PORT & COASTAL SOLUTIONS

Technical Note

Date: 22/03/2019
To: Damian Snell
From: Andy Symonds
Subject: Port of Hay Point 2019 Maintenance Dredging: Turbidity Analysis, Note 1

1. Introduction

Real-time surface turbidity monitoring is being undertaken by Vision Environment (VE) as part of the adaptive management for the 2019 maintenance dredging program at the Port of Hay Point. The monitoring is being undertaken at two trigger sites (Round Top Island and Victor Island) and two control sites (Slade Islet and Freshwater Point). The reason that real-time surface turbidity monitoring has been adopted compared to real-time benthic turbidity monitoring, is because it is considered to reduce the risk of data loss and increase the confidence in the data:

- due to the large tidal range and strong tidal currents in the Hay Point region there is a high probability of ongoing data loss when trying to transmit real-time benthic data. This is because a cable is required to connect the instrument at the seabed to the modem on the surface buoy, but due to the metocean conditions there is a risk that the cable could become entangled or damaged at any time;
- the risk of data loss when using a near-surface logger is low, as both the instrument and modem are located on the same buoy and so there is no long cable which can be entangled or damaged; and
- in the Hay Point region the large tidal range and strong tidal currents result in the turbidity being relatively well mixed through the water column. In these types of environment, the surface turbidity is often found to provide a clearer signal for impact modelling, as the benthic turbidity often includes additional natural spikes due to localised resuspension.

In addition to the real-time surface turbidity monitoring, benthic turbidity data are being concurrently collected by VE using self-logging instruments at the two trigger sites, to provide additional benthic data required for the compliance monitoring. Data from these instruments will be downloaded approximately every two weeks over the duration of the dredging program. This will enable the difference between the benthic turbidity and surface turbidity data to be checked. In addition, the long-term ambient water quality monitoring is continuing throughout the maintenance dredging, with benthic turbidity data being collected by James Cook University (JCU) at seven sites in the Hay Point and Mackay region.

Turbidity thresholds were calculated at the four adaptive management sites based on three years of benthic turbidity data collected as part of the long-term ambient water quality monitoring undertaken by JCU (RHDHV, 2018). The thresholds were determined using the hourly rolling average benthic turbidity and include a benthic turbidity intensity and a duration of time the intensity threshold is exceeded over a set period of time. These thresholds are being adopted as part of the adaptive management and compliance monitoring for the Port of Hay Point 2019 maintenance dredging program (Adaptive Strategies, 2018). The relevant turbidity intensity thresholds are shown in Table 1.

This is the first technical note describing the surface and benthic turbidity data collected during the Port of Hay Point 2019 maintenance dredging program. This note describes data collected between the 19th February 2019 and the 12th March 2019. In addition, the note compares the surface and benthic turbidity and defines representative surface turbidity intensity thresholds which provide comparable exceedance durations to the benthic thresholds. The 2019 maintenance dredging program is scheduled to commence on the 31st March 2019, consequently the entire period analysed and discussed within this note is representative of natural conditions.

Table 1. Benthic turbidity intensity thresholds for the trigger and control sites (RHDHV, 2018).

Location	Benthic Turbidity Intensity Threshold (NTU)
Slade Islet (control)	43
Round Top Island (trigger)	11
Victor Island (trigger)	32
Freshwater Point (control)	104

2. Measured Data

As part of the Port of Hay Point 2019 maintenance dredging program compliance monitoring, VE installed real-time surface turbidity instruments at four monitoring locations (Table 2 and Figure 1) and self-logging benthic turbidity instruments at two monitoring locations (Round Top Island and Victor Island). Dual YSI EXO3 sondes were deployed at each surface and benthic logger location (i.e. there were two instruments measuring turbidity every 10 minutes at the surface and for the two control sites and two instruments measuring at the bed), with the loggers configured to be approximately 0.75 m above the seabed (benthic) and 0.75 m below the water surface (surface). A quality assurance and quality control (QA/QC) check was undertaken on the dual sondes data and where the QA/QC showed that data from both sondes were reliable the data were averaged and when data from one sonde were considered unreliable/erroneous just the data from the other sonde were adopted. In addition, VE undertook turbidity profiling through the water column at the four sites when the instruments were retrieved on the 12th March 2019.

