

# Macquarie Harbour

## Status update for dissolved oxygen

*September 2024*



ENVIRONMENT PROTECTION AUTHORITY

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## Introduction

This report provides a status update of environmental monitoring results for dissolved oxygen measured across various sites within Macquarie Harbour. The results provided in this report have been collected as part of the independent EPA water quality monitoring program for Macquarie Harbour (described below), and the Broadscale Environmental Monitoring conducted by industry as part of the requirements within the Environmental Licences to farm finfish in Macquarie Harbour (described below).

Dissolved oxygen measurements collected under these separate environmental monitoring programs can be compared against water quality guideline values for aquatic ecosystems established by the EPA. These values represent aspirational targets. Water Quality Guideline Values can be set at varying scales of specificity, dependent on data availability. For further information on the EPA's process for establishing Water Quality Guideline Values refer to the EPA document, [Technical Guidance for Water Quality Objectives \(WQOs\) Setting for Tasmania](#).

## Water Quality Guideline Values for Aquatic Ecosystems

For Macquarie Harbour, two different sets of Water Quality Guideline Values have been established, these include Site Specific Guideline Values (SSGVs) and interim Default Guideline Values (DGVs).

### Site Specific Guideline Values for Aquatic Ecosystems

Site Specific Guideline Values (SSGVs) for aquatic ecosystems provide the highest level of specificity as the information is based on historical data available for an individual monitoring site. For the purpose of this review, SSGVs for dissolved oxygen (mg/L) have been derived for the three EPA long-term monitoring sites (Denoted MH12, MH27 and MH34, see Map 1) using data collected between June 1993 and October 2009. SSGVs have been derived for 3 depths (10, 25 and 35 metres) for MH12 and MH27 and 2 depths (10 and 21 metres) for MH34. The SSGVs for each site are presented in Table 1 and are utilised within this report to compare changes in dissolved oxygen at the three EPA long-term monitoring sites.

Table 1 – Annual SSGVs for dissolved oxygen (mg/L)

Site and depth	20th Percentile	80th Percentile
MH12 – 10m	6.0	7.9
MH12 – 25m	3.7	4.9
MH12 – 35m	3.9	5.3
MH27 – 10m	5.1	8.1
MH27 – 25m	3.3	4.3
MH27 – 35m	3.5	4.8
MH34 – 10m	4.9	7.9
MH34 – 21m	3.1	4.3

### Interim Default Guideline Values for aquatic ecosystems

Interim Default Guideline Values (DGVs) for aquatic ecosystems have been derived for Macquarie Harbour. The interim DGVs have been established for three segments of Macquarie Harbour (denoted [NW Macquarie Harbour – Segment 121](#), [Central Macquarie Harbour – Segment 120](#) and [SE Macquarie Harbour – Segment 119](#)) and have been derived from data collected between May 1993 and October 2009 across 40 sites within Macquarie Harbour. Interim DGVs for dissolved oxygen have been established for each of the

three segments, with the 20th percentile representing the lower interim DGV and the 80th percentile representing the upper interim DGV. The interim DGVs for each segment are presented in Table 2 and represent annual interim DGV for depth ranges between 6-25 metres. Within this report, the interim DGVs are used to compare long term changes in dissolved oxygen measured across industry monitoring sites within the three segments of Macquarie Harbour.

Note, the interim DGVs for the less than 6 metre and greater than 25 metre depth ranges have been calculated from the same historical EPA dataset (May 1993 – October 2009) from which the Interim DGVs for the 6-25 metre depth range were calculated. Interim DGVs presented for the less than 6 metres and greater than 25 metre depths have not yet been published on the EPA website. These have been included on figures 9, 10 and 11 below to assist with interpreting the dissolved oxygen measurements.

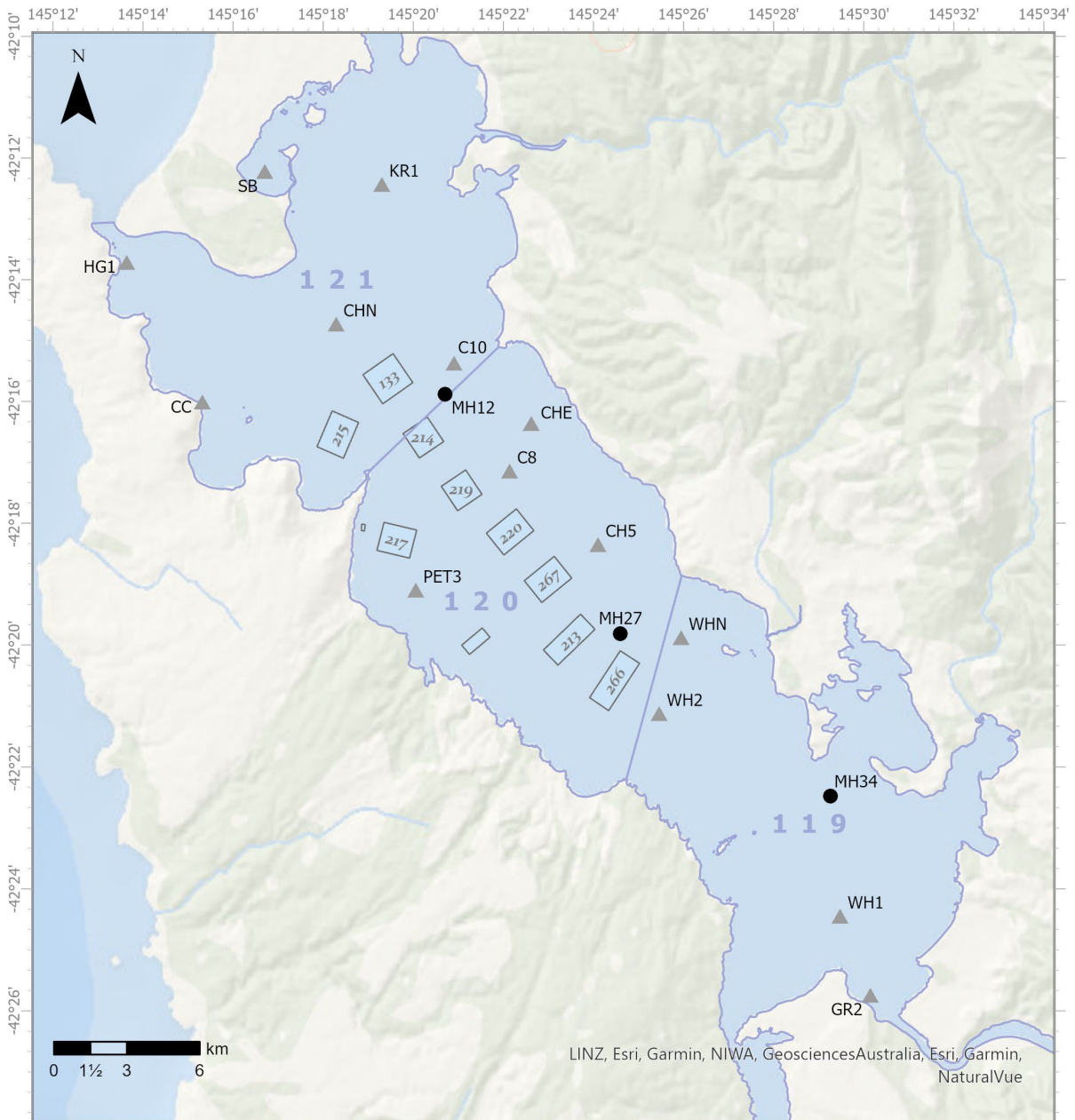
**Table 2 – Annual interim DGVs for dissolved oxygen (mg/L) in Macquarie Harbour. Note Interim DGVs have not been published for less than 6 m and greater than 25m**

