

Quality Assurance Project Plan

Morro Bay National Estuary Program's
Monitoring Program

Prepared for
Central Coast Regional Water Quality Control Board
895 Aerovista Place, Suite 101
San Luis Obispo, CA 93401

and

United States Environmental Protection Agency, Region IX
75 Hawthorne Street
San Francisco, CA 94105

Prepared by
Morro Bay National Estuary Program

December 10, 2021
Version FINAL 15.1

GROUP A ELEMENTS: PROJECT MANAGEMENT

1. TITLE AND APPROVAL SHEETS

Quality Assurance Project Plan

For

PROJECT NAME: Morro Bay National Estuary Program's Monitoring
Program

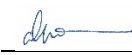
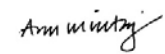
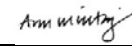
Proposal Identification Number: _____

Date: December 10, 2021

NAME OF RESPONSIBLE ORGANIZATION : Morro Bay National Estuary Program

APPROVAL SIGNATURES
(Add or delete signature lines as needed)

GRANT ORGANIZATION:

<u>Title:</u>	<u>Name:</u>	<u>Signature:</u>	<u>Date:</u>
MBNEP Program Director	Lexie Bell		10-27-2021
MBNEP Program Manager	Ann Kitajima		10-27-2021
QA Officer	Ann Kitajima		10-27-2021

REGIONAL BOARD:

<u>Title:</u>	<u>Name:</u>	<u>Signature:</u>	<u>Date:</u>
QA Officer	Mary Hamilton		

STATE WATER RESOURCES CONTROL BOARD:

<u>Title:</u>	<u>Name:</u>	<u>Signature:</u>	<u>Date:</u>
QA Officer	Andrew Hamilton		02-09-2022

US Environmental Protection Agency:

<u>Title:</u>	<u>Name:</u>	<u>Signature:</u>	<u>Date:</u>
USEPA Project Manager	Suzanne Marr		
USEPA QA Manager	Audrey L. Johnson		

HISTORY OF REVISIONS

Version Number	Date	Revision Details
1.0	May 15, 2002	Final approval from EPA
1.1	June 30, 2003	See table with summary of revisions
	October 27, 2003	See table with summary of revisions. EPA approval of update.
1.2	October 1, 2004	See table with summary of revisions.
	January 25, 2005	EPA approval of update.
2.0	March 31, 2006	Updated to SWAMP compatible.
2.1	April 28, 2006	Incorporated SWAMP QA Team comments into this version.
2.2	July 9, 2006	Incorporated final revisions and comments into this version.
2.3	January 29, 2007	Incorporated EPA comments and awaiting approval before finalizing.
	March 30, 2007	EPA approval of response to comments. Document finalized to be submitted to EPA for signatures.
3.1	August 7, 2007	Annual update submitted to RWQCB for approval.
3.2	August 28, 2007	Responded to RWQCB comments and resubmitted for approval.
3.3	October 9, 2007	Received RWQCB approval of response to comments and generated final document.
4.1	March 26, 2008	Annual update to document for EPA approval.
4.2	October 10, 2008	Responded to EPA comments and resubmitted for approval.
4.3	October 30, 2008	Received final approval from EPA and finalized document for signatures.
5.1	October 30, 2009	Annual update submitted to EPA for approval.
5.2	January 12, 2010	Received conditional approval from EPA and finalized document for signatures, incorporating comments from Mark Kutnink in his email dated December 29, 2009.
6.1	January 12, 2011	Annual updates submitted to EPA for approval.
6.1	August 16, 2011	Received approval from EPA's Office of Quality Assurance.
6.1	August 31, 2011	Received approval from the QA Officer of the CCRWQCB.
6.1	September 12, 2011	Finalized Version 6.1 of the document.
7.1	August 7, 2012	Annual updates submitted to EPA for approval.
7.1	August 21, 2012	Received approval from EPA's Office of Quality Assurance.

Version Number	Date	Revision Details
7.1	December 10, 2012	Received approval from the QA Officer of the CCRWQCB.
8.1	August 21, 2013	Annual updates submitted to EPA for approval.
8.2	September 18, 2013	Received approval from EPA's Office of Quality Assurance.
9.1	September 15, 2014	Annual updates submitted to EPA for approval
9.1	December 30, 2014	Received approval from EPA's Office of Quality Assurance
10.1	December 14, 2015	Annual updates submitted to EPA for approval
10.1	February 9, 2016	Received approval from EPA's office of Quality Assurance
11.1	February 7, 2017	Annual updates submitted to EPA for approval
11.1	February 14, 2017	Received approval from EPA's office of Quality Assurance
12.1	March 22, 2018	Annual updates submitted to EPA for approval
12.1	March 30, 2018	Received approval from EPA's office of Quality Assurance
12.2	September 26, 2018	Received approval from SWRCB Office of QA
13.1	March 22, 2019	Annual updates submitted to EPA for approval
13.1	April 30, 2019	Annual updated version revised with additional information for ocean acidification monitoring
13.1	June 17, 2019	Received approval from EPA's Office of Quality Assurance
13.1	July 10, 2019	Received approval from SWRCB Office of QA
14.1	August 4, 2020	Annual updates submitted to EPA for approval
14.1	September 24, 2020	Received approval from EPA's Office of Quality Assurance
14.1	December 7, 2020	Received approval from SWRCB Office of QA
15.1	September 14, 2021	Annual updates submitted to EPA for approval
15.1	October 26, 2021	Received approval from EPA's Office of Quality Assurance
15.1	November 17, 2021	Annual updates submitted to SWRCB Office of QA

2. TABLE OF CONTENTS

	Page:
Group A Elements: Project Management	1
1. Title and Approval Sheets.....	1
2. Table of Contents.....	5
3. Distribution List.....	8
4. Project/Task Organization.....	9
4.1 Involved parties and roles.	9
4.2 Quality Assurance Officer role	10
4.3 Persons responsible for QAPP update and maintenance.	10
4.4 Organizational chart and responsibilities.....	11
5. Problem Definition/Background	12
5.1 Problem statement.....	12
5.2 Decisions or outcomes	12
5.3 Water quality or regulatory criteria.....	13
6. Project/Task Description.....	14
6.1 Work statement and produced products.....	14
6.2. Constituents to be monitored and measurement techniques	17
6.3 Project schedule	19
6.4 Geographical setting	20
6.5 Constraints	20
8. Special Training Needs/Certification	51
8.1 Specialized training or certifications	51
8.2 Training and certification documentation.....	52
8.3 Training personnel	52
9. Documents And Records	53
Group B: Data Generation and Acquisition.....	53
10. Sampling Process Design.....	53
11. Sampling Methods	56
12. Sample Handling and Custody	61
12.1 Sample handling and transport.....	61
12.2 Chain of custody procedure	63
13. Analytical Methods.....	63
13.1 Analytical methods	63
14. Quality Control.....	70
14.1 Water quality monitoring.....	70
14.2 Bacteria monitoring	73
14.3 Macroinvertebrate monitoring	76
14.4 Flow monitoring.....	76
15. Instrument/Equipment Testing, Inspection, and Maintenance	78
15.1 Equipment testing, inspection and maintenance	78
16. Instrument/Equipment Calibration and Frequency.....	80
16.1 Field instruments.....	80
16.2 Laboratory analytical equipment	83
17. Inspection/Acceptance of supplies and Consumables.....	85
18. Non-Direct Measurements (Existing Data)	85
19. Data Management.....	86

Group C: Assessment and Oversight.....	87
20. Assessments & Response Actions	87
21. Reports to Management	87
Group D: Data Validation and Usability.....	88
22. Data Review, Verification, and Validation Requirements	88
23. Verification and Validation Methods.....	89
24. Reconciliation with User Requirements.....	89
References	89
Acronym List	91

List of Appendices:

APPENDIX A. MORRO BAY NATIONAL ESTUARY PROGRAM BACTERIA MONITORING PROTOCOLS.....	96
APPENDIX B. MORRO BAY NATIONAL ESTUARY PROGRAM WATER QUALITY MONITORING PROTOCOLS AND FIELD GUIDE.....	111
APPENDIX C. MORRO BAY NATIONAL ESTUARY PROGRAM YSI EXO3 SONDE CALIBRATION AND DEPLOYMENT PROTOCOLS	143
APPENDIX D. MORRO BAY NATIONAL ESTUARY PROGRAM DISSOLVED OXYGEN IN THE BAY	147
APPENDIX E. MORRO BAY MONITORING PROGRAM STREAM PROFILING PROTOCOL.....	150
APPENDIX F. MORRO BAY NATIONAL ESTUARY PROGRAM SURFACE ELEVATION TABLE MONITORING	164
APPENDIX G. MORRO BAY NATIONAL ESTUARY PROGRAM BIOASSESSMENT AND ALGAE MONITORING PROTOCOL	169
APPENDIX H. MORRO BAY NATIONAL ESTUARY PROGRAM EELGRASS PERMANENT TRANSECT MONITORING PROTOCOL.....	177
APPENDIX I. MORRO BAY NATIONAL ESTUARY PROGRAM EELGRASS INTERTIDAL BED CONDITION MONITORING PROTOCOLS	188
APPENDIX J. MORRO BAY NATIONAL ESTUARY PROGRAM MULTI-SPECTRAL EELGRASS MAPPING GROUNDTRUTHING METHOD	196
APPENDIX K. MORRO BAY NATIONAL ESTUARY PROGRAM EELGRASS RESTORATION MONITORING PROTOCOL	198
APPENDIX L. MORRO BAY NATIONAL ESTUARY PROGRAM SHOREBIRD SURVEY PROTOCOL.....	203
APPENDIX M. MORRO BAY NATIONAL ESTUARY PROGRAM'S SUSPENDED SEDIMENT MONITORING PROTOCOL	210
APPENDIX N. MORRO BAY NATIONAL ESTUARY PROGRAM EQUIPMENT CALIBRATION PROTOCOLS.....	235
APPENDIX O. MORRO BAY NATIONAL ESTUARY PROGRAM DATA MANAGEMENT PROTOCOLS.....	250
APPENDIX P. MORRO BAY NATIONAL ESTUARY PROGRAM PRESSURE TRANSDUCER PROTOCOL.....	257
APPENDIX Q. MORRO BAY NATIONAL ESTUARY PROGRAM EELGRASS SEED TRANSPLANT MONITORING PROTOCOL	262
APPENDIX R. MORRO BAY NATIONAL ESTUARY PROGRAM CONTINUOUS TEMPERATURE LOGGER PROTOCOL	269
APPENDIX S. MORRO BAY NATIONAL ESTUARY PROGRAM STORMWATER MONITORING PROTOCOL	273
APPENDIX T. CALPOLYSEA BIRD SEAFET PH SENSOR DEPLOYMENT AND CALIBRATION PROTOCOLS.....	279
APPENDIX U. MORRO BAY NATIONAL ESTUARY PROGRAM FRESHWATER SEEPS MONITORING	293
APPENDIX V. MORRO BAY NATIONAL ESTUARY PROGRAM MASTER SITE LIST.	295

Table of Figures:

Figure 4.4. 1. MBNEP Organizational Chart and Responsibilities	11
Figure 6.4.1. Location of Morro Bay Watershed and Tributaries	21
Figure 6.4.2. MBNEP Flow Monitoring Locations	22
Figure 6.4.3. MBNEP Creek and Bay Bacteria Monitoring Locations	23
Figure 6.4.4. MBNEP Monthly Creek Water Quality Monitoring Locations	24
Figure 6.4.5. MBNEP Creek Bimonthly Nutrient Monitoring Locations	25
Figure 6.4.6. MBNEP Bay Dissolved Oxygen Dawn Patrol Monitoring Locations	26
Figure 6.4.7. MBNEP Stream Profiling Monitoring Locations	27
Figure 6.4.8. MBNEP SET Monitoring Locations	28
Figure 6.4.9. MBNEP Bioassessment and Algae Monitoring Locations	29
Figure 6.4.10. MBNEP Eelgrass - Permanent Transect Monitoring Locations	30
Figure 6.4.11. MBNEP Eelgrass - Bed Condition Monitoring Locations	31
Figure 6.4.12. MBNEP Eelgrass - Restoration Monitoring Locations	32
Figure 6.4.14. MBNEP Shorebird Monitoring Locations	34
Figure 6.4.15. MBNEP Suspended Sediment Monitoring Locations	35
Figure 6.4.16. MBNEP Pressure Transducer Monitoring Locations	36
Figure 6.4.17. MBNEP Seeps Monitoring Locations	37
Figure 6.4.18. MBNEP Stormwater Monitoring	38
Figure 6.4.19. Cal Poly Continuous pH Monitoring	39
Figure 6.4.20. MBNEP Continuous Temperature Monitoring Locations	40

Table of Tables:

Table 4.1.1. Personnel responsibilities	9
Table 5.3.1. MBNEP screening levels for monitoring data	13
Table 6.2.1 Constituents monitored and measurement techniques	17
Table 6.3.1. Project schedule timeline	19
Table 7.1.1. Measurement quality objectives	42
Table 7.1.2. Measurement quality objectives for field measurements	48
Table 7.1.3. Measurement quality objectives for laboratory measurements	49
Table 11.1.1. Sampling locations and sampling methods.	58
Table 12.1.1. Sample handling and custody	61
Table 13.1.1. Field analytical methods	63
Table 13.1.2. Field equipment features	65
Table 13.1.3. Laboratory analytical methods	66
Table 14.1.1. Field QC for water quality monitoring	71
Table 14.1.2. Analytical QC for water quality and stormwater monitoring	72
Table 14.2.1. Field QC for bacteria monitoring	74
Table 14.2.2. Analytical QC for bacteria monitoring	74
Table 14.3.1. Analytical QC for macroinvertebrate monitoring	76
Table 14.1.2. Analytical QC for water quality and stormwater monitoring	77
Table 15.1.1. Testing, inspection, maintenance of sampling equipment and analytical instruments	79
Table 16.1.1. Testing, inspection, maintenance of field sampling equipment and analytical instruments	80
Table 16.2.1. Testing, inspection, maintenance of analytical laboratory instruments	83
Table 21.1. QA management reports	88

3. DISTRIBUTION LIST

<u>Title:</u>	<u>Name (Affiliation):</u>	<u>Tel. No.:</u>	<u>QAPP No*:</u>
<u>Contractor Program Director</u>	<u>Lexie Bell (MBNEP)</u>	<u>805-772-3834</u>	<u>1</u>
<u>Contractor Program Manager/QA Officer /VMP staff</u>	<u>Ann Kitajima (MBNEP)</u>	<u>805-772-3834</u>	<u>ORIGINAL</u>
<u>Regional Board QA Officer</u>	<u>Mary Hamilton</u>	<u>805-542-4768</u>	<u>1</u>
<u>USEPA Project Manager</u>	<u>Suzanne Marr (USEPA)</u>	<u>415-972-3468</u>	<u>1</u>
<u>USEPA QA Officer</u>	<u>Audrey L. Johnson (USEPA)</u>	<u>415-972-3431</u>	<u>1</u>
<u>MBNEP Technical Working Group</u>	<u>Yarrow Nelson</u>	<u>805-756-1347</u>	<u>1</u>

4. PROJECT/TASK ORGANIZATION

4.1 Involved parties and roles.

The Morro Bay National Estuary Program (MBNEP) is a collaborative organization that brings local citizens, local government, non-profits, agencies and landowners together to protect and restore the physical, biological, economic and recreational values of the Morro Bay estuary.

Lexie Bell is the program director of the MBNEP. She approves the contract invoices developed by the program manager. The program manager reports directly to the program director.

Ann Kitajima is the MBNEP's Assistant Director, as well as the MBNEP Volunteer Monitoring Program (VMP) manager, and is referred to as the MBNEP Program Manager throughout this document. She also serves as the MBNEP Quality Assurance (QA) Officer for the project. She is responsible for all aspects of the project including organizing VMP staff, scheduling of monitoring, selection and maintenance of monitoring equipment, field and in-house analysis of samples, and contact with the labs used for quality assurance purposes. She is responsible for all contract submittals and for the activities of all VMP staff and volunteers.

The State Water Board QA Officer is responsible for ensuring that the Quality Assurance Project Plan (QAPP) adheres to the QA principles of the State Water Board. The EPA QA Officer is responsible for ensuring that the QAPP adheres to the QA principles of EPA. The Central Coast Regional Water Quality Control Board (CCRWQCB) QA Officer is responsible for ensuring that the QAPP adheres to the QA principles of the Regional Board.

BC Laboratories, Inc. is the lab that conducts nutrient and stormwater analysis and QA analysis for the MBNEP. This contract laboratory is not directly responsible for delivery of any contract submittals. The San Luis Obispo County Public Health Agency Laboratory conducts the analysis of total coliform, *E. coli* and enterococcus samples. This contract laboratory is not directly responsible for delivery of any contract submittals. Both labs will analyze submitted samples in accordance with all method and quality assurance requirements found in this QAPP.

Ecoanalysts, Inc. conducts the analysis of macroinvertebrate samples. The lab will analyze submitted samples in accordance with all method and quality assurance requirements found in this QAPP. This contract laboratory is not directly responsible for delivery of any contract submittals.

Table 4.1.1. Personnel responsibilities

Name	Organizational Affiliation	Title	Contact Information (Telephone number, fax number, email address.)
Ann Kitajima	MBNEP Monitoring Program	Program Manager/Assistant Director/QA Officer	805-772-3834, (f) 805-772-4162, annk@mbnep.org
Lexie Bell	MBNEP	Program Director	805-772-3834, (f) 805-772-4162, lbell@mbnep.org
Stuart Buttram	BC Laboratories	Technical Director	800-878-4911, ex. 240, stuart@bclabs.com
Dr. James Beebe	San Luis Obispo County Public Health Agency	Laboratory Director	805-781-5512, (f) 805-781-1023, jbeebe@co.slo.ca.us

Name	Organizational Affiliation	Title	Contact Information (Telephone number, fax number, email address.)
Gary Lester	EcoAnalysts, Inc.	President	208-882-2588, glester@ecoanalysts.com
Joe Christen	California Department of Public Health	Environmental Scientist	510-412-4638, joe.christen@cdph.ca.gov
John Callaway	University of San Francisco	Project Manager for SET project	(415) 422-5702, callaway@usfca.edu

4.2 Quality Assurance Officer role

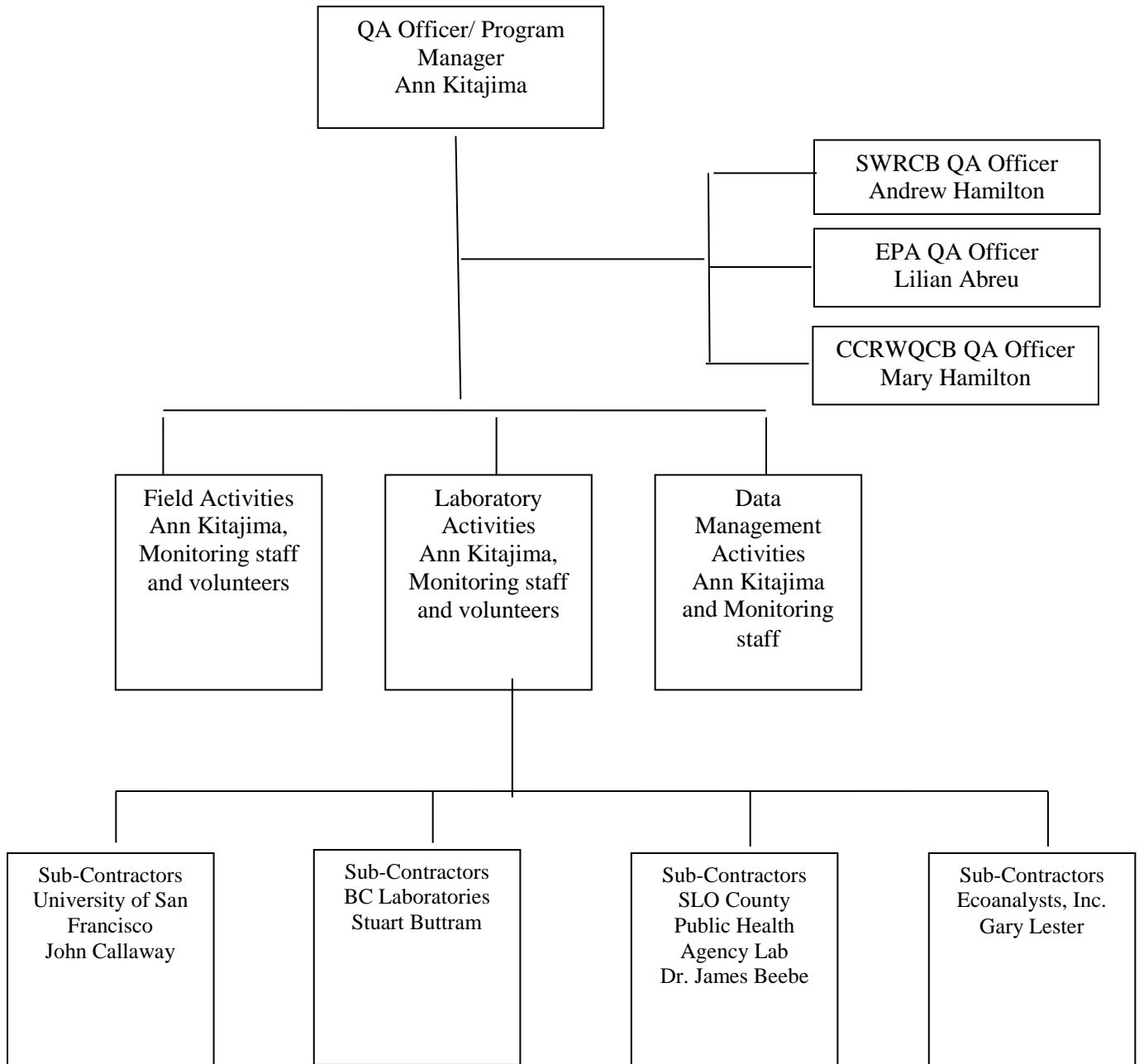
The MBNEP Program Manager is responsible for general oversight of the program including grant management, volunteer recruitment and training, protocol development, data management, data analysis and report writing. The Program Manager also serves as the MBNEP QA Officer for this small program. While the Program Manager oversees the operations of the program, this person is not actually generating the project data. Data collection is conducted by program volunteers and staff. While they receive training and oversight from the Program Manager, their data collection is conducted independent of the Program Manager. Data management and reporting, while overseen by the Program Manager, are conducted by a MBNEP staff member. So while both the MBNEP Program Manager and QA Officer roles are fulfilled by the same individual, there is no bias in the generating of project data.

