DEPARTMENT OF ECOLOGY
State of Washington

Addendum 3 to Quality Assurance Monitoring Plan

Long-Term Marine Waters Monitoring Water Column Program

December 2023

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Addendum 3 to Quality Assurance Monitoring Plan

Long-Term Marine Waters Monitoring, Water Column Program

by
Pool, S., N. Coleman, and H. Young

December 2023

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Signatures are not available on the Internet version.
EAP: Environmental Assessment Program
MMU: Marine Monitoring Unit
WOS: Western Operations Section

1.0 Table of Contents

Note: The numbered headings in this document correspond to the headings in the original QAMP. Only relevant sections are included here; therefore, some numbered headings may be missing.

3.0 Background

This document describes changes planned for 2024 to the sampling effort by the Washington State Department of Ecology's Long-Term Marine Waters Monitoring (MWM) program. It is an addendum to the Quality Assurance Monitoring Plan: Long-Term Marine Waters Monitoring, Water Column Program (Keyzers et al. 2020). This Quality Assurance Monitoring Plan (QAMP) addendum specifies which stations and parameters will be sampled during 2024.

The purpose of the MWM program is to examine and report marine water quality on a regular, long-term basis. Its objectives are to help us understand current existing conditions in the context of environmental factors, identify spatial and temporal trends, and provide high-quality information from sensor measurement and lab sample collection.

All required sections not mentioned in this addendum are discussed in the original QAMP and referenced standard operating procedures (SOPs).

4.0 Project Description

4.4 Tasks required

4.4.1 Data collection

On a year-round, monthly basis, we collect vertical water column profile data for salinity, temperature, dissolved oxygen, turbidity, water clarity, in situ fluorescence, chlorophyll a, dissolved inorganic nutrient species (nitrate, nitrite, ammonium, orthophosphate, and silicate), total nitrogen, total organic carbon, particulate organic carbon, particulate nitrogen, dissolved inorganic carbon, and total alkalinity. These data are collected at 39 marine water sampling stations based on directives from the original Puget Sound monitoring plan for the water column (Keyzers et al. 2020).

Sampling is conducted monthly to maintain a long-term record of water column conditions. Year-round sampling is necessary because many parameters change seasonally, such as chlorophyll, nutrients, salinity, and dissolved oxygen. Sampling is conducted during all 12 months to capture hydrographic trends and to provide a complete data set for analysis of temporal trends (MMC 1988).

4.4.2 pH sensors

In 2022, we discontinued using pH sensors made with glass electrodes. This discontinuation will remain in place.

5.0 Organization and Schedule

5.1 Key individuals and their responsibilities

Table 1. Roles and responsibilities of staff involved with the MWM program.

Staff* Name	Title	Responsibilities
Christopher Krembs MMU Phone: (360) 407-6675	Senior Oceanographer	Determines monitoring and data assessment strategy. Generates indicators of water quality conditions. Leads data review, analysis, interpretation, and reporting. Develops information products. Writes publications and presentations delivered to the agency and public.
Micah Horwith WOS Phone: (360) 485-5473	Ocean Acidification Senior Scientist	Coordinates ocean acidification science within Ecology. Provides recommendations to management to address ocean acidification. Oversees data compilation and analysis and reports findings.
Alex Fisher MMU	Physical Oceanographer	Analyzes and reports on climate, weather, and ocean indicators. Generates data products and analytical tools. Conducts data QA review, analysis, and interpretation. Writes reports and data summaries.
Suzan Pool MMU Phone: (360) 791-8337	Marine Monitoring Scientist	Manages data workflow, processing, and QA review. Analyzes, interprets, and manages data in the EAPMW and EIM database systems. Generates analytical and QC products and develops tools. Writes reports and data summaries.
Holly Young MMU Phone: (564) 669-0458	Marine Waters Field Lead	Coordinates and conducts field sampling, laboratory analysis, instrument calibrations, and instrument maintenance. Records and manages field information. Conducts data QA review, analysis, and interpretation. Writes reports and data summaries.
Christopher Jendrey MMU Phone: (360) 764-9249	Marine Waters Field Scientist	Conducts field sampling, laboratory analysis, instrument calibrations, and instrument maintenance. Records and manages field information. Conducts data QA review, analysis, audits, and interpretation. Performs and publishes EOPS aerial surveys.
Natalie Coleman MMU Phone: (360) 790-5152	Ocean Acidification Scientist	Provides expertise in ocean acidification parameters. Leads/assists with field sampling. Conducts ocean acidification data QA review, analysis, audits, and interpretation. Assists with sensor assessment and annual calibrations. Writes reports and data summaries.
Creston Wood MMU Phone: (564) 669-4470	Marine Monitoring Technician	Assists with research vessel operations, field sampling, laboratory analysis, and instrument maintenance. Conducts QA review. Performs and publishes EOPS aerial surveys.
Julianne Ruffner MMU Phone: (360) 280-4518	Unit Supervisor	Provides internal review of the QAMP and addenda, manages the budget, and approves the final QAMP and QAMP addenda.
Stacy Polkowske WOS Phone: (360) 464-0674	Section Manager	Reviews and approves the final QAMP addendum.
Dean Momohara MEL Phone: (360) 871-8801	Acting Director	Reviews and approves the final QAMP addendum.