Depth (metres)	NW Macquarie Harbour (Segment 121)		Central Macquarie Harbour (Segment 120)		SE Macquarie Harbour (Segment 119)	
	20th Percentile	80th Percentile	20th Percentile	80th Percentile	20th Percentile	80th Percentile
6 – 11	6.9	8.9	6.9	9.2	6.5	9.2
11 – 15	5.2	7.0	4.6	6.9	4.1	6.8
16 – 20	4.3	5.7	3.6	4.9	3.2	4.6
21 – 25	4.0	5.2	3.2	4.2	2.9	4.1

## Independent EPA water quality monitoring program

The EPA has conducted water quality monitoring in Macquarie Harbour since 1993. Monitoring was formalised under the Mount Lyell Remediation Research and Demonstration Project ([MLRRDP](#)) established in 1995, and later expanded to include the World Heritage Monitoring Project. Monitoring under these projects was undertaken on a seasonal basis until February 2023. In September 2023, a single monitoring program was instigated for the entire Harbour.

The EPA undertakes quarterly monitoring of physico-chemical, nutrient and metal data at 15 sites throughout Macquarie Harbour. The EPA data allows for the characterisation of waters entering Macquarie Harbour from the Gordon and King Rivers and entering/exiting the Harbour to the oceanic environment. The EPA monitoring sites are in addition to the 17 sites monitored monthly by the salmon industry under the Broadscale Environmental Monitoring (BEM) requirements of the environmental licences.



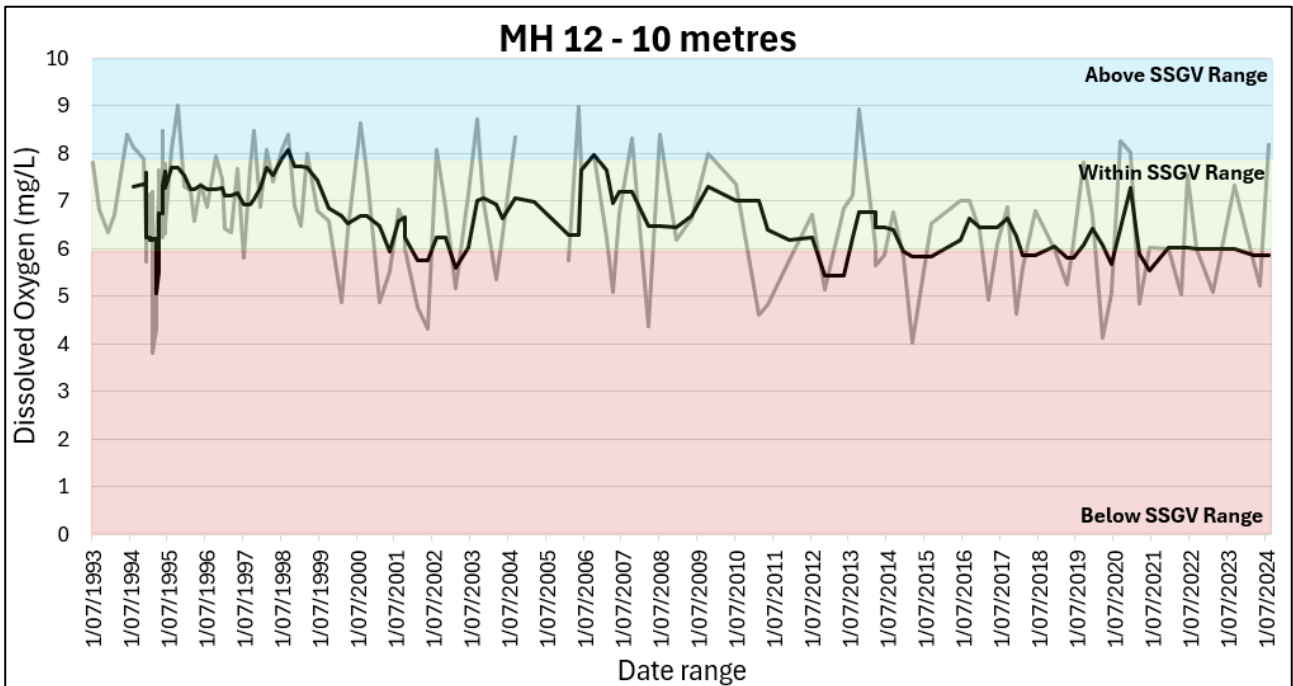
**Map I – Monitoring sites within Macquarie Harbour. Black circles represent EPA monitoring sites and grey triangles represent the I4 industry monitoring sites used in this report.**