4.3 Persons responsible for QAPP update and maintenance.

The MBNEP Program Manager is the person responsible for updates to this QAPP. Changes and updates may be made after a review of the changes by the MBNEP Program Manager and QA Officer. The MBNEP Program Manager will be responsible for making the changes, submitting the drafts for review, preparing a final copy, and submitting the final for signature. The plan will be reviewed annually.

4.4 Organizational chart and responsibilities

Figure 4.4. 1. MBNEP Organizational Chart and Responsibilities



5. PROBLEM DEFINITION/BACKGROUND

5.1 Problem statement

The National Estuary Program was established in 1987 under Section 320 of the Clean Water Act to address long-term planning and management in nationally significant estuaries. In 1995, Morro Bay was accepted into the program. As part of the formation of the Morro Bay National Estuary Program (MBNEP), seven priority problems were identified as major impacts to the estuary. These priority problems are:

1. Accelerated Sedimentation
2. Bacterial Contamination
3. Elevated Nutrients Concentrations
4. Scarce Freshwater Resources
5. Toxic Pollutants
6. Preserving Biodiversity
7. Environmentally Balanced Uses

The threats to the estuary as well as proposed actions to address these threats are outlined in a Comprehensive Conservation and Management Plan for Morro Bay (CCMP). Effectiveness of these implemented actions is tracked by monitoring. The data will help assess effectiveness of implementation actions and guide future actions. The MBNEP helped to establish the Morro Bay Volunteer Monitoring Program (VMP) in the early 1990s both to provide data to guide CCMP actions and to increase public involvement and stewardship in protection of a unique natural resource. The goal of the program is to track long-term trends in the Morro Bay estuary and its watershed, as well as understand the effectiveness of implementation efforts.

5.2 Decisions or outcomes

The MBNEP QAPP is based upon the following goal and seven objectives that are consistent with overall program goals. The objectives listed are in reference to evaluation and research needs of the CCMP. These public concerns, targets and methods of measurement are described in Chapters 5-13 of the MBNEP's Environmental Monitoring Plan (EMP). Further information on targets can be found in the CCRWQCB Basin Plan and in the Total Maximum Daily Load (TMDL) regulations for the Morro Bay watershed.

The primary goal of the program is to track the implementation of CCMP actions and monitor the health of the Morro Bay ecosystem.

In addition to identifying priority problems, the CCMP identified objectives for the program, as follows:

Geomorphological Objective

- ✓ Slow sedimentation by implementing management measures that address erosion and sediment transport

Human Use Objectives

- ✓ Ensure that bay water remains of sufficient quality to support a viable commercial shellfish industry, and safe recreational uses
- ✓ Protect social, economic, and environmental benefits provided by the bay and watershed through comprehensive resource management planning
- ✓ Promote public awareness and involvement in estuarine management issues through education, outreach and use of volunteers

Water Quality (WQ) Objectives

- ✓ Ensure that bay water remains of sufficient quality to support a viable commercial shellfish industry, safe recreational uses, healthy eelgrass beds, habitats for listed species, cold water aquatic habitat, and thriving fish and shellfish populations

Living Resources Objectives

- ✓ Ensure integrity of the broad diversity of natural habitats and associated native wildlife species in the bay and watershed
- ✓ Reestablish healthy steelhead trout habitat in Chorro and Los Osos Creeks

5.3 Water quality or regulatory criteria

Criteria for MBNEP monitoring include Basin Plan standards, Central Coast Ambient Monitoring Program (CCAMP) Attention Levels and other applicable regulatory criteria. Some monitoring methods including stream profiling, shorebird surveying, surface elevation tables (SETs), stream flow, macroinvertebrates, and eelgrass do not have specific criteria for comparison.

Table 5.3.1. MBNEP screening levels for monitoring data

Parameter	Criteria ¹	Source	Comments
<i>E. coli</i> (freshwater) ²	Statistical Threshold Value: 320 MPN/100 mL (90 th percentile of data) Geomean: 100 MPN/100 mL	SWRCB, Part 3 of the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays and Estuaries of California, Bacteria Provisions and a Water Quality Standards Variance Provision	REC-1 Bacteria Water Quality Objectives
<i>Enterococcus spp.</i> (estuarine)	Statistical Threshold Value: 110 MPN/100 mL (90 th percentile of data) Geomean: 30 MPN/100 mL	SWRCB, Part 3 of the Water Quality Control Plan for Inland Surface Waters, Enclosed Bays and Estuaries of California, Bacteria Provisions and a Water Quality Standards Variance Provision	REC-1 Bacteria Water Quality Objectives
Conductivity (for Water Quality)	> 3,000 uS/cm (AGR beneficial use)	CCRWQCB Basin Plan standard	Protects water for use as irrigation water
Dissolved oxygen (freshwater)	< 7.0 mg/L (COLD) < 5.0 mg/L (WARM)	CCRWQCB Basin Plan standards	Protection of aquatic life for cold and warm freshwater
Dissolved oxygen (estuarine)	< 7.0 mg/L, median % saturation < 85% (ocean waters) (COLD, SPWN)	CCRWQCB Basin Plan standard	Protection of cold water species in estuarine environment

Parameter	Criteria ¹	Source	Comments
Nitrate as nitrogen (for Water Quality)	> 1.0 mg/L with supporting evidence, > 10 mg/L (drinking water standard)	CCRWQCB 303(d) Listing Guidance Value	Evidence includes DO < 7.0 or > 13.0 mg/L, extensive algae, etc. (Black, 2010)
Orthophosphate as PO ₄ (for Water Quality)	> 0.36 mg/L	Guideline value	Value developed specifically for Pajaro River but being used for Morro Bay. (Williamson, 1994.; Black, 2010)
pH (for Water Quality)	< 7.0 and > 8.5 (COLD, WARM, estuarine)	CCRWQCB Basin Plan Standard	
Temperature (for Water Quality)	> 21°C	CCRWQCB 303(d) Listing Guidance Value	Optimum range for steelhead of 13 to 21 °C (Moyle, 2002)
Turbidity (for Water Quality)	> 25 NTU (COLD) > 40 NTU (WARM)	CCRWQCB 303(d) Listing Guidance Value	COLD criteria (Sigler, 1984). WARM criteria (Shoup, 2009)
Ammonia (for Water Quality)	> 0.025 mg/L NH ₃ -N as unionized ammonia	CCRWQCB Basin Plan Standard	General objectives, toxicity criteria
Suspended sediment concentration of creek storm flows	NA	NA	No standards exist either in the Basin Plan or as part of CCAMP
Dissolved copper (for Stormwater)	> 0.01 mg/L	CCRWQCB Basin Plan Standard	Standards apply to receiving waters
Dissolved lead (for Stormwater)	> 0.01 mg/L	CCRWQCB Basin Plan Standard	Standards apply to receiving waters
Dissolved zinc (for Stormwater)	> 0.02 mg/L	CCRWQCB Basin Plan Standard	Standards apply to receiving waters
Oil & grease (for stormwater)	> 75 mg/L	CCRWQCB NPDES General Permit	Discharge to ocean waters

¹The criteria in this table indicate the range of concentrations that would be of concern. For example, for total coliform, values greater than 10,000 MPN/100 mL are considered to be of concern. Thus, the criteria in the table is indicated as “> 10,000 MPN/100 mL.”

² As there is no recommended EPA standard for analysis of *E. coli* in marine waters, there is no corresponding value in Table 5.3.1 for comparison of *E. coli* results in marine waters. However, this analysis is conducted by the program for marine samples because the shellfish regulations and the current Basin Plan regulations are written for fecal coliform. Because fecal coliform data is more closely comparable to *E. coli* data than enterococcus results, the program will continue to monitor for both *E. coli* and enterococcus in marine waters.

6. PROJECT/TASK DESCRIPTION

6.1 Work statement and produced products

Bacteria monitoring conducted by program staff and volunteers includes monthly sampling at sites on local creeks and in Morro Bay. All freshwater samples are analyzed for total coliform and *E. coli*, and the marine samples are analyzed for enterococcus. Volunteers and staff analyze duplicate samples, run sterility blanks, and analyze certified reference materials. Occasionally samples are processed by the San

Luis Obispo County Public Health Agency Lab due to logistics which do not allow them to be processed by MBNEP volunteers or staff. Each month, results are forwarded to various landowners and agencies so that any potential public health threats can be addressed. Data is stored in an MBNEP-maintained Access database. Deliverables include a consistent bacteria data set in electronic format and monthly notifications. All data is analyzed in monthly memos and in an annual data summary memo.

Water quality monitoring by program volunteers and staff includes monthly sampling at local creek sites throughout the Morro Bay watershed. Samples are analyzed for pH, temperature, turbidity, conductivity, dissolved oxygen (DO), and orthophosphates as PO_4 . Split samples are sent to a certified laboratory for nutrient QA analysis. Two of the water quality monitoring sites have been designated as 'Agricultural Monitoring Sites'. All of the same analysis takes place at these sites as at the other water quality sites, with the addition of samples collected for laboratory analysis for the following analytes: nitrates as nitrogen, total nitrogen, organic nitrogen, Total Kjeldahl nitrogen, ammonia, nitrite, total phosphorus and orthophosphates as P. Monitoring takes place monthly. Every other month, ten sites are monitored for nitrates and orthophosphates with analysis conducted by a certified laboratory. Data is stored in an MBNEP-maintained Access database. Deliverables include a consistent water quality data set in an electronic format. All data is analyzed in an annual data summary memo.

Seeps monitoring is conducted by program staff and includes every other month collection of samples at up to five freshwater seeps along the back bay shoreline. The flow varies depending on time of year and rainfall. Staff measures the conductivity and salinity of the seep, and collects a sample for nitrate as nitrogen analysis by a certified laboratory. Data is stored in an MBNEP-maintained Access database. Deliverables include a consistent water quality data set in an electronic format. All data is analyzed in a data summary memo.

Flow monitoring by program volunteers includes monthly monitoring at local creek sites throughout the watershed. Staff and volunteers measure creek depth and velocity, and an instantaneous flow rate is estimated from this information. Data is stored in an MBNEP-maintained Access database. Deliverables include a consistent flow data set in an electronic format. Data is provided to partners upon request to support project implementation.

Continuous water quality data is collected by program staff on a monthly basis at local creek sites throughout the watershed. The continuous monitoring equipment is deployed for a week-long time period to collect DO concentration and DO percent saturation at 30-minute intervals. Temperature data is collected in longer deployments (late spring through late fall) with data collected at 30-minute intervals. Data is stored in an MBNEP-maintained Excel database. Deliverables include a consistent water quality data set in an electronic format. All data is analyzed in an annual data summary memo.

Continuous water depth measurements are collected by program staff at local creek sites throughout the watershed. The equipment is deployed permanently at the sites and collects stage height data on 15-minute increments. Data is downloaded from the equipment on a monthly basis and stored in an MBNEP-maintained Excel database. Deliverables include a consistent water depth data set in an electronic format. Data is provided to partners upon request to support project implementation.

Continuous pH measurements in the estuary are collected by Cal Poly faculty and students at the Morro Bay T-pier and a back bay location. The equipment is deployed for approximately half of a year, with monthly checks. Data is collected in 15-minute increments, with 10 measurements taken in a burst to be averaged into a single reading. Data is downloaded from the equipment on a monthly basis and stored in a Cal Poly-maintained database. Deliverables include a consistent estuary pH data set in an electronic format. Data will be analyzed in a report after a year of data collection and will also be used to support other Cal Poly research efforts.

For bioassessment monitoring, program staff and volunteers collect samples on local creeks each year. Algae documenting is conducted in conjunction with bioassessment monitoring. Macroinvertebrate samples are sent to a contract laboratory for analysis. The lab analyzes the sample according to SWAMP SAFIT Level 2 taxonomy protocols, with counts to at least 600. The lab provides the counts as well as various calculated metrics. Data is provided in Excel format. Deliverables include a consistent bioassessment data set in electronic format. All data is analyzed in an annual data summary memo.

For stream profiling, program staff and volunteers monitor sites as needed throughout the watershed. The data is maintained in an Excel spreadsheet and is shared periodically with CCRWQCB staff. Deliverables include a consistent stream profiling data set in electronic format. Data is included in sediment reports.

For SET monitoring, sites are currently monitored approximately every five years, and more frequently if large storm events occur. During the dry season, a complete set of measurements is taken by University of San Francisco personnel at sixteen sites in the salt marsh and other shoreline areas of the bay. The results are presented in sediment monitoring reports.

For eelgrass monitoring, a contractor collects and analyzes bay-wide aerial imagery and creates a bay-wide map showing eelgrass location and density. The aerial imagery is typically collected every other fall with a digital aerial sensor with four channels. The spectral wavelength of each channel is customizable with the use of narrow-band interference filters. The digital image frames are used to generate a GIS-ready, georegistered, mosaiced false color imagery. When these flights take place, MBNEP staff conducts groundtruthing to collect data to support the classification conducted by the contractor. To track the health of eelgrass, MBNEP staff conducts four separate monitoring efforts on eelgrass in the bay: 1) Permanent transect monitoring in six areas of the bay along transects to collect shoot density and other measurements, 2) Seed transplant monitoring for life cycle stages and transplant success, 3) Intertidal bed condition monitoring to determine eelgrass bed conditions through density, patchiness, and observational data, and 4) Restoration bed monitoring on a small scale to test planting methods, locations, and seasonality. The data is stored electronically in MBNEP-maintained Excel spreadsheets. An eelgrass report is created summarizing the effort and results for the year.

Periodically the MBNEP works with a contractor to conduct bay-wide bathymetry surveys. Interferometric side scan sonar will be used in the deeper waters of the bay and LiDAR measurements will be used for the shallower areas to collect topo-bathymetric elevation point data. The contractor will seam together the data sets and conduct the classification to create the bathymetry data layer. All standard accuracy validations will be conducted to ensure data quality. The results will be shared widely with project partners and researchers. The analysis is likely to be conducted at approximately a ten-year frequency.

For bird monitoring, volunteers participate in shorebird monitoring events each fall in partnership with the Morro Coast Audubon Society to conduct bay-wide counts. The data is shared with local birding organizations and stored in electronic Excel format. It is also entered into a data portal developed by Point Blue, who shares the survey results.

For suspended sediment concentration monitoring, samples are collected from one of three creek sites during storm flows using automated samplers. Lab analysis is conducted by MBNEP staff to analyze the samples for their suspended sediment concentration. Data is stored in an MBNEP-maintained Access database. Deliverables include a consistent suspended sediment concentration dataset stored in an electronic format and sediment monitoring report summarizing the results.

For stormwater monitoring, samples are collected from eight sites in the California State Park Marina parking lot at the onset of storms capable of generating flows that drain out of the parking lot. Samples are analyzed by a contract laboratory for concentrations of oil and grease, dissolved copper, dissolved zinc, dissolved lead, total petroleum hydrocarbons from gasoline and diesel, and total suspended solids. Samples will be analyzed by the laboratory for *E. coli*. The results will be summarized in a memo that will be shared with project partners.

6.2. Constituents to be monitored and measurement techniques

Table 6.2.1 summarizes the constituents to be measured for each of the monitoring efforts described in Section 6.1.

Table 6.2.1 Constituents monitored and measurement techniques

Parameter	Monitoring Frequency	Primary or Secondary	Method
Total coliform (freshwater)	Monthly	Primary	IDEXX Colilert-18 analysis
<i>E. coli</i> (freshwater)	Monthly	Primary	IDEXX Colilert-18 analysis
<i>Enterococcus spp.</i> (marine)	Monthly	Primary	IDEXX Enterolert analysis
Conductivity (freshwater)	Monthly	Primary	Meter
Dissolved oxygen (marine and freshwater)	Monthly	Primary	Meter
Orthophosphate as PO ₄ (freshwater)	Monthly	Primary	Meter
pH (freshwater)	Continuously for one-week deployments	Primary	Meter
pH (marine)	Continuously, for approximately six months of year	Primary	Meter
Flow (freshwater)	Monthly	Primary	Meter
Water depth (freshwater)	Continuously	Primary	Meter
Temperature (marine and freshwater)	Monthly	Primary	Meter
Turbidity (freshwater)*	Monthly	Primary	Meter
Laboratory analysis - Nitrate as nitrogen (freshwater)	Once a month for Ag Monitoring Sites, every other month for Water Quality (WQ) sites	Primary	EPA Method 300.0
Laboratory analysis - Orthophosphate as P (freshwater)	Once a month for Ag Monitoring Sites, every other month for WQ sites	Primary	EPA 365.1

Parameter	Monitoring Frequency	Primary or Secondary	Method
Laboratory analysis - Total nitrogen (freshwater)	Once a month for Ag Monitoring Sites	Primary	Calculated
Laboratory analysis - Organic nitrogen (freshwater)	Once a month for Ag Monitoring Sites	Primary	Calculated
Laboratory analysis - Nitrite as N (freshwater)	Once a month for Ag Monitoring Sites and seeps sites	Primary	EPA 353.2
Laboratory analysis – Total Ammonia (freshwater)	Once a month for Ag Monitoring Sites	Primary	SM4500-NH ₃ D
Laboratory analysis - Total Kjeldahl Nitrogen (freshwater)	Once a month for Ag Monitoring Sites	Primary	EPA 351.2
Laboratory analysis - Total Phosphorus (freshwater)	Once a month for Ag Monitoring Sites	Primary	EPA 365.4
Laboratory analysis - Bioassessment Macroinvertebrates	Annually	Primary	SWAMP SAFIT Level 2 protocol
Stream profiling	As Needed	Primary	NA
SETs	As Needed	Primary	NA
Eelgrass – Permanent Transect Monitoring	Annually	Primary	NA
Eelgrass – Bed Condition Monitoring	Annually	Primary	NA
Eelgrass – Restoration Monitoring	Annually	Primary	NA
Eelgrass – Seed Transplant Monitoring	Annually	Primary	NA
Eelgrass – Baywide map	Biennially, approximately	Primary	NA
Bathymetry – baywide data set	Approximately every ten years	Primary	NA
Algae documenting	Annually with bioassessment monitoring	Primary	NA
Bird surveys	Annually	Primary	NA
Suspended sediment concentration	As needed, during storms	Primary	ASTM D 3977
Laboratory analysis – Oil & grease	As needed, during storms	Primary	EPA 1664A HEM
Laboratory analysis – Dissolved copper, dissolved zinc, dissolved lead	As needed, during storms	Primary	EPA 200.8

Parameter	Monitoring Frequency	Primary or Secondary	Method
Laboratory analysis – Total petroleum hydrocarbons – gasoline	As needed, during storms	Primary	EPA 8015B
Laboratory analysis – Total petroleum hydrocarbons – gasoline and diesel	As needed, during storms	Primary	EPA 8015B
Laboratory analysis – Total suspended solids	As needed, during storms	Primary	SM2540D

*Turbidity analysis is considered to be a field measurement run using a field meter. Due to COVID, protocols have been temporarily altered to maintain safe conditions for staff and volunteers. As a temporary measure, samples are collected in the field and brought back to the office to be run shortly after by staff and volunteers using a field meter.

6.3 Project schedule

All monitoring efforts are ongoing with the goal of tracking long-term trends and assessing project effectiveness. For each monitoring effort, the results are summarized in memos and reports. This monitoring is expected to continue, assuming adequate funding is available, beyond the conclusion of the current funding source. The monitoring program is supported by Clean Water Act (CWA) Section 320 funding. Data analysis and review is conducted at a minimum on an annual basis.

Table 6.3.1. Project schedule timeline*

Activity	Date (MM/DD/YY)		Deliverable	Deliverable Due Date
	Anticipated Date of Initiation	Anticipated Date of Completion		
Water quality, flow, bacteria, bioassessment, stream profiling, eelgrass, algae documenting, shorebird surveys	Winter 2022	Spring 2022	Annual data summary memos	None
Sedimentation: SETs, suspended sediment concentrations, stream profiling	Summer 2022	Fall 2022	Annual data summary report	None
Bacteria	Winter 2022	Spring 2022	Monthly memo, Annual data summary memo**	None
Estuarine pH	October 2020	September 2022	Brief report summarizing data	December 2022

*These initiation and completion dates are estimated target dates. The timing of these activities depends on numerous factors beyond our control including staffing availability, seasonal factors (i.e., how much rain we received and when), and others.

**A monthly memo is issued containing the results of the monthly monitoring as well as summary statistics. The focus of the memo is on data that exceeds the EPA 2012 Recreational Water Quality Criteria. We also compile an annual memo summarizing data for the past water year.

6.4 Geographical setting

The Morro Bay estuary is a 2,300-acre semi-enclosed body of water where freshwater flowing from land mixes with the saltwater of the sea. Morro Bay opens into Estero Bay. Morro Bay is fed by a 48,000-acre watershed containing two major creeks, Chorro and Los Osos. Figure 6.4.1 shows the location of the bay, its watershed and the major creeks.

