design, requirements and objectives of the monitoring programme.

In Section 1 we outline the requirements of the WFD and detail the design of the St. Aubin's Bay monitoring programme. Section 2 provides all the monitoring results for the different chemical and ecological quality indicators, and Section 3 applies these results to estimate the interim chemical and ecological status of the bay. In Section 4 we discuss the outcomes of the interim status assessments with respect to the primary chemical pressures on the bay, and the implications of these results for the Bellozanne sewage treatment works. Finally, Section 5 provides a series of recommendations based on the outcomes of the monitoring programme and interim status assessments.

[1] The Environmental Status of St. Aubin's Bay, Jersey According to the Requirements of the Water Framework Directive: Monitoring Programme Technical Specification, Version 2 (wca, Oct 2012).

The work to assess the baseline environmental status of St. Aubin's Bay has comprised a number of stages and this report represents the final report in a series, each related to different phases of the overall assessment. The full series of reports comprises the following titles (this report highlighted):

- Scoping Study to Define the Status of St. Aubin's Bay, Jersey According to the Requirements of the Water Framework Directive (2012).
- The Environmental Status of St. Aubin's Bay, Jersey According to the Requirements of the Water Framework Directive – Monitoring Programme Technical Specification (2012).
- The Environmental Status of St. Aubin's Bay, Jersey According to the Requirements of the Water Framework Directive – Data Management and Assessment for Monitoring Programmes: Interim Report on Chemical Screening Programme (Outcomes and Recommendations) (2012).,
- Poly aromatic Hydrocarbons and Mercury in Sediments: Comparison of St. Helier Port Area, Jersey to other UK Ports (2012).
- **The Environmental Status of St. Aubin's Bay, Jersey According to the Requirements of the Water Framework Directive – Data Management and Assessment for Monitoring Programmes: Monitoring Programme Results and Status Assessments (2013).**

This final report is focused on presenting the results and outcomes of the initial monitoring programme and we have, in places, summarised information that is available in more detail in previous reports in the above series.

1.1 The Water Framework Directive

The Water Framework Directive (WFD) is a holistic approach to managing the water environment in Europe and brings together objectives to protect the water environment from the effects of chemical pollution and broader ecological objectives, designed to protect the structure and function of aquatic ecosystems themselves.

Under the WFD, the overall environmental status of a waterbody (be it river, lake, estuary or coastal) is determined by the assessment of its ecological and chemical status. Ecological status refers to the quality of the structure and functioning of aquatic ecosystems while chemical status is based on the measured concentrations of specified substances in the waterbody.

This system of integrated chemical and ecological assessment provides a framework within which costs and benefits can be properly taken into account when setting environmental objectives, and proportionate and cost-effective combinations of measures to achieve the objectives (which consider a waterbody as a whole) can be designed and implemented.

Despite not being a member of the EU, small island jurisdictions, such as Jersey, may benefit from applying the WFD approach to environmental assessment since it provides an effective means of considering the combined effects of all identified chemical pressures on the island's waterbodies in an integrated manner while also delivering reliable information on which particular combinations of pressures may be driving potentially impoverished ecological status. It also allows for the effects of changes in the identified pressures on the local environment to be reliably measured against a baseline which considers each aquatic environment (freshwater or coastal) of the island as a whole. This means that limited resources can be focused on measures which are likely to result in the greatest benefit in terms of overall environmental improvement, rather than attempting to address individual chemical pollution issues (real or perceived) in isolation of considerations of the wider environmental impacts of combinations of different pressures.

The assessment of a waterbody is achieved by monitoring a series of chemical and ecological quality elements which generate results that can be compared with similar data for reference (uncontaminated) conditions. The degree of deviation from reference conditions for any particular quality element will define its status.

There are five classes for ecological status ('high', 'good', 'moderate', 'poor' and 'bad') and two classes for chemical status ('good' and 'failing good') and for both ecological and chemical status assessments, and overall surface water assessments, the status of a water body will be determined by the results for the quality element with the lowest class (Figure 1).

Estimates of the status of a waterbody will inevitably improve over time, as the amount of monitoring data, on which the status assessment is based, accumulates. As a result, the status of some water bodies will be re-classed as better, or worse, than originally estimated. Classification is therefore normally built up from the monitoring data over a number of stages, in which the data are collected using rolling programmes in which each site is monitored over a number of years. This means that initial status assessments for a particular element may change as the monitoring dataset increases. In general, the status of a particular element can be estimated as soon as enough data have been generated to allow the relevant assessments to be undertaken, however, there is a difference between having enough data to mechanistically undertake the assessment and having a sufficiently representative dataset to be confident of the final status of an element. For this reason, assessments made before monitoring has been carried out over a sufficiently representative period can only be considered to represent the 'interim' status of a particular metric or waterbody.

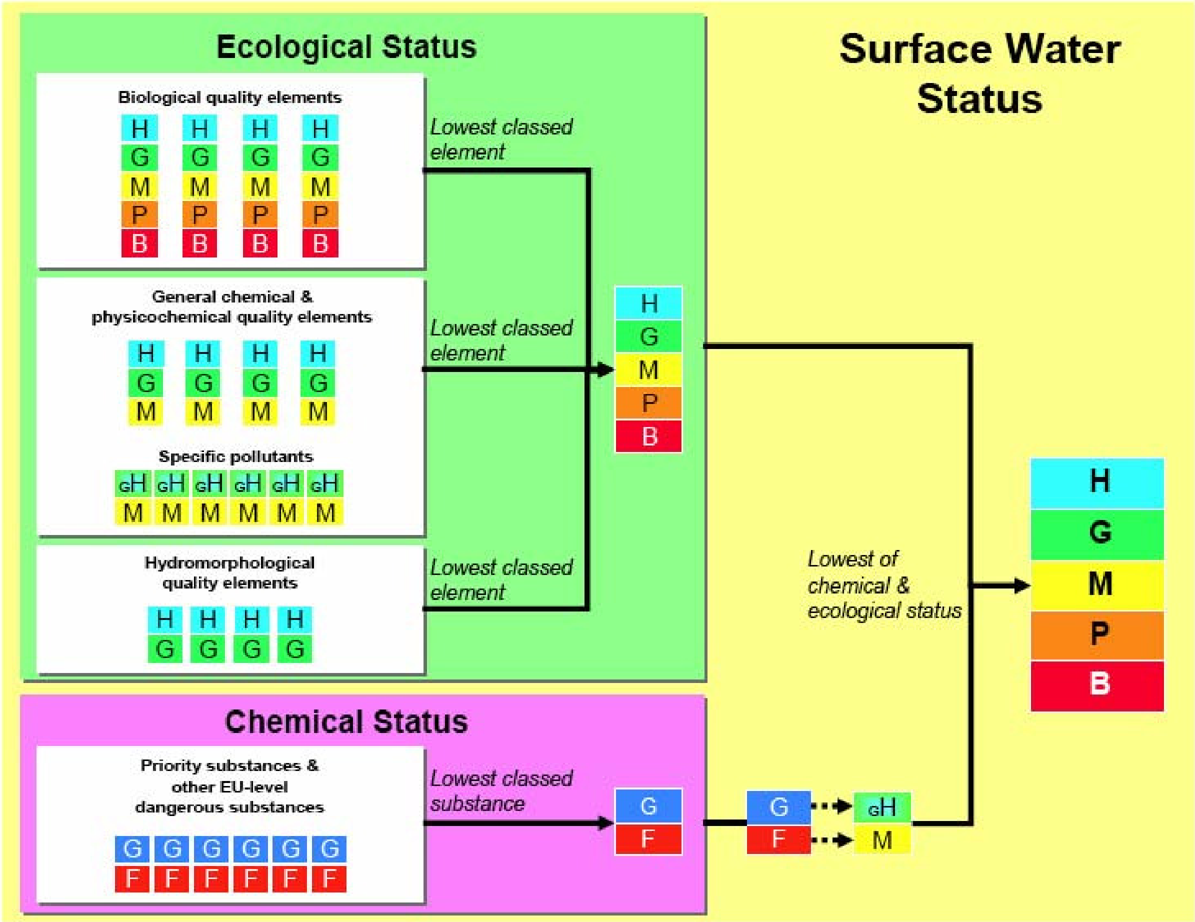

Figure 1 **Surface Water Classification under the Water Framework Directive (UKTAG, 2007/2008)**

1.2 The Monitoring Programme

The monitoring programme for St. Aubin's Bay applied the WFD chemical and ecological indicators for the WFD status assessment of coastal waters, since there is no river entering the bay (Jersey has no true rivers) and therefore the bay cannot be considered to be a transitional waterbody.

The monitoring programme was designed to assess the interim environmental status of St. Aubin's Bay according to the primary chemical pressures identified in the Scoping Report[2], and in particular to determine the chemical pressures inferred on the bay by the Bellozanne sewage treatment works effluent. Full details of the design of the chemical and ecological elements of the programme are provided in the Monitoring Programme Technical Specification[3].

In summary, three separate sampling sites were identified to represent St. Aubin's Bay as a whole. These three sites were selected on the basis of the likely primary sources of chemicals to the bay, namely the Bellozanne sewage treatment works effluent, and activities in the port and La Collette reclamation site areas. The La Collette site is a reclamation area with associated waste activities (energy from waste plant, storage of incinerator ash, composting of green waste and aggregate recycling). The three sites therefore represent the likely areas of maximum chemical impact in the bay.

The main sites monitored were:

- Central Bay - corresponding to the main area receiving chemical inputs derived from the Bellozanne sewage treatment works effluent;
- the port area – corresponding to the area with current or historical chemical inputs from shipping and boating activities, and
- off La Collette reclamation site - corresponding to the area with current or historical chemical inputs from activities ongoing at the La Collette reclamation site.

The chemical screening programme comprised three samples of seawater and sediment, taken at monthly intervals from each of the three sites, as well as the more intensive sampling of the Bellozanne sewage treatment works effluent (four weekly samples taken for one month, and then monthly samples for two further months). The substances monitored in the screening programme were all those EU Priority Substances or UK River Basin Specific Pollutants with the potential to be present, based on the sources of pollution identified in the Scoping Report[2]. The data obtained in the chemical screening programme was used to determine which substances were measured in the longer term chemical monitoring programme. In general, those substances detected (i.e. above their analytical limits of detection) in seawater sampled from each site were included in the long-term monitoring of

[2] Scoping Study to Define the Status of St. Aubin's Bay, Jersey According to the Requirements of the Water Framework Directive (wca, 2012)

[3] The Environmental Status of St. Aubin's Bay, Jersey According to the Requirements of the Water Framework Directive: Monitoring Programme Technical Specification, Version 2 (wca, Oct 2012).

seawater at each site. Substances detected in the treated sewage effluent were also included in the long-term monitoring of seawater at the central bay site (where possible). Substances detected in sediment were monitored in biota in the long-term monitoring programme.

The longer term chemical monitoring programme comprised nine additional monthly samples of seawater taken from each site, so that for the substances selected following the screening programme a set of 12 discrete measurements for each substance were achieved over a 12 month period (i.e. three from the screening programme plus a further nine). However, owing to some errors at the analytical laboratory, some samples were not analysed for some substances or results were not reported, meaning that for some substances the total number of results is less than 12.

Biota (slipper limpets) were collected on three occasions (October 2012, January and April 2013) from the port site, and on one occasion (January 2013) from the central bay site.

The ecological monitoring programme comprised:

- Twelve seawater samples, that were taken at monthly intervals from each site, for the analysis of phytoplankton abundance, taxonomic diversity and chlorophyll-a content.
- Sediment samples that were taken on two occasions (May and October 2012) for the assessment of benthic invertebrate communities. Benthic invertebrates were assessed at the central bay and port sites, but it was not possible to obtain sediment samples for benthic invertebrate analysis from the La Collette reclamation site. For this reason, benthic invertebrate assessments were additionally carried out at a further site, Elizabeth Castle, which is close to the port monitoring site (but outside of the port area).
- Dogwhelks sampled on two occasions (August and September 2012) for the assessment of imposex. These were obtained from a single site in the bay where they were known to occur in sufficient numbers.
- The assessment of rocky shore macroalgae at three sites on a single occasion (September 2012). Because rocky shore macroalgae can only be assessed at suitable rocky shore sites which actually support seaweed growth, it was not possible to undertake the rocky shore macroalgae assessments at the same sites as those used for the chemical and phytoplankton sampling. Three rocky shore sites were therefore selected to represent the bay – Beach Rock, Elizabeth Castle and St. Aubin's Fort. Beach Rock and Elizabeth Castle are close to the central bay and port monitoring sites, respectively. St.Aubin's Fort is situated on the west side of the bay and is not in the proximity of the other sampling sites.
- The assessment of opportunistic macroalgae and seagrass, each on a single occasion (both September 2012) across the entire parts of the bay supporting opportunistic seaweed or seagrass beds.

The United Kingdom Technical Advisory Group on the WFD (UKTAG) best practice and guidance was applied in the monitoring and assessment of each of the specific ecological elements employed in the ecological monitoring programme (UKTAG 2008a,b and 2009a,b,c,d). The ecological assessment methods employed are further detailed in the Scoping Report[4] and Technical Specification[5].

[4] Scoping Study to Define the Status of St. Aubin's Bay, Jersey According to the Requirements of the Water Framework Directive (wca, 2012)

[5] The Environmental Status of St. Aubin's Bay, Jersey According to the Requirements of the Water Framework Directive: Monitoring Programme Technical Specification, Version 2 (wca, Oct 2012).

2 MONITORING RESULTS

2.1 Chemical Monitoring

2.1.1 Chemical Screening

The overall objectives of the initial (screening) phase of the monitoring programme were to identify those EU Priority Substances (existing and proposed) and UK Specific Pollutants that were detectable in, or released to, the bay (i.e. their measured concentrations were greater than the limits of detection for each matrix in which their concentration was measured).

The results of the chemical screening assessment for the three sites in St. Aubin's Bay (seawater and sediment) and the Bellozanne treated sewage effluent are given in Tables 2.1 to 2.7.

The Bellozanne STW effluent was subject to a month of weekly sampling (May 2012), followed by a further two months of monthly sampling (June and July 2012). The full results of the analysis of the STW effluent are given in Table 2.1, below.

Table 2.1 Chemical Screening of the Bellozanne STW Effluent

Substance	Units	Date Sample Taken					
		2 May 2012	8 May 2012	17 May 2012	25 May 2012	22 June 2012	9 July 2012
1,2 Dichloroethane	μgL^{-1}	<1	<1	<1	<1	<1	<1
17 alpha-ethinylestradiol (EE2)	ngL^{-1}	0.636	<0.4	0.949	1.19	0.272	0.155
17 beta-estradiol (E2)	ngL^{-1}	2.39	0.792	3.02	4.79	0.7	0.932
2,4 Dichlorophenol	μgL^{-1}	0.0392	0.0331	0.0411	<0.02	0.0367	No result
2,4 D	μgL^{-1}	0.0103	0.00889	0.00989	0.0133	0.0486	0.019
Ammonia (Unionized)	mgL^{-1}	27.9	19.8	15	16.1	1.65	6.66
Atrazine	μgL^{-1}	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Benzo (g,h,i)-perylene	μgL^{-1}	<0.03	<0.03	<0.03	<0.03	0.2	<0.03
PBDE 183	ngL^{-1}	0.126	<0.120	0.124	0.064	0.063	0.141
PBDE 138	ngL^{-1}	<0.06	<0.12	<0.06	<0.06	<0.06	<0.06
PBDE 85	ngL^{-1}	<0.06	<0.12	0.223	<0.06	<0.06	<0.06
PBDE 153	ngL^{-1}	0.074	0.535	0.487	0.104	0.106	0.06
PBDE 154	ngL^{-1}	0.069	0.435	0.474	0.096	0.078	<0.06
PBDE 99	ngL^{-1}	0.969	4.93	5.04	1.30	1.50	0.721

Substance	Units	Date Sample Taken					
		2 May 2012	**8 May 2012**	**17 May 2012**	**25 May 2012**	**22 June 2012**	**9 July 2012**
PBDE 100	ngL^{-1}	0.205	1.17	1.16	0.415	0.402	0.198
PBDE 47	ngL^{-1}	1.04	3.65	3.71	1.27	1.42	0.884
PBDE 66	ngL^{-1}	<0.06	<0.12	0.187	<0.06	<0.06	<0.06
PBDE 28	ngL^{-1}	0.118	0.269	0.268	<0.06	0.119	0.148
Carbon tetrachloride	μgL^{-1}	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Copper (Dissolved)	μgL^{-1}	5.38	6.58	6.57	6.92	3.6	4.61
DEHP	μgL^{-1}	<0.2	<0.2	<0.2	0.424	<0.2	<0.2
Dichloromethane	μgL^{-1}	<20	<2	<2	<2	<2	<2
Diclofenac	μgL^{-1}	0.522	0.732	0.876	0.671	0.383	0.483
Diuron	μgL^{-1}	0.14	0.0876	0.0852	0.116	0.102	0.103
Indeno (1,2,3-cd) pyrene	μgL^{-1}	<0.05	<0.05	<0.05	<0.05	0.35	<0.05
Mecoprop	μgL^{-1}	0.0219	0.0175	0.0207	0.0238	0.0634	0.153
Nickel (Dissolved)	μgL^{-1}	2.4	2.38	2.98	3.07	2.24	2.01
Nonylphenol	μgL^{-1}	0.644	0.263	<0.2	0.13	<0.625	<0.125
Octylphenol	μgL^{-1}	0.134	<0.1	<0.2	<0.05	<0.25	<0.05
Pentachlorobenzene	μgL^{-1}	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Simazine	μgL^{-1}	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
TBT	μgL^{-1}	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
1,2,3-Trichlorobenzene	μgL^{-1}	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
1,2,4-Trichlorobenzene	μgL^{-1}	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
1,3,5-Trichlorobenzene	μgL^{-1}	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Trichloroethylene	μgL^{-1}	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc (Dissolved)	μgL^{-1}	53.2	37	39.8	39.3	32.5	31.4

< = concentration of the substance in the sample was less than the limit of detection for the analytical method in effluent

Analysis of the Bellozanne STW effluent indicated that a number of EU Priority Substances and UK Specific Pollutants were present in the treated effluent at consistently detectable concentrations. These comprised:

- ethinyl oestradiol (EE2)
- oestradiol (E2)
- 2,4 dichlorophenol
- 2,4 D
- unionised ammonia
- PBDEs
- dissolved copper
- diclofenac
- diruon
- mecoprop
- dissolved nickel
- dissolved zinc.

A smaller number of substances were only detected in isolated samples, and these comprised:

- benzo (ghi) perylene
- DEHP
- indeno (1,2,3-cd) pyrene
- nonylphenol
- octylphenol.

These results suggest that all of these substances can enter St. Aubin's Bay via the sewage treatment works outfall, and the majority are continuously present (at detectable concentrations) in all treated effluent that flows into the bay.

However, the analysis of seawater samples at the central bay sampling site for the same substances indicated that very few of the substances that are detectable in treated sewage effluent are also detectable in seawater following dilution and, of the substances measured in both treated effluent and seawater, only unionised ammonia, oestradiol, nonylphenol, copper and zinc were detectable in both matrices. This suggests that, in general, the treated effluent is sufficiently diluted upon entering the bay to reduce concentrations of most of these substances to below detectable levels. Nevertheless, the parameters governing the dilution characteristics of substances in the treated effluent (concentration in effluent, effluent flow rate, tidal state, weather conditions, etc) are variable and therefore it was possible that the substances entering the bay via the treated effluent stream may be periodically present in seawater at higher concentrations than were measured in this screening programme. All of the EU Priority Substances and UK Specific Pollutants that were detected in the treated effluent were therefore included in the long-term monitoring programme (where analytical capability allowed) to verify that seawater concentrations remain less than limits of detection and that intermittent spikes did not occur (particularly at extremes of low dilution such as at low tide).

Seawater was screened at three sites within St. Aubin's Bay (central bay, the port and La Collette reclamation site) on a monthly basis for three months (May, June and July 2012).

The results of seawater monitoring at the three sites in the bay are shown in Tables 2.2 to 2.4.

