A8.0 Marine water and sediment quality

A8.1 Methodology

A8.1.1 Methodology used to describe the existing environment

The description of the existing environment with regard to marine water and sediment quality has been informed through a combination of desk-based review of existing information and targeted survey work. The scope of the survey was agreed with F.I.G. Planning and Building Services through the environmental scoping process and is described in **Section A8.1.1.1**.

It should be noted that environmental impacts associated with the management of sludge and water present within the FIPASS tanks is not covered within this section; these potential impacts are addressed within **Section A16**. The environmental impacts to marine water quality associated with removal of the barges themselves (from a suspended sediment perspective) are however considered in this section of the EIS.

A8.1.1.1 Site-specific survey

Sediment quality sampling and analysis from Stanley Harbour

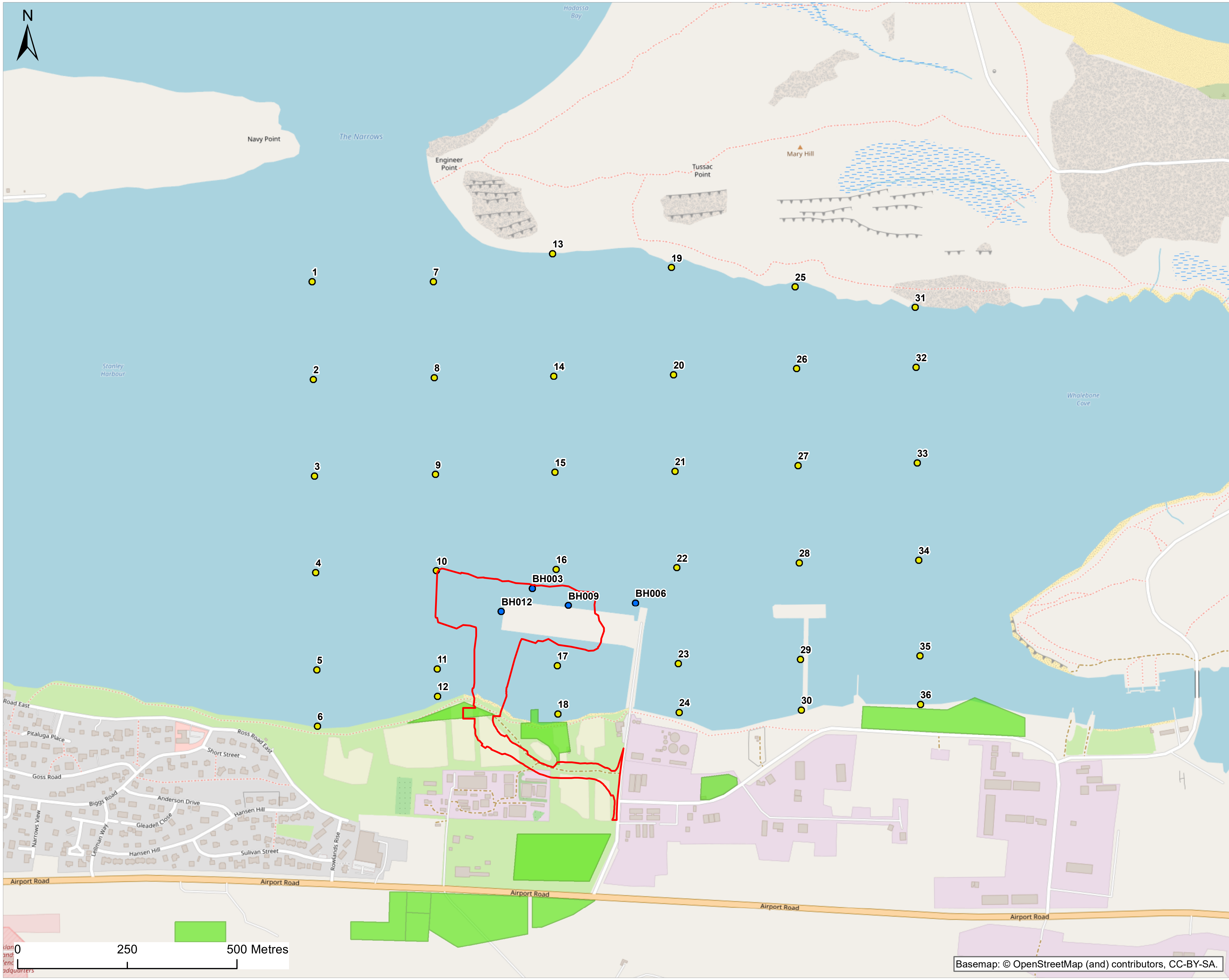
As part of the marine ground investigation undertaken in 2020, sediment samples were recovered from the surface, middle and bottom of four cores (BH003, BH006, BH009 and BH012 shown on **Figure 8.1**) (12 samples in total), drilled within and adjacent to the footprint of the proposed scheme. The sediment samples were shipped to a laboratory in the UK for analysis for the following determinands:

- Total hydrocarbons.
- Polycyclic aromatic hydrocarbons (PAH).
- Polychlorinated biphenyls (PCB).
- Organotins.
- Metals.
- Total organic carbon (TOC).
- PSA (the results from which are summarised in **Section A7.2.4**).
- Inorganic parameters.

The analyses were undertaken in accordance with the procedures and standards for marine sediment quality analysis defined by the Marine Management Organisation (MMO) for sampling in support of marine licence applications in England. In addition, a further 26 surface sediment samples were recovered as part of the benthic marine ecological survey undertaken by SAERI in October/November 2020 (namely samples 1-5, 7-11, 14-17, 20-23, 26-29 and 32-35 shown on **Figure 8.1**). These 26 samples were analysed for PSA and sediment chemistry (metals, PAH, total petroleum hydrocarbons).

The objective of both sampling campaigns was to provide an understanding of the physical and chemical composition of the seabed around the location of the proposed scheme which may experience disturbance during the construction phase.

As reported in **Section A4.2.7**, there is a layer of surficial silt presence above the natural bed deposits within the harbour; this layer is very fluid and mobile. It is therefore considered unlikely that samples of the surficial silts were recovered as part of the 2020 sampling (as recovery of such material would likely be poor given its fluid nature). However, given the known history of sewage discharge into Stanley Harbour, it was agreed with F.I.G.'s Environmental Officer and Policy Advisor that a valid working assumption for EIA purposes is that the surficial sediments within Stanley Harbour are likely to be heavily biologically contaminated.



Key

- Proposed scheme footprint
- Construction phase site layout
- Sediment sample location from 2020 ground investigation
- Sample location from 2020 marine ecological survey

REV	DATE	DESCRIPTION	BY	CHK	APP
P02	01.12.21	SECOND ISSUE	GC	CP	MS
P01	18.05.21	FIRST ISSUE	FC	CP	MS

CLIENT

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PROJECT

New Port Facility at the Falkland Islands

TITLE

Site-Specific Sediment and Water Quality Sampling Locations

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DRAWN	CHECKED	APPROVED
FC	CP	MS
DATE 01.12.21	SCALE 1:8,000	REF.

FIGURE No.	SUITABILITY	REVISION
8.1	S2	P02

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Discussion with F.I.G. in November 2020 confirmed that the main concern associated with the surficial silt is the health and safety risk to construction workers due to the assumed presence of biological contamination within it (as opposed to a risk to the natural environment due to its removal / deposition elsewhere).

It is understood that F.I.G. has commissioned SAERI to undertake a programme of surficial silt sampling, with laboratory analysis for chemical and bacteriological parameters.

Water quality sampling and analysis from Stanley Harbour

Water samples from five locations were recovered in Stanley Harbour in October/November 2020 (station 10, 15, 16, 17, 22 on **Figure 8.1**). Three replicates were recovered from each of the five sampling locations (15 samples in total). The water samples were analysed in the King Edward Memorial Hospital (KEMH) laboratory for total coliform and *E. coli* (a sub-group of faecal coliform) detection and enumeration.