Staff* Name	Title	Responsibilities
Arati Kaza Phone: (360) 407-6964	Ecology's QA Officer	Reviews the draft QAMP addendum and approves the final QAMP addendum.

EIM: Environmental Information Management database
MEL: Manchester Environmental Laboratory
MMU: Marine Monitoring Unit
NRS4: Natural Resource Scientist 4
QA: Quality Assurance; QC: Quality control
QAMP: Quality Assurance Monitoring Plan
WOS: Western Operations Section
*All staff are with Ecology's Environmental Assessment Program (EAP).

5.4 Proposed project schedule

Table 2 summarizes activities conducted during a routine sampling year under the monitoring plan.

Table 2. Proposed project schedule.

Type of Work	Due Date	Lead Staff
Field work completed—sample collection, instrument deployment, data retrieval	Monthly	H. Young, N. Coleman, C. Jendrey
Internal laboratory (MML, MEL) analyses completed	1 month post collection (chlorophyll *a* samples, salinity, bath Winklers, total organic carbon, total nitrogen, particulate carbon, and nitrogen)	H. Young, N. Coleman, C. Jendrey
External laboratory (UW, PMEL) laboratory analyses completed	3 months post collection (nutrients), 2 years (TA/DIC samples)	H. Young, N. Coleman
Aerial observation photos for Eyes Over Puget Sound (EOPS) survey completed	Once a month or as needed	C. Krembs
Instrument and sensor data uploads and subsequent processing and transfer to EAPMW database	Same month as collection	S. Pool, H. Young
Internal laboratory data (MML, MEL)—receipt, processing, and transfer	1 month post analyses	C. Jendrey, H. Young
External laboratory data (UW, PMEL)—receipt, processing, and transfer	3 months post analyses	H. Young, N. Coleman
Instrument and sensor data review and QA/QC and subsequent data adjustments	1 month post collection	S. Pool, A. Fisher, H. Young, N. Coleman, M. Horwith, C. Krembs, C. Jendrey
Sensor assessment bath and performance tests	1 month pre collection	H. Young, N. Coleman, C. Jendrey
Factory and in-house calibrations	Annually pre collection	S. Pool, N. Coleman, C. Jendrey, H. Young
Internal laboratory data (MML, MEL)—review and QA/QC	2 months post analyses	C. Jendrey, S. Pool, H Young, N. Coleman, C. Krembs
External laboratory data (UW, PMEL)—review and QA/QC	4 months post analyses	A. Fisher, S. Pool, N. Coleman, M. Horwith, H. Young, C. Krembs, C. Jendrey