This section includes maps showing monitoring sites as follows:

- Figure 6.4.1. Location of Morro Bay Watershed and Tributaries
- Figure 6.4.2. MBNEP Flow Monitoring Locations
- Figure 6.4.3. MBNEP Creek and Bay Bacteria Monitoring Locations
- Figure 6.4.4. MBNEP Monthly Creek Water Quality Monitoring Locations
- Figure 6.4.5. MBNEP Creek Bimonthly Nutrient Monitoring Locations
- Figure 6.4.6. MBNEP Bay Dissolved Oxygen Dawn Patrol Monitoring Locations
- Figure 6.4.7. MBNEP Stream Profiling Monitoring Locations
- Figure 6.4.8. MBNEP SET Monitoring Locations
- Figure 6.4.9. MBNEP Bioassessment and Algae Monitoring Locations
- Figure 6.4.10. MBNEP Eelgrass - Permanent Transect Monitoring Locations
- Figure 6.4.11. MBNEP Eelgrass - Bed Condition Monitoring Locations
- Figure 6.4.12. MBNEP Eelgrass - Restoration Monitoring Locations
- Figure 6.4.13. MBNEP Eelgrass - Seed Transplant Monitoring Locations
- Figure 6.5.14. MBNEP Shorebird Monitoring Locations
- Figure 6.4.15. MBNEP Suspended Sediment Monitoring Locations
- Figure 6.4.16. MBNEP Pressure Transducer Monitoring Locations
- Figure 6.4.17. MBNEP Seeps Monitoring Locations
- Figure 6.4.18. MBNEP Stormwater Monitoring
- Figure 6.4.19. Cal Poly Continuous pH Monitoring
- Figure 6.4.20. MBNEP Continuous Temperature Monitoring Locations

Note that coordinates for each monitoring site in the maps are listed in Appendix V.

6.5 Constraints

Low creek flow conditions can impact water quality, bacteria, flow and bioassessment monitoring. For bay monitoring, tides must be high enough to avoid stranding in the soft mud. Possible constraints for monitoring include funding for SET, eelgrass, and macroinvertebrate monitoring, which involve costly consultants or laboratories. If funding is inadequate in the future, bay-wide aerial and sonar eelgrass maps, SETs, and detailed bioassessment sample analysis may not be conducted.

The timeline for creating the products listed in Table 6.2.1 are influenced by numerous factors, including organizational capacity, staff availability, the timing of rainfall, etc. If the proposed timelines in the table cannot be met, staff will assess capacity and reschedule the completion of these products.

Figure 6.4.1. Location of Morro Bay Watershed and Tributaries

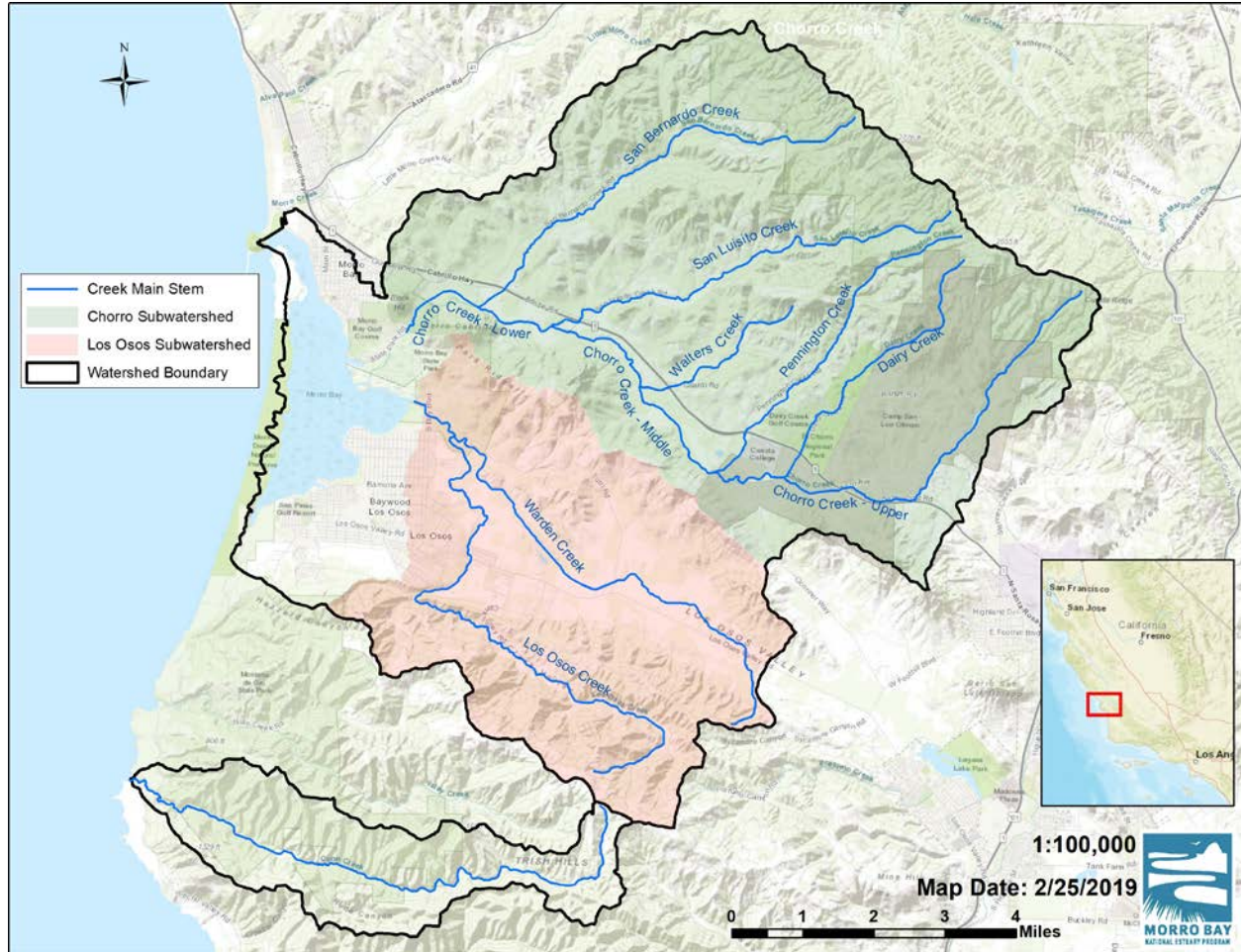


Figure 6.4.2. MBNEP Flow Monitoring Locations

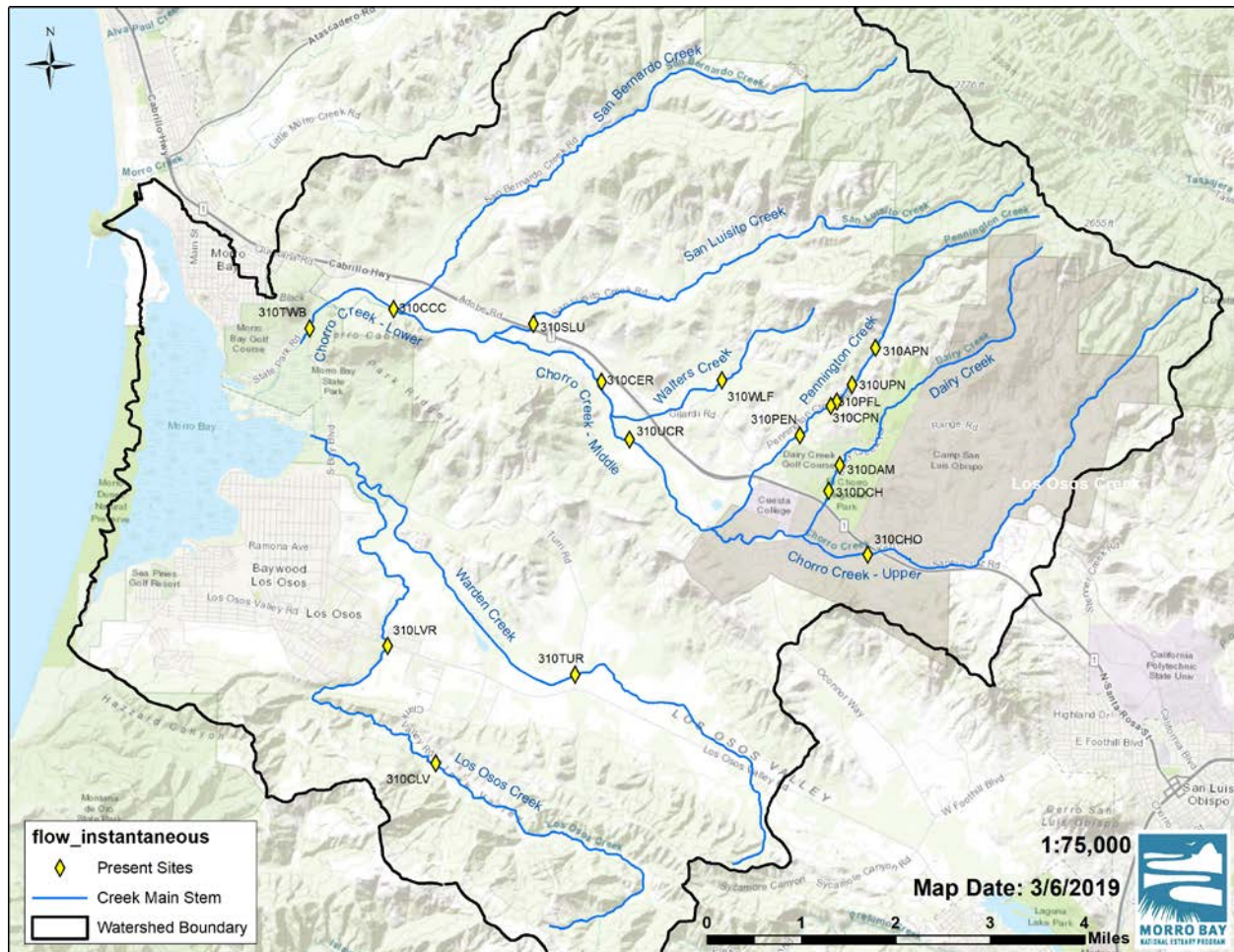


Figure 6.4.3. MBNEP Creek and Bay Bacteria Monitoring Locations

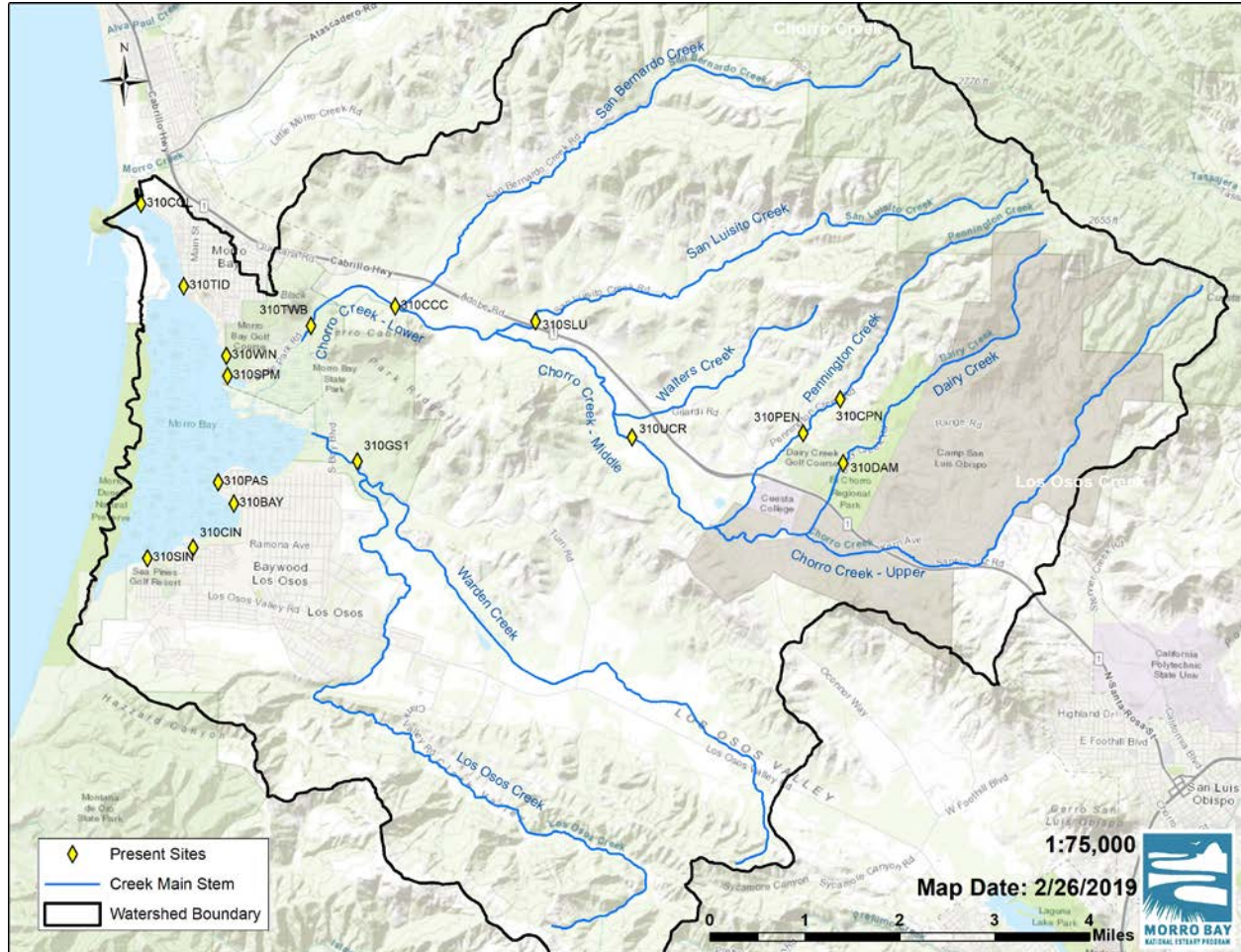
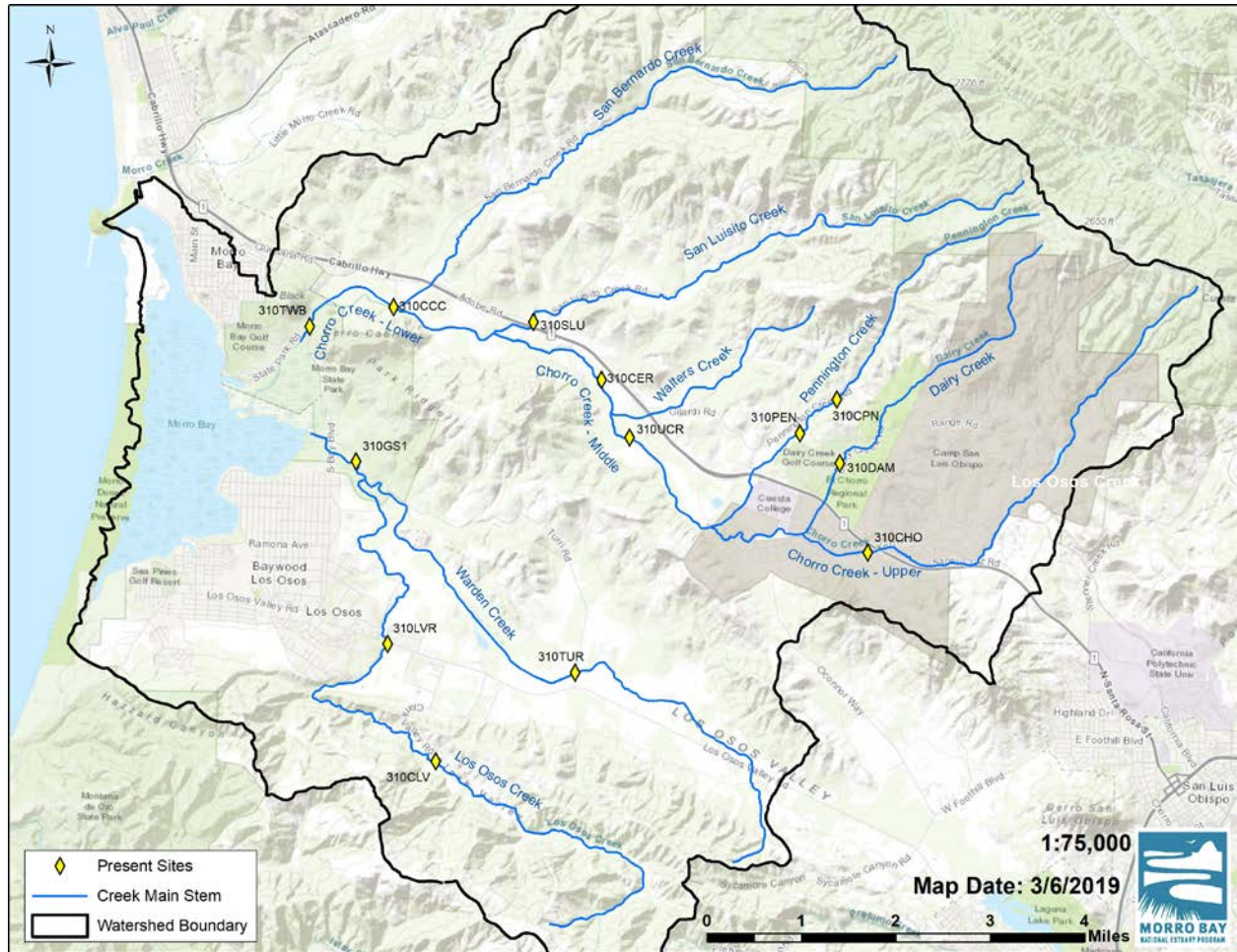


Figure 6.4.4. MBNEP Monthly Creek Water Quality Monitoring Locations



Legend:

- Present Sites (Yellow Diamond)
- Creek Main Stem (Blue Line)
- Watershed Boundary (Black Line)

