# Managing Safe Navigation and Asset Protection in Areas Exposed to Strong Propeller and Thruster Currents

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**Summary**
Currents generated by vessel propellers and thrusters require careful management to ensure safe navigation in ports. Bow thruster generated currents from vessels using Sydney's Overseas Passenger Terminal have had effects on the navigation of small vessels within Sydney Cove and on berthing infrastructure. These effects have been managed by the Port Authority of NSW, with field measurements and targeted hydrographic survey providing valuable data to plan effective operational responses and asset remediation and protection works.

*Keywords: bow thruster, water velocity, bed scour, field measurements*

## Introduction

The Overseas Passenger Terminal (OPT) in Sydney Cove, NSW is a cruise terminal operated by the Port Authority of New South Wales. In the past decade, the wharf and terminal infrastructure have undergone a number of upgrades to accommodate much larger vessel sizes and associated passenger capacities. Over this time the number of vessel arrivals at the OPT has also markedly increased, consistently exceeding 200 annual vessel visits [1] prior to the COVID hiatus.

This increase in both vessel size and number of arrivals has led to stronger and more frequent thruster and propeller wash generated currents within Sydney Cove. The total bow thruster rating of cruise vessels regularly berthing at OPT increased over two-fold following berth upgrades completed in 2016. The presence of these stronger currents, particularly from transverse bow thrusters, has required several management actions to be implemented by the Port Authority and monitoring exercises have been conducted to assist in the design and implementation of these measures.

## Effects of Thruster Currents on Smaller Vessels

In 2015, currents experienced during cruise vessel arrivals were noted to be possibly impacting ferry navigation on arrival to the Circular Quay ferry wharves. Following discussion with relevant stakeholders, the Port Authority engaged Cardno to conduct a field measurement exercise with the following aims:

1) Confirm the presence and cause of the observed currents
2) Characterise the flow within Sydney Cove, and particularly in the approach to the ferry wharves
3) Assess the performance of a horizontal Acoustic Doppler Current Profiler (ADCP) to provide near real-time measurements of the currents

The measurement exercise was conducted in March 2016 during the berthing of a cruise vessel. The Port Authority secured approval for the vessel to run one of its thrusters at 30% capacity for approximately 25 minutes following arrival to allow measurement of the generated currents. During berthing all thrusters were run at 80% capacity for a brief period.

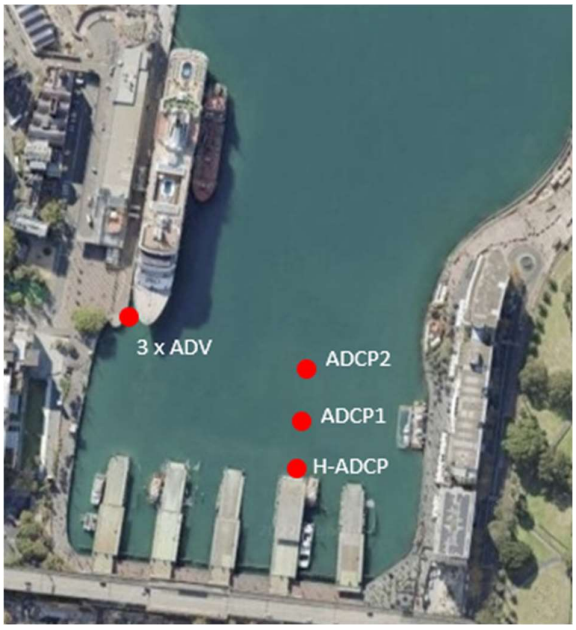


Figure 1 Aerial view of Sydney Cove (Source: Google Earth) showing instrument deployment locations

Four ADCPs were deployed during the exercise as shown in Figure 1:

- A Teledyne RDI 300kHz ChannelMaster ADCP deployed horizontally north facing from a ferry wharf face (H-ADCP)
- Two Teledyne RDI 1200kHz Workhorse Sentinel ADCPs deployed bed-mounted at 40 and 80 metres north of the ferry wharf face (ADCP1 and ADCP2)
- A Teledyne RDI 1200kHz Workhorse Sentinel deployed on a Port Authority survey vessel to conduct north-south transects across the thruster wash (transect lines not shown)

The exercise was successfully completed, with good measurements obtained from all four of the instruments. Figure 2 shows a time series of mid-depth currents measured by the H-ADCP, bed-

mounted ADCP and vessel-mounted ADCP at the same location, approximately 40 metres north of the ferry wharf over the course of the exercise.