Type of Work	Due Date	Lead Staff
EIM data loaded to study ID MarineWater	6 months after sampling year completed	S. Pool, N. Coleman, M. Horwith
EIM data entry review	6 months after sampling year completed	S. Pool, N. Coleman, M. Horwith
EIM complete	6 months after sampling year completed	S. Pool, N. Coleman, M. Horwith
Eyes Over Puget Sound (EOPS) Publication	Monthly or as needed	C. Krembs, C. Jendrey, C. Wood
PSEMP Puget Sound Marine Waters Report	Annually in April	A. Fisher, S. Pool, C. Krembs
Final data products and QA/QC summarized	Annually in May	C. Krembs, A. Fisher, S. Pool
Final performance data quality objectives calculated and submitted to Office of Financial Management	Annually in July	S. Pool

EAPMW: Environmental Assessment Program's Marine Waters database
EIM: Environmental Information Management database
MEL: Manchester Environmental Laboratory
MML: Marine Monitoring Laboratory
PMEL: NOAA Pacific Marine Environmental Laboratory
UW: University of Washington

5.5 Budget and funding

The 2024 budget was estimated for vertical profiling instruments, research vessels, and laboratory analyses. The estimates for contract costs are in Table 3. The estimates for laboratory analyses of discrete samples are in Tables 4 and 5. The costs do not include ocean acidification samples (TA/DIC) for analysis by PMEL, as a different funding source supports these samples. The budget estimates are only part of the program cost as they exclude items such as staffing, some internal laboratory samples and supplies, and some field equipment costs (e.g., repairs and administrative costs).

Table 3. Budget estimate for 2024 data collection contract costs.

Provider	Subtotal Cost
Sea-Bird Scientific equipment	$15,450.00
WET Labs equipment	$4,570.00
Shannon Point Marine Center research vessel use	$43,263.00
Total	**$63,283.00**

Table 4. Budget estimate for 2024 internal laboratory* costs.

Parameter	Number of Monitoring Samples	Number of QA Samples	Total Number of Samples	Cost per Sample	Lab Subtotal Cost
Particulate organic carbon and nitrogen	456	24	480	$46.00	$22,080.00
Total organic carbon	456	24	480	$35.00	$16,800.00
Total nitrogen	456	24	480	$20.00	$9,600.00
Totals	**1,368**	**72**	**1,440**	**$101.00**	**$48,480.00**

*MEL: Manchester Environmental Laboratory

Table 5. Budget estimate for 2024 external laboratory costs.

Parameter	Number of Monitoring Samples	Number of QA Samples	Total Number of Samples	Cost per Sample	Lab Subtotal Cost
Nutrients	1,524	120	1,644	$21.00	$34,524.00
Salinity	7	3	10	$22.00	$220.00
Totals	**1,531**	**123**	**1,654**	**$43.00**	**$34,744.00**

6.0 Quality Objectives

6.1 Data quality objectives

The data quality objectives will follow those stated in Addendum 1 of the QAMP (Bos et al. 2022).

6.2 Measurement quality objectives

The measurement quality objectives will follow those stated in Addendum 1 of the QAMP (Bos et al. 2022).

Table 6 shows updated measurement quality objectives for water sample analyses not reflected in Addendum 1 of the QAMP (Bos et al. 2022). In addition, we plan to add an optical optode and an integrated conductivity-temperature-depth (CTD) instrument. The optode will be a reference check alongside an SBE 43 dissolved oxygen sensor during each cast. The integrated instrument will be deployed in coastal bays and will likely replace a larger profiling package of multiple sensors. Both new instruments are listed in Table 7.

Table 6. Measurement quality objectives for laboratory analyses of water samples.

Laboratory	Parameter	Recovery Limits (%)	RL	MDL or Lowest Concentration of Interest
MEL	Particulate Organic Carbon	±10%	NA	16.5 µg/L
MEL	Particulate Nitrogen	±10%	NA	0.78 µg/L
MEL	Total Organic Carbon	±10%	0.5 mg/L	0.237 mg/L
MEL	Total Nitrogen	±20%	0.1 mg/L	0.057 mg/L

MDL: method detection limit
MEL: Manchester Environmental Laboratory
RL: reporting limit

Table 7. Measurement quality objectives for field instrument measurement methods.