In addition to the above, oceanographic profiles of the water column were taken at two locations within the eastern section of Stanley Harbour (stations 3 and 33) using a conductivity, temperature, depth (CTD) meter with fluorometer. The purpose of this was to understand stratification and mixing within the eastern Stanley Harbour area.

A8.1.1.2 Desk-based review of existing information

A desk-based study has been carried out to inform the description of the baseline conditions for marine water and sediment quality within Stanley Harbour. Information reviewed as part of the desk-study has comprised water quality analysis results (specifically for *E. coli*, coliforms and enterococci) provided by F.I.G. from samples recovered within Stanley Harbour.

A8.1.2 Methodology for assessment of potential impacts

The methodology used to assess the significance of potential environmental impacts on marine sediment and water quality is as described in **Section A6.0**.

In the absence of specific sediment quality guidelines for the marine environment in the Falkland Islands, the assessment of potential impacts associated with disturbance of sediment has been undertaken in accordance with guidelines routinely applied to the assessment of sediment quality in England, namely the Cefas Action Levels (MMO, 2020). The Cefas Action Levels are used as part of a ‘weight of evidence’ approach to assessing the suitability of dredged material for disposal at sea.

The guidance advises that, in general, concentrations of contaminants within sediment which are below Action Level 1 are not considered to be of concern and are, therefore, likely to be approved for disposal in the marine environment. Sediment with concentrations above Action Level 2 is generally considered to be unsuitable for disposal in the marine environment. Concentrations between Action Level 1 and 2 require further consideration before a decision can be made on the risk posed. In the same way, the Action Levels can also be used to provide an indication of risk to the marine environment associated with any sediment disturbance activities and, for this reason, it is commonplace for these guideline values to be used to make an initial assessment of risk posed to the marine environment as part of impact assessment; the Action Levels have been applied in this way for the assessment of the proposed scheme. The Cefas Action Levels are set out in **Table 8.1.**

Table 8.1 Action Levels (MMO, 2020)

Contaminant	Action Level 1 (mg/kg)	Action Level 2 (mg/kg)
Arsenic	20	100
Cadmium	0.4	5
Chromium	40	400

Contaminant	Action Level 1 (mg/kg)	Action Level 2 (mg/kg)
Copper	40	400
Nickel	20	200
Mercury	0.3	3
Lead	50	500
Zinc	130	800
Organotins (TBT, DBT)	0.1	1
PCBs (sum of ICES 7)	0.01	None
PCBs (sum of 25 congeners)	0.02	0.2
PAHs	0.1	None
DDT	0.001	None
Dieldrin	0.005	None

A8.1.2.1 Tidal flushing modelling undertaken to inform the assessment

To inform the assessment of potential impacts to water quality, a tidal flushing model was established and calibrated to simulate the tidal flushing effects during the operational phase of the proposed scheme. The outputs from this modelling exercise have informed the impact assessment presented in **Section A8.4**.

The tidal flushing modelling was undertaken at an early stage in the project; it modelled the predicted effects on tidal flushing as a result of a quay which is both longer and wider than that currently proposed. The predicted effects from the modelling are therefore highly conservative. As the effects from the smaller sized quay would be within the bounds of the assessment undertaken for the larger quay, it was not considered necessary to revisit the modelling.

Comparison with English bathing waters thresholds

To provide an initial assessment of water contamination in Stanley Harbour, bathing water standards implemented in England have been applied to the water quality sample results collected during 2020 (see **Table 8.2**).

As noted in **Section A8.2.1.1**, F.I.G. published advise in October 2020 against swimming or ingesting water from within part of Stanley Harbour. Therefore, the comparison is against very precautionary standards designed to protect human health, rather than predict effects on the marine environment.

Table 8.2 Criteria for coastal bathing waters in England

Classification	*E. coli* concentration (cfu[1]/100ml)	Intestinal enterococci (cfu/100ml)	Confidence level
Excellent	≤250	≤100	95th percentile
Good	≤500	≤200	95th percentile
Sufficient	≤500	≤185	90th percentile
Poor	Values worse than the sufficient levels		

[1] Colony forming units

A8.2 Baseline conditions

A8.2.1 Water quality

A8.2.1.1 Desk-based review of existing information

Water quality

Water quality within Stanley Harbour has historically been poor. This is mainly due to direct discharge of sewage from homes and buildings in Stanley draining directly into the harbour, without any pre-treatment or basic filtering. During the late 1990s, sewage infrastructure was upgraded which allowed sewage from east and central Stanley to be pumped eastwards along the waterfront to discharge at Rookery Bay into the open coast, although still in untreated form. There are, however, remaining outfalls discharging sewage directly into Stanley Harbour at the western end of the town (Royal HaskoningDHV, 2013).

F.I.G. Environment Department recovers water samples from Stanley Harbour for biological analysis as part of an ongoing monitoring project. Such analysis is carried out to establish the level of biological contamination within the surface waters and to determine whether such waters are safe for recreational use. F.I.G. Environment Department provided results of water quality monitoring undertaken at six locations within Stanley Harbour from May 2020 to October 2020. Water samples were recovered from Whalebone Cove, East Stanley South, Monument South, Moody Brook, Public Jetty North and Beach Centre (see **Figure 8.2**). Samples were recovered during various states of the tide across the monitoring period.

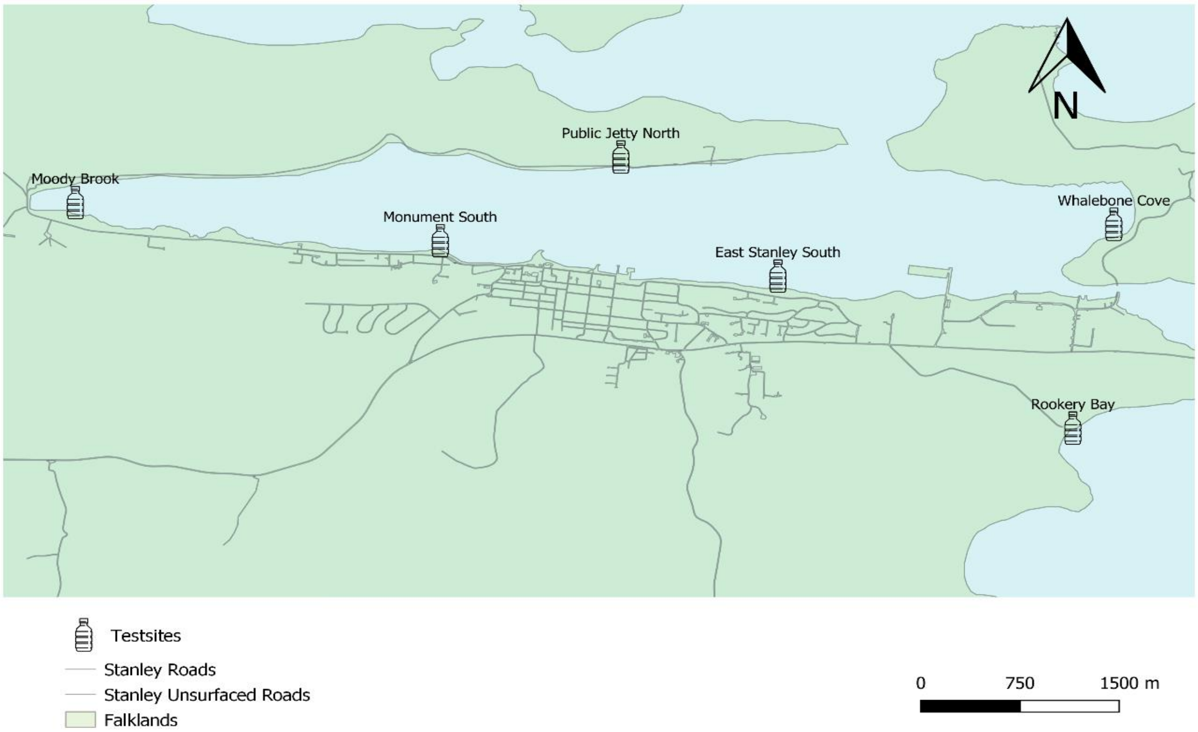

Figure 8.2 Surface water sample locations recovered by F.I.G. as part of ongoing monitoring project (source: F.I.G. Environment Department)

The analysis from these samples confirmed that coliform counts were less than 100 colony forming units (cfu) per 100ml of water at all locations across the full monitoring period, with the exception of the East Stanley South and Monument South monitoring positions (see **Figure 8.2**). The concentrations of coliforms at East Stanley South ranged from 510cfu to 4,100cfu, with a range of 350cfu to 3,900cfu at Monument South across the monitoring period. The peak at both locations was recorded in samples recovered on 28th September 2020 (high tide). A similar pattern can be observed in both the *E.coli* and enterococci counts.