The JCU benthic turbidity data were also considered for the two trigger sites (Round Top Island and Victor Island), these are self-logging benthic instruments which measure turbidity every 10 minutes. The JCU measurements were made using multiparameter instrumentation manufactured by JCU. The JCU turbidity loggers use 180 degree backscatter to measure turbidity giving a turbidity reading in Nephelometric Turbidity Unit's equivalent (NTUe), while the VE loggers use 90 degree backscatter to measure turbidity giving a turbidity reading in Nephelometric Turbidity Unit's (NTU). Instruments using different scattering angles can result in different measurements of turbidity, measurements using both approaches are compared in this note to assess the relative differences. Unfortunately, for the period being analysed there were no benthic turbidity data available at Round Top Island as there was an issue with the instrument at this site.

Table 2. Summary of turbidity monitoring locations.

Location	Depth (m below LAT)	Latitude (VE)	Longitude (VE)	Sediment Type
Slade Islet	11 m	-21.0927° S	149.2411° E	Sandy (shell material)
Round Top Island	8.8 m	-21.1731° S	149.2600° E	Sandy (shell material)
Victor Island	8.6 m	-21.3176° S	149.3128° E	Sandy (shell material)
Freshwater Point	6.1 m	-21.4148° S	149.3360° E	Clay

Figure 1. Location of the four monitoring sites.

3. Turbidity Analysis

The measured benthic (where available) and surface turbidity data as well as the local wind (from the Bureau of Meteorology (BoM) Hay Point weather station (ID: 033317)) and wave conditions (from the Department of Environment and Science waverider buoy at Hay Point) are shown for the four monitoring sites in Figure 2 (Round Top Island), Figure 3 (Victor Island) Figure 4 (Freshwater Point) and Figure 5 (Slade Islet) (please note that the turbidity scale alters between the figures).

The plots show that over the measurement period the turbidity at all four sites has been variable. At all sites the turbidity was elevated between 25/02/2019 and 06/03/2019 due to the increased wind speed and wave height, resulting in the natural resuspension of sediment from the seabed. The lower turbidity corresponds to periods with lower wind speeds and wave heights, although the benthic turbidity data at Victor Island show that at this site short duration increases in turbidity can also occur during the periods of calmer wind and smaller wave heights due to tidal currents with increases around spring tides (new and full moons).

Comparison between the benthic and surface turbidity data at the trigger sites shows that the benthic turbidity is typically higher than the surface turbidity. The difference between the benthic and surface turbidity is greatest during periods of increased turbidity (strong winds and large waves) and smaller during calmer periods. This is further shown by the turbidity profiling through the water column which was undertaken during calm conditions at the end of the measurement period and shows uniform turbidity throughout the water column at all sites except for Freshwater Point where the benthic turbidity was approximately double the surface turbidity (1.3 NTU at the surface and 2.5 NTU at the bed) (Figure 6).

The VE and JCU benthic turbidity data at Victor Island show very similar temporal patterns, with the JCU data having slightly higher short-duration peaks in turbidity compared to the VE data. The similarity in turbidity between the measurements provides additional confidence in the data from both sources especially when it is considered that the turbidity is measured using different approaches.

Note: The white and grey circles along the x-axis represent periods of full and new moon, respectively.

Figure 2. Measured wind (top), wave (middle) and hourly rolling average benthic and surface turbidity (bottom) at Round Top Island.

Note: The white and grey circles along the x-axis represent periods of full and new moon, respectively.

