FINAL
2020 SHELTER ISLAND YACHT BASIN DISSOLVED COPPER TOTAL MAXIMUM DAILY LOAD MONITORING AND PROGRESS REPORT

Submitted to:
California Regional Water Quality Control Board
San Diego Region

Prepared by:

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Prepared for:

Port of San Diego

March 2021

Wood Project No. 2015100105

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PORT of SAN DIEGO

March 29, 2021

California Regional Water Quality Control
Board San Diego Region
2375 Northside Drive,
Suite 100 San Diego, CA
92108-2700
Attn: Mr. Wayne Chiu

Subject: Submittal of the 2020 Shelter Island Yacht Basin Total Maximum Daily Load Monitoring and Progress Report

Dear Mr. Chiu,

Please find enclosed a digital copy of the 2020 Shelter Island Yacht Basin Total Maximum Daily Load Monitoring and Progress Report. This digital submittal assists in adhering to safe practices during the COVID-19 pandemic. If you would like a hard copy, please do not hesitate to request one.

Following submission of this report, the Port and the Shelter Island Yacht Basin stakeholders would like to meet with you and go over the report, address any of your questions, and continue discussions about the final compliance expectations for the TMDL.

I will be following up shortly to schedule a meeting at your convenience.

Please feel free to contact me at (619) 725-6073 if you have any questions on the information provided above.

Respectfully,

Karen Holman
Director, Environmental Protection
San Diego Unified Port District

Attachments: 2020 Shelter Island Yacht Basin Total Maximum Daily Load Monitoring and Progress Report

cc: Jason H. Giffen
John Carter

KH/KT/aa

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March 2021

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Karen Holman
Director, Environmental Protection
San Diego Unified Port District

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ACRONYMS AND ABBREVIATIONS

303(d) list	Clean Water Act Section 303(d) list of water quality impaired segments
AB	Assembly Bill
AFP	antifoulant paint
ASTM	ASTM International
Basin Plan	Water Quality Control Plan for the San Diego Basin – Region 9
BMP	best management practice
CCC	criterion continuous concentration
CCR	California Code of Regulations
CMANC	California Marine Affairs and Navigation Conference
CMC	criterion maximum concentration
COC	chain-of-custody
CTD	conductivity, temperature, and depth
CTR	California Toxics Rule
CWA	Clean Water Act
DO	dissolved oxygen
DOC	dissolved organic carbon
DPR	California Department of Pesticide Regulation
DPR Rule	Section 6190 of Title 3, California Code of Regulations
EC_{50}	median effective concentration
ELAP	California Environmental Laboratory Accreditation Program
ER	equipment rinsate
FAQ	frequently asked question
FB	field blank
HCl	hydrochloric acid
HPD	Harbor Police dock
Investigative Order	Investigative Order No. R9-2011-0036
JRMP	Jurisdictional Runoff Management Plan
LC_{50}	median lethal concentration
LCS	laboratory control sample
LID	low-impact development
LIMS	Laboratory Information Management System
MAR	marine habitat beneficial use
MIACC	Marina Inter-Agency Coordinating Committee
Monitoring Plan	SIYB Dissolved Copper TMDL Monitoring Plan
MS	matrix spike
MS4	Municipal Separate Storm Sewer System
MSD	matrix spike duplicate
N/A	not applicable
Named TMDL Parties	the parties named in the TMDL, namely the Port, marinas and yacht clubs, hull cleaners, boaters, and the City of San Diego
ND	non-detect
NOEC	no observed effect concentration
OAL	Office of Administrative Law
PDF	Portable Data Format
pH	hydrogen ion concentration
PMSD	percent minimum significant difference
Port	San Diego Unified Port District
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
REF	reference
Regional Board	San Diego Regional Water Quality Control Board
SB	Senate Bill

ACRONYMS AND ABBREVIATIONS (continued)

SBE	Sea-Bird Electronics
SIML	Shelter Island Master Leaseholders
SIYB	Shelter Island Yacht Basin
SM	Standard Method
SOP	standard operating procedure
SPAWAR	Space and Naval Warfare Systems Command
SUSMP	Standard Urban Stormwater Mitigation Plan
SWAMP	Surface Water Ambient Monitoring Program
SWQMP	Stormwater Quality Management Plan
SWRCB	State Water Resources Control Board
TIE	toxicity identification evaluation
TMDL	Total Maximum Daily Load
TOC	total organic carbon
TSS	total suspended solids
TST	test of significant toxicity
USEPA	United States Environmental Protection Agency
Weck	Weck Laboratories, Inc.
WER	Water-Effect Ratio
Weston	Weston Solutions, Inc.
WILD	wildlife habitat beneficial use
Wood	Wood Environment & Infrastructure Solutions, Inc.
WQO	water quality objective
YSI	YSI Incorporated

UNITS OF MEASURE

~	approximately
%	percent
±	plus or minus
°C	degree(s) Celsius
<	less than
>	greater than
≤	less than or equal to
≥	greater than or equal to
µg/cm^2/day	microgram(s) per square centimeter per day
µg/L	microgram(s) per liter
µm	micrometer(s)
µS/cm	microSiemens per centimeter
kg/yr	kilogram(s) per year
m^2	square meter(s)
mg/L	milligram(s) per liter
mL	milliliter(s)
ppt	part(s) per thousand

EXECUTIVE SUMMARY

This report is the annual Shelter Island Yacht Basin (SIYB) Dissolved Copper Total Maximum Daily Load (TMDL) Monitoring and Progress Report for 2020, which has been prepared by the San Diego Unified Port District (Port) in compliance with Investigative Order No. R9-2011-0036 (Investigative Order), issued to the Port by the San Diego Regional Water Quality Control Board (Regional Board) on March 11, 2011. The report includes information on the following:

1. Best management practice (BMP) planning and implementation conducted by the Port. The report also includes information provided by the SIYB marinas and yacht clubs related to their BMP efforts.
2. The progress on the number of vessels that have converted from using copper-based hull antifoulant paints (AFPs) to using alternative AFPs (low- and non-copper based). It should be noted that this effort relies primarily on third-party data provided by the SIYB marinas and yacht clubs' annual vessel tracking census.
3. Water quality monitoring conducted by the Port to assess dissolved copper concentrations and toxicity in the water column.
4. An assessment of the trajectories of dissolved copper load and water quality measurements to evaluate progress toward attaining the TMDL compliance requirement and water quality objectives (WQOs).

The 2020 monitoring period is the third year in the final phase of the TMDL compliance period. Per the TMDL implementation, the continuation of a 40 percent (%) load reduction is required. Looking ahead, a 76% load reduction is required to meet TMDL compliance by the end of 2022. Per the requirements of the Investigative Order, the SIYB TMDL Monitoring Plan (Wood Environment & Infrastructure Solutions, Inc. [Wood], 2020a) describes the monitoring program that is used to track the progress of implementing the SIYB Dissolved Copper TMDL and achieving the required dissolved copper load reductions.

This 2020 Monitoring and Progress Report follows the approach described in the most recent Monitoring Plan. It presents BMP implementation in SIYB and San Diego Bay, vessel conversions to low-copper paints and non-copper alternatives, and water quality monitoring results, as required by the Investigative Order.

This report is an annual requirement of the Investigative Order that was issued to the Port. The assessments of BMP implementation, loading, and water quality follow the Port's SIYB TMDL Monitoring Plan prepared in compliance with the Investigative Order. It should be noted that the Port works collaboratively with the marinas and yacht clubs to receive and review the vessel hull paint data used to assess dissolved copper load reductions and evaluate progress toward attaining the final TMDL load reduction requirement. While the vessel data collection is a collaborative effort, the findings, data interpretations, and conclusions made in this report are those of the Port, and are not intended to represent all TMDL parties. Other TMDL parties may identify alternative data interpretations as it relates to data included in the report or other data that were collected separate from this Investigative Order effort. In such instances, the other TMDL Parties may choose to independently provide alternative data interpretations and conclusions to the Regional Board.

Best Management Practice Implementation

A variety of BMPs intended to reduce dissolved copper loading and improve water quality have been implemented in SIYB and throughout San Diego Bay. A summary of the highlights from 2020 is included below and further detailed in Section 3.1 of this report.

- Continuing to keep all Port vessels copper-free by painting with non-copper hull paints, which contribute no load to SIYB
- Continuing to implement, inspect, and enforce the In-Water Hull Cleaning Permit requirements and BMP implementation during hull cleaning events
- Formation of a working group between the Port and SIYB marina and yacht club tenants to ensure close coordination on management strategies aimed at both meeting TMDL compliance and preserving, protecting, and enhancing water quality in SIYB and San Diego Bay
- Ongoing education and outreach efforts, such as regular meetings with stakeholders and up-to-date web content, workshops, and invited speaker presentations
- Pursuing alternative methods for copper reduction and removal in marine waters through the Port's Blue Economy Incubator, which supports research and development of pilot projects aimed at solving environmental issues (e.g., Rentunder Boatwash Pilot Project)
- Collaborating with the California Department of Pesticide Regulation (DPR) and Los Angeles County Department of Beaches and Harbors to stay engaged on state and regional copper-related initiatives, TMDL issues and progress

Vessel Conversions and Reduction of Dissolved Copper

Based on the vessel tracking assumptions discussed in Section 2.2.3 of this report, the transition of a vessel from a high-copper to non-copper hull paint was assumed to reduce annual loading by 0.9 kilogram per year (kg/yr) and the transition to DPR Category I or low-copper hull paints was assumed to reduce loading by 50% (i.e., 0.45 kg/yr). Vessel tracking indicates that, in 2020, there has been a reduction of 48.0% (approximately 1,008 kg/yr) in annual dissolved copper loading to SIYB from vessels when compared with the SIYB TMDL assumed baseline load of 2,100 kg/yr[1].

The 2020 load reduction of 48.0% indicates the continued achievement of the required 40% load reduction. Notable points from the 2020 vessel tracking data are as follows:

- A 95% response rate was accomplished for the 2020 vessel tracking dataset. This response rate may be attributed to continual invested efforts by marina and yacht club representatives in vessel tracking from year to year.
- The vessel tracking data indicate continued transitions to DPR Category I paints since the implementation of the DPR Rule (an increase of 47% since 2018).
- Only 63 vacancies were observed in yacht clubs and marinas in 2020. This number represents the lowest number of vacancies reported since the monitoring program began.

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[1] The total dissolved copper load per the SIYB TMDL equals 2,100 kilograms per year (kg/yr) from vessel paints (the total includes contributions from passive leaching and in-water hull cleaning). The estimated load contributions from background sources, urban runoff, and atmospheric deposition are not included in this total.

Water Quality Monitoring

Monitoring of water column dissolved copper and toxicity is required to track progress toward WQOs. In August 2020, water quality was sampled at six stations in SIYB and at two reference stations[2] (located adjacent to SIYB in the main San Diego Bay navigation channel) to determine dissolved copper concentrations in the basin, test for acute and chronic toxicity, and assess water quality trends.

Results from the August 2020 monitoring event showed that the basin-wide average dissolved copper level was 8.3 micrograms per liter (µg/L), which was similar to the 2005–2008 baseline average (8.3 µg/L). Dissolved copper concentrations at five of the six SIYB sampling stations exceeded both the California Toxics Rule (CTR) criterion continuous concentration (CCC) WQO of 3.1 µg/L and the CTR acute criterion maximum concentration (CMC) WQO of 4.8 µg/L. These results are consistent with those observed in previous monitoring years.

The results from the 2020 monitoring program indicated that one station (SIYB-1, the station farthest inside the basin) had statistically significant effects on developing mussel larvae. This finding is consistent with results of previous studies. The Pacific topsmelt acute toxicity tests were performed twice for the 2020 SIYB TMDL Monitoring Program. The combined results of the initial and follow-up tests suggest that there did not appear to be an acute toxic response related to ambient water quality in SIYB in 2020.

Adaptive Management through the Final TMDL Phase

Since the initiation of the TMDL monitoring program, multiple copper load reduction strategies have been developed and implemented. While these strategies have resulted in copper load reduction that has met TMDL interim compliance targets, annual water quality monitoring has not shown a corresponding decrease in water column dissolved copper levels. Given this disconnect, further efforts are needed to analyze existing and potential sources of copper and their relationship to water quality.

From an adaptive management standpoint, the water quality monitoring results to date indicate that further copper load reduction strategies should emphasize a direct relation to water quality improvement. Consequently, greater emphasis by all Named TMDL Parties needs to be focused on identifying additional load reduction strategies or other sources within their operations that will reduce copper loads and produce measurable improvements in water quality and movement toward the CTR CCC WQO (3.1 µg/L). Meeting the final TMDL compliance point is likely to require additional direct load reductions coupled with the load reduction efforts already in place (e.g., the 2018 DPR Rule and continued transition to non-copper alternatives), further understanding of sources and their load contributions, and a better understanding of how these efforts directly impact water quality. The Port continues to reassess copper loading attributed to in-water hull cleaning as one such strategy that needs to be further evaluated.

In addition, as continued transition to DPR Category I paints occurs, it will also be critical to understand the effect the transition has on water quality. It is important to note that the full hull paint transition and its effect on water quality is likely to extend beyond the TMDL timeline. It will

[2] To supplement the TMDL compliance monitoring, a second reference station (SIYB-REF-2) was added to the sample locations for the 2020 monitoring program (further described in Section 2.3.1).

be important to observe this transition and incorporate adaptive management strategies reflective of such findings over time.

A suite of recommendations has been provided in this report to identify the implementation strategies the Port intends to undertake for the final years of the TMDL. It is expected that the other Named TMDL Parties will continue BMP implementation as required by the TMDL. The Port will continue to conduct outreach and engage with individual marinas and yacht clubs, hull cleaners, and boaters as well as with the Regional Board to continue progress on the TMDL and determine the best suite of actions for the final years of the TMDL.

1.0 INTRODUCTION

This report is the annual Shelter Island Yacht Basin (SIYB) Dissolved Copper Total Maximum Daily Load (TMDL) Monitoring and Progress Report for 2020, which has been prepared by the San Diego Unified Port District (Port) in compliance with Investigative Order No. R9-2011-0036 (Investigative Order), issued by the San Diego Regional Water Quality Control Board (Regional Board) to the Port on March 11, 2011 (Regional Board, 2011). The Investigative Order, issued under Section 13325 of the Porter-Cologne Water Quality Control Act, requires that the Port provide technical reports on the progress of implementation of the SIYB TMDL. To evaluate progress, the annual monitoring program is composed of three components: (1) best management practice (BMP) planning and implementation to reduce dissolved copper loading, (2) the tracking of vessel paint use to assess the number of vessel hulls converted from using copper-based antifoulant paints (AFPs) to using non-copper or low-copper alternatives, and (3) water quality monitoring to measure dissolved copper concentrations and toxicity in the water column. Data collected annually through the monitoring program is then used to assess trajectories of dissolved copper load and water quality measurements to evaluate progress toward attaining the TMDL and water quality objectives (WQOs).

The assessments of BMP implementation, loading, and water quality follow the Port's SIYB TMDL Monitoring Plan prepared in compliance with the Investigative Order. The Port works collaboratively with the marinas and yacht clubs to receive and review the vessel hull paint data used to assess dissolved copper load reductions and evaluate progress toward attaining the final TMDL load reduction requirement. The annual vessel tracking is conducted both by the Port and the SIYB marinas and yacht clubs. However, the SIYB marinas and yacht clubs' data are collected independently from the Port and provided to the Port for review and inclusion in the annual report. Data from the SIYB marinas and yacht clubs are included, as received, in the appendices of this report. The loading analyses provided in the report incorporates this third-party vessel hull paint data with other Port datasets using the methodology identified in the SIYB TMDL Monitoring Plan.

It should be noted that this report is an annual requirement of the Investigative Order that was issued to the Port. While the vessel data collection is a collaborative effort, the findings, data interpretations and conclusions made in this report are those of the Port, and are not intended to represent all TMDL parties. Other TMDL parties may identify alternative data interpretations as it relates to data included in the report or other data that were collected separate from this Investigative Order effort. In such instances, the other TMDL Parties may choose to independently provide alternative data interpretations and conclusions to the Regional Board.

1.1 Background

Shelter Island Yacht Basin is a recreational yacht basin near the mouth of San Diego Bay, California, and is composed of marinas and yacht clubs, an anchorage, a fuel dock, and other facilities that support recreational boating (Figure 1-1).

Copper is commonly used as a biocide in vessel AFPs because of its effectiveness in reducing fouling of vessel hulls. In the State of California, the Department of Pesticide Regulation (DPR) regulates the use of copper in vessel paints; it is currently legal to use copper-based paints that are registered with, and meet the DPR's registration requirements for pesticide usage. However, these paints leach copper into the water column. Copper is toxic not only to the targeted fouling organisms on vessel hulls, but possibly also to other non-targeted organisms that inhabit the basin.

SIYB waters contain dissolved copper concentrations that have exceeded the dissolved copper numeric WQOs, as well as the toxicity and pesticides narrative WQOs, and may threaten and impair the wildlife habitat and marine habitat beneficial uses in the basin. Because of this exceedance, SIYB was placed on the list of impaired water bodies compiled pursuant to federal Clean Water Act (CWA) Section 303(d) (the 303(d) list). The SIYB TMDL was developed to address and resolve this impairment by requiring reductions to the loading of dissolved copper into SIYB waters.

Figure 1-1. Location of Shelter Island Yacht Basin Within San Diego Bay

1.2 SIYB TMDL Compliance Schedule

Under Resolution R9-2005-0019, the SIYB TMDL requires that the parties named in the TMDL, namely the Port, marinas and yacht clubs, hull cleaners, boaters, and the City of San Diego (Named TMDL Parties), reduce loading of dissolved copper into the water column by 76 percent (%), from 2,163 kilograms per year (kg/yr) to 567 kg/yr over a 17-year period (Regional Board, 2005). This period extends to 2022, based on the official SIYB TMDL approval date[3] of February 9, 2005. No reductions in dissolved copper loading were required during the initial two-year orientation period (2005–2007). The subsequent 15-year period requires incremental reductions of dissolved copper loading by 10% within 7 years (2012); by 40% within 12 years (2017); and by 76% within 17 years (2022) (Table 1-1).

Table 1-1.
Loading Targets for SIYB TMDL Attainment

Stage	Time Period	% Reduction from SIYB TMDL Estimated Loading	Reduction to be Attained by End of Year	Estimated Target Loading (kg/yr of Dissolved Copper)
1	2005–2007	0	N/A	N/A
2	2008–2012	10[a]	2012 (7 years)	1,900
3	2013–2017	40[b]	2017 (12 years)	1,300
4	2018–2022	76	2022 (17 years)	567

Notes:
a. Loading calculations presented in the 2012 SIYB TMDL Monitoring and Progress Report showed that a 17% load reduction had been achieved. Compliance with the 2012 load reduction goal of 10% or greater was confirmed by the Regional Board in a letter to the Port dated July 26, 2013.
b. Loading calculations presented in the 2017 SIYB TMDL Monitoring and Progress Report showed that a 40% load reduction had been achieved. Compliance with the 2017 load reduction goal of 40% or greater was confirmed by the Regional Board October 10, 2018 Executive Officer's Report as part of the monthly Regional Board meeting.
% = percent; kg/yr = kilogram(s) per year; N/A = not applicable; SIYB = Shelter Island Yacht Basin; TMDL = Total Maximum Daily Load

For the first SIYB TMDL compliance year (2012), loading calculation estimates presented in the 2012 Monitoring Report (AMEC Environment & Infrastructure, Inc., 2013) indicated a 17% reduction in dissolved copper loading to SIYB, thus exceeding the 10% requirement. In a letter to the Port dated July 26, 2013, the Regional Board stated, "*Based on the data submitted and information provided in the Report [2012 SIYB TMDL Monitoring and Progress Report], the 10 percent reduction in dissolved copper loading required to demonstrate compliance with the SIYB TMDL by the December 1, 2012 compliance date was achieved*" (Regional Board, 2013). This letter is provided in Appendix E.

Similarly, loading calculation estimates presented in the 2017 Monitoring Report (Amec Foster Wheeler Environment & Infrastructure, Inc., 2018) indicated a 45% reduction in dissolved copper loading to SIYB, exceeding the 40% compliance requirement for the third stage of the SIYB TMDL (2017). In a letter to the Port dated September 11, 2018, the Regional Board stated, *"The Port District's 2017 Report marks the end of Stage 3 of the interim loading targets, and suggests that overall the Yacht Basin is meeting the 40 percent reduction target as a result of improved use of best management practices and vessel conversions to less toxic hull coatings"* (Regional Board,

[3] For a TMDL to be incorporated into the *Water Quality Control Plan for the San Diego Basin – Region 9* (Basin Plan; 1994), it must be approved by the Regional Board, State Water Resources Control Board (SWRCB), Office of Administrative Law (OAL), and United States Environmental Protection Agency (USEPA) Region 9. The official TMDL approval date is the OAL approval date.

2018). At the October 10, 2018 Regional Board Monthly Meeting, the Executive Officer's Report confirmed and memorialized that the SIYB TMDL efforts had successfully achieved the 2017 compliance requirement. The letter from the Regional Board and the October 2018 Executive Officer's Report are included in Appendix E.

The fourth and final stage of the TMDL began in 2018. The TMDL requires a 76% reduction in the loading of dissolved copper into SIYB by the end of 2022.

1.3 Sources of Dissolved Copper

Based on the Regional Board's source analysis, the total mass load of dissolved copper to SIYB was estimated to be 2,163 kg/yr, of which 98% of the inputs were attributable to passive leaching of copper from copper-based hull paints on vessels and to hull cleaning activities (Table 1-2). The TMDL identifies the Port, marinas and yacht clubs, hull cleaners, and boaters as responsible for reducing loads in their respective areas, operations, and activities. The total copper load from the SIYB TMDL equals 2,100 kg/yr from vessel paints. The estimated load reduction resulting from background, urban runoff, and atmospheric deposition (which equates to approximately 63 kg/yr) is not included in this total. This report evaluates the dissolved copper loading based on the vessel-related contribution, totaling 2,100 kg/yr, originating from the Harbor Police dock, transient dock, and weekend anchorage, as well as marinas and yacht clubs, where boats reside and hull cleaning activities occur.

Table 1-2.
Sources of Dissolved Copper per the SIYB TMDL

Source	Estimated Mass Load to SIYB (kg/yr)	Contribution to SIYB (% Dissolved Copper)
Passive Leaching	2,000	93
Hull Cleaning	100	5
Urban Runoff	30	1
Background	30	1
Direct Atmospheric Deposition	3	<1
Sediment	0	0
Total	2,163	100

Notes:
< = less than; % = percent; kg/yr = kilogram(s) per year; SIYB = Shelter Island Yacht Basin

1.4 Water Quality Objective Criteria

The WQO for dissolved copper in SIYB is equal to the National Recommended Water Quality Criteria for Aquatic Life of the United States Environmental Protection Agency (USEPA) and the California Toxics Rule (CTR) water quality criteria for dissolved copper in marine environments (USEPA, 2000). Continuous or chronic exposures may not exceed 3.1 micrograms per liter (µg/L) over a 4-day average; acute exposures may not exceed 4.8 µg/L over a 1-hour average. In addition, numeric WQOs must not be exceeded more than once every three years.

In addition to numeric WQOs, the *Water Quality Control Plan for the San Diego Basin – Region 9* (Basin Plan) established narrative WQOs for toxicity and pesticides (Regional Board, 1994) as follows:

Toxicity Objective – *All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life. Compliance with this objective will be determined by use of indicator organisms, analyses of species diversity, population density, growth anomalies, bioassays of appropriate duration, or other appropriate methods as specified by the Regional Board.*

Pesticide Objective – *No individual pesticide or combination of pesticides shall be present in the water column, sediments or biota at concentration(s) that adversely affect beneficial uses. Pesticides shall not be present at levels which will bioaccumulate in aquatic organisms to levels which are harmful to human health, wildlife or aquatic organisms.*

Two beneficial uses within SIYB are threatened by elevated dissolved copper concentrations: marine habitat (MAR) and wildlife habitat (WILD). The Regional Board indicated that if numeric WQOs are met for dissolved copper, then narrative WQOs will also be considered to be met. However, because current numeric WQOs are not site-specific, direct assessments of toxicity, as well as SIYB biota, also directly indicate basin-wide attainment of beneficial uses and narrative WQOs.

1.5 Monitoring Purpose

The Investigative Order requires the Port to complete an annual evaluation, interpretation, and tabulation of vessel information, BMPs, and water quality sampling. Because of the proportional contribution of copper loading to SIYB from copper-based hull paints, tracking of vessel conversions from copper to non-copper or lower copper hull paints is the primary method used to assess compliance with SIYB TMDL load reduction targets. Water quality monitoring is required because it assesses long-term trends in the basin and provides comparisons with the numeric and narrative WQOs, as measured by surface water dissolved copper concentrations and toxicity. Monitoring is a necessary component to evaluate whether the trajectory of water quality measurements will meet WQOs. By conducting both vessel tracking and water quality monitoring on an annual basis, the program may eventually be able to evaluate the relationship between load reductions and water quality. Additionally, this approach will provide the data needed to assess the overall effectiveness of the SIYB TMDL implementation in attaining both loading reductions and numeric WQOs to protect the basin's MAR and WILD beneficial uses.

1.6 Revision of Monitoring Plan

The Monitoring Plan (Revision 6) (Wood Environment & Infrastructure Solutions, Inc. [Wood], 2020a) was updated for the 2020 monitoring year to reflect the 2020 monitoring period dates and to include safety measures enacted to address the COVID-19 pandemic. In addition, the following components were added to the TMDL water quality monitoring program to supplement compliance monitoring, as described further in Section 2.3:

- Addition of a second reference site (SIYB-REF-2) to the water quality monitoring locations
- Addition of a second water quality monitoring event to be conducted during the winter[4]

[4] Results from the winter water quality monitoring event will be included in the 2021 annual monitoring and progress report.

1.7 Implementation of Best Management Practices

The Port has developed a comprehensive copper reduction program and is implementing BMPs to reduce copper loads at the Harbor Police dock, transient dock, and weekend anchorage, as well as supporting the other Named TMDL Parties with their load reduction and BMP implementation efforts in SIYB and throughout San Diego Bay. The five elements of this program are:

- Testing and research
- Transition to non-copper hull paints and DPR Category I paints (i.e., paints with leach rates less than or equal to (≤) 9.5 micrograms per square centimeter per day [$\mu g/cm^2/day$])
- Policy development and legislation
- Education and outreach to boaters
- Monitoring and data assessment

The marinas and yacht clubs in SIYB also implement BMPs and compile vessel information from boat owners to assist in the preparation of this report.

Over the course of the SIYB TMDL program, multiple quality control measures have been integrated to build on previous knowledge and to help effectively implement the SIYB TMDL program.

Additional measures include:

- Meetings between the Port and other stakeholders in SIYB about the SIYB TMDL, including formation of a working group between the Port and SIYB marina and yacht club tenants in 2020 (further described in Section 1.8)
- Increased scrutiny of water quality data and analytical methods
- Ongoing reassessment of field sampling techniques, including additional oversight of field procedures
- Review of methods used to track the types of hull paints used on vessels in SIYB
- Updates and improvements to modeling of copper loads, including assessments of in-water hull cleaning

These measures have been implemented to collect relevant useful data and to enhance communication among the marinas and yacht clubs and other Named TMDL Parties. The intent of this iterative and collaborative process is to provide transparency and provide a known and scientifically defensible dataset to support the SIYB TMDL compliance requirements.

1.8 New Initiatives and Adaptive Management

The following new program initiatives were implemented or planned during the 2020 monitoring year:

1. Starting in 2020, a supplemental second reference station (SIYB-REF-2), located farther from the mouth of SIYB, was added as a sampling location, as described in Section 2.3.

The addition of a second reference station farther away from SIYB may provide a better understanding of the gradient of dissolved copper levels in San Diego Bay moving away from the mouth of SIYB, as well as a better understanding of the background conditions within San Diego Bay outside of SIYB. Chemistry results for the additional reference station are provided in Section 3.3.

2. In May 2020, a working group was formed between the Port and SIYB marina and yacht club tenants to ensure close coordination on management strategies that both meet TMDL compliance and preserve, protect, and enhance water quality in SIYB and San Diego Bay. The Regional Board began participating in working group meetings in December 2020.
3. The Port included a winter monitoring event in SIYB in the Monitoring Plan update (Revision 6) completed in 2020 (Wood, 2020a). This winter monitoring event was added to supplement the annual compliance monitoring, which occurs in the summer. Water quality monitoring was conducted using the same sampling and analysis methodologies as those employed for the summer compliance monitoring, as discussed in Section 2.3. The purpose of this winter monitoring event is to provide a better understanding of the seasonal variability of dissolved copper levels in SIYB and at the reference locations during a period of cooler water temperatures and lower frequency of hull cleaning and vessel usage relative to the summer months. Monitoring for this winter event was conducted in February 2021, and results will be included in the 2021 monitoring report.
4. The Port continued to evaluate the trajectories of dissolved copper loading and water quality in 2020. To date, there has been a disconnect between copper load reduction and water quality in SIYB. Despite the continued transition to low-copper alternative AFPs, the water quality has not demonstrated a correlated improvement. The Port has continued efforts to fill data gaps related to in-water hull cleaning to better understand the effects of in-water hull cleaning on water quality.