Consultation with F.I.G.'s Environmental Officer and Policy Advisor in December 2020 has confirmed that the East Stanley South and Monument South sampling locations are adjacent to sewage outfalls, resulting in the higher concentrations present. In addition, surface water draining from FIPASS is not currently collected and treated and, therefore, any contaminants within this water are discharged directly to the marine environment.

Based on the results, F.I.G. published advice in October 2020 which recommended against swimming within the harbour between the Beaver Hanger (in west Stanley) and FIPASS, until advised otherwise. This advice remains in force at the time of writing.

A8.2.1.2 Results from site-specific water quality monitoring in Stanley Harbour

Water quality monitoring

As noted in **Section A8.1.1.1**, water samples were recovered from five locations within Stanley Harbour during October 2020 and analysed for coliform and *E. coli* detection and enumeration. The results of laboratory analysis are presented in **Table 8.3**.

Based on the information presented in **Table 8.3**, it is evident that the presence of coliforms and *E.coli* is greatest within samples 10 and 17 (**Figure 8.1**), located to the immediate north-west and south of FIPASS respectively. The samples with the lowest concentrations of coliforms and *E.coli* were recovered to the immediate north (samples 15 and 16) and north-east of FIPASS (sample 22).

However, based on the *E.coli* concentrations reported in **Table 8.3** and the bathing water thresholds detailed in **Table 8.2**, the coastal waters would be classified as 'excellent', as the concentration of *E.coli* is less than 250cfu/100ml. In addition, the results from these samples are typically comparable with the results from samples collected by F.I.G. from May 2020 to October 2020 (reported in **Section A8.2.1.1**). As a result, whilst there is evidence of biological contamination from some of the wider samples, the overall water quality (from a biological perspective) in the area is generally good. It should be noted however that the impact of COVID-19 may be misrepresenting the water quality in the harbour; cruise ship vessels cause significant disturbance of sediment on the bed of the harbour. As these vessels have been significantly reduced in number due to COVID-19, the water quality in the harbour may appear better than pre COVID-19.

Table 8.3 Water quality results from Stanley Harbour recovered in October 2020

Sample location (see Figure 8.1)	Coliform detection and enumeration (cfu/100ml)	*E.coli* detection and enumeration (cfu/100ml)
Sample 10A	110	87
Sample 10B	120	100
Sample 10C	91	82
Sample 15A	18	11
Sample 15B	22	17
Sample 15C	12	11
Sample 16A	46	27
Sample 16B	45	33
Sample 16C	47	25
Sample 17A	140	71
Sample 17B	130	70

Sample location (see Figure 8.1)	Coliform detection and enumeration (cfu/100ml)	*E.coli* detection and enumeration (cfu/100ml)
Sample 17C	130	76
Sample 22A	7	4
Sample 22B	10	6
Sample 22C	17	6

Water column profiles

Data from the site-specific CTD profiles shows that the water column within the eastern part of Stanley Harbour is well mixed with little detectable stratification (**Figure 8.3** and **8.4**). Seawater temperature increased over the survey period by approximately 1°C. Salinity remained relatively consistent throughout the survey period. Productivity (chlorophyll a, detected as fluorescence) increased towards the end of the survey period.

A weather station located at the F.I.G. Department of Agriculture indicated the air temperature increased by a degree during this period, and wind speed decreased. The increase in chlorophyll a may possibly be a response to increased temperatures and reduced wind speed.

Dissolved oxygen concentrations in Berkeley Sound are generally considered to be high, likely due to the relatively cold water temperatures which enables more oxygen to dissolve in the water and the high energy mixing caused by wave, tidal and wind driven systems. The dissolved oxygen concentrations typically decrease with depth in the Sound.

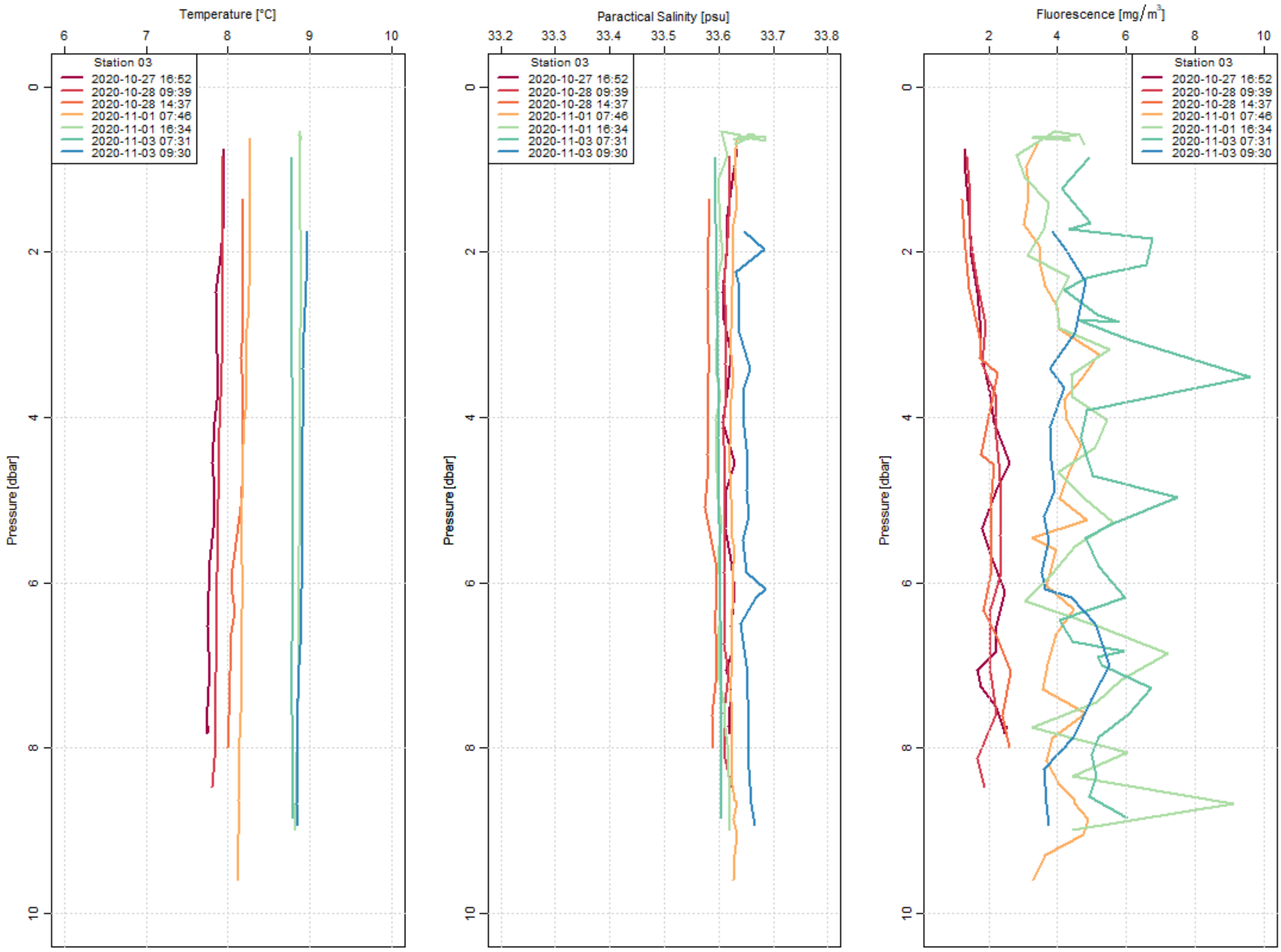

Figure 8.3 CTD data at Station 03 (refer to Figure 8.1)