Measurement	Precision (RSD)	Manufacturer (Model #)	Manufacturing Reported Range	Manufacturing Reported Accuracy	Lowest Value
Temperature	±0.005°C	RBR*duet* T.ODO *fast*	-5°–35°C	±0.002°C	-5°C
Dissolved oxygen	±10 µM	RBR*duet* T.ODO *fast*	0–500 µM	±8 µM	0 µM
Conductivity	±0.002 mS/cm	RBR*concerto*	0–85 mS/cm	±0.003 mS/cm	0 mS/cm
Pressure	0.25 dbar	RBR*concerto*	0–500 dbar	0.25 dbar	0 dbar
Temperature	±0.005°C	RBR*concerto*	-5°–35°C	±0.002°C	-5°C
Dissolved oxygen	±10 µM	RBR*concerto*	0–500 µM	±8 µM	0 µM

RSD: relative standard deviation

7.0 Study Design

7.2 Field Data Collection

7.2.1 Sampling locations and frequency

We plan to retain the sampling locations and frequency identified in Addendum 1 of the QAMP (Bos et al. 2022).

7.2.2 Field parameters and laboratory analytes to be measured

We plan to continue to use one CTD package at each station, as identified in Addendum 1 of the QAMP (Bos et al. 2022).

We plan to conduct monitoring solely on research vessels. The research vessels we would use in 2024 are Ecology's R/V *Skookum* and R/V *Salish SeaCat* and Western Washington University Shannon Point Marine Center's R/V *Magister* and R/V *Zoea*. We will sail the R/V *Skookum* for coastal stations in Willapa Bay and Grays Harbor and the R/V *Salish SeaCat* throughout Puget Sound. The Shannon Point Marine Center's vessels will be for sampling in North Sound, Central Sound, and Hood Canal if we need an operational vessel.

With one exception, we plan to continue collecting sample types and depths identified in Addendum 1 of the QAMP (Bos et al. 2022). The exception is a change in salinity replicate samples. In 2023, we collected ten replicate samples from annual in-house bath assessments and sent them to the University of Washington (UW) for external analysis. We will continue this in 2024. The annual assessment will occur in September/October to make sure an annual check of field conductivity sensors and an internal benchtop salinometer used for Marine Monitoring Lab analysis of salinity (Coleman 2022). Also, we will collect three replicates from monthly in-house bath assessments. The monthly assessments evaluate field sensor performance and benchtop salinometer. We will compare the three sample replicates with the benchtop salinometer and evaluate this instrument against international seawater standards for calibration (Young et al. 2023).

8.0 Field Procedures

8.2 Measurement and sampling procedures

We plan to continue deploying a CTD package with Sea-Bird Scientific (formerly Sea-Bird Electronics) SBE 25*plus* and WET Labs' and Satlantic's auxiliary sensors under the same company umbrella. One change is that we plan to use RBR Global's CTD package integrated with an optical dissolved oxygen sensor. This package is intended for sampling in coastal bays with shallow station depths and, therefore, less discrete bottle samples to collect for laboratory analysis. A six-month side-by-side comparison of our SBE 25*plus* against the RBR Global CTD package will be conducted before RBR's CTD package is deployed solely for coastal bay data acquisition.

We will continue the sample collection plan outlined in Table 8 of Addendum 2 of the QAMP (Coleman et al. 2023).

8.8 Other activities

We will continue to collect zooplankton samples for the Salish Sea Marine Survival Project (SSMSP) at one of the Strait of Juan de Fuca stations, SJF002, along with two vertical net tows for zooplankton at Hood Canal stations HCB003 and HCB004. For more information on SSMSP, see the Pacific Salmon Foundation's Salish Sea Marine Survival Project — 2017 – 2018 Research Plan (PSF 2016).

9.0 Laboratory Procedures

9.1 Laboratory procedures table

Table 8 lists the laboratory methods we will use to analyze water samples during 2024. There is no change from the 2022 analytical methods identified in Addendum 1 of the QAMP (Bos et al. 2022). Total nitrogen has a new reporting limit because a new laboratory instrument changed the limit from a previous instrument.