1.9 Content of Report

This TMDL Monitoring and Progress Report for SIYB presents the monitoring results for 2020 and includes the following:

- BMP implementation, including those implemented by the Port in SIYB and throughout San Diego Bay, as well as those implemented by the Shelter Island Master Leaseholders (SIML) TMDL Group, marinas, and yacht clubs in SIYB
- Methods to assess, estimate, and reduce copper loads
- Evaluation, interpretation, and tabulation of data collected by the Port, marinas, and yacht clubs on vessel tracking and hull paint conversions
- Water quality monitoring data, including results from chemical and toxicological evaluations of surface water samples collected in August 2020
- Information regarding ongoing copper initiatives and other copper-related issues considered germane to the SIYB TMDL
- Discussion of the 2020 TMDL monitoring program findings
- A summary of the Port’s recommendations related to its Copper Reduction Program

The report also includes several appendices with additional supporting information and data. Appendix A is the 2020 SIYB TMDL Monitoring Plan. Appendix B contains BMP plans for the Port, as well as marinas and yacht clubs. Appendix C includes vessel tracking data (including information for each available slip) for the entire SIYB. Appendix D contains the water quality monitoring results for the August 2020 sampling event, including field-collected data, the analytical chemistry report, and the toxicity testing report. Appendix E includes SIYB-related correspondence between the Port and other agencies, as well as other pertinent information.

2.0 METHODS

This section describes in detail the BMP plans in place to reduce copper loads, methods used to estimate load reductions (e.g., vessel hull paint tracking), field program methods to assess dissolved copper levels in SIYB, and project-specific quality assurance (QA) and quality control (QC) procedures used during water quality monitoring and data analysis.

2.1 Implementation of Best Management Practices in SIYB and San Diego Bay

The Port has developed a copper reduction program and maintains a cumulative list of copper reduction BMPs implemented in support of the TMDL (Appendix B). In addition, the marinas and yacht clubs created specific BMP plans. Information is submitted annually to the Port that details the BMPs and actions that marinas and yacht clubs have implemented throughout the year to reduce dissolved copper loads to SIYB. The BMP plans are also provided in Appendix B.

The report in Appendix B also describes BMPs or other actions implemented by the Port to reduce dissolved copper discharges from vessel hulls into harbors or marinas bay-wide within San Diego Bay. In addition, as required by the IO, the Port reported the actions that were taken to reduce dissolved copper discharges to marinas beyond San Diego Bay, including actions with statewide or national applicability.

2.2 Dissolved Copper Load Analysis

This section describes the methods and procedures used to estimate dissolved copper loading into SIYB during the 2020 monitoring period, including vessel tracking methodologies and estimates of the contribution of dissolved copper into SIYB attributable to passive leaching and in-water hull cleaning.

2.2.1 Tracking Hull Paint Use: DPR Product/Label Database

The DPR Rule (3 California Code of Regulations [CCR] section 6190) went into effect on July 1, 2018, establishing a maximum leach rate for copper antifouling paints that is protective of aquatic environments. Under this regulation, paint manufacturers are no longer allowed to import or sell copper-based paints with leach rates greater than 9.5 $\mu g/cm^2/day$ in the state of California. It should be noted that any existing stock could be sold until June 30, 2020.

Since the implementation of the DPR Rule in July 2018, many copper-based AFPs have been reformulated to meet maximum allowable copper leach rate requirements for AFP products registered in California for use on recreational vessels. To assist with vessel tracking efforts, the DPR California Product/Label Database Application[5] was used to determine whether copper-based AFP products are actively registered (i.e., DPR Category I paints with leach rates ≤9.5 $\mu g/cm^2/day$). This database identifies the registration status of AFP products, as well as relevant product information such as paint name, copper content, and USEPA registration number. Copper-based AFP products that exceed the maximum copper leach rate of

[5] The DPR California Product/Label Database Application can be accessed at: https://apps.cdpr.ca.gov/docs/label/labelque.cfm

9.5 µg/cm^2/day (i.e., non-Category I paints) can no longer be registered through the DPR and are classified as “Inactive” in the DPR Product/Label Database registration status.

In addition to copper-based AFPs, the DPR Product/Label Database was used to track other non-copper biocide AFPs (e.g., zinc, Irgarol, etc.) that are registered through the DPR. Non-biocide paints and products (which do not require registration through the DPR) were tracked using information obtained from the product manufacturers’ websites.

2.2.2 Vessel Tracking

Annual reduction of copper loading was assessed by tracking conversions of hull paints from copper to non-copper or lower copper products (i.e., either by leach rate or copper content) for vessels moored in SIYB. The annual vessel tracking is conducted both by the Port (for the Harbor Police dock, transient dock, and weekend anchorage) and the SIYB marinas and yacht clubs. SIYB marinas and yacht clubs’ data were collected independently from the Port and provided to the Port for review and inclusion in this report, as described below.

Yacht club and marina operators collect vessel data by surveying their boaters for vessel-related information listed in Table 2-1. A standard survey form has been made available to all marinas and yacht clubs in SIYB. An example of this survey form is in Appendix B.

Table 2-1.
Vessel Survey Data Collected in 2020

Vessel Tracking Data Fields	
1.	Name of Marina or Yacht Club
2.	Slip/Mooring Reference Number
3.	Percentage of Time Occupied
4.	Vessel Type (power or sail)
5.	Vessel Length
6.	Vessel Beam Width
7.	Paint Type (Copper, DPR Category I, Low-copper, or Non-copper)
8.	Paint Product Name
9.	Paint Product Number
10.	Boatyard Name or Purchase Date
11.	Painting Date (month)
12.	Painting Date (year)[a]
13.	% Copper
14.	USEPA Registration Number (when applicable)

Notes:
a. Aged-copper paints are determined by the painting date. To be considered an aged paint for the 2020 survey, the vessel would have had to be painted on or prior to December 31, 2017.
% = percent; DPR = Department of Pesticide Regulation; USEPA = United States Environmental Protection Agency

If no response was initially received or if the vessel tracking survey form lacked pertinent information, yacht clubs and marina operators made follow-up efforts to obtain missing or incomplete records. Vessel information was then submitted to the Port in mid-January 2021 for review and inclusion in this report. Data from the SIYB marinas and yacht clubs are included, as received, in Appendix C of this report.

Since 2018, the Port has also required all marinas and yacht clubs as Named TMDL Parties to provide a self-certification statement to the Port along with their vessel tracking data submittals. For each facility, the signed self-certification statement states that the data were prepared under the signatories' knowledge and direction and that the data represented truthful, accurate, and complete information. Self-certification letters for each marina and yacht club are provided in Appendix E.

Once the survey results were received by the Port, annual hull survey data from marinas and yacht clubs were crossed-checked against the USEPA registration number (when applied) and then by the product name in the DPR California Product/Label Database. If the information conformed to the DPR California Product/Label Database, the vessel's paint was tracked as identified in the aforementioned categories. Non-biocide paints and products (which do not require registration through the DPR) were verified using information obtained from the product manufacturers' websites.

Vessel tracking data from SIYB also included the percentage of time that slips were unoccupied or were occupied by vessels with copper, lower copper (DPR Category I and low-copper paints), aged-copper paints, non-copper, or unknown hull paints, as required by the Investigative Order (Table 2-2). The occupancy rate at most marinas and yacht clubs in SIYB was calculated using a nightly count of empty slips. The annual percentage of time that the slip was occupied was determined by dividing the total number of days occupied by 365 days.

Table 2-2.
Vessel Tracking Data Collected for 2020

Vessel Tracking Data Fields	
1.	Total number of slips or buoys in facility available to be occupied by vessels
2.	Number of unoccupied slips or buoys and length of time unoccupied during each year
3.	Number of vessels confirmed with copper-based hull paints and approximate length of time occupying a slip or buoy in facility each year
4.	Number of vessels confirmed with aged-copper-based hull paints[a] and approximate length of time occupying a slip or buoy in facility each year
5.	Number of vessels confirmed with DPR Category I or low-copper paints[b] and approximate length of time occupying a slip or buoy in facility each year
6.	Number of vessels confirmed with alternative hull paints, by hull paint type, and approximate length of time occupying a slip or buoy in facility each year
7.	Number of vessels with unconfirmed information regarding hull paints and approximate length of time occupying a slip or buoy in facility each year
8.	Estimate of the dissolved copper load reduction achieved for the year (kg/yr and percent)

Notes:
a. Per Regional Board letter dated July 26, 2013.
b. Per Regional Board email dated October 21, 2015.
DPR = Department of Pesticide Regulation; kg/yr = kilogram(s) per year

For all vessel tracking data submittals, lower copper (DPR Category I or low-copper) and non-copper hull paints were confirmed if the required supporting data that were provided (i.e., all of the required data fields were completed) for a given hull paint were consistent with the DPR Product/Label Database (biocide paints) or product manufacturer's website (non-biocide paints or products). Vessels stored out of the water (e.g., on HydroHoists®) or in slip liners, or reported to have no bottom paint, were also confirmed as having non-copper paint for that slip. For vessels to be considered as having hulls with aged-copper paints, the painting date submitted must have been on or before December 31, 2017 for the 2020 monitoring year.

To be conservative, loading was calculated for unconfirmed paints by assuming that paint was copper-based (i.e., non-Category I) if the vessel owner did not know the paint's registration number or product name, or if information provided was inconsistent with the DPR database (e.g., paint name and/or registration number provided were for different paints).

As previously mentioned, the DPR Rule went into effect on July 1, 2018, establishing a maximum leach rate of 9.5 µg/cm^2/day for copper-based AFPs registered through the DPR and sold in California. As a result of the full implementation of the DPR Rule, a majority of vessels painted since July 2018 will have DPR Category I paints. However, it should be noted that the existing stock of paints with leach rates exceeding the DPR maximum leach rate criterion could be sold until June 30, 2020. Therefore, vessels with unknown and unconfirmed paints from the 2020 survey were still assumed to be copper (i.e., non-Category I paints) to be conservative in load calculations and in accordance with assumptions listed in the SIYB TMDL Monitoring Plan.

Data obtained from the annual vessel tracking survey were used to estimate the annual dissolved copper load to SIYB from vessels under both confirmed and unconfirmed scenarios, as described further in Section 2.2.3.

2.2.3 Annual Dissolved Copper Load

To estimate dissolved copper loads attributed to vessels for the SIYB TMDL monitoring program, the in-water hull-cleaning load (100 kg/yr) and passive leaching load (2,000 kg/yr) identified in Appendix 2 of the SIYB TMDL[6] were combined to form a total vessel-related load of 2,100 kg/yr. This vessel-related baseline load was divided by the total vessel population identified in the TMDL (2,363 vessels), which resulted in an annual per-vessel load of 0.89 kg/yr (rounded to 0.9 kg/yr). Therefore, any reference to the annual per-vessel dissolved copper load is considered to be 0.9 kg/yr.

The dissolved copper load attributed to in-water hull cleaning was identified in Appendix 2 of the SIYB TMDL (Regional Board, 2005) as approximately 100 kg/yr. As part of the Regional Board's load estimation, it was assumed that all SIYB vessel hulls were painted with copper paint, all hulls were cleaned approximately monthly, and in-water hull cleaning BMPs were used during half of the cleaning events. As discussed above, the annual per-vessel dissolved copper load is 0.9 kg/yr. This total annual per-vessel load is composed of the load from passive leaching (approximately 0.86 kg/yr) and in-water hull cleaning[7] (approximately 0.04 kg/yr) per Appendix 2 of the SIYB TMDL (Regional Board, 2005).

The SIYB TMDL copper load reduction is assessed by tracking the number of vessel hulls with copper paint, lower copper paint (DPR Category I or low-copper), aged-copper paint, or non-copper paint, as well as by counting the number of vacant slips in SIYB. Vessels that have

[6] Appendix 2 of the SIYB TMDL is at the following website address: http://www.waterboards.ca.gov/sandiego/water_issues/programs/watershed/souwatershed.shtml

[7] The annual copper load contribution from in-water hull cleaning (0.04 kg/yr) presented in this report is based on the TMDL load assumption of 5%.

aged-copper paint are considered to have a lower copper load (i.e., 0.45 kg/yr), but are tracked separately.

The vessel tracking program estimates loading reductions conservatively. If the hull paint name and type are unknown, the paint is assumed to be copper-based. Additionally, if the most recent painting date is unknown, the vessel is assumed to be painted recently. Lastly, if the occupancy time of a slip or mooring is not reported, the slip or mooring is assumed to be occupied 100% of the time (i.e., 365 days per year). Data on paint categories for transient vessels visiting the transient dock and weekend anchorage were not available; therefore, these vessels were assumed to have copper hull paints.

The assumptions below were used by the Regional Board to derive the baseline copper loading identified in Appendix 2 of the SIYB TMDL (Regional Board, 2005). Calculation of loading reductions for the 2020 SIYB TMDL monitoring program was based on comparisons with these baseline conditions:

- All 2,363 SIYB slips or buoys were occupied by a number of vessels (N_v).
- All 2,363 recreational vessels moored within SIYB have copper-based paints 100% of the time.
- Annual loading from passive leaching basin wide (L_p) equals 2,000 kg/yr.
- Annual loading from hull cleaning (L_h) equals 100 kg/yr.
- Average annual loading per vessel (L_v) with copper hull paint equals 0.9 kg/yr, where $L_v = (L_p + L_h)/N_v$.

In accordance with the SIYB TMDL, this loading reduction analysis assumed an average loading reduction of approximately 0.9 kg/yr for every vessel in SIYB that converted from copper-based to non-copper-based paints. The use of lower copper hull paints was also recognized in the SIYB TMDL as a viable means of reducing copper loading to the basin. Lower copper paints are identified as DPR Category I paints and paints having a copper content of less than 40% (i.e., low-copper). This loading reduction analysis also assumed that, on average, each vessel that transitioned to lower copper hull paints reduced annual dissolved copper loading by 50% (0.43 kg/yr for passive leaching + 0.02 kg/yr for in-water hull cleaning). Aged-copper paints also were considered as a 0.45 kg/yr load if they were applied prior to December 31, 2017.

Annual loading was calculated for each slip by multiplying the reported dissolved annual loading for a given hull paint category by the percentage of time a slip was reported to be occupied (e.g., the product of 0.9 kg/yr for copper hull paints and 90% occupancy results in an annual loading of 0.81 kg/yr). In the case of the weekend anchorage and transient dock, data on the length of stay indicated by each permit issued were used to calculate annual occupancy and loading. Because no hull paint data were collected, all vessels at the weekend anchorage and transient dock were assumed to have copper paints. Therefore, annual dissolved copper loading due to passive leaching and hull cleaning was calculated by multiplying the annual dissolved copper load (0.9 kg/yr) by the average number of vessels occupying the anchorage or transient dock in 2020 and the average percentage of time that slips were occupied.

Calculations of annual dissolved copper loading were performed using assumptions listed in Table 2-3. As recommended in the 2015 Monitoring and Progress Report, starting in 2016 and continuing through 2020, the copper loads from passive leaching and in-water hull cleaning are calculated and presented separately. The copper loading estimates in Section 3.2.4 present both a combined total load estimate, as well as separate load estimates for passive leaching and in-water hull cleaning contributions using the assumption in Appendix 2 of the SIYB TMDL (Regional Board, 2005).

Table 2-3.
Dissolved Copper Loading Calculation Assumptions

Dissolved Copper Loading Assumptions	
1.	All vessels moored in SIYB at the enactment of the TMDL had copper hull paints.
2.	Average annual dissolved copper load from a vessel with copper paint equals 0.9 kg/yr.
	a. The passive leaching load from a vessel with copper paint equals 0.86 kg/yr.
	b. The cleaning load from a vessel with copper paint equals 0.04 kg/yr.
3.	Vessels with unknown hull paints have copper paint.
4.	Slips/moorings for which occupancy data are not provided are considered to be 100% occupied.
5.	Annual dissolved copper load from a vessel with non-copper hull paint equals 0 kg/yr.
6.	DPR Category I paints are paints with leach rates ≤9.5 μg/cm²/day. These paints are considered as lower copper.
7.	Low-copper hull paints are paints with less than 40% copper. These paints are also considered as lower copper.
8.	Average annual dissolved copper load from a vessel with lower copper paint equals 0.45 kg/yr.
	a. The passive leaching load from a vessel with lower copper paint equals 0.43 kg/yr.
	b. The cleaning load from a vessel with lower copper paint equals 0.02 kg/yr.
9	Vessels determined to have aged-copper paint (i.e., copper paint applied to a vessel hull prior to December 31, 2017[a]) have an annual dissolved copper load equal to 0.45 kg/yr.
10.	Annual loads are normalized by the percentage of time vessels are docked in SIYB.

Notes:
a. December 31, 2017 is the cutoff date for vessels to be considered to have aged-copper paint for the 2020 annual monitoring and progress report load calculation. This cutoff date will advance by one year for each subsequent annual load calculation.
% = percent; μg/cm²/day = microgram(s) per square centimeter per day; ≤ = less than or equal to; DPR = Department of Pesticide Regulation; kg/yr = kilogram(s) per year; SIYB = Shelter Island Yacht Basin; TMDL = total maximum daily load

2.3 Water Quality Monitoring

Water quality samples were collected to measure the average concentration of dissolved copper in the basin. The monitoring methods used were consistent with those of prior studies conducted by the Regional Board in SIYB, as reported in Appendix 6 of the SIYB TMDL Technical Report (Regional Board, 2005). To maintain consistency with these prior studies, water quality was monitored at six stations in SIYB and at a reference station in the main channel of San Diego Bay adjacent to SIYB. An additional reference station was included during the 2020 monitoring year[8]. These station locations were similar to those sampled by the Regional Board and met the Investigative Order requirement of spatially representing dissolved copper concentrations in SIYB, as described in the original Monitoring Plan and most recent update (Weston Solutions, Inc. [Weston], 2011; Wood, 2020a).

[8] To supplement the TMDL compliance monitoring, a second reference station (SIYB-REF-2) was added to the sample locations for the 2020 monitoring program (further described in Section 2.3.1).

Dissolved copper concentrations were compared with the surface water baseline level of 8.3 ± 1.4 µg/L (mean plus or minus standard error). This baseline value was calculated using surface water quality data collected between 2005 and 2008 from stations in the immediate vicinity of the Regional Board monitoring station network (Weston, 2011).

2.3.1 Sampling Station Locations

To date, the annual compliance monitoring program has been conducted at six stations within SIYB and one reference station (SIYB-REF-1[9]) in the main channel of San Diego Bay (Table 2-4 and Figure 2-1). A supplemental second reference station (SIYB-REF-2), located farther from the mouth of SIYB, was added as a sample location in 2020 to provide a better understanding of the gradient of dissolved copper levels in San Diego Bay moving away from the mouth of SIYB, as well as a better understanding of the background conditions within San Diego Bay outside of SIYB. Station locations are provided in Table 2-4 and Figure 2-1. To the greatest extent possible, samples were collected within approximately ±3 meters of the target coordinates.

Table 2-4.
Sampling Station Coordinates

Station	Target		Actual	
	Latitude	Longitude	Latitude	Longitude
SIYB-1	32.71821	-117.22601	32.71823	-117.22604
SIYB-2	32.71412	-117.22921	32.71414	-117.22922
SIYB-3	32.71550	-117.22989	32.71549	-117.22990
SIYB-4[a]	32.71683	-117.23203	32.71682	-117.23201
SIYB-5	32.71217	-117.23297	32.71218	-117.23298
SIYB-6	32.70858	-117.23514	32.70883	-117.23511
SIYB-REF-1[a]	32.70406	-117.23232	32.70407	-117.23234
SIYB-REF-2[b]	32.70926	-117.22544	32.70947	-117.22516

Notes:
a. SIYB-REF-1 was identified as SIYB-REF in prior reports.
b. SIYB-REF-2 was added as a second reference station in 2020 to supplement the TMDL compliance monitoring.

9 Previously identified as "SIYB-REF".

Figure 2-1. Shelter Island Yacht Basin TMDL Sampling Station Locations for the 2020 Monitoring Program

2.3.2 Sampling Date

Surface water at the eight sampling stations (six SIYB stations and two San Diego Bay reference stations) was sampled on August 20, 2020. In accordance with the Monitoring Plan, water sampling bracketed slack high tide during the summer[10], as depicted in Figure 2-2.

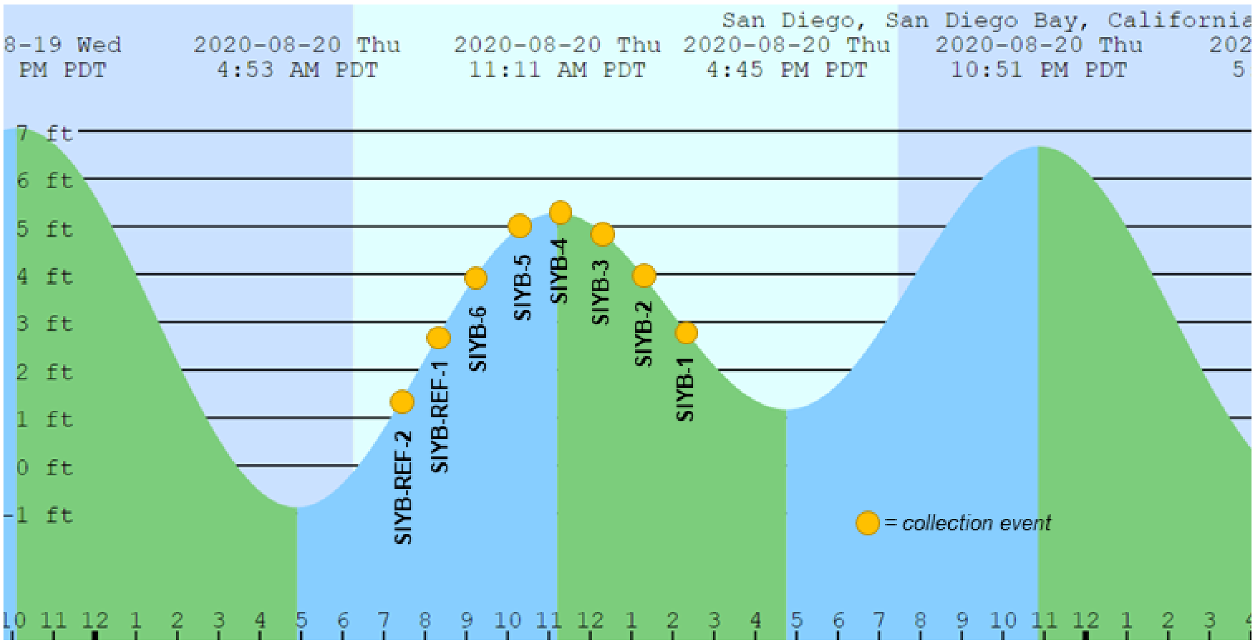

Figure 2-2. August 20, 2020 Sample Collection Times Versus Tide

2.3.3 Sample Collection

Discrete water samples were collected at each station using a Niskin bottle deployed from a sample collection vessel. "Clean-hands" sampling techniques were used, consistent with the project-specific and approved SIYB TMDL Quality Assurance Project Plan (QAPP) (Wood, 2020b). All stations were located using the Differential Global Positioning System.

Samples were collected within the top 1 meter of the basin surface; these samples are referred to as "surface water." Field measurements were taken at each station for temperature, conductivity, salinity, hydrogen ion concentration (pH), and dissolved oxygen (DO) using a YSI Incorporated (YSI) Pro Plus data sonde. Following the collection and preservation of water samples, a top-to-bottom water quality profile using a Sea-Bird Electronics (SBE) Conductivity, Temperature, and Depth (CTD) profile instrument was captured to evaluate temperature, conductivity, salinity, pH, DO, and light transmittance at the station.[11] In situ analytical methods and detection limits are listed in Table 2-5.

[10] To supplement the annual TMDL compliance monitoring, a second water quality monitoring event was conducted in February 2021 using the same sampling and analysis methodologies as the compliance monitoring event performed in the summer. Results from the winter monitoring event will be included in the 2021 monitoring report.

[11] Due to field collection schedule limitations, no CTD water quality profile was captured at station SIYB-REF-2.

Table 2-5.
In Situ Analytical Methods and Detection Limits

Water Quality Measurement	Method	Instrument Sensitivity
Temperature	SBE CTD and YSI Pro Plus	± 0.1 °C
Specific Conductance	SBE CTD and YSI Pro Plus	± 1 µS/cm
Salinity	SBE CTD and YSI Pro Plus	± 0.1 ppt
pH	SBE CTD and YSI Pro Plus	± 0.1 pH unit
Dissolved Oxygen	SBE CTD and YSI Pro Plus	± 0.1 mg/L
Light Transmittance	SBE CTD	± 0.1%

Notes:
± = plus or minus; % = percent; °C = degrees Celsius; µS/cm = microSiemens per centimeter; CTD = conductivity, temperature, and depth; mg/L = milligram(s) per liter; pH = hydrogen ion concentration; ppt = part(s) per thousand; SBE = Sea-Bird Electronics; YSI = YSI Incorporated

After collection, water samples were transferred to labeled containers for analysis of total and dissolved copper and zinc, total organic carbon (TOC), dissolved organic carbon (DOC), total suspended solids (TSS), and toxicity[12].

Detailed field notes were recorded during sample collection at each station and all samples were logged on a chain-of-custody (COC) form, and then placed in a cooler on ice. Samples were stored at 4 degrees Celsius (°C) in the dark until delivered to the appropriate laboratory for analysis, within 24 hours of collection. Water chemistry analyses were conducted by Weck Laboratories, Inc. (Weck) of City of Industry, California; toxicity tests were conducted by Wood Aquatic Toxicology Lab of San Diego, California. Both laboratories are accredited through the California Environmental Laboratory Accreditation Program (ELAP). Photographs taken during field sampling are presented in Figure 2-3.

2.3.4 Equipment Decontamination and Cleaning

The Niskin bottle was cleaned prior to sampling with clean, soapy water and thoroughly rinsed with deionized water. Upon deployment, the Niskin bottle received a thorough site water rinse at each station prior to sample collection. After collection, water samples were transferred using the clean-hands method from the Niskin bottle to laboratory-certified, contaminant-free, high-density polyethylene bottles.

12 Because the sample from SIYB-REF-2 was only collected to assess variability in dissolved copper levels at the reference stations, this sample was not tested for toxicity.

Photo A. Water quality readings of temperature, conductivity, salinity, pH, and dissolved oxygen are taken before, during, and after sampling using a YSI Pro Plus data sonde.

Photo B. Recording of weather conditions, activities such as boat cleaning, and any other observations that may have an impact on water quality is an important component of the field monitoring program.

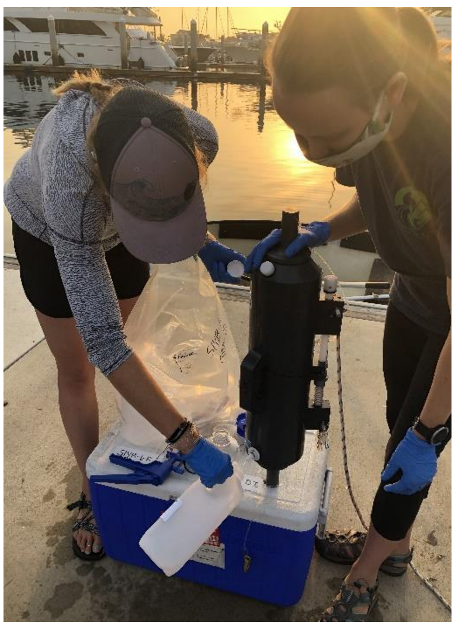

Photo C. Water samples are collected using a Niskin bottle and following clean sampling techniques.

Photo D. Water samples are filtered in the field immediately after collection for analysis of dissolved metals.

Figure 2-3. Field Sampling Photographs

2.3.5 COVID-19 Safety Protocols

Field

Water quality monitoring conducted in compliance with the TMDL was considered to be an essential activity during the COVID-19 response. As such, field efforts were conducted following safety protocols to adhere to local, state, and federal COVID-19 guidelines. The project-specific Monitoring Plan (Wood, 2020a) and Health and Safety Plan (Wood, 2020c) were revised in 2020 to include additional safety protocols to prevent the spread of COVID-19.

Field staff were required to drive to the field site in separate vehicles to allow for social distancing. Prior to sampling, field staff were required to certify that they had no known exposure to persons with COVID-19 within the past 14 days and had no symptoms of COVID-19 (e.g., fever, cough, sore throat, or breathing difficulty). Face coverings were worn by all personnel for the duration of the field operations. In addition, field staff distanced and remained on the rear deck of the vessel in the open air to the maximum possible extent. Typically, a Port representative is present on the vessel during the sampling activities; however, due to the COVID-19 restrictions, the field team was limited to Wood staff to allow for social distancing when possible. While Port staff were unable to participate in field activities, Wood's Field QA Officer was present to oversee the sample and data collection process, as described further in Section 2.4.1.