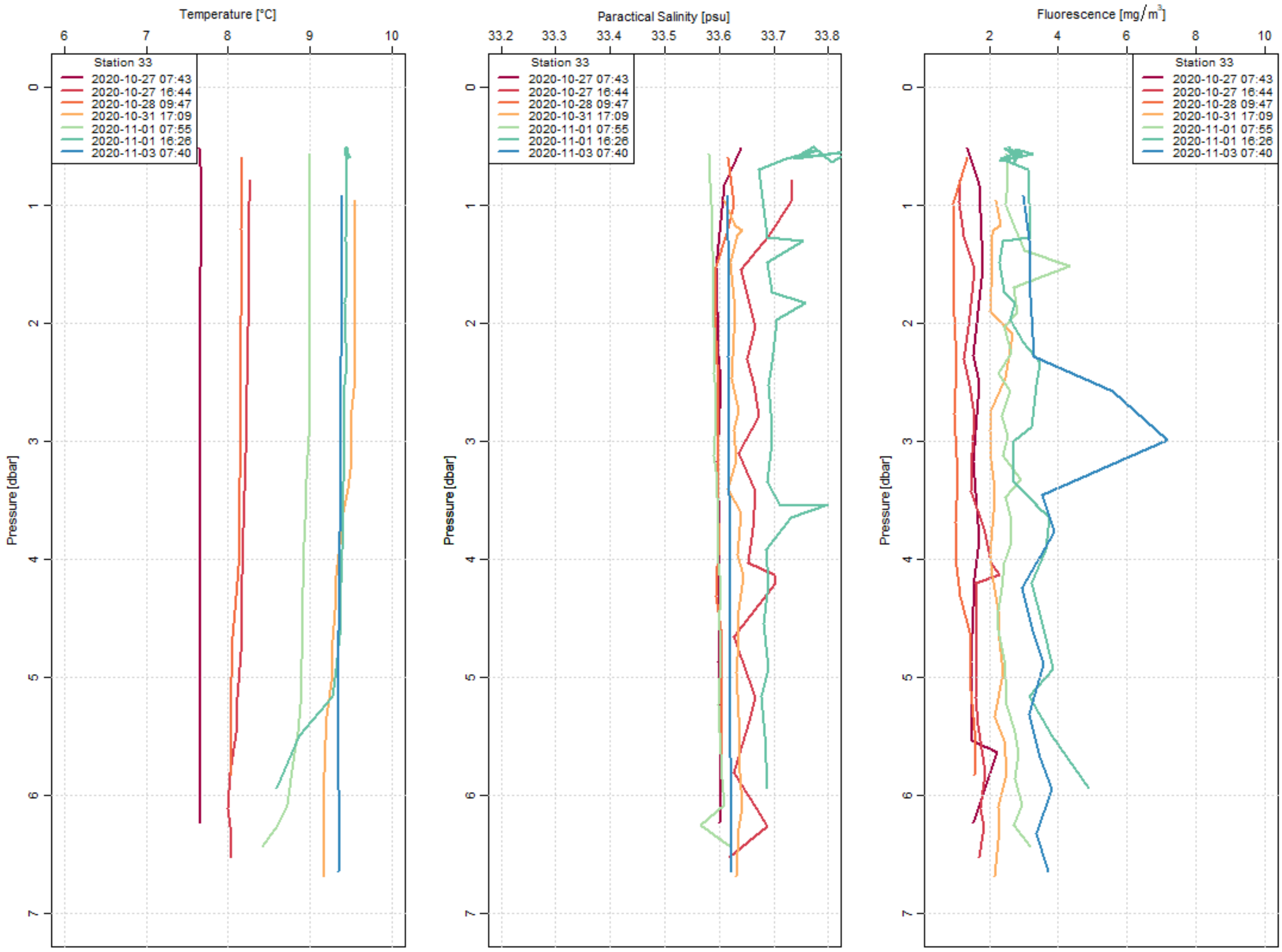

Figure 8.4 **CTD data at Station 33 (refer to Figure 8.1)**

A8.2.2 Sediment quality

A8.2.2.1 Results from site-specific sediment quality survey

The results of the laboratory analysis undertaken on the 12 sediment samples recovered as part of the site-specific ground investigation are summarised in **Table 8.4** and discussed below.

Table 8.4 **Summary of sediment quality data from samples recovered as part of the site-specific survey**

Contaminant	Min. conc. (mg/kg) (dry weight)	Max. conc. (mg/kg) (dry weight)	Average conc. (mg/kg) (dry weight)	Action Level 1 exceedance (no. of samples)	Action Level 2 exceedance (no. of samples)
Arsenic	<0.5	6.6	2.3	No (0)	No (0)
Cadmium	0.08	1.4	0.3	Yes (2)	No (0)
Chromium	1.7	15.6	5.9	No (0)	No (0)
Copper	3.9	62.6	13.6	Yes (1)	No (0)
Mercury	<0.01	0.08	0.03	No (0)	No (0)
Nickel	0.8	12.0	4.2	No (0)	No (0)

Contaminant	Min. conc. (mg/kg) (dry weight)	Max. conc. (mg/kg) (dry weight)	Average conc. (mg/kg) (dry weight)	Action Level 1 exceedance (no. of samples)	Action Level 2 exceedance (no. of samples)
Lead	9.9	27.8	18.3	No (0)	No (0)
Zinc	9.8	84.0	34.1	No (0)	No (0)
DBT	<0.005	<0.005	<0.005	No (0)	No (0)
TBT	<0.005	<0.005	<0.005	No (0)	No (0)
Acenaphthene	<0.001	0.0093	0.0018	No (0)	-
Acenaphthylene	<0.001	0.0046	0.0015	No (0)	-
Anthracene	<0.001	0.0160	0.0024	No (0)	-
Benzo(a)anthracene	<0.001	0.0422	0.0046	No (0)	-
Benzo(a)pyrene	<0.001	0.0459	0.0048	No (0)	-
Benzo(b)fluoranthene	<0.001	0.0368	0.0042	No (0)	-
Benzo(e)pyrene	<0.001	0.0374	0.0042	No (0)	-
Benzo(ghi)perylene	<0.001	0.0295	0.0035	No (0)	-
Benzo(k)fluoranthene	<0.001	0.0251	0.0031	No (0)	-
C1 Naphthalene	<0.001	0.0073	0.0020	No (0)	-
C1 Phenanthrene	<0.001	0.0531	0.0064	No (0)	-
C2 Naphthalene	<0.001	0.0226	0.0039	No (0)	-
C3 Naphthalene	<0.001	0.0108	0.0031	No (0)	-
Chrysene	<0.001	0.0434	0.0048	No (0)	-
Dibenzo(ah)anthracene	<0.001	0.0061	0.0014	No (0)	-
Fluoranthene	<0.001	0.1020	0.0106	Yes (1)	-
Fluorene	<0.001	0.0082	0.0017	No (0)	-
Indeno(1,2,3-c,d)pyrene	<0.001	0.0322	0.0036	No (0)	-
Naphthalene	<0.001	0.0053	0.0015	No (0)	-
Perylene	<0.001	0.0519	0.0088	No (0)	-
Phenanthrene	<0.001	0.0510	0.0064	No (0)	-
Pyrene	<0.001	0.0977	0.0104	No (0)	-
PCB – sum of ICES7	0.0005	0.0012	0.0006	No (0)	No (0)
PCB – sum of ICES25	0.0019	0.0044	0.0022	No (0)	No (0)

The data indicates that the sediment samples are relatively low risk in terms of contaminant concentrations. There were no sediment samples that exceeded Action Level 2 and only a very small number exceeded Action Level 1. As a result, sediment quality at the surface and at depth (from a chemical perspective) within the footprint of the proposed scheme is good.

