Warrenpoint Dredge Monitoring - 2017

Environmental Monitoring Report

Instrumental Data: 30/05/2017 – 12/07/2017

Prepared by AFBI Fisheries and Aquatic Ecosystems Branch for ADBP

Contents

Summary

Between May and July 2017, maintenance dredging was undertaken in Warrenpoint Harbour. This report summarises the instrumental monitoring data from one temporary monitoring station, commissioned to monitor water quality during and after these operations. Turbidity and dissolved oxygen measurements were made continually alongside temperature and salinity observations. Permanent monitoring stations operated by AFBI in both the Inner and outer Lough were maintained providing other locations and parameters for continuity and context.

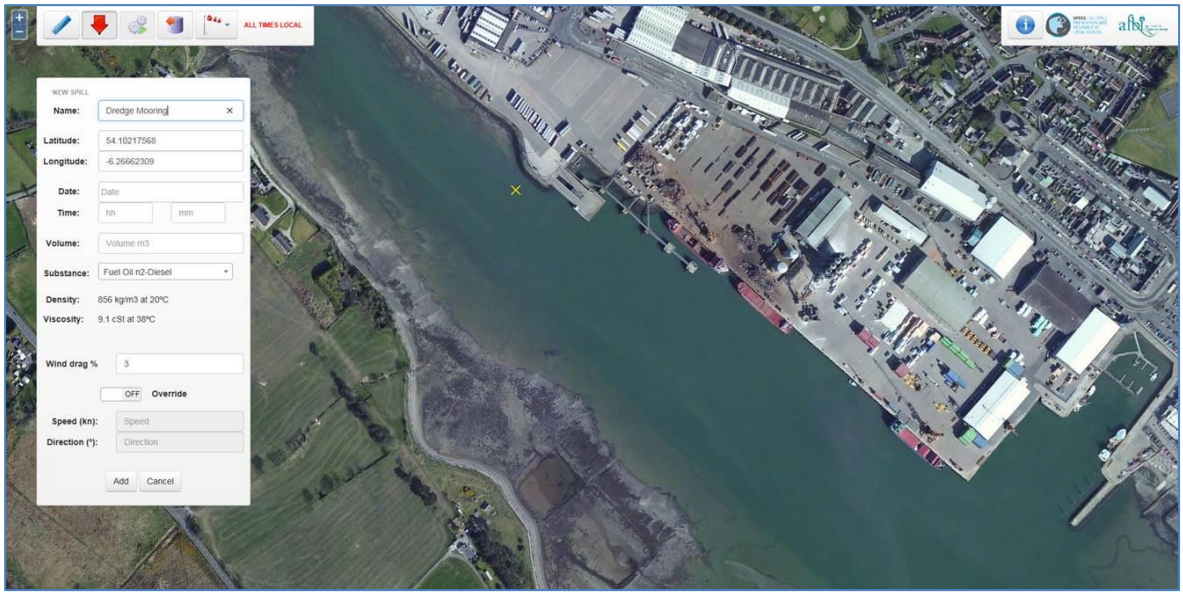

Figure 1. Warrenpoint Harbour monitoring station location.

This report summarises the monitoring periods where instruments were commissioned for the dredging works at the monitoring location identified in Figure 1. Continuous water quality monitoring was successful (100% data recovery) and at no point during the dredge activity were alarms for suspended sediment or dissolved oxygen attributed to the dredge activity. The License threshold of 600mg/L^{-1} suspended sediment was not, and the higher turbidity readings observed were associated with spring tides. On no occasion did dissolved oxygen concentrations drop below the license threshold of 4 mg/L^{-1}, and only 2.6 % (#91) of observations were below the (alert) concentration of 6 mg/L^{-1} for brief periods of time associated with low water spring tides.

Location	Start Date	End Date	# Records	License		Advisory	
				> 600 mg/L-1 Turbidity Alarms	< 4 mg/L-1 Dissolved Oxygen Alarms	> 300 mg/L-1 Turbidity Alerts (advisory)	< 6 mg/L-1 Dissolved Oxygen Alerts (advisory)
Warrenpoint Harbour	30/05/2017	12/07/2017	3086	**0**	**0**	4	91

Table 1. Summary data from Warrenpoint water quality monitoring. Alarms are defined as events with individual or consecutive readings breaching a license threshold, whereas advisory *"alerts"* notify of unusual levels that should be looked at as a precautionary measure. Alarms may be individual observations and do not represent a breach of license condition unless they are sustained (for SPM) for more than 6 hours.