Table 2.2 Chemical Screening of Seawater Sampled from the Central Bay Site

Substance	EQS	Units	Date Sample Taken		
			21 May 2012	21 June 2012	13 July 2012
1,2 Dichloroethane	10	μgL^{-1}	<1	<1	<1
EE2	0.000007	ngL^{-1}	<0.07	<0.2	<0.07
E2	0.00008	ngL^{-1}	<0.2	<0.5	0.178
2,4 Dichlorophenol	20	μgL^{-1}	<0.02	<0.02	<0.02
2,4 D	0.3	μgL^{-1}	<0.005	<0.005	<0.005
Ammonia (Unionized)	21	μgL^{-1}	11	14	<10
Anthracene	0.1	μgL^{-1}	<0.01	<0.01	<0.01
Arsenic (Dissolved)	25	μgL^{-1}	1.5	1.2	1.4
Atrazine	0.6	μgL^{-1}	<0.003	<0.003	<0.003
Benzene	8	μgL^{-1}	<0.1	<0.1	<0.1
Benzo (g,h,i) perylene	0.00082	μgL^{-1}	<0.01	<0.01	<0.01
Cadmium (Dissolved)	0.2	μgL^{-1}	<0.04	<0.04	<0.04
Carbon tetrachloride	12	μgL^{-1}	<0.1	<0.1	<0.1
Chlorfenvinphos	0.1	μgL^{-1}	<0.01	<0.01	<0.01
Chlorpyriphos	0.03	μgL^{-1}	<0.002	<0.002	<0.002
Chromium VI (Dissolved)	0.6	μgL^{-1}	<30	<30	<30
Copper (Dissolved)	5	μgL^{-1}	0.26	0.32	0.429
Cypermethrin	0.0000082	μgL^{-1}	<0.002	<0.002	<0.002
DEHP	1.3	μgL^{-1}	<0.2	<0.2	<0.2
Diazinon	0.01	μgL^{-1}	<0.002	<0.002	<0.002

Substance	EQS	Units	Date Sample Taken		
			21 May 2012	21 June 2012	13 July 2012
Dichloromethane	20	μgL^{-1}	<3	<3	<3
Dichlorvos	0.00006	μgL^{-1}	<0.004	<0.004	<0.004
Dimethoate	0.48	μgL^{-1}	<0.006	<0.006	<0.006
Diuron	0.2	μgL^{-1}	<0.01	<0.01	<0.01
Endosulfan A*	0.0005	μgL^{-1}	<0.003	<0.003	<0.003
Endosulfan B*		μgL^{-1}	<0.004	<0.004	<0.004
α-Hexachlorocyclohexane*	0.002	μgL^{-1}	<0.003	<0.003	<0.003
β-Hexachlorocyclohexane*		μgL^{-1}	<0.003	<0.003	<0.003
δ-Hexachlorocyclohexane*		μgL^{-1}	<0.001	<0.001	<0.001
ε-Hexachlorocyclohexane*		μgL^{-1}	<0.003	<0.003	<0.003
γ-Hexachlorocyclohexane (lindane)*		μgL^{-1}	<0.003	<0.003	<0.003
Iron (Dissolved)	1000	μgL^{-1}	<100	<100	<100
Isoproturon	0.3	μgL^{-1}	<0.01	<0.01	<0.01
Lead (Dissolved)	1.3	μgL^{-1}	0.0428	0.0449	0.0727
Linuron	0.5	μgL^{-1}	<0.01	<0.01	<0.01
Mecoprop	18	μgL^{-1}	<0.005	<0.005	<0.005
Naphthalene	2	μgL^{-1}	<0.01	<0.01	<0.01
Nickel (Dissolved)	8.6	μgL^{-1}	<0.3	<0.3	<0.3
Nonylphenol	0.3	μgL^{-1}	<0.5	<0.625	0.25
Octylphenol	0.3	μgL^{-1}	<0.5	<0.25	<0.1
Pentachlorophenol	0.4	μgL^{-1}	<0.02	<0.02	<0.02
cis-Permethrin*	0.01	μgL^{-1}	<0.002	<0.002	<0.002
trans-Permethrin*		μgL^{-1}	<0.001	<0.001	<0.001
Simazine	1	μgL^{-1}	<0.003	<0.003	<0.003
TBT	0.0002	μgL^{-1}	<0.0005	<0.0005	<0.0005
Terbutryne	0.0065	μgL^{-1}	<0.004	<0.004	<0.004
1,2,3-Trichlorobenzene*	0.4	μgL^{-1}	<0.01	<0.01	<0.01
1,2,4-Trichlorobenzene*		μgL^{-1}	<0.01	<0.01	<0.01
1,3,5-Trichlorobenzene*		μgL^{-1}	<0.01	<0.01	<0.01
Trichloroethylene	10	μgL^{-1}	<0.1	<0.1	<0.1
Trifluralin	0.03	μgL^{-1}	<0.002	<0.002	<0.002
Zinc (Dissolved)	40	μgL^{-1}	0.748	0.687	5.2

< = concentration of the substance in the sample was less than the limit of detection for the analytical method in seawater
* EQS = sum of substances listed

Table 2.3 Chemical Screening of Seawater Sampled from the Port Site

Substance	EQS	Units	Date Sample Taken		
			21 May 2012	21 June 2012	11 July 2012
1,2 Dichloroethane	10	μgL^{-1}	<1	<1	<1
Ammonia (Unionized)	21	μgL^{-1}	13	<10	<10
Anthracene	0.1	μgL^{-1}	<0.01	<0.01	<0.01
Arsenic (Dissolved)	25	μgL^{-1}	1.8	1.3	1.3
Benzene	8	μgL^{-1}	<0.1	<0.1	<0.1
Benzo (g,h,i) perylene	0.00082	μgL^{-1}	<0.01	<0.01	<0.01
Cadmium (Dissolved)	0.2	μgL^{-1}	<0.04	<0.04	<0.04
Carbon tetrachloride	12	μgL^{-1}	<0.1	<0.1	<0.1
Chromium VI (Dissolved)	0.6	μgL^{-1}	<30	<30	<30
Copper (Dissolved)	5	μgL^{-1}	0.88	0.578	0.903
Dichloromethane	20	μgL^{-1}	<3	<3	<3
Iron (Dissolved)	1000	μgL^{-1}	<100	<100	<100
Lead (Dissolved)	1.3	μgL^{-1}	0.218	0.197	0.109
Naphthalene	2	μgL^{-1}	<0.01	<0.01	<0.01
Nickel (Dissolved)	8.6	μgL^{-1}	<0.3	<0.3	0.309
TBT	0.0002	μgL^{-1}	<0.0005	<0.0005	0.00086
Trichloroethylene	10	μgL^{-1}	<0.1	<0.1	<0.1
Zinc (Dissolved)	40	μgL^{-1}	2.79	1.69	5.15

< = concentration of the substance in the sample was less than the limit of detection for the analytical method in seawater

Table 2.4 Chemical Screening of Seawater Sampled from the La Collette Site

Substance	EQS	Units	Date Sample Taken		
			21 May 2012	21 June 2012	11 July 2012
1,2 Dichloroethane	10	μgL^{-1}	<1	<1	<1
Ammonia (Unionized)	21	μgL^{-1}	18	<10	<10
Anthracene	0.1	μgL^{-1}	<0.01	<0.01	<0.01
Arsenic (Dissolved)	25	μgL^{-1}	1.7	1.3	1.3
Benzene	8	μgL^{-1}	<0.1	<0.1	<0.1
Benzo (g,h,i) perylene	0.00082	μgL^{-1}	<0.01	<0.01	<0.01
Cadmium (Dissolved)	0.2	μgL^{-1}	<0.04	<0.04	0.0573
Carbon tetrachloride	12	μgL^{-1}	<0.1	<0.1	<0.1
Chromium VI (Dissolved)	0.6	μgL^{-1}	<30	<30	<30
Copper (Dissolved)	5	μgL^{-1}	1.77	0.422	8.68
Dichloromethane	20	μgL^{-1}	<3	<3	<3
Iron (Dissolved)	1000	μgL^{-1}	<100	<100	<100
Lead (Dissolved)	1.3	μgL^{-1}	0.538	0.0938	1.54
Naphthalene	2	μgL^{-1}	0.0187	<0.01	<0.01
Nickel (Dissolved)	8.6	μgL^{-1}	0.407	<0.3	4.35
TBT	0.0002	μgL^{-1}	<0.0005	<0.0005	<0.0005
Trichloroethylene	10	μgL^{-1}	<0.1	<0.1	<0.1
Zinc (Dissolved)	40	μgL^{-1}	9.64	1.67	53.2

< = concentration of the substance in the sample was less than the limit of detection for the analytical method in seawater

The analysis of seawater samples at the three sites in St. Aubin's Bay indicated that very few of the EU Priority Substances or UK Specific Pollutants monitored were detected and, of those that were, the majority of seawater concentrations were well below the relevant EQS value.

At the central bay site, oestradiol and nonylphenol were detected in single samples (both July), unionised ammonia was detected in two samples (May and June) and dissolved arsenic, copper, lead and zinc were detected in all three samples taken. With the exception of oestradiol, all the measured concentrations were less than the EQS value for each of these substances.

At the port and La Collette reclamation sites, unionised ammonia, dissolved cadmium, TBT and naphthalene were detected in single samples, dissolved nickel was detected in one sample at the port (July) and two samples at La Collette reclamation site (May and July), and dissolved arsenic, copper, lead and zinc were consistently detected in all three samples from each site.

At the port site, all the concentrations of detected substances were less than their EQS value, however, at the La Collette reclamation site the concentrations of copper, lead and zinc were all in excess of the EQS for the seawater sample taken in July demonstrating that the measured concentrations of these metals can vary considerably over time, and can range from not detectable to above the EQS depending on factors which affect the input of substances from their sources (e.g. weather conditions).

Therefore, all substances detected in one or more seawater sample taken from each of the sites in the screening programme were subject to long-term monitoring across a range of seasons and weather conditions to provide sufficient information with which to calculate an annual average concentration (for comparison with the EQS) and characterise the variability in seawater concentration.

The screening programme additionally featured sediment monitoring for a small number of EU Priority Substances which are difficult to measure in water and for which the EQS is based on the measured concentration in the tissues of biota. The objective in this element of the screening programme was to identify which of these substances are detectable in sediment in the bay, and therefore required to be monitored in biota in the long-term programme.

Sediment was sampled from the same three sites within the St. Aubin's Bay as the seawater samples. The sediment samples were all taken on a single sampling occasion (25 June 2012), however, a series of replicate samples were obtained at each site (four from the central bay, and three each from the port and La Collette reclamation site).

The results of sediment monitoring at the three sites in the bay are shown in Tables 2.5 to 2.7, below.

Table 2.5 Chemical Screening of Sediment Sampled from the Central Bay Site

Substance	Units	Date Samples Taken			
		25 June 2012			
Benzo (a) pyrene	$ugkg^{-1}$	<2	<2	<2	<2
Benzo (b and k) fluoranthene	$ugkg^{-1}$	<10	<10	<10	<10
Brominated diphenylethers	$ugkg^{-1}$	<0.1	<0.1	<0.1	<0.1
Fluoranthene	$ugkg^{-1}$	2.96	<3	<2	<2
Heptachlor/Heptachlor epoxide	$ugkg^{-1}$	<3	<3	<3	<3
Hexachlorobenzene	$ugkg^{-1}$	<2	<2	<2	<2
Hexachlorobutadiene	$ugkg^{-1}$	<1	<1	<1	<1
Indeno (1,2,3-cd) pyrene	$ugkg^{-1}$	<10	<10	<10	<10
Mercury	$ugkg^{-1}$	6	5	6	7

< = concentration of the substance in the sample was less than the limit of detection for the analytical method in sediment

Table 2.6 Chemical Screening of Sediment Sampled from the Port Site

Substance	Units	Date Samples Taken		
		25 June 2012		
Benzo (a) pyrene	$ugkg^{-1}$	62.6	27.8	54.7
Benzo (b and k) fluoranthene	$ugkg^{-1}$	83.4	49.7	93.5
Fluoranthene	$ugkg^{-1}$	72.8	65.7	119
Indeno (1,2,3-cd) pyrene	$ugkg^{-1}$	32.5	18.4	33.8
Mercury	$ugkg^{-1}$	10	10	8

< = concentration of the substance in the sample was less than the limit of detection for the analytical method in seawater

Table 2.7 Chemical Analysis of Sediment Sampled from the La Collette Site

Substance	Units	Date Samples Taken		
		25 June 2012		
Benzo (a) pyrene	$ugkg^{-1}$	<2	<2	<2
Benzo (b and k) fluoranthene	$ugkg^{-1}$	<10	<10	<10
Fluoranthene	$ugkg^{-1}$	<2	<2	20.2
Indeno (1,2,3-cd) pyrene	$ugkg^{-1}$	<10	<10	<10
Mercury	$ugkg^{-1}$	6	5	3

< = concentration of the substance in the sample was less than the limit of detection for the analytical method in seawater

Of the substances measured in sediment, only mercury was detected in all samples at all sites. Fluoranthene was also detected in isolated samples at the central bay and La Collette reclamation sites. Significant concentrations (compared to their limits of detection) of a range of PAHs were consistently detected in sediment samples taken from the port suggesting widespread contamination of the sediment in this area with oils and fuels.

A number of substances that were included in the monitoring programme technical specification[6] were not measured in treated effluent, seawater or sediment as no analytical method has yet been developed for these substances (in the relevant matrix) by the analytical contractor selected by States of Jersey, Environmental Protection Section to undertake the analyses (Environment Agency, National Laboratory Service). In the main, these substances comprised those substances included in the recent (2012) EU Priority Substances proposal. In treated effluent the only substances not monitored were the C10-13 Chloroalkanes and HBCDD, however, in seawater the list also extended to aclonifen, alachlor, bifenox, the cyclodiene pesticides, diclofenac and quinoxyfen.

In sediment, the substances that were included in the technical specification but not measured in the screening programme monitoring were dicofol, HBCDD, pentachlorobenzene, the brominated diphenylethers and heptachlor/heptachlor epoxide.

[6] The Environmental Status of St. Aubin's Bay, Jersey According to the Requirements of the Water Framework Directive: Monitoring Programme Technical Specification, Version 1 (wca, March 2012).

While it is currently not possible to assess the chemical status of St. Aubin's Bay according to the concentrations of these substances present in the environment, they should be included in future monitoring programmes (as analytical capability is developed) which seek to assess the environmental status of the bay against the baseline established by the current monitoring programme. Based on the results of the screening programme (and where analytical capability allowed) the longer term chemical monitoring programme of seawater at the central bay site included all the substances detected in one or more samples of treated sewage effluent or in seawater taken from the central bay site in the screening programme, with the exception of oestradiol and ethinyl oestradiol. These two substances have been proposed as EU Priority Substances (2012) but no EQS will now be set until, at the earliest, 2016. As there is no EQS against which to measure compliance in this baseline assessment, there is no requirement to measure their environmental concentrations.

Seawater monitoring at the port and La Collette reclamation sites included all those substances detected in one or more seawater samples taken from those sites in the screening programme.

Chemical monitoring of biota in St. Aubin's Bay included all those substances detected in sediments taken from the bay in the screening programme.

Table 2.8 summarises the substances measured in the longer term chemical monitoring programme.

Table 2.8 Substances and Matrices Monitored in Longer term Monitoring Programme

Site/ Matrix	Substance	Rationale (Screening Programme)
Central Bay/ Seawater	2,4 Dichlorophenol	Detected in STW effluent
	2,4 D	Detected in STW effluent
	Ammonia (unionised)	Detected in STW effluent and seawater
	Benzo(g,h,i) perylene	Detected in STW effluent
	PBDEs	Detected in STW effluent
	Copper)(Dissolved)	Detected in STW effluent and seawater
	DEHP	Detected in STW effluent
	Diuron	Detected in STW effluent
	Mecoprop	Detected in STW effluent
	Nonylphenol	Detected in STW effluent and seawater
	Octylphenol	Detected in STW effluent
	Zinc (Dissolved)	Detected in STW effluent and seawater
	Total Inorganic Nitrogen	Phys-chem Measurement
	Arsenic (Dissolved)	Detected in seawater
	Lead (Dissolved)	Detected in seawater
Port/ Seawater	Ammonia (unionised)	Detected in seawater
	Arsenic (Dissolved)	Detected in seawater
	Copper (Dissolved)	Detected in seawater
	Lead (Dissolved)	Detected in seawater
	Nickel (Dissolved)	Detected in seawater
	Zinc (Dissolved)	Detected in seawater
	TBT	Detected in seawater
	Total Inorganic Nitrogen	Phys-chem Measurement
La Collette/ Seawater	Arsenic (Dissolved)	Detected in seawater
	Ammonia (unionised)	Detected in seawater
	Copper (Dissolved)	Detected in seawater
	Lead (Dissolved)	Detected in seawater
	Nickel (Dissolved)	Detected in seawater
	Zinc (Dissolved)	Detected in seawater
	Cadmium (Dissolved)	Detected in seawater
	Naphthalene	Detected in seawater
	Total Inorganic Nitrogen	Phys-chem Measurement
Biota	Benzo(g,h,i) perylene	Detected in sediment (Port only)
	Benzo(b and k) fluoranthene	Detected in sediment (Port only)
	Indeno(1,2,3-cd) pyrene	Detected in sediment (Port only)
	Fluoranthene	Detected in sediment
	Mercury	Detected in sediment

The PBDEs were not eventually monitored in seawater at the central bay site as the analysing laboratory had no analytical method for their measurement in seawater.

2.1.2 Longer term Chemical Monitoring

The objectives of the longer term monitoring programme were to monitor the concentrations of the EU Priority Substances and UK Specific Pollutants over a sufficient period to allow the derivation of a reliable annual average concentration for each substance. This annual average concentration can then be compared with an Environmental Quality Standard (EQS) to determine the interim chemical (Priority Substances) or ecological (Specific Pollutants) status of the bay, according to compliance or failure with each substance-specific EQS.

For this element of the programme, chemical measurements were made in seawater and biota (selected substances based on the sediment screening results).

In addition, the longer term chemical monitoring programme included measurements of salinity, and the concentrations of both dissolved oxygen and total inorganic nitrogen in seawater. These physico-chemical parameters are required to support the interim ecological status assessment.

The results of the longer term chemical monitoring programme are shown in Tables 2.9 to 2.16.

Tables 2.9 to 2.11 show the results of the monthly monitoring of seawater for the EU Priority Substances and UK Specific Pollutants identified in Table 2.8.

Table 2.9 Longer Term Chemical Monitoring at the Central Bay Site

Substance	Date/ Concentration (µgL^{-1})											
	May 2012	Jun 2012	Jul 2012	Aug 2012	Sept 2012	Oct 2012	Nov 2012	Dec 2012	Jan 2013	Feb 2013	Mar 2013	Apr 2013
2,4 Dichlorophenol	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
2,4 D	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Ammonia (unionized)	11	14	<10	<10	<10	<10	10	29	22	<10	56	<10
Arsenic (Dissolved)	1.5	1.2	1.4	<1	1.4	1.64	1.35	1.46	1.4	1.45	1.41	1.48
Benzo (g,h,i) perylene	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Copper (Dissolved)	0.26	0.32	0.429	0.201	<0.2	<0.2	0.255	<0.2	<0.2	<0.2	<0.2	<0.2
DEHP	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<1	<0.2	<1	<0.2	<0.2	<0.2
Diuron	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Lead (Dissolved)	0.0428	0.0449	0.0727	<0.04	<0.04	<0.04	0.049	0.08	0.066	0.048	0.068	<0.04
Mecoprop	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Nonylphenol	<0.5	<0.625	0.25	<0.25	0.261	<0.3	<0.125	<0.25	<0.3	<0.625	<0.25	<0.25
Octylphenol	<0.5	<0.25	<0.1	<0.1	<0.05	<0.1	<0.05	<0.1	<0.1	<0.25	<0.1	<0.1
Zinc (Dissolved)	0.748	0.687	5.2	0.983	<0.4	<0.4	0.694	1.12	1.66	0.788	1.24	<0.4

< = concentration of the substance in the sample was less than the limit of detection for the analytical method in seawater

Table 2.10 Longer Term Chemical Monitoring at the Port Site

Substance	Date/ Concentration (μgL^{-1})												
	May 2012	**Jun 2012**	**Jul 2012**	**Aug 2012**	**Sep 2012**	**Oct 2012**	**Nov 2012**	**Dec 2012**	**Jan 2013**	**Feb 2013**	**Mar 2013**	**Apr 2013**	**May 2013**
Ammonia (unionized)	13	<10	<10	<10	<10	17	28	17	12	<10	<10	<10	Not Measured
Arsenic (Dissolved)	1.8	1.3	1.3	1.4	1.5	1.53	1.47	1.29	1.43	1.44	1.35	1.37	Not Measured
Copper (Dissolved)	0.88	0.578	0.903	0.875	0.442	0.232	0.69	0.342	0.385	0.373	0.355	0.483	0.394
Lead (Dissolved)	0.218	0.197	0.109	0.124	<0.04	<0.04	0.046	0.063	0.149	0.097	0.162	0.067	0.052
Nickel (Dissolved)	<0.3	<0.3	0.309	<0.3	Not Measured	<0.3	0.3	<0.3	Not Measured	<0.3	<0.3	<0.3	<0.3
TBT	<0.0005	<0.0005	0.00086	<0.0005	<0.0005	<0.0005	<0.0005	Not Measured	Not Measured	<0.0005	<0.0005	Not Measured	<0.0005
Zinc (Dissolved)	2.79	1.69	5.15	3.62	1.01	1.18	2.86	2.1	2.64	1.64	2.63	1.88	2.06

< = concentration of the substance in the sample was less than the limit of detection for the analytical method in seawater

Table 2.11 Longer Term Chemical Monitoring at the La Collette Site

Substance	Date/ Concentration (μgL^{-1})												
	May 2012	Jun 2012	Jul 2012	Aug 2012	Sep 2012	Oct 2012	Nov 2012	Dec 2012	Jan 2013	Feb 2013	Mar 2013	Apr 2013	May 2013
Ammonia (unionized)	18	<10	<10	<10	<10	14	19	11	10	<10	<10	11	Not Measured
Arsenic (Dissolved)	1.7	1.3	1.3	1.2	1.6	1.63	1.35	1.41	1.47	1.37	1.51	1.39	Not Measured
Cadmium (Dissolved)	<0.04	<0.04	0.0573	<0.04	<0.04	<0.04	<0.04	Not Measured	<0.04	<0.04	<0.04	<0.04	Not Measured
Copper (Dissolved)	1.77	0.422	8.68	0.226	<0.2	<0.2	0.326	<0.2	<0.2	<0.2	<0.2	0.423	Not Measured
Lead (Dissolved)	0.538	0.0938	1.54	0.0468	<0.04	<0.04	0.052	0.242	0.047	0.103	0.135	0.084	Not Measured
Naphthalene	0.0187	<0.01	<0.01	0.0443	0.0132	<0.01	<0.01	Not Measured	Not Measured	<0.01	<0.01	<0.01	<0.01
Nickel (Dissolved)	0.407	<0.3	4.35	<0.3	<0.3	<0.3	0.396	Not Measured	<0.3	<0.3	<0.3	0.35	Not Measured
Zinc (Dissolved)	9.64	1.67	53.2	0.711	<0.4	0.845	1.39	0.985	0.985	1.36	1.6	1.14	Not Measured

< = concentration of the substance in the sample was less than the limit of detection for the analytical method in seawater

Tables 2.12 to 2.14 show the results of monthly monitoring of seawater for the physico-chemical parameters total inorganic nitrogen, dissolved oxygen and salinity.