Table 8. Laboratory measurement methods, expected ranges, and reporting limits.

Measurement Lab Analyte	Matrix	Expected Range	Reporting Limit	Analytical Methods
Total Alkalinity	Seawater	500–2180 (µmol kg^{-1})	±0.1% µmol kg^{-1}	Dickson et al., 2007 (SOP 3b)
Dissolved Inorganic Carbon	Seawater	550–2160 (µmol kg^{-1})	±0.1% µmol kg^{-1}	Dickson et al., 2007 (SOP 2)
Particulate Organic Carbon	Seawater	40–15000 µg/L	40 µg/L	EPA 440.0
Particulate Nitrogen	Seawater	1–1600 µg/L	5 µg/L	EPA 440.0

Measurement Lab Analyte	Matrix	Expected Range	Reporting Limit	Analytical Methods
Total Organic Carbon	Seawater	1–8 mg/L	0.5 mg/L	SM 5310 B
Total Nitrogen	Seawater	0.025–1.00 mg/L	0.1 mg/L	SM 4500-N B
Dissolved Inorganic Nitrate	Seawater	0.00–40.00 µM	0.15 µM	EPA 353.4; IOC, 1994
Dissolved Inorganic Nitrite	Seawater	0.00–2.00 µM	0.01 µM	EPA 353.4; IOC, 1994
Dissolved Inorganic Ammonium	Seawater	0.00–10.00 µM	0.05 µM	EPA 349
Dissolved Inorganic Orthophosphate	Seawater	0.00–4.00 µM	0.02 µM	EPA 365.5; IOC, 1994
Dissolved Inorganic Silicate	Seawater	0.00–200.00 µM	0.21 µM	EPA 366; IOC, 1994
Chlorophyll *a*	Seawater	0.00–200.00 µg/L	0.01 mg/L	EPA 445.0
Salinity	Seawater	0.00–36.00 PSU	0.002 PSU	IOC, 1994
Salinity	Seawater	0.05–39.00 PSU	0.05 PSU	Ecology SOP EAP053; Coleman, 2022

12.0 Audits and Reports

12.1 Field, laboratory, and other audits

Data audits are conducted monthly on sensor and lab data after they have been processed and uploaded to the EAPMW database. Annual audits are conducted for every sampling year after data have been finalized. These audits occur four to six months after the sampling year is completed.

To audit lab data, we track, reconcile, and monitor the status of samples delivered to all laboratories for analyses and track any problems that arise. After the sampling year, we will conduct several audits to assess overall attainment, identify missing or erroneous results, and summarize overall completeness.

We audit sensor data results from initial collection through processing and review to finalization. We monitor counts by month and station at multiple points in the workflow. We look for missing, duplicate, or irregular data results. A final step is to audit our EAPMW database and the agency EIM database after loading data. This tracking to determine "conservation of data points" makes sure all data have been flagged appropriately and no data are overlooked, duplicated, or lost.

12.2 Responsible personnel

Table 9. Staff responsible for data quality assurance and audits.