Introduction & Method

The principle potential environmental risks from dredging around the Warrenpoint area are considered to be to the shellfish industry both upstream and downstream of the works, and to the passage of migratory fish. There are also potential risks associated with the conservation features of adjacent designated sites.

The Clanrye river supports both migratory and non-migratory fish species. The areas upstream of the harbour support a wild mussel fishery. Carlingford Lough also supports a significant aquaculture industry. Sites licensed for bottom culture of shellfish (predominantly mussels) cover approximately 931 hectares of the subtidal area of Carlingford Lough and approximately 240.1 hectares of the intertidal area of the Lough is licensed for the off bottom (trestle) culture of oysters. It is estimated that licensed aquaculture beds cover approximately 23.9% of the total area of the Lough.

The upper reaches of the Lough are shallow and dominated by fine muddy sand beds and intertidal mud-flats, whilst the seaward entrance to the Lough is a mixture of boulder, cobble and bedrock forming numerous small islands and reefs. The areas of Carlingford Lough on the Northern side of the dredged channel have been designated as a Special Protection Area (SPA) for breeding Sandwich and Common Terns and overwintering (non breeding) Light Bellied Brent Geese, an Area of Special Scientific Interest (ASSI), an Area of Outstanding Natural Beauty (AONB) and a RAMSAR site (as designated under the Convention on Wetlands of International Importance (also known as the Ramsar Convention). The areas of Carlingford Lough on the Southern side of the dredged channel have been designated as a Special Area of Conservation (SAC) for the Annex I habitats Annual vegetation of drift lines and Perennial vegetation of stony banks, a SPA for overwinter (non breeding) Light bellied Brent Geese and wetlands and also is a proposed Natural Heritage Area.

Real-time monitoring systems using well-proven technology were custom built at AFBI and established at an agreed location in the Harbour area so that a reactive approach to operational management could be taken. Monitoring of suspended sediment and dissolved oxygen concentrations was performed using an automated monitoring buoy with multi-parameter water quality monitoring instruments. These packages operate autonomously 24 hours a day and have active anti-fouling protection and "push" data transmission. The data from the monitoring instruments is captured and pushed to a remote data-server using the GPRS mobile phone data network. Data telemetry is 2 way allowing reconfiguration of the system where required. The system generates "Alarm" and "Alert" messages if threshold criteria are breached - these warnings are sent to mobile devices that are monitored 24 hours per day. For this programme, a precautionary low oxygen *alert* threshold of < 6 mg/L^{-1}, and a precautionary turbidity *alert* threshold of > 150 NTU which equates to approximately 218 mg/L^{-1} of suspended sediment (see data notes for details of regressions) were established. The "Alarm" thresholds are higher that the "Alert" thresholds and align with the license concentrations for suspended solids and dissolved oxygen – the more conservative regression was used to ensure better confidence in compliance (see appendix).