Table 2.12 Physico-chemical Monitoring at the Central Bay Site

Parameter	Date/ Measurement												
	Apr 2012	May 2012	Jun 2012	Jul 2012	Aug 2012	Sep 2012	Oct 2012	Nov 2012	Dec 2012	Jan 2013	Feb 2013	Mar 2013	Apr 2013
Salinity (‰)	35.6	35.6	35.6	35.6	35.4	35.6	35.5	35.5	35.4	35	35.2	35.7	35.1
Dissolved Oxygen (mgL^{-1})	8.8	8.5	8.5	8.1	7.5	7.3	7.7	8.0	9.7	9.3	10.9	10.8	12.5
Total Inorganic Nitrogen (μgL^{-1})	Not measured	Not measured	Not measured	Not measured	<210	<210	<217	<210	<229	252	<270	<256	<210

< = concentration of the substance in the sample was less than the limit of detection for the analytical method in seawater

Table 2.13 Physico-chemical Monitoring at the Port Site

Parameter	Date/ Measurement												
	Apr 2012	May 2012	Jun 2012	Jul 2012	Aug 2012	Sep 2012	Oct 2012	Nov 2012	Dec 2012	Jan 2013	Feb 2013	Mar 2013	Apr 2013
Salinity (‰)	35.5	35.6	35.5	35.6	35.4	35.5	35.5	35.2	35.4	35.1	35.3	35.7	35
Dissolved Oxygen (mgL^{-1})	8.7	8.8	8.2	8.0	6.8	7.3	7.7	7.9	9.3	9.0	11.0	10.6	12.5
Total Inorganic Nitrogen (μgL^{-1})	Not measured	Not measured	Not measured	Not measured	<210	<210	<210	<228	<217	242	<220	<210	<210

< = concentration of the substance in the sample was less than the limit of detection for the analytical method in seawater

Table 2.14 Physico-chemical Monitoring at the La Collette Site

Parameter	Date/ Measurement												
	Apr 2012	May 2012	Jun 2012	Jul 2012	Aug 2012	Sep 2012	Oct 2012	Nov 2012	Dec 2012	Jan 2013	Feb 2013	Mar 2013	Apr 2013
Salinity (‰)	35.6	35.6	35.6	35.4	35.4	35.6	35.5	35.5	35.5	35.1	35.4	35.7	35.1
Dissolved Oxygen (mgL^{-1})	8.5	8.6	8.3	8.2	7	7.3	7.7	8.1	9.8	9.1	11	10.6	12.4
Total Inorganic Nitrogen (μgL^{-1})	Not measured	Not measured	Not measured	Not measured	<210	<210	<214	<219	<211	<210	<210	<210	<211

< = concentration of the substance in the sample was less than the limit of detection for the analytical method in seawater

Tables 2.15 and 2.16 show the results of biota monitoring for the EU Priority Substances identified in Table 2.8.

Biota monitoring was carried out in slipper limpets collected from the port and central bay sites only.

Table 2.15 Biota Monitoring at the Central Bay Site

Substance	Date/ Concentration (μgkg^{-1})
	Jan 2013
Fluoranthene	18
Mercury	1.7

Table 2.16 Biota Monitoring at the Port Site

Substance	Date/ Concentration ($\mu g kg^{-1}$)		
	Oct 2012	Jan 2013	Apr 2013
Benzo(a) pyrene	<0.5	<0.5	<0.5
Benzo(b) fluoranthene	<0.7	<0.7	0.75
Benzo(k) fluoranthene	<0.6	<0.6	<0.6
Indeno(1,2,3-cd) pyrene	<0.5	<0.5	<0.5
Fluoranthene	1.22	2.16	0.98
Mercury	0.29	9.5	15.9

< = concentration of the substance in the sample was less than the limit of detection for the analytical method in seawater

2.2 Ecological Monitoring

The objectives of the ecological monitoring programme were to generate the necessary biological data required to assess the interim status of the various WFD ecological indicators. These indicators measure the ecological responses to pressures inferred on the coastal environment by toxic chemicals and nutrients. The monitoring data collected for each indicator is used to estimate the degree of ecological disturbance from a reference condition (which is considered to represent no disturbance) caused by inputs of toxic chemicals or nutrients to the bay. This degree of disturbance or Ecological Quality Ratio (EQR) is then used to determine the ecological status of the bay, according to each indicator of pressure.

2.2.1 Phytoplankton

The abundance of certain indicator phytoplankton species, and the total chlorophyll-a concentration, was measured in discrete seawater samples taken from each site at monthly intervals over a 12 month period.

Tables 2.17 to 2.19 show the abundance of phytoplankton species measured in each monthly seawater sample at each of the three sampled sites.

Table 2.17 Phytoplankton species and abundance at the Central Bay Site

Phytoplankton Taxon	Date/ Measurement (Cells per Litre)											
	Apr 2012	May 2012	June 2012	Jul 2012	Aug 2012	Sep 2012	Oct 2012	Nov 2012	Dec 2012	Jan 2013	Feb 2013	Mar 2013
Araphiated diatom <20 µm	0	0	0	0	0	0	1154	0	0	0	0	0
Araphiated diatom 20-50 µm	0	0	0	0	0	0	0	0	0	60	0	522
Asterionellopsis kariana	0	0	0	0	0	0	0	0	0	180	0	0
Bacillaria paxillifer	0	0	214	10	0	0	0	0	0	0	192	0
Bacteriastrum	0	286	0	0	0	0	0	0	0	0	0	0
Biddulphia alternans	0	0	0	0	0	0	77	39	80	120	0	77
Centric Diatom <20 µm	0	0	0	0	0	0	0	0	0	100	0	2089
Centric Diatom 20-50 µm	286	143	0	0	0	0	39	0	200	360	39	6268
Centric Diatom >50µm	0	0	0	0	0	0	0	0	0	0	0	192
Chaetoceros (Hyalochaetae)	0	0	0	120	5429	1714	0	269	720	0	346	0
Chain diatom ribbon	0	0	0	0	0	0	0	0	400	340	0	7835
Cyanobacteria	0	0	71	0	0	0	0	0	0	0	0	0
Cylindrotheca closterium / Nitzschia longissima	286	143	143	200	143	571	231	192	920	620	500	7313
Dactyliosolen fragilissimus	9714	11429	0	0	1571	4000	154	0	0	0	39	0
Dinophyceae <20 µm armoured	0	0	0	0	0	0	0	0	0	60	0	0
Dinophyceae 20-50 µm armoured	0	0	0	0	0	0	0	0	0	0	0	522
Dinophyceae <20 µm naked	0	0	0	0	0	0	0	0	0	40	0	0
Euglenophyceae	0	0	0	0	714	143	0	0	0	0	0	0
Guinardia delicatula	571	571	2071	2050	35857	31286	769	115	0	0	0	0
Guinardia flaccida	0	0	0	0	0	143	0	0	0	0	0	0
Guinardia striata	0	0	0	0	0	1571	654	0	0	0	0	0

Phytoplankton Taxon	**Date/ Measurement (Cells per Litre)**											
	Apr 2012	**May 2012**	**June 2012**	**Jul 2012**	**Aug 2012**	**Sep 2012**	**Oct 2012**	**Nov 2012**	**Dec 2012**	**Jan 2013**	**Feb 2013**	**Mar 2013**
Gyrosigma/Pleurosigma	1000	11143	500	10	0	0	0	0	0	40	0	0
Heterocapsa triquetra	0	10709	0	0	0	0	0	0	0	0	0	0
Heterocapsa	0	0	0	0	0	5355	0	0	0	0	0	0
Lauderia annulata	0	0	0	0	0	0	0	39	0	0	0	154
Leptocylindrus danicus	0	0	0	0	0	0	192	0	0	40	0	0
Melosira	0	0	0	30	0	0	0	0	0	0	0	0
Microflagellates	10709	53546	32128	0	96383	21419	23066	0	2999	35983	28833	80439
Navicula <20 µm	143	286	0	10	0	0	0	0	0	0	0	0
Navicula 20-50 µm	0	0	0	0	0	0	269	0	0	0	39	0
Paralia sulcata	857	0	357	0	0	0	1192	154	920	1980	885	0
Podosira stelligera	0	0	0	0	0	0	0	0	0	60	0	0
Prorocentrum micans	0	0	0	0	0	143	0	0	0	40	0	39
Protoperidinium bipes	0	0	0	0	0	0	0	0	0	0	0	522
Pseudo-nitzschia <5 µm	0	0	0	0	0	571	154	0	0	0	0	1045
Pseudo-nitzschia >5 µm	0	0	71	0	2429	286	0	0	0	20	0	522
Raphiated pennate <20 µm	0	143	0	0	0	714	0	0	440	100	0	0
Raphiated pennate 20-50 µm	0	0	0	0	0	0	0	0	0	340	0	0
Rhizosolenia imbricata	0	0	0	0	0	0	269	0	40	20	0	77
Rhizosolenia setigera	857	2143	20714	820	143	857	192	192	160	20	38.46	77
Skeletonema	0	1571	0	7250	5571	7286	3385	4346	3880	160	7885	115435
Thalassionema nitzschioides	0	0	0	0	0	286	192	231	920	0	500	6790
Thalassiosira <10 µm	0	0	0	0	0	0	0	0	0	0	0	70514
Thalassiosira 10-50 µm	429	0	0	0	0	1286	154	500	200	40	0	8880

Table 2.18 Phytoplankton species and abundance at the Port Site

Phytoplankton Taxon	Date/ Measurement (Cells per Litre)											
	Apr 2012	May 2012	June 2012	Jul 2012	Aug 2012	Sep 2012	Oct 2012	Nov 2012	Dec 2012	Jan 2013	Feb 2013	Mar 2013
Alexandrium 20-50 µm	0	143	0	0	0	0	0	0	0	0	0	0
Araphiated diatom <20 µm	0	0	0	0	0	0	0	0	0	80	0	26116
Araphiated diatom >50 µm	0	0	0	0	0	0	0	0	0	0	0	39
Asterionellopsis glacialis	0	286	0	0	0	0	0	0	0	0	0	0
Bacillaria paxillifer	0	0	214	0	571	0	0	0	0	140	692	0
Biddulphia alternans	0	0	0	0	0	0	154	39	40	40	0	0
Centric Diatom <20 µm	0	0	0	0	0	429	0	0	0	80	0	1567
Centric Diatom 20-50 µm	571	0	0	0	0	0	0	0	160	60	0	6268
Centric Diatom >50µm	0	0	0	0	0	0	0	0	0	0	0	154
Chaetoceros (Hyalochaetae)	0	571	857	0	12000	6571	577	0	240	0	539	0
Chaetoceros (Phaeoceros)	143	0	0	0	0	0	0	0	0	120	0	0
Chain diatom ribbon	0	0	0	0	0	0	0	0	960	1720	0	0
Cylindrotheca closterium / Nitzschia longissima	143	429	286	286	1000	1286	1577	308	480	840	731	4701
Dactyliosolen fragilissimus	5857	13429	0	0	4714	10286	77	231	0	0	0	6268
Dinophyceae <20 µm armoured	0	0	0	0	0	0	0	0	0	40	0	0
Dinophyceae <20 µm naked	0	0	0	0	0	0	0	0	0	20	0	0
Dinophyceae 20-50 µm naked	0	0	0	0	0	0	0	0	0	0	0	522
Eucampia cornuta	0	0	0	0	1000	0	0	0	0	0	0	0
Euglenophyceae	0	0	71	0	0	429	0	0	40	0	0	0

Phytoplankton Taxon	**Date/ Measurement (Cells per Litre)**											
	Apr 2012	**May 2012**	**June 2012**	**Jul 2012**	**Aug 2012**	**Sep 2012**	**Oct 2012**	**Nov 2012**	**Dec 2012**	**Jan 2013**	**Feb 2013**	**Mar 2013**
Guinardia delicatula	0	571	2286	8143	36429	38000	423	1000	0	80	0	0
Guinardia flaccida	0	0	0	0	0	0	0	154	0	0	0	0
Guinardia striata	0	0	0	0	0	1571	154	769	0	0	0	0
Gyrosigma/Pleurosigma	429	6429	1143	143	0	0	0	77	0	0	39	0
Helicotheca tamesis	0	0	0	0	0	0	0	39	40	0	0	0
Heterocapsa triquetra	0	0	16064	0	0	0	0	0	0	0	0	0
Lauderia annulata	143	0	0	0	0	0	0	0	0	0	0	522
Leptocylindrus danicus	0	0	0	0	1857	0	77	0	0	40	0	0
Melosira	0	0	0	0	0	0	39	0	0	0	0	0
Microflagellates	32128	21419	5355	21419	37482	5355	76887	23066	4498	17992	34599	123792
Navicula 20-50 µm	0	0	0	0	0	0	0	154	0	0	0	0
Odontella	0	0	0	0	0	0	0	0	0	20	0	0
Other Diatoms	0	0	0	0	0	0	0	0	0	20	0	0
Paralia sulcata	1429	0	0	214	0	0	423	923	560	580	0	7313
Prorocentrum micans	0	0	0	0	0	143	0	0	0	0	0	39
Pseudo-nitzschia <5 µm	0	0	143	0	2714	0	0	0	0	0	0	522
Pseudo-nitzschia >5 µm	0	0	0	0	1000	1429	0	0	0	100	0	0
Raphiated pennate <20 µm	0	0	0	0	571	571	0	0	160	60	0	0
Raphiated pennate >50 µm	0	0	0	0	0	0	0	0	0	20	0	39
Raphiated pennate 20-50 µm	286	0	71	0	0	0	0	0	0	260	0	0
Rhizosolenia imbricata	0	0	0	1786	0	0	0	346	0	0	0	0
Rhizosolenia setigera	286	14297	17857	0	214	2571	385	192	80	0	39	39

Phytoplankton Taxon	**Date/ Measurement (Cells per Litre)**											
	Apr 2012	**May 2012**	**June 2012**	**Jul 2012**	**Aug 2012**	**Sep 2012**	**Oct 2012**	**Nov 2012**	**Dec 2012**	**Jan 2013**	**Feb 2013**	**Mar 2013**
Scrippsiella	0	0	71	0	0	0	0	0	0	0	0	0
Skeletonema	857	2143	8714	20857	9429	4714	11077	3154	4840	1100	5885	103944
Striatella unipunctata	0	0	0	0	143	0	0	0	0	0	0	0
Thalassionema nitzschioides	0	0	0	0	214	0	423	77	480	100	423	0
Thalassiosira <10 µm	0	0	0	0	0	0	0	0	0	0	0	54845
Thalassiosira 10-50 µm	0	0	0	0	0	2571	2077	0	0	0	0	6268

Table 2.19 Phytoplankton species and abundance at the La Collette Site

Phytoplankton Taxon	Date/ Measurement (Cells per Litre)											
	Apr 2012	May 2012	June 2012	Jul 2012	Aug 2012	Sep 2012	Oct 2012	Nov 2012	Dec 2012	Jan 2013	Feb 2013	Mar 2013
Actinoptychus	0	0	0	0	0	0	0	0	0	0	0	39
Araphiated diatom <20 µm	0	0	0	0	0	0	0	0	0	0	0	12536
Araphiated diatom 20-50 µm	0	143	0	0	0	0	0	0	0	40	0	1567
Asterionellopsis glacialis	143	143	0	0	0	0	0	0	0	0	0	0
Asterionellopsis kariana	0	0	0	0	0	0	0	0	0	200	0	0
Bacillaria paxillifer	0	0	0	0	429	0	0	0	0	0	885	0
Bacteriastrum	143	0	0	0	0	0	0	0	0	0	0	0
Biddulphia alternans	0	0	0	0	0	0	0	0	10	40	0	0
Centric Diatom <20 µm	0	0	0	0	0	0	0	0	0	120	0	3134
Centric Diatom 20-50 µm	0	0	0	0	0	0	0	0	10	480	115	6268
Centric Diatom >50µm	0	0	0	0	0	0	0	0	0	0	0	231
Cerataulina pelagica	0	0	0	0	286	0	39	0	0	0	0	0
Chaetoceros (Hyalochaetae)	1429	1429	429	643	10286	7714	0	1885	0	480	0	522
Chaetoceros (Phaeoceros)	0	0	0	0	0	0	0	0	20	0	0	0
Chain diatom ribbon	0	0	0	0	0	1429	0	0	450	2680	0	0
Cylindrotheca closterium / Nitzschia longissima	1143	571	214	2143	0	1000	115	1308	380	600	231	4701
Dactyliosolen fragilissimus	4714	15143	0	0	3000	6286	462	808	0	0	269	2089
Dinophyceae 20-50 µm armoured	1436	0	0	0	0	0	0	0	0	0	0	0
Dinophyceae <20 µm naked	0	0	0	0	0	0	0	0	0	40	0	0
Dinophyceae 20-50 µm naked	0	0	0	0	0	0	0	0	0	0	0	522

Phytoplankton Taxon	**Date/ Measurement (Cells per Litre)**											
	Apr 2012	**May 2012**	**June 2012**	**Jul 2012**	**Aug 2012**	**Sep 2012**	**Oct 2012**	**Nov 2012**	**Dec 2012**	**Jan 2013**	**Feb 2013**	**Mar 2013**
Euglenophyceae	0	0	0	0	429	714	0	0	20	0	0	0
Guinardia delicatula	0	571	3000	17357	34000	47571	4731	423	0	0	0	0
Guinardia flaccida	0	0	0	0	0	143	77	0	0	40	0	0
Guinardia striata	0	0	0	0	1429	1429	692	0	0	0	0	0
Gyrosigma/Pleurosigma	429	7571	929	71	0	0	0	0	0	20	0	0
Helicotheca tamesis	0	0	0	0	0	0	0	0	0	0	77	0
Lauderia annulata	286	0	0	0	0	0	0	0	20	0	0	0
Leptocylindrus danicus	0	0	0	0	571	0	0	39	0	0	77	0
Leptocylindrus minimus	0	0	0	0	0	0	0	0	0	0	0	2089
Lithodesmium undulatum	0	0	0	0	0	0	0	0	0	0	0	77
Melosira	0	0	0	0	0	0	0	0	0	0	154	0
Microflagellates	64255	16064	10709	85674	26773	21419	17300	0	2999	28487	57665	54845
Navicula <20 µm	0	0	0	0	0	0	0	0	0	0	0	522
Navicula 20-50 µm	0	5355	0	0	0	0	154	0	0	0	0	0
Paralia sulcata	1286	1426	571	857	0	0	1000	0	100	3400	0	3134
Prorocentrum micans	143	0	0	0	0	143	0	0	20	0	0	1045
Pseudo-nitzschia <5 µm	0	0	0	71	714	429	0	0	0	40	0	0
Pseudo-nitzschia >5 µm	0	0	0	0	0	1571	0	0	0	0	0	522
Raphiated pennate <20 µm	0	0	0	429	571	1143	0	0	490	80	0	0
Raphiated pennate >50 µm	0	0	0	0	0	0	0	0	0	40	0	39
Raphiated pennate 20-50 µm	143	0	71	0	0	0	0	0	0	160	0	1567
Rhizosolenia imbricata	0	0	0	0	0	286	115	77	0	40	0	77
Rhizosolenia pungens	0	0	0	71	0	0	0	0	0	0	0	0

Phytoplankton Taxon	**Date/ Measurement (Cells per Litre)**											
	Apr 2012	**May 2012**	**June 2012**	**Jul 2012**	**Aug 2012**	**Sep 2012**	**Oct 2012**	**Nov 2012**	**Dec 2012**	**Jan 2013**	**Feb 2013**	**Mar 2013**
Rhizosolenia setigera	429	1571	15429	2857	143	2286	192	115	0	0	39	154
Skeletonema	429	2857	1571	60286	5429	13571	2923	7269	580	120	4731	135283
Thalassionema nitzschioides	0	0	0	0	571	571	462	308	0	0	0	3656
Thalassiosira <10 µm	0	0	0	0	0	0	0	0	0	0	0	50666
Thalassiosira 10-50 µm	0	0	0	0	0	0	231	1385	30	40	0	4179

Table 2.20 shows the chlorophyll a concentration of each seawater sample taken for the phytoplankton assessments.