A8.2.2.2 Results from sediment samples recovered from the wider Stanley Harbour

The results of the laboratory analysis undertaken on the 26 surface sediment samples recovered as part of the 2020 benthic survey are summarised in **Table 8.5** and discussed below.

Table 8.5 Summary of sediment quality data from samples recovered from the wider Stanley Harbour

Contaminant	Min. conc. (mg/kg) (dry weight)	Max. conc. (mg/kg) (dry weight)	Average conc. (mg/kg) (dry weight)	Action Level 1 exceedance (no. of samples)	Action Level 2 exceedance (no. of samples)
Arsenic	<1	21	10.46	Yes (1)	No (0)
Cadmium	<0.5	4.1	2.77	Yes (24)	No (0)
Chromium	1	40	22.96	Yes (1)	No (0)
Copper	<1	119	23.42	Yes (2)	No (0)
Mercury	<0.17	1.2	0.43	Yes (15)	No (0)
Nickel	<1	19	11.00	No (0)	No (0)
Lead	2	52	22.38	Yes (1)	No (0)
Zinc	5	214	70.69	Yes (2)	No (0)
DBT	-	-	-	-	-
TBT	-	-	-	-	-
Acenaphthene	<0.01	<0.01	<0.01	No (0)	-
Acenaphthylene	<0.01	<0.01	<0.01	No (0)	-
Anthracene	<0.02	<0.02	<0.02	No (0)	-
Benzo(a)anthracene	<0.04	<0.04	<0.04	No (0)	-
Benzo(a)pyrene	<0.04	<0.04	<0.04	No (0)	-
Benzo(b)fluoranthene	<0.05	<0.05	<0.05	No (0)	-
Benzo(e)pyrene	-	-	-	-	-
Benzo(ghi)perylene	<0.05	<0.05	<0.05	No (0)	-
Benzo(k)fluoranthene	<0.07	<0.07	<0.07	No (0)	-
C1 Naphthalene	-	-	-	-	-
C1 Phenanthrene	-	-	-	-	-
C2 Naphthalene	-	-	-	-	-
C3 Naphthalene	-	-	-	-	-
Chrysene	<0.06	<0.06	<0.06	No (0)	-
Dibenzo(ah)anthracene	<0.04	<0.04	<0.04	No (0)	-
Fluoranthene	<0.08	<0.08	<0.08	No (0)	-
Fluorene	<0.01	<0.01	<0.01	No (0)	-
Indeno(1,2,3-c,d)pyrene	<0.03	<0.03	<0.03	No (0)	-
Naphthalene	<0.03	<0.03	<0.03	No (0)	-
Perylene	-	-	-	-	-

Contaminant	Min. conc. (mg/kg) (dry weight)	Max. conc. (mg/kg) (dry weight)	Average conc. (mg/kg) (dry weight)	Action Level 1 exceedance (no. of samples)	Action Level 2 exceedance (no. of samples)
Phenanthrene	<0.03	<0.03	<0.03	No (0)	-
Pyrene	<0.07	<0.07	<0.07	No (0)	-

Various metals were found in concentrations greater than Action Level 1 in the 26 sediment samples recovered; these comprise arsenic, cadmium, chromium, copper, mercury, lead and zinc. None of the metal concentrations present were greater than Action Level 2. Elevated concentrations of cadmium and mercury were relatively widespread; however, the remaining metals encountered were only marginally elevated above Action Level 1. Concentrations of all PAH compounds were less than Action Level 1 in all samples (all concentrations were less than the laboratory limit of detection). Surface samples in the wider harbour are therefore considered to be variable with concentrations falling between Action Level 1 and Action Level 2.

A8.2.2.3 Summary of sediment quality data

The samples recovered as part of the site-specific sediment quality survey at FIPASS confirmed that samples at the surface and at depth contained relatively few exceedances of Action Level 1. The only contaminants present in excess of Action Level 1 were located at the surface. This aligns with the results obtained from the sediment quality survey undertaken within the wider Stanley Harbour (i.e. some exceedances of Action Level 1 for metals, however it should be noted that samples at depth were not recovered as part of the wider Stanley Harbour survey).

Based on the results, it is concluded that the seabed sediments in the footprint of the development, if disturbed, are unlikely to give rise to significant environmental effects. Surface sediments in the wider harbour vary in terms of quality, but given that disturbance of these sediments is not predicted as a result of the proposed scheme, no further consideration is necessary.

A8.2.3 Future evolution of the baseline in the absence of the proposed scheme

There is a risk that in the absence of the proposed scheme, the condition of the FIPASS barges would continue to degrade, potentially resulting in the release of contaminated sludge and water into Stanley Harbour. Otherwise, the baseline conditions are unlikely to significantly vary from existing in the absence of improvements in the quality of discharges into Stanley Harbour.

A8.3 Potential impacts during construction

A8.3.1 Increase in suspended sediment concentrations/turbidity

There are several pathways which could give rise to increases in suspended solid concentrations (and therefore impact on turbidity) within Stanley Harbour during construction. These are as follows:

- Removal of the surficial silt on the bed of the harbour to allow the proposed new quay to be constructed on the natural seabed deposits.
- General working in and around the seabed (i.e. during removal of mooring dolphins and construction of the new quay/causeway).

The highest risk to increases in suspended sediment concentrations would be during the removal of the surficial silt via suction techniques. It is anticipated that this material would be removed over a period of 17 months; however, this would not be a continuous process, as breaks in the removal of sediment would be required to facilitate other construction activities. There would be large periods over this 17-month duration where no suction dredging would be undertaken. Additionally, the removal would be undertaken as carefully as possible to reduce the risk of releasing sediments during the process. Tidal currents are sufficiently low that any plume is likely to remain localised to the works (**Section A7.2.2**).

The surficial silt would not be disposed back into the marine environment following removal; rather it would be pumped directly into geotubes to be located in a bunded remediation area on land (shown on **Figure 4.1**). Water draining from the geotubes would be captured and transferred into settlement areas and would pass through an interceptor prior to discharging back into the harbour (to minimise release of sediments and therefore risk to water quality during discharge).

With respect to rock/aggregate placements and general working in the marine environment (with the exception of surficial silt removal and dismantling of the FIPASS barges), construction will be undertaken using land-based equipment only. To minimise resuspension of sediment, rock is to be carefully placed onto the bed of the harbour rather than deposited in an uncontrolled manner. Any release of sediment would only be via temporary disturbance when interaction occurs with the seabed.

Overall, therefore, the impact on water quality during the removal of the surficial sediments from the bed and placement of construction materials on the seabed is considered to be of low magnitude given that the works are temporary, the impact would cease on completion and there is no capital dredging proposed. The sensitivity of the harbour is considered to be medium due to potential limited capacity to accommodate change, due to its semi-enclosed nature. The overall impact is therefore deemed to be of **minor adverse** significance.

A8.3.1.1 Mitigation and residual impact

All possible mitigation measures have been built into the proposed construction methodology (i.e. rock to be carefully placed onto the bed of the harbour, removal of surficial silt as carefully as possible, use of settlement areas prior to discharging water back into the harbour) and therefore no further mitigation has been identified. As a result, the residual impact predicted to be of **minor adverse** significance.