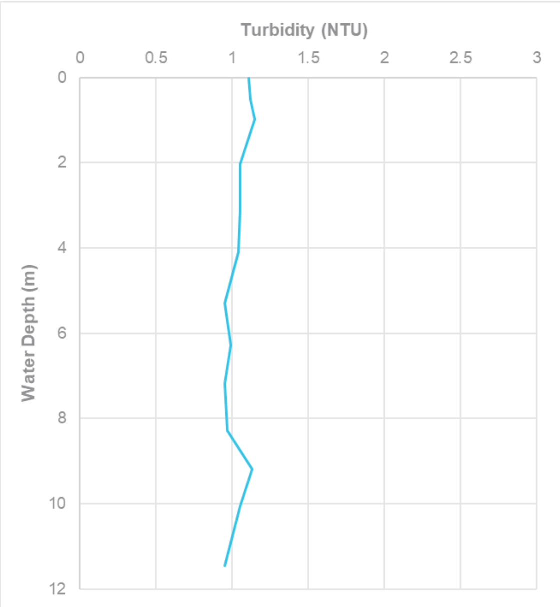
Figure 3. Measured wind (top), wave (middle) and hourly rolling average benthic and surface turbidity (bottom) at Victor Island.

Note: the white and grey circles along the x-axis represent periods of full and new moon, respectively.

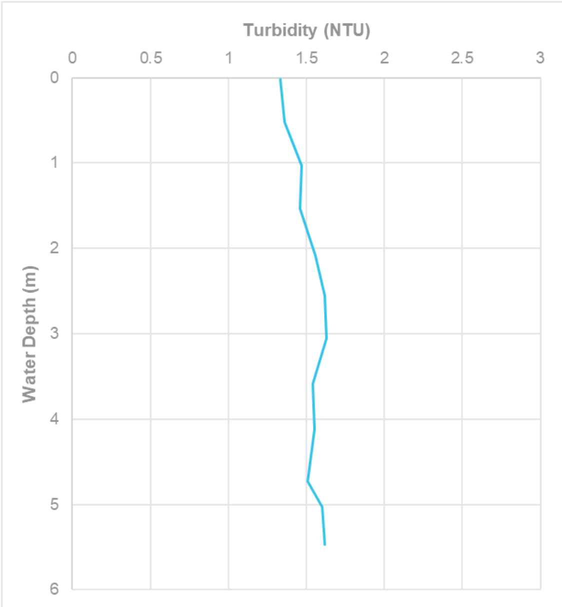
Figure 4. Measured wind (top), wave (middle) and hourly rolling average benthic and surface turbidity (bottom) at Freshwater Point.

Note: the white and grey circles along the x-axis represent periods of full and new moon, respectively.

Figure 5. Measured wind (top), wave (middle) and hourly rolling average benthic and surface turbidity (bottom) at Slade Islet.



Round Top Island



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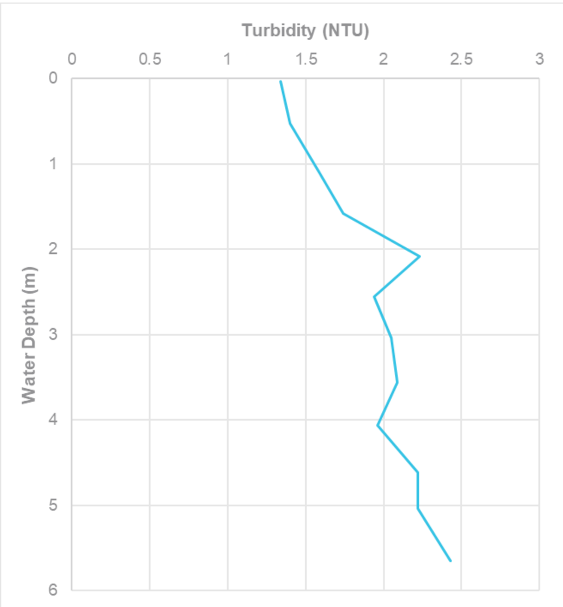
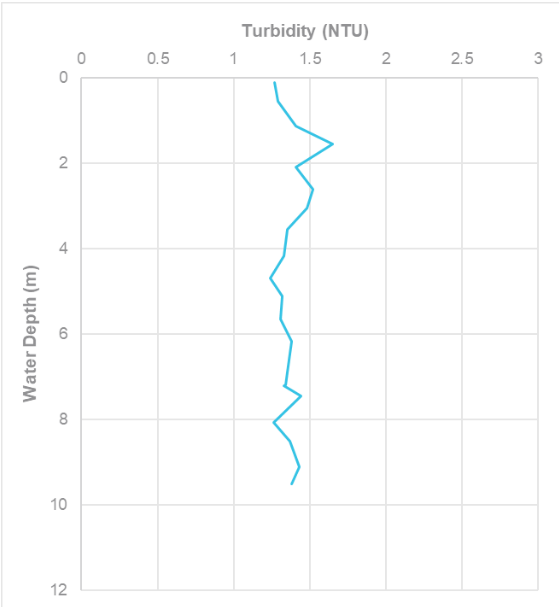


Freshwater Point



Slade Islet

Figure 6. Measured turbidity profiles through the water column on 12/03/2019 at the four VE monitoring sites.