Table 2.20 Chlorophyll a Concentration of Seawater Samples

Sampling Date	Chorophyll a (μgL^{-1})		
	Central Bay Site	Port Site	La Collette Site
Apr 2012	1.12	1.04	0.78
May 2012	0.45	0.95	0.84
Jun 2012	0.42	0.59	0.53
Jul 2012	0.87	0.84	1.15
Aug 2012	0.2	1.12	0.06
Sep 2012	0.34	0.06	0.2
Oct 2012	0.48	0.56	0.67
Nov 2012 (A)	0.34	0.486	0.42
Nov 2012 (B)	0.42	1.29	0.81
Dec 2012	0.25	0.06	0.140
Jan 2013	1.26	Reported as '0'	Reported as '0'
Feb 2013	0.11	0.112	0.252
Mar 2013	0.59	0.224	0.336

2.2.2 Macroalgae

Two different types of macroalgae (seaweed) monitoring were carried out in accordance with the WFD ecological assessment requirements for coastal waters. The first assessed the abundance of certain rocky shore indicator species, while the second assessed the extent and biomass of opportunistic macroalgal species.

The rocky shore assessment involved a single survey (September 2012) at three rocky sites bearing seaweed. Because rocky shore macroalgae can only be assessed at suitable rocky shore sites which actually support seaweed growth, it was not possible to undertake the rocky shore macroalgae assessments at the same sites as those used for the chemical and phytoplankton sampling. Three rocky shore sites were therefore selected to represent the bay – Beach Rock, Elizabeth Castle and St. Aubin's Fort. Beach Rock and Elizabeth Castle are close to the central bay and port monitoring sites, respectively. St.Aubin's Fort is situated on the west side of the bay and is not in the proximity of the other sampling sites.

The opportunistic macroalgae assessment also comprised a single survey (September 2012) but assessed the entire intertidal habitat bearing opportunistic macroalgae.

Tables 2.21 and 2.22 show the results for the rocky shore and opportunistic macroalgae surveys.

Table 2.21 Rocky Shore Macroalgae Assessment

Site		
St. Aubin's Fort	**Elizabeth Castle**	**Beach Rock**
Taxa Present		
Pelvetia canaliculata	*Pelvetia canaliculata*	*Ectocarpus siliculosus*
Fucus spiralis	*Ascophyllum nodosum*	*Fucus serratus*
Ascophyllum nodosum	*Ectocarpus siliculosus*	*Cladophora rupestris*
Fucus vesiculosus	*Fucus serratus*	*Ulva lactuca*
Ectocarpus siliculosus	*Cladophora rupestris*	*Chondrus crispus*
Fucus serratus	*Ulva lactuca*	*Fucus vesiculosus*
Blidingia marginata	*Catenella caespitosa*	*Polysiphonia stricta*
Cladophora rupestris	*Chondrus crispus*	*Ceramium secundatum*
Ulva lactuca	*Polysiphonia lanosa*	*Mastocarpus stellatus*
Catenella caespitosa	*Corallina officinalis*	*Halurus flosculosus*
Chondrus crispus	*Blidingia minima*	*Pylaiella littoralis*
Polysiphonia lanosa	*Cladostephus spongiosus*	*Osmundea pinnatifida*
Corallina officinalis	*Fucus spiralis*	*Rhodothamniella floridula*
	Fucus vesiculosus	
	Polysiphonia stricta	
	Ceramium secundatum	
	Polysiphonia fucoides	
	Mastocarpus stellatus	
	Furcellaria lumbricalis	
	Halurus flosculosus	
	Cryptopleura ramosa	

Table 2.22 Opportunistic Macroalgae Assessment

Quadrat (m^2)	% Cover of Quadrat with Opportunistic Species	No. of Opportunistic Species	% of Quadrat with Entrained Algae	No. of Entrained Species	Total Wet Weight of Algae in Quadrat (g)
1	11	3	0	0	32
2	14	2	0	0	118
3	23	2	0	0	116
4	22	2	0	0	90
5	21	2	0	0	204
6	18	2	0	0	172
7	6	1	0	0	8
8	1	1	0	0	8
9	16	1	0	0	74
10	16	1	0	0	70
11	10	1	10	1	124
12	6.5	2	6.5	1	56
13	23	3	5	1	560
14	100	3	0	0	2672
15	36	3	0	0	622
16	60	2	5	1	1078
17	22	1	10	1	104
18	20	1	32	1	190
19	5	1	32	1	66
20	50	1	40	1	1166
21	11	1	0	0	40
22	4	1	0	0	22
23	4	1	0	0	8
24	48	2	0	0	662
25	18	1	5	1	198
26	52	2	50	1	506
27	10	2	10	1	26
28	100	3	20	1	3670

Total Extent of Macroalgal Bed	
Hectares	**m^2**
78.75	787474

Quadrat (m^2)	% Cover of Quadrat with Opportunistic Species	No. of Opportunistic Species	% of Quadrat with Entrained Algae	No. of Entrained Species	Total Wet Weight of Algae in Quadrat (g)	Total Extent of Macroalgal Bed
29	86	1	0	0	7654	
30	94	3	0	0	15138	
31	20	1	0	0	132	
32	30	1	50	1	1152	
33	1	1	30	1	8	
34	24	1	24	1	320	
35	41	1	0	0	1556	
36	100	2	0	0	5168	
37	47	1	0	0	2874	
38	11	1	0	0	72	
39	49	1	0	0	1238	
40	2	1	0	0	14	
41	69	1	0	0	1346	
42	22	1	0	0	156	
43	28	1	0	0	716	
44	83	1	0	0	4992	
45	29	3	0	0	298	
46	41	1	0	0	1758	
47	35	1	0	0	572	
48	2	1	8	1	24	
49	100	1	0	0	8722	
50	28	1	2	1	146	

2.2.3 Seagrass

A seagrass assessment was also undertaken in accordance with the WFD ecological assessment requirements for coastal waters. The premise of the seagrass assessment is to estimate the loss (or increase) of seagrass beds over a defined time period.

A single survey was undertaken of each of the seagrass beds in St.Aubin's Bay (East and West) in September 2012 which assessed the species present, coverage and total extent of the seagrass beds in each location. This information was compared with an earlier seagrass survey (2011).

Table 2.23 shows the results of the 2011 and 2012 seagrass surveys.

Table 2.23 Seagrass Assessments

<table>
<tr><th>Bed</th><th>Quadrat (m^2)</th><th>No. of Species</th><th>% Cover of Quadrat</th><th colspan="4">Total Extent of Seagrass Bed</th></tr>
<tr><td rowspan="15">East</td><td>1</td><td>1</td><td>10</td><th colspan="2">2011</th><th colspan="2">2012</th></tr>
<tr><td>2</td><td>1</td><td>6.5</td><th>Hectares</th><th>km^2</th><th>Hectares</th><th>km^2</th></tr>
<tr><td>3</td><td>1</td><td>5</td><td rowspan="13">26.7</td><td rowspan="13">0.267</td><td rowspan="13">29</td><td rowspan="13">0.29</td></tr>
<tr><td>4</td><td>1</td><td>5</td></tr>
<tr><td>5</td><td>1</td><td>10</td></tr>
<tr><td>6</td><td>1</td><td>32</td></tr>
<tr><td>7</td><td>1</td><td>32</td></tr>
<tr><td>8</td><td>1</td><td>40</td></tr>
<tr><td>9</td><td>1</td><td>5</td></tr>
<tr><td>10</td><td>1</td><td>50</td></tr>
<tr><td>11</td><td>1</td><td>10</td></tr>
<tr><td>12</td><td>1</td><td>20</td></tr>
<tr><td>13</td><td>1</td><td>50</td></tr>
<tr><td>14</td><td>1</td><td>30</td></tr>
<tr><td>15</td><td>1</td><td>24</td></tr>
<tr><td rowspan="6">West</td><td>16</td><td>1</td><td>12</td><td rowspan="6">81.2</td><td rowspan="6">0.812</td><td rowspan="6">81.4</td><td rowspan="6">0.814</td></tr>
<tr><td>17</td><td>1</td><td>32</td></tr>
<tr><td>18</td><td>1</td><td>21</td></tr>
<tr><td>19</td><td>1</td><td>21</td></tr>
<tr><td>20</td><td>1</td><td>33</td></tr>
<tr><td>21</td><td>1</td><td>27</td></tr>
</table>

2.2.4 Benthic Invertebrates

A summer (May 2012) and winter (October 2012) benthic invertebrate survey was undertaken over the period of the ecological monitoring programme in accordance with the WFD ecological monitoring requirements for coastal waters.

Benthic invertebrates were assessed at the central bay and port sites, but it was not possible to obtain sediment samples for benthic invertebrate analysis from the La Collette reclamation site. For this reason, benthic invertebrate assessments were additionally carried out at a further site, Elizabeth Castle, which is close to the port monitoring site (but outside of the port area).

In the May 2012 survey, three samples were obtained from each of the three monitoring sites and the numbers of benthic invertebrate species found in each sample recorded. The October 2012 survey was undertaken in the same way, however, only two samples were taken from the central bay site, and only one sample each from the port and Elizabeth Castle sites.

The results of the benthic invertebrate surveys are shown in Tables 2.24 and 2.25.

Table 2.24 Benthic Invertebrate Assessment (May 2012)

Benthic Invertebrate Taxon	No. of Individuals								
	Central Bay Site			Elizabeth Castle Site			Port Site		
	Sample A	Sample B	Sample C	Sample A	Sample B	Sample C	Sample A	Sample B	Sample C
Capitella capitata - Annelida	0	0	0	4	2	2	0	0	0
Euclymene oerstedii - Annelida	0	0	0	6	2	3	0	0	0
Galathowenia oculata - Annelida	2	0	3	0	0	0	1	0	0
Lanice conchilega - Annelida	0	0	0	3	2	1	0	0	0
Malacoseros fuliginosus - Annelida	0	0	0	0	0	0	0	1	0
Maldane sarsi - Annelida	0	0	0	2	3	0	0	0	0
Nephtys hombergi - Annelida	0	0	0	0	1	0	0	0	0
Nereis diversicolor - Annelida	0	0	0	0	0	0	1	0	1
Pygospio elegans - Annelida	0	2	3	17	11	8	0	0	0
Scoloplos armiger - Annelida	4	2	3	2	6	5	0	0	1
Spio sp. - Annelida	0	0	0	3	5	2	0	0	0
Tuberficoides benedii - Annelida	0	0	0	0	0	0	92	71	119
Unidentified Sp1 - Annelida	0	1	1	4	3	3	0	2	1
Unidentified Sp2 - Annelida	0	0	0	3	1	2	0	0	0
Unidentified Sp3 - Annelida	0	0	0	1	1	4	0	0	0
Ampelisca brevicornis - Crustacea	0	0	0	1	2	3	0	0	0
Bathyporeia nana - Crustacea	7	2	4	1	0	1	0	0	0
Corophium arenarium - Crustacea	0	0	0	0	1	0	0	0	0
Leucothoe incise - Crustacea	1	0	1	0	0	0	0	0	0
Leptosynapta galliennei - Echinodermata	0	0	0	0	0	1	0	0	0
Loripes lucinalis - Mollusca	0	0	0	2	1	1	0	0	0
Priapulus caudatus - Priapulida	0	0	0	0	0	0	0	1	0
Total No. of Specimens	**14**	**7**	**15**	**49**	**41**	**36**	**94**	**75**	**122**
Total No. of Taxa	**4**	**4**	**6**	**13**	**14**	**13**	**3**	**4**	**4**

Table 2.25 Benthic Invertebrate Assessment (October 2012)

Benthic Invertebrate Taxon	No. of Individuals			
	Central Bay Site		Elizabeth Castle Site	Port Site
	Sample A	Sample B	Sample A	Sample A
Capitella capitata - Annelida	0	0	7	0
Euclymene oerstedii - Annelida	0	0	0	0
Euclymene lumbricoides - Annelida	0	0	4	0
Galathowenia oculata - Annelida	2	6	0	0
Lanice conchilega - Annelida	0	0	2	0
Malacoseros fuliginosus - Annelida	0	0	0	0
Maldane sarsi - Annelida	0	0	1	0
Nephtys hombergi - Annelida	0	0	0	0
Nereis diversicolor - Annelida	0	0	0	0
Pygospio elegans - Annelida	0	0	14	0
Scoloplos armiger - Annelida	1	0	7	1
Terebellidae (*Amphrite figulus*?)	0	0	1	0
Spio sp. - Annelida	0	0	4	0
Tuberficoides benedii - Annelida	0	0	0	47
Unidentified Sp1 - Annelida	0	0	2	0
Unidentified Sp2 - Annelida	0	0	0	0
Unidentified Sp3 - Annelida	0	0	0	0
Unidentified Sp4 - Annelida	0	0	2	0
Unidentified Sp5 - Annelida	0	0	1	0
Cumopsis longipes - Crustacea	3	0	0	0
Apseudes latreillii - Crustacea	1	0	0	0
Idotea pelagica - Crustacea	1	0	1	0
Ampelisca brevicornis - Crustacea	0	0	5	1
Bathyporeia nana - Crustacea	0	0	0	0
Carcinius maenus - Crustacea	0	0	0	0
Corophium arenarium - Crustacea	0	0	0	0
Leucothoe incise - Crustacea	2	1	1	0
Urothoe brevicornis - Crustacea	0	0	2	0

Benthic Invertebrate Taxon	**No. of Individuals**			
	Central Bay Site		**Elizabeth Castle Site**	**Port Site**
	Sample A	**Sample B**	**Sample A**	**Sample A**
Nebalia bipes - Crustacea	0	0	1	0
Iphinoe trispinosa - Crustacea	0	0	1	0
Praunus flexuosus - Crustacea	0	0	1	0
Prionotoleberis norvegica - Crustacea	0	0	1	0
Crangon crangon - Crustacea	0	0	1	0
Leptosynapta galliennei - Echinodermata	0	0	1	0
Loripes lucinalis - Mollusca	0	0	0	0
Priapulus caudatus - Priapulida	0	0	0	0
Total No. of Specimens	**10**	**7**	**59**	**49**
Total No. of Taxa	**6**	**2**	**20**	**3**

2.2.5 Imposex in Dogwhelks

Imposex occurs in female dogwhelks when exposed to TBT, which is present in certain anti-foulant paints used on boats and ships. Whilst the use of TBT in anti-foulant paints has decreased markedly in recent years, largely as a result of an International Maritime Organisation (IMO) ban on their use, TBT is still found in coastal and estuarine waters and sediments in the UK, and UK dogwhelk populations continue to exhibit signs of exposure.

While TBT was not monitored in the St. Aubin's Bay sediment screening programme, it was measured in both the seawater and treated sewage effluent screening programmes, and was measured (above analytical limits of detection) in a single seawater sample taken from the port site. This suggests that TBT is present in the sediments at the port site, probably as a result of historic rather than current contamination, and can be measured in relatively high concentrations in seawater at this site when the sediment is disturbed (e.g. in bad weather).

The detection of TBT in seawater in the screening programme meant that it was necessary to undertake a survey to assess the degree of imposex in dogwhelk populations in St. Aubin's Bay, caused by exposure to TBT. Two separate dogwhelk surveys were undertaken (August and September 2012), and the results of both surveys were combined to assess the degree of imposex according to the requirements of the WFD ecological status assessment.

Table 2.26 shows the results of these surveys.

Imposex relates to the development of male reproductive structures in female dogwhelks as a result of exposure to TBT. The index used to measure the degree of imposex in a female dogwhelk is the Vas Deferens Sequence Stage (VDS). The VDS of an individual female dogwhelk relates to the degree of penis and vas deferens development, and ranges from no-effect (Stage 0) to an effect that can result in complete reproductive impairment or death of the snail (Stage 6). The Vas Deferens Sequence Index (VDSI) is the mean VDS for a population of sampled female dogwhelks, and indicates the degree of reproductive impairment of the dogwhelk population.

Table 2.26 Imposex Assessments

Specimen ID	Shell Length	Sex	Penis Length (mm)	Vas Deferens Stage (VDS)
1	27.4	F	0	0
2	32.6	F	1.0	3
3	28.8	M	3.0	NA
4	25.8	F	0	0
5	30.0	F	1.0	4
6	26.4	F	0	0
7	23.4	M	3.4	NA
8	29.2	F	0.6	3
9	24.5	M	3.0	NA
10	30.8	F	1.0	3
11	26.5	F	0	0

Specimen ID	**Shell Length**	**Sex**	**Penis Length (mm)**	**Vas Deferens Stage (VDS)**
12	28.9	M	3.4	NA
13	29.0	M	4.0	NA
14	31.6	M	3.1	NA
15	25.8	F	0	0
16	30.0	M	3.3	NA
17	26.4	F	0	0
18	28.2	M	3.2	NA
19	27.1	F	0.5	3
20	26.5	F	0	0
21	27.1	M	3.2	NA
22	25.3	M	3.8	NA
23	26.6	F	0	0
24	26.7	M	3.2	NA
25	27.6	M	3.3	NA
26	27.0	F	0	0
27	30.9	M	2.5	NA
28	25.5	M	2.8	NA
29	30.2	F	0	2
30	24.8	M	3.2	NA
31	25.9	F	0	0
32	26.6	F	0	0
33	27.0	M	3.2	NA
34	27.6	F	0	0
35	27.2	F	0	0
36	25.1	F	0	0
37	27.4	F	0.5	3
38	27.0	M	3.2	NA
39	24.6	M	3.4	NA
40	27.5	M	3.2	NA
41	26.1	M	3.3	NA
42	25.5	M	3.3	NA
43	26.1	F	0	0
44	30.0	F	0	0
45	27.9	M	3.0	NA
46	25.7	M	3.2	NA
47	25.7	M	3.2	NA
48	27.1	M	3.0	NA
49	23.2	F	0	0
50	25.3	M	3.0	NA
51	26.3	M	3.0	NA
52	25.8	F	1.0	3
53	26.3	M	3.1	NA
54	26.1	F	0	0
55	26.0	M	3.0	NA
56	37.7	F	0	0
57	26.0	M	3.0	NA

Specimen ID	Shell Length	Sex	Penis Length (mm)	Vas Deferens Stage (VDS)
58	26.2	F	0.5	3
59	28.6	M	3.4	NA
60	25.5	F	0	0
61	23.2	F	0	0
62	26.7	M	3.3	NA
63	23.9	M	3.0	NA
64	25.5	F	0	0
65	25.8	F	1.2	3
66	26.4	F	0	0
67	27.5	M	3.1	NA
68	25.1	M	3.3	NA
69	23.5	F	0	0
70	24.5	F	0	0
71	26.6	M	3.2	NA
72	30.6	M	3.4	NA
73	25.7	M	3.5	NA
74	26.5	M	3.2	NA
75	24.2	M	3.3	NA
76	25.6	M	3.8	NA
77	26.5	M	3.0	NA
78	23.7	M	2.4	NA
79	22.2	M	2.7	NA
80	29.8	F	0	0
81	26.6	F	0	0
82	24.8	F	0	0
83	25.1	M	3.0	NA
84	25.2	M	3.0	NA
85	27.0	M	2.8	NA
86	21.5	M	2.3	NA
87	27.1	M	3.0	NA
88	25.2	F	0	0
89	27.8	F	0	0
90	22.9	M	2.3	NA
91	24.9	M	2.6	NA
92	25.2	M	2.8	NA
93	23.5	M	2.5	NA
94	24.8	F	0	0
95	26.9	F	0	2
96	29.2	M	2.2	NA
97	29.4	F	0	0
98	23.3	F	0	0
99	25.8	F	0	0
100	28.4	F	0	0

Specimen ID	Shell Length	Sex	Penis Length (mm)	Vas Deferens Stage (VDS)
101	28.0	F	0	0
102	25.4	F	0	0
103	28.1	M	2.5	NA
104	29.5	F	0	0
105	27.0	M	3.2	NA
106	29.3	M	3.2	NA
107	26.1	F	0	0
108	24.4	M	2.6	NA
109	25.2	M	3.5	NA
110	27.7	F	0	0
Number of Females	**51**			
Total VDS	**32**			
VDS Index	**0.63**			

3 STATUS ASSESSMENTS

3.1 Chemical Status Assessment

The interim chemical status assessment is based the measured concentrations of those EU Priority Substances monitored in the longer term chemical monitoring programme at each site.