Marine Monitoring Staff	Title	Responsibilities
Christopher Krembs	Senior Oceanographer	Audits of historical sensor and lab data sets. Monthly participation in CTD data reviews, including nitrate sensor data. Monthly data statistical analysis of bath sensor assessment. Leads routine data finalization work and special data QC and management projects.
Micah Horwith	Ocean Acidification Senior Scientist	Leads data statistical analysis, QA/QC, and audits of the TA, DIC, and salinity data. Monthly review of the TA/DIC and dissolved oxygen field and laboratory data. Leads routine O.A. data finalization work.
Alex Fisher	Physical Oceanographer	Generates monthly review products of water masses and temperature-salinity trends. Conducts monthly review of CTD temperature, salinity, and density data. Rotating data duties to run monthly audits at all stages of QC. Conducts variety of audits on an as-needed basis. Leads routine data finalization work and special data QC and management projects.
Suzan Pool	Marine Monitoring Scientist	Business lead for marine waters data management with EAP Information Technology group. Conducts monthly review of CTD temperature, salinity, and density data. Rotating data duties to run monthly audits at all stages of QC. Conducts routine, historical, and current data audits. Leads routine data finalization work and special data QC and management projects.
Holly Young	Marine Waters Field Lead	Monthly review of the CTD fluorescence data. Leads the monthly tracking, reconciliation, QA/QC, and audits of field and laboratory data. Supports variety of audits on an as-needed basis.
Christopher Jendrey	Marine Waters Field Scientist	Monthly review of the CTD transmissometer and turbidity data. Monthly tracking, reconciliation, QA/QC, and audits of field and laboratory data. Supports variety of audits on an as-needed basis.
Natalie Coleman	Ocean Acidification Scientist	Leads the tracking, reconciliation, QA/QC, and audits of TA, DIC, and salinity data and other field and lab data. Monthly review of the TA, DIC, and dissolved oxygen field and laboratory data. Supports variety of audits on an as-needed basis.
Creston Wood	Marine Monitoring Technician	Monthly review of CTD transmissometer and turbidity data. Supports monthly tracking, reconciliation, QA/QC, and audits of field and laboratory data. Supports variety of audits on an as-needed basis.

CTD: conductivity-temperature-depth
DIC: Dissolved inorganic carbon
TA: Total alkalinity

12.4 Responsibility for reports

Table 10. Staff responsible for reports.

Marine Monitoring Staff	Title	Responsibilities
Christopher Krembs	Senior Oceanographer	Audits of historical sensor and lab data sets. Monthly participation in CTD data reviews. Monthly data statistical analysis of bath sensor assessment. Leads routine data finalization work and special data QC and management projects.
Alex Fisher	Physical Oceanographer	Leads data statistical analysis, QA/QC, and audits of physical variables.
Suzan Pool	Marine Monitoring Scientist	Monthly review of the CTD temperature, salinity, and density data. Rotating data duties to run monthly audits at all stages of QC. Conducts variety of audits on an as-needed basis. Leads routine data finalization work and special data QC and management projects.

CTD: conductivity-temperature-depth

15.0 References

Bos, J., Coleman, N., Horwith, M. Rauschl, E., Albertson, S., Ruffner, J., Krembs, C. 2022. Addendum 1 to Quality Assurance Project Plan: Long-Term Marine Waters Monitoring, Water Column Program. Publication 22-03-103. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/2203103.html.

Coleman, N. 2022. Standard Operating Procedure EAP053, Version 1.0: Marine Water Salinity Sample Analysis. Publication 22-03-201. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/2203201.html

Coleman, N., Pool, S., Young, H., Horwith, M., Krembs, C., and Ruffner, J. 2023. Addendum 2 to Quality Assurance Monitoring Plan: Long-Term Marine Waters Monitoring, Water Column Program. Publication 23-03-109. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/2303109.html.

Keyzers, M., Bos, J., Albertson, S. 2020. Quality Assurance Monitoring Plan: Long-Term Marine Waters Monitoring, Water Column Program. Publication 21-03-108. Washington State Department of Ecology, Olympia. https://apps.ecology.wa.gov/publications/SummaryPages/2103108.html.

MMC [Monitoring Management Committee]. 1988. Puget Sound Ambient Monitoring Program: Final Report. Puget Sound Water Quality Authority, Olympia, WA. https://www.eopugetsound.org/sites/default/files/features/resources/PugetSoundCommResearch1988Optimized.pdf

PSF [Pacific Salmon Foundation]. 2016. Salish Sea Marine Survival Project — 2017 – 2018 Research Plan. PSF, 300-1682 West 7th Ave., Vancouver, BC, Canada V6J 4S6. https://marinesurvival.wpengine.com/wp-content/uploads/Strait-of-Georgia-Marine-Survival-Research-Plan-2017-2018.pdf

Young, H., Coleman, N., Pool, S., Krembs, C. 2023. Standard Operating Procedure EAP086, Version 4.0: Marine Waters Sensor Performance Assessment – Lab Procedures. (In Publication). Washington State Department of Ecology, Olympia.