Laboratory

Additional COVID-19 safety protocols were also implemented by chemistry and toxicology laboratory staff including, but not limited to, the following:

- All personnel were required to check their temperature prior to entering the laboratory and review questions related to personal health before starting work.
- All personnel were required to wear a mask or face covering at all times while in the laboratory.
- In-house personnel were required to maintain a safe social distance (i.e., a minimum of 6 feet) from each other as much as possible.
- All client meetings and communication were performed through digital media (i.e., no in-person communication).

There were no changes to standard laboratory procedures, and all samples were analyzed in accordance with the test methods, as described in Section 2.3.6.

2.3.6 Laboratory Analyses

After collection was completed, samples were transported to the laboratory under customary COC protocols. Samples were analyzed for total and dissolved copper, total and dissolved zinc, TOC, DOC, and TSS, following certified USEPA or Standard Method (SM) test methods. Test method selection was based on the best available combination of sensitivity (low-level detection limits), accuracy (minimum susceptibility to bias or matrix interference), and precision (reproducibility), in accordance with the QAPP.

General water quality measurements (of temperature, conductivity, salinity, pH, DO, light transmittance, TOC/DOC, and TSS) were also taken at each station. Natural water quality parameters such as DOC are well known to affect the bioavailability and toxicity of copper in marine environments (Delgadillo-Hinojosa et al., 2008; Rosen et al., 2005; and Zirino et al., 2002). Zinc was also included for testing because it can be used as an alternative biocide in AFPs. Both total zinc and dissolved zinc were measured to determine whether concentrations are increasing as vessel hull paints are converted from copper-based to non-copper-based paints.

Analysis of water quality data included calculations of average surface water dissolved copper concentrations to compare with the dissolved copper CTR criterion continuous concentration (CCC) WQO (3.1 µg/L). In Section 3.3, the 2020 dissolved copper results are compared with the 2005–2008 baseline data as reported in the original Monitoring Plan (Weston, 2011) to evaluate the change in dissolved copper levels in the surface waters over time.

The laboratory analytical methods and target detection and reporting limits are specified in Table 2-6. Actual method detection and reporting limits are provided in the chemistry laboratory report in Appendix D.

Table 2-6.
Laboratory Analytical Methods

Water Quality Measurement	Method	Target Method Detection Limit	Target Reporting Limit
Total Copper	USEPA 1640	0.0038 µg/L	0.010 µg/L
Dissolved Copper	USEPA 1640	0.0038 µg/L	0.010 µg/L
Total Zinc	USEPA 1640	0.036 µg/L	0.20 µg/L
Dissolved Zinc	USEPA 1640	0.036 µg/L	0.20 µg/L
TOC	SM 5310 B	0.016 mg/L	0.10 mg/L
DOC	SM 5310 B	0.016 mg/L	0.10 mg/L
TSS	USEPA 2450 D	1.0 mg/L	5.0 mg/L

Notes:
µg/L = microgram(s) per liter; DOC = dissolved organic carbon; mg/L = milligram(s) per liter; SM = Standard Method; TOC = total organic carbon; TSS = total suspended solids; USEPA = United States Environmental Protection Agency

Toxicity testing consisted of a 96-hour acute bioassay test to be consistent with the SIYB TMDL guidance (Regional Board, 2005) using Pacific topsmelt (*Atherinops affinis*). Additionally, a 48-hour chronic bioassay test using mussel larvae (*Mytilus galloprovincialis*) was performed. Previous studies have used the 48-hour mussel larvae chronic test as their primary indicator of toxicity because *Mytilus galloprovincialis* is considered one of the most sensitive species used in the calculation of the water quality criterion for copper in marine environments (USEPA, 1995a). However, both tests were used to assess compliance with the narrative toxicity objective.

2.3.6.1 Topsmelt 96-Hour Acute Bioassay

Topsmelt acute toxicity tests were initiated on August 21, 2020 following the procedures described in *Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms* (USEPA, 2002). Juvenile topsmelt were exposed for 96 hours to three sample concentrations (0.5 dilution series) and a control. Each concentration was tested with six replicates and five topsmelt per replicate. Water quality measurements of DO, temperature, pH, and salinity were conducted daily. Test conditions are summarized in Table 2-7. After 96 hours, percent survival was calculated. The test was considered acceptable if mean survival was greater than or equal to 90% in the controls.

During the topsmelt acute toxicity tests (initiated on August 21, 2020), there was an issue with the health of the test organisms which required follow-up testing, as discussed further in Section 3.3.2. A follow-up test was performed on August 27, 2020 on the undiluted[13] samples using a different batch of topsmelt to supplement the initial test data. Test conditions for the follow-up test are also summarized in Table 2-7.

Table 2-7.
Conditions for the 96-Hour Pacific Topsmelt Bioassay

96-Hour Acute Fish Survival Bioassay Conditions	
Samples Tested[a]	SIYB-1, SIYB-2, SIYB-3, SIYB-4, SIYB-5, SIYB-6, SIYB-REF-1
Date Sampled	August 20, 2020
Test Dates	August 21–25, 2020 (initial test) August 27–31, 2020 (follow-up test)
Test Species	Pacific topsmelt *(Atherinops affinis)*
Test Protocol	USEPA Acute Manual, 2002 (EPA/821/R-02/012)
Test Acceptability Criterion	≥90% mean survival in the laboratory control
Test Type and Duration	Acute survival/96-hour static-renewal (48-hour water renewal)
Organism Supplier	Aquatic BioSystems, Fort Collins, Colorado
Control Water Source	Scripps Pier seawater, 20-µm filtered
Acclimation Time[b]	August 21, 2020 test: 3 days August 27, 2020 test: 2 days
Age at Test Initiation[c]	August 21, 2020 test: 14 days old August 27, 2020 test: 13 days old
Test Concentrations	August 21, 2020 test: 0 (laboratory control), 25, 50, and 100% sample August 27, 2020 test: 0 (laboratory control) and 100% sample
Replicates per Sample	6
Organisms Exposed per Replicate	5
Exposure Volume	250 mL

Notes:
a. Because the sample from SIYB-REF-2 was only collected to assess variability in dissolved copper levels at the reference stations, this sample was not tested for toxicity.
b. There is no USEPA method requirement for acclimation time (USEPA, 2002). However, the toxicity laboratory recommends a minimum 1- to 2-day acclimation time prior to testing. Both topsmelt batches used for testing were acclimated for at least 2 days, as recommended by the laboratory.
c. The USEPA method requires topsmelt to be 7 to 15 days old at test initiation (USEPA, 2002). Both topsmelt batches used for testing were within this age range.
≥ = greater than or equal to; µm = micrometer(s); mL = milliliter(s); % = percent; USEPA = United States Environmental Protection Agency

13 Due to an insufficient number of test specimens available for the August 27, 2020 follow-up test, only the undiluted sample from each station (100% concentration) and control samples could be tested.

A 96-hour reference toxicant test using copper chloride was conducted concurrently with the initial[14] topsmelt acute toxicity test to evaluate the relative sensitivity of test organisms to a single known chemical, as well as the laboratory's proficiency with the test procedure. The topsmelt reference toxicant tests were conducted with copper concentrations of 0, 25, 50, 100, 200, and 400 µg/L. The reference toxicant test was conducted concurrently with the initial SIYB acute toxicity tests and used test organisms from the same batch. Following test termination, the median lethal concentration (LC_{50}) was calculated and compared with historical laboratory reference toxicant test data for this species. Test organisms are considered appropriately sensitive when the test LC_{50} is within two standard deviations of the historical laboratory mean.

2.3.6.2 Bivalve 48-Hour Bioassay

The 48-hour bivalve larvae tests were initiated on August 21, 2020 for all samples collected in SIYB and followed the procedures described in *Short-term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to West Coast Marine and Estuarine Organisms* (USEPA, 1995b).

Bivalves were exposed to five sample concentrations and a control. Each concentration was tested with five replicates and approximately 150 larvae were targeted for inoculation into each replicate. Daily water quality measurements included DO, temperature, pH, and salinity. Test conditions are summarized in Table 2-8.

After test termination, the percentage of surviving embryos with normal development was calculated to determine whether normality had been significantly reduced. The test was considered acceptable if (1) at least 50% of larvae survived in the controls, and (2) an average of 90% of surviving larvae developed normally in the controls. In addition, the percent minimum significant difference in the test must be less than 25. A combined endpoint of normal surviving embryos is reported.

A 48-hour reference toxicant test using copper chloride was conducted concurrently with the project sampling to evaluate the relative sensitivity of test organisms and the laboratory's proficiency with the test procedure. The bivalve reference toxicant test was conducted with copper concentrations of 0, 2.5, 5.0, 10, 20, and 40 µg/L. The same batch of test organisms was used for both the reference toxicant test and the project samples. At test termination, the median effective concentration (EC_{50}) was calculated and compared with historical laboratory reference toxicant test data for this species. Test organisms are considered to be responsive and appropriately sensitive if the test EC_{50} was within two standard deviations of the respective historical laboratory mean.

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[14] Due to the limited availability of test organisms, no reference toxicant test was performed concurrently with the follow-up test initiated on August 27, 2020. The controls for the initial Pacific topsmelt reference toxicant test initiated on August 21, 2020 met corresponding minimum test acceptability criteria. Results of this reference toxicant test are discussed in Section 3.3.2.3.

Table 2-8.
Conditions for the 48-Hour Mussel Development Bioassay

48-Hour Chronic Bivalve Survival and Shell Development Bioassay Conditions	
Samples Tested[a]	SIYB-1, SIYB-2, SIYB-3, SIYB-4, SIYB-5, SIYB-6, SIYB-REF-1
Date Sampled	August 20, 2020
Test Dates	August 21–23, 2020
Test Species	Mediterranean mussel *(Mytilus galloprovincialis)*
Test Protocol	USEPA/600/R-95/136 (USEPA, 1995b); ASTM, 1998
Test Acceptability Criteria	Mean percent survival in the laboratory control must be 50%, and 90% of surviving organisms must have normal shell development. The PMSD in the test must be less than 25.
Test Type/Duration	Bivalve larvae survival and development (endpoint reported as normal development of surviving embryos) – Static/48 hours
Organism Source	Mission Bay, San Diego, California
Control Water Source	Scripps Pier seawater, 20-µm filtered
Age Class of Mussels Exposed	<4 hour-old embryos
Test Concentrations	0 (laboratory control), 6.25, 12.5, 25, 50, and 100% sample
Replicates/Sample	5
Initial Density of Organisms Exposed per Replicate	~200
Exposure Volume	10 mL

Notes:
a. Because the sample from SIYB-REF-2 was only collected to assess variability in dissolved copper levels at the reference stations, this sample was not tested for toxicity.
~ = approximately; < = less than; µm = micrometer(s); % = percent; ASTM = ASTM International; mL = milliliter(s); PMSD = percent minimum significant difference; USEPA = United States Environmental Protection Agency

2.3.7 Toxicity Statistical Analyses

Determinations of toxicity using the 96-hour topsmelt and 48-hour mussel bioassays were statistically assessed using the Comprehensive Environmental Toxicity Information System™, Tidepool Scientific Software. Survival of topsmelt fish and normal development of surviving mussel embryos in each test dilution from SIYB were compared with organism performance observed in control exposures to filtered clean seawater collected from the end of the pier at Scripps Institution of Oceanography in La Jolla, California. Results were used to determine LC_{50} and EC_{50} values. If fish survival and normal embryo development in the controls did not differ significantly from those of the treatments, then conditions within were considered nontoxic at the station. The test of significant toxicity (TST) method was used to identify any samples that exhibited a statistically significant difference from the control (USEPA, 2010).

2.4 Quality Assurance and Quality Control

This section describes the QA/QC procedures for all field activities and laboratory analyses. Specific QA/QC procedures are provided in detail in the approved project-specific SIYB TMDL QAPP (Wood, 2020b).

2.4.1 Field QA/QC

Sampling process QA/QC included preparation prior to, during, and after sample collection to minimize the possibility of compromising sample integrity. The sample collection team was trained in and followed field sampling standard operating procedures (SOPs), as described in the SIYB QAPP (Wood, 2020b).

As discussed in Section 2.3.5, a Port representative is typically present on the vessel to oversee sampling activities; however, due to the COVID-19 restrictions, the field team was limited to Wood staff to allow for social distancing when possible. While Port staff were unable to participate in field activities, Wood's Field QA Officer was onboard the sampling vessel at all times to review each step of the sample and data collection process. Additionally, Port-approved field checklists were used throughout the sampling event to ensure that all procedures were consistent at each station, all samples were collected in exactly the same manner at every station, and all required field data were properly recorded (see Appendix D). Observations of activities (e.g., vessel hull cleaning) surrounding the sampling area were recorded on field data sheets at each station and during movement between stations.

Field staff members were careful to avoid contamination of samples at all times, wore powder-free nitrile gloves during sample collection, and used the clean-hands technique. All samples were collected in laboratory-supplied, laboratory-certified, contaminant-free sample bottles. Field measurement equipment was checked for operation in accordance with the manufacturer's specifications and was inspected for damage prior to use and when returned from use. The QA/QC checks for the 2020 monitoring year are summarized as follows:

- QAPP updates
- Verification of laboratory certifications
- Field mobilization and equipment checklists
- Field sampling QA/QC checklists
- Field equipment calibrations records
- Observations of water clarity
- Staff training on QAPP-required field procedures
- Field conditions and water quality data sheets
- Onboard QA/QC oversight
- Observations for hull cleaning or other water-quality-impacting activities near sampling station locations

As required by Surface Water Ambient Monitoring Program (SWAMP) protocols, the monitoring program also included the addition of a field replicate. The field replicate sample consisted of a second complete set of samples collected at one of the sampling stations (SIYB-1 in the 2020 monitoring program). The purpose of the field replicate is to assess variability in sampling procedures as well as ambient conditions.

Chemistry and toxicity samples were uniquely identified on sample labels using indelible ink. All sample containers were identified by the project title, appropriate identification number, date and time of sample collection, and preservation method. Sample labels were inspected by a QA reviewer before and after bottles were filled at each station to ensure that every sample and analysis type was labeled correctly before moving to the next station. All samples were kept on ice from the time of sample collection until delivery to the analytical laboratory for analysis within method-specified holding times (Table 2-9). Wood delivered toxicity samples on the same day as sample collection to Wood Aquatic Toxicology Lab; chemistry samples were delivered by courier to Weck the following day (August 21, 2020). Both Weck and Wood Aquatic Toxicology Lab are accredited by the California ELAP for the specific tests that were performed at the time they were conducted.

Table 2-9.
Sample Holding Times

Analyte	Holding Time
TOC	28 days
DOC	28 days[a]
Total Copper	180 days
Dissolved Copper	48 hours[b]
Total Zinc	180 days
Dissolved Zinc	48 hours[b]
TSS	7 days
48-hour Acute Bioassay	36 hours
96-hour Chronic Bioassay	36 hours

Notes:

a. The holding time is applicable to preserved sample. The sample is filtered in the field into a bottle with HCl preservative for DOC analysis.

b. The holding time for metals after preservation is 180 days. The dissolved fraction is filtered in the field through a 0.45-µm glass fiber filter using a bottle top vacuum filtration system. Samples are preserved at the laboratory immediately upon receipt from the courier, within 24 hours of sample collection.

µm = micrometer(s); DOC = dissolved organic carbon; HCl = hydrochloric acid; TOC = total organic carbon; TSS = total suspended solids

2.4.2 Laboratory Analytical QA/QC

The QA objectives for chemical analysis conducted by the participating analytical laboratories are provided in their individual laboratory QA manuals. The objectives for accuracy and precision involved all aspects of the testing process, including:

- Methods and SOPs
- Calibration methods and frequency
- Data analysis, validation, and reporting
- Internal QC
- Preventive maintenance
- Procedures to ensure data accuracy and completeness

Results of all laboratory QA/QC analyses are reported in Appendix D. Any QC samples that failed to meet the specified QA/QC criteria in the methodology or QAPP were identified, and the corresponding data were appropriately qualified. Furthermore, in cases where laboratory data were not within control limits, follow-up testing was performed by the laboratory to verify results wherever applicable. All QA/QC records for the various testing programs are kept on file for review, as applicable.

2.5 Chain-of-Custody Procedures

COC procedures were used for all samples throughout the collection, transport, and analytical process. The principal documents used to identify samples and to document possession were COC records, field logbooks, and field tracking forms. COC procedures were initiated during sample collection. A COC record was provided with each sample or group of samples. Each Wood employee who had custody of the samples signed the form and ensured that the samples were always attended unless properly secured.

Documentation of sample handling and custody included the following:

- Client and project name
- Sample identifier
- Sample collection date and time
- Any special notations on sample characteristics or analysis
- Initials of the person collecting the sample
- Date the sample was sent to the analytical laboratory

Completed COC forms were placed in a plastic envelope and kept inside the cooler containing the samples. As previously noted, the water samples were couriered to Wood Aquatic Toxicology Lab and Weck on the same day that the samples were collected or the following day (August 20–21, 2020). This level of effort provided additional security for the COC process and ensured that all holding times were met.

Upon sample delivery to the analytical laboratory, the COC form was signed by the person receiving the samples. COC records were included in the final reports prepared by the analytical laboratories. Following completion of the analytical analyses, remaining sample material was stored until the holding time expired; samples were then disposed of properly.

2.6 Data Review and Management

Field and laboratory data were reviewed for completeness and accuracy prior to data analysis and reporting, and were stored in a database, as described in Sections 2.6.1 and 2.6.2.

2.6.1 Data Review

After each survey, field data sheets were checked for completeness and accuracy by the field staff and the QA reviewer. In addition, all sample COC forms were checked against sample labels at the end of the day prior to sample transport to the laboratories. In the laboratory, technicians documented sample receipt in laboratory logbooks, and samples were logged into the electronic Laboratory Information Management System (LIMS) for sample tracking purposes to ensure that holding times were met and samples were efficiently analyzed. Logbooks were maintained at each instrument to provide hardcopy documentation of analytical runs, and data generated by each instrument were directly uploaded to the LIMS system for data review and processing. Data validation was performed within the LIMS and included application of both performance-based and project-specific QC criteria to reject or accept specific data. Data for laboratory analyses were entered directly onto data sheets. The technician who generated the data had primary responsibility for the accuracy and completeness of the data. Each technician reviewed the data to ensure the following:

- The sample description information was correct and complete.
- The analysis information was correct and complete.
- The results were correct and complete.
- The documentation was complete.

All data were subsequently reviewed and verified by each section supervisor and released to the laboratory project manager to determine whether data quality objectives had been met for final reporting, and whether appropriate corrective actions had been taken when necessary. Any necessary corrective actions were coordinated with the laboratory project manager, the laboratory QA/QC director, and the Wood project manager for resolution.

2.6.2 Data Management

All laboratories supplied analytical results in Adobe Portable Data Format (PDF) files. After completion of the data review by participating team laboratories, laboratory results were forwarded to Wood for review and reporting. All laboratory records that were submitted, including any raw data, are included in Appendix D with each laboratory report.

3.0 RESULTS

This section provides details on the Port's dissolved copper BMP implementation activities; the marinas and yacht clubs' dissolved copper BMP implementation activities; results of the vessel tracking census; estimates of copper load reduction; and results of the ambient water quality and toxicity monitoring performed in SIYB in 2020.

3.1 BMP Implementation

All Named TMDL Parties have obligations to implement BMPs and meet copper loading reduction requirements outlined in the SIYB TMDL (i.e., a 76% reduction in copper loading by the end of 2022). The Port continues to address copper loading at the Harbor Police dock, the transient dock, and the weekend anchorage, and continues to support the load reduction efforts of the other Named TMDL Parties. The Port has implemented or is in the process of planning and implementing several categories of BMPs and other actions to reduce dissolved copper loads to SIYB, including:

- Hull paint transition
- Hull-cleaning BMPs
- Education and outreach
- Grant funding and incentives
- Alternative hull paint studies
- Agency-wide activities
- Monitoring
- Reporting
- Policy/regulation
- Testing and research
- Structural and mechanical BMPs

Marinas and yacht clubs have also indicated to the Port that they are implementing BMPs. Sections 3.1.1. and 3.1.2 describe specific BMPs used during the 2020 monitoring year. Section 3.1.1 was provided directly by the Port. Section 3.1.2 of this report was provided directly by individual marinas and yacht clubs and the SIML TMDL Group.

3.1.1 Port of San Diego BMPs to Reduce Copper Loading

The Port has taken the lead in developing a program to reduce copper in SIYB and throughout San Diego Bay. A critical "launch" component of the program was the adoption of the Board of Port Commissioner's Resolution 2009-230 in 2009. This resolution memorialized the strategies and commitments the Port would employ for the Copper Reduction Program to reduce dissolved copper in and around San Diego Bay. As part of its Copper Reduction Program, the Port has initiated, and is in the process of planning and implementing, a number of BMPs and other actions to reduce discharges of dissolved copper into harbors and marinas within SIYB, throughout San Diego Bay, and statewide. The Port's program is a pragmatic approach that complied with the interim goals and is currently implementing strategies aimed at achieving the final goal of the SIYB TMDL. The program focuses on the largest source contributions of copper, identifies a strategic approach for implementing projects over the short and long term aimed at copper reduction, and seeks to effectively achieve regulatory compliance for loading and improved water quality while balancing economic and public interests.

The projects implemented by the Port since the Regional Board adopted the SIYB TMDL have reduced dissolved copper discharges to SIYB and also have supported the load reduction efforts of the other Named TMDL Parties, including the SIYB marinas and yacht clubs, hull cleaners, and boaters. The Port's Copper Reduction Program began in 2007 and identified over 30 key initiatives, many of which enabled the Port and the other Named TMDL Parties to comply with the SIYB TMDL's first and second interim targets.

During the 2020 reporting period, the Port continued to focus on policy and regulation approaches aimed at improving water quality as well as reducing copper loading. In May 2020, the Port and SIYB marinas and yacht clubs formed the Port Marina Working Group, which was established to ensure close coordination on management strategies aimed at achieving TMDL compliance and preserving, protecting, and enhancing water quality in SIYB and San Diego Bay. Outreach and education remained a valuable component to continue to engage stakeholders and interested parties in both the In-Water Hull Cleaning Permit and Ordinance review process that continued into 2020 and other load reduction discussions.

In 2020, Port staff began the planning process for a special study to better understand the effects of in-water hull cleaning on water quality. Feedback from stakeholder engagement sessions in 2019 identified this data gap and also suggested the frequency of cleaning and types of tools used vary greatly from vessel to vessel and between divers and in-water hull cleaning companies. This highlighted the need to better understand in-water hull cleaning behaviors and how those connect with water quality.

Lastly, the Port continued to support and encourage the other Named TMDL Parties (i.e., boaters, in-water hull cleaners, and SIYB marinas and yacht clubs) in copper reduction efforts within their leaseholds and operations/activities.

In addition to continued focus on policy and regulation, as well as education and outreach, the Port made progress across all focused areas of the Copper Reduction Program:

- **Policies and Regulation**: The Port continued the implementation of its In-Water Hull Cleaning Ordinance which requires that BMPs be implemented by hull cleaners during all in-water hull cleaning activities. A variety of additional initiatives were completed, including: submitting a comment letter to provide input on the State Water Resources Control Board (SWRCB) Draft 2020–2025 Nonpoint Source Program Implementation Plan; monthly conference calls with Los Angeles County Department of Beaches and Harbors to stay engaged on regional TMDL issues and progress; and continued implementation of a high-frequency in-water hull cleaning inspection schedule.
- **Testing and Research**: Under the Port's Blue Economy Incubator, an agreement was finalized with the Rentunder Boatwash company and the Port for Phase 2 testing of the Rentunder Boatwash Pilot project. Phases 1 and 2 of the pilot project evaluate how the technology may assist with copper remediation.
- **Implementation and Facilitation of Hull Paint Transitions**: All Port vessels continue to be painted with non-copper hull paints, contributing no load to SIYB.
- **Education and Outreach**: All interested parties were exposed to the issues via outreach efforts such as TMDL status updates to stakeholder groups, information dissemination through digital efforts, conference presentations, newspaper articles, and other outreach initiatives. Of note for 2020 is the formation of the Port Marina Working Group, which

included bi-weekly meetings with marina and yacht club representatives aimed at improving water quality.

- **Companion Programs**: Construction site inspections, commercial business inspections, and Standard Urban Stormwater Mitigation Plan (SUSMP) implementation continued.
- **Monitoring and Reporting**: In addition to annual TMDL monitoring, the 2018 Regional Harbor Monitoring Program Core Monitoring Final Report was completed. This report takes an in-depth look at water and sediment quality throughout San Diego Bay, including SIYB.

The main elements of the Port's 2020 Copper Reduction Program efforts are described below. A complete list of the Port's BMPs, the status of each, and brief effectiveness assessments are in Appendix B.

Policies and Regulation to Reduce Copper Loading

Policies, regulations, and legislative efforts to reduce copper loading are instrumental to the Port's Copper Reduction Program, not only to help meet regulatory compliance requirements, but also to work toward reducing copper throughout San Diego Bay.

When the Port adopted Resolution 2009-230 in 2009, the objective was to specifically detail strategies for reducing copper throughout San Diego Bay, including the following:

- Complying with the provisions of regulatory requirements and achieving reductions in copper levels within or in advance of the time frames specified in the SIYB TMDL;
- Identifying viable options for reducing copper levels in San Diego Bay;
- Supporting regulations on hull paints at a state or federal level;
- Developing, as necessary, policies, ordinances, procedures, and/or programs to achieve load reductions;
- Working with tenants and stakeholders to identify and implement copper reduction strategies; and
- Maintaining the Port vessel fleet as 100% non-copper.

Strategies outlined in Resolution 2009-230 have resulted in the Port's policy, regulation, and legislative efforts to date, all of which are in place to assist in copper reduction throughout San Diego Bay.

DPR Copper Paint Rule: Implementation and Coordination

The DPR Rule (3 CCR section 6190) went into effect on July 1, 2018, establishing a maximum leach rate for copper antifouling paints. This regulation is the result of joint efforts by the Port and state legislators with the passing of Assembly Bill (AB) 425, requiring the DPR to adopt a leach rate protective of aquatic environments. Starting July 1, 2018 paint manufacturers were no longer allowed to import or sell paints in the state of California with leach rates greater than 9.5 $\mu g/cm^2/day$. However, it was noted existing stock could be sold until June 30, 2020. While this point-of-sale regulation is expected to assist in TMDLs, it is unknown when and how the effects of the regulation will translate to improved water quality. Further, the DPR has cautioned that additional mitigation measures are still required.

For the 2020 reporting year, the grace period for all high-copper paints that were in stock at stores and boatyards expired on June 30, 2020. It is expected that that any vessel painted after this date in California with copper-based AFPs will be painted with the lower-leach rate paints (i.e., DPR Category I paints).

Port and DPR staff held several conference calls, continuing their ongoing collaborative partnership that promotes consistency in copper paint-related regulations across the state. In 2020, the Port continued collaboration with the DPR for their statewide special study to evaluate whether Category I paints are improving water quality in impaired basins over time. This study was first conducted in 2019 and is anticipated to be conducted every other year for the next several years, if DPR funding is available.

The Port assisted DPR staff in conducting their 2019 study with efforts that included providing access to SIYB for sampling, providing a sampling vessel, facilitating communications between the DPR and the marinas, yacht clubs, and other SIYB stakeholders during the special study planning process, and data sharing. The Port plans to continue collaborating with the DPR by offering similar support in future years.

This partnership enables long-term copper reduction planning to align with state efforts. Specifically, the special study being conducted by the DPR will inform the Port on the effectiveness of the 2018 DPR Rule in improving water quality.

Correspondence with State and Federal Agencies

Regular communications with state and federal agencies, policy makers, and legislators promote consistency in requirements being developed across the state. They also provide a valuable networking mechanism to discuss strategies for implementation of activities and lessons learned and to build upon successful activity models. During 2020, the following correspondences occurred:

State Water Resources Control Board

The *2020–2025 Nonpoint Source Program Implementation Plan* was prepared by the SWRCB, the Regional Water Quality Control Boards, and the California Coastal Commission. It presents the general goals and objectives for addressing nonpoint source pollution between July 2020 and June 2025 using both statewide and regional approaches. On June 13, 2020, the SWRCB released the draft and solicited feedback from the public. The document was organized by general topics, and within subsections both the SWRCB and various Regional Boards discussed strategic plans to address water and sediment quality issues associated with each topic. **The Port provided comments that highlighted the need for statewide solutions to the copper issue, highlighting that the Draft Implementation Plan itself had identified copper impairments as a statewide problem. The comment letter is included in Appendix E.**

Specifically, comments discussed the challenge of regionally controlling copper loading from a legally available product which is regulated at the state level, and also addressed the need for loading reduction strategies and enforcement to be uniform across the state. **The Port also suggested the need to better understand how the 2018 DPR Rule (i.e., capping the leach rate on paints) and recent findings related to the water quality impacts from in-water hull cleaning are both affecting water quality in impaired water bodies such as SIYB.**

2020 California Marine Affairs and Navigation Conference Winter Meeting

From January 15–17, 2020 Port staff attended the California Marine Affairs and Navigation Conference (CMANC) Winter Meeting in Los Angeles, California. Port staff were invited to speak on a TMDL-specific panel and shared lessons learned and updates regarding the SIYB TMDL. Other panelists included staff from the Port of Los Angeles and the Los Angeles County Department of Public Works.