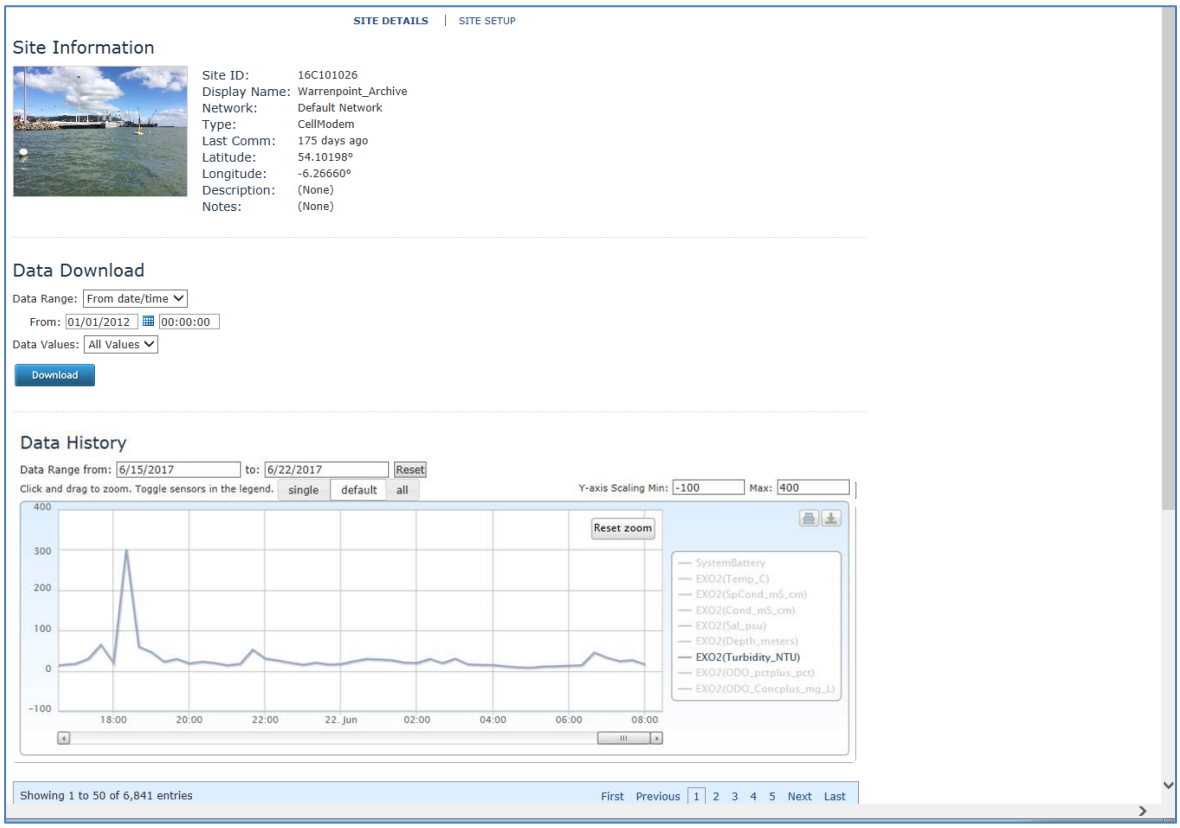

Figure 2. Secure data portal provided for the Warrenpoint monitoring programme illustrating real-time data from the monitoring station.

Turbidity measurements are made by optical backscatter (a measure of the suspended load of the water) which in this context assists in the monitoring water quality and ensure we understand the environment and assess the contribution of the dredging operation to any perturbation.

The measurement of dissolved oxygen is performed optically by a sensor that uses the luminescence lifetime method to measure oxygen saturations (relative to air). This method is now used because it offers the most stable, repeatable and sensitive method for oxygen detection, thus reducing sensor drift and prolonging deployment times. The sensor has its own passive and mechanical cleaning systems that when combined with the improved sensor stability ensures measurement accuracy. Quality Assurance (QA) measurements integrated into AFBI's data management system ensures measurements are traceable to the Winkler titration method and will stand up to the highest level of scrutiny. The oxygen sensor is integrated into a multi-parameter water quality monitoring sonde that uses a logarithm to combine the dissolved oxygen saturation data from the sensor with the temperature and salinity data to calculate the dissolved oxygen concentrations in the water at the point of measurement. This calculated concentration value allows real time assessments of concentration against license and policy thresholds (4 mg/L^{-1}) facilitating quick and reactive management options, as the instrument (after calculating actual concentrations) will generate alarm notifications for AFBI in near-real time.

Data records are created and automatically analysed every 20 minutes whilst the server updates the website data every hour. Two way communications between the server and the monitoring hardware allows AFBI to manage data delivery dynamically so in the event of an environmental anomaly sampling strategies can be modified.

Data and Results:

Monitoring Summary

Data collection started on the 30/05/2017 in Warrenpoint Harbour. Data collection continued through to 12/06/2017 with good quality optical turbidity and dissolved oxygen measurements recovered in real-time throughout the contract. Operational monitoring stopped on instruction from Warrenpoint Harbour (email from Catriona Dowling dated 11/07/2017), and the mooring remained in place (and operational) until a convenient recovery opportunity was identified. All hardware was removed on 31/08/17 during routine operations on Carlingford Lough. A total of 3086 valid real time measurement records were generated by the monitoring station over the duration of the programme delivering data on turbidity and dissolved oxygen (additionally providing temperature, pressure and salinity). This data return represents a 100.0% delivery success when down-time for servicing and failures resulting from biological fouling are accounted for.

The environmental conditions at the Warrenpoint Harbour monitoring site were routine and anticipated – the fouling of sensors did not impact observations, as water conditions did not encourage excessive biological growth or sediment/floc accumulation. Where alerts were generated they were assessed and qualified with the contract consultants; when confirmed not to be associated with dredge activity then no corrective management actions were recommended.

The License threshold of 600mg/L^{-1} of suspended sediment was not exceeded for more than 6 hours at the monitoring location (Figure 4). There was a high turbidity reading of 301.77 NTU at 18:20 21/06/17 which was isolated and not sustained (see Figure 2). This did not exceed the concentration threshold of the license, and was not a breach of license threshold nor was it sustained for more than 6 hours. This anomalous value could have been caused by a plug of high turbidity water or piece of debris passing the sensor. An alert was raised and the data were assessed – no further action was required.