4. Threshold Analysis

The benthic turbidity intensity thresholds which were defined by RHDHV (2018) have been applied to the measured benthic data at the two trigger sites, to calculate the duration of time that the intensity thresholds were exceeded (Table 3). At Round Top Island the benthic turbidity threshold was exceeded for 103 hours over the 21-day period, while at Victor Island the exceedance duration varies between 35 hours (based on the VE data) and 59 hours (based on the JCU data). As Victor Island is a trigger site for the adaptive management the higher exceedance duration of 59 hours has been adopted to define the surface turbidity intensity threshold as this is considered to be the conservative approach, (i.e. this will result in a lower surface turbidity intensity threshold and therefore the potential for more hours of exceedance at the trigger site).

To estimate the hours that the benthic turbidity intensity threshold would be expected to have been exceeded over the 21-day period, benthic turbidity data from the long-term ambient water quality monitoring was analysed to identify comparable exceedance events. The wave conditions and benthic turbidity at the four monitoring sites are shown for a comparable event in Figure 7. The wave conditions during the event were similar to the 2019 measurement period, with the significant wave height (H_s) peaking between 1.5 and 2 m and the duration of the larger wave heights (H_s > 1 m) being approximately nine days. Over a 21-day period around the increased wave conditions the durations that the benthic intensity thresholds were exceeded varied between the sites from 58 hours to 83 hours. Based on this it is assumed that approximately comparable benthic exceedance durations would be expected at all four of the monitoring sites, but to be conservative the lower exceedance duration of 59 hours associated with Victor Island will be adopted to define the surface turbidity thresholds at the control sites of Slade Islet and Freshwater Point. This approach is considered conservative as adopting the lower of the two exceedance durations from the two trigger sites will result in a higher surface turbidity intensity threshold and therefore the potential for less hours of exceedance at the control sites.

Surface turbidity intensity thresholds were calculated for the four sites to ensure that they replicated the relevant benthic intensity threshold duration exceedances (see Figure 2 to Figure 5 and Table 4). These surface turbidity intensity thresholds can be applied to the real-time surface turbidity data as part of the adaptive management, to help inform ongoing management measures which are required for the Port of Hay Point 2019 maintenance dredging.