## Results

### MH12

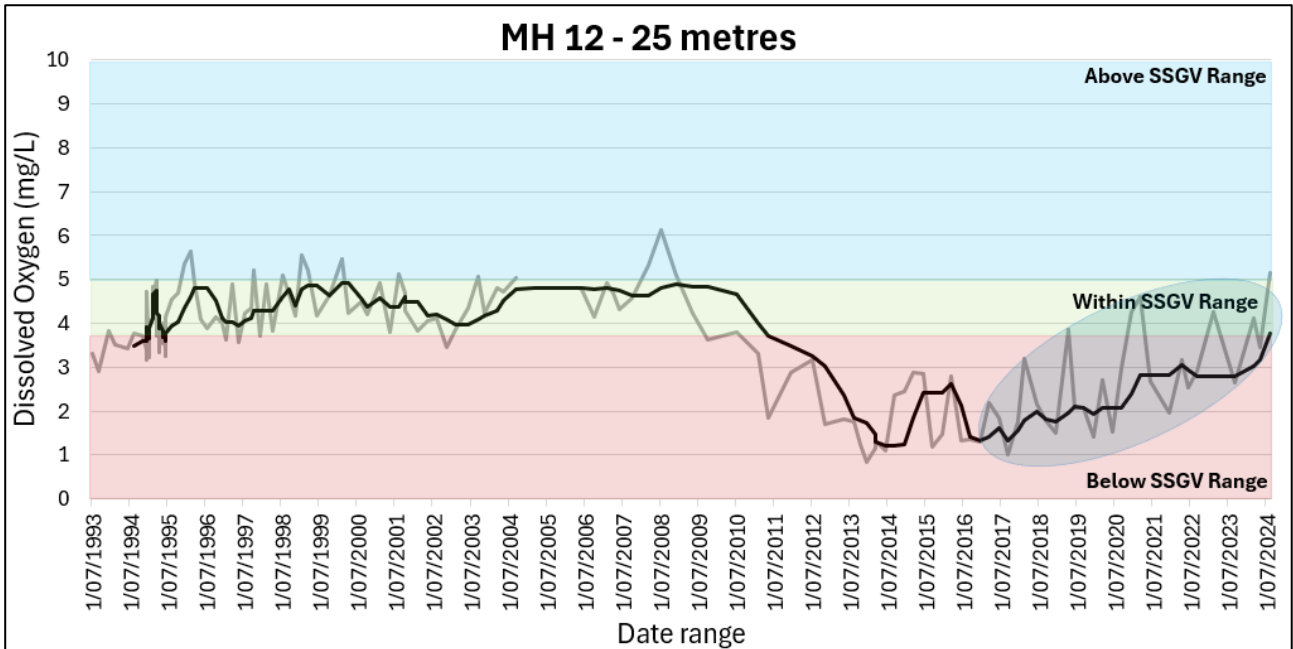
Site MH12 is located within the northwestern part of the Harbour and is situated approximately 2.2 km southwest of Sophia Point (Map 1). The site is between 45 to 50 m deep.

The rolling median for dissolved oxygen at MH12 has periodically dipped below the lower SSGV of 6.0 mg/L for the 10 metre depth range. Prior to 2010 these events tended to be of short duration lasting one to three months (Figure 1). Since 2010 there has been a gradual reduction in the rolling median, with an increase in frequency and duration of periods below the SSGV range. The lowest recorded values of dissolved oxygen at 10 metres depth at MH12 (3.8 mg/L) occurred during 1995.



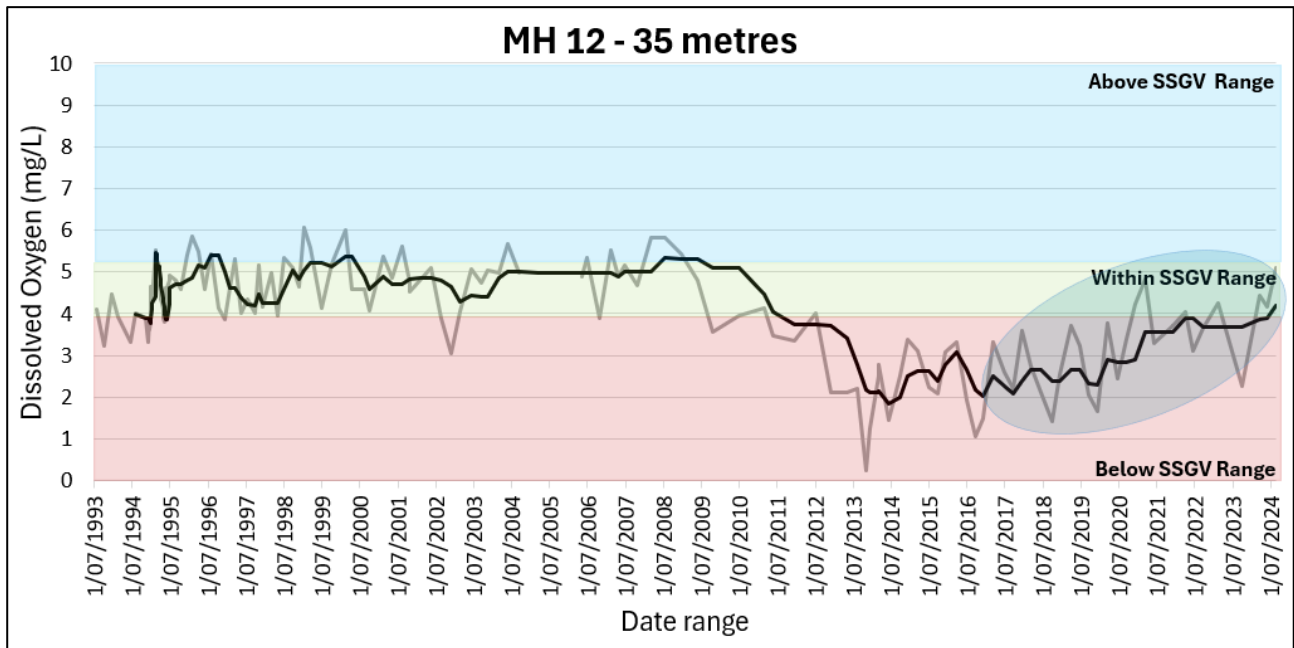
**Figure 1 – Dissolved oxygen (mg/L) measurements at 10 metre water depth at EPA monitoring site MH12. The grey solid line represents the raw quarterly dissolved oxygen measurements, while the black solid line represents the dissolved oxygen rolling median. SSGVs are represented on the figure, with the blue window being above the SSGV range, the green window being within the SSGV range and the red window being below the SSGV range.**

The rolling median for dissolved oxygen at MH12 for the 25 metre depth declined sharply in late 2010, falling to as low as 1.2 mg/L in 2014 (Figure 2). Since 2014 the rolling median has gradually increased to the current value of 3.8 mg/L. From July 2010 to April 2019 all dissolved oxygen readings were below the SSGV of 3.7 mg/L with the lowest reading being below 1.0 mg/L in December 2013. Since April 2019 dissolved oxygen readings have ranged from 1.4 to 5.2 mg/L, with readings since December 2021 being above 2.0 mg/L.



**Figure 2 – Dissolved oxygen (mg/L) measurements at 25 metre water depth at EPA monitoring site MH12. The grey solid line represents the raw dissolved oxygen measurements, while the black solid line represents the dissolved oxygen rolling median. SSGVs are represented on the figure, with the blue window being above the SSGV range, the green window being within the SSGV range and the red window being below the SSGV range.**

The rolling median for dissolved oxygen at MH12 for the 35 metre depth declined sharply in late 2010, falling to as low as 1.8 mg/L in June 2014 (Figure 3). Since June 2014 the rolling median for dissolved oxygen has gradually increased to the current value of 4.2 mg/L, which is within the SSGV range for MH12.