There were low Dissolved Oxygen concentrations (< 6mg/L^{-1}) between 02:40 22/06/17 and 05:20 22/06/17 – these concentrations raised precautionary "alerts", but did not breach the license criteria of < 4mg/L^{-1}. Alerts raised meant that the data were assessed with input from the consultants – no further action was required.

Suspended solids

Turbidity levels at the monitoring station were typically below 25 mg/L-1 (70 % of all observations). Some peaks in turbidity did occur with automated alerts (>150 NTU) – these events most likely occurred as a result of debris passing the optical sensing pathway as the observations were unusually high and were not sustained. These alerts were dismissed after assessment, with no further action being required.

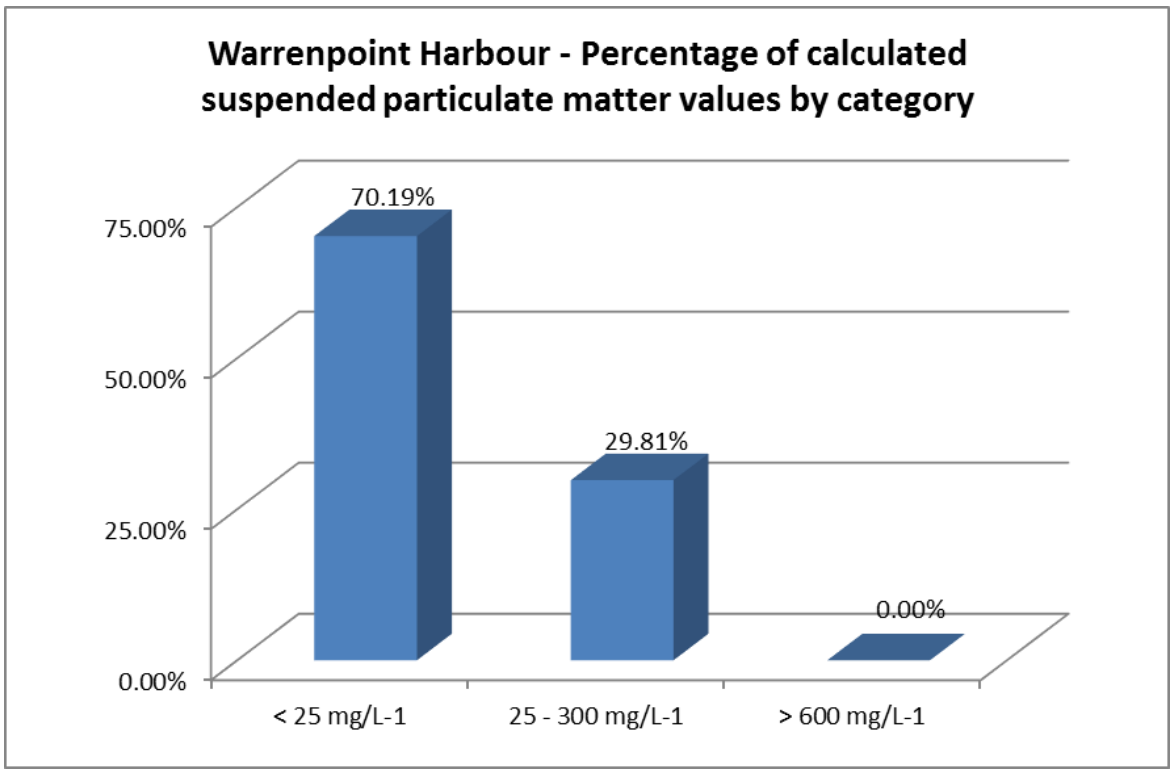

Figure 3. Percentage of turbidity measurements by category, illustrating the prevalence of turbidity values below 25 NTU.