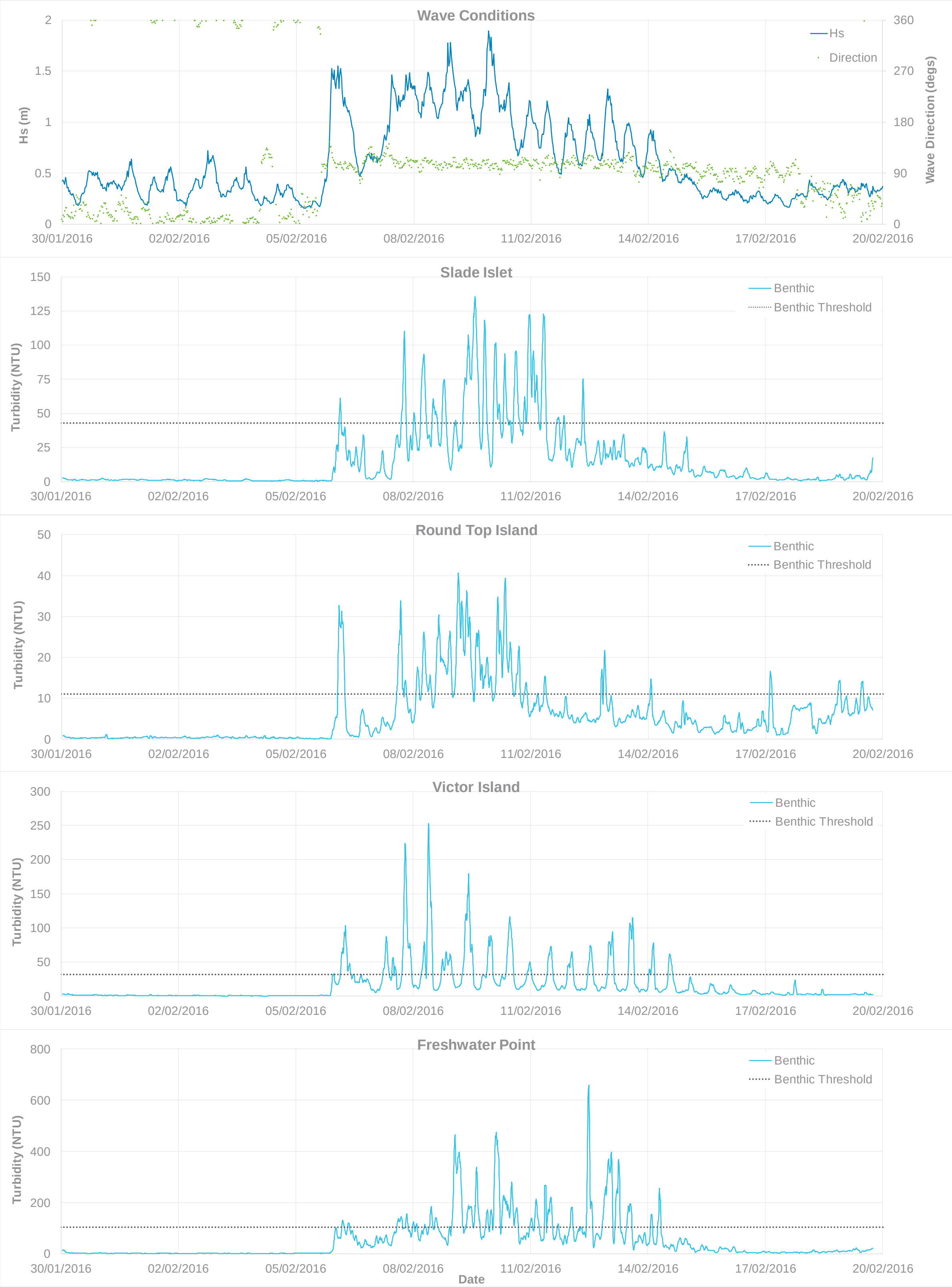
Every two weeks when the benthic turbidity loggers are serviced and the data downloaded, the correlation between the benthic and surface turbidity intensity thresholds will be checked by calculating the duration exceedance for the benthic and surface turbidity data.

Table 3. Duration exceedance for the benthic turbidity thresholds.

Location	Benthic Turbidity Threshold (NTU)	Duration VE Benthic Data Exceeded (hrs)	Duration JCU Benthic Data Exceeded (hrs)
Round Top Island	11	103	NA
Victor Island	32	35	59

Table 4. Surface turbidity intensity thresholds and associated duration exceedance.

Location	Surface Turbidity Threshold (NTU)	Duration VE Surface Data Exceeded (hrs)
Slade Islet	8.9	59
Round Top Island	8.1	102
Victor Island	13.7	60
Freshwater Point	24.3	59



Note: Turbidity axes differ for each site.

Figure 7. Measured wave (top) and hourly rolling average JCU benthic turbidity data at the four monitoring sites for an exceedance event in 2016.

5. Summary

This assessment has provided an interpretation of benthic and surface turbidity measurements obtained prior to the Port of Hay Point 2019 maintenance dredging program. In addition, analysis of the turbidity data has allowed surface turbidity intensity thresholds to be defined which correspond to the benthic turbidity intensity thresholds previously defined based on three years of benthic turbidity data collected as part of the ongoing long-term ambient water quality monitoring program.

6. References

RHDHV, 2018. Port of Hay Point: Environmental thresholds, Maintenance dredging management and monitoring. March 2018.

Adaptive Strategies, 2018. Port of Hay Point: Maintenance dredging environmental management plan. March 2018.