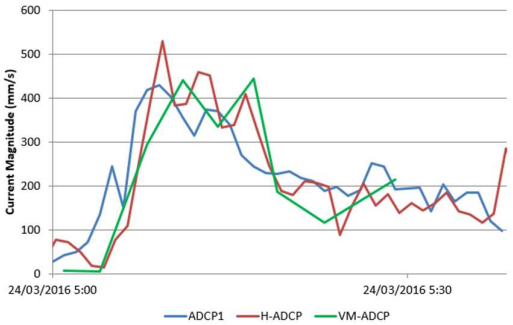


Figure 2 Current Magnitude mid-depth 40 metres north of ferry wharf during measurement exercise showing bed-mounted ADCP1 (blue), H-ADCP (red) and vessel-mounted ADCP (green)

The three instruments measured data with good agreement given the observed spatial variability during the exercise.

Following the successful completion of this exercise, the Port Authority permanently installed the H-ADCP in Sydney Cove to assist ferry operations by providing near real-time current measurements. The instrument provides a horizontal current profile extending over 100 metres north of the ferry wharf providing a good description of generated currents.

**Asset Protection Works**

Following assessment of routine hydrographic surveys of the OPT berth by the Port Authority's hydrographic survey team, surveys at increased frequency were conducted from November 2017 to March 2018 to evaluate the rate of seabed change identified in the southern end of the OPT berth pocket. This monitoring identified scouring and associated accretion likely associated with thruster wash. Figure 3 shows the depth difference in the southern OPT between 2014 and 2018 with areas of scour in blue and accretion in red.

To confirm the processes causing this scour and to characterise the associated near-bed currents, the Port Authority engaged Cardno to conduct a monitoring program. Three Nortek Vector Acoustic Doppler Velocimeters (ADVs) were deployed to allow high resolution current measurements in the turbulent wash zone at the base of the quay wall, as shown in Figure 1. The instruments were installed by divers in January 2020, with continuous 2Hz measurements recorded and transmitted in real-time until recovery in April 2020 thus capturing all vessel arrivals and departures over this period. The instrument placement was guided by the survey data and vessel specifications of scheduled arrivals. The instruments were placed in an area with observed limited depth change but within expected high currents.

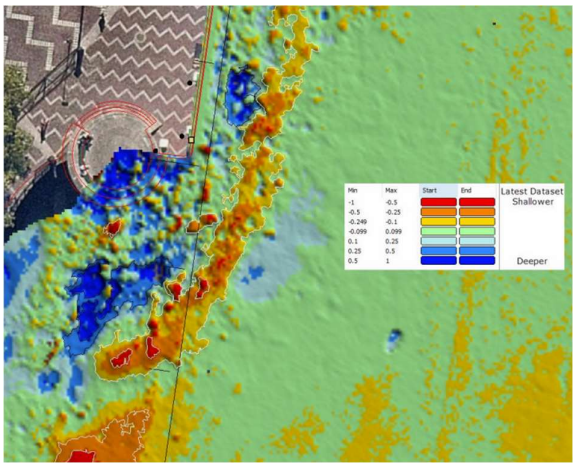


Figure 3 Depth difference in the southern OPT between 2014 and 2018 (Source: Port Authority of NSW survey)

Results of the monitoring confirmed the scour processes occurring in this region of the berth and have supported the design of asset protection works to ensure the continued safe operation of the berth. Port Authority is continuing detailed design of these works, including physical modelling of the final concepts.

Both the 2020 ADV near-bed measurements and the 2016 ADCP profile measurements have been compared against design estimates presented in the PIANC Guidelines for Protecting Berthing Structures from Scour Caused by Ships [2] and design estimates for both zones of current velocity are confirmed to be conservative.

**Conclusion**

Field measurements of thruster generated currents and hydrographic surveys have provided valuable data for the Port Authority to effectively manage the effects of bow thruster currents in Sydney Cove. Real-time current measurements support operational vessel traffic management and measured currents provide a sound basis for ongoing asset remediation and protection design works.

**References**

[1] Port Authority of NSW (2020) Annual Report 2019/20, Sydney

[2] PIANC (2015), Guidelines for Protecting Berthing Structures from Scour Caused by Ships, Report 180, Brussels