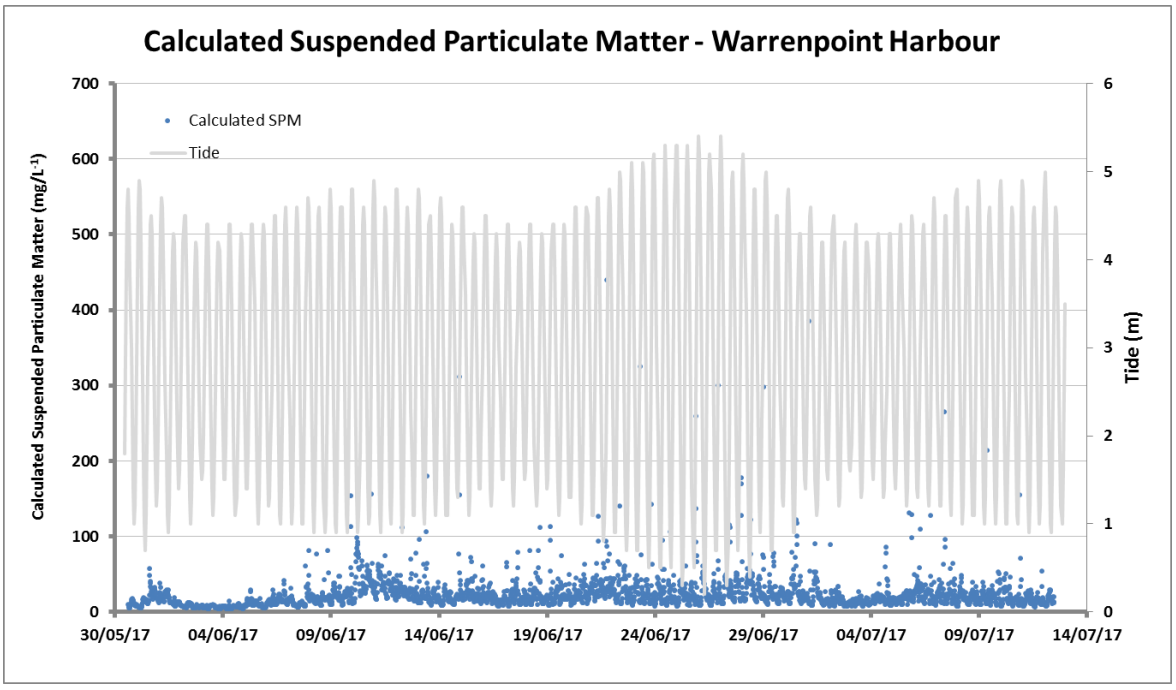

Figure 4. Suspended Particulate Matter at the Warrenpoint Harbour monitoring station.

The high turbidity (>300 NTU) observed on 1 occasion (Figure 2) was not coincidental with low oxygen concentrations, again, reinforcing the position that this was not a sustained or representative "high-turbidity" event. The high turbidity measurements did not approach the 6 hr threshold that was previously recommended by NIEA as best practice when levels are above 600 mg/L^{-1} (an equivalent of approximately 410 NTU). Figures 3 and 4 illustrate turbidity levels during the monitoring period were generally < 100 mg/L^{-1}, and only a very small proportion of measurements were above this calculated concentration.

Dissolved Oxygen

All dissolved oxygen concentration observations were above the license threshold of 4 mg/L^{-1} (Figure 5). At no time were low dissolved oxygen concentrations observed, and only 91 observations (2.9%) were below the precautionary "alert" threshold of 6 mg/L^{-1} (Figures 5 and 6). All alerts were reviewed by an operator in real time to assess the significance and potential for impact, and no precautionary measures or further management action were deemed appropriate.

Dissolved oxygen concentrations showed variation on diel and tidal cycles reflecting the background water quality at this location. Patterns of Dissolved Oxygen concentrations can be seen with regard to the spring-neap tidal cycle (Figure 6) as well as the daily tidal cycle (figure 7), with under-saturations of oxygen typically seen around low tide (Figure 7.