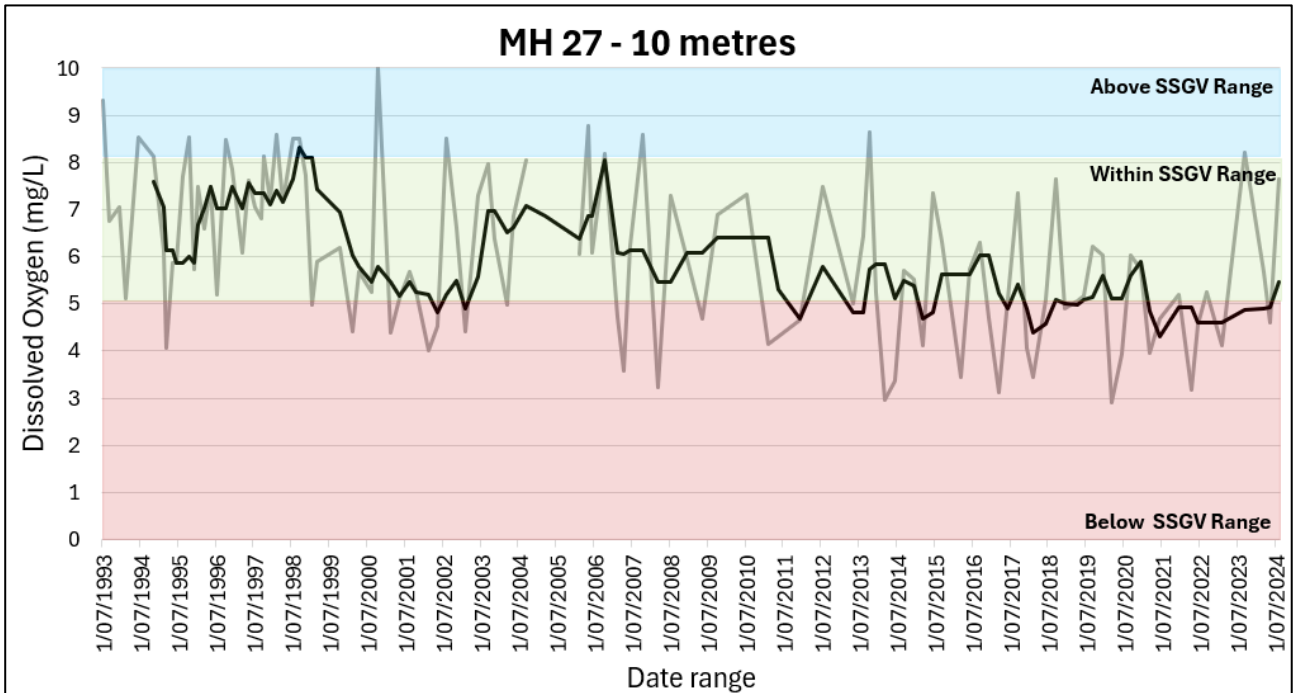


**Figure 3 – Dissolved oxygen (mg/L) measurements at 35 metre water depth at EPA monitoring site MH12. The grey solid line represents the raw dissolved oxygen measurements, while the black solid line represents the dissolved oxygen rolling median. SSGVs are represented on the figure, with the blue window being above the SSGV range, the green window being within the SSGV range and the red window being below the SSGV range.**

## MH27

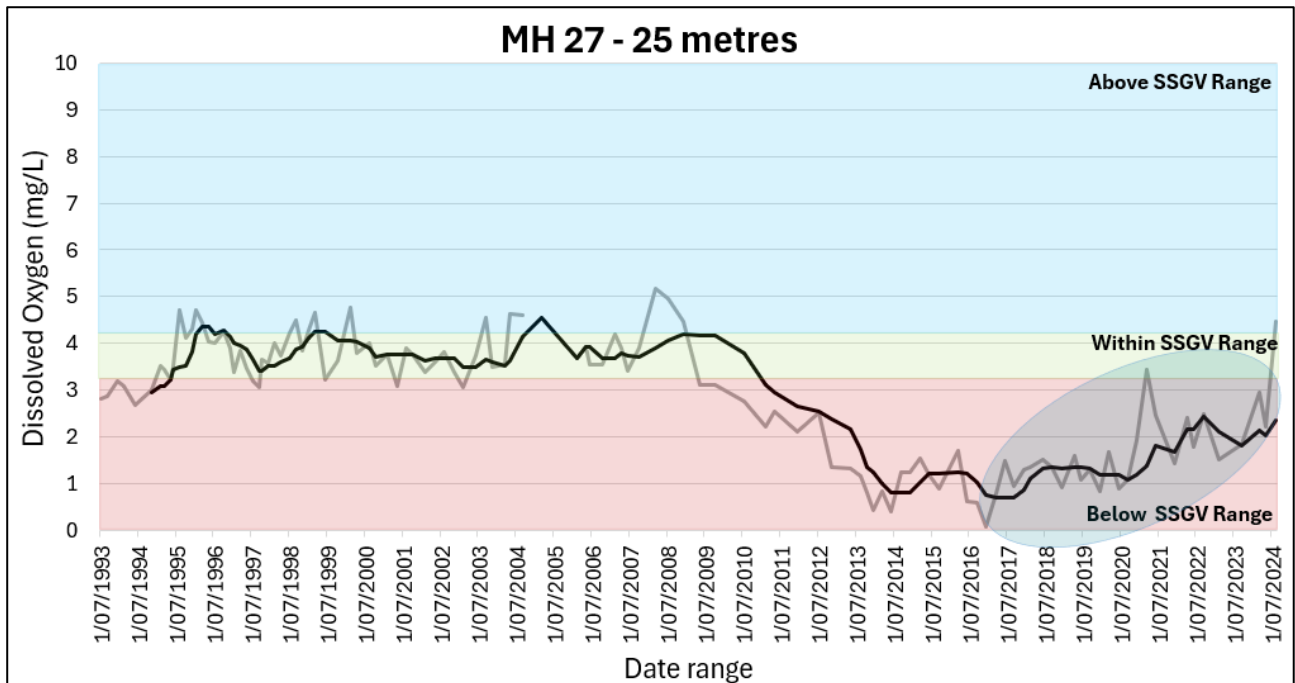
Site MH27 is located within the central part of the Harbour, situated approximately 2.5 km southwest of Coal Point (Map 1). The site is between 35 to 40 m deep.

The rolling median for dissolved oxygen at MH27 has periodically dipped below the lower SSGV limit of 5.1 mg/L for the 10 metre depth. Prior to 2010 these events tended to be of short duration lasting one to three months (Figure 4). Since 2010 there has been a gradual reduction in the rolling median, with an increase in frequency and duration of periods below the SSGV range. On two occasions dissolved oxygen levels have been recorded below 3.0 mg/L. The rolling median for dissolved oxygen calculated for 10 metres (5.5 mg/L) currently sits within the SSGV limits for MH27.