California State Lands Commission

The Port was approached by the California State Lands Commission to discuss their commercial vessel in-water hull cleaning full capture device special study. Port Staff held multiple calls with the State Lands Commission to assess whether San Diego Bay would be a good candidate to serve as one of several study sites across the country. **While it was ultimately determined that San Diego Bay was not going to be utilized for this study, the Port continues coordination on copper reduction efforts with other agencies such as the State Lands Commission to identify areas where collaboration could be beneficial to copper reduction efforts.**

Marina Inter-Agency Coordinating Committee

Two Marina Inter-Agency Coordinating Committee (MIACC) meetings occurred during the 2020 reporting year, one on June 17, 2020, and the second on December 7, 2020. Topics of discussion for the June 2020 meeting included a review of the 2019 California Ocean Plan and a presentation by the DPR on the on the monitoring of dissolved copper in California waterways. The December 2020 meeting covered topics including the San Diego Regional Board's presentation on the TMDL for dissolved copper in SIYB from their perspective, the coastal sediment workgroup, and coastal and marina response to comments for the 2020–2025 Nonpoint Source Implementation Plan. **Port staff participated in the meeting discussions. The Port's participation in this working group remains valuable as it serves as a venue for the discussion of copper impairment issues across the state, acting as a conduit to address said issues at the state level.**

Coordination with Other Regions on Copper TMDLs and Impairments

In 2020, Port staff held monthly "Copper Catch Up" calls with the Los Angeles County Department of Beaches and Harbors to discuss both agencies' TMDL programs and share lessons learned for copper reduction efforts. Staff from both agencies discussed alignment in regional approaches to copper reduction, where applicable, that greatly strengthen both programs, such as discussing a regional approach to better understand in-water hull cleaning contributions to water quality and potential grant opportunities related to in-water hull cleaning BMPs. Seven meetings were held in 2020.

On January 29, 2020, Port staff attended a webinar update on the Marina del Rey Harbor Copper Site-Specific Objectives study presented for the Technical Advisory Committee and stakeholders. The web meeting provided a summary of progress on the project and included results for the second and third Water-Effect Ratio (WER) sampling events that were conducted in 2019.

On May 14, 2020, Port staff attended another webinar update on the Marina del Rey Harbor Copper Site-Specific Objectives study presented for the Technical Advisory Committee and stakeholders. This meeting provided a summary of progress on the project and included results for the fourth and fifth WER sampling events held in 2019.

Regulations for In-Water Hull Cleaning

Since October 2011, the Port's in-water hull-cleaning regulations have been in place requiring hull-cleaning businesses to obtain Port-issued permits to conduct hull cleaning on tidelands, develop BMP plans and implement BMPs during all cleaning activities, and ensure that all hull cleaners are trained on the BMPs. The regulations also require marinas to check each hull cleaner for proof of a valid permit and to prohibit non-permitted divers from working in their facilities. At the end of 2012, the Port began issuing identification cards to all permitted hull cleaners to facilitate check-in at the marinas, a process that continued into 2020.

In-Water Hull Cleaning Permit requirements continued in 2020. Tracking efforts occurred via collaborative efforts made by the Port, marinas, and yacht clubs to continue implementing the check-in process. Port staff conducted inspections of the Harbor Police and transient docks, marinas, yacht clubs, and the hull cleaners that were conducting business in these areas to ensure Permit requirements, including BMP implementation, were being followed.

The Port conducted 80 inspections for In-Water Hull Cleaning activities and 60 marina and yacht club inspections bay-wide in 2020. Consistent with the recent overall programmatic adjustment to place a greater focus on Port areas, in-water hull cleaning inspections of the Harbor Police dock and transient docks, accounted for 31 percent (25 of 80) of the completed inspections.

In September 2019, the Port started a review of its current In-Water Hull Cleaning Ordinance, Permit, and required BMPs. During this review process, the current Ordinance and Permit structure remained in place and enforceable, and BMPs were required for all hull cleaning businesses. In 2020, the review process continued with Port staff assessing public comments received during 2019 outreach events and determining the next steps in the review process. A common theme from comments received focused on the need to address existing data gaps (such as how the act of in-water hull cleaning effects water quality) prior to amending the Ordinance and Permit. Efforts to address these data gaps are underway.

For the 2020 reporting period, all existing Permits remained in place and new permits were issued on a conditional basis, with their expiration/reissuance process coinciding with any upcoming Ordinance revisions. Key permitting statistics are as follows:

- 102 permits have been issued since the onset of the regulation.
- 58 hull-cleaning permits are active (as of December 31, 2020)
- 9 new conditional hull-cleaning permits were issued in 2020.

Boat hull before and after cleaning

To date, the regulations helped to reduce copper loads from in-water hull cleaning by requiring the use of diver BMPs. Until a revised Ordinance and Permit Program is finalized, the in-water hull cleaning regulations remain in place and enforceable as they have in previous years.

Testing and Research

The Testing and Research component of the Copper Reduction Program was developed to assist all Named TMDL Parties in finding solutions to reduce their copper loads, conduct detailed assessments of water quality, and identify new or innovative solutions to improve water quality. Additional testing and research strategies that could further assist with copper reduction in SIYB include the following:

Copper Removal Approaches

The Port's Blue Economy Incubator was established in 2016 to support entrepreneurship, foster sustainable aquaculture, and help drive blue tech innovation. Ideal candidates for the Port's Blue Economy Incubator include technologies that may help improve sediment and water quality in San Diego Bay. In 2017, two copper-related pilot projects were identified:

1. A San Diego-based company, Red Lion Chem Tech, proposed a one-year pilot project to demonstrate their core technology to remove soluble copper in seawater through an active and passive filtration system. This project has been delayed.
2. A Sweden-based company, Rentunder, proposed a multi-year pilot project to demonstrate their drive-in boatwash technology, a new approach that offers an alternative to current in-slip hull cleaning practices, which may help reduce copper particulates released into San Diego Bay.

In 2018, the Rentunder Boatwash Pilot Project commenced, demonstrating technology that offers an alternative to current in-slip hull cleaning practices. Using this technology, vessel hulls are cleaned in an enclosed basin; a gate is opened and allows for boats to enter prior to cleaning; the gate is then raised for the duration of cleaning and lowered again after cleaning to allow the boat to exit. In addition, particulate matter resulting from the cleaning is captured in the basin floor and removed via vacuuming.

The Boatwash Pilot Project consists of two phases. Phase 1 was conducted from 2018 through 2019 and results were published in a Phase 1 Final Report in June 2019 (Wood, 2019). **In 2020, recommendations for Phase 2 of the Rentunder Boatwash Pilot Project were submitted by Rentunder to the San Diego Regional Board and stakeholders. An agreement was finalized with Rentunder and the Port for Phase 2 testing, estimated to begin in 2021.**

Hull Paint Transitions

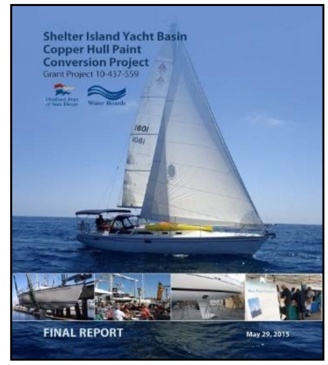
The transition from copper to non-copper alternatives is one of the most direct approaches to reduce copper loading. By transitioning to the available non-copper alternatives, load reduction is achieved by both active removal during in-water hull cleaning and passive leaching. The Port recognizes that while the 2018 DPR Rule will assist in attaining TMDL goals, additional mitigation measures will still be necessary to achieve full compliance with the final loading target in SIYB. **In 2020, Port staff held several phone calls with representatives from two alternative hull coating companies (SeaCoat and Nature Coat) to learn about progress in bringing their respective products to the recreational boating market.**

In addition to its proactive efforts to convert its own fleet of vessels, the Port continues to support efforts to assist other Named TMDL Parties in reducing their copper loads by encouraging hull paint transitions.

Conversion of Port Fleet

During the first interim compliance phase, the Port completed the transition of its fleet of boats to non-copper paints. Boats were painted with various alternatives, largely depending on their use patterns. In 2020, the Port continued to maintain a copper-free fleet, therefore eliminating any copper loading contributions from both in-water hull cleaning and passive leaching from its fleet of vessels. **All 15 of the Port's boats continue to use non-copper paints, resulting in a 13.5-kg/yr copper load reduction, and zero copper loading to SIYB.**

Private Boaters



In 2011, the Port successfully secured a CWA Section 319(h) nonpoint source program grant from the SWRCB for $600,000 to help with hull paint transitions. The grant-funded SIYB Hull Paint Conversion Project provided cost offsets for SIYB boaters who use non-biocide paints. This project supported efforts to assist other Named TMDL Parties in reducing their copper loads and was completed in May 2015, and it is believed that some participants continue to use non-biocide paints. **A total of 41 boats were transitioned as a result of this effort, and it is the Port's understanding that most of these conversions currently remain in place. This effort resulted in a direct load reduction of 36.9 kg/yr.**

Education and Outreach

The Port has developed an extensive education and outreach program geared toward educating Named TMDL Parties and other stakeholders on the use of alternative hull paints and increasing their awareness of the environmental impacts of copper paints. The education and outreach program also serves to engage stakeholders in the TMDL issues at the local, regional, state, and federal level.

Audiences Reached in 2020

The Port continued to ensure that frequent and consistent messages were delivered through multiple media avenues. Outreach efforts continued via email and phone-call responses to public inquiries, regular meetings with marinas and yacht clubs, "one-on-one" meetings when requested with SIYB marina and yacht club managers to discuss the TMDL and copper reduction efforts, and continued hosting of web-access to brochures and information. A new and significant effort in the 2020 reporting year included the creation of the Port Marina Working Group, which was formed in May 2020, led by a Port Commissioner and focused on achieving TMDL compliance and improving water quality in SIYB.

The efforts under the Education and Outreach component of the Copper Reduction Program were designed to reach different stakeholders and audiences, depending on the outreach mechanism (Table 3-1). While each component was designed for a primary audience, secondary audiences may also benefit from the information. In 2020, the Education and Outreach component of the Copper Reduction Program was affected by the COVID-19 pandemic in terms of audiences reached; however, several efforts were still able to be undertaken. The 2020 outreach efforts are summarized below.

Table 3-1.
Target Audiences Reached by Outreach Events

Outreach Component	Audience Reached							
	Regulators	Academics	Government Agencies	Boaters	Marinas	Boatyards	Paint Manufacturers	General Public
Booths at Events[1]	-	-	-	-	-	-	-	-
Conference Attendance	P	P	P	-	-	-	-	-
Guest Speaking Engagements	P	P	P	P	P	P	S	S
Workshops[1]	-	-	-	-	-	-	-	-
Printed Outreach Material	S	S	S	P	P	S	S	P
Dedicated Web Address to Copper Reduction Program	P	P	P	P	P	P	P	P
Peer-Based Testimonials	S	S	S	P	P	S	S	P
Newspaper Articles	P	S	P	P	P	P	P	P
"One-on-One" Meetings	-	-	-	P	P	-	-	-
Public Engagement Sessions[1]	-	-	-	-	-	-	-	-

Notes:
P = Primary Audience, indicating the most likely audience reached with the associated outreach effort.
S = Secondary Audience, indicating audiences that could be potentially reached with the associated outreach effort.
[1]Efforts under these initiative topics were did not occur in 2020 due to COVID-19.

SIYB TMDL Stakeholder Meetings

In 2018, Port staff began a series of one-on-one meetings with marina and yacht club managers to personalize outreach efforts and to foster collaborative relationships. The Port fostered these efforts with the goals of improving vessel tracking data, re-engaging other Named TMDL parties on TMDL progress and to discuss the additional copper reduction efforts needed to reach full TMDL compliance.

One-on-one meetings continued in 2020 when requested by individual marinas and yacht clubs.

Port Marina Working Group

In May 2020, representatives from the marinas and yacht clubs in SIYB, Port staff, and a Port Commissioner formed the Port Marina Working Group to collaborate (where applicable) on efforts aimed to improve water quality and achieve TMDL compliance. This group met bi-weekly through October 2020 and monthly thereafter for a total of 12 meetings during this reporting period. The Working Group established the following vision and mission:

> **Vision**: Water Quality First
>
> **Mission**: A working group between the Port and Shelter Island Yacht Basin Marina Tenants to ensure close coordination on management strategies that meet TMDL compliance and preserve, protect, and enhance water quality in Shelter Island Yacht Basin and San Diego Bay.

These meetings fostered discussions on topics including existing data gaps and how to address them to better understand the connection between in-water hull cleaning and water quality, current copper loading models, annual TMDL monitoring and reporting, and state-level discussions on the TMDL. **This group also started including the Regional Board in these meetings to discuss the SIYB progress to date and challenges remaining. The Regional Board will continue to be an integral part of these meetings for the final two TMDL years.**

Workshops, Seminars, Conferences, and Public Engagement Sessions

Ongoing public education and outreach also can occur in the form of conference attendance and invited speaker opportunities. In addition to providing information on the Port's Copper Reduction Program and TMDL status, staff in attendance may also gain valuable insight from other presentations that discuss regulatory framework and project examples. Further, seminars and workshops allow for more focused topics to be discussed in depth and at length, thus providing the opportunity to both disseminate proper information and provide additional learning experiences for Port staff.

Conferences

In 2020, conferences relevant to the SIYB TMDL were postponed or cancelled as a result of COVID-19.

Guest Speaker Invitations

In 2020, Port staff were invited to present at three speaking engagements at the local, regional, and national/international levels. It should be noted that meetings after March 2020 were held in a virtual format due to COVID-19 social distancing requirements. Topics covered included the Port's In-Water Hull Cleaning Ordinance and Permit Program review process, an update on the Blue Economy Incubator program (including the Rentunder Boatwash) and an overview on water quality challenges facing the Port.

The following guest speaker appearances were made:

- *San Diego Port Tenants Association Marine Recreation Committee, San Diego, CA* – Port staff were invited to present on the status of the Ordinance and Permit review process.

The Marine Recreation Committee is comprised of a variety of Port tenants with many directly involved with the SIYB (January 21, 2020). Approximately 35 people attended.

- *Environmental Advisory Committee* – Port staff gave a Blue Economy Incubator update which included discussing the Rentunder Boatwash Pilot Project (September 16, 2020). Approximately 30 people virtually attended.
- *Ports Water Quality Meeting 2020* – Port staff were invited to present on water quality challenges and initiatives to a group of representatives from several ports from across the country (November 2, 2020). Approximately 25 people virtually attended.

Dedicated Web Address

The Port has developed a dedicated web address, www.sandiegobaycopperreduction.org, that links viewers to all elements of its Copper Reduction Program. The link, which was started in 2010, provides information on hull paint conversion efforts such as the 319(h) grant project, hull cleaning regulations, and general paint research information. The site also contains downloadable materials such as frequently asked questions (FAQs), applications to obtain a hull cleaning permit, data relevant to copper impairment, and recent press releases relevant to copper reduction. Monitoring studies are also available on the website***.***

In 2020, the Copper Reduction Program website was completely updated and reorganized to offer a more user-friendly experience. Port staff provided updated lists of permitted hull cleaners as new information became available. The website was also updated with current information regarding the In-Water Hull Cleaning Ordinance and Permit review process. In addition, a dedicated email address, hullcleaning@portofsandiego.org, continued to remain available to facilitate information transfer among interested parties. Staff also ensured that the website was readily available and that information remained current and easy to find.

Peer-Based Testimonials

Another media tool is peer-based marketing, with local boaters discussing their experiences using alternative paint products. During 2012, video testimonials were developed and displayed at the 2012 expo. In 2013, the video was posted on the Port's website. Additional written testimonials were also included so that readers could learn about other local boaters' experiences***. As of December 31, 2020, the video had been viewed 1,133 times.***

Newspaper Articles

The Log newspaper has a 52,000-person readership in southern California and is available at more than 500 boating-related locations throughout the region. **In 2020, one article appeared in The Log related to the Port's Copper Reduction Program, and specifically SIYB. The Log publication reaches many in the local boating community and has served as an important vehicle for informing the public about the Port's efforts regarding copper reduction in San Diego Bay:**

- January 9, 2020: This article, "Port of San Diego hopes to fine-tune in-water hull cleaning policy" summarized the Port's review of the In-Water Hull Cleaning Ordinance and Permit program and the decision to extend the period of stakeholder feedback review.

Internal Education

Increasing Port-wide awareness about the Copper Reduction Program, alternative paint use, and status of water quality regulations is vital to a successful program. A solid understanding of the program attracts support by the Port's decision makers, such as the Board of Port Commissioners and executive team, and so enables projects and policy decisions to move forward. An informed executive team can also ensure that adequate funding is available to implement the program. As such, Port staff continually seek opportunities to provide information on key items of the Copper Reduction Program. The following information was provided to the Port Board and executives during 2020:

- January 30, 2020: A Port Board memorandum provided a summary of the Marina del Rey Harbor Site-Specific Objective Study Technical Advisory Committee Review meeting.
- February 11, 2020: Port staff appeared before the Board during the President's Report to provide a status update on the draft amended Ordinance review.
- March 5, 2020: A Port Board memorandum provided notification of an upcoming public scoping meeting for an in-water hull cleaning pilot study to be held April 2, 2020 (*note this meeting was postponed due to COVID-19).*
- April 16, 2020: A Port Board memorandum provided notification of the submittal of the SIYB 2019 Annual TMDL Compliance Report to the Regional Board.
- August 6, 2020: A Port Board memorandum provided notification of the submittal of a comment letter in response to the SWRCB Draft 2020–2025 Nonpoint Source Program Implementation Plan.
- August 13, 2020: A Port Board memorandum provided notification of the 2020 SIYB TMDL annual monitoring event.

Long Term Vessel Planning Committee

In September 2020, the Harbor Police department created a committee to strategically plan for long-term vessel acquisitions for the Harbor Police fleet. Port staff that work with the Copper Reduction Program are on the committee to ensure vessels added to the fleet remain copper free.

Partnerships and Collaboration

Since the inception of the SIYB TMDL, the Port has been working to identify opportunities with other Named TMDL Parties, academia, and other agencies to develop and provide outreach, testing opportunities, funding opportunities, and policies. In 2020, the Port participated in multiple collaborative opportunities with groups within San Diego, throughout the California boating and regulatory communities, and with other Ports across the country. These activities and groups include:

- Coordination with the SIML TMDL Group and other SIYB marinas on SIYB TMDL annual reporting;
- Regular participation in state-led MIACC meetings for antifouling and marina-related topics;

- One-on-one meetings with SIYB TMDL listed tenants (i.e., marinas and yacht clubs) when requested to continue to foster collaborative relationships that may result in accurate vessel tracking and innovative copper reduction efforts that are facility-specific;
- Collaborative discussions with Los Angeles County Department of Beaches and Harbors to discuss Copper Reduction Program efforts and lessons learned from the SIYB TMDL to date; and
- Port staff discussions with the Port of Seattle to learn about their innovative bioremediation efforts that use oyster barrels to remove copper from water.

Additional Efforts (Companion Programs)

Several other Port programs directly or indirectly support the Copper Reduction Program's efforts. The Blue Economy Incubator (discussed above) continues to be instrumental in identifying potential pilot studies that may assist in continued efforts to reduce copper concentrations and improve water quality throughout San Diego Bay.

The Port's Stormwater Program incorporates BMPs to decrease copper loading from landside activities bay-wide and specifically into SIYB. These efforts, described below, are primarily related to compliance requirements set forth in the Municipal Separate Storm Sewer System (MS4) Permit. Information related to the implementation efforts for these programs can be found in the Port Jurisdictional Runoff Management Plan (JRMP) Annual Report at:

https://pantheonstorage.blob.core.windows.net/environment/SDUPD-JRMP-Report-Form-and-Supplemental-Tables_FY19-20_Submitted-1-28-2021.pdf

Construction Site Inspections

Construction inspections ensure that sites undergoing development or redevelopment control pollution and prevent discharges. For construction sites and facilities that do not comply, the Port takes enforcement action.

Commercial Business Inspection Program

Per the requirements of the Municipal Permit, the Port inspects commercial facilities in SIYB and bay-wide. One component, the Port's marina inspection program, provides opportunities to educate boat owners about pollution prevention, focusing on visual observations to identify sources of pollution and the pollution prevention practices implemented at the marinas and yacht clubs, including over-water work and boat maintenance. The goal of the inspections is to help implement behavior changes that will help reduce pollution (including copper) in bay waters.

Stormwater Quality Management Plan and Development of Regulations

The Port incorporates Stormwater Quality Management Plan (SWQMP) requirements on applicable development and redevelopment projects bay-wide. Depending on the type and size of the projects, SWQMP requirements could include site design, source controls, and treatment controls such as low-impact development (LID). All efforts help reduce copper loading into San Diego Bay. Since 2009, 34 bay-wide projects overall with metals as priority pollutants have been implemented, treating a total of 114.25 acres. In SIYB, there have been five existing projects overall with metals as priority pollutants, treating a total of 9.19 acres.

Monitoring and Reporting

The main goal of the Monitoring and Reporting component of the Copper Reduction Program is to assess long-term improvements in water quality. Several special studies have been implemented to address data gaps in basin water quality dynamics and copper loading. The data collected for the annual monitoring program and through various special studies have all contributed to a better understanding of basin water quality dynamics in SIYB.

Regional Harbor Monitoring Program

This bay-wide monitoring program assesses the ambient conditions in San Diego Bay and other southern California harbors on the basis of comparisons with historical data and comparisons of contaminant concentrations with known surface water and sediment thresholds. The program samples water, sediment, benthic infauna, and a variety of fish species in San Diego Bay. Upon completion of the study, a comprehensive report is generated. The Port is the lead agency on this project.

The core monitoring program was conducted at 58 stations in San Diego Bay from July through September 2018, with 10 of these stations in marina strata. Each station was sampled for water quality, sediment quality, and benthic community health. **In December 2020, the 2018 San Diego Regional Harbor Monitoring Program Final Report was published and can be found at:**

https://pantheonstorage.blob.core.windows.net/environment/Regional-Harbor-Monitoring-Program-2018-Final-Report.pdf

3.1.2 Marina, Yacht Club, and SIML TMDL Group BMPs to Reduce Copper Loading

Section 3.1.2 of this report has been provided directly by individual marinas and yacht clubs and the SIML TMDL Group. This information is being included by the Port to comply with the requirements of the Investigative Order. Questions pertaining to the BMP selection or descriptions of information within this section should be directed to the Named TMDL Parties, as applicable.

The SIYB marinas and yacht clubs implement BMPs annually to reduce copper loading from their respective facilities and operations. The marinas and yacht clubs' BMP manual and summary of marina and leasehold vessel tracking was provided to the Port and is included in Appendix B of this report.

SIML TMDL Group

The Shelter Island Master Leaseholder Group adopts and follows the below BMP's on an ongoing basis. Numerous BMPs, over the past ten years, have been developed, applied, modified and assessed for effectiveness. We continue to adapt BMPs to regulatory developments, and local ordinance. We measure the success of these BMPs by projected load reductions. Accordingly, we have as in improvement of the process, we have refined the method by which load reductions are made. We are encouraged by the load reductions accomplished to date and feel that we are better informed on the effectiveness of BMPs from the refined method. These and additional BMP actions are described in more detail in Appendix B.

Program Improvement

- **Assess and Improve-** Adapt to scientific findings and adopt independent model for load calculation
- **Collaboration–** Participate in meetings and coordination with Port staff and Port consultants on new and ongoing scientific studies
- **BMP Subcommittee –**conducted 4 meetings in 2020
- **Consultancy and Guidance –** retained an environmental professional
- **Seek Alternative Methods –** Facilitation of dry storage on land and support of inter-club sailing regattas using dry storage boats reduce copper load

Technical Improvement

- Fish and wildlife Consults
- Developed advisory groups with scientists and experts in field

Outreach

- **Hull Surveys–** 95% of boaters holding slips in member organizations were contacted about antifouling paint usage.
- **Communication –** email blasts and were sent to boatowners with information on TMDL

  Across Companies- Reached out to boatyards and paint manufacturers

Education

- **Meetings –** Participation and attendance at SIYB TMDL Group meetings since 2005 including 12 group meetings in 2020
- **Training -** Ongoing staff trainings for existing and new marina employees
- **Procedures –** Ongoing procedures for verifying and monitoring Port Diver Permit
- **Signage-**Posting diver BMP signs at marinas and yacht club entrances

Posted sign informing hull cleaners and boat owners about BMPs

Bay Club Marina

In addition to the BMP information mentioned above, the Bay Club Marina revised its wharfage agreement in 2019 to include a number of environmental conditions, including those related to copper loading and the TMDL. These facility-specific BMPs are included as part of the Bay Club Marina contract for private wharfage that is signed by the owners that berth their vessels at this facility. The portions of the Bay Club Marina Hotel contract with its vessel-owner tenants that specifically address copper reduction are summarized below.

- "Owner also understands that he/she will be required to provide an annual bottom paint questionnaire to the marina office by November 15 each year that includes the following information: paint name, color, product number, brand, copper percentage, boatyard name, and date of paint was applied."
- "Marina recommends the use of non-toxic, biocide free bottom paints."
- "Hull cleaning must utilize Best Management Practices to minimize discharge of bottom paint into the water."
- "Vessel Owners are required to use environmentally friendly hull cleaning companies who are licensed by the Port of San Diego and use Best Management Practices and monitor their divers."

3.2 SIYB TMDL Vessel Tracking

Evaluation, interpretation, and tabulation of vessel tracking data are provided in this section. Through enhanced activities by marina and yacht club managers to survey boaters, approximately 95% of boat owners responded (based on the final combined 2020 survey) and reported information regarding their hull paint. This response rate is indicative of continual invested effort from year to year. Figure 3-1 illustrates the changes in response rate over previous surveys.

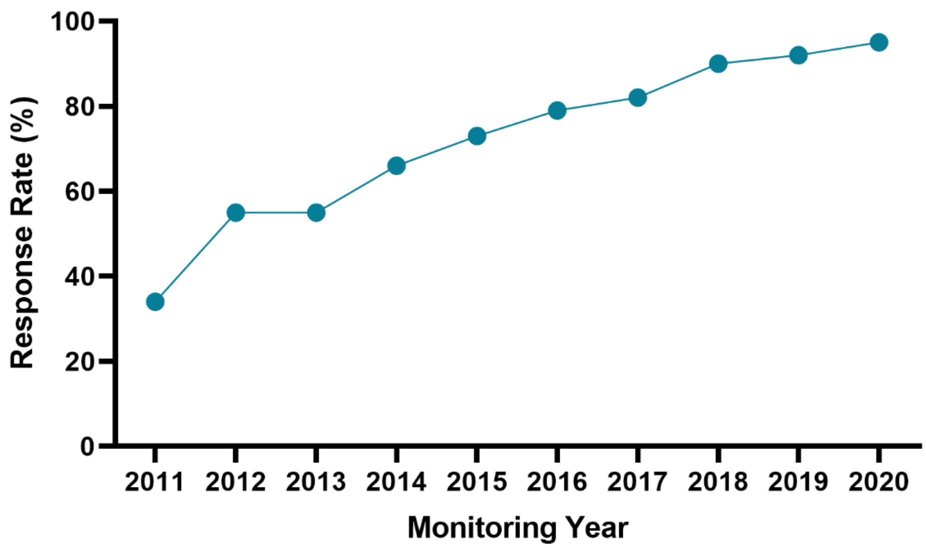


Figure 3-1. Vessel Census Response Rate by Monitoring Year

3.2.1 Vessel Counts by Hull Paint Type

Vessel conversion calculations were based on data provided by SIYB marinas and yacht clubs, in addition to data from the Harbor Police dock, transient dock, and weekend anchorage.

The 2020 census of the hull paint types reported by all SIYB marinas and yacht clubs is as follows:

- A total of 2,169 vessels were included in the 2020 census of hull paint types in marinas and yacht clubs.
- 511 vessels have copper or unknown (assumed to be copper) hull paint.

- 998 vessels have paints considered as lower copper. These vessels consist of the following:
  - 985 vessels[15] have paint that is listed as a DPR Category I (low-leach) paint.
  - 13 vessels have low-copper paint (non-Category I with less than 40% copper content).
- 542 vessels have aged-copper hull paint.
- 118 vessels have either non-copper paints, no bottom paint, or are stored in slip liners or HydroHoists®.