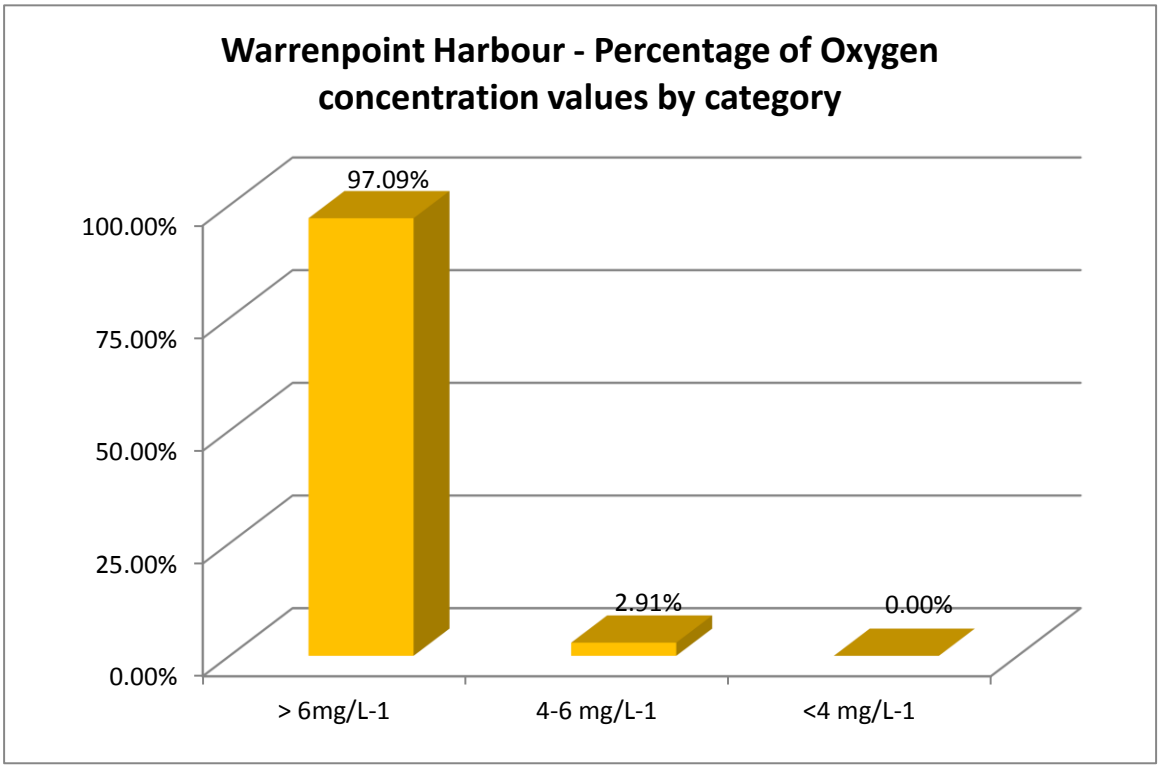

Figure 5. Dissolved Oxygen concentration by category. A Concentration of < 6 mg/L^{-1} was established as an operational "alert" threshold, whilst < 4mg/L^{-1} was an operational "alarm" threshold.

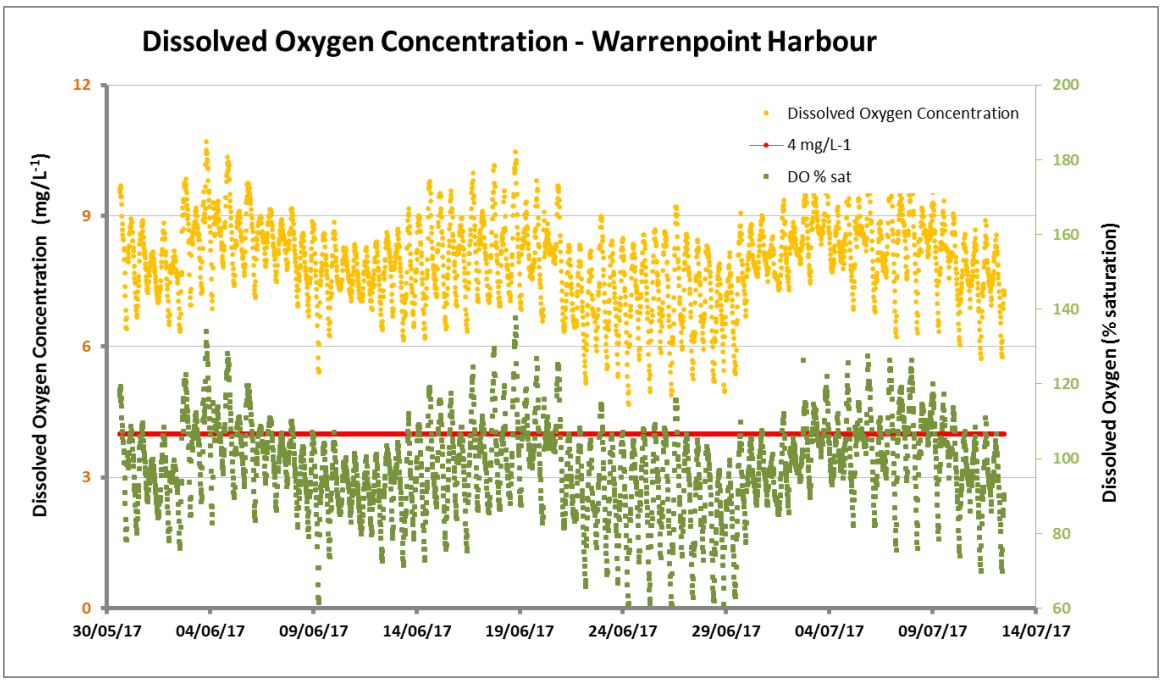

Figure 6. Dissolved Oxygen concentrations (yellow) and saturation (green) at Warrenpoint Harbour monitoring station. Note the concentration (yellow) does not fall below 4mg/L-1.