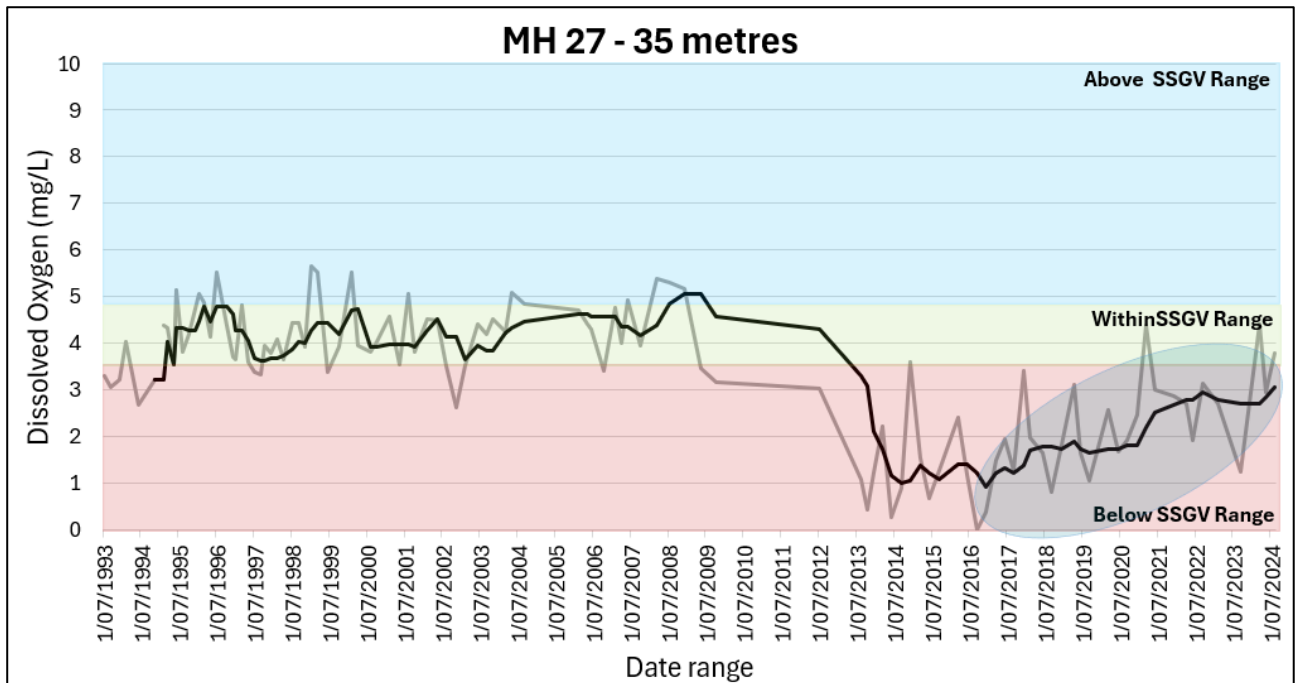
**Figure 4 – Dissolved oxygen (mg/L) measurements at 10 metre water depth at EPA monitoring site MH27. The grey solid line represents the raw dissolved oxygen measurements, while the black solid line represents the dissolved oxygen rolling median. SSGVs are represented on the figure, with the blue window being above the SSGV range, the green window being within the SSGV range and the red window being below the SSGV range.**

The rolling median for dissolved oxygen at MH27 for the 25 metre depth declined sharply from 2010, falling to as low as 0.8 mg/L in 2014 (Figure 5). From December 2014 to September 2020 all dissolved oxygen levels measured at 25 metres from MH27 ranged between 0.1 to 1.7 mg/L and the rolling median varied between 0.7 to 1.4 mg/L. Since September 2020 dissolved oxygen levels have increased from 1.1 to 4.5 mg/L resulting in the rolling median also increased from 1.1 to 2.3 mg/L.



**Figure 5 – Dissolved oxygen (mg/L) measurements at 25 metre water depth at EPA monitoring site MH27. The grey solid line represents the raw dissolved oxygen measurements, while the black solid line represents the dissolved oxygen rolling median. SSGVs are represented on the figure, with the blue window being above the SSGV range, the green window being within the SSGV range and the red window being below the SSGV range.**

The rolling median for dissolved oxygen at MH27 for the 35 metre depth declined sharply in mid 2012, falling to as low as 1.0 mg/L in September 2014 (Figure 6). Since 2014 the rolling median has gradually increased to the current value of 3.1 mg/L. On numerous occasions between July 2013 and July 2018 dissolved oxygen levels were observed below 1.0 mg/L with the lowest value being 0.0 mg/L in September 2016. Since September 2018 all readings have been above 1.0 mg/L.

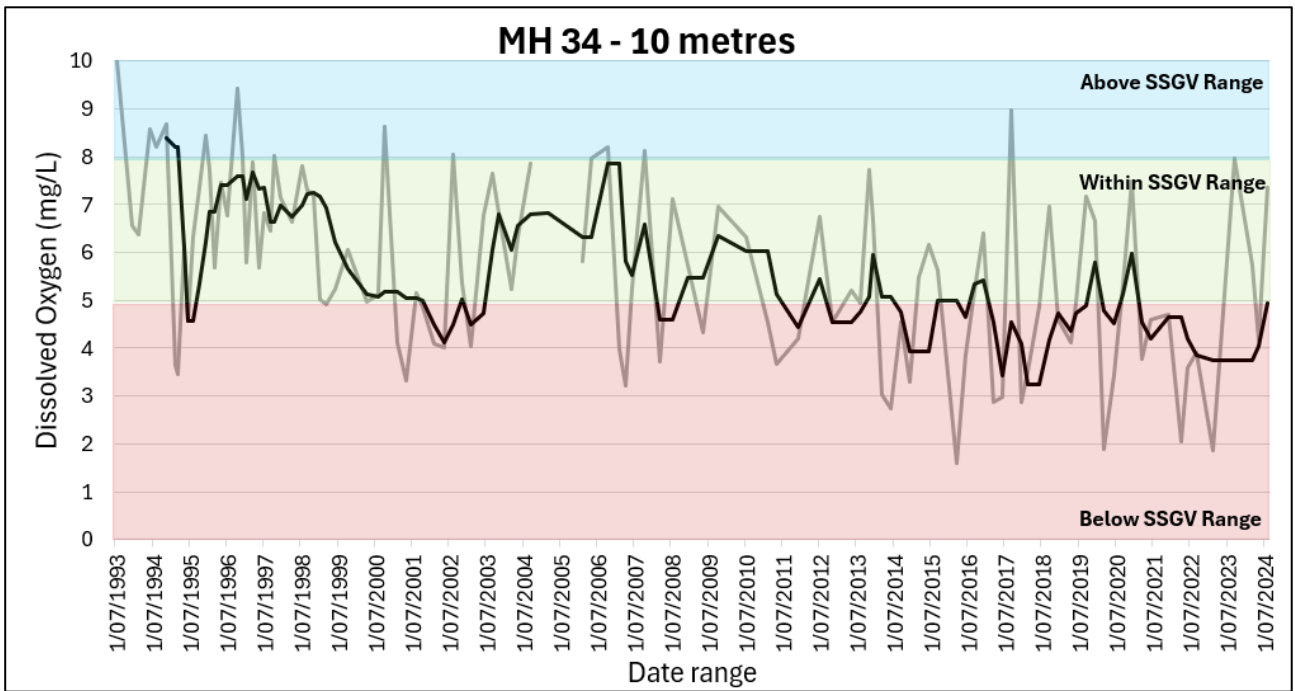


**Figure 6 – Dissolved oxygen (mg/L) measurements at 35 metre water depth at EPA monitoring site MH27. The grey solid line represents the raw dissolved oxygen measurements, while the black solid line represents the dissolved oxygen rolling median. SSGVs are represented on the figure, with the blue window being above the SSGV range, the green window being within the SSGV range and the red window being below the SSGV range.**