The 2020 census of the hull paint types reported from the Harbor Police dock, transient dock, and weekend anchorage is as follows:

- 15 Port vessels berthed at the Harbor Police dock have non-copper paints or no bottom paint.
- There are 66 spaces in SIYB where transient vessels can be berthed (26 slips at the transient dock and 40 mooring locations at the weekend anchorage). All vessels that were berthed at these two locations in 2020 are considered to have unknown (assumed to be copper) hull paint.

3.2.2 Slip Count and Occupancy

Based on the information provided by the Port and SIYB marinas and yacht clubs, 2,315 slips[16] in SIYB were available to be occupied by vessels in 2020, including the weekend anchorage with a capacity of up to 40 guest vessels, 26 transient dock slips, and 17 slips at the Harbor Police dock. There was a decrease of 48 slips in 2020 compared with the baseline of 2,363 identified slips and moorings reported in the SIYB TMDL.

Of the 2,315 slips and moorings in SIYB during 2020, 65 slips (63 slips in the marinas and yacht clubs and 2 slips at the Harbor Police dock) were reported to be vacant year-round, leaving 2,250 slips that were occupied for at least a portion of time in 2020. Slip occupancy rates for each hull paint type are also shown in Tables 3-3 through Table 3-6. On average, slips and moorings in SIYB were occupied 91% of the time.

3.2.3 Vessel Dimensions

The average-size vessel in SIYB in 2020, based on reported hull lengths and beam widths, was 11.8 meters (38.7 feet, total length) by 3.7 meters (12.2 feet, beam width) (Appendix C). The average wetted hull surface area of 2020 SIYB vessels was calculated to be 37.2 square meters (m^2). Figure 3-2 depicts average wetted hull surface area from 2012–2020.

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15 This includes six vessels painted with Coppercoat®. Coppercoat® is classified as “non-leaching” on the manufacturer’s website; however, this product is registered as a pesticide with the DPR. Vessels with Coppercoat® were classified as “DPR Category I” for load calculations based on the DPR Product/Label Database, as described in Section 2.2.1. This issue is discussed further in Section 4.1.3.

16 At several locations in SIYB, single slips can be occupied by more than one vessel. In these cases, the slip count may include each vessel within the slip. For example, if two vessels occupy a single slip, the slip count for this location may have been reported as two slips, not one. Efforts to improve consistency on this issue remain ongoing.

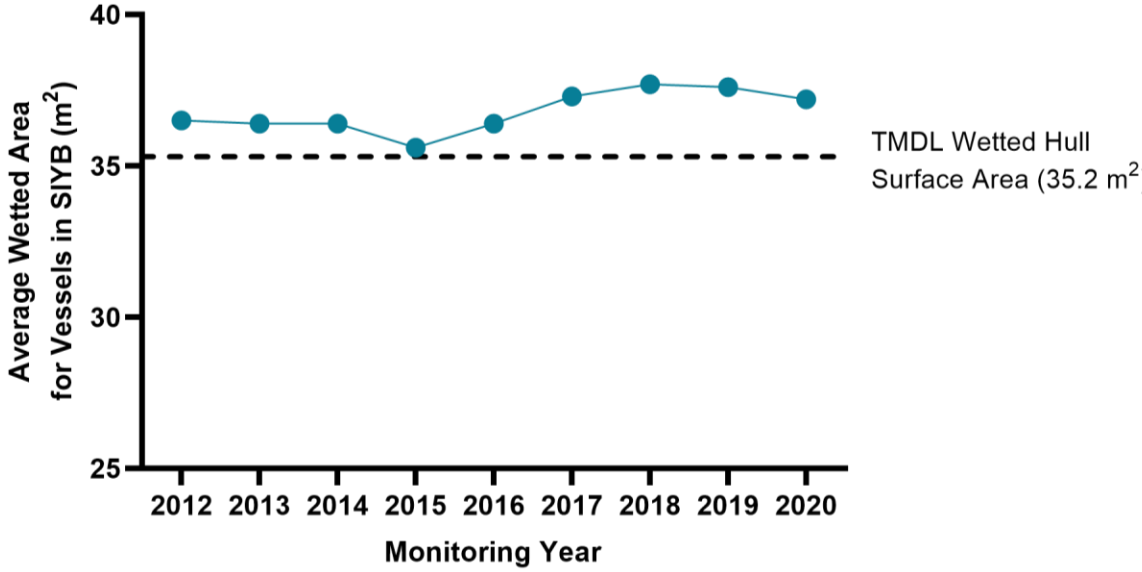


Figure 3-2. Average Wetted Hull Surface Area in SIYB by Monitoring Year, 2012–2020

3.2.4 Estimated Copper Load and Load Reduction

Estimates of the dissolved copper load and load reduction for 2020 are presented in this section. Dissolved copper load estimates are presented first as a total load including load attributed to passive leaching and in-water hull cleaning combined (Table 3-2). Dissolved copper load estimates are then parsed out to show loads attributed to passive leaching (Tables 3-3 and 3-4) and in-water hull cleaning (Tables 3-5 and 3-6) separately.

Based on the assumptions described in Section 2.2.3, combined total dissolved copper load estimates were calculated by multiplying the number of vessels in each AFP category by the total per-vessel load (0.9 kg/yr for copper, assumed copper, and unconfirmed paints, or 0.45 kg/yr for DPR Category I, low-copper, and aged-copper paints). The load estimate for each category was then corrected for average vessel occupancy. The total 2020 load estimates from passive leaching and in-water hull cleaning sources combined are presented in Table 3-2 and as follows:

- Vessels with copper (or assumed copper) paints contributed a load of 447 kg/yr. This total includes 424 kg/yr from vessels in yacht clubs and marinas and hull cleaning activities occurring in those facilities, roughly 95% of the loading from this paint type category, and 23.4 kg/yr from vessels at the transient dock and weekend anchorage and hull cleaning activities occurring in those locations, roughly 5% of the loading from this paint category.
- DPR Category I paints are present in marinas and yacht clubs and contributed a dissolved copper load of approximately 416 kg/yr.
- Low-copper hull paints are present in marinas and yacht clubs and contributed a dissolved copper load of 5.3 kg/yr.
- Aged-copper paints are present in marinas and yacht clubs and contributed an annual dissolved copper load of 224 kg/yr.
- No dissolved copper load was contributed to SIYB by 133 vessels with either confirmed non-copper paint, vessels in slip liners or HydroHoists®, or vessels that were unpainted.

This includes 118 vessels in marinas and yacht clubs and all 15 Port vessels berthed at the Harbor Police dock.

- A total of 63 slips within the SIYB marinas and yacht clubs and 2 slips at the Harbor Police dock were reported to be vacant year-round, and therefore did not contribute a dissolved copper load into the basin.

In summary, vessels painted with copper paints, DPR Category I paints, low-copper hull paints, and aged-copper paints contributed a combined passive and in-water hull cleaning load of 1,092 kg/yr of dissolved copper to SIYB in 2020. This total dissolved copper load is composed of approximately 1,069 kg/yr (97.9%) for vessels in yacht clubs and marinas and hull cleaning activities occurring in those facilities plus approximately 23.4 kg/yr (2.1%) for vessels at the Harbor Police dock, transient dock, and weekend anchorage and hull cleaning activities occurring in those locations.

Table 3-2.
2020 Estimated Copper Load and Load Reduction from TMDL Baseline

Copper Loading Category	Total Copper Load (kg/yr)
SIYB Vessels in Yacht Clubs and Marinas with Copper or Unknown Paint (Assumed Copper)	424
SIYB Vessels in Yacht Clubs and Marinas with DPR Category I (Low Leach Paint)	416
SIYB Vessels in Yacht Clubs and Marinas with Confirmed Low-Copper Paint	5.3
SIYB Vessels in Yacht Clubs and Marinas with Unconfirmed Low-Copper Paint	N/A
SIYB Vessels in Yacht Clubs and Marinas with Aged-copper Paint	224
SIYB Vessels in Yacht Clubs and Marinas with Confirmed Non-Copper Paint or No Paint	0
SIYB Vessels in Yacht Clubs and Marinas with Unconfirmed Non-Copper Paint	N/A
Port HPD Fleet	0
Transient Dock and Weekend Anchorage in SIYB	23.4
SIYB Yacht Club and Marina Year-Round Vacancies	0[a]
Port HPD Year-Round Vacancies	0[b]
Grand Total Load	1,092
Load Reduction from TMDL Baseline[c]	***1,008 (48.0%)***

Notes:
a. 63 slips within the SIYB marinas and yacht clubs were reported to be vacant year-round and therefore contributed no dissolved copper load to SIYB.
b. 2 slips at the Harbor Police dock were reported to be vacant year-round and therefore contributed no dissolved copper load to SIYB.
c. The total copper load from the TMDL equals 2,100 kg/yr from vessel paints (passive leaching and in-water hull cleaning, combined). The estimated load due to background, urban runoff, and atmospheric deposition is not included in this total.
% = percent; DPR = Department of Pesticide Regulation; HPD = Harbor Police dock; kg/yr = kilograms per year; N/A = not applicable; SIYB = Shelter Island Yacht Basin; TMDL = Total Maximum Daily Load

In addition to combined total dissolved copper load estimates presented in Table 3-2, load estimates are presented separately for passive leaching and in-water hull cleaning for the 2020 monitoring year. Estimated dissolved copper loads in 2020 attributed to the TMDL-derived passive leaching load allocation are shown in Table 3-3 (yacht clubs and marinas) and Table 3-4 (Harbor Police dock, transient dock, and weekend anchorage). Estimated dissolved copper loads in 2020 attributed to the TMDL-derived in-water hull cleaning load allocation are shown in Table 3-5 (yacht clubs and marinas) and Table 3-6 (Harbor Police dock, transient dock, and weekend anchorage).

Passive load estimates were calculated by multiplying the number of vessels in each category by either 0.86 kg/yr (for copper, assumed copper, and unconfirmed paints) or 0.43 kg/yr (for DPR Category I, low-copper, and aged-copper paints). In-water hull cleaning load estimates were calculated by multiplying the number of vessels in each category by either 0.04 kg/yr (for copper, assumed copper, and unconfirmed paints) or 0.02 kg/yr (for DPR Category I, low-copper, and aged-copper paints). The load estimate for each category was then corrected for average vessel occupancy (i.e., Average Time Occupied in Tables 3-3 through 3-6).

Table 3-3.
2020 Copper Load by Vessel Hull Type and Reported Occupancy at Yacht Clubs and Marinas as a Result of Passive Leaching Using TMDL Assumptions

Vessel Hull Paint Category	Number per Category	Average Time Occupied[d]	Copper Load per Vessel (kg/yr)[e]	Total Copper Load (kg/yr)
Copper or Unknown (Assumed Copper)	511	92.1%	0.86	405
DPR Category I (Low Leach)	985[c]	93.8%	0.43	397
Low-Copper (Confirmed)	13	90.5%	0.43	5.06
Low-Copper (Unconfirmed)[a]	0	N/A	0.86	N/A
Aged-Copper Paint[b]	542	91.9%	0.43	214
Non-Copper (Confirmed or Not Painted)	118	92.3%	0	0
Non-Copper (Unconfirmed)[a]	0	N/A	0.86	N/A
Vacant Slips (Yacht Clubs and Marinas)	63	--	--	0
Total Vessels (Yacht Clubs and Marinas)	***2,169[f]***	***--***	***--***	***1,021***

Notes:

a. Low- or non-copper paints that were not confirmed are counted as high-copper paint (0.86 kg/yr load for passive leaching), per the Monitoring Plan.
b. Calculations for aged-copper paints are similar to those for low-copper paints (0.43 kg/yr load for passive leaching).
c. This includes six vessels painted with Coppercoat®. Coppercoat® is classified as "non-leaching" on the manufacturer's website; however, this product is registered as a pesticide with the DPR. Vessels with Coppercoat® were classified as "DPR Category I" for load calculations based on the DPR Product/Label Database, as described in Sections 2.2.1 and 4.1.3.
d. The average total occupancy was derived by the count within each vessel hull paint category multiplied by the average percent occupancy for that category; values are presented to three significant figures.
e. Based on per-vessel load identified for passive leaching in Appendix 2 of the SIYB TMDL.
f. Note: Vacant slips are not included in this total.

% = percent; DPR = Department of Pesticide Regulation; kg/yr = kilogram(s) per year; N/A = not applicable

Table 3-4.
2020 Copper Load by Vessel Hull Type and Reported Occupancy at the Harbor Police Dock, Transient Dock, and Weekend Anchorage as a Result of Passive Leaching Using TMDL Assumptions

Vessel Hull Paint Category	Number per Category	Average Time Occupied[b]	Copper Load per Vessel (kg/yr)[c]	Total Copper Load (kg/yr)
Port Fleet (Confirmed Non-Copper)	15	92.9%	0	0
Transient Dock[a] (Copper or Unknown and Assumed to be Copper)	26	58.6%	0.86	13.1
Weekend Anchorage[a] (Copper or Unknown and Assumed to be Copper)	40	26.9%	0.86	9.26
Vacant Slips (Port HPD Dock)	2	--	--	0
Total Vessels (HPD, Transient Dock, and Weekend Anchorage)	***81[d]***	***--***	***--***	***22.4***

Notes:

a. Calculated as an average, based on total number of days a slip was occupied by a guest vessel.
b. The average total occupancy was derived by the count within each vessel hull paint category multiplied by the average percent occupancy for that category; values are presented to three significant figures.
c. Based upon per vessel load identified for passive leaching in Appendix 2 of the SIYB TMDL.
d. Note: Vacant slips are not included in this total.

% = percent; kg/yr = kilogram(s) per year; HPD = Harbor Police dock; N/A = not applicable

Table 3-5.
2020 Copper Load by Vessel Hull Type and Reported Occupancy at Yacht Clubs and Marinas as a Result of In-Water Hull Cleaning Using TMDL Assumptions

Vessel Hull Paint Category	Number per Category	Average Time Occupied[d]	Copper Load per Vessel (kg/yr)[e]	Total Copper Load (kg/yr)
Copper or Unknown (Assumed Copper)	511	92.1%	0.04	18.8
DPR Category I (Low Leach)	985[c]	93.8%	0.02	18.5
Low-Copper (Confirmed)	13	90.5%	0.02	0.24
Low-Copper (Unconfirmed)[a]	0	N/A	0.04	N/A
Aged-Copper Paint[b]	542	91.9%	0.02	9.96
Non-Copper (Confirmed or Not Painted)	118	92.3%	0	0
Non-Copper (Unconfirmed)[a]	0	N/A	0.04	N/A
Vacant Slips (Yacht Clubs and Marinas)	63	--	--	0
Total Vessels (Yacht Clubs and Marinas)	***2,169[f]***	**--**	**--**	***47.5***

Notes:
a. Low- or non-copper paints that were not confirmed are counted as high-copper paint (0.04 kg/yr load for hull cleaning), per the Monitoring Plan.
b. Calculations for aged-copper paints are similar to those for low-copper paints (0.02 kg/yr load for hull cleaning).
c. This includes six vessels painted with Coppercoat®. Coppercoat® is classified as “non-leaching” on the manufacturer’s website; however, this product is registered as a pesticide with the DPR. Vessels with Coppercoat® were classified as “DPR Category I” for load calculations based on the DPR Product/Label Database, as described in Sections 2.2.1 and 4.1.3.
d. The average total occupancy was derived by the count within each vessel hull paint category multiplied by the average percent occupancy for that category; values are presented to three significant figures.
e. Based upon per vessel load identified for in-water hull cleaning in Appendix 2 of the SIYB TMDL.
f. Note: Vacant slips are not included in this total.
% = percent; DPR = Department of Pesticide Regulation; kg/yr = kilogram(s) per year; N/A = not applicable

Table 3-6.
2020 Copper Load by Vessel Hull Type and Reported Occupancy at the Harbor Police Dock, Transient Dock, and Weekend Anchorage as a Result of In-Water Hull Cleaning Using TMDL Assumptions

Vessel Hull Paint Category	Number per Category	Average Time Occupied[b]	Copper Load per Vessel (kg/yr)[c]	Total Copper Load (kg/yr)
Port Fleet (Confirmed Non-Copper)	15	92.9%	0	0
Transient Dock[a] (Copper or Unknown and Assumed to be Copper)	26	58.6%	0.04	0.61
Weekend Anchorage[a] (Copper or Unknown and Assumed to be Copper)	40	26.9%	0.04	0.43
Vacant Slips (Port HPD Dock)	2	--	--	0
Total Vessels (HPD, Transient Dock, and Weekend Anchorage)	***81[d]***	**--**	**--**	***1.04***

Notes:
a. Calculated as an average, based on total number of days a slip was occupied by a guest vessel.
b. The average total occupancy was derived by the count within each vessel hull paint category multiplied by the average percent occupancy for that category; values are presented to three significant figures.
c. Based upon per vessel load identified for in-water hull cleaning in Appendix 2 of the SIYB TMDL.
d. Note: Vacant slips are not included in this total.
% = percent; HPD = Harbor Police dock; kg/yr = kilogram(s) per year

Based on the estimated total dissolved copper load from passive leaching and in-water hull cleaning combined (1,092 kg/yr), the load reduction for 2020 was calculated and presented in Table 3-2. Load reduction is determined by subtracting the estimated dissolved copper load from the 2,100-kg/yr baseline load attributed to vessels identified in the SIYB TMDL Technical Report (passive leaching = 2,000 kg/yr and in-water hull cleaning = 100 kg/yr). Based upon these calculations, the 2020 estimated copper load reduction is 1,008 kg/yr (i.e., 2,100 kg/yr minus 1,092 kg/yr = 1,008 kg/yr), which is a 48.0% reduction compared with the baseline load identified in the TMDL.

3.3 SIYB TMDL Water Quality Monitoring

This section summarizes the results of the 2020 annual analytical chemistry and toxicity monitoring program conducted by the Port in SIYB. Detailed laboratory reports are provided in Appendix D.

3.3.1 Surface Water Chemistry

Annual water quality monitoring was performed on August 20, 2020. Surface water samples were tested for concentrations of total and dissolved copper and zinc, DOC, TOC, and TSS. Results of the monitoring survey are presented in Table 3-7; a QA/QC summary of all analytical laboratory data is in Section 3.3.1.2. The chemistry results report submitted by the analytical laboratory is in Appendix D.

Table 3-7.
Chemistry Results for SIYB Surface Waters, August 2020 Event

Station	Dissolved Copper (µg/L)	Total Copper (µg/L)	Dissolved Zinc (µg/L)	Total Zinc (µg/L)	DOC (mg/L)	TOC (mg/L)	TSS (mg/L)
SIYB-1	**15**	15	42	43	2.8	2.7	11
SIYB-2	**10**	9.5	29	110	2.6	2.7	8
SIYB-3	**9.9**	9.6	27	27	2.6	2.5	7
SIYB-4	**9.0**	8.4	24	25	2.8	2.6	8
SIYB-5	**5.4**	5.2	16	17	2.9	2.5	5
SIYB-6	0.77	1.3	2.2	3.0	1.6	2.6	7
SIYB-REF-1	0.29	0.43	0.83	1.2	1.5	1.4	9
SIYB-REF-2	1.0	1.2	4.1	4.9	1.8	2.3	11

Notes:
Values in **bold** are above the USEPA National Recommended Water Quality criterion continuous concentration (CCC) for dissolved copper of 3.1 µg/L in marine waters.
No values were above the CCC for dissolved zinc of 81 µg/L.
High tide on 08/20/2020 was +5.29 feet at 11:12AM; tidesandcurrents.noaa.gov
µg/L = microgram(s) per liter; DOC = dissolved organic carbon; mg/L = milligram(s) per liter; REF = reference; SIYB = Shelter Island Yacht Basin; TOC = total organic carbon; TSS = total suspended solids

Dissolved Copper – Dissolved copper levels within SIYB ranged from 0.77 to 15 µg/L. The lowest concentration within the basin occurred at the outermost station (SIYB-6); the highest concentration was recorded at the innermost station (SIYB-1). The concentrations of dissolved copper at the reference stations (SIYB-REF-1 and SIYB-REF-2) were 0.29 µg/L and 1.0 µg/L, respectively. Dissolved copper concentrations at five of the six SIYB stations exceeded the dissolved copper USEPA National Recommended Water Quality CTR CCC WQO of 3.1 µg/L and criterion maximum concentration (CMC) WQO of 4.8 µg/L. The concentrations of dissolved copper at the outermost station in SIYB (SIYB-6), as well as both reference stations located outside of SIYB, were below both WQOs.

Total Copper – Total copper concentrations measured in SIYB followed a similar spatial pattern, ranging from 1.3 µg/L at the outermost station (SIYB-6) to 15 µg/L at the innermost station (SIYB-1). The total copper concentrations at the reference stations (SIYB-REF-1 and SIYB-REF-2) were 0.43 µg/L and 1.2 µg/L, respectively.

Dissolved Zinc – Dissolved zinc concentrations in SIYB followed a spatial pattern similar to that of dissolved copper. Concentrations ranged from 2.2 to 42 µg/L within SIYB (lowest at SIYB-6 and highest at SIYB-1). The concentrations at SIYB-REF-1 and SIYB-REF-2 were 0.83 µg/L and 4.1 µg/L, respectively. Dissolved zinc levels in SIYB have remained well below the USEPA CCC of 81 µg/L during all SIYB TMDL monitoring events.

Total Zinc – Total zinc concentrations followed a similar spatial pattern, with values ranging from 3.0 µg/L at SIYB-6 to 110 µg/L at SIYB-2. The concentrations of total zinc at SIYB-REF-1 and SIYB-REF-2 were 1.2 µg/L and 4.9 µg/L, respectively.

DOC – DOC concentrations in the water column, which have been shown to affect the bioavailability of free copper, were relatively consistent at stations SIYB-1 through SIYB-5, ranging from 2.6 milligram(s) per liter (mg/L) to 2.9 mg/L. The concentrations of DOC at the outermost station in SIYB (SIYB-6) and the reference stations outside of SIYB were slightly lower, ranging from 1.5 to 1.8 mg/L.

TOC – Similarly, measured concentrations of TOC were relatively consistent for all samples in SIYB, ranging from 2.5 mg/L to 2.7 mg/L. The concentrations of TOC at SIYB-REF-1 and SIYB-REF-2 were 1.4 mg/L and 2.3 mg/L, respectively.

TSS – Measured concentrations of TSS were relatively consistent for all six stations in SIYB, ranging from 5 mg/L at SIYB-5 to 11 mg/L at SIYB-1. The concentrations of TSS at SIYB-REF-1 and SIYB-REF-2 were 9 mg/L and 11 mg/L, respectively.

3.3.1.1 Comparison of SIYB Dissolved Copper Levels over Time

An average basin-wide dissolved copper concentration was calculated (excluding the reference stations) for comparison with the prior SIYB TMDL monitoring results (Figure 3-3). The basin-wide average concentration of dissolved copper measured in 2020 was 8.3 µg/L ± 2.0 µg/L (mean ± standard error), which is equal to the 2005–2008 baseline level (8.3 µg/L). The 2020 basin-wide average dissolved copper concentration in the surface waters is consistent with that observed in 2019. However, dissolved copper concentrations have increased compared with results from prior monitoring events (2012–2018).

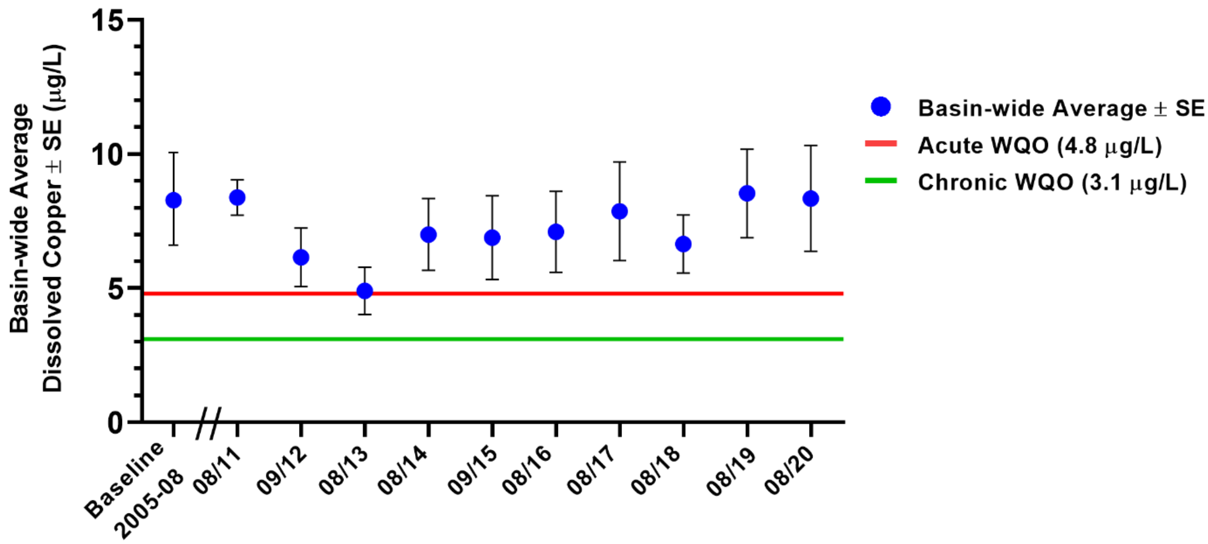


Figure 3-3. Average Dissolved Copper Concentrations by Year in SIYB Relative to Baseline Conditions

3.3.1.2 Analytical Chemistry QA/QC

All samples were submitted to the analytical laboratory on the day after they were collected (August 21, 2020). The samples were received in good condition at Weck at 2.6°C and on ice. The samples for dissolved metals analyses were field-filtered by Wood and preserved by the laboratory immediately upon receipt. All samples met holding time requirements for analysis.

Analytical chemistry results underwent a thorough QA/QC evaluation; they were determined to meet the data quality objectives in the QAPP and were deemed acceptable for reporting purposes, with the qualifications noted in the QA section of the individual laboratory reports (these issues are summarized below). The analytical laboratory report in Appendix D has a specific QA/QC section that highlights any qualified data.

The following information summarizes the relevant data QA/QC-related findings associated with the 2020 SIYB TMDL study:

- **Issue** – Seawater samples were diluted for copper and zinc between 1 to 20 times due to matrix interference, resulting in elevated detection limits.
    - **Resolution –** The analytical laboratory routinely dilutes samples to ensure sample concentrations are within instrument calibration ranges. Diluting the samples also allows the laboratory to provide more accurate results by eliminating the potential matrix effect often observed in metal analyses of seawater samples. The final analyte concentrations reported by the laboratory are well above the associated reporting limits for all affected samples. Therefore, the analytical QA/QC officer determined that there is no impact on data usability.
- **Issue** – Similar to results in previous events (e.g., 2016–2019) low-level detections of dissolved and total zinc were observed in the equipment rinsate (ER) blank.
    - **Resolution** – Ideally, the level of metals in this QA sample should be very low or non-detect. Total and dissolved concentrations of zinc were reported as non-detect (ND) in the field blank (FB), indicating that the low-level detections reported in the

ER sample may be due to potential trace contamination of the Niskin sampler. However, the concentrations of zinc in the ER were negligible relative to sample concentrations measured within SIYB and therefore are not considered a significant data bias.

- **Issue** – Dissolved concentrations for copper were higher than the corresponding total copper concentrations in 4 of 9 of the samples (3–7% higher).
  - **Resolution –** Review of the analytic blank, ER, and FB results for copper did not indicate any significant contamination that may have resulted during field filtration or laboratory analysis. The laboratory (Weck) was consulted to evaluate possible analytical details that may have influenced these deviations. They include:
    - Different calibration run between the total metals and dissolved metals, which can result in slight differences in the calculated result.
    - Different dilutions performed between total and dissolved metals, with a small margin of error in performing dilutions.
    - Concentrations of total and dissolved copper in the lab blanks were reported as ND (including the dissolved filtration step) ruling out the possibility of lab contamination in the dissolved aliquot.

    These slight deviations are not considered significant enough to warrant retesting or recollection of samples and/or reconfirmation testing. All results were reported within acceptance criteria determined by the method and SOP and therefore considered usable for their intended data purposes and reported as provided by the laboratory.
- **Issue –** Sample concentrations were within the expected ranges of values compared to historical concentrations, with the exception of total zinc at station SIYB-2 (110 µg/L).
  - Since the corresponding QA/QC samples (SIYB-1 replicate, matrix spike [MS] and matrix spike duplicates [MSDs]) had acceptable recoveries and RPDs, the elevated total zinc at SIYB-2 appears to be due to sample heterogeneity (e.g., a stray particle of zinc) and considered anomalous in nature. The corresponding SIYB-2 dissolved zinc concentration is 29 µg/L, which is in line with historical values and appears to be representative of the site.
- **Issue** – Spiking levels were appropriate as requested for all analytes with the exception of the DOC/TOC laboratory control samples (LCS), which was spiked at 1 mg/L (one-half of the MS/MSD spike level of 2 mg/L).
  - **Resolution –** There is no data impact from the lower DOC/TOC LCS spiking level. Results are therefore considered usable for their intended data purposes and are reported as provided by the laboratory.
- **Issue –** Low-level detections of DOC/TOC were observed in the ER blank and the FB.
  - **Resolution –** Trace detections of DOC and TOC measured in the ER and FB are of a range similar to those of previous events and may be representative of trace field and/or laboratory contamination. Corresponding laboratory QA/QC samples met all project-specific limits in the QAPP. As similar low-level detections have been observed in previous events, extra care is taken in the field to ensure that sampling equipment is thoroughly cleaned and rinsed prior to collection of each

sample. However, due to the ubiquitous nature of these constituents, some combined low-level contamination from the field and analytical testing is expected, even under clean room conditions. These low-level detections are not considered significant enough to warrant retesting or recollection of samples and testing. All results are considered usable for their intended data purposes and are reported as provided by the laboratory.