For each substance measured at each site, an annual average concentration has been calculated as the mean substance concentration across all the monthly seawater samples taken in the chemical monitoring programme.

Where the measured concentration of a substance in a sample was reported by the analysing laboratory as being less than the analytical limit of detection, the substance specific limit of detection multiplied by 0.5 has been used in the calculation of the annual average concentration.

The limit of detection is the minimum concentration of a substance in a sample that can be measured using the analytical detection method that has been applied to a sample for that substance. The concentration of a substance that is below the limit of detection in a sample cannot be quantified but may range from none (zero) up to the detection limit itself. Such so-called 'censored' analytical values present problems when attempting to calculate an average concentration for a substance for which there are results both above and below the limit of detection. 'Censored' values are therefore generally set at either zero or at half the limit of detection. For the calculation of WFD annual average concentrations, half the limit of detection is substituted for each 'censored' value unless the EQS against which the average concentration is compared is based on the sum of a number of different (related) substances, in which case zero is substituted for the 'censored' value.

3.1.1 Seawater

Tables 3.1 to 3.3 show the interim chemical status assessments for seawater for the three sites within St. Aubin's Bay.

Table 3.1 Chemical Status Assessment for Seawater at the Central Bay Site

Substance	No. of Samples Taken	Units	EQS	No. of Individual Samples Failing EQS (%)	Annual Average Concentration[2]	Interim Chemical Status Classification
Benzo (g,h,i) perylene	12	μgL^{-1}	0.00082[1]	12[3]	0.005	Less than Good[4]
DEHP	12	μgL^{-1}	1.3	0	0.167	Good
Diuron	12	μgL^{-1}	0.2	0	0.005	Good
Lead (Dissolved)	12	μgL^{-1}	1.3[1]	0	0.046	Good
Nonylphenol	12	μgL^{-1}	0.3	2[3]	0.187	Good
Octylphenol	12	μgL^{-1}	0.3	0	0.075	Good

[1] Proposed EQS
[2] Where individual analytical results reported as < LOD, the LOD * 0.5 has been used to calculate Annual Average concentration
[3] Failure of one or more samples based on LOD * 0.5 being greater than the EQS value
[4] Not a true failure but effect of (0.5 x LOD) > EQS. No substance detected in any samples down to LOD of analytical method.

The overall interim chemical status of the central bay site with respect to the concentrations of EU Priority Substances in seawater is considered to be 'Good'.

No benzo (g,h,i) perylene was detected in any of the seawater samples from the central bay site, and the apparent 'failure' of the EQS for this substance is an effect of half the limit of detection being greater than the EQS. However, because the limit of detection is insufficiently sensitive to assess the concentration of benzo (g,h,i) perylene against its EQS value, it is possible that the EQS was exceeded. Therefore, if a laboratory can be sourced that can offer a suitably sensitive analytical method for this substance we would recommend that any future chemical monitoring includes this substance to provide clarity on the compliance or non-compliance of environmental concentrations with the EQS value.

Table 3.2 Chemical Status Assessment for Seawater at the Port Site

Substance	No. of Samples Taken	Units	EQS	No. of Individual Samples Failing EQS (%)	Annual Average Concentration[2]	Interim Chemical Status Classification
Lead (Dissolved)	13	μgL^{-1}	1.3[1]	0	0.102	Good
Nickel (Dissolved)	11	μgL^{-1}	8.6	0	0.178	Good
TBT	10	μgL^{-1}	0.0002	1	0.0003	Less than good[3]

[1] Proposed EQS
[2] Where individual analytical results reported as < LOD, the LOD * 0.5 has been used to calculate Annual Average concentration
[3] Failure partly caused by effect of (0.5 x LOD) > EQS, however, one sample = > LOD & EQS and considered a 'true' exceedance. Confidence of failure based on all results =0.95 but failure remains uncertain owing to the predominance of < LOD values in the dataset.

The overall interim chemical status of the port site with respect to the concentrations of EU Priority Substances in seawater is considered to be 'Good'.

TBT was detected in only one seawater sample from the port site. While the apparent 'failure' of the EQS for this substance is partly an effect of half the limit of detection being greater than the EQS, the single detection of TBT significantly exceeded the EQS value. Because of the magnitude of this single exceedance, the failure of the annual average concentration to meet the EQS value must be considered valid. However, where the annual average concentration of a substance exceeds the EQS, it is necessary to assess the confidence of this failure by evaluating the distribution of the individual measurements used to calculate the annual average (this allows account to be taken of potential errors and uncertainties in the sampling and analysis processes). Generally, a confidence of failure which is less than 95% (0.95) is considered uncertain, and would not result in improvement measures.

This confidence of the TBT failure for this assessment is 0.9489 (i.e. 0.95) and therefore this EQS failure would generally be considered to be certain. However, despite the high single exceedence, we do not consider the annual average value to be reliable owing to the predominance of censored values in the dataset, and therefore we have not proposed an interim chemical status classification based on this apparent EQS failure. We recommend that any future chemical monitoring in the port includes TBT to allow an assessment of the frequency of failure of the EQS over a longer timescale. For example, a single further exceedance of the EQS would suggest that the chemical status of the port (based on TBT) is less than 'Good', while a further 12 months of monitoring with no exceedances would confirm that the apparent EQS failure should not be considered significant.

Table 3.3 Chemical Status Assessment for Seawater at the La Collette Site

Substance	No. of Samples Taken	Units	EQS	No. of Individual Samples Failing EQS (%)	Annual Average Concentration[2]	Interim Chemical Status Classification
Cadmium (Dissolved)	11	μgL^{-1}	0.2	0	0.023	Good
Lead (Dissolved)	12	μgL^{-1}	1.3[1]	1	0.244	Good
Naphthalene	11	μgL^{-1}	2	0	0.011	Good
Nickel (Dissolved)	11	μgL^{-1}	8.6	0	0.596	Good

[1] Proposed EQS
[2] Where individual analytical results reported as < LOD, the LOD * 0.5 has been used to calculate Annual Average concentration

The overall interim chemical status of the La Collette reclamation site with respect to the concentrations of EU Priority Substances in seawater is considered to be 'Good'.

3.1.2 Biota

Since only three or four separate samples of slipper limpets were taken across the whole of the bay within the biota monitoring programme, the results from all the sites have been combined in order to allow the calculation of annual average values.

Table 3.4 shows the interim chemical status assessment for biota in St. Aubin's Bay.

Table 3.4 Chemical Status Assessment for Biota in St.Aubin's Bay

<table>
<tr><th>Substance</th><th>No. of Samples Taken</th><th>Units</th><th>EQS</th><th>No. of Individual Samples Failing EQS (%)</th><th>Annual Average Concentration[2]</th><th>Interim Chemical Status Classification</th></tr>
<tr><td>Benzo(a) pyrene</td><td>3</td><td>$\mu g\ kg^{-1}$ wet weight</td><td rowspan="4">Σ = 10[1]</td><td rowspan="4">0</td><td rowspan="4">Σ = 0.75</td><td rowspan="4">Good</td></tr>
<tr><td>Benzo(b) fluoranthene</td><td>3</td><td>$\mu g\ kg^{-1}$ wet weight</td></tr>
<tr><td>Benzo(k) fluoranthene</td><td>3</td><td>$\mu g\ kg^{-1}$ wet weight</td></tr>
<tr><td>Indeno(1,2,3-cd) pyrene</td><td>3</td><td>$\mu g\ kg^{-1}$ wet weight</td></tr>
<tr><td>Fluoranthene</td><td>4</td><td>$\mu g\ kg^{-1}$ wet weight</td><td>30</td><td>0</td><td>1.31</td><td>Good</td></tr>
<tr><td>Mercury</td><td>4</td><td>$\mu g\ kg^{-1}$ wet weight</td><td>20</td><td>0</td><td>10.8</td><td>Good</td></tr>
</table>

[1] Proposed EQS
[2] Where individual analytical results reported as < LOD, the LOD * 0.5 has been used to calculate Annual Average concentration

The overall interim chemical status of St. Aubin's Bay with respect to the concentrations of EU Priority Substances in biota is considered to be 'Good'.

3.2 Ecological Status

3.2.1 Physico-Chemical Indicators

The interim ecological status of the bay according to the physico-chemical parameters, dissolved oxygen and total inorganic nitrogen has been assessed based on all measurements made across all three seawater sampling sites. The results of this assessment are shown in Table 3.5, below.

Table 3.5 Physico-Chemical Assessment for St. Aubin's Bay

Determinand	Units	No. of Samples	Result	Interim Ecological Status
Dissolved Oxygen	mgL^{-1}	39	7.15[1]	High
Total Inorganic Nitrogen	$\mu molL^{-1}$	12	9.55[2]	Good

[1] 5^{th} Percentile; All individual measurements normalised to a salinity of 35 ‰ based on measured salinity of each sample.
[2] Mean of all measurements from samples taken between Nov 2012 and Feb 2013; 0.5 * LOD used to calculate mean where individual results < LOD.

Ecological status assessments based on inorganic nitrogen concentration are generally based on dissolved inorganic nitrogen (DIN), however, the seawater samples taken from the sites in St. Aubin's Bay were not filtered and therefore only total inorganic nitrogen was measured. The inorganic nitrogen status assessment therefore represents a worst-case (i.e. TIN > DIN).

The ecological status of coastal waterbodies is generally evaluated using the inorganic nitrogen concentrations measured in samples taken between November and February at a coastal salinity of 30-34.5 ‰. The salinity of the waters in St. Aubin's Bay is, however, consistently in excess of 34.5 ‰.

The measured relationship between salinity and inorganic nitrogen concentration could not be determined owing to the pre-dominance of censored values in the dataset (only two of the twelve measurements were reported as greater than the limit of detection for the analytical method), the use of measurements of TIN rather than DIN, and the high salinities of the waters in the bay.

In addition, the turbidity of the waters were determined qualitatively, rather than by measuring the concentration of suspended solids, which did not allow the measured TIN result to be compared with a turbidity-adjusted standard value.

Nevertheless, the coastal water standards have been applied (with no salinity adjustment and assuming 'clear' turbidity) and result in an interim ecological status of 'Good' for inorganic nitrogen.

These results are discussed further in Section 4.2.

3.2.2 Specific Pollutants

The Specific Pollutant ecological status assessment is based on the measured concentrations of those UK Specific Pollutants monitored in the longer term chemical monitoring programme at each site.

For each substance measured at each site, an annual average concentration has been calculated as the mean substance concentration across all the monthly seawater samples taken in the chemical monitoring programme.

Where the measured concentration of a substance in a sample was reported as being less than the analytical limit of detection, the limit of detection multiplied by 0.5 was used in the calculation of the annual average concentration.

Tables 3.6 to 3.8 show the interim ecological status assessments according to UK Specific Pollutants for seawater for the three sites within St. Aubin's Bay.

Table 3.6 Specific Pollutant Assessment for Seawater at the Central Bay Site

Substance	No. of Samples Taken	Units	EQS	No. of Individual Samples Failing EQS (%)	Annual Average Concentration*	Interim Ecological Status
2,4 Dichlorophenol	12	μgL^{-1}	20	0	0.01	Good
2,4 D	12	μgL^{-1}	0.3	0	0.0025	Good
Ammonia (unionized)	12	μgL^{-1}	21	3	14.3	Good
Arsenic (Dissolved)	12	μgL^{-1}	25	0	1.35	Good
Copper (Dissolved)	12	μgL^{-1}	5	0	0.1804	Good
Mecoprop	12	μgL^{-1}	18	0	0.0025	Good
Zinc (Dissolved)	12	μgL^{-1}	40	0	1.14	Good

* Where individual analytical results reported as < LOD, the LOD * 0.5 has been used to calculate Annual Average concentration

The overall interim ecological status of the central bay site with respect to the concentrations of UK Specific Pollutants is considered to be 'Good'.

Table 3.7 Specific Pollutant Assessment for Seawater at the Port Site

Substance	No. of Samples Taken	Units	EQS	No. of Individual Samples Failing EQS (%)	Annual Average Concentration*	Interim Ecological Status
Ammonia (unionized)	12	μgL^{-1}	21	1	10.2	Good
Arsenic (Dissolved)	12	μgL^{-1}	25	0	1.43	Good
Copper (Dissolved)	13	μgL^{-1}	5	0	0.533	Good
Zinc (Dissolved)	13	μgL^{-1}	40	0	2.404	Good

* Where individual analytical results reported as < LOD, the LOD * 0.5 has been used to calculate Annual Average concentration

The overall interim ecological status of the port site with respect to the concentrations of UK Specific Pollutants is considered to be 'Good'.

Table 3.8 Specific Pollutant Assessment for Seawater at the La Collette Site

Substance	No. of Samples Taken	Units	EQS	No. of Individual Samples Failing EQS (%)	Annual Average Concentration*	Interim Ecological Status
Ammonia (unionized)	12	μgL^{-1}	21	0	9.42	Good
Arsenic (Dissolved)	12	μgL^{-1}	25	0	1.44	Good
Copper (Dissolved)	12	μgL^{-1}	5	1	1.04	Good
Zinc (Dissolved)	12	μgL^{-1}	40	1	6.14	Good

* Where individual analytical results reported as < LOD, the LOD * 0.5 has been used to calculate Annual Average concentration

The overall interim ecological status of the La Collette reclamation site with respect to the concentrations of UK Specific Pollutants is considered to be 'Good'.

3.2.3 Phytoplankton

The ecological assessment according to phytoplankton is an indicator of nutrient pressures on a waterbody, and is based on three separate metrics.

The bloom frequency is a measure of the frequency of which the overall phytoplanktonic density exceeds certain threshold levels. A high frequency of phytoplanktonic blooming is an indicator of excess nutrients being available in the waterbody.

The seasonal succession of phytoplankton is based on the exceedance of specific temporal boundary values for the numbers of diatom and dinoflagellate cells. Exceedance of these boundary values indicates excessive growth caused by eutrophication.

The biomass is simply a measure of the total density of phytoplankton in a sample, based on the total concentration of chlorophyll-a.

3.2.3.1 Bloom Frequency

Table 3.9 shows the results of the bloom frequency assessment for St. Aubin's Bay. Since none of the bloom frequency indicators were elevated above their respective threshold values at any of the sites across the entire assessment period (12 months), the results have been tabulated for the bay as a whole rather than split into separate sites.

Table 3.9 Bloom Frequency Assessment for St. Aubin's Bay

Metric	No. of Samples[1]	Measurement	Value
Chlorophyll Bloom Frequency	36	Percentage of samples with chlorophyll a > 10 µg/L	0
Individual Taxa Bloom Frequency	36	Percentage of samples with any single taxa > 250,000 cells per litre	0
Total Taxa Bloom Frequency	36	Percentage of samples with total phytoplankton > 1,000,000 cells per litre	0
Phaeocystis Bloom Frequency	36	Percentage of samples with *Phaeocystis* > 1,000,000 cells per litre	0
Combined Bloom Frequency	36	Mean of individual metrics	0
Reference Value	10		
Ecological Quality Ratio (EQR)[2]	1.11		
Normalised EQR[3]	1.06		
Interim Ecological Status	**High**		

[1] 12 months, all 3 sites
[2] (100-[Combined Bloom Frequency])/(100-[Reference Value])
[3] Normalised according to the River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions to the Environment Agency (2009) in order to place all the three phytoplankton metrics onto the same scale.

Based on similar surveys undertaken in the UK, the outcome of the bloom frequency assessment for St. Aubin's Bay is unusual. Such surveys in the UK generally indicate the exceedance of one or more of the bloom frequency indicator thresholds, even if the overall frequency is low (and therefore the status is 'High' to 'Good'). This could, therefore, be an indication of potential issues with the sampling or preservation of samples for phytoplankton analysis.

Based on the face value assessment of these results, the interim ecological status of the bloom frequency metric is considered to be 'High'.

These results are discussed further in Section 4.2.

3.2.3.2 Seasonal Succession

Tables 3.10 to 3.12 show the seasonal succession assessments for the three seawater sampling sites in St. Aubin's Bay.