### MH34

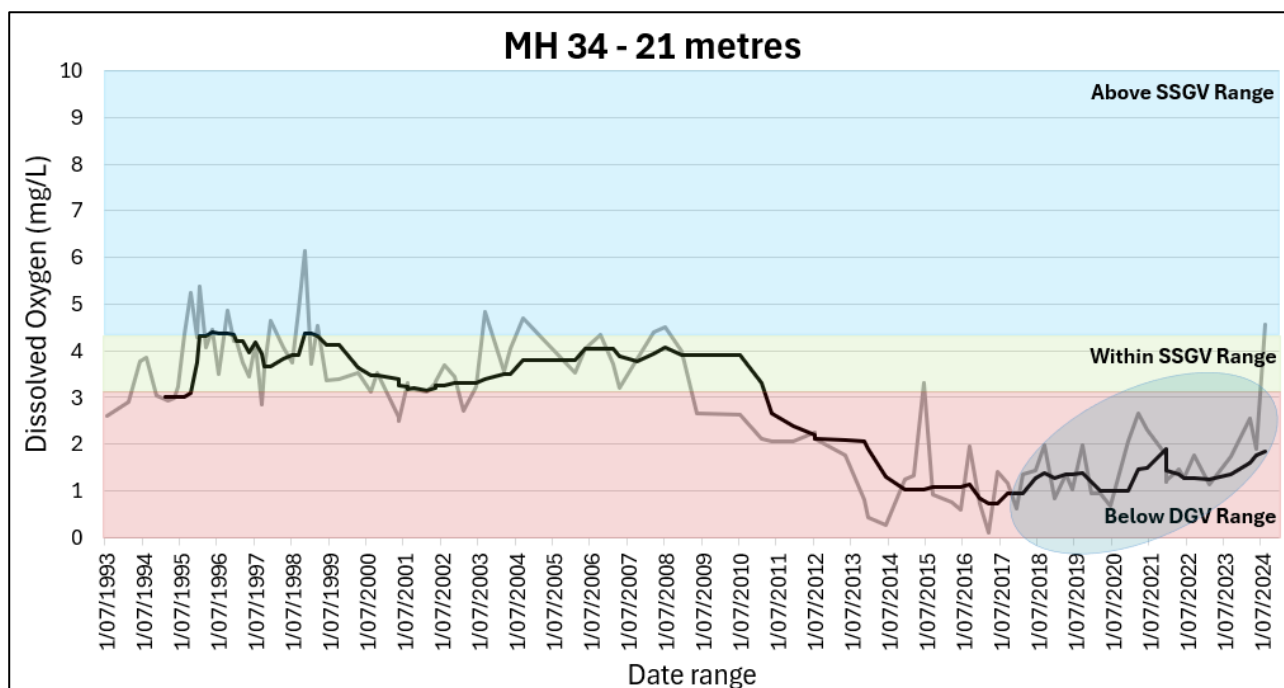
Site MH34 is located within the southeastern part of the Harbour and is situated approximately 1.2 km south of Gould Point within the World Heritage Area (WHA) (Map 1). The site is between 20 to 25 m deep.

The rolling median for dissolved oxygen at MH34 has periodically dipped below the lower SSGV of 4.9 mg/L for the 10 metre depth. Prior to 2010 these events tended to be infrequent (Figure 7). Since 2015 the rolling median has frequently been calculated to be below the lower SSGV.



**Figure 7– Dissolved oxygen (mg/L) measurements at 10 metre water depth at EPA monitoring site MH34. The grey solid line represents the raw dissolved oxygen measurements, while the black line represents the dissolved oxygen rolling median. SSGVs are represented on the figure, with the blue window being above the SSGV range, the green window being within the SSGV range and the red window being below the SSGV range.**

The rolling median for dissolved oxygen at MH34 for the 21 metre depth started to decline sharply in July 2010, falling to as low as 1.0 mg/L in December 2014 (Figure 8) and continued to decline to 0.7 mg/L in 2017. The rolling median has shown a gradual increase since September 2017 with the current value being 1.8 mg/L. This is considerably lower than the lower SSGV range of 3.1 mg/L. Since June 2020 dissolved oxygen levels have not been observed below 1.0 mg/L, with a sharp increase of 4.6 mg/L measured in August 2024.



**Figure 8– Dissolved oxygen (mg/L) measurements at 21 metre water depth at EPA monitoring site MH34. The grey solid line represents the raw dissolved oxygen measurements, while the black line represents the dissolved oxygen rolling median. SSGVs are represented on the figure, with the blue window being above the SSGV range, the green window being within the SSGV range and the red window being below the SSGV range.**

## Conclusions

The EPA monitoring data presented in this report for the three monitoring sites within Macquarie Harbour provides a long time series of quarterly observations of dissolved oxygen concentrations across multiple depths. The data demonstrates that at 10 metres water depth across the three monitoring sites that there has been a reduction in the median dissolved oxygen concentrations in Macquarie Harbour, which began to reduce in about 2010. For depths greater than 20 metres, a sharp decline in the median dissolved oxygen concentrations was observed across the three monitoring sites and this commenced in approximately 2010, with median concentrations at these depths varying across the three monitoring sites. Since 2017, there has been a general increase in the median dissolved oxygen concentrations below 20 metres across the three monitoring sites, with the largest improvements in median dissolved oxygen concentrations being observed since 2020. The two monitoring sites in the NW section (MH 12) and the Central section (MH 27) of Macquarie Harbour have shown the greatest improvement in median dissolved oxygen concentrations below 20 meters compared to the MH 34 monitoring site which is the closest of the three stations to the Gordon River.

## Industry Broadscale Environmental Monitoring

The salmon farming companies have been required to conduct Broadscale Environmental Monitoring (BEM) within Macquarie Harbour since October 2011. This monitoring program has required up to 17 sites to be monitored to characterise water quality within the Harbour, including waters entering the Harbour from the Gordon and King Rivers and waters entering/exiting the Harbour to the oceanic environment. This report has collated dissolved oxygen data from 14 industry monitoring sites within the Harbour (Map 1), excluding data sampled within the rivers and outside of Macquarie Heads, to describe the water quality condition of the Harbour in three segments. For Segments 121 (NW Macquarie Harbour) we have combined data from 5 sites (KRI, CHN, CC, SB and HGI), for Segment 120 (Central Macquarie Harbour) we have combined data from 5 sites (C10, CHE, C8, CH5 and PET3), and for segment 119 (SE Macquarie Harbour) we have combined data from 4 sites (WH1, WH2, WHN and GR2). Note, C10 was included into Segment 120 as the site is close to the boundary of 2 segments (121 and 120) and its location is adjacent to where finfish farming occurs hence the water quality would be more reflective of conditions around these farms.