- **Issue** – DOC values in several cases were higher than the TOC values reported for the same sample.
    - **Resolution** – Water samples for TOC and DOC analyses are dispensed to separate sample vials in the field, and laboratory analyses are conducted separately. This sample collection and testing approach can sometimes result in TOC levels being slightly lower than DOC levels. The magnitudes of these minor differences are in general agreement with results from previous events. Corresponding laboratory QA/QC samples met all QAPP limits, and concentrations measured in the associated laboratory blanks were very low to non-detect. The differences were not considered significant enough to warrant retesting or recollection of samples and testing. All results are considered usable for their intended data purposes and are reported as provided by the laboratory.

3.3.2 Toxicity

In addition to water chemistry analyses, the samples were tested for toxicity using an acute 96-hour survival exposure with a marine larval fish (Pacific topsmelt) and a chronic 48-hour survival and development test using bivalve embryos (Mediterranean mussel). The complete toxicity laboratory report for the 2020 summer monitoring event is in Appendix D.

3.3.2.1 Pacific Topsmelt 96-Hour Acute Bioassay

As mentioned in Section 2.3.6.1, the Pacific topsmelt acute bioassay was conducted twice for the 2020 monitoring program. The initial test was initiated the day following sample collection within the method holding time of 36 hours, while the follow-up test was initiated one week later (August 27, 2020) outside of the holding time referenced in the USEPA whole effluent toxicity test methods.

During the initial Pacific topsmelt bioassay conducted on August 21, 2020, two of the four sets of laboratory controls did not meet the minimum test acceptability criterion of 90% mean survival. In addition, there was a 20 to 25% reduction in fish survival in all test samples (including the reference site), regardless of site or sample concentration (Table 3-8). Because the initial topsmelt test did not meet the control test acceptability criteria the test was deemed invalid. However, a thorough evaluation of the results of the initial test (presented in Table 3-8) suggests that the observed effects in both the control and test samples were not due to a toxic response but rather attributable to test organism health based on the following lines of evidence:

- There was no consistent dose-response relationship observed in the samples during the initial topsmelt test. In other words, survival of topsmelt did not decrease with increasing sample concentration. Rather, mean survival was relatively consistent across sample concentrations from all sites, ranging from 73.3 to 83.3%. This type of flat dose response curve would not be expected if a toxicant was responsible for the observed effect.

- During the initial topsmelt test, two of the four sets of laboratory controls had a mean survival of 80% (which did not meet test acceptability criteria of 90%). This finding indicates that the issue with organism health was observed in clean filtered laboratory control water, in addition to the SIYB and reference water samples.

The reduction in survival across sample concentrations from all sites in SIYB and the reference site in San Diego Bay, as well as in two of the four controls, suggests that there was no toxic response observed but rather the batch of fish used to initiate the initial topsmelt test was suboptimal. Further discussion regarding issues with topsmelt health is provided in the Toxicity QA/QC Section 3.3.2.3.

Table 3-8.
Results of the 96-Hour Pacific Topsmelt Bioassay – 8/21/2020 Test

Concentration (% Sample)	Station/Mean Survival (%)						
	SIYB-1	SIYB-2	SIYB-3	SIYB-4	SIYB-5	SIYB-6	SIYB-REF-1
Laboratory Control[a]	90.0	80.0[b]	80.0[b]	90.0	90.0	80.0[b]	80.0[b]
25	76.7	76.7	76.7	83.3	73.3	73.3	73.3
50	80.0	76.7	76.7	76.7	73.3	76.7	73.3
100	76.7	80.0	76.7	76.7	76.7	76.7	76.7
Test Results							
TST (Pass/Fail)[a,c]	Pass	Pass	Pass	Fail	Pass	Pass	Pass
NOEC (%)[a,c]	50	100	100	100	100	100	100
LC_{50} (%)	>100	>100	>100	>100	>100	>100	>100

Notes:
Values in **bold** indicate a statistically significant decrease in survival compared to the lab control using both the TST and the USEPA 2002 acute method guidance flowchart statistical methods.
The reference toxicant LC_{50} value (102 µg/L copper) for this test was within two standard deviations of the Wood Aquatic Toxicology Laboratory historical mean (70.7–276 µg/L copper), indicating typical organism sensitivity to copper.
a. Statistical comparisons presented in Table 3-8 (above) were performed using control survival associated with each site. To be conservative, statistical comparisons presented in the toxicity laboratory report (Appendix D) were performed using only the controls that met test acceptability criteria (90% survival). This did not affect overall conclusions.
b. Two of the four laboratory controls did not meet the minimum test acceptability criterion of 90% mean survival; therefore, the test was considered invalid. The undiluted (100%) samples were retested on 8/27/2020 with a different batch of fish (see Table 3-9).
c. Because the minimum test acceptability criterion of 90% mean survival was not met in all laboratory controls, the test was considered invalid, and statistics are provided for informational purposes only. However, a thorough evaluation of the results of the initial test suggests that the observed effects in both the control and test samples were not due to a toxic response but rather attributable to test organism health. To supplement the initial test data, a follow-up test was performed using a different batch of topsmelt.
µg/L = microgram(s) per liter; > = greater than; % = percent; LC_{50} = concentration estimated to be lethal to 50% of the organisms; NOEC = no observed effect concentration; TST (Pass/Fail) = test of significant toxicity; TST Pass = sample is nontoxic according to the TST calculation; TST Fail = sample is toxic according to the TST calculation; USEPA = United States Environmental Protection Agency

To supplement the initial test data, a follow-up test was performed on August 27, 2020[17] on the undiluted[18] samples collected on August 20, 2020 using a different batch of topsmelt. The follow-up test passed all control test acceptability criteria and showed no statistically significant toxic responses using both traditional Student's t-test comparisons and the TST pass/fail

[17] The follow-up test was performed outside of the required holding time of 36 hours. Results of this test are considered to be qualified.

[18] Due to the limited availability of test organisms, only the undiluted samples from each station and control samples were tested on August 27, 2020.

approach (Table 3-9). The follow-up test was performed 7 days post-sample collection, which exceeds the USEPA holding time requirement of 36 hours. Consequently, the results of the follow-up testing are considered qualified but supportive of the conclusion that toxicity was also not present in the initial test.

Table 3-9.
Results of the 96-Hour Pacific Topsmelt Bioassay – 8/27/2020 Test[a]

Concentration (% Sample)	Station/Mean Survival (%)						
	SIYB-1	SIYB-2	SIYB-3	SIYB-4	SIYB-5	SIYB-6	SIYB-REF-1
Laboratory Control	93.3	93.3	93.3	93.3	93.3	90.0	90.0
100	100	96.7	90.0	90.0	93.3	83.3	90.0
Test Results							
TST (Pass/Fail)	Pass	Pass	Pass	Pass	Pass	Pass	Pass
NOEC (%)	100	100	100	100	100	100	100
LC_{50} (%)	>100	>100	>100	>100	>100	>100	>100

Notes:
Values in **bold** indicate a statistically significant decrease in survival compared to the lab control using both the TST and the USEPA 2002 acute method guidance flowchart statistical methods.
a. To supplement the initial test, which had an issue with test organism health, a follow-up test was performed on August 27, 2020 using a different batch of topsmelt. The follow-up test was performed 7 days post-sample collection, which exceeds the USEPA holding time requirement of 36 hours. Consequently, the results of the follow-up testing are considered qualified.
> = greater than; % = percent; LC_{50} = concentration estimated to be lethal to 50% of the organisms; NOEC = no observed effect concentration; TST (Pass/Fail) = test of significant toxicity; TST Pass = sample is nontoxic according to the TST calculation; USEPA = United States Environmental Protection Agency

Overall, based on the combined results of the initial and follow-up acute toxicity tests, there did not appear to be an acute toxic response related to ambient water quality in SIYB in 2020. Rather, the observed across-the-board reduction in fish survival of approximately 20-25% (regardless of test site) in the initial test indicates that there was an issue with this specific batch of topsmelt. This determination was further supported by the results of the follow-up test, in which no toxic response was observed using a different batch of fish.

Detailed results and QA/QC summaries for the toxicity testing performed by Wood Aquatic Toxicology Laboratory are presented in the laboratory report in Appendix D.

3.3.2.2 Bivalve Larvae 48-Hour Chronic Bioassay

Results of the mussel development tests conducted on SIYB surface water samples are summarized in Table 3-10. Results are presented as a combined endpoint of survival and development per the USEPA (1995b) protocol.

Bivalve tests were conducted on both filtered and unfiltered samples (for the 100% treatments only). Filtration on the 100% concentration samples was conducted to safeguard against potential undesirable effects from resident organisms in the raw water samples.

A bivalve larvae test is considered acceptable (i.e., valid) if at least 50% of the control larvae survived and an average of 90% of surviving control larvae developed normally. Control survival for the 2020 tests ranged from 84.3% to 98.6%; average control survival was 92.2% (which exceeds the test acceptability criteria of 50% survival; see toxicity report in Appendix D). Bivalve larvae normality in the controls ranged from 95.8% to 97.6%; average control normality was 96.9% (which exceeds the test acceptability criteria of 90% normal development). Based upon these high levels of control survival and normal development, the 2020 SIYB bivalve larvae tests met the required acceptability criteria and the tests were deemed valid.

A statistically significant decrease in the combined survival and development endpoint using the TST test was observed in one of the six samples tested (SIYB-1) from within the basin. Exposure of bivalve larvae to the undiluted and unfiltered SIYB-1 sample (i.e., 100% concentration) resulted in 49.7% combined survival and normal development compared with the laboratory control level (91.0%); these effects were statistically significant using both the USEPA (1995b) statistical approach and the TST analysis. For the undiluted and filtered samples tested, a statistically significant decrease in the combined survival and normal development endpoint was also observed in the SIYB-1 sample (62.6% combined survival and normal development). Bivalve larvae toxicity was not observed in samples collected from any of the other stations in SIYB or the reference station (SIYB-REF-1). The full toxicity testing report is provided in Appendix D.

Table 3-10.
Results of the 48-Hour Bivalve Larvae Bioassay

Concentration (% Sample)	Mean Combined Survival and Normal Development						
	SIYB-1	SIYB-2	SIYB-3	SIYB-4	SIYB-5	SIYB-6	SIYB-REF-1
Laboratory Control	91.0	93.0	87.0	88.9	80.7	94.8	90.1
6.25	93.4	94.4	90.9	83.5	81.0	93.8	87.3
12.5	92.2	92.8	90.9	86.0	87.0	95.6	94.4
25	95.1	92.1	92.3	87.9	84.6	96.2	93.3
50	87.2	93.8	90.0	84.6	87.3	93.6	90.2
100	**49.7**	87.6	80.1	87.0	82.3	93.2	94.0
100 (1.2-µm filtered)[a]	**62.6**	91.8	86.9	91.3	82.2	95.5	90.1
Test Results							
TST (Pass/Fail) unfiltered sample	Fail	Pass	Pass	Pass	Pass	Pass	Pass
TST (Pass/Fail) filtered sample	Fail	Pass	Pass	Pass	Pass	Pass	Pass
EC_{50} (% unfiltered sample)	<100	>100	>100	>100	>100	>100	>100
EC_{50} (% filtered sample)	>100	>100	>100	>100	>100	>100	>100

Notes:
Values in **bold** indicate a statistically significant decrease compared to control.
The reference toxicant EC_{50} value (5.37 µg/L copper) for this test was within two standard deviations of the Wood Aquatic Toxicology Laboratory historical mean (4.79–15.1 µg/L copper), indicating typical organism sensitivity to copper.
a. Each undiluted sample was also tested filtered through 1.2-µm filter to remove potentially harmful native algae that might interfere with test organism performance. Mean combined survival and normal development in the filtered control was 90.6%.
µg/L = microgram(s) per liter; µm = micrometer(s); > = greater than; < = less than; % = percent; EC_{50} = concentration estimated to cause an adverse effect on 50% of the organisms; TST (Pass/Fail) = test of significant toxicity; TST Pass = sample is nontoxic according to the TST calculation; TST Fail = sample is toxic according to the TST calculation

3.3.2.3 Toxicity QA/QC

Field Observations

On August 17, 2020, as well as the day prior to sample collection (August 19, 2020), reconnaissance surveys were conducted in SIYB to evaluate the study area for the presence of algal blooms and for general water clarity. In addition to these visual assessments, the reconnaissance surveys also included collection of water samples that were sent to the laboratory to be analyzed for the presence of harmful algal species. The analyses showed that the water clarity in SIYB was acceptable and that the collected water samples did not contain an abundance of harmful algae species. Based upon these findings, it was determined that the sample collection should proceed as planned.

Sample Receipt

Samples were received in good condition on the same day that they were collected (August 20, 2020). The SIYB samples were delivered on ice and received in the laboratory within the USEPA recommended temperature range of 0–6°C. The mussel test and initial topsmelt test were initiated on August 21, 2020 within the 36-hour holding time requirement. The follow-up topsmelt test was performed 7 days post-sample collection, which exceeds the USEPA method 36-hour holding time.

Toxicity Test Validity

Pacific Topsmelt 96-Hour Acute Bioassay

As discussed in Section 3.3.2.1, the Pacific topsmelt acute bioassay was conducted twice for the 2020 monitoring program. After issues with test organism health were observed during the initial testing, follow-up testing was conducted to supplement initial test results. A thorough evaluation[19] was performed to assess issues observed with test organism health, as well as interpret overall results of the initial and follow-up acute toxicity tests. The evaluation is summarized below.

During the initial Pacific topsmelt bioassay conducted on August 21, 2020, two of the four laboratory controls did not meet the minimum test acceptability criterion of 90% mean survival; therefore, this test was determined to be invalid. However, the reduction in survival across sample concentrations from all sites in SIYB and the reference site in San Diego Bay, as well as in two of the four controls, indicates that the batch of fish used to initiate the initial topsmelt test was suboptimal. Therefore, based upon review of the initial test results, the reduced and variable survival observed was determined to not be a toxic response, but rather attributable to overall organism health.

Topsmelt larvae used by Wood’s testing laboratory are obtained from Aquatic BioSystems, Inc. and shipped from their culturing facility in Colorado to San Diego. Aquatic BioSystems is the only supplier of topsmelt for toxicity testing in the United States. For the 2020 monitoring event, mortality of fish on arrival and during acclimation at the Wood Aquatic Toxicology Laboratory was

[19] Results of this evaluation were provided to the Port by Wood in response to a letter received by SIMLG, which requested clarification of acute toxicity testing results. This correspondence is included in Appendix E for reference.

slightly greater than desired, but not enough (in the opinion of the laboratory manager) to delay testing. Consequently, the topsmelt test proceeded as planned.

After observing the obvious reduction in topsmelt survival in all test samples and the controls, Wood Aquatic Toxicology Laboratory evaluated potential factors that could have impacted test organism health. Upon further review, it was noted that the receipt temperature for the batch of topsmelt used for the initial testing (23–24°C) was elevated compared to a typical receipt temperature goal of 20°C or less. The timing of this shipment from the culture facility in Colorado to San Diego coincided with a record heat wave in the southwest, which likely had an impact on the quality of fish. However, as mentioned previously, the initial topsmelt testing proceeded as planned because fish mortality upon arrival and during acclimation was not great enough to delay testing.

To supplement the initial study data, Wood Aquatics Toxicology Laboratory performed a follow-up test on the undiluted (100% concentration) samples using a different batch of topsmelt. The topsmelt used for the follow-up test appeared much healthier based on visual observations including their active movement, vibrant appearance, rapid response to feeding, and fewer mortalities during holding and acclimation. The follow-up test passed all control test acceptability criteria and showed no statistically significant toxic responses. The follow-up test was performed 7 days post-sample collection, which exceeds the USEPA holding time requirement of 36 hours. Consequently, the results of the follow-up testing are considered qualified but supportive of the conclusion that toxicity was also not present in the initial test. While the recommended holding time of 36 hours was exceeded for the follow-up test, samples were held at 4°C in enclosed containers with no headspace during that time, as required by USEPA (2002).

Overall, based on the combined results of the initial and follow-up acute toxicity tests, there did not appear to be an acute toxic response related to ambient water quality in SIYB in 2020. Rather, the observed across-the-board reduction in fish survival of approximately 20-25% (regardless of test site) in the initial test indicates that there was an issue with this specific batch of topsmelt. This determination was further supported by the results of the follow-up test, in which no toxic response was observed using a different batch of fish.

Bivalve Larvae 48-Hour Chronic Bioassay

The bivalve embryo development test met all test acceptability criteria set by the USEPA, as well as internal laboratory QA program requirements. All bivalve embryo development test data is considered valid and acceptable for reporting purposes with no qualifiers.

The QA/QC summary of the toxicity test results provided by Wood Aquatic Toxicology Laboratory is in Appendix D.

Reference Toxicant Tests

Concurrent reference toxicant results for the initial[20] Pacific topsmelt test and the bivalve larvae test are summarized in Table 3-11 and Table 3-12, respectively. The controls for the initial Pacific topsmelt and bivalve larvae reference toxicant tests initiated on August 21, 2020 both met

[20] Due to the limited availability of test organisms, no reference toxicant test was performed concurrently with the follow-up test initiated on August 27, 2020.

corresponding minimum test acceptability criteria. The calculated LC_{50} for the Pacific topsmelt was within the acceptable range (i.e., within two standard deviations of the laboratory historical mean); however, it was at the low end of the acceptable range (Table 3-11), further indicating suboptimal organism health. The calculated EC_{50} value for the bivalve test fell within two standard deviations of the laboratory historical mean, indicating that the test organisms used during this round of testing exhibited typical sensitivity to copper.

Table 3-11.
Summary of Reference Toxicant Test Results for Pacific Topsmelt – 8/21/2020

Copper Chloride Reference Toxicant Test			
Concentration (µg/L Copper)	**Mean Percent Survival**	**LC_{50} (µg/L Copper)**	**Historical LC_{50} ± 2SD Range (µg/L Copper)**
Laboratory Control	90	102	70.7 – 276
25	80		
50	65		
100	45		
200	30		
400	0		

Notes:
µg/L = microgram(s) per liter; LC_{50} = concentration estimated to be lethal to 50% of the organisms; SD = standard deviation

Table 3-12.
Summary of Reference Toxicant Test Results for Bivalve Larvae

Copper Chloride Reference Toxicant Test			
Concentration (µg/L Copper)	**Mean Combined Survival and Normal Development**	**EC_{50} (µg/L Copper)**	**Historical EC_{50} ± 2SD Range (µg/L Copper)**
Laboratory Control	92.4	5.37	4.79 – 15.1
2.5	85.6		
5.0	57.4		
10	0		
20	0		
40	0		

Notes:
µg/L = microgram(s) per liter; EC_{50} = concentration estimated to cause an adverse effect on 50% of the organisms; SD = standard deviation

Curved Hinged Larvae

During the 2014 monitoring, it was noted that some of the abnormal larvae (approximately 70%) were enumerated as “abnormal” because they had a slightly curve-hinged shell (i.e., bean-shaped) rather than a straight-hinged D-shaped shell.[21] To evaluate the recurrence of this observation for future TMDL bivalve larvae tests, the laboratory scored the larvae as (1) larvae with a fully developed shell with a straight-hinged D-shape, (2) partially developed larvae with a

[21] Photographs of bivalve larvae with slightly curved hinged shells were included in the 2014 SIYB TMDL report (AMEC Environment & Infrastructure, Inc., 2015).

concave or curved hinge, and (3) larvae that fail to develop a shell or display severe morphological defects.

As described in Appendix D, approximately 0.1 to 3.4% of the bivalve larvae in the undiluted, unfiltered samples for SIYB-1, SIYB-2, SIYB-3, SIYB-4, SIYB-5 for the 2020 study were partially developed but did not possess a straight hinge. One of these samples, from SIYB-1, resulted in statistically significant toxicity to bivalve larvae. No curved hinges were observed in samples from SIYB-6 or SIYB-REF-1. A smaller percentage of the larvae were partially developed with a curve-hinged shell in 2020 compared with 2014. The factor(s) that contributed to the elevated number of curve-hinged shells observed in the SIYB-1 sample in 2014 (>70%) did not recur in 2020 (see the Wood Aquatic Toxicology Laboratory report contained in Appendix D for more information).

4.0 DISCUSSION

This section provides discussion related to copper loading, water quality, and TMDL trajectory based on data and information collected during this and previous reporting periods.

4.1 Dissolved Copper Load

The 2020 vessel tracking program estimated an annual dissolved copper load to SIYB of 1,092 kg/yr. The relative allocation of loading attributed to passive leaching for vessels moored in SIYB yacht clubs and marinas and hull cleaning occurring in these facilities was approximately 1,069 kg/yr (97.9%). Approximately 23.4 kg/yr (2.1%) was attributed to passive leaching for vessels located at the Harbor Police dock, transient dock, and weekend anchorage, as well as hull cleaning occurring within these locations. These values were calculated by adding together the estimated contributions from (1) copper and assumed-copper paints, (2) DPR Category I and confirmed low-copper paints, and (3) aged-copper paints, and taking occupancy rate into account.

Figure 4-1 presents dissolved copper loads from 2012 to 2020 compared with the TMDL baseline load (2,100 kg/yr). This figure also includes the estimated annual load in relation to the TMDL interim and final load reduction targets. The results of the vessel tracking efforts were used to estimate a dissolved copper load reduction of 48.0% (1,008 kg/yr) for 2020 compared with the TMDL baseline load (2,100 kg/yr). The data indicate a lessening trend toward meeting the final TMDL target of 567 kg/yr by 2022.

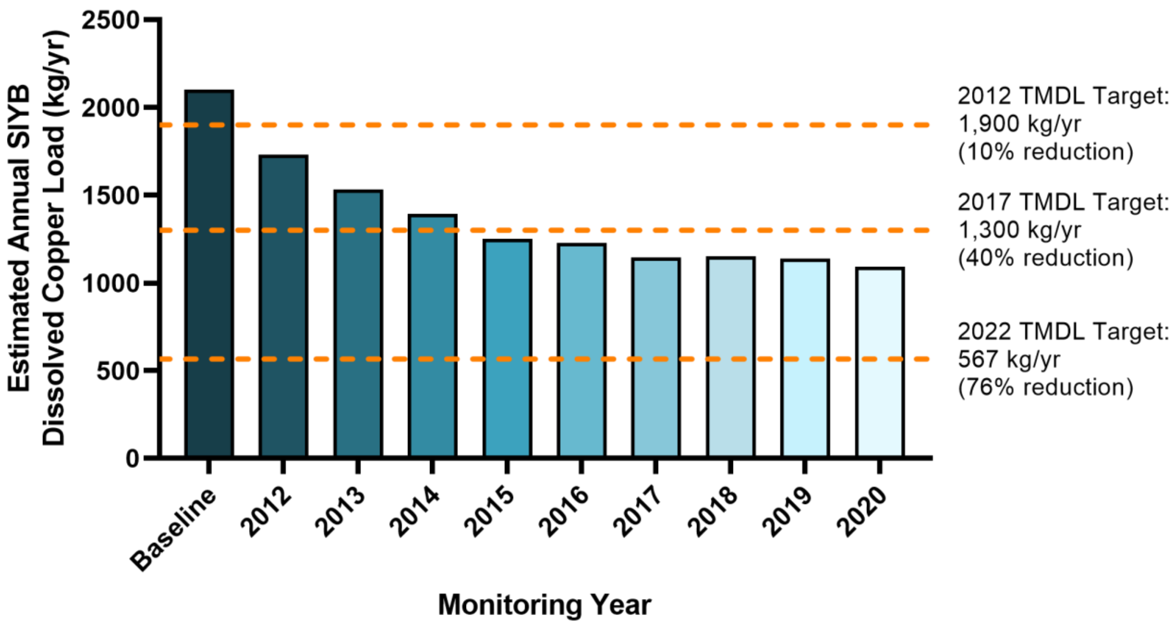


Figure 4-1. Annual SIYB Copper Load per Monitoring Year

4.1.1 Dissolved Copper Load Reduction Sources

The estimated load reduction of 48.0% was calculated by summing all individual load contribution sources and then subtracting this total from the TMDL baseline (i.e., 2,100 kg/yr minus 1,092 kg/yr equals 1,008 kg/yr). Load reduction sources include use of lower copper paints, aged-copper paints, non-copper paints or no paints, vacant slips, and decreased slip occupancy rate. The relative input from each category contributing to the total load reduction is shown in Figure 4-2.

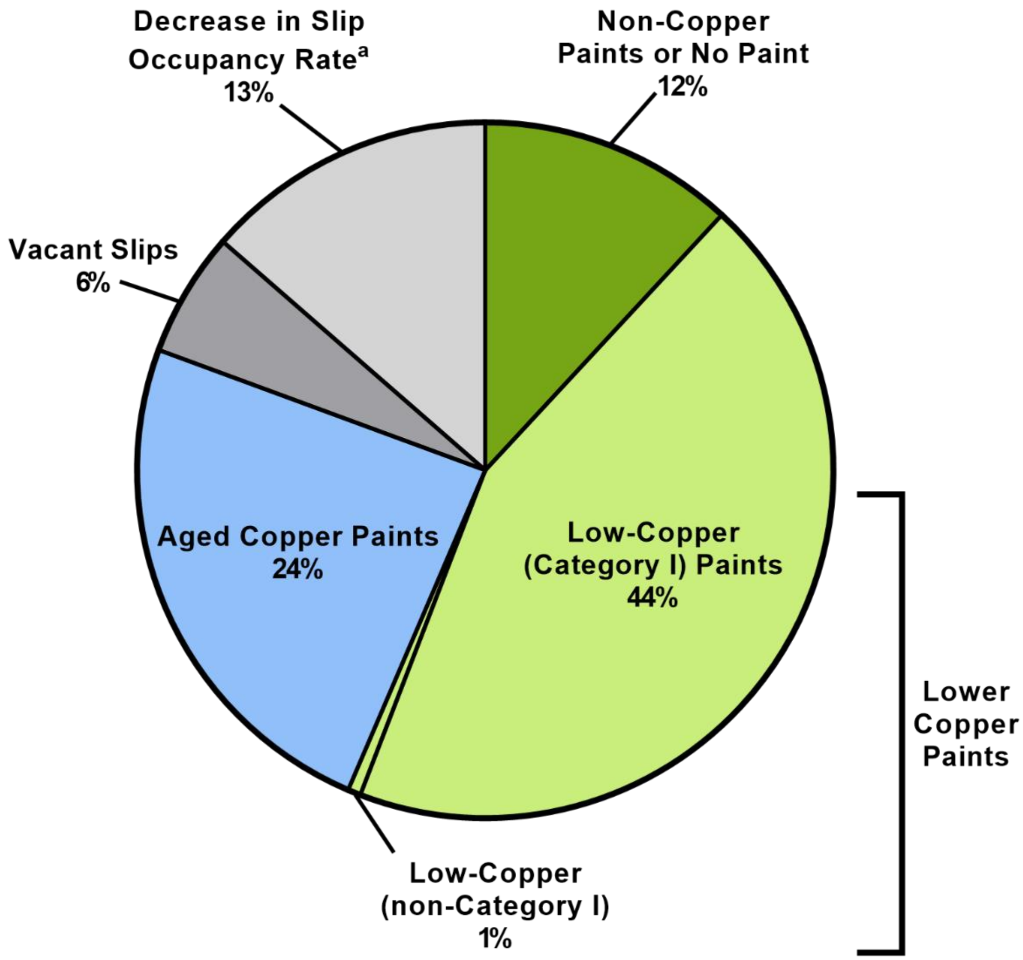


Figure 4-2. 2020 Estimated Load Reduction (1,008 kg/yr) Relative Percentage per Category[b]

Notes:
a. Decrease in average slip occupancy represents the load reduction due to an average occupancy rate of 91% for all vessels in SIYB.
b. The 2020 estimated load reduction (1,008 kg/yr) does not include the load reduction due to the difference between the number of total slips used in the TMDL load calculation (2,363) and the number of slips reported in 2020 (2,315). Therefore, the percent breakdown per category is relative to the 1,008-kg/yr estimated load reduction.