Table 3.10 Seasonal Succession Assessment for Diatom Species in St. Aubin's Bay

Site	Month	Total Number Diatom Cells per Litre	Y-value[1]	Z-value[2]	Seasonal Reference Upper Bound	Total Number of Samples	% of Samples with Z< upper bound
Central Bay	April 2012	14143	9.56	1.93	0.39	12	0
	May 2012	27857	10.23	2.29	0.95		
	June 2012	24071	10.09	2.22	1.43		
	July 2012	10500	9.26	1.78	1.26		
	August 2012	51143	10.84	2.62	1.07		
	September 2012	50571	10.83	2.61	0.58		
	October 2012	9077	9.11	1.70	0.05		
	November 2012	6077	8.71	1.49	-0.17		
	December 2012	8880	9.09	1.69	-0.17		
	January 2013	4600	8.43	1.34	-0.12		
	February 2013	10462	9.26	1.78	-0.16		
	March 2013	227790	12.34	3.41	-0.06		
Port	April 2012	10143	9.22	1.76	0.39	12	0
	May 2012	25286	10.14	2.24	0.95		
	June 2012	31571	10.36	2.36	1.43		
	July 2012	31429	10.36	2.36	1.26		
	August 2012	71857	11.18	2.79	1.07		
	September 2012	70000	11.16	2.78	0.58		
	October 2012	17462	9.77	2.05	0.05		
	November 2012	7462	8.92	1.60	-0.17		
	December 2012	8040	8.99	1.64	-0.17		
	January 2013	5460	8.61	1.43	-0.12		
	February 2013	8346	9.03	1.66	-0.16		
	March 2013	218603	12.30	3.38	-0.06		
La Colette	April 2012	10571	9.27	1.78	0.39	12	0
	May 2012	36783	10.51	2.44	0.95		

Site	Month	Total Number Diatom Cells per Litre	Y-value[1]	Z-value[2]	Seasonal Reference Upper Bound	Total Number of Samples	% of Samples with Z< upper bound
	June 2012	22214	10.01	2.17	1.43		
	July 2012	84786	11.35	2.88	1.26		
	August 2012	57429	10.96	2.68	1.07		
	September 2012	85429	11.36	2.89	0.58		
	October 2012	11192	9.32	1.81	0.05		
	November 2012	13615	9.52	1.91	-0.17		
	December 2012	2090	7.64	0.92	-0.17		
	January 2013	8620	9.06	1.67	-0.12		
	February 2013	6577	8.79	1.53	-0.16		
	March 2013	233052	12.36	3.42	-0.06		

[1] Y=Ln [Cells per Litre]

[2] Z=(Y–P)/S, where P = Set Reference Mean for Y (5.90) and S = Set Reference Standard Deviation for Y (1.89)

Table 3.11 Seasonal Succession Assessment for Dinoflagellate Species in St. Aubin's Bay

Site	Month	Total Number Dinoflagellate Cells per Litre	Y-value[1]	Z-value[2]	Seasonal Reference Upper Bound	Total Number of Samples	% of Samples with Z< upper bound
Central Bay	April 2012	0 (1[3])	0	-3.25	0.44	12	66.7
	May 2012	10709	9.28	2.78	0.63		
	June 2012	0 (1[3])	0	-3.25	0.88		
	July 2012	0 (1[3])	0	-3.25	0.86		
	August 2012	0 (1[3])	0	-3.25	0.92		
	September 2012	5498	8.61	2.35	1.18		
	October 2012	0 (1[3])	0	-3.25	0.48		
	November 2012	0 (1[3])	0	-3.25	0.15		
	December 2012	0 (1[3])	0	-3.25	-0.19		
	January 2013	140	4.94	-0.04	-0.11		
	February 2013	0 (1[3])	0	-3.25	0.05		
	March 2013	1083	6.99	1.29	0.06		
Port	April 2012	0 (1[3])	0	-3.25	0.44	12	83.3
	May 2012	143	4.96	-0.02	0.63		
	June 2012	16135	9.69	3.04	0.88		
	July 2012	0 (1[3])	0	-3.25	0.86		
	August 2012	0 (1[3])	0	-3.25	0.92		
	September 2012	143	4.96	-0.02	1.18		
	October 2012	0 (1[3])	0	-3.25	0.48		
	November 2012	0 (1[3])	0	-3.25	0.15		
	December 2012	0 (1[3])	0	-3.25	-0.19		
	January 2013	60	4.09	-0.59	-0.11		
	February 2013	0 (1[3])	0	-3.25	0.05		
	March 2013	561	6.33	0.86	0.06		
La Colette	April 2012	286	5.65	0.43	0.44	12	91.7
	May 2012	0 (1[3])	0	-3.25	0.63		
	June 2012	0 (1[3])	0	-3.25	0.88		
	July 2012	0 (1[3])	0	-3.25	0.86		
	August 2012	0 (1[3])	0	-3.25	0.92		

Site	Month	Total Number Dinoflagellate Cells per Litre	Y-value[1]	Z-value[2]	Seasonal Reference Upper Bound	Total Number of Samples	% of Samples with Z< upper bound
	September 2012	143	4.96	-0.02	1.18		
	October 2012	0 (1[3])	0	-3.25	0.48		
	November 2012	0 (1[3])	0	-3.25	0.15		
	December 2012	20	3.00	-1.30	-0.19		
	January 2013	40	3.69	-0.85	-0.11		
	February 2013	0 (1[3])	0	-3.25	0.05		
	March 2013	1567	7.36	1.53	0.06		

[1] Y=Ln [Cells per Litre]
[2] Z=(Y–P)/S, where P = Set Reference Mean for Y (5.00) and S = Set Reference Standard Deviation for Y (1.54)
[3] No dinoflagellates measured in sample, default of 1 cell per Litre used to undertake calculations

Table 3.12 Overall Seasonal Succession Assessment for St. Aubin's Bay

Site	Season Succession Indicator[1]	Reference Value	Ecological Quality Ratio (EQR)[2]	Normalised EQR[3]	Interim Ecological Status
Central Bay	33.3	80	0.42	0.34	Poor
Port	41.7		0.52	0.42	Moderate
La Collette	45.8		0.57	0.46	Moderate
Overall St. Aubin's Bay	**NA**	**NA**	**NA**	**0.41[4]**	**Moderate**

[1] [% of samples with diatom Z-score < upper bound + % of samples with dinoflagellate < upper bound] / 2
[2] [Seasonal Succession Indicator] / Reference Value
[3] Normalised according to the River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions to the Environment Agency (2009) in order to place all the three phytoplankton metrics onto the same scale.
[4] Mean of normalised EQRs for each individual site

As with the bloom frequency, the lack of any dinoflagellates in some seawater samples is a cause for concern, and may suggest some issues with sampling or the preservation of samples. This means that the majority of samples do not display elevated dinoflagellate numbers.

The seasonal succession assessment for diatoms does, however, indicate elevated cell numbers across the entire 12 months of sampling. This is a strong indicator of nutrient enrichment.

The interim ecological status according to seasonal succession for each site is based on the average of the elevated cell numbers across both groups of phytoplankton, and the overall ecological status for the bay is the average of the EQR values for all three sites. Based on the face value assessment of these results, the interim ecological status of the seasonal succession metric is considered to be 'Moderate'.

This may be a conservative assessment, and if further monitoring suggests that there are also elevated numbers of dinoflagellates at sites within the bay, the overall ecological status for seasonal succession is likely to be less than 'Moderate'.

These results are discussed further in Section 4.2.

3.2.3.3 Biomass

Table 3.13 shows the phytoplankton biomass assessment for the three seawater sampling sites in St. Aubin's Bay.

Table 3.13 Phytoplankton Biomass Assessment for St. Aubin's Bay

Site	No. of Samples	Chlorophyll-a (μgL^{-1}, 90th Percentile)[1]	Reference Value	Ecological Quality Ratio (EQR)[2]	Normalised EQR[3]	Interim Ecological Status
Central Bay	8	0.94	6.67	7.07	1	High
Port	8	1.06		6.29	1	High
La Collette	8	0.93		7.15	1	High
Overall St. Aubin's Bay	**NA**	**NA**	**NA**	**NA**	**1[4]**	**High**

[1] Growing season (March to April)
[2] Reference Value / [Chlorophyll-a]
[3] Normalised according to the River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions to the Environment Agency (2009) in order to place all the three phytoplankton metrics onto the same scale.
[4] Mean of normalised EQRs for each individual site

As with the low numbers of phytoplankton cells indicated by the bloom frequency assessment and the dinoflagellate element of the seasonal succession assessment, the chlorophyll-a concentrations of seawater samples (indicating total phytoplankton biomass)are much lower than would be expected based on the results of similar surveys undertaken in the UK. This may suggest an issue with the sampling of seawater samples, the filtration of samples to obtain chlorophyll-a samples or the storage of the chlorophyll-a samples following sample filtration.

Based on the face value assessment of these results, the interim ecological status of the phytoplankton biomass metric is considered to be 'High'.

These results are discussed further in Section 4.2.

3.2.3.4 Summary of Phytoplankton Assessments

Table 3.14 summarises the overall interim ecological status of the bay according to phytoplankton, based on the data obtained in the St. Aubin's Bay monitoring programme. The results are presented as overall interim status assessments for each metric (across all three sites) and for each site (across all three metrics).

Table 3.14 Overall Ecological Status of St. Aubin's Bay for Phytoplankton

Metric	Site	Normalised EQR	Mean EQR	Interim Ecological Status
Biomass	Central Bay	1	1	High
	Port	1		
	La Collette	1		
Bloom Frequency	Central Bay	1.06	1.06	High
	Port	1.06		
	La Collette	1.06		
Seasonal Succession	Central Bay	0.34	0.41	Moderate
	Port	0.42		
	La Collette	0.46		
Site	**Metric**	**Normalised EQR**	**Mean value**	**Interim Ecological Status**
Central Bay	Biomass	1	0.8	High
	Bloom Frequency	1.06		
	Seasonal Succession	0.34		
Port	Biomass	1	0.83	High
	Bloom Frequency	1.06		
	Seasonal Succession	0.42		
La Collette	Biomass	1	0.84	High
	Bloom Frequency	1.06		
	Seasonal Succession	0.46		
Overall Interim Ecological Status for Phytoplankton*	**0.82**	**High**		

*Mean for across all metrics and all sites

While the metric-specific assessment for seasonal succession indicates 'Moderate' ecological status, the other two metrics indicate 'High' ecological status. When the EQR results are averaged across each site, the lack of response for the biomass and bloom frequency indicators balance the effects measured for diatoms in the seasonal succession assessment, and the overall interim status for all three sites (and therefore the bay as a whole) is 'High'. This suggests minimal impacts by nutrient enrichment.

These results are discussed further in Section 4.2.

Ecological status assessment for phytoplankton generally requires a minimum of two years monitoring data to ensure that representative conditions are captured. We would therefore recommend that the phytoplankton monitoring programme is extended for at least a further 12 months, and that the results of this extended survey are combined with the results presented here to update the status assessments.

3.2.4 Macroalgae

The ecological assessment according to macroalgae is an indicator of nutrient pressures on a waterbody. The assessment is based on two separate indicators for which the ecological status is derived independently.

The rocky shore macroalgal assessment is a measure of the total number of seaweed species and the relative proportions of different groups of seaweed species at a site. This assessment is based on five metrics: the total number of different taxa, proportion of chlorophytes, proportion of rhodophytes, proportion of opportunistic taxa and the ratio of certain indicator taxa split into two 'ecological status groups' (ESG). These metrics are combined in the final ecological status assessment for a site.

The opportunistic macroalgal assessment measures the extent of beds and biomass for opportunistic intertidal seaweed species. This opportunistic seaweed assessment is also split into five metrics: the total extent of macroalgal beds, cover of available intertidal habitat, biomass of opportunistic macroalgal mats, biomass over the available intertidal habitat and the proportion of entrained algae. The metrics are combined to derive the final ecological status assessment for a site.

3.2.4.1 Rocky Shore Macroalgae

Tables 3.15 and 3.16 show the results of the interim ecological status assessment for rocky shore macroalgae.

Table 3.15 Rocky Shore Macroalgae Assessment for St. Aubin's Bay

Metric		Site / Value		
		St. Aubin's Fort	Elizabeth Castle	Beach Rock
Number of Taxa		13	21	13
Normalised Number of Taxa[1]		13.91	22.47	13.91
Number of Chlorophyta		3	3	2
Proportion of Chlorophyta		0.23	0.14	0.15
Number of Rhodophyta		4	11	7
Proportion of Rhodophyta		0.31	0.52	0.54
Number of Opportunistic Taxa		3	3	3
Proportion of Opportunistic Taxa		0.23	0.14	0.23
Number of ESG1		8	10	5
Number of ESG2		5	11	8
ESG Ratio		1.60	0.91	0.63
Ecological Quality Ratios (EQRs)	**Reference Value**			
Number of Normalised Taxa[2]	35	0.40	0.64	0.40
Proportion of Chlorophyta[3]	0.15	0.90	1.01	1.00
Proportion of Rhodophyta[4]	0.55	0.56	0.95	0.98
Proportion of Opportunistic Taxa[5]	0.1	0.85	0.95	0.85
ESG Ratio[6]	1	1.60	0.91	0.63

[1] [Number of Taxa] * [Shore Correction Factor]; A Shore Correction Factor of 1.07 was derived according to Tables 1 and 2 of UKTAG Coastal Water Assessment Methods: Macroalgae - Rocky Shore Reduced Species List (2009).

[2] [Normalised Number of Taxa] / Reference Value

[3] (1-[Proportion of Chlorophyta]) / (1-Reference Value)

[4] [Proportion of Rhodophyta] / Reference Value

[5] (1-[Proportion of Opportunistic Taxa]) / (1-Reference Value)

[6] [ESG Ratio] / Reference Value

Table 3.16 summarises the overall interim ecological status of the bay according to rocky shore macroalgae, based on the data obtained in the St. Aubin's Bay monitoring programme. The results are presented as overall interim status assessments for each metric (across all three sites) and for each site (across all five metrics).

Table 3.16 Overall Ecological Status of St. Aubin's Bay for Rocky Shore Macroalgae

Metric	Site	Normalised EQR[1]	Mean EQR	Interim Ecological Status
Normalised Number of Taxa	St. Aubin's Fort	0.34	0.41	Moderate
	Elizabeth Castle	0.54		
	Beach Rock	0.34		
Proportion of Chlorophyta	St. Aubin's Fort	0.58	0.73	Good
	Elizabeth Castle	0.81		
	Beach Rock	0.8		
Proportion of Rhodophyta	St. Aubin's Fort	0.35	0.62	Good
	Elizabeth Castle	0.75		
	Beach Rock	0.76		
Proportion of Opportunistic Taxa	St. Aubin's Fort	0.42	0.49	Moderate
	Elizabeth Castle	0.62		
	Beach Rock	0.42		
ESG Ratio	St. Aubin's Fort	1	0.69	Good
	Elizabeth Castle	0.71		
	Beach Rock	0.37		
Site	**Metric**	**Normalised EQR**	**Mean value**	**Interim Ecological Status**
St. Aubin's Fort	Normalised Number of Taxa	0.34	0.54	Moderate
	Proportion of Chlorophyta	0.58		
	Proportion of Rhodophyta	0.35		
	Proportion of Opportunistic Taxa	0.42		
	ESG Ratio	1		
Elizabeth Castle	Normalised Number of Taxa	0.54	0.69	Good
	Proportion of Chlorophyta	0.81		
	Proportion of Rhodophyta	0.75		
	Proportion of Opportunistic Taxa	0.62		
	ESG Ratio	0.71		

Site	Metric	Normalised EQR	Mean value	Ecological Status
Beach Rock	Normalised Number of Taxa	0.34	0.54	Moderate
	Proportion of Chlorophyta	0.8		
	Proportion of Rhodophyta	0.76		
	Proportion of Opportunistic Taxa	0.42		
	ESG Ratio	0.37		
Overall Interim Ecological Status for Rocky Shore Macroalgae[2]	**0.59**	**Moderate**		

[1] Normalised according to the River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions to the Environment Agency (2009) in order to place all the three phytoplankton metrics onto the same scale.
[2] Mean for across all metrics and all sites

The metric-specific assessment for number of taxa and proportion of opportunistic taxa indicate 'Moderate' interim ecological status, while the other three rocky shore metrics indicate Good' interim ecological status. When the EQR results are averaged across each site, the 'Moderate' status assessments are sufficiently low to result in an overall 'Moderate' ecological status for the St. Aubin's Fort and Beach Rock sites, but the Elizabeth Castle site appears not to be impacted overall, with a 'good' overall interim status.

The overall interim ecological status for the bay as a whole is 'Moderate' for rocky shore macroalgae. Given that the driving metrics in this assessment are number of taxa and proportion of opportunistic macroalgae, this suggests that opportunistic species are colonising the available rocky shore habitat at the expense of slower growing species, resulting in a reduction in the taxomonic diversity of rocky shore species.

These results are discussed further in Section 4.2.

3.2.4.2 Opportunistic Macroalgae

Table 3.17 shows the results of the ecological status assessment for opportunistic intertidal macroalgae. This assessment was undertaken as a single survey encompassing the entire intertidal habitat for opportunistic seaweed in the bay.

Table 3.17 Opportunistic Macroalgae Assessment for St. Aubin's Bay

Metric	Value	Units	Reference Value	Ecological Quality Ratio (EQR)	Normalised EQR[1]	Interim Ecological Status
Total Extent of Macroalgal Bed	78.75	Hectares	10	0.87[2]	0.49	Moderate
Cover of Available Intertidal Habitat	33.33	Percent	5	0.70[3]	0.36	Poor
Biomass of Opportunistic Macroalgal Mats	1334.36	g Wet Weight m^{-2}	100	0.79[4]	0.36	Poor
Biomass over the Available Intertidal Habitat	444.72	g Wet Weight m^{-2}	100	0.94[5]	0.62	Good
Proportion of Entrained Algae	19.97	Percent	1	0.81[6]	0.4	Moderate
Overall Ecological Status for Opportunistic Macroalgae	**NA**	**NA**	**NA**	**NA**	**0.45[7]**	**Moderate**

[1] Normalised according to the River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions to the Environment Agency (2009) in order to place all the three phytoplankton metrics onto the same scale.
[2] (551-[Total Extent of Macroalgal Bed]) / (551-Reference Value)
[3] (100-[Cover of Available Intertidal Habitat]) / (100-Reference Value)
[4] (6000-[Biomass of Opportunistic Macroalgal Mats]) / (6000-Reference Value)
[5] (6000-[Biomass over Available Interidal Habitat]) / (6000-Reference Value)
[6] (100-[Proportion of Entrained Algae]) / (100-Reference Value)
[7] Mean for across all metrics and all sites

The opportunistic macroalgae metrics 'cover of available intertidal habitat' and 'biomass of opportunistic macroalgal mats' both indicate 'Poor' interim ecological status. This suggests significant localised eutrophication is causing excessive growth of intertidal seaweed, although this interim status will need to be confirmed by further monitoring.

In addition, the metrics 'total extent of macroalgal bed' and 'proportion of entrained algae' indicate that the interim ecological status of the bay according to this indicator is 'Moderate'. The EQR boundary between 'Moderate' and 'Poor' ecological status for opportunistic macroalgae is 0.4 and therefore the interim ecological status of the 'proportion of entrained algae' metric can be considered to be 'borderline' between 'Poor' and 'Moderate'.

The interim ecological status for 'biomass over the available intertidal habitat' metric indicates 'Good' interim ecological status, which balances the poorer assessments to some degree and results in an overall interim status assessment for the whole bay (across all the metrics) as 'Moderate'.

These results indicate that the surface cover of the intertidal habitat by opportunistic intertidal seaweed beds in the bay is highly elevated (compared to reference conditions), and that where this seaweed is present its biomass is also elevated. There are also more modest elevations of the total size of the macroalgal bed and the proportion of algae growing into the substrate. The estimated biomass of algae over the whole available intertidal habitat does not, however, appear to be impacted.

Taking these outcomes as a whole, this could suggest that the most excessive growth of opportunistic macroalgae is relatively localised in certain areas of the available intertidal habitat, possibly in the area that receives the sewage treated effluent at low tide. In addition, there is some overall enlargement of the macroalgal beds and increased entrainment of algae across the entire intertidal habitat. As outlined above, these interim assessments will need to be confirmed by further monitoring.

These results are discussed further in Section 4.2.

3.2.5 Seagrass

The ecological assessment according to seagrass is an indicator of nutrient pressures on a coastal waterbody. Seagrass beds are particularly sensitive to the secondary pressures of nutrient enrichment and may decrease in size and diversity owing to encroachment by opportunistic macroalgae or shading by phytoplankton.

The seagrass assessment is a measure of the total extent and shoot cover, and taxonomic diversity, of seagrass beds. This assessment is based on three metrics: taxonomic composition, shoot loss and reduction in extent of seagrass beds. These metrics are combined in the final ecological status assessment for a site.

There are two distinct beds of seagrass in St. Aubin's Bay, one in the east and one in the west, and these were assessed separately in a single survey (2012) which was compared with a previous survey carried out in 2011.

Table 3.18 shows the results of the ecological status assessment for seagrass in St. Aubin's Bay.

Table 3.18 Seagrass Assessment for St. Aubin's Bay

Metric	Site	Value	Units	Reference Value	Ecological Quality Ratio (EQR)[5]	Normalised EQR[1]	Interim Ecological Status
Taxonomic Composition[2]	East Bed	0	Percent	25	1.33	1	High
	West Bed	0			1.33	1	High
Shoot Loss[3]	East Bed	-9.83		10	1.11	1	High
	West Bed	-21.67			1.22	1	High
Extent Loss[4]	East Bed	-8.61		10	1.11	1	High
	West Bed	-0.25			1.21	1	High
Overall Ecological Status for Seagrass	**NA**	**NA**	**NA**	**NA**	**NA**	**1[6]**	**High**

[1] Normalised according to the River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions to the Environment Agency (2009) in order to place all the three phytoplankton metrics onto the same scale.
[2] 100*(1-([Number Seagrass Species Present] / [Number Seagrass Species Expected])); Number of Seagrass Species expected = 1
[3] 100*(([2011 Shoot Cover]-[2012 Shoot Cover]) / [2011 Shoot Cover]); Estimate of 20% used for 2011 Shoot Cover based on slight increase in size of beds between 2011 and 2012
[4] 100*([2011 Area of bed]-[2012 Area of bed]) / [2011 Area of bed]
[5] All EQRs calculated as (100-[observed value]) / (100-[reference value])
[6] Mean for across all metrics and all sites

The 2011 seagrass survey which was used to compare with the survey carried out as part of this monitoring programme only included an evaluation of the total area of each bed and did not include measurements of shoot cover. However, as the results show a slight increase in the size of the seagrass beds between 2011 and 2012, it has been assumed that shoot cover has also slightly increased.

Overall, the seagrass assessment suggests that there is minimal impact on seagrass beds caused by the secondary impacts of nutrients and that the overall interim ecological status according to seagrass is 'High'. This suggests that the nutrient pressures highlighted by the macroalgae assessments are not severe enough to have inferred secondary effects on seagrass beds, and supports the overall 'Moderate' interim ecological status assessments from the macroalgae results; that is nutrient pressures in the bay as a whole are 'borderline' and the most severe effects are likely to be very localised (e.g. in the area of treated sewage effluent discharge).

It is, however, recommended that a further seagrass survey is undertaken in 2013 (including both bed extent and shoot cover) to confirm that there are no secondary nutrient impacts occurring.