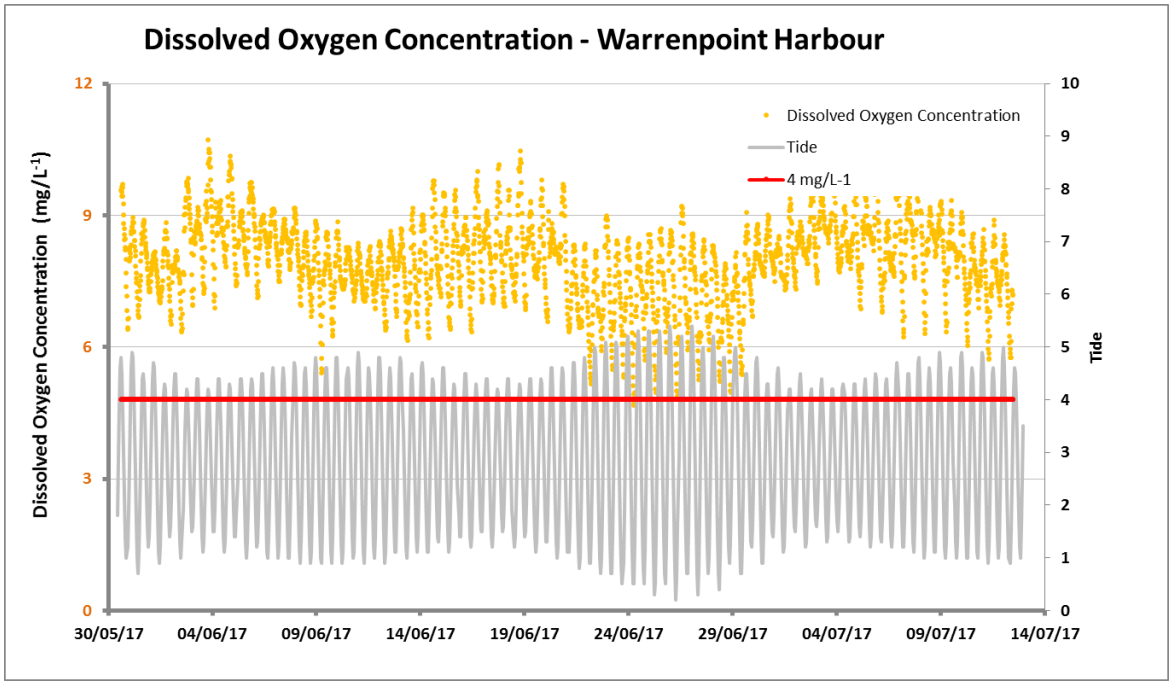

Figure 7. Dissolved oxygen concentrations and tide height at Warrenpoint Harbour monitoring station. Note the concentration (yellow) does not fall below 4mg/L-1