A8.3.2 Release and dispersion of biologically and chemically contaminated sediment

The potential risk to the marine environment associated with the release of biological and chemical material is related to the area over which any sediment release would be experienced. As detailed in **Section A8.3.1**, the extent of sediment release is predicted to be confined to a small area around the footprint of the proposed marine works. As a result, any release of contamination within the sediment would be limited to this extent.

Given the relatively low concentrations of chemical contamination within the sediments, the magnitude of effect would be considered to be very low if released into the environment. However, there is a strong possibility of elevated levels of organic matter, nutrients and bacteria in surficial sediments to be removed which could impact on physical water quality parameters such as dissolved oxygen concentrations and algal growth, when disturbed.

Given the temporary nature of the proposed surficial silt removal process and the highly localised footprint for removal (in addition to the fact that suspended sediment would remain localised to the point of disturbance due to the low tidal currents in the harbour), any effects would be limited in spatial extent. Measures to reduce the release of sediment as far as possible would be adopted during the works to assist in reducing the zone of influence as far as reasonably practicable. As a result, the magnitude of effect is considered to be low. Given the medium sensitivity of the harbour, the overall impact is deemed to be of **minor adverse** significance.

A8.3.2.1 Mitigation and residual impact

All possible mitigation measures have been built into the proposed construction methodology and therefore no further mitigation has been identified. As a result, the residual impact is predicted to be of **minor adverse** significance.

A8.4 Potential effects during operation

A8.4.1 Alteration to flushing characteristics of area and effects on water quality

As noted in **Section A8.1**, a modelling exercise has been undertaken to determine the flushing characteristics of the area which will be semi-enclosed as a result of the proposed scheme. To undertake the modelling exercise, the hydrodynamic model (as described in **Section A7.0**) was coupled with a dispersion module to simulate dispersion processes. To determine the potential for dispersion, a pollutant (with no decay) was set to 100% within the area to be semi-enclosed by the proposed new quay and causeway in the model; the model was run for a two-month period. The results from the model following three days and six days of simulation are shown in **Figure 8.5** and **8.6**. Three and six days of simulation were chosen as this shows the shortest time period at which there is a negligible effect (i.e. there would be very little to show on **Figure 8.5** or **8.6** if the model was run for a longer duration).

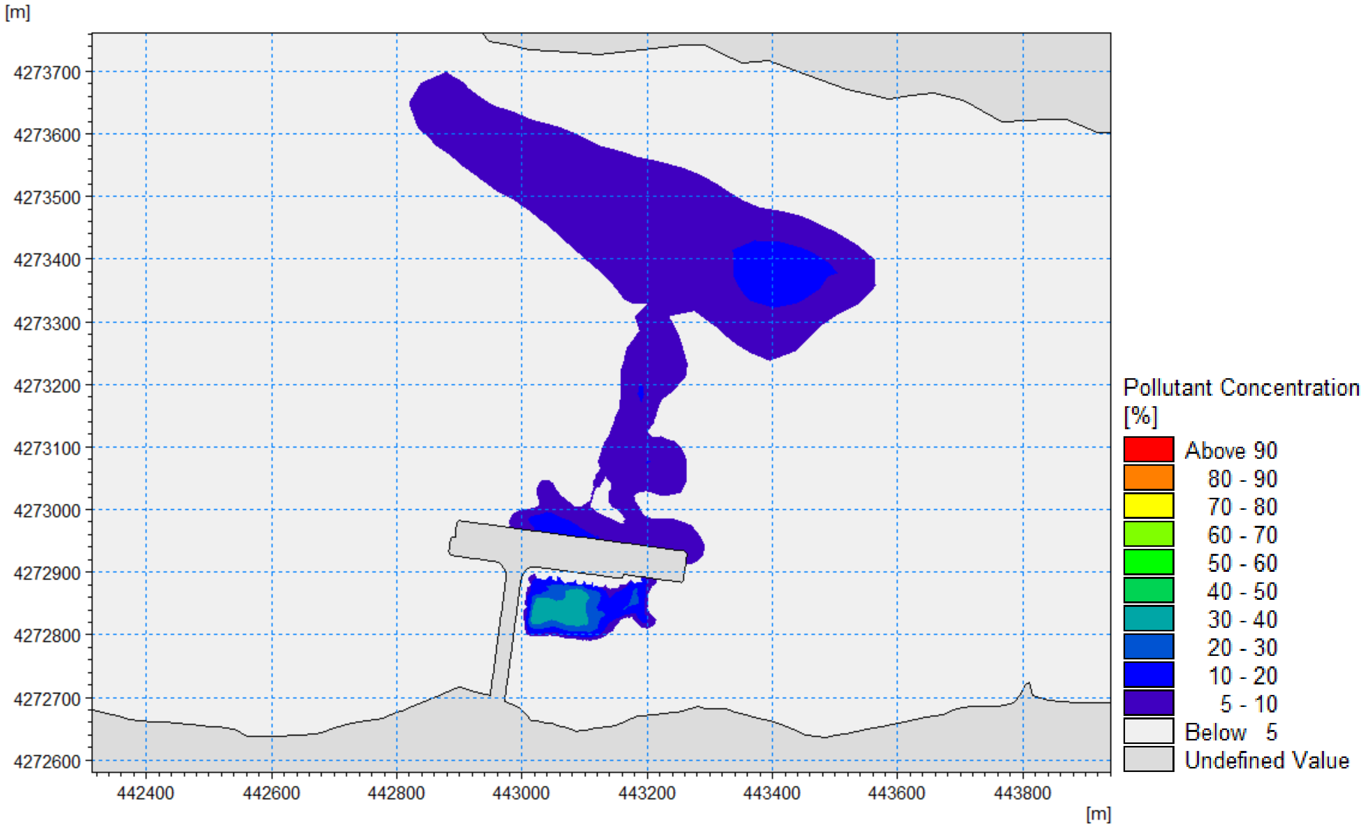

Figure 8.5 Pollutant concentrations around the proposed scheme footprint after three days