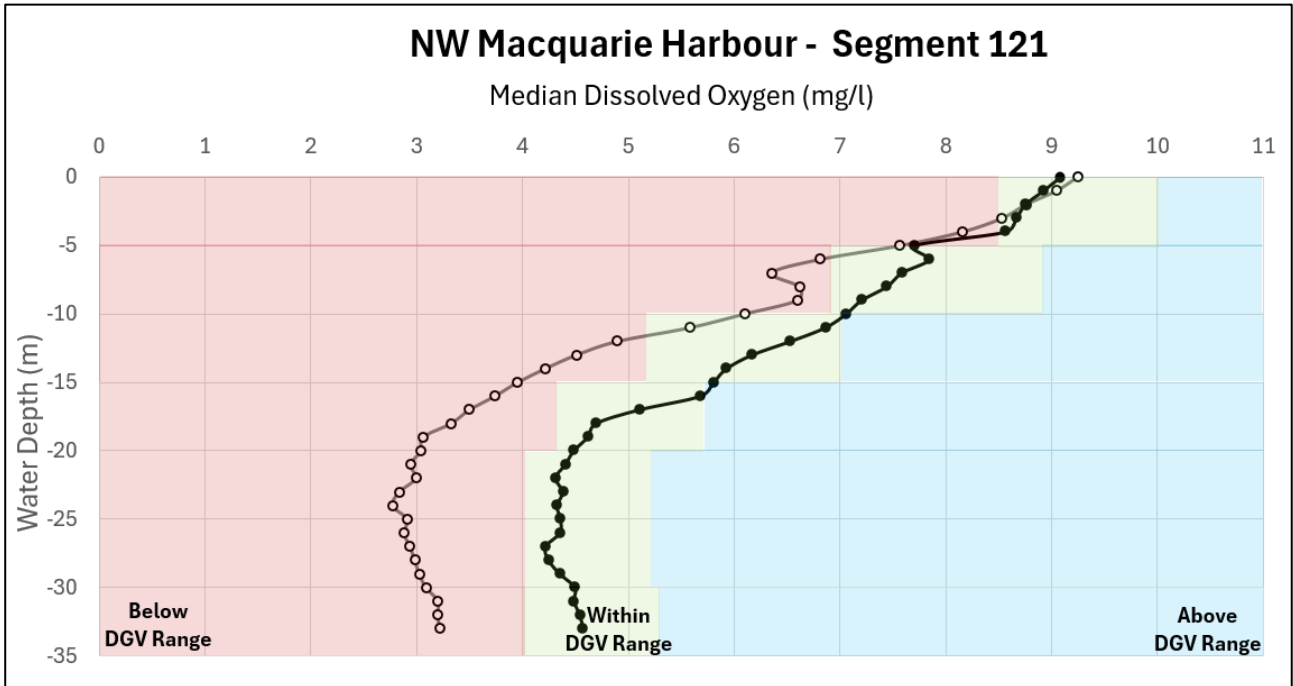
The industry broadscale environmental monitoring data presented in this report provides a snap-shot across two 12-month periods (2016/2017 and 2023/2024). The 2016/2017 period was chosen to illustrate the dissolved oxygen status of the Harbour when the EPA Director became responsible for environmental regulation of salmon farming in Macquarie Harbour. This was the period when the EPA Director first issued determinations to reduce the biomass of salmon in the Harbour. The 2023/2024 period was chosen to provide an update on the current dissolved oxygen status within the Harbour.

In contrast to the EPA independent monitoring data presented in the previous section of this report, the industry BEM data presented below has been averaged across the sites within each segment of Macquarie Harbour to provide representative median dissolved oxygen profiles calculated using 12 months of data. Median dissolved oxygen profiles are compared to the published interim DGVs for aquatic ecosystems.

## Results

### NW Macquarie Harbour – Segment 121

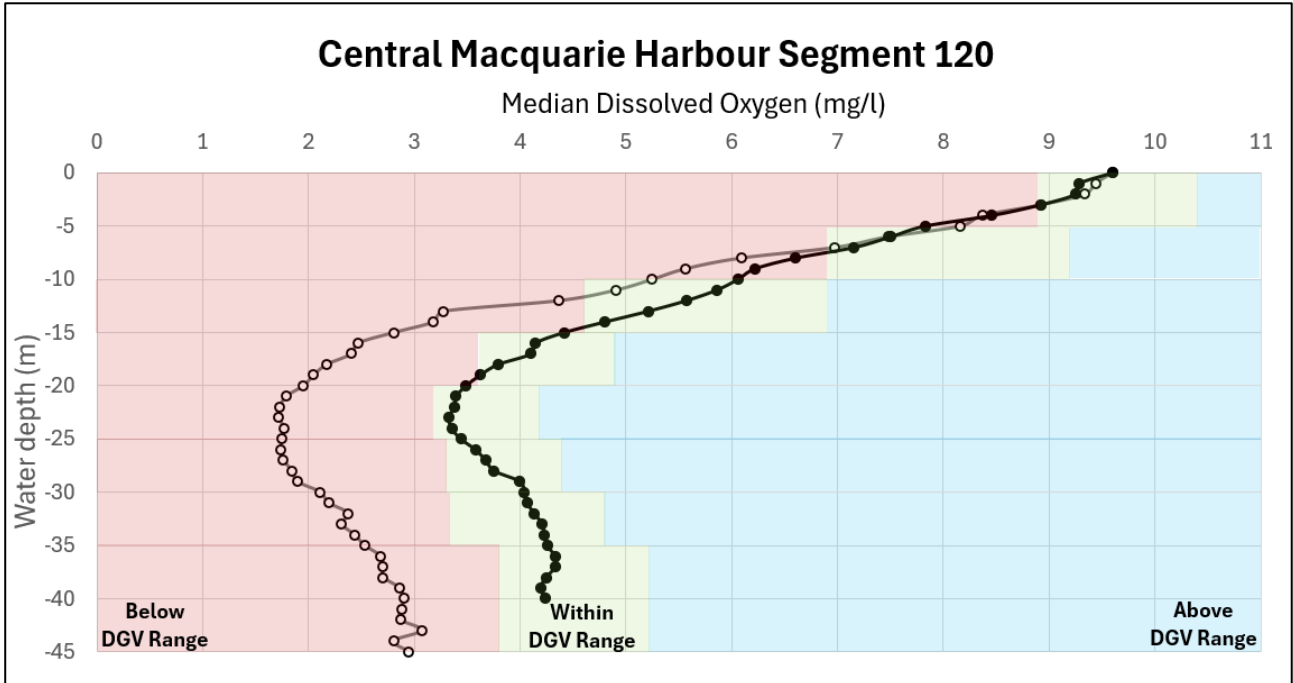
The dissolved oxygen conditions across the depth profile of NW Macquarie Harbour (Segment 121, map 1) have improved since 2016/2017 (Figure 9). The latest 12-month period (Sept 2023 – Aug 2024) demonstrates that across the entire depth range surveyed, median dissolved oxygen concentrations measured are within the interim DGV range.