Map Date: 3/6/2019

Scale: 0 to 4 Miles

Map Title: MORRO BAY NATIONAL ESTUARY PROGRAM

Figure 6.4.6. MBNEP Bay Dissolved Oxygen Dawn Patrol Monitoring Locations

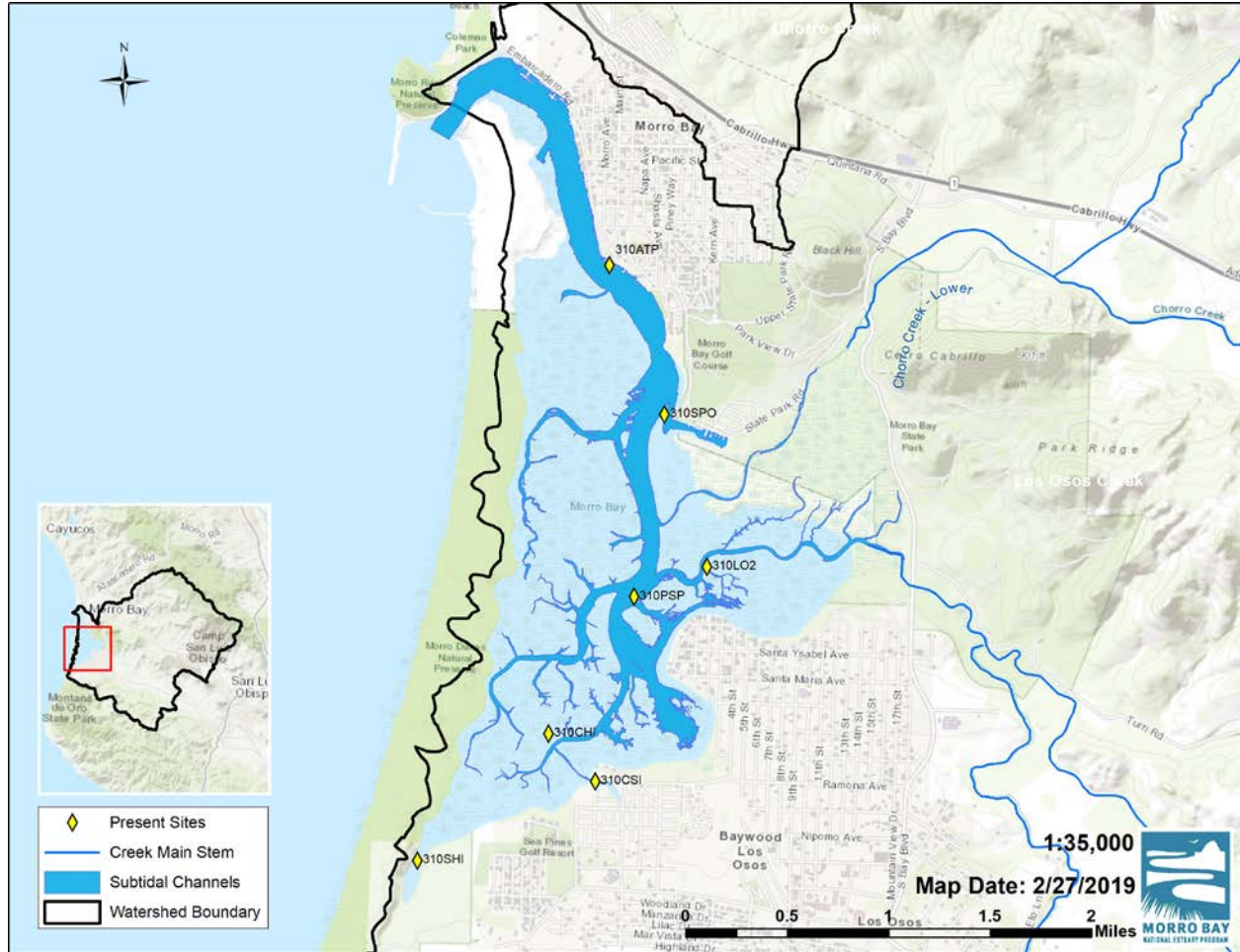


Figure 6.4.7. MBNEP Stream Profiling Monitoring Locations

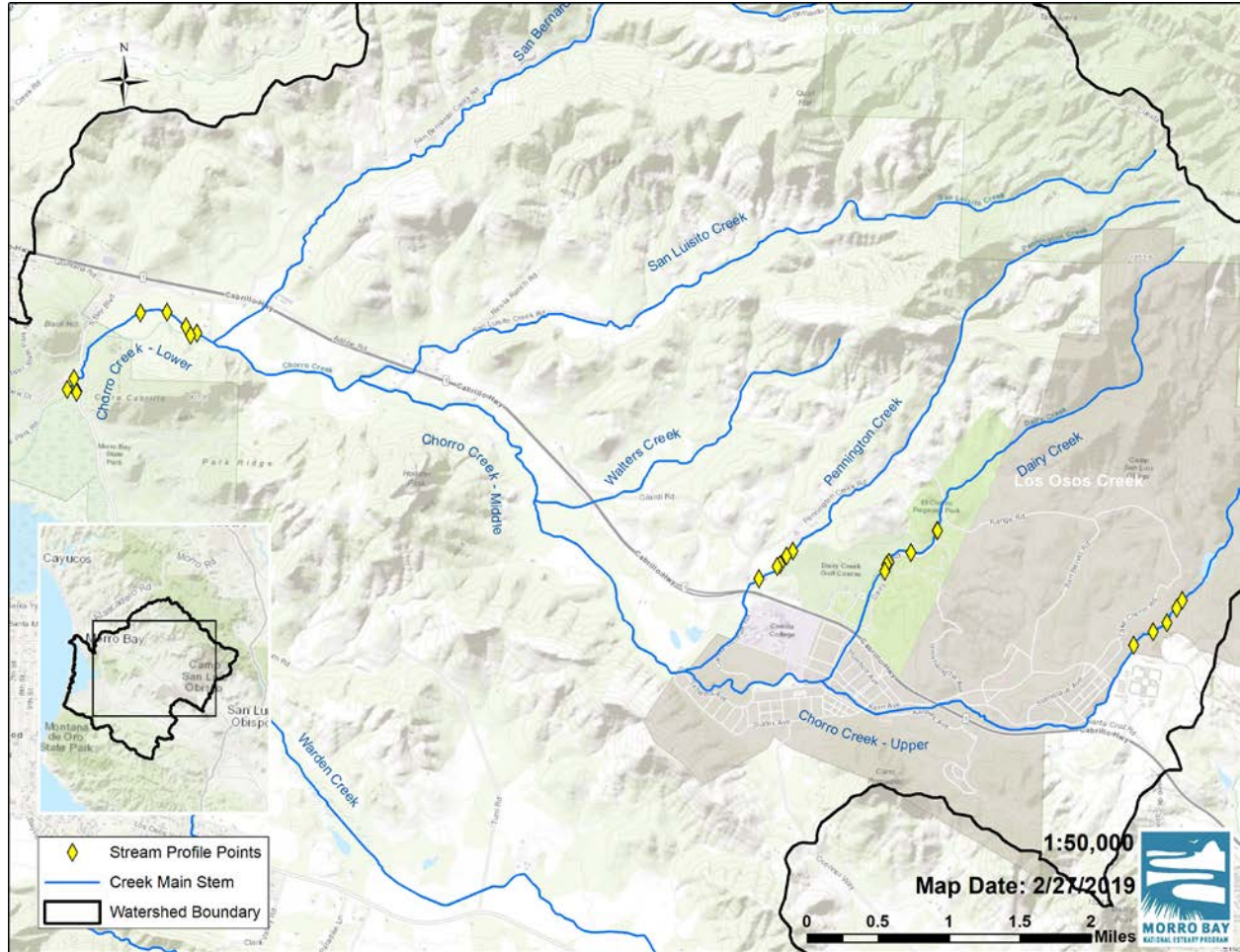


Figure 6.4.8. MBNEP SET Monitoring Locations

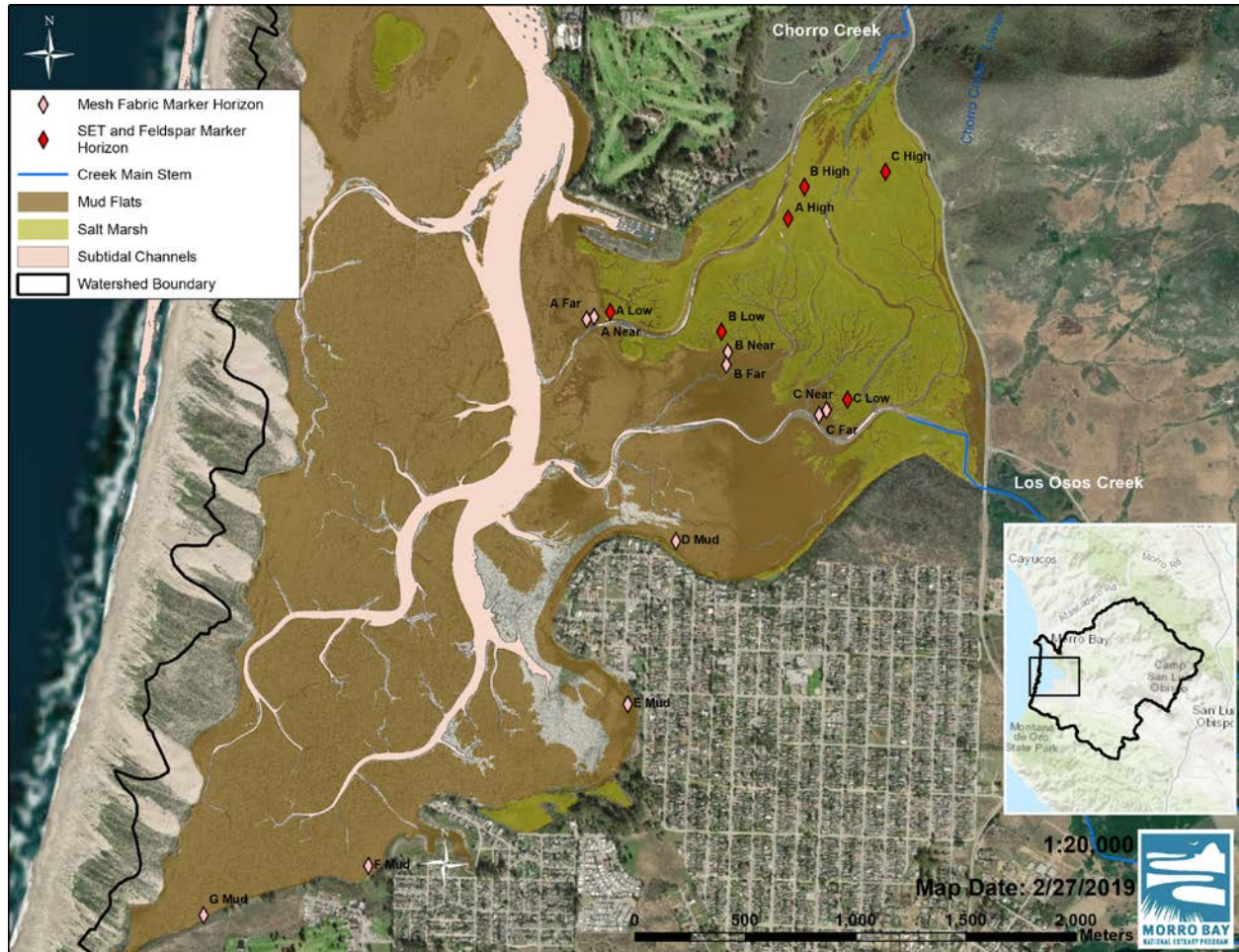


Figure 6.4.9. MBNEP Bioassessment and Algae Monitoring Locations

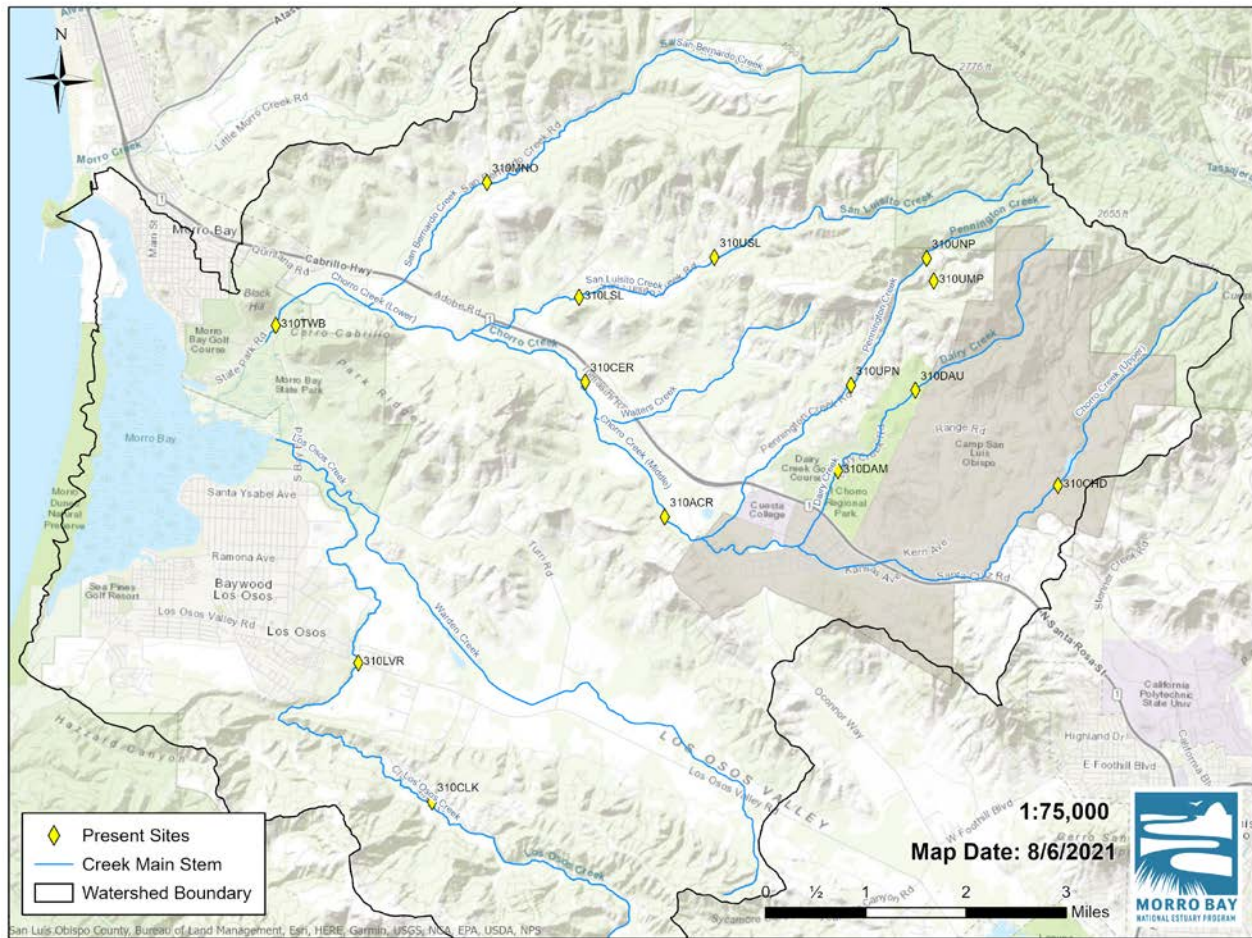


Figure 6.4.10. MBNEP Eelgrass - Permanent Transect Monitoring Locations



Figure 6.4.11. MBNEP Eelgrass - Bed Condition Monitoring Locations



Figure 6.4.12. MBNEP Eelgrass - Restoration Monitoring Locations



Figure 6.4.13. MBNEP Eelgrass - Seed Transplant Monitoring Locations

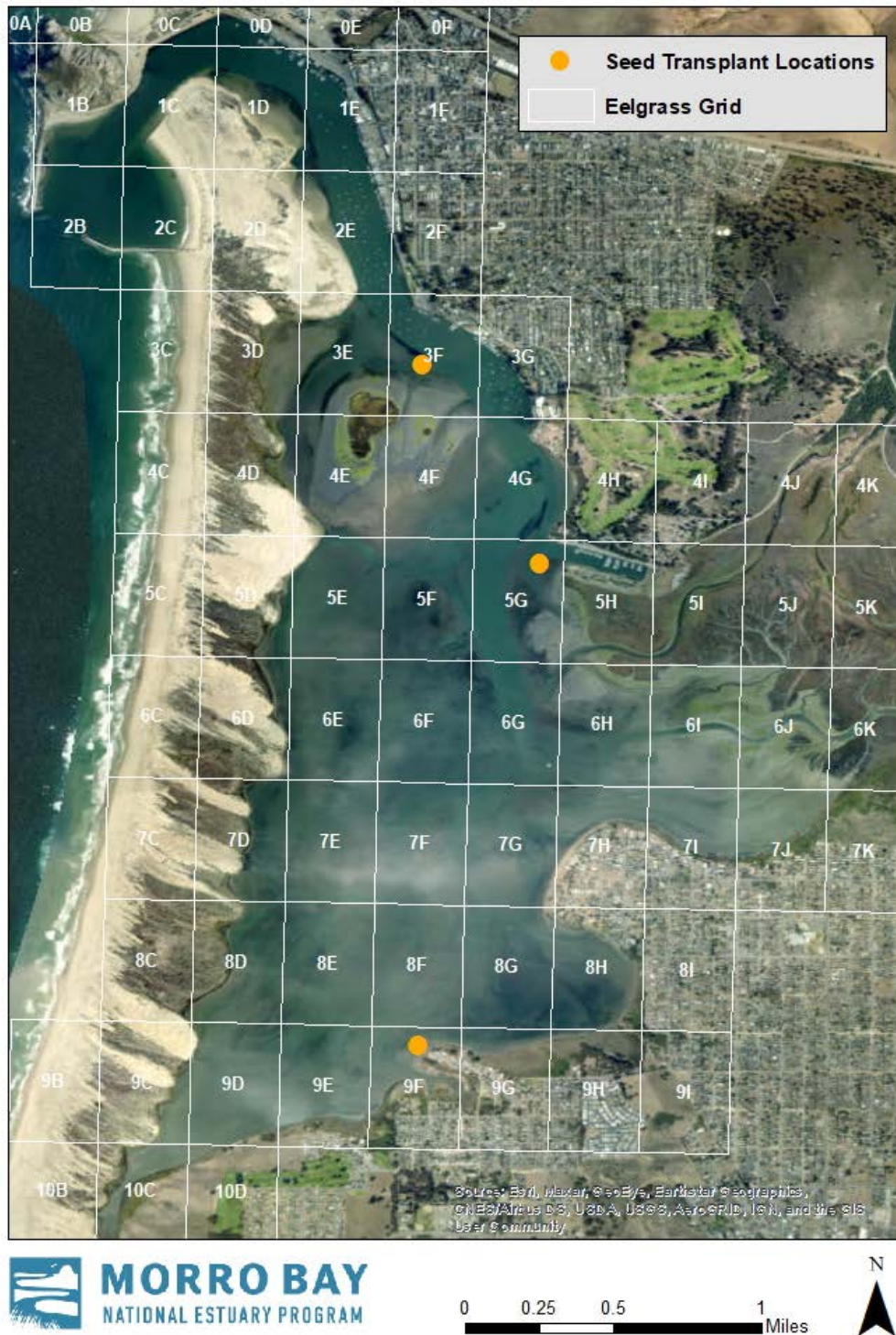


Figure 6.4.14. MBNEP Shorebird Monitoring Locations

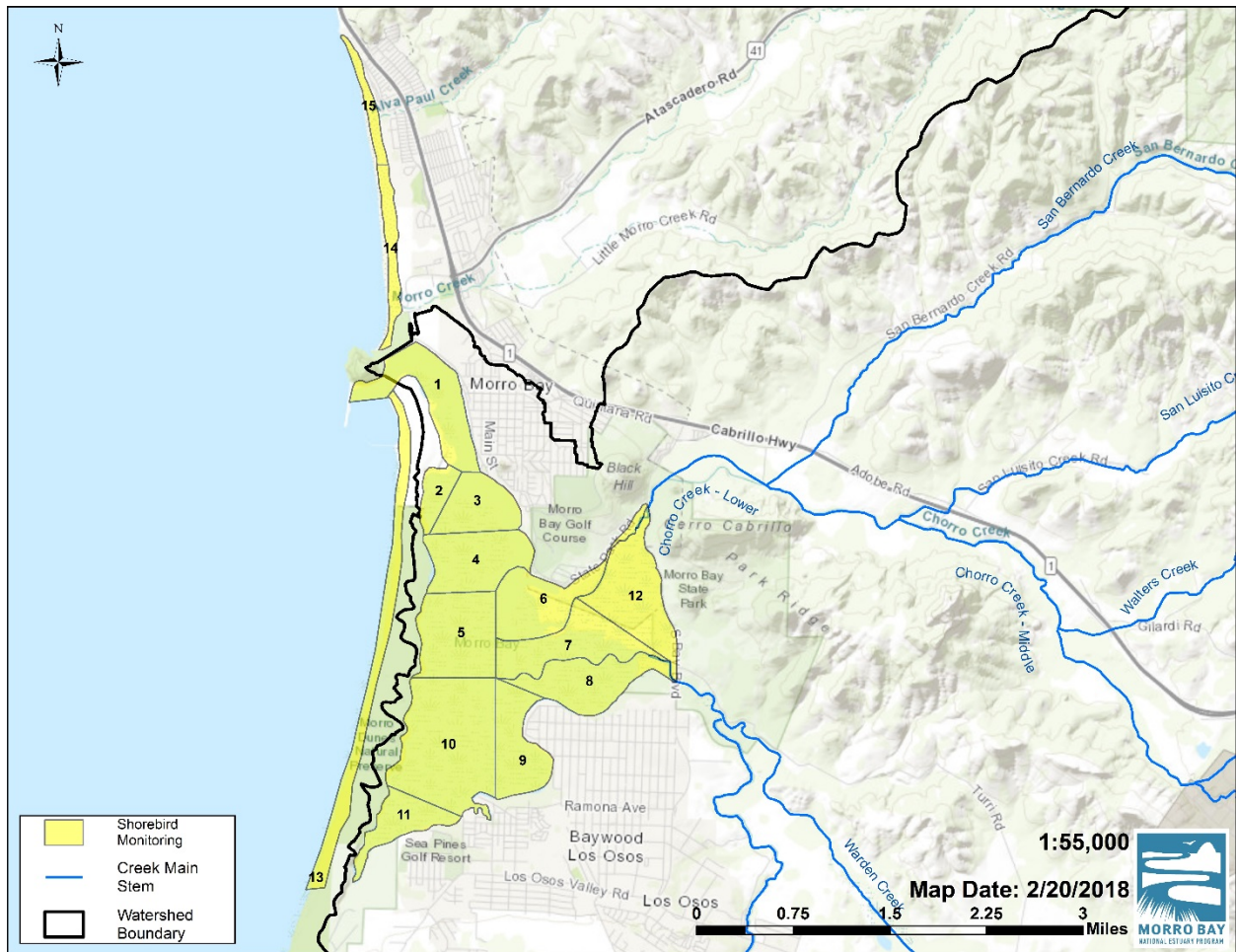


Figure 6.4.15. MBNEP Suspended Sediment Monitoring Locations

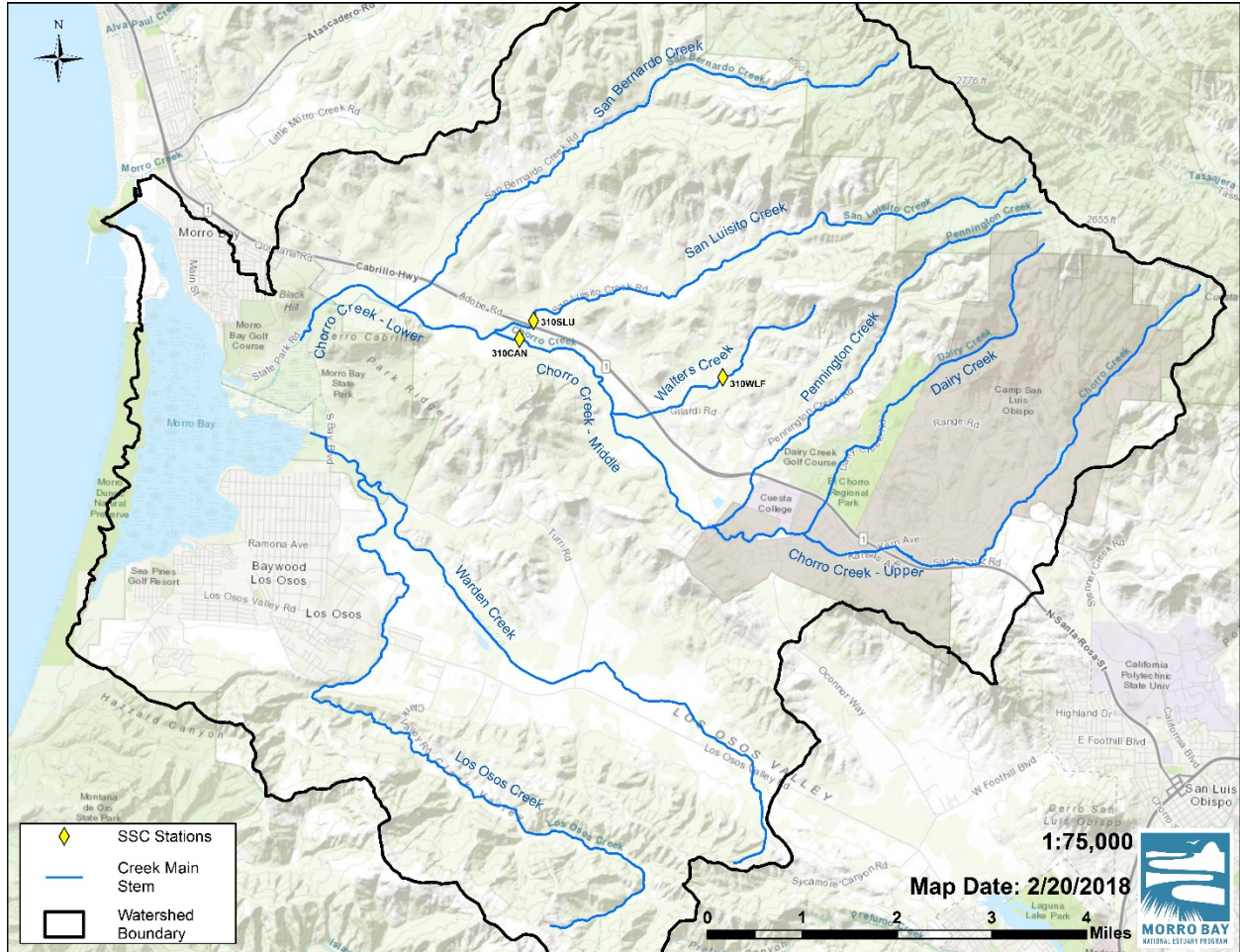


Figure 6.4.16. MBNEP Pressure Transducer Monitoring Locations

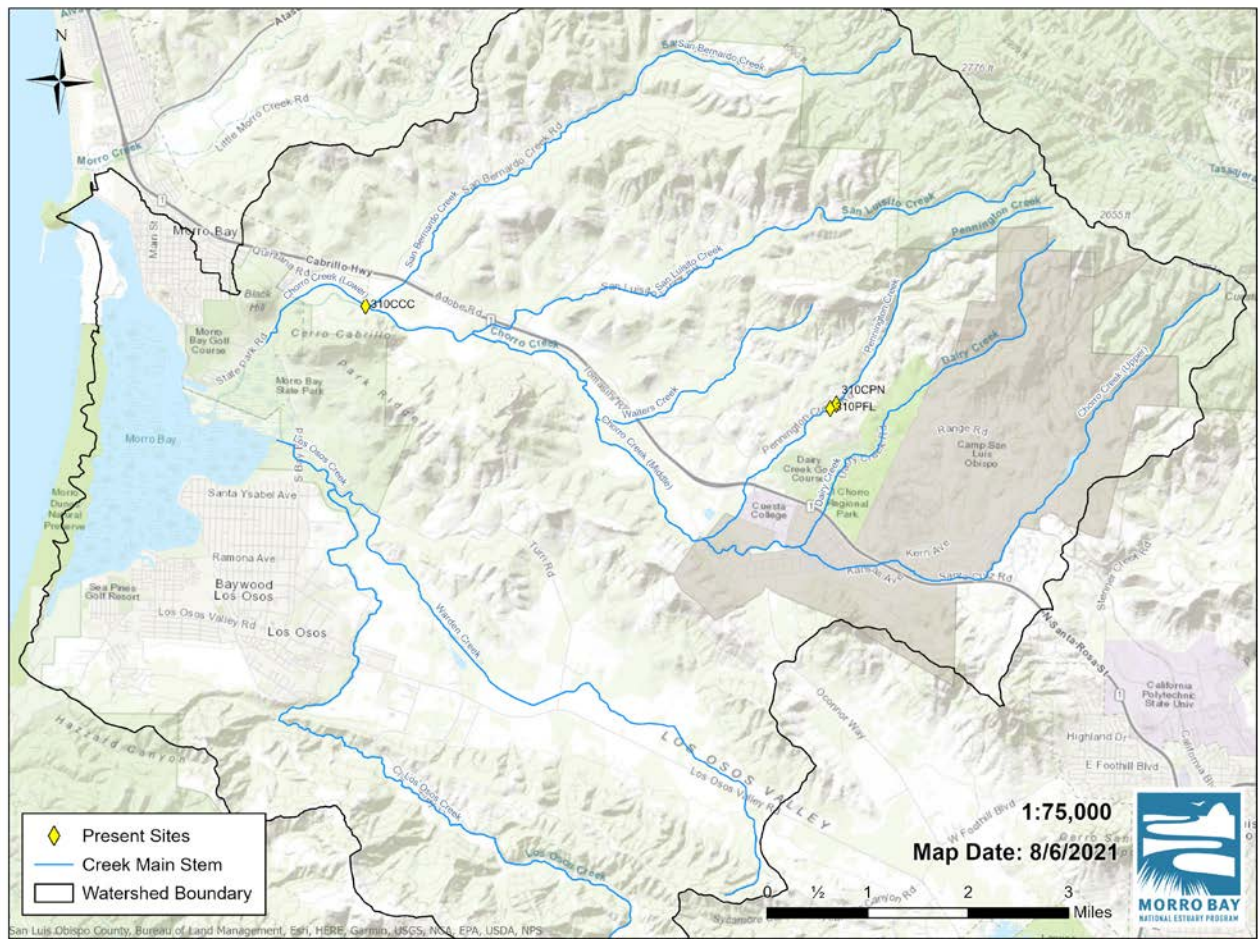


Figure 6.4.17. MBNEP Seeps Monitoring Locations

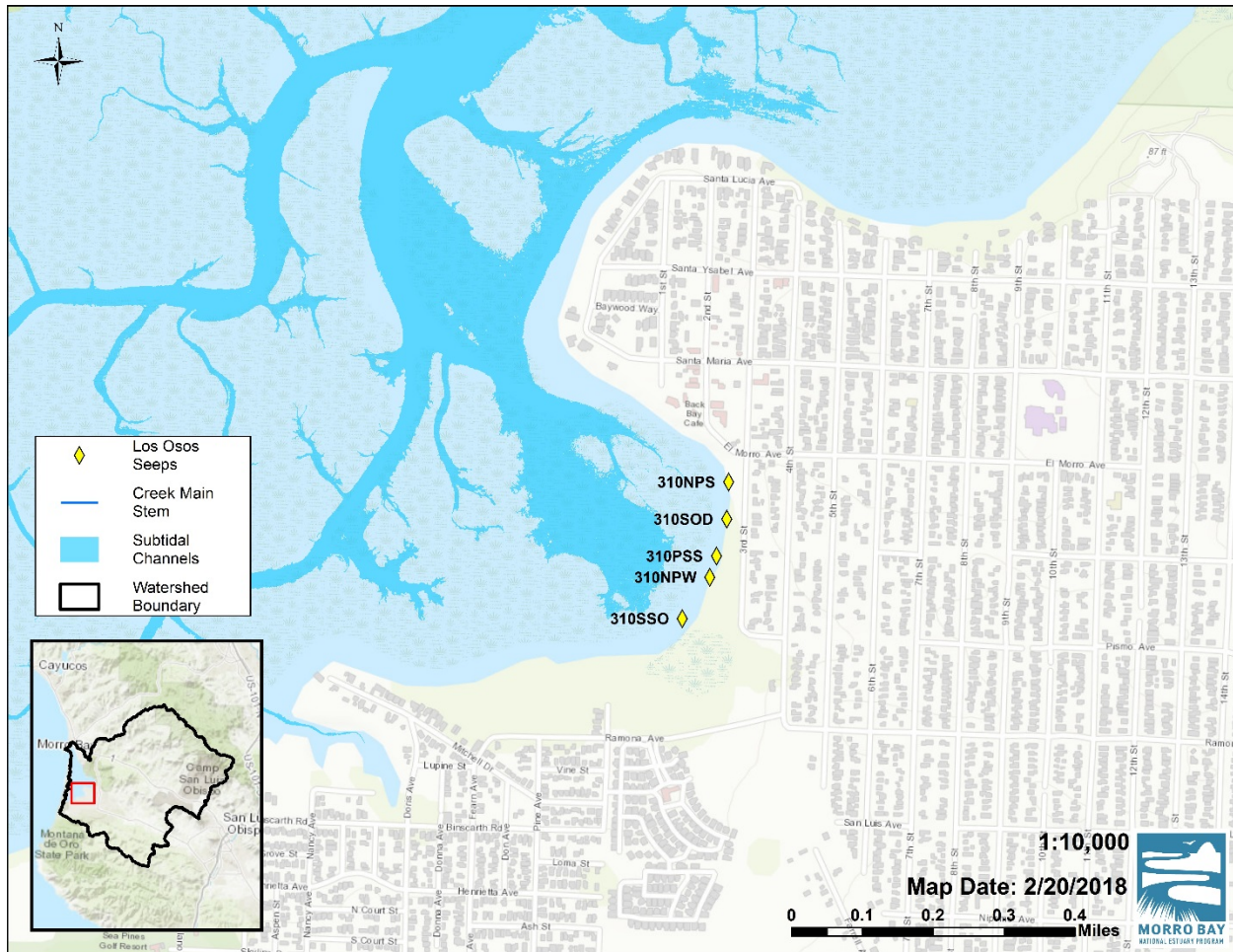


Figure 6.4.18. MBNEP Stormwater Monitoring

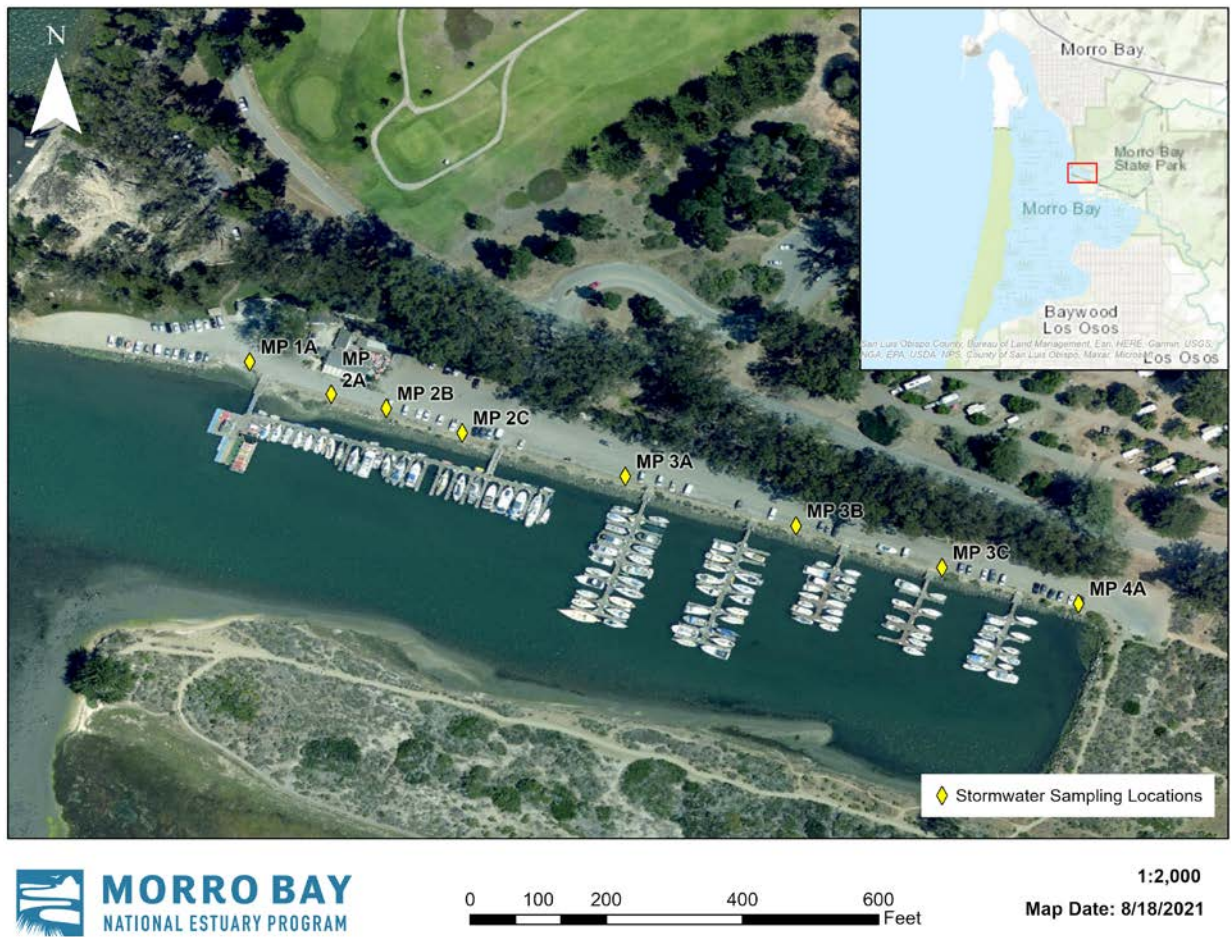


Figure 6.4.19. Cal Poly Continuous pH Monitoring

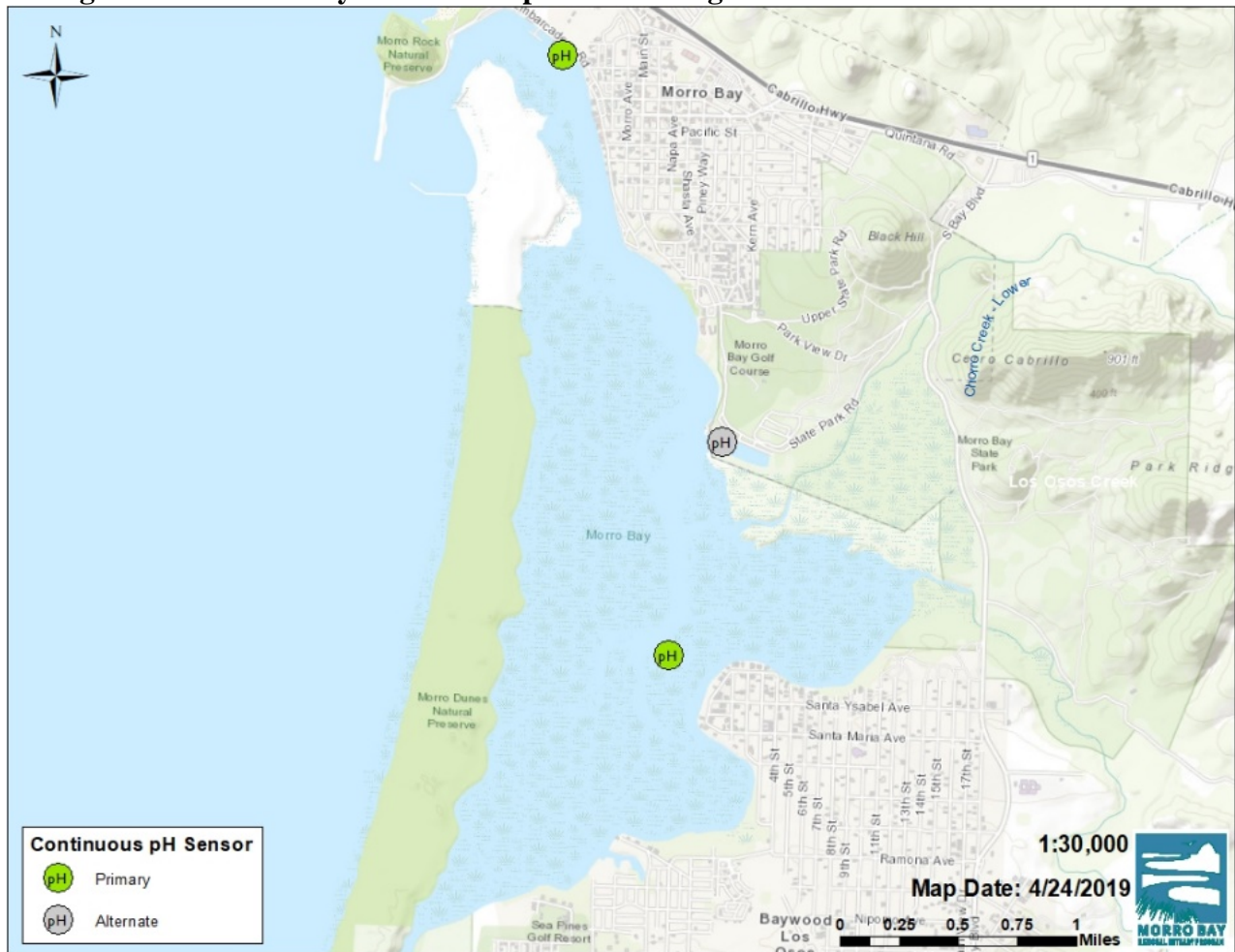
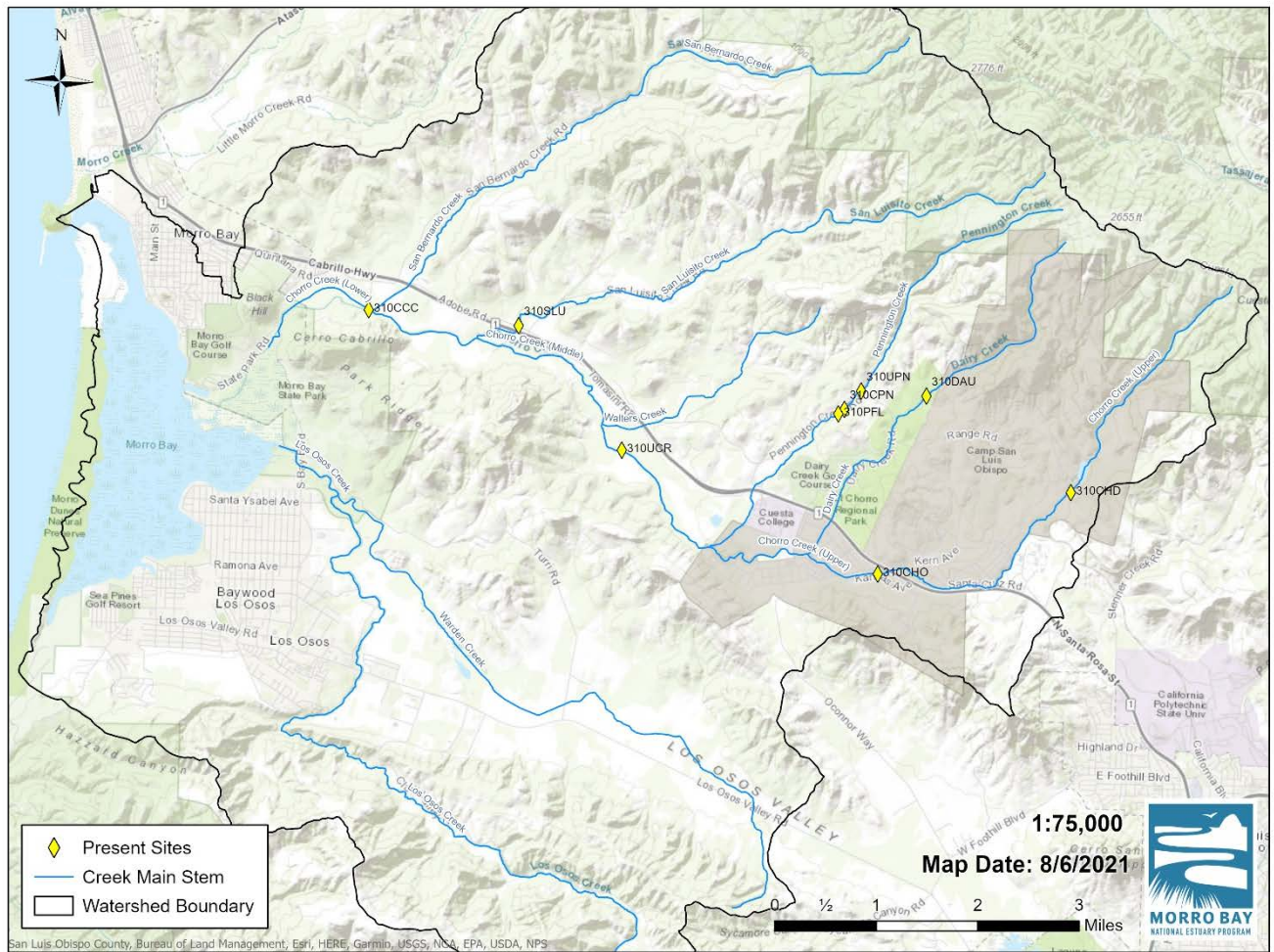


Figure 6.4.20. MBNEP Continuous Temperature Monitoring Locations



For a list of the latitudes and longitudes of the sites in the maps above, please refer to Appendix V.

7. Quality Objectives and Criteria for Measurement Data

Data Quality Objectives (DQOs) are essential because they set limits of allowable error to ensure that data are useable and support project goals. Data Quality Indicators (DQIs) are the quantitative statistics and qualitative descriptors used to interpret the degree of acceptability or utility of data to a user. Measurement Quality Objectives (MQOs) lay out the numeric targets associated with the DQIs that must be met in order to meet the project DQOs.

Data Quality Indicators

DQIs are the quantitative measures and qualitative descriptors used to set limits of acceptable levels of data error. The principal data quality indicators are representativeness, sensitivity, completeness, accuracy, precision, bias, and comparability.