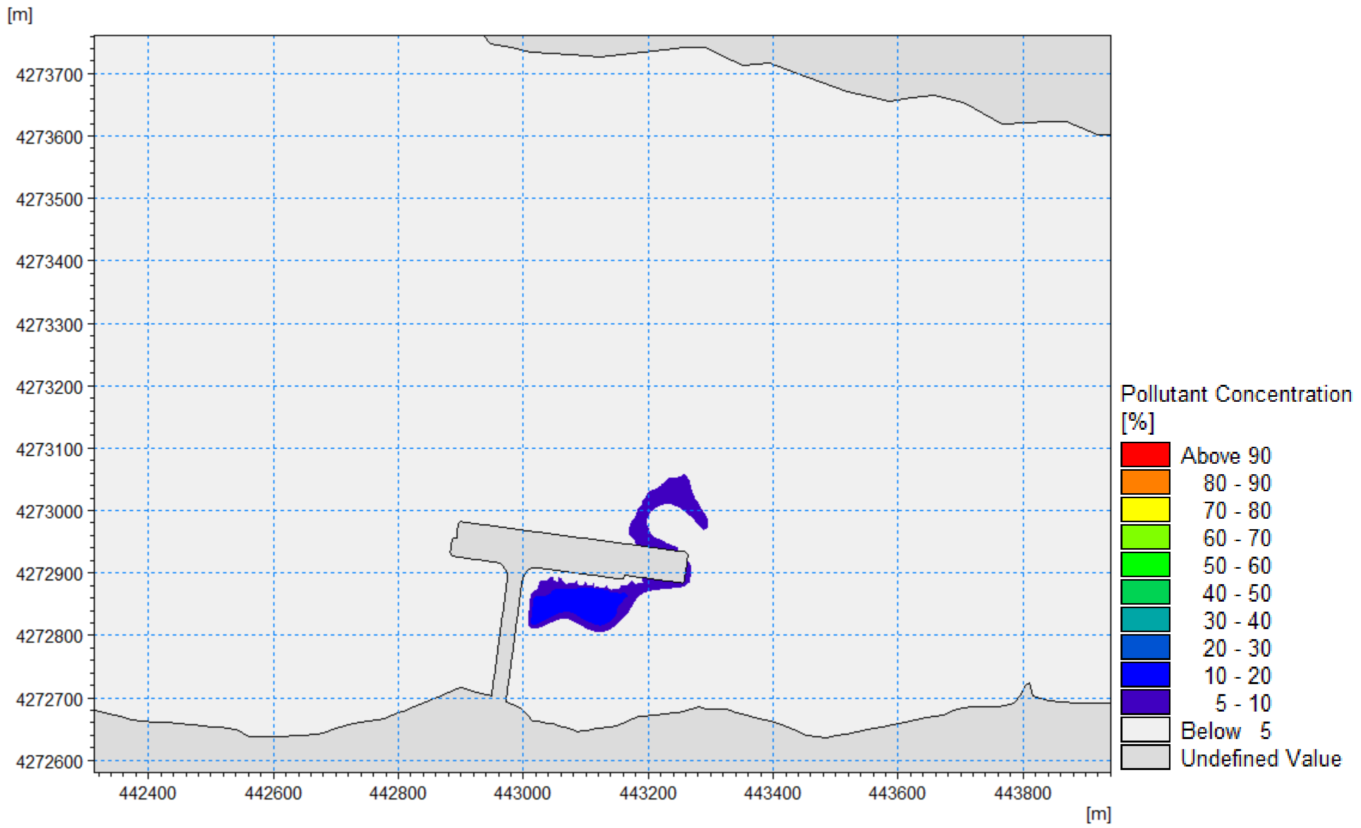

Figure 8.6 **Pollutant concentrations around the proposed scheme footprint after six days**

Figure 8.7 and **8.8** show contour plots of retention time for the pollutant in days; specifically, **Figure 8.7** shows the retention time for 50% dilution of the pollutant (i.e. time taken for 50% of the pollutant to decay), whilst **Figure 8.8** shows the retention time for 10% dilution (i.e. time taken for 90% of the pollutant to decay).

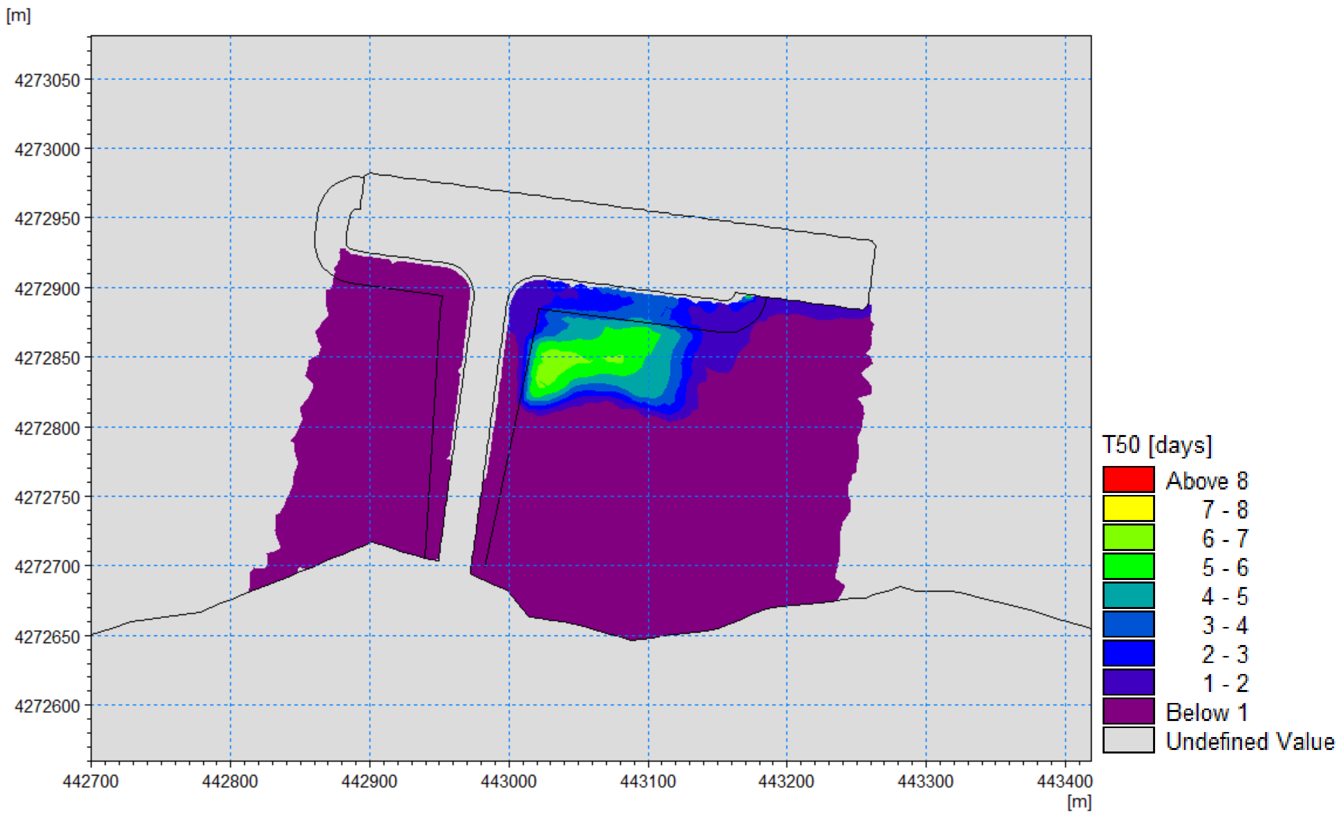

Figure 8.7 **Retention time for T50 of the pollutant concentration (i.e. time for 50% of the pollutant to decay)**