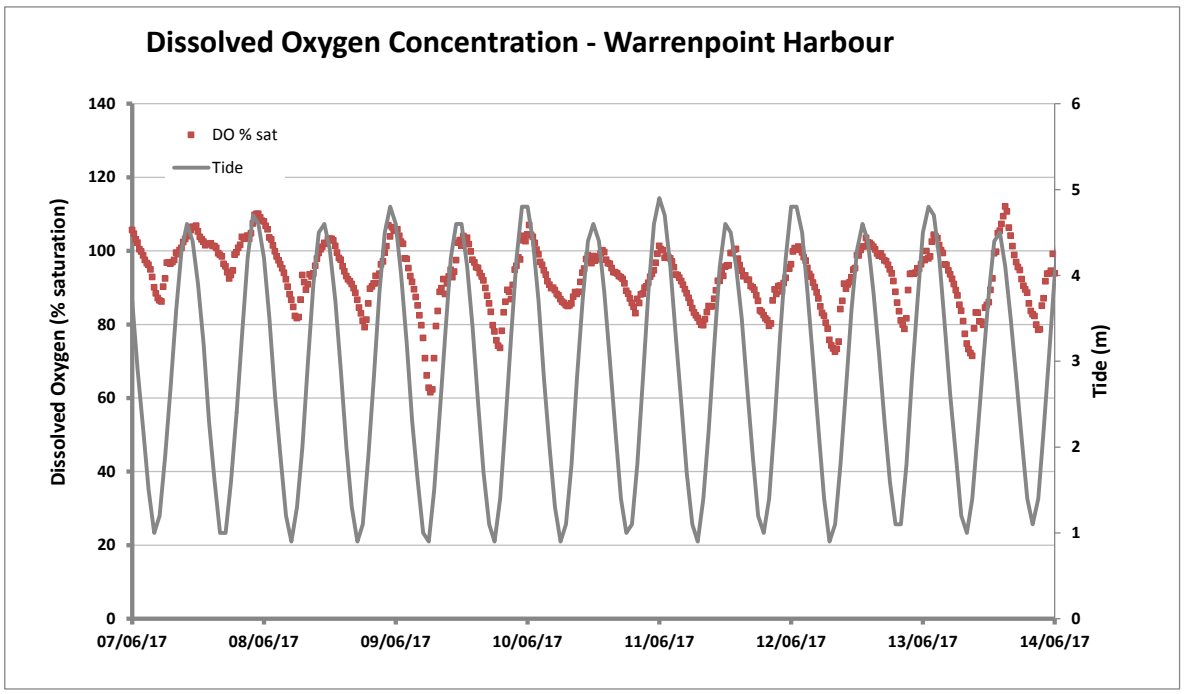

Figure 8. Dissolved Oxygen saturations at Warrenpoint Harbour monitoring station, showing tidal variation in oxygen saturation (relative to atmospheric).

Appendix 1 - Data Notes.

Data are generated using oceanographic instruments with full antifouling measures (passive copper based alloy coatings and active mechanical wiping mechanisms supported by frequent routine manual servicing). Monitoring packages are supported with on-site validation and calibration using certified reference instruments and laboratory assays. The instruments that AFBI supply measure all necessary parameters at all sites (turbidity, dissolved oxygen, conductivity, temperature and depth) and operate under AFBI's ISO 9001 accreditation. Data that may have been compromised by fouling remain within this report, as without quantitative measures of when fouling started to influence a measurement there is no objective way to screen the data out. In this case, care with interpretation of the data is necessary to avoid calling false positives with "alerts", but this will tend to give a more conservative approach. All antifouling systems worked without fail during this contract, so we are confident that the data is of the highest standard possible.

Suspended Sediment units.

Suspended sediment data are observed as optical backscatter (in NTU) - instrumental measurements are traceable to calibrated standards and this facilitates a regulating authority to make broader comparisons between sites and/or over time. The expression of instrumental measures of suspended solids in "mg/L^{-1}" can be problematic because of the nature of the measurement; reporting a "calculated suspended load" has many difficulties as the relationship between suspended load and optical reactivity is complex and can lead to uncertainty in the expression of results.

The reporting of suspended sediment in mg/L^{-1} can be made when laboratory analysis for suspended sediments are complete from ongoing sampling (allowing a full regression against the instrumental measurements), but this process may not ensure good regressions of optical measurements against laboratory assays because of the potential for not covering the "range" of optical measurements encountered, and due to the variable optical reactivity of sediment loads over time.

Laboratory measurements undertaken during previous studies at this location identified the optical measurements relationship to suspended sediment as:

$$\textit{Suspended solids } (mg/L^{-1}) = (1.46 * NTU)$$

Alert thresholds of 150 NTU form part of a precautionary approach by setting the alarm for the calculated suspended sediment load at what was previously calculated to be 300 mg/L^{-1}. This study has made "alert" conditions at a calculated suspended sediment load of 218 mg/L^{-1}, and an Alarm threshold of a calculated suspended sediment load of 438 mg/L^{-1}. These conservatively applied thresholds allow time for the situation to be assessed early whilst sediment loads are still rising towards the licensed thresholds so that management action (where appropriate) can be taken.

Dissolved Oxygen units.

Dissolved oxygen was measured by calibrated optical instrumentation, and expressed as a concentration in mg/L^{-1} after being converted from % atmospheric saturation using an algorithm to account for the temperature and salinity of the water the measurement was made in. These measurements are calibrated against reference measurements, but typically fall within 5% (of atmospheric saturation) of the reference instrument measurements and are considered accurate. Data are converted and reported by the instrument to mg/L^{-1}, and have been expressed in this report as mg/L^{-1} to allow for the simple comparison to policy criteria. Parameters measured both *in-situ* and as Quality Assurance (such as Dissolved Oxygen and Salinity) are calibrated and traceable to accredited standards (for example, the Winkler titration method for oxygen).