Representativeness indicates how well the data represents environmental conditions. This is addressed through the overall sampling design. Sites were selected to maximize spatial variability and are typically located at the bottoms of tributaries. The sample schedule was designed to maximize representativeness by optimizing the sampling frequency and location. Often, data end users were involved in these decisions to ensure that the data generated would be adequate for their analytical needs.

Sensitivity for chemistry analysis is the lowest value an instrument or method can measure with reasonable statistical certainty. The contract laboratories selected for this project utilize analytical methods with laboratory-determined method detection limits (MDL) and reporting limits (RL) that meet the level of sensitivity required to meet the MQOs for this project.

Completeness is the percentage of data available for use versus the total amount of data collected. Data may be unavailable for use due to unavoidable circumstances such as laboratory error, samples lost or contaminated, etc. Because this monitoring program is a long-term program, any missed data at a specific site or time period can generally be collected during a later monitoring event. Completeness percentages were determined to help assess the effectiveness of this monitoring program and are provided in Tables 7.1.2 and 7.1.3.

Accuracy is the closeness of agreement between a measured value and the true value. For field quality assurance, various methods are employed to measure data accuracy. For water quality field measurements, accuracy is ensured through regular calibration of monitoring equipment. See Table 16.1.1 for more details. For orthophosphates and turbidity field measurements, a monthly QA sample is collected at the time measurements are taken and sent to a contract laboratory as an accuracy check. Blanks are run monthly. Samples submitted to the contract laboratory for analysis are run for a spiked lab control sample, matrix spikes, matrix spike duplicates, blanks, and laboratory control samples. For bacteria analysis both internally and by contract laboratories, blanks and certified reference materials are run to ensure accuracy. Each year the MBNEP submits blank blind samples to the contract laboratories for analysis. Accuracy checks are conducted for 10% of the project's total samples, and each must have a relative percent difference (RPD) less than 25%.