3.2.6 Benthic Invertebrates

The ecological status according to benthic invertebrates is generally an indicator of toxicity caused by chemical contamination.

The benthic invertebrate assessment is based on three metrics: the number of taxa, the AZTI Marine Biotic Index (AMBI), which is a measure of the overall pollution sensitivity of a macroinvertebrate community, and Simpson's Evenness, a measure of the evenness of the abundance distribution of different taxa within a community. These metrics are combined to derive an EQR for the Infaunal Quality Index (IQI) for a site.

Table 3.19 shows the results of the ecological status assessment according to IQI across all three sampling sites in the bay (summer and winter surveys).

Table 3.19 Benthic Invertebrate Assessment for St. Aubin's Bay

Site	Survey	Metric	Value[1]	Reference Value	Ecological Quality Ratio (EQR)	Interim Ecological Status
Central Bay	May 2012	Average Number of Taxa	5	21.4	0.464[2]	NA
		Simpson's Evenness Index	0.198	0.962	0.067[3]	NA
		AMBI Index	1.738	0.638	0.448[4]	NA
		Infaunal Quality Index (IQI)	NA	NA	0.96[5]	High
	October 2012	Average Number of Taxa	4	21.4	0.457[2]	NA
		Simpson's Evenness Index	0.139	0.962	0.072[3]	NA
		AMBI Index	2.186	0.638	0.410[4]	NA
		Infaunal Quality Index (IQI)	NA	NA	0.90[5]	High
Elizabeth Castle	May 2012	Average Number of Taxa	13	21.4	0.515[2]	NA
		Simpson's Evenness Index	0.116	0.962	0.074[3]	NA
		AMBI Index	2.344	0.638	0.396[4]	NA
		Infaunal Quality Index (IQI)	NA	NA	0.97[5]	High
	October 2012	Average Number of Taxa	20	21.4	0.536[2]	NA
		Simpson's Evenness Index	0.017	0.962	0.082[3]	NA
		AMBI Index	2.406	0.638	0.391[4]	NA
		Infaunal Quality Index (IQI)	NA	NA	1.01[5]	High
Port	May 2012	Average Number of Taxa	4	31.8	0.435[2]	NA
		Simpson's Evenness Index	0.935	0.91	0.006[3]	NA
		AMBI Index	5.948	0.603	0.095[4]	NA
		Infaunal Quality Index (IQI)	NA	NA	0.23[5]	Bad

Site	Survey	Metric	Value[1]	Reference Value	Ecological Quality Ratio (EQR)	Interim Ecological Status
	October 2012	Average Number of Taxa	3	31.8	0.426[2]	NA
		Simpson's Evenness Index	0.021	0.91	0.086[3]	NA
		AMBI Index	5.816	0.603	0.107[4]	NA
		Infaunal Quality Index (IQI)	NA	NA	0.37[5]	Poor
Overall Interim Ecological Status for IQI			**NA**	**NA**	**0.74[6]**	**Good**

[1] Mean of values reported for each sub-sample by States of Jersey, Environmental Protection Section
[2] 0.54*([Number of Taxa] / [Reference Value])^0.1
[3] 0.08*(1-[Simpson's Index]) / [Reference Value]
[4] 0.38*(1-[AMBI] / 7) / [Reference Value]
[5] ([Number of Taxa EQR} + [Simpson's EQR] + [AMBI EQR] – 0.4) / 0.6
[6] Mean of IQI across all sites and surveys

With the exception of the port site, the IQI ecological status assessments generally indicate that there is no impact on macroinvertebrate communities from chemical contamination in the bay. The interim ecological status for both the central bay and Elizabeth Castle sites is indicated to be 'High', based on the surveys carried out in this assessment.

At the port, however, the IQI assessment indicated severely impoverished macroinvertebrate communities in both the May ('Bad' ecological status) and October ('Poor' ecological status) surveys. This is perhaps unsurprising since the port is not a natural site and has been subject to long-term contamination by shipping and other port activities. The sediment in which any macroinvertebrates are living was shown in the sediment screening programme to be highly contaminated with PAHs (likely derived from fuels and oils).

The significant difference between the ecological status (according to IQI) of the port and the other two monitoring sites in St. Aubin's Bay suggests that the port site is probably not representative of the bay as a whole, and as it is an anthropogenic area, is unlikely to ever represent anything approaching 'reference' or pristine conditions.

The overall interim ecological status of the bay according to IQI, based on this assessment, is 'Good', but would be expected to be 'High' if an alternative site were substituted for the port.

3.2.7 Imposex

The ecological status assessment according to imposex is designed to evaluate the potential for sub-lethal toxic effect on common dogwhelk populations, caused by exposure to TBT.

As TBT was measured (in a single sample) in seawater from the port site, an imposex assessment was necessary to complete the ecological status assessment of the bay.

Table 3.20 shows the results of the ecological status assessment for imposex, based on two surveys of imposex carried out in August and September 2012.

Table 3.20 Imposex Assessment for St. Aubin's Bay

Metric	Value
Number of females	51
Total VDS	32
VDSI	0.63
Ecological Quality Ratio*	0.895
Interim Ecological Status	**Good**

* (6-[VDSI])/6

This indicates that imposex effects on dogwhelk populations in St. Aubin's Bay are minimal and the overall interim ecological status according to imposex can be considered to be 'Good'.

3.3 Overall Status Assessment

As outlined in Section 1.1, the overall environmental classification of the status of a waterbody according to the requirements of the WFD is based on a worst-case assessment. That is the waterbody is assigned the lowest status achieved across all the sites generating monitoring data and all the different pressure indicators that have been assessed.

Table 3.21 summarises the chemical and ecological status for each site and each pressure indicator, based on the results obtained in the St. Aubin's Bay monitoring programme.

For the opportunistic macroalgae, seagrass and imposex indicators, only a bay-wide status assessment is possible since the monitoring was not undertaken at separate sites, but addressed the potential impact on the bay as a whole.

Table 3.21 Summary of Overall WFD Status Classifications for St. Aubin's Bay

Site	Element	Metric	Interim Status	Overall Interim Status
Central Bay/ Beach Rock	Chemical Status	Priority Substances	Good	Moderate
	Ecological Status	Specific Pollutants	Good	
		Phytoplankton	High	
		Rocky Shore Macroalgae	Moderate	
		Benthic Invertebrates	High	
Port	Chemical Status	Priority Substances	Good	Poor
	Ecological Status	Specific Pollutants	Good	
		Phytoplankton	High	
		Benthic Invertebrates	Poor	
La Collette	Chemical Status	Priority Substances	Good	Good
	Ecological Status	Specific Pollutants	Good	
		Phytoplankton	High	
Elizabeth Castle	Ecological Status	Rocky Shore Macroalgae	Good	Good
		Benthic Invertebrates	High	
St. Aubin's Fort	Ecological Status	Rocky Shore Macroalgae	Moderate	Moderate
St. Aubin's Bay	Chemical Status	Priority Substances	Good	**Moderate**
	Ecological Status	Physico-chemical Conditions	Good	
		Specific Pollutants	Good	
		Phytoplankton	High	
		Rocky Shore Macroalgae	Moderate	
		Opportunistic Macroalgae	Moderate	
		Seagrass	High	
		Benthic Invertebrates	Good	
		Imposex	Good	

The overall interim status of the central bay site is 'Moderate' and this outcome is driven by the rocky shore macroalgae assessment. This indicates that the primary pressure in the central bay is moderate impacts from nutrient enrichment.

The overall interim status of the port site is 'Poor' and this outcome is based on the benthic invertebrate assessment, indicating that the primary pressure in the port is severe impacts from chemical contamination. While this is not supported by the chemical status assessment for the port (with the possible exception of TBT), the impoverished invertebrate communities in the port probably relate to sediment contamination with fuels and oils (as indicated by the sediment screening programme).

The overall interim status of the La Collette reclamation site is 'Good', and there appear to be no particular impacts of concern at this site (if it is assumed that the phytoplankton assessments are reliable, see Section 4.2) – although no benthic invertebrate or rocky shore macroalgal assessments were undertaken at this site.

The overall interim status of the Elizabeth Castle site is 'Good', based on assessments of benthic invertebrates and rocky shore macroalgae only.

The overall interim status of the St. Aubin's Fort site is 'Moderate', based on the assessment of rocky shore macroalgae only.

The overall interim ecological status of the bay is based on the average EQR values for each individual indicator across all of the sites and therefore the overall interim status of the bay is considered to be 'Moderate'. This is driven by the macroalgal assessments and suggests moderate impacts across the bay from nutrient enrichment.

4. DISCUSSION

4.1 Chemical Contamination

Based on the 12 month chemical monitoring programme that has been carried out in this assessment in St. Aubin's Bay, there appear to be few concerns with regard to contamination by toxic substances. None of the EU Priority Substances or UK River Basin Specific Pollutants monitored exceeded their substance-specific Environmental Quality Standard (EQS) value based on an assessment of their Annual Average concentrations measured in seawater, and the overall interim chemical status of the bay according to the requirements of the WFD has been determined to be 'Good'. In addition, the those ecological indicators designed to assess impacts from toxic chemicals (benthic invertebrates and imposex) both indicated overall 'Good' interim ecological status.

However, some substances did exceed the relevant EQS in single samples, suggesting peaks in the relevant substance concentration. Such peaks may be caused by increased inputs, reduced dilution or adverse weather conditions (which may suspend contaminants bound to sediments) at the time of sampling.

At the central bay site unionized ammonia exceeded its EQS value (21 μgL^{-1}) in three separate spot samples (29, 22 and 56 μgL^{-1} in samples taken in December 2012, January 2013 and March 2013, respectively).

The Bellozanne sewage treatment works is likely to be the source of the vast majority of ammonia entering the bay. The concentrations of unionised ammonia measured in spot samples of treated sewage effluent monitored during the screening programme ranged from 1,650 to 27,900 μgL^{-1} suggesting that, at least over the three month effluent screening programme (May to July 2012), the sewage treatment works was relatively ineffective at nitrifying the ammonia entering the works. Nevertheless, it is clear that for the majority of the time there is sufficient dilution in the bay to reduce these inputs to below the EQS value. The measurement of 56 μgL^{-1} (more than twice the EQS value) in the seawater sample taken from the central bay in March 2013 therefore suggests an extremely high treated effluent concentration of ammonia or a low available dilution at the time of sampling. This may mean that the concentration of ammonia in the bay routinely exceeds the EQS value when dilution is low (i.e. at low tide). It is therefore recommended that monitoring of ammonia is continued at the central bay site, particularly at periods of low dilution. In addition, it will be necessary to assess the effectiveness of the nitrification process following the replacement of the works, to ensure that the replacement is successful at reducing concentrations of ammonia entering the bay.

The concentration of benzo (g,h,i) perylene and nonylphenol in seawater samples taken from the central bay site also apparently exceeded their respective EQS values, however, in both these cases, this was an effect of a lack of sensitivity of the analytical method used to analyse the samples, and not a true exceedence. The concentration of nonylphenol in two seawater samples was reported as < 0.625 μgL^{-1} and, because half of the analytical limit of detection has been used to assess compliance with the EQS value (0.3 μgL^{-1}), this suggests that the EQS could have been exceeded. The source of nonylphenol to the bay is also likely to be the sewage treatment works, and therefore it is recommended that monitoring of nonylphenol is also continued at this site to ensure that concentrations remain in compliance with the EQS value. No benzo (g,h,i) perylene was measured in any of the seawater samples taken from the central bay above the limit of detection of the analytical method (0.01 μgL^{-1}). However, the EQS for this substance is 0.00082 μgL^{-1} and so the substitution of the censored values with half the limit of detection results in an annual average concentration of 0.005 μgL^{-1}, which exceeds the EQS. This exceedence seems likely to be an artefact of the analytical process, however, it is not possible to be certain of this, and therefore it is recommended that the monitoring of this substance be continued, if possible using a more sensitive analytical method (limit of detection <= 0.0005 μgL^{-1}).

Of the other substances monitored at the central bay site, only the metals arsenic, copper, lead and zinc were detected in seawater above their analytical limits of detection, although all were well below their respective EQS values.

The screening of the sewage treatment works effluent indicated that both copper and zinc are present in the treated effluent and the treated effluent therefore contributes to the concentrations of these metals detected in the bay, however these two metals are consistently present at all three of the monitoring sites in the bay. In addition to the treated sewage effluent, there are likely to be a range of other sources of metals to the bay, including run-off and port activity (e.g. fuel and engine components).

Arsenic and lead were also detected at all three sites within the bay. Neither metal was measured in the STW effluent as it was not envisaged that there were any processes contributing to the treated effluent that could result in their presence. While it is possible that these metals could be entering the bay via the treated effluent, the fact that they are found at roughly similar concentrations across each site suggests another source.

There are a number of surface water outfalls to the bay, and while monitoring data for these (provided by States of Jersey, Environmental Protection Section) did not include metal analysis, this could present a further source of metals to the bay. It is therefore recommended that monitoring of arsenic, copper, lead and zinc is continued at the central bay site, and that they should also be measured in any future monitoring of surface water outfalls entering the bay.

Sediment screening resulted in the detection of both mercury and fluoranthene in sediments at the central bay site, and follow-up biota (slipper limpet) monitoring in the central bay indicated that both of these substances were also present in the tissues of slipper limpets.

While the concentration of fluoranthene measured in biota was well below the biota EQS, the concentration of mercury detected in biota (17.6 $\mu g/kg^{-1}$) was close to (but still less than) the biota EQS (20 $\mu g/kg^{-1}$). It should be noted, however, that the biota EQS values were derived for fish (either for the protection of secondary predators or humans) and may not directly relate to the uptake of substances by slipper limpets, which are filter feeders.

There remains to be much discussion at an EU level with regard to the optimal approaches to be applied in monitoring against biota EQS, however these results at least indicate that these two substances are present in the central bay. Neither fluoranthene nor mercury was monitored in the treated sewage effluent, although results from the UK Chemical Investigations Programme which monitored a large number of treated sewage effluents in the UK has suggested that both can be present in treated sewage effluent. Both of these substances were also detected in sediment and biota sampled from the port area, and therefore another possible source is the movement of contaminated sediment from the port into the wider bay.

The impact of chemical contamination is also indicated by the benthic invertebrate element of the ecological status assessment under the WFD. The benthic invertebrate assessments carried out at the central bay site in May and October 2012 both indicated a 'High' interim status according to this metric, suggesting minimal impact on invertebrate communities owing to contamination by toxic substances in this area of the bay. This supports the interim chemical status assessments and indicates that the periodical peaks of ammonia concentration measured in the central bay are likely to be of relatively short duration and do not infer significant long-term effects on invertebrate communities.

At the port site, only ammonia and TBT exceeded their EQS values, both in single samples.

The ammonia concentration measured in the seawater sample taken in November 2012 was 28 μgL^{-1} (exceeding the EQS for ammonia by 7 μgL^{-1}). The remainder of the seawater samples taken from the port contained an ammonia concentration of <10 to 17 μgL^{-1}. While it is possible that high concentrations of ammonia entering the bay via the treated sewage effluent could (possibly in low dilution conditions) also be responsible for this single exceedance, it does not correspond to the exceedances measured in single samples at the central bay site (December 2012, January 2013, March 2013) and therefore it seems possible that there may be a separate source of ammonia entering the port area. Sewage discharges from shipping (either treated or untreated) may be such a candidate source.

The single exceedance of the TBT EQS (July 2012) was from a seawater sample that States of Jersey, Environmental Protection Section reported was taken in bad weather. This, and the fact that TBT was not detected in any of the other seawater samples taken from the bay, suggests that TBT is present in the sediment of the port (likely as a result of its historical use in anti-foulant paints) and this contaminated sediment was re-suspended during the bad weather, resulting in its presence in seawater. The very high concentration of TBT detected in this single sample (more than four times the EQS value) indicates that the sediments in the port may be highly contaminated with TBT. TBT was not measured in the sediment screening programme since this monitoring was focussed on those EU Priority Substances for which biota standards have been set (TBT has a water EQS). Nevertheless, it is recommended that any future sediment monitoring of the port area includes TBT, in order to assess the extent of historical contamination and the potential for re-suspension which may cause toxic effects.

Despite only a single exceedance of the TBT EQS being measured in the port area (of 10 samples taken), the degree of exceedance combined with the use of half the limit of detection for the other nine samples results in a calculated annual average concentration of 0.0003 μgL^{-1} which exceeds the EQS value (0.0002 μgL^{-1}). However, this is not considered to be a reliable failure of the EQS because the majority of samples contained a concentration which was less than the limit of detection. The fact that sediment containing TBT is likely to be re-suspended in bad weather means that there is a real possibility that this site could fail the chemical status assessment (based on TBT) in the future. It is therefore imperative that it is confirmed that there are no ongoing inputs of TBT to the port area, and that the extent of TBT contamination in the port sediments is fully evaluated.

Despite the obvious presence of TBT in the port area, the ecological assessment designed to assess the potential effects of TBT on biota, the assessment of imposex in dogwhelks, did not indicate any significant effects. Dogwhelk surveys carried out in the bay in August and September 2012 indicated a relatively low incidence of imposex, and overall 'Good' interim ecological status based on the imposex metric. This suggests that TBT concentrations are probably localised to the port area and that the dogwhelk populations in the bay have largely recovered from any more extensive contamination that may have occurred in the past.

The metals, arsenic, copper, lead, nickel and zinc are all also detectable in seawater sampled in the port area, although all well below their respective EQS values. As discussed above, there may be a number of sources of such metals entering the bay in general; however, it would seem likely that the source of many of these metals to the port environment is from activities taking place in the port area itself.

Sediment samples taken from the port area indicated that a number of PAHs (benzo(a)pyrene, benzo(b and k)fluoranthene, fluoranthene and indeno(1,2,3-cd)pyrene) were all present in port sediments, along with mercury. Follow-up biota monitoring in slipper limpets sampled from the port area also showed that the limpets had accumulated detectable concentrations of mercury and fluoranthene, although none of the other PAHs could be detected in biota. Such substances are likely to be entering the port environment as a result of shipping activities (e.g. fuels, oils and engine components) and, given that this area has been an operational port for many years, it is not unexpected to find that the sediments in this area are contaminated with such substances. The long-term anthropomorphic disturbance of the port area means that the overall condition of the environment in this area is not expected to be supportive of good ecological quality, owing to ongoing disturbance (both physically and in relation to contamination) which is an unavoidable consequence of the operation of a large-scale port. However, it does seem that the contamination of sediments and biota with the majority of the PAHs detected in the port is relatively localised, with only fluoranthene being detected in sediments outside of the port area, and only flouranthene and mercury apparently being accumulated in detectable quantities by filter-feeding biota. It is recommended, however, that further sediment monitoring of the port area is carried out to ascertain the full extent of contamination.

Benthic invertebrate sampling was also carried out in the port area in order to determine its interim ecological status with respect to impacts from chemical contamination. Conversely to the other two sites at which benthic invertebrate assessments were carried out, the assessments of invertebrates in the port area suggested that communities were severely impacted (compared to reference conditions) and the interim ecological status (for this site specifically) was determined to be 'Bad' and 'Poor' for surveys carried out in May and October 2012, respectively. As noted above, this is not an unexpected outcome for such a disturbed site, and, as this assessment is focused on those invertebrates living in the sediment, this outcome supports the results of the sediment assessments.

The benthic invertebrate assessments carried out at the Elizabeth Castle site in May and October 2012 both indicated a 'High' interim status according to this metric, suggesting minimal impact on invertebrate communities caused by toxic substances in this area of the bay. Given the proximity of this site to the port, it seems that the impacts on invertebrate communities apparent in the port do not extend beyond the area of concentrated port activity.

The three main sites at which monitoring was undertaken were selected on the basis of the likely primary sources of chemicals entering the bay which included the activities at the port. While the port is a highly modified site, it is nevertheless situated in the bay, and therefore contaminants discharged into the port area are able to enter the wider bay. However, while the port area is therefore relevant to the overall WFD status of the bay, in retrospect, its selection as one of the three sites used to assess the interim WFD status of St. Aubin's Bay was probably not ideal owing to it being a highly modified area which is unrepresentative of the bay as a whole. While the outcomes of ecological assessment suggested 'less than good' status in this specific area, the overall ecological status (according to benthic invertebrates) is based on the assessment across all the sites in the bay, and the high status of the other two sites means that, on average, the results obtained in the port have not caused the overall interim status to be significantly affected. It is recommended, however, that any future monitoring to assess the status of the bay according to WFD requirements, should not be undertaken in the port and that a new 'third' site be selected which is more representative of the bay as a whole. The assessments made in the port area could also be completely removed from the overall interim status assessment for the bay, which would result in the improvement of some metrics (e.g. the benthic invertebrate metric for the bay as a whole would improve from 'Good' to 'High' interim status), but would not result in an improvement of the overall interim status of the bay (which would remain 'Moderate').