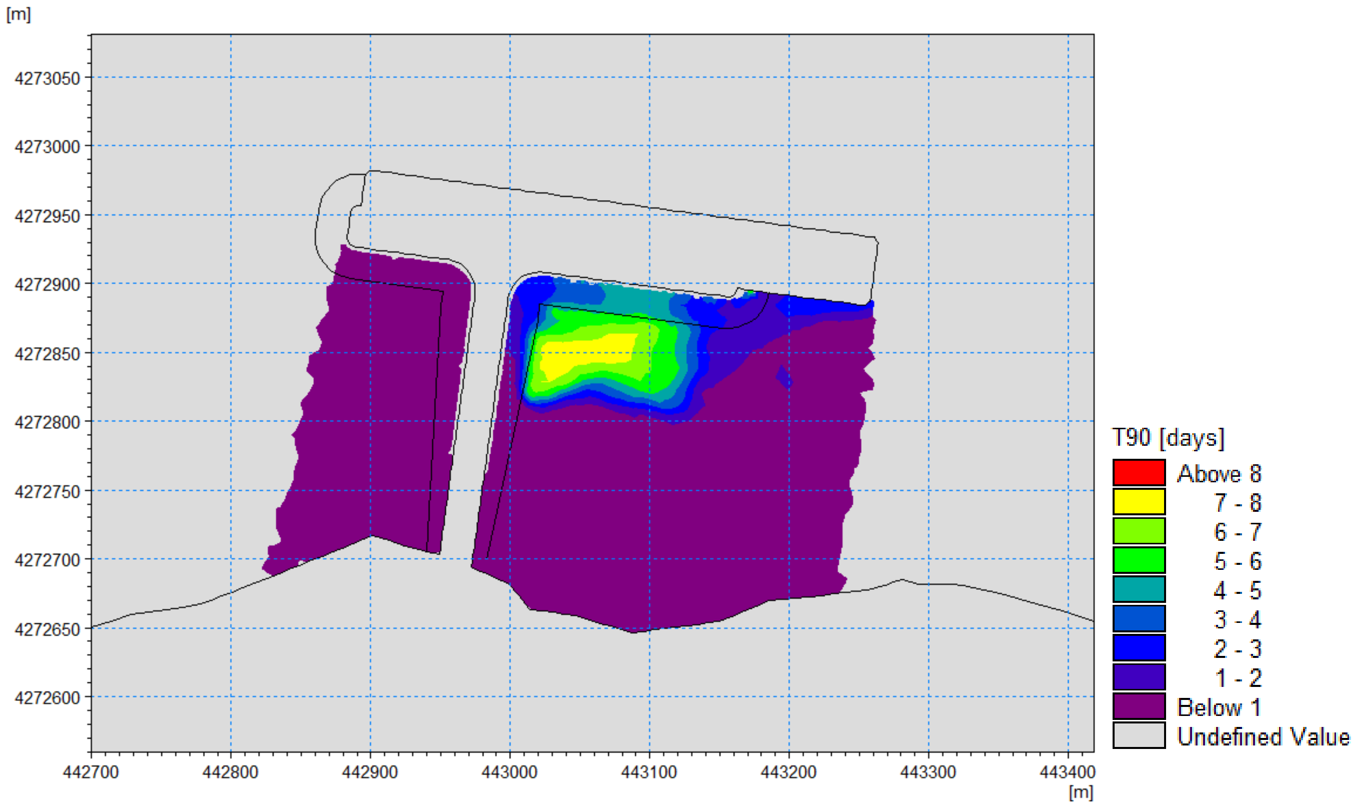

Figure 8.8 Retention time for T90 of the pollutant concentration (i.e. time for 90% of the pollutant to decay)

PIANC (2008) guidance states that full water exchange of an enclosed area should occur within four days (as an objective). This is in line with guidance from the US Environmental Protection Agency (EPA, 1985), which states:

- Exchange of water in four days is "good".
- Exchange of water in ten days is "fair".
- Exchange of water in 10 days or more is "poor".

The results of the flushing modelling indicate that pollutant concentrations in most of the semi-enclosed area created as a result of the proposed scheme reduce to below 20% within three days and that the retention time for 90% dilution (T90) is less than one day. Longer retention times (up to seven to eight days) are limited to the north-west corner of the semi-enclosed area, between the proposed quay and causeway. Circulation within the area of water around the proposed scheme footprint is therefore considered to be "good" for most of the area, with "fair" in the more sheltered north-western corner.

Based on the results of the flushing model, any effects on water quality as a result of an accidental pollution incident which may arise due to the proposed scheme are predicted to be rapidly diluted, within a day, for most of the semi-enclosed area. Additionally, treatment of foul water (to surface water runoff standards) and surface water prior to discharge into the harbour (as outlined in **Sections A4.4.3**) further reduces the risk of polluting water requiring exchange. In addition, the proposed berthing of vessels on the southern face of the quay (including those at the pontoon) is likely to reduce the potential for shoaling of sediment / stagnation of the area.

Therefore, effects associated with lack of water exchange such as a build-up of nutrients or pressures on dissolved oxygen levels associated with organic matter are predicted to be of low magnitude (adverse). The sensitivity of the water body is considered to be medium. The overall impact is therefore considered to be of **minor adverse** significance.

A8.4.1.1 Mitigation and residual impact

All possible mitigation measures have been embedded into the proposed scheme design and therefore no further measures are required or practicable. As a result, the residual impact is predicted to be of **minor adverse** significance.

A8.4.2 Increase in suspended sediment concentrations/turbidity due to disturbance of bed material

Operational phase dredging to maintain the depth of the approach and berth through its lifetime is not proposed as part of the scheme. Therefore, the only potential for increases in suspended solid concentrations is related to vessel propellors disturbing the seabed as vessels approach and, in particular, manoeuvre in the berths (noting that this is also an existing impact experienced at FIPASS).

Sediment sampling between The Narrows and FIPASS has shown that deposits are slightly gravelly muddy sand (11 samples) or gravelly muddy sand (eight samples) and one further sample of muddy sandy gravel was also noted immediately seaward of FIPASS. Resuspension of sediments due to vessels manoeuvring has been measured in various studies and model results show that sediment plumes are mostly generated from the smaller particles (i.e. silt) and are transported by currents with most of the plume settling to the bottom quickly (i.e. in six to 10 hours). Clay particles stay in the water column for another four to five days before they either settle to the bottom or are flushed out (United States Government, 2016).

Given the sediments in the area are muddy sandy gravel (so consist of less of the finer fractions with no clay), settlement is considered likely to occur relatively quickly and locally to where it was suspended given the low tidal currents in the area (**Section A8.3.1**) and coarser nature of the material (**Section A7.2.4**). Within the semi-enclosed area and where reduced water exchange is predicted in the north-west corner (i.e. where the proposed pontoon is to be located), settlement is even more likely to occur locally to the point of disturbance (see **Section A8.4.1**).

Overall, the magnitude of effect is considered to be very low (adverse). Given the medium sensitivity of the harbour, the overall impact is deemed to be **negligible**.

A8.4.2.1 Mitigation and residual impact

It is not possible to mitigate this potential impact. As a result, the residual impact is predicted to be **negligible**.

A8.4.3 Release and dispersion of biologically and chemically contaminated sediment

Given the ongoing discharge of untreated sewage into the harbour, it is likely that surficial silt will continue to build up on the bed of the harbour during the operational phase; however, this will likely be limited to the western side of the proposed new causeway given the location of discharges in relation to the footprint of the proposed scheme.

The area of the harbour which will become semi-enclosed to the east of the proposed causeway and south of the quay is less likely to experience a build-up of the surficial silt given the construction of the causeway which would act as a barrier. Additionally, discharges from the proposed scheme itself will either be passed through a hydrocarbon interceptor prior to discharge (**Section A8.4.4** with regard to surface water runoff) or treated via a package plant (**Section A8.4.5** with regard to foul water generated by the proposed scheme). As a consequence, significant effects on water quality parameters associated with chemical and biological parameters are less likely during the operational phase compared to the existing scenario with FIPASS.

Overall, the magnitude of effect is considered to be very low (adverse). Given the medium sensitivity of the harbour, the impact is deemed to be of **negligible** significance.

A8.4.3.1 Mitigation and residual impact

It is not possible to mitigate this potential impact. As a result, the residual impact is predicted to be of **negligible** significance.

A8.4.4 Reduction in water quality due to surface water run-off

Surface water drainage from the quay is proposed to fall towards the rear of the quay into a longitudinal slot drain which will discharge into Stanley Harbour via a hydrocarbon interceptor.

Surface water runoff from the proposed access road will flow into a series of swales to be excavated along the northern side of the road (and drainage pipes where space is not available to construct the swales). The swales and pipes will convey surface water runoff along the length of the road, which will pass through an impermeable aggregate chamber to remove silts and oils prior to discharging into Stanley Harbour.

Given the above, the magnitude of effect is considered to be very low (beneficial) (as the surface water is to pass through hydrocarbon interceptors and aggregate chamber which will remove contaminants prior to discharge into the harbour). Given the medium sensitivity of the harbour, the overall impact is deemed to be of **negligible** significance.

A8.4.4.1 Mitigation and residual impact

It is not possible to mitigate this potential impact. As a result, the residual impact is predicted to be of **negligible** significance.

A8.4.5 Reduction in water quality due to discharge of foul sewage

Package sewage treatment plants will be used within Building A, the welfare block on the eastern part of the quay (Building B3) and the gatehouse building (Building D). These treatment plants will treat the foul water to surface water standards prior to discharging into Stanley Harbour via the surface water drainage system. This would be a considerable improvement over and above the existing situation on FIPASS, where foul sewage is discharged without any form of treatment directly into the harbour.

The magnitude of effect is considered to be medium (beneficial). Given the medium sensitivity of the harbour, the overall impact is deemed to be **minor beneficial**.

A8.4.5.1 Mitigation and residual impact

No mitigation measures are required. The residual impact is predicted to be of **minor beneficial** significance.