Overall, the data from 2020 indicate that low-copper paints (specifically DPR Category I paints) and aged-copper paints account for approximately 70% of the decrease in annual copper loads. Reductions in the overall occupancy rate (relative to the occupancy rate specified in the TMDL), as well as full vacancies (i.e., slips that are vacant for the entire 2020 monitoring year), account for the second largest copper load decrease. Non-copper paints, slip liners, and HydroHoists® are all considered non-copper alternatives, which do not contribute a copper load (i.e., zero-load alternatives). Notably, the use of non-copper alternatives, which can provide the greatest load reduction benefit, accounted for the smallest fraction of copper reduction strategies in 2020. It should be noted that the Port fleet was converted to non-copper paints in 2012 and does not contribute to copper loading in SIYB.

4.1.2 Annual Variation in Dissolved Copper Load Categories

The annual vessel tracking program has been a part of the SIYB TMDL Monitoring Plan since 2012. Tracking of the load attributed to various classes of vessel paints allows for documentation of changes in paint use, as well as any changes in the other load categories (e.g., slip occupancy, aged-copper paints). Figure 4-3 presents the distribution of paint load categories from 2012 to 2020.

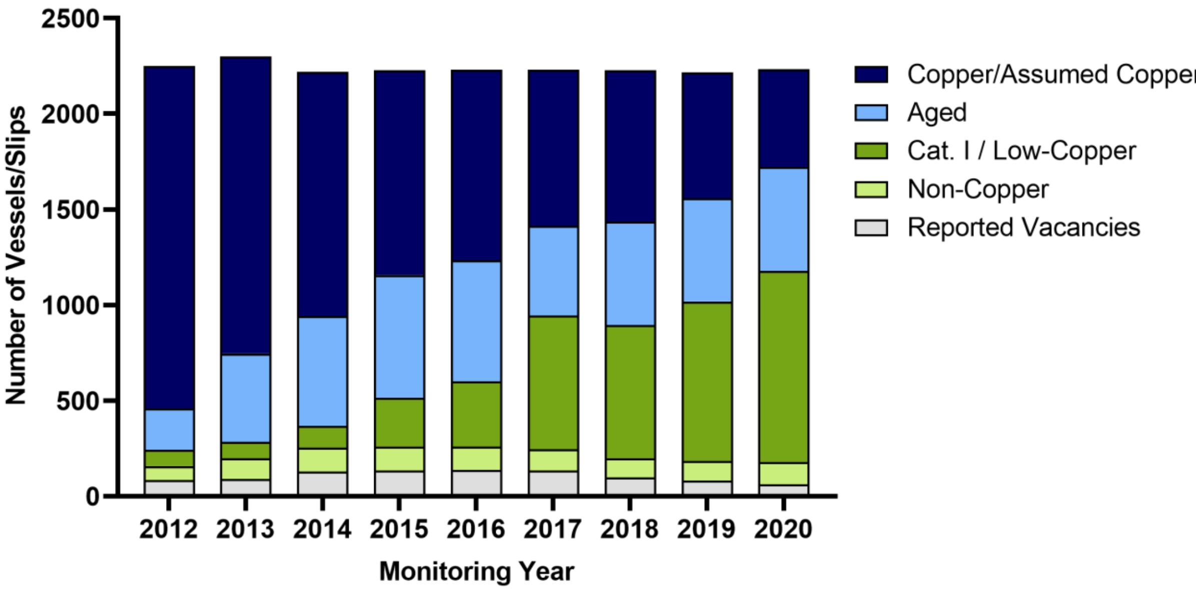


Figure 4-3. Load Categories per TMDL Year, 2012–2020

Since the implementation of the Port's monitoring program in 2011, there has been a notable shift from the use of high-copper paints to DPR Category I/low-copper paints. In particular, the number of vessels with DPR Category I paints in 2020 (985 vessels) increased by 47% relative to 2018 (672 vessels) when the DPR Rule was first implemented. In addition, the total number of vessels with high-copper (confirmed, unconfirmed, or unknown) paints in 2020 was lower (35%) than that reported in 2018. The number of vessels with non-copper alternatives has remained relatively consistent since 2013. Further, only 63 vacancies were observed in yacht clubs and marinas in 2020, which is the lowest number of vacancies reported since the inception of the monitoring program (Figure 4-4). This shift in paint use is expected since the DPR Rule was designed to phase out the use of high-copper paints applied in California, and is expected to continue over the next several years.

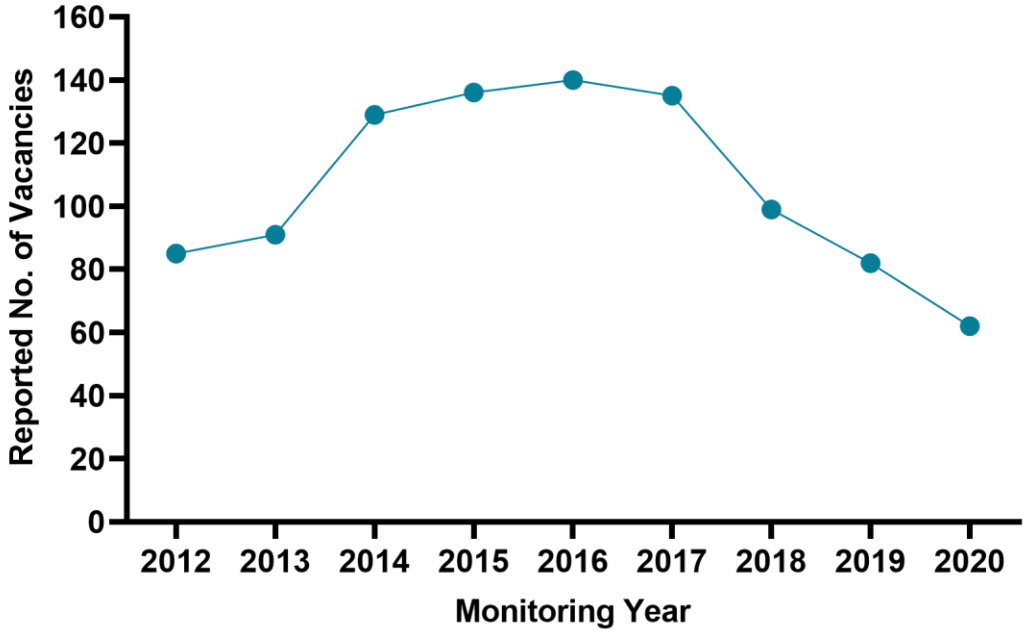


Figure 4-4. Reported Vacancies per TMDL Year, 2012–2020

4.1.3 Alternative Load Reduction Scenarios: Category I Paint Tracking Efforts during the DPR Rule Transition Period

Following the DPR Rule implementation in July 2018, the transition to Category I low-leach paints began to be noticeable in paint use trends, as the majority of newly painted vessels were confirmed to be painted with DPR Category I paints. However, the DPR Rule allowed for existing stock of high copper paints (those exceeding the maximum leach rate requirement of 9.5 µg/cm^2/day) to be sold until June 30, 2020. During this transitional period (July 1, 2018 through June 30, 2020), it became increasingly difficult to track paint use and distinguish between original paint formulations with leach rates exceeding 9.5 µg/cm^2/day and paints that were reformulated to meet the DPR maximum leach rate requirements. In many cases, a particular paint name could be associated with both a high-copper and DPR Category I paint. For example, a high-copper paint "Ultra-Kote" was reformulated to meet DPR Rule maximum leach rate requirements; however, its name has not changed, and only the USEPA registration number (which is not always known or provided) can be used to distinguish between the DPR Category I and high-copper formulations. In addition, some uncertainty exists with paint classification due to inconsistent product information obtained from different sources. For example, Coppercoat® is classified as "non-leaching" on the manufacturer's website[22], but is a registered pesticide with the DPR.

While the DPR maintains a database of paints, it is continually updated as products are reformulated. In addition, boatyards may refer to paints by a more general nomenclature, making it difficult to truly understand what product was applied. As such, the accuracy and knowledge of specific vessel paint data such as the paint's name, USEPA registration number, and product

22 https://www.coppercoatusa.com/faq.php

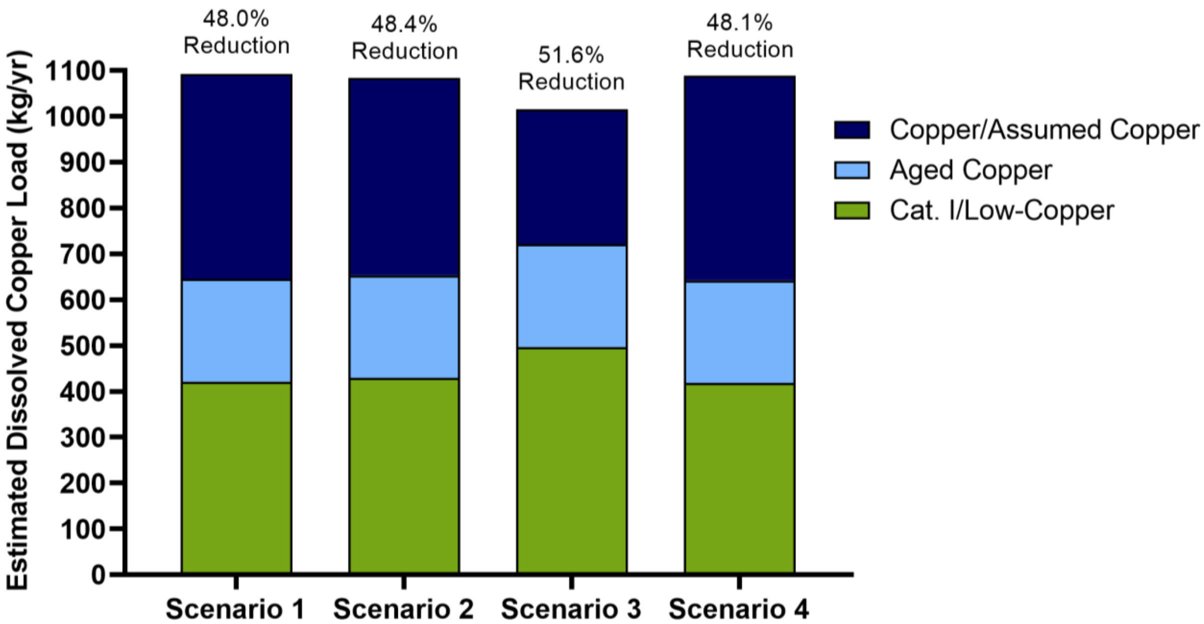
number become critical to understanding the specific product that was applied and whether that product is high copper or DPR Category I.

The vessel tracking approach defined in the SIYB TMDL Monitoring Plan estimates loads conservatively. If a vessel's paint is unknown or cannot be confirmed to be low copper or non-copper based upon the product information supplied, the paint is assumed to be high copper and assigned a full load of 0.9 kg/yr. Therefore, vessels painted during the 2020 reporting period that were unknown or could not be confirmed to have DPR Category I or non-copper paints are assumed to be high copper and assigned a full load of 0.9 kg/yr. The load estimate of 1,092 kg/yr presented in this report was calculated using these conservative assumptions.

However, it is possible that vessels with unknown or unconfirmed paints were actually painted with DPR Category I paints as a result of the DPR Rule implementation and paint availability in the boatyards. To account for potential inconsistencies associated with vessel tracking since the implementation of the DPR Rule and the DPR Product/Label database, alternative load estimates were also calculated for four possible scenarios, each using different assumptions, as follows:

- <u>Scenario 1- Original Loading Approach:</u> This scenario represents the dissolved copper load estimate using the original SIYB TMDL Monitoring Plan assumptions presented in Table 2-3 in Section 2.2.3. Any vessels painted after December 31, 2017 (or with an unknown painting date) with unknown or unconfirmed paints were conservatively assumed to have copper paint (0.9 kg/yr/vessel).
- <u>Scenario 2 – Paint-Date Driven Loading Approach After Surplus Phase Out</u>: This scenario represents the dissolved copper load estimate assuming that all vessels painted after June 30, 2020 (when non-Category I copper-based paints can no longer be sold) have DPR Category I paint (0.45 kg/yr/vessel). Any vessels painted with unknown or unconfirmed paints and unknown painting dates were conservatively assumed have copper paint (0.9 kg/yr/vessel).
- <u>Scenario 3 – Paint-Date Driven Loading Approach After DPR Rule Implementation</u>: This scenario represents the dissolved copper load estimate assuming that all vessels painted after the original DPR Rule implementation date, July 1, 2018, have DPR Category I paint (0.45 kg/yr/vessel). This scenario assumes that boatyards did not have any surplus of high copper paints, and boaters therefore had no access to stockpiles. Any vessels painted with unknown or unconfirmed paints and unknown painting dates were conservatively assumed have copper paint (0.9 kg/yr/vessel).
- <u>Scenario 4 – Loading Approach Assuming Coppercoat® is "Non-Leaching"</u>: This scenario represents the dissolved copper load estimate assuming that all vessels painted with Coppercoat® are "non-leaching", as classified on the manufacturer's website, and therefore not contributing dissolved copper load to SIYB (0.0 kg/yr/vessel). As previously described, Coppercoat® is classified as "non-leaching" by the manufacturer, but is a registered pesticide with the DPR. Based on the DPR Product/Label Database and in accordance with the methods described in Section 2.2.1, all six vessels painted with Coppercoat® were classified as "DPR Category I" (0.45 kg/yr/vessel) for the 2020 load calculations presented in Section 3.2 of this report (Scenario 1 in Figure 4-5).

Loading estimates for each scenario are presented in Figure 4-5.



Notes:
Scenario 1: Original assumptions
Scenario 2: Assume vessels painted after June 30, 2020 are Category I
Scenario 3: Assume vessels painted after June 30, 2018 are Category I
Scenario 4: Assume vessels painted with Coppercoat® are "non-leaching"

Figure 4-5. Loading Estimate Scenarios Based on Painting Date

Dissolved copper load estimates calculated for Scenarios 2 and 3 based on painting date assumptions result in a slight increase in calculated load reduction relative to that calculated using the original SIYB TMDL Monitoring Plan assumptions. However, even with the adjustments that assume boatyards predominantly apply DPR Category I paints during the DPR Rule transition, a number of vessels remain with unknown paints and unknown painting dates that are conservatively assumed to have copper paints. However, three years following the end of the DPR Rule transition period (June 30, 2023), all copper paints, if painted in California and/or paint is purchased in California by the boater, will be either DPR Category I paints or aged paints.

4.1.4 Dissolved Copper Load Trajectory Following DPR Rule Implementation

Moving forward, a key assumption is that all or most vessels in SIYB are expected to have DPR Category I, aged, or non-copper paints by June 30, 2023 due to the DPR Rule. This assumption is valid because the vessel tracking data supplied by the SIYB marinas and yacht clubs indicate the majority of vessels are painted in California boatyards. While the ongoing transition to DPR Category I paints is critical to future load reductions in SIYB, the complete transition process will require time for full implementation. It is anticipated that the timeline for full realization of the DPR Rule will exceed the SIYB TMDL schedule that requires that the final compliance requirement for copper loading be achieved by the end of 2022.

Using the 2020 vessel count and occupancy information as a guide, a future loading scenario (i.e., the transition from high-copper paints to DPR Category I paints) over the final phase of the TMDL would result in an approximately 60 percent copper load reduction compared with the TMDL baseline load (Figure 4-6).

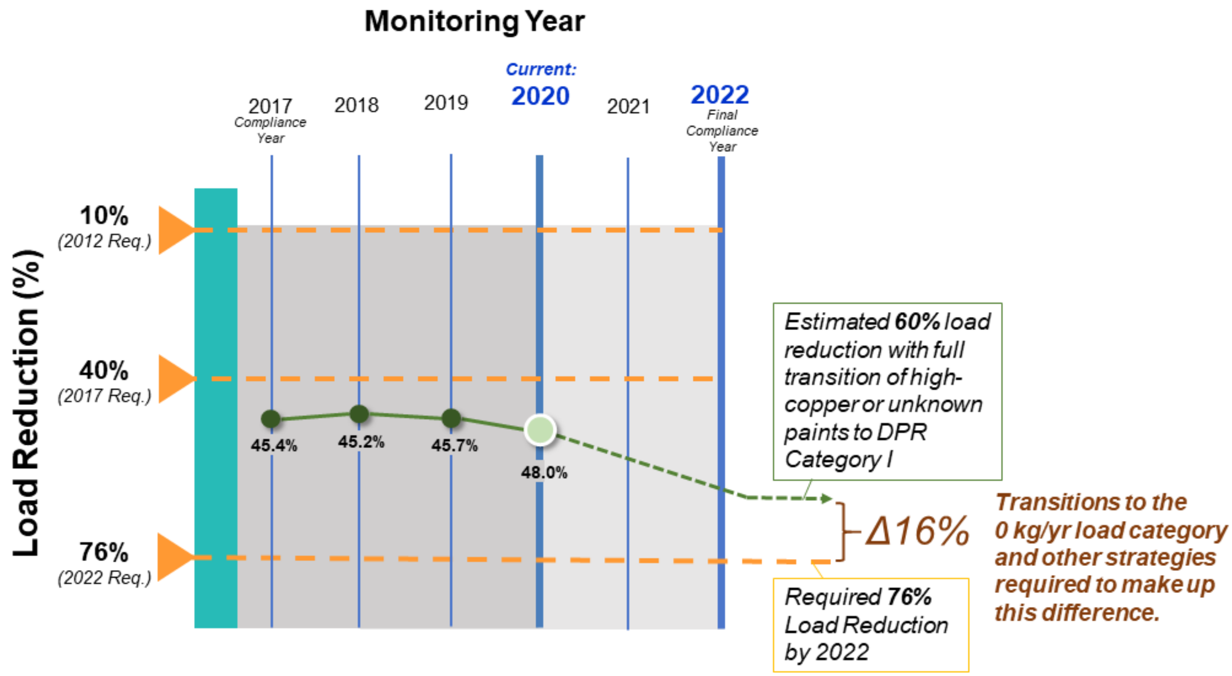


Figure 4-6. Estimated Load Reduction with Fully Realized DPR Rule and Required Reductions for TMDL Compliance

It is anticipated that even with a full transition to DPR Category I paints under the DPR Rule, based upon the current TMDL's loading assumptions, the final target load of 567 kg/yr will not be achieved by the end of 2022 or beyond that date without additional load reduction measures, such as conversions to non-copper alternatives instead of opting for low-copper products.

4.2 Water Quality Monitoring

This section discusses the findings from the water quality monitoring conducted in SIYB in 2020.

4.2.1 Dissolved Copper Levels

The basin-wide average dissolved copper level during the 2020 monitoring program was 8.3 µg/L. Copper levels at the five innermost stations in SIYB (SIYB-1 through SIYB-5) exceeded the CTR CCC WQO of 3.1 µg/L on the day of sample collection. Dissolved copper concentrations at these five stations also exceeded the CTR acute CMC water quality objective (4.8 µg/L) in 2020, which is consistent with previous monitoring years.

The two most recent monitoring years (i.e., 2019 and 2020) resulted in the two highest basin-wide dissolved copper average concentrations (8.5 µg/L and 8.3 µg/L, respectively) measured since monitoring was initiated in 2011. Baseline water quality monitoring conducted during the 2005–2008 period prior to the Port's TMDL monitoring efforts were consistent with the most recent results (8.3 ± 1.4 µg/L).

Figure 4-7 presents the dissolved copper levels measured at each station from 2011 through 2020. A gradient in dissolved copper levels in SIYB exists where higher concentrations are found near the head of the basin (Station SIYB-1) and dissolved copper levels decrease moving toward the mouth (i.e., Station SIYB-6 and within San Diego Bay [SIYB-REF-1 and SIYB-REF-2]). In most years, copper levels at SIYB-6 have been below both WQOs and close to or below the acute WQO at SIYB-5.

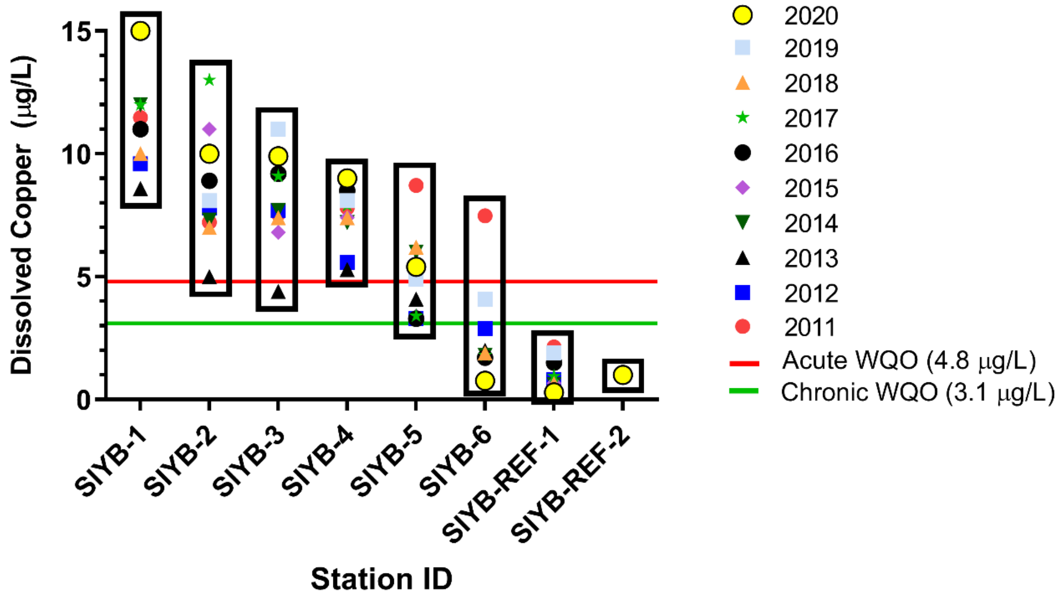


Figure 4-7. Dissolved Copper Comparison by Sampling Station

4.2.2 Toxicity

Bivalve larvae chronic survival and development is considered a primary indicator of copper toxicity, because the mussel species (*Mytilus galloprovincialis*) is considered one of the most sensitive genera used in the calculation of the water quality criterion for copper in marine environments (USEPA, 1995a). Since 2012, chronic toxicity of bivalve larvae has only been observed at two sampling stations (SIYB-1 and SIYB-2). Station SIYB-1 has shown a toxic response during all monitoring events since the program began in 2011. While no toxic response has been observed in station SIYB-2 for the past three years (2018–2020), toxicity has been observed at this station periodically since the program began in 2011. Stations SIYB-1 and SIYB-2 are the closest to the head of the basin and have the highest concentrations of vessels within the immediate vicinity, as well as the highest copper concentrations, compared with other stations. Consistent with previous SIYB monitoring events, results from the 2020 monitoring indicated no chronic toxicity at the sampling stations in the middle or near the mouth of the basin.

As discussed in Section 3.3.2, Pacific topsmelt acute toxicity tests were performed twice for the 2020 SIYB TMDL Monitoring Program. Although the results of the follow-up test were considered qualified due to a sample holding time exceedance, the combined results of the initial and follow-up tests suggest that there did not appear to be an acute toxic response related to ambient water quality in SIYB in 2020.

It is also important to note that a toxic response in Pacific topsmelt was observed at station SIYB-4 in 2018 and 2019; however, the cause of this toxicity is unknown. In accordance with the Monitoring Plan[23], samples were recollected at this site for confirmation testing in 2019, and

23 Due to unexplained toxicity observed during the 2018 monitoring program, toxicity testing methods in the Monitoring Plan were updated in 2019 to include conditions that may necessitate a toxicity identification evaluation (TIE).

toxicity was no longer present; therefore, no additional evaluation (i.e., a toxicity identification evaluation) was warranted. Similarly, there did not appear to be a toxic response observed at station SIYB-4 in 2020. However, given the transient nature of acute toxicity observed at SIYB-4, this site will continue to be monitored closely in future monitoring events.

4.3 Comparison of Achieved Load Reduction to Monitored Water Column Dissolved Copper Concentrations

The calculated dissolved copper loading has decreased approximately 48% since the implementation of the TMDL in 2011. As more vessels transition to use of lower copper paints, the calculated annual load has decreased because lower copper paints are assigned a dissolved copper load of 0.45 kg/yr/vessel in comparison to a full copper load (0.9 kg/yr/vessel). However, the rate of load reduction has slowed substantially since 2017 (Figure 4-1) and appears to be in a steady state of copper loading.

In contrast, although the average basin-wide water column dissolved copper levels decreased slightly between 2012 and 2018, the average basin-wide water column dissolved copper levels in 2019 and 2020 were similar to pre-TMDL baseline levels (8.3 µg/L) (Figures 3-3 and 4-8).

Conceptually, the observed concentrations of dissolved copper in the water column should be positively correlated to the calculated copper loading in SIYB. The primary goal of copper load reduction efforts is to decrease water column copper concentrations to meet the CTR regulatory criterion target of 3.1 µg/L. Hence, with greater copper load reduction, an associated decrease in water column dissolved copper concentrations is expected; however, to date, this has not occurred consistently. Potential factors that may influence water column concentrations in enclosed basins include vessel paint practices, hull management practices, and potential influences from the bay or elsewhere. These topics are identified and analyzed below.

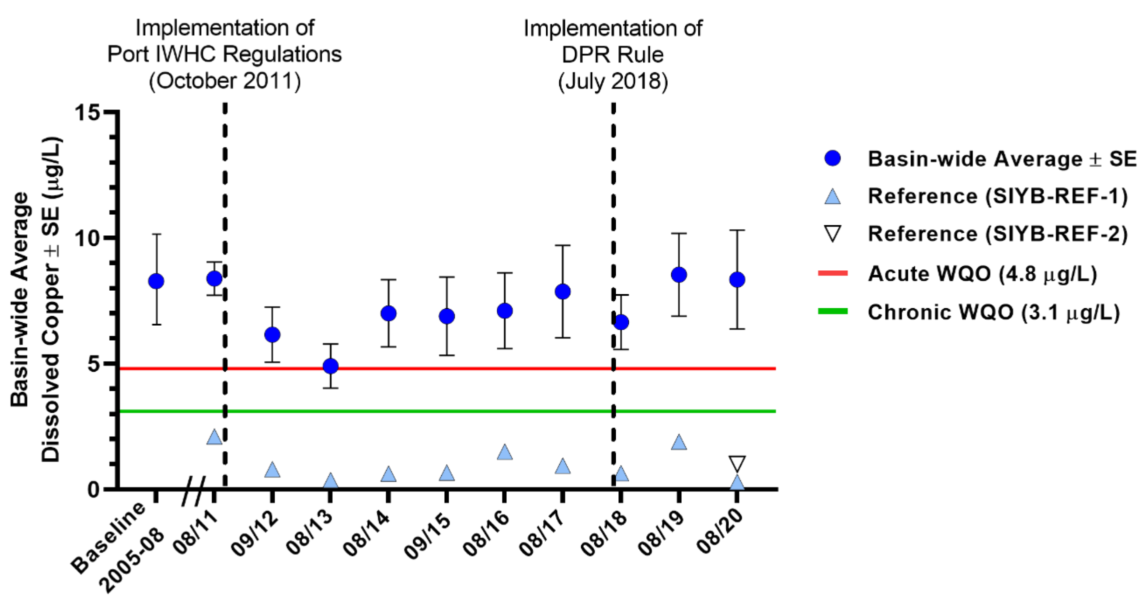


Figure 4-8. Key Load Reduction Initiatives and Water Quality

***Vessel Paint*:** A notable 47% conversion of vessels painted with high copper paint to low-leach copper DPR Category I paints has occurred since 2018 and DPR Rule implementation (Figure 4-8). Predictions using the paint type conversions and original TMDL loading assumptions would be expected to result in concurrent improvement in SIYB water column dissolved copper levels, or, at minimum, a downward shift in the water quality trajectory as more lower leaching DPR Category I copper paints are used.

The DPR Rule requiring the use of DPR Category I paints for recreational vessels (Figure 4-8) was implemented in 2018. Since that time, monitoring results in 2019 and 2020 indicate an increase of nearly 2 µg/L in the basin-wide average of water column dissolved copper concentration. It is unknown at this time whether a full transition to lower leaching DPR Category I paints would change the water quality trajectory, especially given the initial two years (and an almost 50% shift) of transitioning to DPR Category I paints without an observed decrease in dissolved copper levels.

Moreover, as shown in Figure 4-6 and discussed earlier in Section 4.1.4, the expected load reduction resulting from DPR Rule implementation alone is not anticipated to achieve the ultimate TMDL target load of 567 kg/yr, even beyond the TMDL timeline.

Another notable paint use behavior observed over the past five years is extremely limited use of non-biocide paints in SIYB. Despite longstanding education efforts and grant initiatives to supplement paint application, the number of vessels with non-copper alternatives has remained relatively consistent since 2013. Port paint studies and discussions with boatyards, paint manufacturers, and boaters identify higher upfront application costs, difficulty in cleaning, and product unfamiliarity as some reasons for having copper AFP remain the paint of choice. Given that copper AFPs remain a legal and familiar paint choice, behavior changes become increasingly difficult to encourage through voluntary means. While it is difficult to discern the exact reasons for boaters' lack of non-biocide paint use, the adoption of the DPR Rule demonstrates that copper AFPs will likely remain a legally available product on the market which may ultimately be an unintended consequence limiting the transition to non-copper alternatives.