At the La Collette reclamation site, EQS failures were observed in single individual samples for copper, lead and zinc (all July 2012). As outlined above, the samples taken in July 2012 were obtained during bad weather and this (combined with the lack of EQS exceedance in all other samples from the same site) suggests that the sediments at this site are contaminated with these metals, and these have been re-suspended in the rough water. The concentrations of cadmium and nickel were also at their highest in the July 2012 seawater samples from La Collette reclamation site (although below their respective EQS values).

All these metals were detected in one or more seawater samples taken from La Collette reclamation site (although all bar those detailed above were below the relevant EQS value) at mean concentrations that were higher than those measured at the central bay and port sites, suggesting a more localised source was contributing to at least some the metal contamination at La Collette reclamation site, most likely ongoing or historical activities specific to this area. Arsenic was also detected at La Collette reclamation site, but at approximately the same concentrations as the other two sites.

Ammonia and naphthalene were also detected in isolated seawater samples taken from La Collette reclamation site, although concentrations never exceed their respective EQS values.

Mercury and fluoranthene were detected in sediments taken from La Collette reclamation site. Mercury was detected at similar concentrations as detected in sediments at the other two sites, however, flouranthene was only detected in one (of 3) samples and was at a higher concentration than the central bay, but significantly lower than detected at the port.

4.2 Eutrophication

In order to assess the potential for nutrient impacts in the bay, a series of eutrophication indicators were assessed as part of the ecological monitoring programme. These included the measurement of total inorganic nitrogen concentrations, and phytoplankton abundance and taxonomic diversity, in seawater samples taken from the central bay, port and La Collette reclamation sites, as well as the assessment of both rocky shore and opportunistic intertidal macroalgae, and seagrass beds. The rocky shore macroalgal assessment was undertaken at different sites from those at which chemical and phytoplankton monitoring was carried out, since it was necessary to select suitable rocky shore sites supporting seaweed growth. The opportunistic macroalgae and seagrass assessments were undertaken on a bay-wide basis covering the entire areas at which intertidal macroalgae or seagrass beds were present.

Based on the 12 month ecological monitoring programme there appears to be clear evidence of some impact from nutrients, although not all of the indicators of nutrient impacts were in agreement. The overall physico-chemical, phytoplankton and seagrass assessments all suggested that there were no nutrient impacts (taking the bay as a whole), while both macroalgal assessments indicated some degree of impact from nutrients. The overall interim ecological status of the bay according to those metrics designed to assess impacts from nutrients was therefore assessed to be 'Moderate' compared to reference conditions, and this overall interim WFD status classification of the bay is driven by the 'Moderate' interim ecological status determined in the macroalgal assessments.

Total inorganic nitrogen (TIN) concentrations were measured in seawater samples at all three sites over nine months (August 2012 to April 013). In all but two of the 27 samples in which TIN was measured, the concentration of TIN was less than the limit of detection for the analytical method in seawater. One sample each from the central bay site and the port site (both taken in January 2013) displayed a TIN concentration above the limit of detection (252 and 242 μgL^{-1}, respectively).

The ecological status indicator for nitrogen is actually dissolved inorganic nitrogen (DIN) rather than TIN, however, only TIN was measured in the assessment. This should, however, indicate a worst-case assessment since the TIN should always be greater than the DIN (since it includes both dissolved and undissolved inorganic nitrogen). The indicator itself is based on the mean DIN concentration (as μmol^{-1}) across all seawater samples taken between November and February, adjusted to a salinity of 32 ‰ (based on the measured linear relationship between salinity and DIN). In addition, the standard against which the final adjusted DIN value is assessed is different depending upon the degree of measured turbidity of the seawater.

In the St. Aubin's Bay assessment, half the limit of detection was used to calculate the mean TIN concentration for November 2012 to February 2013 (with the exception of the two samples that showed concentrations above the limit of detection), and this resulted in a mean TIN concentration of 9.55 μmol^{-1}. This generally indicates 'Good' interim ecological status for inorganic nitrogen, however, a number of assumptions have been made in deriving this status.

Firstly, the defined ecological assessment of coastal waters according to DIN is based on those waters having a salinity of 30 to 34.5 ‰. The salinity of the waters in St. Aubin's Bay is in the range 35 to 36 ‰ and therefore the ecological status assessments established for UK coastal waters do not apply. This increased salinity compared to UK coastal waters is likely due to the small size of the Jersey landmass, and the lack of any substantial freshwater entering the bay, which make the waters surrounding the island more akin to UK offshore waters (which are not subject to WFD assessments). Despite the fact that only TIN was measured and the high salinity of the seawater samples, a derivation of the linear relationship between measured TIN and measured salinity was attempted, however, this did not produce reliable results owing to the use of half the limit of detection for most individual values for TIN in the derivation.

Secondly, no reliable turbidity measurements (as mgL^{-1} suspended solids) were derived in the monitoring programme so it was not possible to assess the appropriate standard to apply based on turbidity. In the absence of this data, it was assumed that the waters in St. Aubin's Bay were 'clear' and the standard for 'clear' waters was applied.

Given the various assumptions made in deriving the ecological status assessment for inorganic nitrogen and the fact that TIN was measured rather than DIN, it is considered that the interim status assessment for this physico-chemical metric is likely to be unreliable. We would therefore recommend that a more reliable assessment of this parameter is undertaken over the next 12 months by measuring dissolved inorganic nitrogen (DIN) (i.e. in filtered samples) using an analytical method with a sensitivity of at least 50 μgL^{-1}, and measuring the associated turbidity (as mgL^{-1} suspended solids) and salinity of seawater samples. It may then possible to derive a reliable relationship between salinity and DIN and derive an estimate of the DIN adjusted to 32 ‰.

As noted in the previous sections, it is suspected that there may be some issues with the filtration of seawater samples for the assessment of chlorophyll-a concentrations and that, based on measurements obtained in the UK, the overall abundance of phytoplankton measured in seawater samples from St. Aubin's Bay is much lower than would be expected from such an assessment. In addition, ecological status assessments based on the phytoplankton metrics generally require data from at least two years of monitoring before a status assessment can be made.

Nevertheless, based on the data on phytoplankton gathered in the 12 month monitoring programme, an assessment of the interim ecological status according to phytoplankton has been undertaken. Assessments made across all three phytoplankton metrics (bloom frequency, seasonal succession and phytoplankton biomass) for each site indicates 'High' interim ecological status for all three sites individually, and also for the bay as a whole (all sites, all metrics). This suggests no impact from nutrient enrichment in the bay.

However, a consideration of each phytoplankton metric separately highlights a mismatch between the various metrics and suggests that the assessments carried out may not have produced reliable results.

For the bloom frequency metric, the assessment is based on the total numbers of phytoplankton cells present in each sample. The low total numbers of phytoplankton cells in all samples means that none of the critical values determining the status of this element have been exceeded, resulting in the maximum possible status (i.e. 'High'). This is considered to be a highly unusual outcome based on similar assessments undertaken in the UK, and therefore may highlight potential issues in the sampling of seawater for phytoplankton and the preservation of samples. We would therefore recommend a thorough review of the procedures applied for taking and preserving of phytoplankton samples to ensure they comply with the document 'UKTAG Coastal Water Assessment Methods, Phytoplankton Multimetric Tool Kit (2009)' prior to undertaking any further phytoplankton monitoring.

Similarly, the phytoplankton biomass is based on the total concentration of chlorophyll-a retained after the filtration of seawater samples. Again the sampling and filtration of seawater samples and the subsequent preservation of chlorophyll-a samples on filter papers prior to analysis are critical to obtaining reliable results for the assessment of this metric. The chlorophyll-a concentrations obtained for samples taken from St. Aubin's Bay are also much lower than would be expected compared to similar surveys carried out in the UK. This appears to correlate with the low total numbers of algal cells obtained, but both of these measurements could conceivably have been affected by the same issues, especially if they are related to sampling and/or preservation. The low chlorophyll-a concentrations mean that the interim ecological status for this metric has also been determined as 'High'.

The seasonal succession assessment shows a different outcome to the bloom frequency and phytoplankton biomass assessments, and the interim ecological status across all three sites has been determined to be 'Moderate'. This metric is based on the numbers of diatoms and dinoflagellate cells not exceeding certain temporally-based boundary values, the exceedance of which indicates excessive growth caused by eutrophication. Diatom numbers were shown to exceed these parameters in all of the samples taken (36 samples across all three sites) indicating excessive growth owing to nutrient enrichment. However, dinoflagellate numbers only exceeded the seasonal succession parameters in seven of the 36 samples taken, and in 21 of the samples no dinoflagellates were detected at all. Again, compared to similar assessments in the UK, it is unusual to find no dinoflagellate cells at all in samples of seawater taken at any time of the year. Thus the very low numbers of dinoflagellates detected has to some extent mediated the seasonal succession results for diatoms, and the overall 'Moderate' interim status achieved for seasonal succession may be an over estimate.

Of course, Jersey is relatively distant from UK shores and therefore there is no reason to assume that the results obtained for the assessment of phytoplankton should mirror those obtained in the UK. The results could therefore be accurate, and there is simply less phytoplankton present in Jersey's waters than there are in UK waters. The outcome of the seasonal succession assessment for diatoms does, however, appear to suggest that some nutrient enrichment is occurring (as do the macroalgal assessments outlined below) in contrast to the other phytoplankton measurements.

Compared to other slower growing indicators of nutrient enrichment, the phytoplankton metrics are likely to be the most responsive and sensitive indicators of short-term changes in nutrient inputs to a waterbody. The continued monitoring of phytoplankton and chlorophyll-a in seawater samples is therefore recommended for at least a further 12 months (following a re-evaluation of the sampling, preservation and filtration procedures) to put this first year's monitoring results into context, and allow an assessment of any short-term changes in nutrient concentrations as a result of modifications to the sewage treatment works.

The macroalgal assessments undertaken as part of this study have provided a more unequivocal outcome with respect to nutrient pressures acting on the bay, and assessments of both rocky shore species and opportunistic intertidal macroalgal species indicate that, overall, the bay is at 'Moderate' interim status and some eutrophication is occurring.

The rocky shore macroalgal metrics assess the number of different rocky shore taxa present at a site as well as the relative proportions of different types of rocky shore seaweed. Based on the monitoring carried out in this survey, the interim ecological status for rocky shore macroalgae derived for Elizabeth Castle was 'Good', while the interim status of the St. Aubin's Fort and Beach Rock sites was 'Moderate'. The driving metrics for the sites with 'Moderate' status were overall number of taxa and the proportion of opportunistic species present at these two sites, and these indicators were sufficiently impacted to result in an overall status of 'Moderate' for rocky shore macroalgae. This suggests some impact from nutrient enrichment in the bay.

The assessment of opportunistic intertidal species also indicated that the bay is at 'Moderate' interim status with respect to nutrient impacts, however the assessment of seagrass did not indicate any impacts (and in fact seagrass beds appear to have slightly increased between 2011 and 2012). This may suggest that the nutrient enrichment affecting the rocky shore and opportunistic seaweed is not yet at a sufficient level to affect the seagrass beds.

The 'Moderate' interim ecological status outcomes for the macroalgal indicators drive the entire interim WFD status classification of the bay (based on the 'one-out all-out' principle) and therefore the interim status classification of the bay has been determined to be 'Moderate'. On this basis, and considering the outcomes of all the status assessments as a whole (both nutrients and chemical contamination), nutrients are likely to be the primary issue affecting the bay with respect to this interim WFD status assessment.

The 'Moderate' interim status of the driving nutrient indicators (macroalgae), the potentially contradictory phytoplankton assessment (i.e. if it is assumed that the results obtained for phytoplankton are reliable) and the lack of effects on seagrass does, however, suggest a 'borderline' rather than critical nutrient issue or that impacts caused by nutrients are only beginning to be realised. Thus, a continuation of the nutrient monitoring programme is critical to both confirm these assessments and to highlight any trends in impacts. The current 'borderline' status of nutrient impacts in the bay means that a reduction in nutrient inputs (from all sources) could result in a relatively rapid improvement in those ecological status indicators driving the overall WFD status classification.

4.3 Implications for the Bellozanne Sewage Treatment Works

While the Bellozanne treated sewage effluent certainly discharges some EU Priority Substances and UK River Basin Specific Pollutants to St. Aubin's Bay, most notably ammonia, this assessment clearly indicates that, for the most part, these are not discharged at high enough concentrations to exceed EQS values (based on annual average assessments) in the receiving environment. Nevertheless, some 'spikes' of high ammonia concentration do appear to occur and, under lower dilution conditions, these can periodically exceed the EQS value and could potentially excerpt a toxic effect on macroinvertebrate communities in the bay. The proposed replacement of the sewage works should improve the nitrification of ammonia in the treated sewage effluent and eventually result in a reduction in the concentrations of ammonia being discharged. This study has also indicated that it is pressures from nutrient inputs that are driving the current ecological status of St. Aubin's Bay and that a reduction in nutrient inputs is likely, in the longer-term, to result in an improvement of the ecological (and therefore overall) status of the bay. Given that the sewage treatment works is the primary point source of inorganic nitrogen into the bay, a replacement treatment works that includes both improved nitrification processes and the addition of a reliable de-nitrification process should be able to reduce the concentrations of inorganic nitrogen in the final treated effluent to a significant degree. While improvement of the nitrification processes beyond their current efficiency will undoubtedly reduce the concentrations of ammonia and nitrite discharged to the bay, it is only by the addition of an efficient de-nitrification process that overall reductions in the total concentration of nutrients entering the bay (via the treated sewage effluent) can be achieved. While de-nitrification processes are not generally popular among sewage treatment providers in the UK, who prefer to rely on dilution to reduce the high nitrate concentrations present in final treated effluent (following efficient nitrification) especially at coastal discharge sites, this is likely to change in areas where WFD ecological assessments classify coastal sites as less than 'Good' on the basis of local nutrient enrichment caused by sewage discharges.

Given the 'moderate' or 'borderline' impacts currently realised in the bay, a reduction in nutrient concentrations discharged into the bay by the treated sewage effluent is likely to go some way to reducing nutrient concentrations in the bay and may provide the basis for a relatively rapid recovery of the indicators of nutrient enrichment currently driving the ecological assessment.

5 RECOMMENDATIONS

Based on the outcomes and conclusions made on the basis of the interim chemical and ecological status assessments for St. Aubins Bay, we make the following recommendations with respect to future monitoring activities in the bay and the replacement of the Bellozanne sewage treatment works.

1. There were some EU Priority Substances which could not be monitored in seawater owing to a lack of an appropriate analytical method. These substances include aclonifen, alachlor, bifenox, the cyclodiene pesticides, and quinoxyfen. While it is currently not possible to assess the chemical status of St. Aubin's Bay according to the concentrations of these substances present in the environment, they should be included in future monitoring programmes (as analytical capability is developed) which seek to assess the environmental status of the bay against the baseline established by the current monitoring programme.

2. It is recommended that monitoring of ammonia is continued at the central bay site, particularly at periods of low dilution. It will be necessary to assess the effectiveness of the nitrification process following the completion of the replacement of the works, to ensure that the replacement is successful at reducing concentrations of ammonia entering the bay.

3. Benthic invertebrate surveys should also be carried out in the central bay both during and after the sewage treatment works replacement period.

4. No benzo (g,h,i) perylene was detected in any of the seawater samples from the central bay site ,and the apparent 'failure' of the EQS for this substance is an effect of half the limit of detection being greater than the EQS. However, because the limit of detection is insufficiently sensitive to assess the concentration of benzo (g,h,i) perylene against its EQS value, it is possible that the EQS was exceeded. Therefore, if a laboratory can be sourced that can offer a suitably sensitive analytical method for this substance we would recommend that the future chemical monitoring programme includes this substance to provide clarity on the compliance or non-compliance of environmental concentrations with the EQS value.

5. It is also recommended that monitoring of nonylphenol is continued at the central bay site to ensure that concentrations remain in compliance with the EQS value.

6. There are a number of surface water outfalls to the bay, and while monitoring data for these (provided by States of Jersey, Environmental Protection Section) did not include metal analysis, this could present a further source of metals to the bay. It is therefore recommended that monitoring of arsenic, copper, lead and zinc are continued at the central bay site, and that they should also be measured in any future monitoring of surface water outfalls entering the bay.

7. We recommend that any future chemical monitoring in the port includes TBT to allow an assessment of the frequency of failure of the EQS over a longer timescale. For

example, a single further exceedance of the EQS would suggest that the chemical status of the port (based on TBT) is less than 'Good', while a further 12 months of monitoring with no exceedances would confirm that the apparent EQS failure should not be considered significant.

8. Further sediment monitoring of the port area should be undertaken to ascertain the full extent of contamination by PAHs and mercury. In addition, this sediment monitoring in the port should include TBT in order to assess the extent of historical contamination and the potential for re-suspension which may cause toxic effects.

9. While additional monitoring has been recommended for the port area, we consider that this site is not representative of the bay as a whole and should not be used for further assessments of the status of the bay against the requirements of the WFD. Any future monitoring programme that is designed to re-assess the overall status of the bay and undertake a re-classification should include a new 'third' site which is more representative of the bay as a whole.

10. We recommend that a more reliable assessment of total inorganic nitrogen is undertaken over the next 12 months (as part on the ongoing monitoring programme) by measuring dissolved inorganic nitrogen (DIN) (i.e. in filtered samples) using an analytical method with a sensitivity of at least 50 μgL^{-1}, and measuring the associated turbidity (as mgL^{-1} suspended solids) and salinity of seawater samples. It may then be possible to derive a reliable relationship between salinity and DIN and derive an estimate of the DIN adjusted to 32 ‰.

11. A continuation of the ecological monitoring programme for nutrient pressures is considered critical to both confirm the results of these initial assessments and to highlight any trends in impacts from nutrient enrichment.

    The continued ecological monitoring programme for nutrients should include:

- A minimum of 12 months additional phytoplankton monitoring which commences prior to the replacement of the Bellozanne sewage works and extends beyond the completion of the replacement works.

  The results of this extension to the survey should be combined with the results presented here and the status assessments updated.

  A thorough review of the procedures applied for taking and preserving phytoplankton samples and the filtration of samples for chlorophyll a should be carried out prior to commencing the extension to the phytoplankton monitoring programme.

- At least one further rocky shore macroalgae and one further opportunistic macroalgae assessment should be conducted following replacement of the Bellozanne sewage treatment works.

- A further seagrass survey should be in undertaken in 2013 (including both bed extent and shoot cover) to confirm that there are no secondary nutrient impacts occurring in the bay.

12. Given that the sewage treatment works is the primary point source of inorganic nitrogen into the bay, it is recommended that the replacement treatment works include both improvements to the efficiency of the nitrification processes and the addition of a reliable de-nitrification process (i.e. by replacing or modifying the existing inefficient anoxic de-nitrification tanks). If successfully implemented this should result in a reduction in concentrations of inorganic nitrogen entering the bay and may provide the basis for a recovery from the current moderately nutrient impacted status.

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7 REFERENCES

United Kingdom Technical Advisory Group (UKTAG) on the Water Framework (2007). Recommendations on Surface Water Classification Schemes for the Purposes of the Water Framework Directive.

United Kingdom Technical Advisory Group (UKTAG) on the Water Framework (2008a). Coastal Water Assessment Methods, Benthic Invertebrate Fauna, Invertebrates in Soft Sediments (Infaunal Quality Index (IQI)).

United Kingdom Technical Advisory Group (UKTAG) on the Water Framework (2008b). Coastal Water Assessment Methods, Benthic Invertebrate Fauna, Dog Whelks (*Nucella lapillus*) – Imposex Assessment.

United Kingdom Technical Advisory Group Directive (UKTAG) on the Water Framework (2009a). Transitional and Coastal Water Assessment Methods, Angiosperms, Seagrass (*Zostera*) Bed Assessment.

United Kingdom Technical Advisory Group (UKTAG) on the Water Framework (2009b). Coastal Water Assessment Methods, Macroalgae, Rocky Shore Reduced Species List.

United Kingdom Technical Advisory Group (UKTAG) on the Water Framework (2009c). Coastal Water Assessment Methods, Macroalgae, Macroalgal Bloom Assessment (Opportunistic Macroalgae).

United Kingdom Technical Advisory Group (UKTAG) on the Water Framework (2009d). Coastal Water Assessment Methods, Phytoplankton, Phytoplankton Multi-metric Tool Kit.

DEFRA (2009). The River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Directions 2009.

Environment Agency (2011). Method Statement for the Classification of Surface Water Bodies v2.0.