The precision of a measurement describes how close the agreement is between multiple measurements. For field measurements, duplicate measurements are collected monthly and reviewed to ensure that they meet the MQOs. Analytical laboratories conduct duplicate and matrix spike duplicate analysis to ensure precision. Duplicates are run for 10% of the project's total samples, and each must have an RPD less than 25%. At least one laboratory duplicate per analytical batch (defined as 20 samples or less) is required.

The RPD between the two replicate samples will be less than the MQOs defined in the QAPP. For bacteria analysis, each year staff analyzes 15 pairs of replicate samples from a variety of sites to generate the R_{log} criteria. Each month, an analyst runs both portions of a split sample. To meet the precision criteria, the results must be within the R_{log} criteria. Each year the MBNEP submits split samples blind to the contract laboratories for analysis.

Bias is the quantitative measure of the difference between a measured value and the true value. Bias can be unintentionally introduced through improper timing, reach selection, sample contamination, and site selection. These biases are controlled by ensuring field staff and volunteers are trained in proper site selection. Field blanks are also used to measure any contamination introduced during the process. QA samples are randomly distributed among all sites and samplers throughout the year to identify and eliminate bias.

Comparability is the measure of confidence that a dataset can be compared to and combined with another for decision-making purposes. MBNEP site selection and sampling design were developed in conjunction with the CCRWQCB and other local experts to ensure data comparability over the years.

Note that suspended sediment monitoring protocols do not allow for the typical quality assurance measures. The suspended sediment monitoring methods were selected in consultation with USGS's Sediment Monitoring Laboratory in Marina, CA as well as staff in the Santa Maria office. The method of monitoring does not allow for splitting of samples for analysis to determine accuracy, precision, or completeness. Analysis will be conducted to assess recovery. The monitoring program will participate in the USGS Sediment Lab Quality Assurance (SLQA) program which produces single blind samples which will be analyzed in our laboratory at least annually during years when this monitoring effort is active. Based on this analysis, we will be able to assess our recovery rate.

Table 7.1.1 details the activities undertaken to ensure data quality, both for field and lab activities, as described generally above.

Table 7.1.1. Data quality indicators

Group	Parameter	Representative-ness	Bias	Precision	Accuracy	Completeness	Sensitivity*
Field	Bacteria (sample collection in the field)	Yes. Monitoring sites were selected to maximize spatial variability. All monitoring takes place monthly throughout the year, which was determined to be an adequate level of seasonality. End users of the data determined this frequency to be adequate for statistical analysis.	Yes. Training in field techniques minimizes bias.	Yes. Monthly, a volunteer or staff member analyzes a split sample for comparison to precision criteria.	NA	Yes. See Table 7.1.2.	NA

Group	Parameter	Representative-ness	Bias	Precision	Accuracy	Completeness	Sensitivity*
Laboratory	Bacteria (sample analysis in the lab)	NA	Yes. Training in field and lab techniques minimizes bias.	Yes. Monthly, a volunteer or staff member analyzes a split sample for comparison to precision criteria.	Yes. Certified reference material.	Yes. See Table 7.1.2.	NA
Field	Water quality	Yes. Monitoring sites were selected to maximize spatial variability. All monitoring takes place monthly throughout the year, which was determined to be an adequate level of seasonality. End users of the data determined this frequency to be adequate for statistical analysis.	NA	Yes. Monthly replicate readings taken for all meters and kits.	Yes. Pre and post-calibration of equipment.	Yes. See Table 7.1.2.	NA
Field	Water quality (Continuous Monitoring)	Yes. Monitoring sites were selected in areas where changes due to project implementation were of interest. All monitoring takes place monthly throughout the year, which was determined to be an adequate level of seasonality. End users of the data determined this frequency to be adequate for statistical analysis.	NA	Yes. Side-by-side deployment of two units.	Yes. Pre and post-calibration of equipment with each deployment event.	Yes. See Table 7.1.2.	NA
Laboratory	Water quality	NA	Yes. See Table 7.1.2.	Yes. See Table 7.1.2.	Yes. See Table 7.1.2.	Yes. See Table 7.1.2.	Yes. See Table 7.1.2.
Field	Flow	Yes. Monitoring sites were selected to maximize spatial variability. All monitoring takes	Yes. Training in field techniques minimizes bias.	Duplicate velocity measurements are collected at multiple points	NA	Yes. See Table 7.1.2.	NA

Group	Parameter	Representative-ness	Bias	Precision	Accuracy	Completeness	Sensitivity*
		place monthly throughout the year, which was determined to be an adequate level of seasonality. End users of the data determined this frequency to be adequate for statistical analysis.		in the transect once a month.			
Field	Water depth	Yes. Monitoring sites were selected to maximize spatial variability. All monitoring takes place continuously throughout the year, which was determined to be an adequate level of seasonality. End users of the data determined this frequency to be adequate for statistical analysis.	Yes. Advice and review by experts minimize bias. Comparison of water depth data with flow measurement.	Duplicate depth measurements are collected at multiple points in the transect once a month.	NA	NA	NA
Field	Continuous bay pH	Yes. Monitoring sites were selected to maximize spatial variability. Monitoring takes place continuously throughout the year to provide an adequate level of seasonality.	Yes. Advice and review by experts minimize bias.	<0.001 pH units	Yes. Collect a discrete sample for comparison. +/- 0.05 pH units	NA	NA
Field	Stream Profiling	Yes. Monitoring sites were selected to maximize spatial variability. All monitoring takes place approximately every five years, during the dry season. It was determined to be an adequate frequency for statistical analysis.	Yes. Training in field techniques minimizes bias.	NA	NA	Yes. See Table 7.1.2.	NA

Group	Parameter	Representative-ness	Bias	Precision	Accuracy	Completeness	Sensitivity*
Field	SETs	Yes. Monitoring sites were selected to maximize spatial variability. All monitoring takes place periodically during the dry season. It was determined to be an adequate frequency.	Yes. Training in field techniques minimizes bias.	NA	NA	Yes. See Table 7.1.2.	NA
Field	Macroinvertebrates	Yes. Monitoring sites were selected to maximize spatial variability. All monitoring takes place annually each spring. This frequency provides an adequate level of seasonality. It was determined to be an adequate frequency for statistical analysis.	Yes. Training in field techniques minimizes bias.	NA	NA	Yes. See Table 7.1.3.	NA
Laboratory	Macroinvertebrates	NA	NA	Yes. Lab re-sorts 100% of all samples and 10% of the samples are re-identified by a second taxonomist.	Yes. Lab re-sorts 100% of all samples and 10% of the samples are re-identified by a second taxonomist.	Yes. See Table 7.1.3.	NA
Field	Eelgrass	Yes. Monitoring sites were selected to maximize spatial variability. Transect monitoring takes place annually each fall. Aerial mapping takes place biennially. This frequency provides an adequate level of seasonality. It is unknown if/when sonar mapping would be repeated.	Yes. Training in field techniques minimizes bias.	NA	NA	Yes. See Table 7.1.2.	NA

Group	Parameter	Representative-ness	Bias	Precision	Accuracy	Completeness	Sensitivity*
Field	Eelgrass-Bed Condition Monitoring	Yes. Monitoring sites were selected to maximize spatial variability. Transect monitoring takes place seasonally.	Yes. Training in field techniques minimizes bias.	NA	NA	Yes. See Table 7.1.2.	NA
Field	Eelgrass – Restoration Monitoring	Yes. Monitoring sites were selected to maximize spatial variability. Monitoring takes place seasonally.	Yes. Training in field techniques minimizes bias.				
Field	Seed Transplant Monitoring	Yes. Monitoring sites were selected to maximize spatial variability. Monitoring takes place seasonally.	Yes. Training in field techniques minimizes bias.				
Field	Baywide Bathymetry	Decadal frequency was determined to be appropriate.	NA	NA	One cross line will be required within the survey. Position accuracy and classification accuracy will be verified.	NA	NA
Field	Algae	Yes. Monitoring sites were selected to maximize spatial variability. All monitoring takes place annually during bioassessment, which was determined to be an adequate level of seasonality. End users of the data determined this frequency to be adequate for statistical analysis.	Yes. Training in field techniques minimizes bias.	NA	NA	Yes. See Table 7.1.2.	NA
Field	Shorebird surveys	Yes. Monitoring sites were selected to maximize spatial variability. All monitoring takes place annually each	Yes. Training in field techniques minimizes bias.	NA	NA	Yes. See Table 7.1.2.	NA

Group	Parameter	Representative-ness	Bias	Precision	Accuracy	Completeness	Sensitivity*
		fall. This frequency provides an adequate level of seasonality. It was determined to be an adequate frequency for statistical analysis.					
Field	Suspended sediment concentration	Yes. Monitoring sites were selected based on safety considerations, existing infrastructure, and to target sediment loads in relation to on-going and future restoration work. Monitoring takes place during storms of various amounts of rainfall to represent varying flow conditions.	Yes. Training in field techniques minimizes bias.	NA	NA	NA	NA
Laboratory	Suspended sediment concentration	NA	NA	Yes. SLQA provides replicate samples for analysis. Results must be within +/- 1 mg.	Due to the nature of the analysis, samples cannot be split for analysis by an independent laboratory. However, single blind samples are obtained from the USGS Sediment Lab for analysis. Sample results must be within +/- 1 mg.	NA	NA
Laboratory	Stormwater Monitoring	Yes. Monitoring sites were selected to cover the largest possible drainage area and includes outflows that are activated at varying rain intensities and depths.	Yes. Training in field techniques minimizes bias.	Yes. See table 7.1.3	Yes. See table 7.1.3	Yes. See table 7.1.3	Yes. See table 7.1.3

*All analytical methods were selected to ensure that the results were of adequate sensitivity for comparison to the screening levels for monitoring data laid out in Table 5.3.1.

See Table 7.1.2 and 7.1.3 for descriptions of how each measurement quality objective will be determined.

Table 7.1.2. Measurement quality objectives for field measurements

Group	Parameter	Accuracy	Precision	Target Reporting Limit	Completeness
Water quality	Dissolved oxygen	± 0.3 mg/L	± 0.75 mg/L or 25%	0.01 mg/L	90%
Water quality	Temperature	$\pm 0.1^{\circ}\text{C}$	$\pm 0.5^{\circ}\text{C}$ or 25%	0.1 $^{\circ}\text{C}$	90%
Water quality	Conductivity	$\pm 1\%$ of range	± 5 or 25%	0.1 uS for high range meter	90%
Water quality	pH electrode	$\pm 25\%$	$\pm 25\%$	0.01 pH	90%
Water quality	Turbidity	See below.	See below.	0.01 NTU	90%
Water quality	Orthophosphate as PO_4	$\pm 25\%$	$\pm 25\%$	0.33 mg/L	90%
Flow	Flow (cubic feet per second)	± 0.25 ft ³ /sec	$\pm 25\%$	NA	90%
Water quality (Continuous Monitoring)	DO	± 0.1 mg/L when < 8 mg/L ± 0.2 mg/L when > 8 mg/L $\pm 10\%$ reading when > 20 mg/L	± 0.75 mg/L or 25%	0.01 mg/L	90%
Water quality (Continuous Monitoring)	Temperature	$\pm 0.10^{\circ}\text{C}$	$\pm 0.5^{\circ}\text{C}$ or 25%	0.1 $^{\circ}\text{C}$	90%
Water quality (Continuous Monitoring)	pH	± 0.05 pH units	< 0.001 pH units	0.0001 pH units	90%
Stream	Elevation along	± 0.05 ft	NA	NA	90%

Group	Parameter	Accuracy	Precision	Target Reporting Limit	Completeness
profiling	profile				
Water Depth	Water depth	$\pm 0.1\%$ Full Scale	NA	NA	90%
SETs	Elevation change	± 1.5 mm	NA	NA	90%
Eelgrass	Shoot density, blade length etc.	NA	NA	NA	90%
Algae documenting	Photo documenting	NA	NA	NA	90%
Shorebirds	Bird counts	NA	NA	NA	90%

The acceptable difference between the two readings for turbidity are for ≤ 5 NTU (± 2 NTU), for ≤ 25 NTU (± 5 NTU), for ≤ 100 NTU (± 20 NTU), for ≤ 500 NTU (± 50 NTU), for $\leq 1,000$ NTU (± 100 NTU), for $\leq 10,000$ NTU (± 200 NTU), for $\leq 100,000$ NTU (± 300 NTU).

Table 7.1.3. Measurement quality objectives for laboratory measurements

Group	Parameter	Accuracy	Precision	Recovery	Target Reporting Limits	Completeness
Bacteria	<i>E. coli</i>	Within range of CRM	Meets R_{log} criteria for the year	NA	2 MPN/100 mL	90%
Bacteria	Enterococcus	Within range of CRM	Meets R_{log} criteria for the year	NA	2 MPN/100 mL	90%
Water quality	Nitrates as N	80 – 120%	$\pm 10\%$	90-110%	0.1 mg/L	90%
Water quality (analysis by lab)	Ortho-phosphate as P	90-110%	$\pm 10\%$	90-110%	0.02 mg/L	90%
Water quality - Ag Monitoring Sites	Ammonia-Nitrogen	90 - 110%	$\pm 10\%$	90 - 110%	0.05 mg/L	90%
Water quality - Ag Monitoring	Total Kjeldahl	90 - 110%	$\pm 20\%$	90 - 110%	0.2 mg/L	90%

Group	Parameter	Accuracy	Precision	Recovery	Target Reporting Limits	Completeness
Sites	Nitrogen					
Water quality - Ag Monitoring Sites	Nitrite as N	90 - 110%	$\pm 10\%$	90 - 110%	0.05mg/L	90%
Water quality - Ag Monitoring Sites	Total Phosphorus	80 - 120%	$\pm 20\%$	85 - 115%	0.05 mg/L	80%
Water quality	Turbidity	NA	NA	NA	0.1 NTU	90%
Bioassessment	Benthic invertebrates	$\leq 10\%$ difference in sorting efficacy, differences in identification discussed between taxonomists until agreement is reached.	$\leq 10\%$ difference in sorting efficacy, differences in identification discussed between taxonomists until agreement is reached.	NA	NA	80%
Suspended sediment monitoring	Suspended sediment concentration	NA	± 1 mg	Single blind samples from USGS sediment lab. Analyzed twice annually. Results must be within ± 1 mg.	2 mg	NA
Stormwater Monitoring	Oil & Grease	78 – 114%	$\pm 18\%$	78 – 114%	75 mg/L	80%
Stormwater Monitoring	Dissolved Copper, Dissolved	70-130%	$\pm 20\%$	85-115%	Cu: 0.01 mg/L Pb: 0.01	85%

Group	Parameter	Accuracy	Precision	Recovery	Target Reporting Limits	Completeness
	Zinc, Dissolved Lead				mg/L Zn: 0.02 mg/L	
Stormwater Monitoring	Total Petroleum Hydrocarbons (TPH)- Gasoline	70-130%	$\pm 20\%$	85-115%	NA	80%
Stormwater Monitoring	Total Petroleum Hydrocarbons (TPH)- Diesel	50-127%	$\pm 24\%$	52-128%	NA	70%
Stormwater Monitoring	Total Suspended Solids	NA	$\pm 10\%$	NA	NA	90%

8. SPECIAL TRAINING NEEDS/CERTIFICATION

8.1 Specialized training or certifications

Each of the training sessions prepares program volunteers for MBNEP volunteer monitoring efforts. All are offered on an as-needed basis. All trainees receive information on safety in the field. After training, volunteers will “shadow” a qualified volunteer monitor in that given protocol. Shadowing is defined as performing the given protocol, but with supervision to remind the trainee of safety and quality assurance guidelines. All staff and volunteers receive training prior to the start of a monitoring effort. Bioassessment monitoring requires specialized training provided by the California Department of Fish and Wildlife Aquatic Bioassessment Laboratory or CCRWQCB staff, which is attended each year by MBNEP staff.

The MBNEP QA Officer is responsible for overseeing training of all MBNEP staff and volunteers. The MBNEP QA Officer provides training to MBNEP staff. Volunteers are trained by MBNEP staff under supervision of the QA Officer.

Laboratory accreditation from the State Water Board’s Environmental Lab Accreditation Program (ELAP) is not required because MBNEP data is not utilized for compliance assessment. However, to ensure data of known and documented quality, all laboratories utilized by the MBNEP for water quality analysis are ELAP accredited.

Following is a brief discussion of training pertinent to each monitoring task. Volunteer monitors will carry out all protocols in the field, except bacteriological and nutrient testing.

Water Quality Monitoring Training:

This training, conducted by MBNEP staff, emphasizes water sampling safety protocols. Training includes instruction on how to calibrate and properly operate field meters to monitor nutrients, DO, turbidity, temperature and conductivity. Water quality training will be split into estuarine and freshwater

monitoring training. Documentation of training attendees will be recorded and maintained in a training log.

Continuous monitoring water quality meters and continuous water depth equipment are deployed by MBNEP staff. New staff receive training from MBNEP staff per the monitoring protocol. Estuarine pH sensors are deployed by Cal Poly staff, who handle all staff training per the monitoring protocol.

Flow Monitoring Training:

A training conducted by MBNEP staff demonstrates the use of the flow meter, while emphasizing water safety precautions. Documentation of training attendees will be recorded and maintained in a training log.

Bioassessment and Algae Monitoring Training:

MBNEP staff train program volunteers in the techniques for collection of bioassessment samples. All samples are analyzed by a laboratory, and thus sample identification is not emphasized. All monitoring is conducted under the direct guidance of a MBNEP staff member. MBNEP staff receive an annual refresher training from CCRWQCB or California Department of Fish & Wildlife staff. Documentation of training attendees will be recorded and maintained in a training log.

Bacteria Monitoring Training:

MBNEP staff trains program volunteers in proper technique for sample collection in the field, including sterile technique. Volunteers are then trained in the lab by MBNEP staff in sample analysis techniques using IDEXX methodologies. The lab protocols include sample dilution, sample preparation, and reading and documenting lab results. Documentation of training attendees will be recorded and maintained in a training log.

Stream Profiling Training:

MBNEP staff train program volunteers in the techniques for plotting stream cross-sections at established points throughout the watershed. All monitoring is conducted under the direct guidance of a MBNEP staff member. Documentation of training attendees will be recorded and maintained in a training log.

Shorebird Monitoring Training:

Local birding experts train program volunteers in the protocol for conducting bay-wide shorebird counts. Bird identification is not included in the training because only birders of sufficient expertise participate in the effort.

8.2 Training and certification documentation

All training is documented in a training log where program staff record the volunteer trained, type of training, and staff conducting the training. When monitoring protocols are updated, volunteers are re-trained, and this is also documented in the training log. Upon starting with the program, MBNEP staff receive training in all areas of the program as part of their basic orientation. All training documentation is overseen by the MBNEP QA Officer.

8.3 Training personnel

All MBNEP staff training is provided by the MBNEP QA Officer and/or experienced staff who ensure that all necessary training has been completed. All volunteer training is overseen by the MBNEP QA Officer and provided by MBNEP staff who ensure that all appropriate volunteer training has been completed. Analytical laboratories are responsible for providing training to their own personnel.

9. DOCUMENTS AND RECORDS

The MBNEP will maintain records for sample collection and laboratory testing. Samples sent to a laboratory for analysis will include a chain of custody form. The laboratories generate records for sample receipt and storage, analyses, and reporting. Sampling collection records contain a unique site ID, date, time, monitor's name, equipment used, data recorded, weather and rainfall information, and tidal information (if applicable).

The MBNEP has an existing database of field measurements. The program uses an Access database and Excel spreadsheets to store all program data. The Data Manager, an MBNEP staff member, maintains this electronic data with oversight by the MBNEP QA Officer. The files are saved to MBNEP's cloud storage with regular backup on an external hard drive.

Cal Poly will store files (typically in Excel and MATLAB format) in the Cal Poly OneDrive, which is backed up via cloud storage.

All monitoring records generated are stored at the MBNEP office, both paper and electronic copies. The analytical laboratories records pertinent to this project will be maintained at the lab locations. Copies of all laboratory results will be sent to the MBNEP via mail, email or electronic data retrieval system and stored in the project file. All records contain the unique sample ID, date of sample receipt, date of analysis, analytical methods, method detection limit (if applicable), reporting limit (if applicable) and measured value.

All data records, both volunteer-generated and laboratory-generated, that do not meet the objectives outlined in the approved QAPP will be flagged as acceptable or unacceptable and excluded from any future analysis or reporting. QA Officer will work with staff, volunteers, or contract laboratories to develop corrective actions. Any necessary retraining will be conducted.

Copies of this QAPP will be distributed to all parties involved with the project and made available to MBNEP staff. Copies of relevant sections will be sent to the analytical laboratories for distribution within the labs. Any future amended QAPPs will be held and distributed in the same fashion. All originals of subsequent amended QAPPs will be held at the MBNEP. Copies of versions, other than the most current, will be labeled as such so as not to create confusion.

Persons responsible for maintaining records for this project are as follows. MBNEP staff will maintain all sample collection, sample transport, chain of custody, and laboratory analyses forms at the MBNEP office. MBNEP staff will also maintain at the MBNEP office all records associated with the receipt and analysis of samples, and all records submitted by the laboratory. MBNEP staff will maintain the database permanently. Each individual laboratory will maintain records in accordance with its own QAPP requirements. The MBNEP Program Manager will oversee the actions of these persons and will arbitrate any issues relative to records retention and any decisions to discard records.

Copies of the records will be maintained at the MBNEP office and the analytical laboratories for at least five years after project completion. The database will be maintained without discarding. The QAPP will be maintained without discarding.

Other documents generated during the course of this project include monthly status reports, annual data summary memos, an annual training log, and quarterly database submittals.