To date, it appears that increased usage of DPR Category I paints is not having the anticipated positive effect on improving water quality, nor is it encouraging boaters to use non-copper alternatives. This issue remains a significant limitation in further reducing copper loads into SIYB and changing the water quality patterns being observed in SIYB.

In-Water Hull Cleaning: Figure 4-8 presents an evaluation of large-scale programmatic shifts and/or policy actions and their potential correlated loading adjustments in comparison to water quality findings. As shown in Figure 4-8, the greatest reduction in the average basin-wide dissolved copper level occurred between 2011 and 2013, decreasing from 8.4 µg/L to 4.9 µg/L. One potential contributing factor to this pattern could be that this timeframe corresponded with the initial introduction of the Port's in-water hull cleaning regulations. However, it is important to note that there is not a direct study that evaluated this, only the anecdotal water quality shift that was identified during the annual TMDL monitoring.

Additional support suggesting that in-water hull cleaning may have more of an impact on copper loading and water quality than originally estimated comes from modeling studies conducted after the TMDL was adopted. Scientific investigations conducted by Space and Naval Warfare Systems Command (SPAWAR) (Earley et al. ,2013) are considered updates to sound science that take into account vessel paint life cycle load contributions from both passive leaching and in-water hull cleaning. Findings suggest that loading from hull cleaning occurs over an extended period following each hull cleaning event over the life cycle of the paint. When viewed from a paint life cycle perspective, loading associated with in-water hull cleaning may contribute up to 40% of total copper loading. This estimate exceeds the original TMDL in-water hull cleaning loading assumption of 5%.

In addition, a TMDL Conceptual Model review was conducted by the Port in 2019 (Wood and Dudek, 2019) comparing available data from the TMDL, the SPAWAR study (Earley et al., 2013) and SIYB-specific information. This model review demonstrated that the recent Life Cycle Dynamic Model and the robust data analyses set forth within that model, provide total load calculations that are consistent with the TMDL and best represent real-time use conditions occurring in marina basins. Further, this TMDL Conceptual Model Review evaluated the different modeled loading contributions related to in-water hull cleaning frequencies and suggested adaptive management measures to vessel hull cleaning frequency and adjustments to implementation practices may lead to copper load reductions and water quality improvements (see Figures 4-9 and 4-10 and additional discussion in Wood and Dudek, 2019).

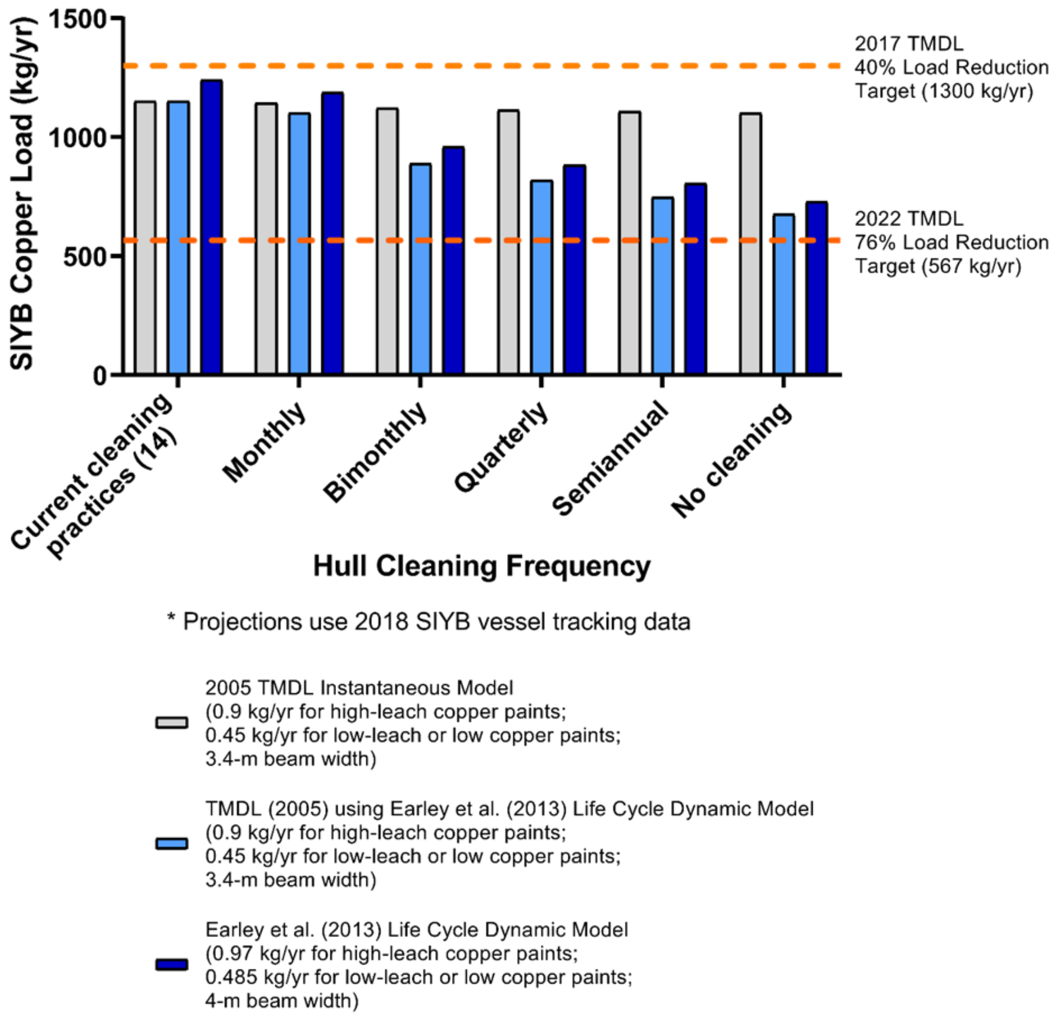


Figure 4-9. Copper Loading Estimates for Different Hull Cleaning Frequencies Using the 2005 TMDL Instantaneous and Life Cycle Dynamic Models*
(Source: Wood and Dudek, 2019)

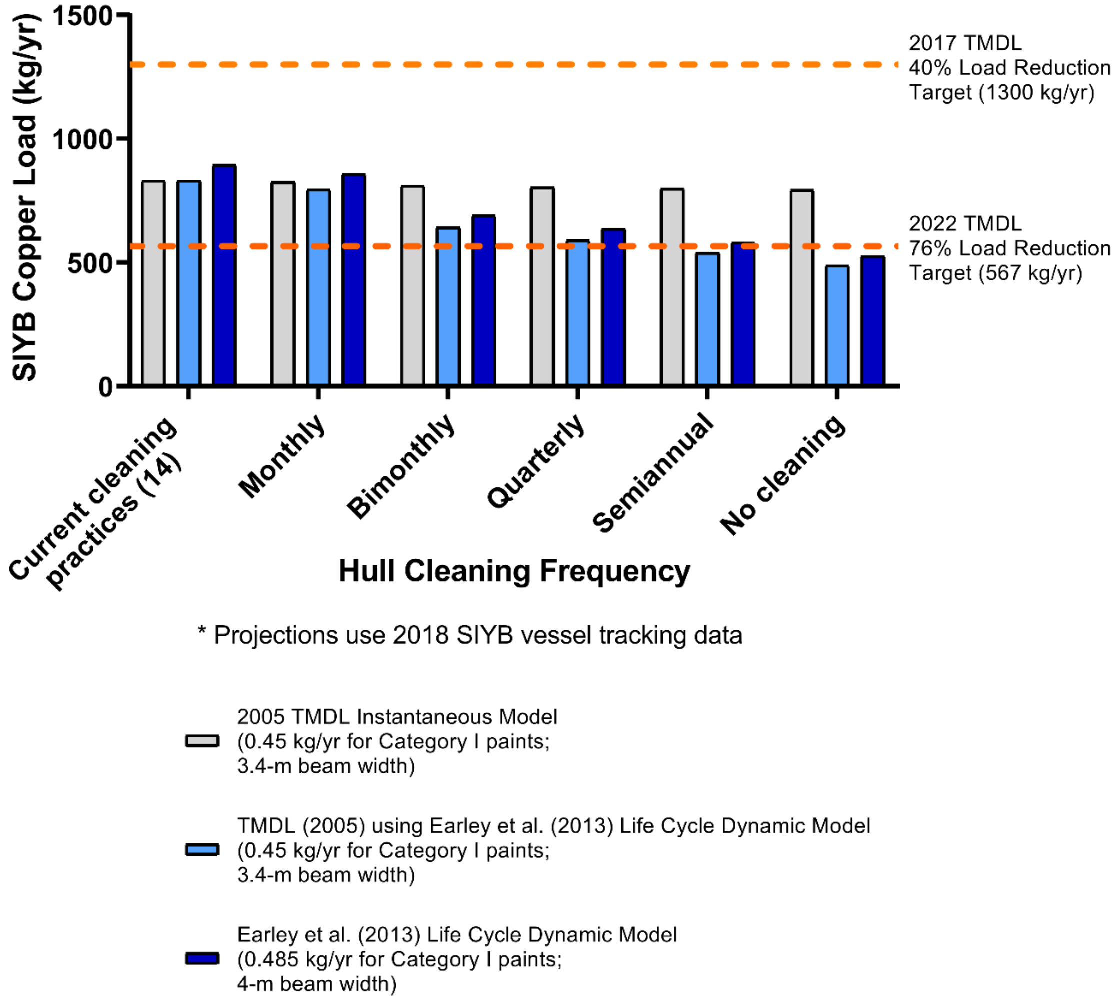


Figure 4-10. Copper Loading Estimates for Various Hull Cleaning Frequencies Using TMDL Instantaneous and Life Cycle Dynamic Models after Fully-Realized DPR Rule* (Source: Wood and Dudek, 2019)

In 2019, the Port conducted outreach efforts related to potential amendments to its in-water hull cleaning ordinance. It is important to note that BMPs and permit requirements remained in effect during the ordinance review efforts and continue through this time. However, new BMP approaches aimed at aligning with DPR mitigation strategies, such as once-per-month cleaning and use of soft carpet, were not supported by any of the other Named TMDL Parties. Industry professionals indicated during these outreach events that DPR Category I paints often require a higher frequency of cleaning and additional effort (e.g., enhanced cleaning pressure and/or more abrasive tools) compared to high-copper (non-Category I) paints. If loading from hull cleaning is associated with cleaning frequency, these factors may contribute to the increase in dissolved copper observed in SIYB in 2019 and 2020. While there is not enough existing information to determine whether this behavior change is accurate or could be linked to the upward shift in the basin's copper levels, the correlation between the factors is nonetheless interesting.

In addition, a previous study conducted by the Port evaluated the particulate copper emissions resulting from in-water hull cleaning activities. This study found that, in addition to the dissolved copper load associated with in-water hull cleaning, the average estimated particulate copper load from all recreational vessels in SIYB from hull cleaning is approximately 2,080 kg/yr (Amec Earth & Environmental, Inc., 2006). As such, this demonstrates the importance of fully understanding the environmental impacts of in-water hull cleaning activities.

Additional data and information are needed to confirm the relative contribution of copper loading associated with the TMDL or the Life Cycle Dynamic Model's in-water hull cleaning assumptions, cleaning behaviors, BMP use, and water quality.

***Bay Influences on SIYB*: ** Water column dissolved copper concentrations in basins, harbors, and bays can vary with annual and seasonal climatic patterns, localized winds and tides, and other factors. Although there has been some slight variation in San Diego Bay's dissolved copper concentrations as measured at SIYB-REF-1 from 2011–2020, the ambient bay dissolved copper concentration was measured below the CTR CCC and CMC regulatory thresholds (3.1 µg/L and 4.8 µg/L, respectively) in all annual monitoring events. Further, dissolved copper concentrations measured during the 2018 Regional Harbor Monitoring Program throughout San Diego Bay were generally below the CTR CCC of 3.1 µg/L, with the exception of areas within marinas (particularly SIYB), industrial/port areas, and freshwater-influenced areas, as depicted in Figure 4-11 (Wood, 2020d).

In contrast, with only minor exceptions, dissolved copper concentrations measured in the most enclosed portions of SIYB have exceeded the CCC and CMC regulatory thresholds during each monitored event (Figure 4-7). In addition, dissolved copper concentrations measured in SIYB during the 2018 Regional Harbor Monitoring Program were higher in SIYB than observed anywhere else in San Diego Bay (Figure 4-11) (Wood, 2020d). These data suggest that dissolved copper concentrations measured within SIYB, including the recent uptick in dissolved copper, are not directly correlated with dissolved copper concentrations in ambient bay conditions. Further, a supplemental reference station (SIYB-REF-2) was added to the sampling locations in 2020 to provide a better understanding of the background ambient conditions within San Diego Bay outside of SIYB. While some variability was observed in dissolved copper concentrations between reference stations (0.29 µg/L at SIYB-REF-1 and 1.0 µg/L at SIYB-REF-2), concentrations at both reference stations were well below the WQOs, and consistent with those measured in all previous TMDL monitoring events. This suggests that other factors may be driving changes observed in dissolved copper levels in SIYB, rather than the bay itself.

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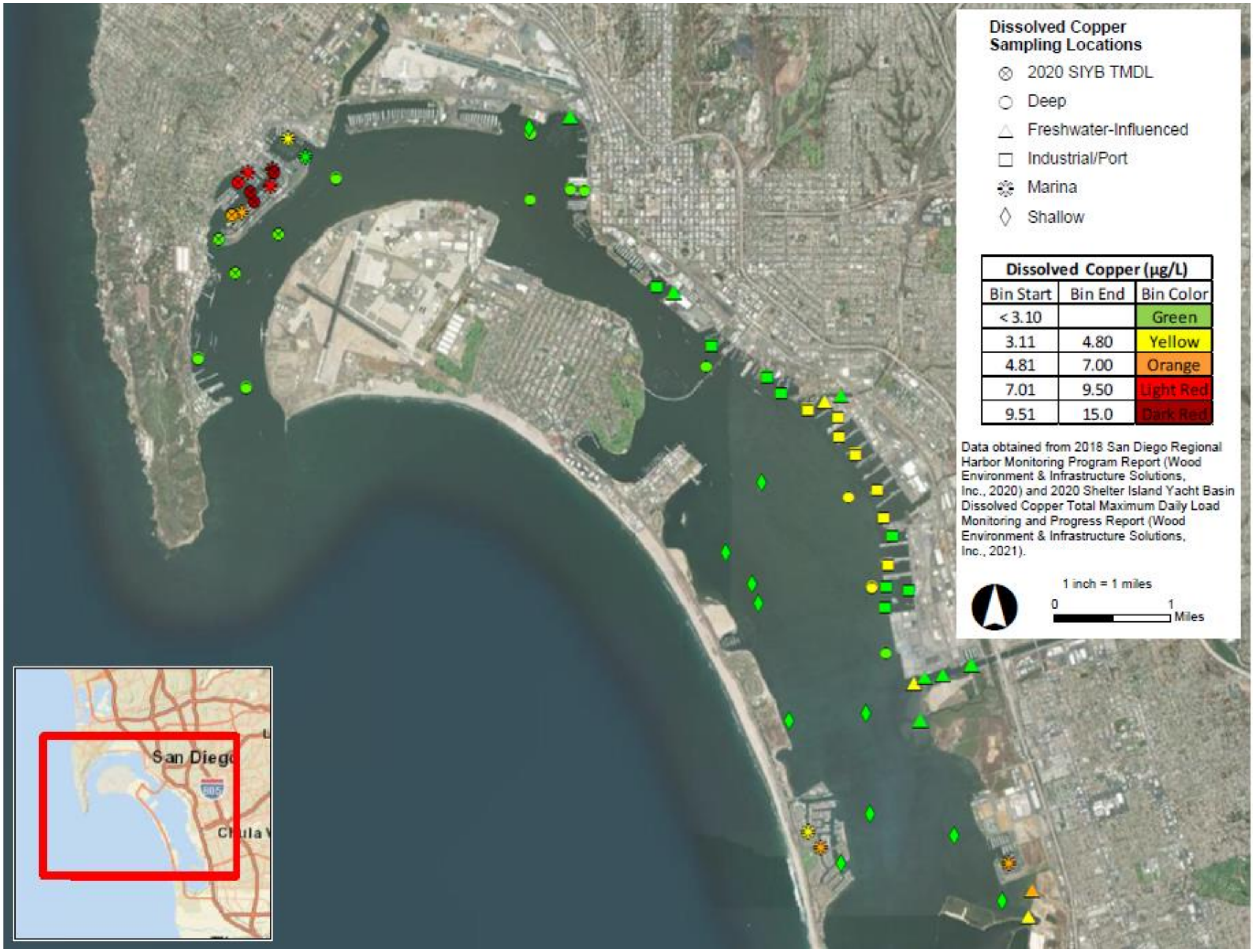

Figure 4-11. San Diego Bay Dissolved Copper Concentrations (Source: Wood, 2020d)

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4.4 Future Load Reductions

Since monitoring for the Investigative Order began, there have been observed annual reductions in loading (including meeting the 10 and 40% interim loading reduction goals); however, continued annual loading reductions have slowed more recently and have somewhat leveled off. Further, as stated previously, while loading has decreased according to the TMDL model, water quality has not followed suit. Dissolved copper in the waters of SIYB has remained above WQOs, and more recently has increased, even after the implementation of the DPR Rule (low-leach paints), which all but eliminated the application of high-copper leaching AFPs on recreational boats.

The remaining TMDL timeline is critically short with two years to meet the final target, a 76% load reduction. Currently, the water quality trajectory is not matching the load reduction trends despite considerable implementation efforts that have been, and continue to be made by the Port and other Named TMDL Parties (1) to transition boats away from high-leaching copper AFPs, (2) to employ in-water hull cleaning BMPs and, (3) to educate boaters. These efforts follow closely in line with the copper reduction approaches identified in the Regional Board's SIYB TMDL Technical Report as well as the Port's TMDL Implementation Plan. While that finding does not suggest that those implementation strategies should be discarded, it signals that more should be done to increase the use of non-copper alternatives, to fully understand the current sources and their loading potential, and to evaluate other possible sources in facilities, sediments, and the basin itself.

Over the past several years, the Port has been carefully analyzing its Copper Reduction Program components, conducting special studies to better understand water quality dynamics in SIYB, and evaluating the copper loading sources to determine where programmatic adjustments will most impactfully and directly address water quality. The following sections highlight some of the challenges that remain in addressing the most significant loading sources, namely copper AFP use and in-water hull cleaning, and provide an outlook for some key next steps.

<u>Hull Paint Use</u>

The DPR has primary jurisdiction over the registration of copper AFPs and their use in California. A pesticide product must be registered with the state (i.e., DPR) before it can be used or offered for sale in California. The DPR is also responsible for the scientific evaluation and registration of pesticide products including copper AFPs and is responsible for conducting assessments of human and environmental impacts related to product use prior to a product being registered for use.

Throughout the TMDL, the Port has actively pursued state actions and the DPR involvement in appropriately regulating paint use. During adoption of the TMDL in 2005, the Port coordinated with the State and Regional Boards to incorporate a provision requiring DPR to take action to address water quality concerns associated with copper AFPs (State Board Resolution 2005-0071; Appendix E). The Port also has promoted legislative initiatives to prompt the DPR to make state-level changes to copper AFP use. Such efforts included Senate Bill (SB) 623 (Kehoe), a legislative initiative in 2013 to eliminate copper hull paint. SB 623 (Kehoe) was ultimately pulled from the legislative docket, and a second initiative, AB 425 (Atkins) was adopted that required the DPR to set a copper AFP leach rate to address the protection of aquatic environments from the effects of exposure to that paint.

The 2018 DPR Rule requiring a maximum leach rate of 9.5 μg/cm^2/day for copper AFPs was the outcome of the legislative effort, AB 425, to regulate leaching at the state level. However, although it is still relatively early in the transition process, data collected in 2019 and 2020 in SIYB suggests that the paints may not be working as intended. While reported SIYB vessel paint data for 2019 and 2020 indicates the notable shift towards using DPR Category I low-leach copper AFPs (a 47% increase in use since 2018), the dissolved copper levels in SIYB have also continued to increase in the same time frame, rather than decrease, and there has been no increase or change in the use of non-copper alternatives. In addition, it has been discovered that the in-water hull cleaning practices for the DPR Category I paints are not well understood.

Given that copper AFPs are DPR-registered products and legal to use throughout California, the tools available to the Port to successfully address impacts from copper AFPs in SIYB are limited. As such, it is critical that the Regional Board and DPR become more actively involved in discussions and decision-making about the DPR Category I paints and their effects on water quality and re-examine loading assumptions in relation to vessel paint type and water quality. Further, while DPR Category I paints will likely become more prevalent, the use of non-copper alternatives remains a strategy that should be strongly pursued by the Regional Board, DPR, and the boating community.

In-Water Hull Cleaning

The TMDL attributes the most significant sources of dissolved copper in SIYB to passive leaching from copper-based hull paints (93%) and also to the in-water hull cleaning of vessels with copper-based hull paints (5%). However, while DPR regulates copper AFP use, currently there is no State or Regional Board NPDES program, permit, or Waste Discharge Requirements regulating the in-water hull cleaning industry. In addition, the Port's recent efforts to update BMP requirements to align with the DPR mitigation strategies (once-per-month cleaning, soft carpet, etc.) were met with resistance, suggesting limited support for changing hull cleaning behaviors. Further, because hull cleaning occurs within the water, the use of BMPs to fully capture or control copper discharges appears limited.

The studies completed after the adoption of the TMDL suggest that in-water hull cleaning is closely inter-connected to passive leaching of paints; their contributions cannot be easily proportioned. However, as discussed previously, those studies also suggest that in-water hull cleaning loading may be significantly greater than originally estimated, especially if the particulate load to the sediments is also considered.

To date, a link between in-water hull cleaning load modeling and water quality has not been developed. Based on the aforementioned modeling efforts showing the potential for in-water hull cleaning to be anywhere between 5% or greater than 40% of the copper load, understanding the relationship between water quality and in-water hull cleaning is critical to advance the next suite of management actions. Moreover, if significant water quality impacts are discovered, the potential for water quality impairment in all marina basins may warrant further state attention. Active involvement from the Regional Board will be essential in evaluating in-water hull cleaning activities and the threat to water quality and addressing the loading from the hull cleaning industry.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The SIYB TMDL monitoring program results indicate that the third interim target achieved in 2017, a 40% load reduction, continued through the third year of the final TMDL compliance phase. Current achievements have been a result of vessel tracking (95% response rate), implementation of various BMPs (see Section 3.1), and conversions from high-copper paints to DPR Category I paints, low-copper paints, and non-copper alternatives (i.e., non-copper paints, slip liners, HydroHoists®, etc.). The 2020 vessel tracking data show a load reduction of 48.0% (approximately 1,008 kg/yr) in annual dissolved copper loading to SIYB from vessels when compared with the SIYB TMDL-assumed baseline loading of 2,100 kg/yr (Table 5-1).

Table 5-1.
TMDL Interim Requirements and Achievements

TMDL Stage	Compliance Year	Required Load Reduction (%)	Required Load (kg/yr)	Actual Load Reduction (%)
1	2007	0%	2,163	Baseline
2	2012	10%	1,900	17.6% ✓
3	2017	40%	1,300	45.4% ✓
3	*2020*	*40%*	*1,300*	*48.0%* ✓
4	2022	76%	567	--

Notes: *Italicized* line indicates current (2020) load reduction presented in this report.

The reduction in dissolved copper load in 2020 was driven primarily by an increase in the number of vessels with DPR Category I paints as a result of the implementation of the DPR Rule. It is anticipated that the increase in the number of vessels in SIYB with DPR Category I paints will accelerate in the coming years as high-copper paints are phased out with the full realization of the DPR Rule, and will then level off as the transition becomes complete. It will be critical to understand the effects on water quality as this change progresses.

The average basin-wide dissolved copper concentration observed in 2020 was similar to that observed in 2019. However, dissolved copper levels observed in 2019 and 2020 are the highest measured since the monitoring program began in 2011. Chronic toxicity continues to be limited to SIYB-1 [24], which is located in the head of the basin where dissolved copper concentrations have consistently been the highest. The combined results of the initial and follow-up acute toxicity tests suggest that there did not appear to be an acute toxic response related to ambient water quality in SIYB in 2020.

The Port has assumed a leadership role by developing a Copper Reduction Program that supports hull paint research, administering voluntary and policy-based copper reduction initiatives, and hosting outreach events for the recreational boating community to educate the community on copper water quality issues and solutions. The goal of these efforts is to reduce copper loading and improve the water quality in San Diego Bay.

[24] Chronic toxicity has been limited to SIYB-1 only for three consecutive monitoring events (2018–2020).

The robust water quality and vessel paint tracking data provided in this and previous annual reports have enabled the Port to evaluate how the aforementioned efforts to date have translated to loading reductions and water quality changes, as well as identify where data gaps exist. While copper AFPs remain legally available statewide, most boaters will continue to use and maintain these products. Without modifying paint availability at the state level or regulating the pollution from the in-water hull cleaning industry, achieving desired loading reductions and water quality standards may not be attainable, especially within the TMDL timeline that exists today.

As mentioned in this report, there remains a disconnect in the loading and water quality trajectory. Improving the understanding of the water quality impacts associated with in-water hull cleaning and the effects of the DPR Category I paint transition are critical when finding the most effective solutions to improve water quality. With a limited amount of time until the end of the TMDL, it is important that these factors be carefully considered by the state's regulatory agencies, the Regional Board and DPR, and have their active involvement with the Port to determine the next steps. Further, it is imperative moving forward that the DPR take a larger role in managing the use of copper paints and coordinating with the Regional Boards to implement approaches consistently across the state.

Continuing Actions for the Final TMDL Phase: Port

Based on review of the 2011–2020 monitoring data, it is anticipated that additional activities to reduce copper loads will be needed to meet final TMDL load reduction targets and lower SIYB dissolved copper concentrations to meet CTR criteria. However, addressing the significant data gaps related to in-water hull cleaning and DPR Category I paint use requires more input from the state's regulatory agencies. The Port will continue its implementation efforts throughout the remaining TMDL timeline. During this period, an emphasis will be placed on evaluating the water quality impacts from in-water hull cleaning and working with the DPR and Regional Board to identify strategic approaches to address paint use and in-water hull cleaning locally and at the state level.

Potential next steps that the Port will consider for the final two years of this TMDL include the following:

- Improve the understanding of in-water hull cleaning and how industry behaviors impact water quality. Consider pilot study(ies) that evaluate water quality in relation to in-water hull cleaning activities; assess the relative impact of cleaning frequency, tools, and methods on various vessel hull paint types and ages; and evaluate recent modeling projections.
- Partner with the Regional Board to share and discuss findings related to loading and water quality; identify potential policy actions that address water quality at a broader scale than SIYB; develop strategies for increasing the use of and addressing limitations of non-biocide alternatives; and analyze the timing of recent initiatives and their impact on the TMDL timeline and load allocations, making adjustments as warranted.
- Coordinate with the Regional Board to update the SIYB TMDL Conceptual Model to (1) incorporate the loading assumptions provided in the Earley et al. (2013) Life Cycle Dynamic Model, and (2) use the Life Cycle Dynamic Model moving forward for annually calculating copper loads for TMDL compliance and reporting purposes.

- Continue collaborative communication with the DPR to evaluate potential ancillary effects of conversion to DPR Category I paints and other alternative paints.
- Engage the Regional Board, the DPR, and state legislative offices to consider legislative actions or broader statewide policy(ies) related to hull paint use or in-water hull cleaning, dependent upon the outcomes of the hull cleaning water quality studies
- Consider ordinances and/or other administrative measures to reduce or eliminate in-water hull cleaning activities at the Harbor Police dock, transient dock, and weekend anchorage.

SIYB marinas and yacht clubs and other Named TMDL Parties also have a responsibility to conduct load reduction actions throughout the entire duration of the TMDL. Moving forward, each Named TMDL Party will need to evaluate practices and activities within their purview leading to load contributions. Non-copper transitions, implementation of additional BMPs at SIYB facilities, adjustments to hull cleaning practices and/or frequencies, and other alternative mechanisms that have the potential to result in direct copper load reductions should be evaluated by the other Named Parties and implemented as appropriate. Direct load reductions should focus on closing the gap between the copper load reduction expected from the full realization of the DPR Rule and the TMDL compliance requirement of a 76% load reduction by 2022, as well as meeting the WQO for the basin.

The Port remains committed to working with the Regional Board, the DPR, and the other Named TMDL Parties to identify and implement processes founded in sound science in a manner that is most beneficial to water quality in SIYB, San Diego Bay, and across the state, which may include but is not limited to TMDL adjustments, state regulations, and balancing water quality and recreational beneficial uses on the bay.

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