**Figure 9 – Median dissolved oxygen (mg/L) profile averaged across five monitoring sites (KRI, CHN, CC, SB and HGI) within NW Macquarie Harbour. The data represented by the open circles on the figure are the median dissolved oxygen data calculated from 12 months of data from Sept 2016 – Aug 2017, and the data represented by the black circles are the median dissolved oxygen data calculated from 12 months of data from Sept 2023 – Aug 2024. Interim DGVs are represented on the figure, with the blue window being above the interim DGV range, the green window being within the interim DGV range and the red window being below the interim DGV range.**

## Central Macquarie Harbour

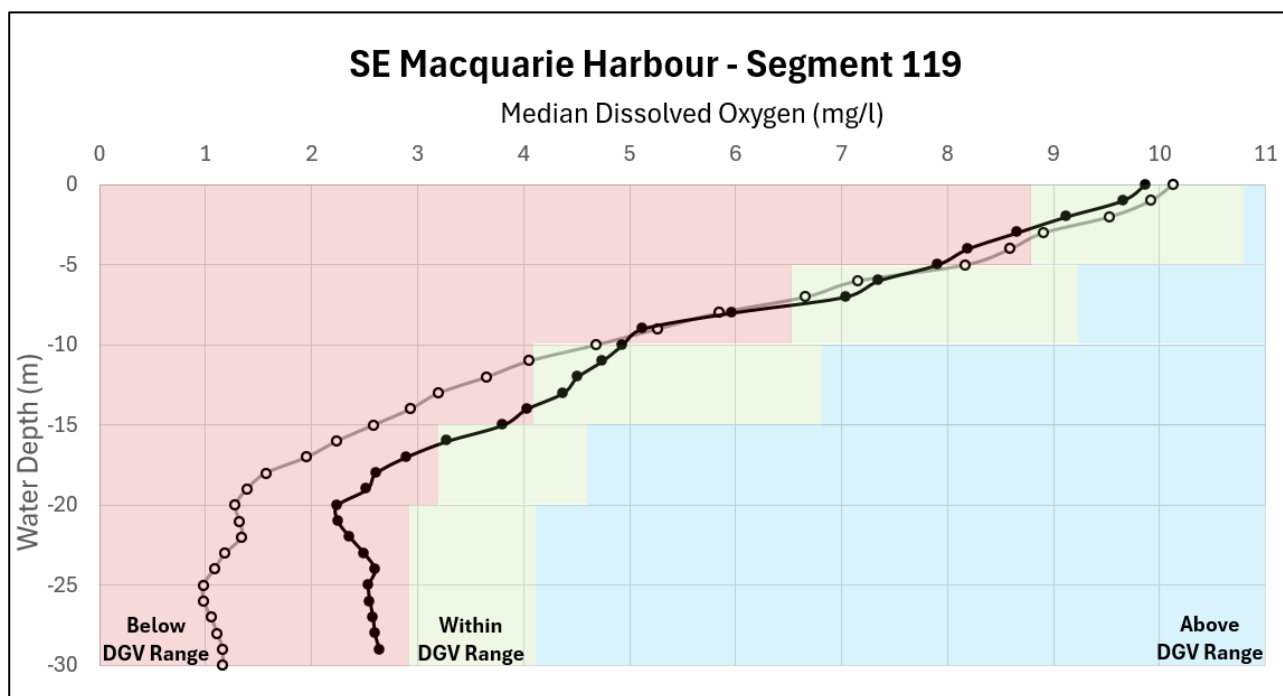
The dissolved oxygen conditions across the depth profile of Central Macquarie Harbour (Segment 120, map 1) have improved since 2016/2017. The data demonstrates that for the last 12-month period dissolved oxygen levels across the entire depth range surveyed, are within the interim DGV ranges published by the EPA for the Central Macquarie Harbour (Figure 10).



**Figure 10 – Median dissolved oxygen (mg/L) profile averaged across five monitoring sites (C10, CHE, C8, CH5 and PET3) within Central Macquarie Harbour. The data represented by the open circles on the figure are the median dissolved oxygen data calculated from 12 months of data from Sept 2016 – Aug 2017, and the data represented by the black circles are the median dissolved oxygen data calculated from 12 months of data from Sept 2023 – Aug 2024. Interim DGVs are represented on the figure, with the blue window being above the interim DGV range, the green window being within the interim DGV range and the red window being below the interim DGV range.**

## SE Macquarie Harbour – Segment 119

The dissolved oxygen conditions across the depth profile of SE Macquarie Harbour (Segment 119, map 1) have generally improved since 2016/2017 (Figure 11). The latest 12-month period (Sept 2023 – Aug 2024) demonstrates that above 10 metres, dissolved oxygen concentrations have remained stable to measurements undertaken during the 2016/2017 period. Between 10 – 16 metres median dissolved oxygen concentrations have improved with values within the DGV Range and below 16 meters there has been continual improvement in median dissolved oxygen concentrations. However, below 16 metres, further improvement of dissolved oxygen concentrations are needed within SE Macquarie Harbour to reach the interim DGV range.



**Figure 11 – Median dissolved oxygen (mg/L) profile averaged across four monitoring sites (WH1, WH2, WHN and GR2) within SE Macquarie Harbour. The data represented by the open circles on the figure the median dissolved oxygen data calculated from 12 months of data from Sept 2016 – Aug 2017, and the data represented by the black circles are the median dissolved oxygen data calculated from 12 months of data from Sept 2023 – Aug 2024. Interim DGVs are represented on the figure, with the blue window being above the interim DGV range, the green window being within the interim DGV range and the red window being below the interim DGV range.**

## Conclusions

The industry broadscale environmental monitoring data presented in this report demonstrates an improvement of dissolved oxygen conditions across the Harbour. The upper 16 metres of the water column across all segments of the Harbour are generally within the interim DGV range. Below 16 metres the median dissolved oxygen concentrations measured have increased across the NW and Central segments of Macquarie Harbour and are now within the interim DGV ranges published by the EPA. However, further improvements of dissolved oxygen concentrations of bottom waters of the SE segment of Macquarie Harbour are needed to allow the median dissolved oxygen concentrations to reach the interim established DGV ranges.



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