GROUP B: DATA GENERATION AND ACQUISITION

10. SAMPLING PROCESS DESIGN

Size of study area: Water quality, bacteria, flow, stream profiling, water depth and bioassessment

monitoring sites were selected to monitor as much of the watershed as possible. Thus, sites tend to be at the downstream locations of tributaries or near potential significant impacts. Additionally, many sites were selected based on historical monitoring efforts in the area such as the National Monitoring Program. Safe access and landowner permission are other major factors in site selection. Sites for continuous monitoring of water quality parameters are typically selected to be upstream and downstream of improvement projects or other features of interest such as point sources. The eelgrass transects were distributed throughout the bay to look at the influence from different factors present in each region of the bay. Eelgrass mapping and bathymetry mapping covers the entire bay. The shorebird study area follows the historical sites established in historical studies. The SETs were established in portions of the bay where the most change due to sedimentation could be expected. Suspended sediment concentration sites were established to help characterize the effects of on-going and future restoration work as well as to track overall suspended sediment load from the Chorro watershed. Continuous water depth measurement sites were established to help characterize surface flows in order to develop a water balance for the Chorro Valley, to track the impact of water conservation efforts, and to identify future project locations. The bay pH sensors are deployed in locations with other water quality sensor infrastructure already in place so that the data supports ongoing monitoring efforts.

Volume or time period represented by a sample: Water quality, bacteria and flow monitoring are conducted on a monthly basis. Agricultural Monitoring (Ag monitoring) water quality sites are monitored monthly during times of adequate surface flows. A subset of water quality sites is monitored every other month for nutrients with analysis conducted by a lab. Continuous monitoring of temperature is conducted during the dry season (typically from late spring through late fall). Continuous water depth monitoring is conducted year-round. Bay pH monitoring will be conducted for approximately half of the year, with month-long deployments scheduled throughout the year. Bioassessment and algae monitoring are conducted once a year in the appropriate season. Eelgrass mapping through aerial imagery or sonar data collection is typically monitored every other year, depending on funding. Permanent transect eelgrass monitoring occurs annually for shoot density and other measurements. Intertidal bed condition monitoring occurs annually to determine eelgrass bed conditions through density, patchiness, and observational data. Eelgrass restoration monitoring takes place seasonally to test planting methods, locations, and seasonality. Bathymetry monitoring occurs on approximately a decadal timeframe since it is measuring long-term changes. Eelgrass seed transplant monitoring takes place seasonally to assess life cycle stages and transplant success.

Stream profiling and SET monitoring takes place every several years due to the long-term nature of the sediment measurements. Shorebird monitoring events are conducted each fall. Suspended sediment monitoring data is collected during storms which generate flow above base-flow conditions.

Type and total number of samples needed: Water samples for bacteria analysis are collected at eight creek sites and eight bay sites. One 100-mL water sample is collected at each site where 1:10 dilutions are run, and two 100-mL samples are collected at each site where an undiluted and 1:10 sample are run or a quality assurance analysis is being conducted for that site, in which case larger volumes of water may be required. Water quality monitoring is conducted at 13 creek sites and seven bay sites. Bimonthly nutrient monitoring for nitrates and orthophosphates takes place at ten sites. Water samples are collected in sterile 4 oz. Whirl-pak bags for nutrient analysis. If a sample is needed for quality assurance or the sample will be analyzed by the contract laboratory, water samples are collected in 8 oz. plastic bottles. Samples for analysis for ammonia, Total Kjeldahl nitrogen, and total phosphorus are collected in 16 oz. bottles containing H₂SO₄ preservative. Flow data is collected at 17 creek sites during times of measurable flow. Bioassessment samples include insects and debris collected from creek beds. The total number of bioassessment monitoring sites is 13, but the number monitored varies from year to year based on water levels, funding, staff availability and other factors. For continuous monitoring of water quality, continuous water depth monitoring, stream profiling, SETs, algae documenting, and bird surveys, no

samples are collected. For suspended sediment concentration monitoring, creek water samples are collected at up to three sites. Each sample bottle is filled to 400 mL by an automated sampler, and 24 bottles can be collected during a sampler run. The sampler must then have the bottles swapped out and the timer re-set for additional sample collection. For bay pH monitoring, the sensors will be visited monthly and discrete samples will be collected for sensor calibration. These 500-mL discrete samples are collected using a Niskin sampler either from a dock, a boat, or diving.

Where samples are taken: See maps from Section 6.4. Sites are identified in various ways. While all are identified through GPS, volunteers in the field for bacteria, water quality, flow, bioassessment, algae, and shorebirds monitoring identify sites through the use of landmarks. For monitoring of suspended sediment, eelgrass, SETs, continuous water depth and stream profiling, permanent benchmarks are established at each of the monitoring sites, and they are located with the aid of GPS. Either MBNEP staff or contractors conduct these monitoring efforts and are trained in the use of GPS. The bay pH monitoring will be conducted at two locations in the bay: the front bay at the T-pier and the back bay at the existing water quality sensor array. If one of those locations is unavailable for some reason, then the alternate location is at the State Park Marina.

If sites become inaccessible: Samples can be collected within the same reach or immediate area at a more accessible location. Staff and volunteers are trained in site selection so they have the knowledge to identify a new site location if a new one becomes inaccessible. If conditions are unsafe, staff and volunteers will delay sample collection until access becomes safe.

Project activity schedules: Monitoring for water quality, agricultural monitoring water quality, bacteria, and flow is conducted on a monthly basis, year-round. A subset of water quality sites is monitored every other month for nitrates and orthophosphates with analysis conducted by the laboratory. Continuous monitoring of temperature takes place from late spring through late fall. Continuous water depth monitoring takes place year-round. Creek algae documenting takes place once a year in the spring during bioassessment monitoring. Bay samples must be collected at the appropriate tidal cycle and thus this monitoring schedule is dictated by the tides. In-bay monitoring for DO must be conducted within two hours after sunrise on a tide to allow safe access via kayak. This allows the volunteers to capture the lowest DO levels of the diurnal cycle. All QA samples will be delivered to the lab by MBNEP staff or courier. Staff will make every effort to deliver the bacteria samples to the lab in time for them to be analyzed within eight hours of collection. If this is not possible, they will be delivered for analysis within 24 hours of collection. Bay pH monitoring will be conducted in month-long deployments for approximately six months of the year. Permanent Transect, Bed Condition Monitoring, Restoration Monitoring, and Seed Transplant monitoring for Eelgrass all takes place annually or seasonally. Bioassessment occurs once a year during the spring, and samples are typically delivered to the lab within two months, although they can be held for up to five years. Eelgrass aerial imagery and sonar is collected biennially, depending on funding availability and the amount of rainfall. In heavy rainfall years, more frequent monitoring may take place. Bathymetry monitoring is conducted on a decadal timeframe. Stream profiling and SET monitoring takes place on a frequency of several years since the monitoring is intended for long-term tracking of sedimentation in the bay. Tidally-influenced monitoring such as bay water quality, bacteria, eelgrass, SETs, and shorebirds are scheduled upon review of a tide table to ensure adequate access and optimal conditions. Suspended sediment monitoring is conducted during storms taking place during the rainy season. Samples are delivered within 48 hours of collection to the sediment laboratory. Sediment samples do not have a hold time requirement but are kept either in a refrigerator or at room temperature in the dark.

Critical vs. informational data: All data collected for this effort is considered to be critical data.

Sources and reconciliation of variability: For water quality and bacteria monitoring, potential sources of variability include improper sample handling or lab techniques and environmental variability. Samples

are split for 10% of samples collected. If split samples sent to the laboratory for analysis differ consistently from volunteer conducted analysis, additional quality assurance will be conducted and training refreshers will be conducted to remedy the problem and minimize operator-introduced sources of variability. Data should be within the measurement quality objectives listed in Table 7.1.3. If these objectives are not met, the data are flagged in the database and are not included in any data analysis. Other measures to address variability include wearing gloves during sample collection and analysis, use of clean or sterile containers for sample collection and analysis, and intense training for volunteers in proper sampling technique. For bay pH, sources of variability include improper sample handling. Duplicate discrete samples are collected for each sensor monthly for analysis and differences will be assessed. Any variability will be reconciled through additional training. For flow monitoring, continuous water depth monitoring and bioassessment sampling, proper site selection is the largest source of variability and is addressed through volunteer and staff training. For algae documenting, eelgrass, and shorebird monitoring, the greatest sources of variability are the individual making the assessment, and this can only be addressed through training. For stream profiling, proper site identification is likely the greatest source of variability and can only be addressed through training. For suspended sediment monitoring, the largest sources of variability include malfunctioning of the automated sampler, sample bottles that are not clean, and contamination during the laboratory analysis process. These are addressed through training and use of detailed protocols.

Sources of bias or misrepresentation: For bacteria, a potential source of bias is in the interpretation of testing results. Volunteers and staff must interpret a color change to read the results. This bias is addressed for bacteria monitoring by periodically splitting samples for all analysis and comparing the results from the split samples to the R_{log} criteria. Volunteers and staff also analyze a certified reference material of known bacteria concentration to check their accuracy. For water quality monitoring nutrient analysis, detailed procedures must be followed as related to reaction times, sample temperatures, etc. Volunteers and staff analyze a split sample while the other half is sent to a QA lab for analysis. The compared results must be within the measurement quality objectives outlined in Table 7.1.3. If they are not, then the sample collection and laboratory techniques will be reviewed to eliminate any potential source of bias and the data will be flagged in the database. For continuous water depth monitoring, flow monitoring and macroinvertebrate sampling, proper site selection is the largest source of bias and is addressed through volunteer and staff training. For algae documenting, eelgrass, and shorebird monitoring, the greatest sources of bias are the individual making the assessment and this can only be addressed through training. For stream profiling, a potential source of bias is improper use of the monitoring equipment, which can only be addressed through training. For suspended sediment monitoring, the method of analysis does not allow for splits or duplicates to be analyzed for comparison. The largest source of bias would be improper laboratory techniques such as inadequate drying of filters and improperly calibrated lab equipment such as scales. This is addressed through training in laboratory techniques as well as detailed calibration procedures. For bay pH, the largest sources of bias would be calibration errors, which can only be addressed through training.

11. SAMPLING METHODS

All bacteria samples are aquatic samples. They will be collected as grab samples using sterile jars from approximately mid-stream and from just below the water's surface. The sterile sample jars hold 120-mL and are made from high density plastic. They are purchased from IDEXX Laboratories for use with the IDEXX testing system. The sealed, sterile jars contain sodium thiosulfate to neutralize chlorine which may be present at some sites. These bottles are used once and then disposed of. When samples are collected, the collector makes sure to leave some headspace in the jar. To collect samples to be split, a larger volume of water is required. Larger, 250-mL autoclavable bottles are used for sample collection. The bottles are autoclaved between uses to ensure that they are sterile. Samples are inverted 25 times and

then 100 mL is decanted into each of two IDEXX 120-mL jars prior to analysis. Excess sample can be disposed of down the drain. Bacteria monitoring requires a wet lab with an autoclave, incubators and a source of sterile distilled water. MBNEP bacterial analysis by program staff and volunteers is conducted at the Morro Bay-Cayucos Wastewater Treatment Plant Laboratory. Plant personnel operate the facility's autoclave to provide the sterilized glassware and distilled water needed for analysis. If it is determined that the sample collection method is introducing error into the results, the MBNEP QA Officer will reassess both the monitoring protocol and how the volunteers follow the protocol. If a source of error is identified, the protocol will be revised and volunteers and staff will be re-trained.

For water quality monitoring, measurements are taken from approximately mid-stream and from just below the water's surface. All sampling equipment is rinsed with deionized water upon completion of the monitoring. pH meters are rinsed with tap water. All monitoring is conducted in the field using field meters. Water samples for quality assurance purposes are collected from mid-stream, just below the water's surface. A large, clean container is used to collect a single sample. The sample is gently mixed and then split. A portion is used to fill a sterile 4 oz. Whirl-pak bag for the volunteer's analysis and a portion is used to triple rinse and then fill a clean container provided by the laboratory for one-time use. All samples are aqueous samples. Excess sample is disposed of by the lab. Other than the field equipment, no special equipment or facilities are required for analysis. If it is determined that the sample collection method is introducing error into the results, the MBNEP QA Officer will reassess both the monitoring protocol and how the volunteers and staff follow the protocol. If a source of error is identified, the protocol will be revised and volunteers and staff will be re-trained.

Macroinvertebrate samples for bioassessment are stored in clean 16-oz plastic containers. The samples contain creek substrate and macroinvertebrates. Every attempt is made to remove all plant matter. The D-ring sampling net, bucket and sieves are rinsed between monitoring sites to minimize contamination. Excess samples are disposed of by the lab. No additional equipment or facilities are required for the sampling. All analysis is conducted by the laboratory. If samples are too large to fit in the 16-oz collection jar, larger debris is rinsed and removed until the sample is small enough. A 95% isopropyl alcohol preservative is added to each jar as soon as possible after collection. If it is determined that the sample collection method is introducing error into the results, the MBNEP QA Officer will reassess both the monitoring protocol and how the volunteers and staff follow the protocol. If a source of error is identified, the protocol will be revised and volunteers and staff will be re-trained.

For continuous water depth monitoring, flow, SETs, stream profiling, algae documenting, and shorebird monitoring, no samples are collected.

For bay pH, monthly samples are collected and preserved with mercury chloride to be a pH calibrant for the field sensors. Samples of 500 mL are collected with a trigger-deployed Niskin sampler. They are analyzed using a Dissolved Inorganic Carbon instrument with a Licor 7000 NDIR analyzer, a Total Alkalinity titrator, or a custom automated spectrophotometric pH instrument using m-cresol purple indicator dye. The preserved samples may be stored in the laboratory for up to six months before analyzing.

For suspended sediment monitoring, samples are collected from creeks during storms using automated samplers which draw water through an intake in the creek and up into a sampler housing which contains 24 bottles. The intake is located in an area in the creek where it will remain submerged but is not at risk of becoming buried by sediment or crushed in a debris jam. All samples are aqueous samples. The samplers are programmed to draw a certain volume of water at a certain frequency. Each sample is 400 mL, leaving headspace at the top of the bottles. These samples do not require any refrigeration. Following filtration, sample supernate water is disposed of down the drain. Sample bottles are rinsed with DI water and allowed to dry completely before being re-deployed in the field. If it is determined that the method of sample collection is introducing bias into the results, the protocol will be revised and monitoring

personnel will be retrained.

In all of these monitoring efforts, any problems are identified by MBNEP staff in conjunction with the MBNEP QA Officer. Protocols will be revisited and any appropriate volunteer re-training will take place to correct the problem. These corrections will be documented in the updated monitoring SOPs as well as the volunteer training log.

See Appendices for copies of all monitoring SOPs.

Table 11.1.1. Sampling locations and sampling methods.

Sampling Location	Location ID Number	Matrix	Depth (units)	Analytical Parameter	# Samples (include field duplicates)	Sampling SOP #
Bacteria - All creek sites, stormwater run-off sites	See Fig 6.4.3	Water	Below surface	<i>E. coli</i> , total coliform	1 per month at each site plus one split per month	MBVMP Bacteria Monitoring Protocol
Bacteria - All bay sites	See Fig 6.4.3	Water	Below surface	<i>E. coli</i> and entero-coccus	1 per month at each site plus one split per month	MBVMP Bacteria Monitoring Protocol
Water Quality - All creek sites	See Fig 6.4.6	Water	Below surface	Orthophosphates as PO ₄	1 per site per month	MBVMP Water Quality Monitoring Protocol
Water Quality - All creek sites	See Fig 6.4.6	Water	Below surface	Orthophosphates as P, Nitrate as N, Turbidity	For QA, split samples at 10% of sites per month, sent to lab for analysis.	MBVMP Water Quality Monitoring Protocol
Water Quality – Bimonthly Nutrient Monitoring of Creeks	See Fig 6.4.6	Water	Below surface	Nitrates as N, Orthophosphates as P	For Bimonthly Nutrient sites, samples sent to lab four times per year.	MBVMP Water Quality Monitoring Protocol
Water Quality - Ag Monitoring	See Fig 6.4.6	Water	Below surface	Nitrates as N, Orthophos	For Ag Sites, 1 set per month sent to lab.	MBVMP Water Quality Monitoring

Sampling Location	Location ID Number	Matrix	Depth (units)	Analytical Parameter	# Samples (include field duplicates)	Sampling SOP #
Sites				phates as P		Protocol
Water Quality - Ag Monitoring Sites	See Fig. 6.4.3	Water	Surface	Total Nitrogen, Nitrite as N	One per site, once a month	BCGEN058
Water Quality - Ag Monitoring Sites	See Fig. 6.4.3	Water	Surface	Organic Nitrogen	One per site, once a month	Calculated
Water Quality - Ag Monitoring Sites	See Fig. 6.4.3	Water	Surface	Ammonia as Nitrogen	One per site, once a month	BCGEN061
Water Quality - Ag Monitoring Sites	See Fig. 6.4.3	Water	Surface	Total Kjeldahl Nitrogen	One per site, once a month	BCGEN059
Water Quality - Ag Monitoring Sites	See Fig. 6.4.3	Water	Surface	Total Phosphorus	One per site, once a month	BCGEN060
Water Quality – bay dissolved oxygen sites	See Fig 6.4.6	Water	Below surface	Salinity, temperature, DO	1 sample per month at each site	MBVMP DO in the Bay Protocol
Water Quality – bay pH (calibration	See. Fig. 6.4.18	Water	2 m from bay bottom	pH	One per sensor per deployment	SeaBird SeaFET pH Sensor Deployment and Calibration

Sampling Location	Location ID Number	Matrix	Depth (units)	Analytical Parameter	# Samples (include field duplicates)	Sampling SOP #
for sensors)						Procedures
Suspended sediment	See Fig. 6.4.17	Water	Surface	Suspended sediment concentration	Depends on number of storms and frequency of sample collection	MBVMP Suspended Sediment Monitoring Protocol
Macroinvertebrates - All sites	See Fig 6.4.12	Macroinvertebrate samples	Creek bottom	Benthic invertebrates	1 composited sample per site	MBVMP Macroinvertebrate Sampling and Rapid Bioassessment Protocol
State Park Marina	See Fig 6.4.17	Water	Surface	Total Suspended Solids	One per site, frequency variable	MBNEP Stormwater Monitoring Protocol
State Park Marina	See Fig 6.4.17	Water	Surface	Oil & Grease	One per site, frequency variable	MBNEP Stormwater Monitoring Protocol
State Park Marina	See Fig 6.4.17	Water	Surface	Dissolved metals: Pb, Zn, Cu	One per site, frequency variable	MBNEP Stormwater Monitoring Protocol
State Park Marina	See Fig 6.4.17	Water	Surface	Total Petroleum Hydrocarbons (TPH)- Gasoline	One per site, frequency variable	MBNEP Stormwater Monitoring Protocol
State Park Marina	See Fig 6.4.17	Water	Surface	Total Petroleum Hydrocarbons (TPH)- Diesel	One per site, frequency variable	MBNEP Stormwater Monitoring Protocol

12. SAMPLE HANDLING AND CUSTODY

12.1 Sample handling and transport

The field sampler is personally responsible for the care and custody of the samples collected until they are transferred or dispatched properly. Samples should include the date and time of collection, sample location, sampler name, and analysis to be performed. Collected samples will be kept in an ice chest with ice or ice packs. Volunteers conducting the sample collection and analysis are required to complete field datasheets. These include the following information: time of sample collection; sample ID numbers, including unique IDs for any replicate or blank samples; the results of any field measurements (e.g., temperature, DO, pH, conductivity, turbidity) and the time that measurements were made; qualitative descriptions of relevant water conditions (e.g., color, flow level, clarity) or weather (e.g., wind, rain) at the time of sample collection; and a description of any unusual occurrences associated with the sampling event, particularly those that may affect sample or data quality. Samples will be clearly labeled with an indelible marker and include the site ID, sampling date and time, sampler name, and parameter to be analyzed for.

For bioassessment samples, 95% isopropyl alcohol should be added to the sample as soon as possible.

For discrete grab samples for calibrating bay pH equipment, the sample is transferred into a 500-mL glass sample bottle through tubing and allowed to overflow to remove all bubbles and headspace. Use syringe to remove water to create headspace. Add 120 uL of 100% saturated Mercury II Chloride via pipette. Insert the greased glass stopper, and use band and clip to secure stopper. Invert bottle several times to fix thoroughly. Sample can be stored for up to six months in the laboratory.

After returning from the field, all water samples for water quality and bacteria analysis will be analyzed immediately, transferred to the laboratory refrigerator, or delivered to the analytical laboratory or its courier.

Upon completion of sample collection, suspended sediment samples should be capped and transported to the sediment lab. Each bottle will be labeled with the date and time of sample collection and then weighed, without the cap, to determine the total sample weight. Bottles have been pre-weighed and the tare weights are stored in the sediment monitoring database. Samples can then be stored either in the refrigerator or in a dark, cool location until they are processed.

All bacteria samples are hand delivered to the labs. Water quality samples to be analyzed by the lab are picked up by a lab courier for delivery to the lab or shipped via an overnight courier service. Pick-ups and deliveries are scheduled to comply with all hold time requirements.

Bioassessment samples are drained of alcohol preservative, double-bagged and overnight shipped to the lab. Lab personnel immediately refill the samples with alcohol.

Contract laboratories will follow sample custody procedures outlined in their QA plans. Contract laboratory QA plans are on file with the respective laboratory.

All samples remaining after successful completion of analyses will be disposed of properly. It is the responsibility of the personnel of each analytical laboratory to ensure that all applicable regulations are followed in the disposal of samples or related chemicals.

Laboratories shall maintain custody logs sufficient to track each sample submitted and to analyze or preserve each sample within specified holding times.

Table 12.1.1. Sample handling and custody

Parameter	Container	Volume	Initial Preservation	Holding Time
<i>E. coli</i> , enterococcus	Sterile, sealed plastic jar	120 mL	Sodium thiosulfate, cool to 4°C; dark.	24-hour hold time, but 8 hour if

Parameter	Container	Volume	Initial Preservation	Holding Time
	purchased from IDEXX Laboratories			conditions allow, at 4°C, dark.
Orthophosphate as P, analysis by volunteer	Whirl-pak bag	4 oz.	None	48 hour at $\leq 6^{\circ}\text{C}$, dark.
Nitrates as N and Orthophosphate as P, Nitrite as N, Total Nitrogen, Organic Nitrogen, analysis by laboratory	Plastic jar provided by BC Laboratories	16 oz.	None	48 hour at $\leq 6^{\circ}\text{C}$, dark.
Turbidity, analysis by lab for QA purposes	Plastic bottle provided by BC Laboratories	8 oz.	None	48 hours at $\leq 6^{\circ}\text{C}$
Ammonia-nitrogen, Total Kjeldahl Nitrogen, Total Phosphorus, analysis by lab	Plastic bottle provided by BC Laboratories	8 oz.	H ₂ SO ₄ preservative	28 days, at $\leq 6^{\circ}\text{C}$ in the dark.
Bay pH	Glass bottle	500 mL	100% saturated Mercury II Chloride	6 months after being fixed
Benthic invertebrates	Wide mouth plastic jar	16 oz.	95% isopropyl alcohol	5 years
Suspended sediment	Plastic bottle with cap	1000 mL	None	Unlimited hold time, in dark cool location.*
Oil & Grease: analysis by lab	Glass amber jar with cap provided by BC Laboratories	32 oz.	HCl preservative	28 days
Dissolved Copper, Dissolved Zinc, Dissolved Lead, analysis by lab	Plastic bottle with cap provided by BC Laboratories	16 oz.	Lab filters, preserves with HNO ₃ to pH < 2	6 months

Parameter	Container	Volume	Initial Preservation	Holding Time
Total Petroleum Hydrocarbons (TPH)-Gasoline, analysis by lab	Glass vial provided by BC Laboratories	(3) 40 mL	HCl preservative, cool to $\leq 6^{\circ}\text{C}$	14 days
Total Petroleum Hydrocarbons (TPH)-Diesel, analysis by lab	Glass amber jar with cap provided by BC Laboratories	32 oz.	Cool to $\leq 6^{\circ}\text{C}$	14 days
Total Suspended Solids, analysis by lab	Plastic bottle with cap provided by BC Laboratories	32 oz.	Cool to ≤ 6	7 days at $< 6^{\circ}\text{C}$
<i>E. coli</i>	Sterile, sealed plastic jar purchased from IDEXX Laboratories	120 mL	None	24 hours with an optimal hold time within 8 hours, at 4°C , dark.

**This hold time is per USGS protocols for suspended sediment concentration analysis.*

12.2 Chain of custody procedure

The volunteers and staff shall have custody of samples during field sampling. Chain of custody forms will accompany all samples during transport to contract laboratories. These are completed by MBNEP staff. Forms are signed by the lab and the person relinquishing the sample. Copies of these forms are maintained by MBNEP staff. All bacteria and water quality samples will be transported to the analytical laboratory directly by volunteers, MBNEP staff or by laboratory or overnight courier.

See Appendix for a sample chain of custody form.

13. ANALYTICAL METHODS

13.1 Analytical methods

The data in Table 13.1.1 and 13.1.3 do not apply to stream profiling, SETs, eelgrass, algae, bathymetry, or shorebird monitoring. In the following tables, the term MDL refers to the Method Detection Limit which is the lowest concentration an instrument can distinguish from zero but cannot quantify. This is generally established by the lab conducting the analysis. These terms do not apply to the activities listed in Table 13.1.1, which covers field analysis.

Table 13.1.1. Field analytical methods

Analyte	Laboratory / Organization	Project Action Limit (units, wet or dry weight)	Project Quantitation Limit (units, wet or dry weight)	Analytical Method/ SOP
Flow	Field monitoring by MBNEP volunteers	NA	Depth = 0.2 ft, Velocity = 0.01 ft/sec	MBVMP Water Quality Monitoring Protocols
Conduct-	Field monitoring	$> 3,000 \text{ uS}$ (for	0.10 uS for high	MBVMP Water

Analyte	Laboratory / Organization	Project Action Limit (units, wet or dry weight)	Project Quantitation Limit (units, wet or dry weight)	Analytical Method/ SOP
ivity (Water Quality)	by MBNEP volunteers	Water Quality only)	range meter	Quality Monitoring Protocols
Dissolved oxygen (Water Quality and Dawn Patrol)	Field monitoring by MBNEP volunteers	< 7.0 mg/L	0.01 mg/L	MBVMP Water Quality Monitoring Protocols
Bay pH (continuous)	Field monitoring by Cal Poly	< 7.5 pH units	6.5 pH units	SeaBird SeaFET pH Sensor Deployment and Calibration Procedure
Temperature (Water Quality and Dawn Patrol)	Field monitoring by MBNEP volunteers	> 21°C	0.1°C	MBVMP Water Quality Monitoring Protocols
Turbidity (Water Quality)	Field monitoring by MBNEP volunteers	> 25 NTU	0.01 NTU	MBVMP Water Quality Monitoring Protocols
Orthophosphates as PO ₄ (Water Quality)	Field monitoring by MBNEP volunteers	> 0.36 mg/L	0.33 mg/L	MBVMP Water Quality Monitoring Protocols
Dissolved Oxygen (Continuous Water Quality Monitoring)	Continuous Monitoring with deployment by MBNEP staff	< 7.0 mg/L	0.01 mg/L	MBVMP Hobo Calibration and Deployment Protocol, 2017
Temperature (Continuous Water Quality Monitoring)	Continuous monitoring with deployment by MBNEP staff	> 21°C	0.1°C	MBVMP Hobo Calibration and Deployment Protocol, 2017, MBNEP Continuous Temperature Logger Protocol
pH (Continuous Water Quality Monitoring)	Continuous monitoring with deployment by MBNEP staff	< 7.0 or > 8.5 pH units	-1.0 pH	MBVMP EXO3 Sonde Protocol

Analyte	Laboratory / Organization	Project Action Limit (units, wet or dry weight)	Project Quantitation Limit (units, wet or dry weight)	Analytical Method/ SOP
Suspended sediment concentration	Sample collection and analysis by VMP staff	NA	NA	MBVMP Suspended Sediment Monitoring Protocol

Table 13.1.2. Field equipment features

Monitoring Effort	Equipment Description	Measurement Principle	Major Attributes
Flow	Marsh-McBirney Flo-Mate 2000, HACH FH950	Electromagnetic	Velocity averaging
Water depth	In-Situ Inc., Level TROLL 500	Piezoresistive transducer	Automatic barometric pressure compensation
pH (Water Quality, continuous)	YSI EXO3 Multi-Parameter Water Quality Sonde	Ion-selective electrode	Temperature compensation
Conductivity (Water Quality)	YSI Pro 2030	Voltage drop	Temperature correction
Dissolved oxygen (Water Quality and Dawn Patrol)	YSI Pro 2030	Membrane covered polarographic	Self-calibrating
Temperature (Water Quality and Dawn Patrol)	YSI Pro 2030	Thermistor	
Turbidity (Water Quality)	HACH 2100P, 2100Q Turbidimeters	Nephelometric	Auto ranging
Orthophosphates as PO ₄ (Water Quality)	HACH DR/890	Ascorbic acid reduction reaction, colorimeter	
Dissolved Oxygen (Water Quality Continuous Monitoring)	YSI EXO3 Multi-Parameter Water Quality Sonde	Optical (dynamic luminescence quenching)	No flow required
Temperature (Water Quality Continuous Monitoring)	YSI EXO3 Multi-Parameter Water Quality Sonde	Thermocouple	
Temperature (Water Quality Continuous Monitoring)	HOBO MX2203 TidbiT	Thermistor	Detects when water is present, Bluetooth

Monitoring Effort	Equipment Description	Measurement Principle	Major Attributes
			connectivity for download
Conductivity (Continuous)	YSI EXO3 Multi-Parameter Water Quality Sonde	Voltage drop	Temperature correction
pH (Continuous)	SeaBird SeaFET V2 pH sensor	Ion sensitive field effect transistor	

Table 13.1.3. Laboratory analytical methods

Analyte/ Instrumentation	Laboratory / Organization	Project Action Limit (units, wet or dry weight)	Project Quantitation Limit (units, wet or dry weight)	Analytical Method/ SOP	MDLs (1)
Total coliform (IDEXX Colilert-18)	MBNEP In-house laboratory	> 10,000 MPN/100mL	2 MPN/100mL for an undiluted sample	MBVMP Bacteria Monitoring Protocols	1 MPN/100 mL for an undiluted sample
<i>E. coli</i> (IDEXX Colilert-18)	MBNEP In-house laboratory	Statistical Threshold Value: 320 MPN/100 mL (90 th percentile of data) Geomean: 100 MPN/100 mL	2 MPN/100mL for an undiluted sample	MBVMP Bacteria Monitoring Protocols	1 MPN/100 mL for an undiluted sample
Enterococcus (IDEXX Enterolert)	MBNEP In-house laboratory	Statistical Threshold Value: 110 MPN/100 mL (90 th percentile of data) Geomean: 30 MPN/100 mL	2 MPN/100mL for an undiluted sample	MBVMP Bacteria Monitoring Protocols	1 MPN/100 mL for an undiluted sample

Analyte/ Instru- mentation	Labora- tory / Organiza- tion	Project Action Limit (units, wet or dry weight)	Project Quantitation Limit (units, wet or dry weight)	Analytical Method/ SOP	MDLs (1)
pH (spectroph otometer)	Cal Poly	< 7.5 pH units	6.5 pH units	Carter et al. 2013 DOI 10.4319/lom.2013. 11.16	NA
Nitrate as N (Dionex DX-100 IC)	BC Laboratori es	10 mg/L for Water Quality	0.1 mg/L	EPA Method 300.0	0.024mg/L
Orthophos phates as P (Smart- Chem)	BC Laboratori es	> 0.12 mg/L for Water Quality	0.05 mg/L	EPA 365.1	0.017 mg/L
Total Kjeldahl Nitrogen	BC Laboratori es	NA	0.2 mg/L	EPA 351.2	0.088 mg/L
Nitrite as N	BC Laboratori es	NA	0.17 mg/L	EPA 353.2	0.01 mg/L
Total Phosphoru s	BC Laboratori es	NA	0.05 mg/L	EPA 365.4	0.018 mg/L
Ammonia as N (Smart- Chem)	BC Laboratori es	NA	0.2 mg/L	SM 4500-NH3 G	0.067 mg/L
Turbidity for Water Quality (for QA)	BC Laboratori es	> 25 NTU	0.1 NTU	SM 2130B	0.1 NTU
Total coliform (IDEXX Colilert-18)	County of San Luis Obispo Public Health Laborator y	> 10,000 MPN/100 mL	2 MPN/100mL for an undiluted sample	Standard Methods 9223 B	1 MPN/100 mL for an undiluted sample
<i>E. coli</i>	County of	Statistical	2 MPN/100mL	Standard Methods	1 MPN/100 mL for

Analyte/ Instru- mentation	Labora- tory / Organiza- tion	Project Action Limit (units, wet or dry weight)	Project Quantitation Limit (units, wet or dry weight)	Analytical Method/ SOP	MDLs (1)
(IDEXX Colilert-18)	San Luis Obispo Public Health Laboratory	Threshold Value: 320 MPN/100 mL (90 th percentile of data) Geomean: 100 MPN/100 mL	for an undiluted sample	9223 B	an undiluted sample
Enterococcus (IDEXX Enterolert)	County of San Luis Obispo Public Health Laboratory	Statistical Threshold Value: 110 MPN/100 mL (90 th percentile of data) Geomean: 30 MPN/100 mL	2 MPN/100mL for an undiluted sample	Standard Methods 9230 D	1 MPN/100 mL for an undiluted sample 10 MPN/100 mL for a 1:10 diluted sample
Fecal/thermotolerant coliform (multiple tube fermentation – MTF)	County of San Luis Obispo Public Health Laboratory	> 43 MPN/100 mL	2 MPN/100 mL for an undiluted sample	Standard Methods 9221E	Lower: 1.8 MPN Upper: >1600 MPN Upper with extra dilution: >16000 MPN
Benthic macroinvertebrates ¹	Ecoanalysts, Inc.	NA	600 minimum individuals	Ecoanalysts Laboratory SOP/QA Plan 2007*	NA
Suspended sediment concentration	MBNEP Sediment Laboratory by VMP staff	NA	2 mg	MBVMP Suspended Sediment Monitoring Protocol (Derived from ASTM D 3977)	NA
Oil & Grease	BC Laboratori	75 mg/L	6.7 mg/L	EPA-1664 HEM	0.74 mg/L

Analyte/ Instrumentation	Laboratory / Organization	Project Action Limit (units, wet or dry weight)	Project Quantitation Limit (units, wet or dry weight)	Analytical Method/ SOP	MDLs (1)
	es				
Dissolved Copper, Dissolved Zinc, Dissolved Lead	BC Laboratori es	Cu: 0.01 mg/L Pb: 0.01 mg/L Zn: 0.02 mg/L (for receiving waters, not for runoff)	Cu: 0.002 mg/L Pb: 0.001 mg/L Zn: 0.005 mg/L	EPA 200.8	Cu: 0.00032 mg/L Pb: 0.000021 mg/L Zn: 0.0022 mg/L
Total Petroleum Hydrocarb ons (TPH)- Gasoline ²	BC Laboratori es	NA	0.05 mg/L	EPA 8015B	0.011 mg/L
Total Petroleum Hydrocarb ons (TPH)- Diesel ²	BC Laboratori es	NA	0.23 mg/L	EPA 8015B-TPHd	0.049 mg/L
Total Suspended Solids	BC Laboratori es	NA	3.2 mg/L	SM2540D	0.5 mg/L

¹Bioassessment sample analysis is conducted per the following SWAMP SOP, with customization or modifications per the QA Officer's request:

http://www.waterboards.ca.gov/water_issues/programs/swamp/docs/bmi_lab_sop_final.pdf

²A regulatory criteria do not exist for TPH, and no value will be adopted as a Project Action Limit. This TPH data is considered to be a baseline screening level data to determine the impacts of stormwater runoff from a parking lot into nearby Morro Bay, prior to treatment. An upcoming project will divert and treat the stormwater runoff. This sampling will illustrate the impacts of the treatment by demonstrating the reduction in pollutants.

If failures occur, the appropriate laboratory personnel will address the problem and contact the MBNEP QA Officer with any proposed solutions or resolutions.

All excess samples will be disposed of properly by laboratory personnel following their own documented SOPs.

Analytical results are typically available for bacteria and water quality samples within two weeks. If a rush is needed on the analysis, results can be transmitted via phone or email in a more timely manner.

Macroinvertebrate samples for bioassessment typically take three months for analysis and reporting by the analytical lab.

14. QUALITY CONTROL

14.1 Water quality monitoring

Quality assurance and quality control activities for sampling processes include the collection of field splits for nutrient testing and the preparation of field blanks. For field splits, the volunteers collect a sample and split it. Half is analyzed by the volunteer and half is sent to the laboratory for analysis. The laboratory will analyze the split samples to assess the accuracy and bias criteria.

Blanks will be prepared by pouring deionized water into a clean sample collection container provided by the laboratory. This blank is carried in the field in a cooler with ice packs, to simulate as closely as possible how the nutrient samples are handled. The laboratory will analyze the field blanks submitted.

In order to monitor the sampling process, the MBNEP QA Officer will randomly observe sampling processes and compare the actual actions against the sampling SOP.

Volunteers will split water quality samples and analyze both samples to determine precision. The relative percent difference (RPD) between the two results should be within 25%. This analysis is conducted for 10% of samples analyzed by volunteers.

The RPD is calculated as follows:

$$RPD = (X1 - X2) * 100 / [(X1 + X2) / 2] \quad \text{where } X1 \text{ is the larger value}$$

The volunteers will periodically analyze deionized water using the water quality nutrient field test kits to assess their sample handling and laboratory techniques. The result should be less than the method detection limit. This analysis is conducted for 10% of samples analyzed by volunteers. This also ensures the quality of each batch of reagents. The results are analyzed as follows:

$$X1 < MDL \quad \text{where } X1 \text{ is the analysis result by the volunteers and the MDL is the method detection limit for the method of analysis.}$$

Water quality data will also be tested for outliers. During data reviews, data is plotted and any values that are out of range with the majority of the data at a given site are revisited and checked for possible equipment malfunction, operator error and other possible explanations for out of range results. If the results appear to be valid given the circumstances (i.e., weather-related) then the data remains in the database as valid. If a determination cannot be made as to whether or not the data is valid, then when the data is analyzed with Minitab box plots, the outliers are identified and are not included in the calculation of medians, interquartile ranges, etc. The Minitab criterion for an outlier is values that are at least 1.5 times the interquartile range ($Q3 - Q1$) from the edge of the box. The nutrient laboratory, BC Laboratories, is an ELAP-certified lab (Certification # 1186) that undergoes the annual inspection and recertification process. Any data that fails to meet the lab's own measurement quality objectives will be addressed by the laboratory following its own SOPs. The accuracy, precision, completeness and recovery criteria are laid out in Table 7.1.3. Precision is determined by calculating the RPD (as shown above). Accuracy, recovery and completeness are calculated as follows:

$$\text{Accuracy \% difference} = [(X1 - X2) * 100] / (X1) \quad \text{where } X1 \text{ is the known value}$$

$$\% \text{ Recovery} = [(\text{matrix plus spike result} - \text{matrix result}) / (\text{expected matrix plus spike result})] * 100$$

$$\% \text{ Completeness} = [\# \text{ valid samples} / \# \text{ total planned samples}] * 100$$

Data that fails to meet the data quality objective will be flagged as such in the database and will not be used in subsequent analysis. If this occurs, volunteer protocols and technique will be reviewed. If necessary, protocols will be revised and volunteers will be re-trained.

In the following tables, TRL stands for Target Reporting Limit.

Table 14.1.1. Field QC for water quality monitoring

Matrix: Water		
Sampling SOP: MBVMP Water Quality Monitoring Protocols, YSI EXO3 Sonde Protocol, SeaBird SeaFET pH Sensor Deployment and Calibration Procedure, MBNEP Continuous Temperature Logger Protocol		
Analytical Parameter(s): orthophosphates, turbidity, pH, temperature		
Analytical Method/SOP Reference: See Table 14.1.2.		
# Sample locations: Various. (See Section 6.4).		
Field QC	Frequency/Number per sampling event	Measurement Quality Objective Acceptance Limits
Equipment Blanks: continuous bay pH	Prior to deployment	Within ± 0.07 pH units
Field Blanks: nutrients	One sample per year for water quality monitoring	< MDL for target analyte
Field Duplicate Pairs: nutrients	10% of total samples for water quality nutrient analysis	RPD < 25%
Field Duplicate Pairs: turbidity	One sample per month analyzed both by MBNEP equipment and a certified lab.	The acceptable difference between the two readings are: for ≤ 5 NTU (± 2 NTU), for ≤ 25 NTU (± 5 NTU), for ≤ 100 NTU (± 20 NTU), for ≤ 500 NTU (± 50 NTU), for $\leq 1,000$ NTU (± 100 NTU), for $\leq 10,000$ NTU (± 200 NTU), for $\leq 100,000$ NTU (± 300 NTU)
Field Duplicate Pairs: pH	One sample per month analyzed by MBNEP equipment and a certified lab.	RPD < 25%
Field Duplicate Pairs: continuous bay pH	One sample per sensor per month	Within ± 0.07 pH units
Field Duplicate Pairs: DO	One sample per month analyzed both by MBNEP equipment and Winkler titration	± 1 mg/L
Other: continuous water temperature	At time of deployment and retrieval, take a second reading with a calibrated temperature meter	RPD < 25%

Table 14.1.2. Analytical QC for water quality monitoring

Matrix: Water		
Sampling SOP: MBVMP Water Quality Monitoring Protocols, BCGEN048, BCGEN075, BCGEN014, BCGEN061, BCGEN059, BCGEN060, BCGEN055		
Analytical Parameter(s): Nitrates as N, orthophosphates as P, TKN, Nitrite as N, Total Phosphorus, turbidity, Total ammonia-nitrogen		
Analytical Method/SOP Reference: Nitrates (EPA 300.0), Orthophosphates (EPA 365.1), Turbidity (SM 2130B), Ammonia-Nitrogen (SM 4500-NH ₃ G), TKN (EPA 351.2), Total Phosphorus (EPA 365.4), Nitrite as N (EPA 353.2)		
# Sample locations: Various (See Section 6.4)		
Laboratory QC	Frequency/Number	Measurement Quality Objective Acceptance Limits
Method Blank	One per batch	< TRL
Reagent Blank	One per new lot	< TRL
Instrument Blank	One per day of analysis	<TRL
Lab. Duplicate	One per batch or one per 10 samples	Orthophosphates: RPD \leq 10% Nitrates: RPD \leq 10% Turbidity: \leq 10% Ammonia-Nitrogen: RPD \leq 10% TKN: RPD \leq 20% Total Phosphorus: RPD \leq 20% Nitrite as N: RPD \leq 10%
Lab. Matrix Spike	One per batch or one per 10 samples	Orthophosphates: recovery 90-110% Nitrates: recovery 80-120% Turbidity: NA Ammonia-Nitrogen: recovery 90-110% TKN: recovery 90-110% Total Phosphorus: recovery 80-120% Nitrite as N: recovery 90-110%
Matrix Spike Duplicate	One per batch or one per 10 samples	Orthophosphates: 90-110%, RPD \leq 10% Nitrates: 80-120%, RPD \leq 10% Turbidity: NA Ammonia-Nitrogen: 90-110%, RPD \leq 10% TKN: recovery \leq 90-110%, RPD < 20%

		Total Phosphorus: recovery \leq 80-120%, RPD<20% Nitrite as N: recovery \leq 90-110%, RPD<10%
Lab. Control sample	One per batch or one per 10 samples	Orthophosphates: 90-110% Nitrates: 90-110% Turbidity: NA Ammonia-Nitrogen: 90-110% TKN: recovery < 90-110% Total Phosphorus: recovery < 85-115% Nitrite as N: recovery < 90-110%

14.2 Bacteria monitoring

Quality assurance and quality control activities for sampling processes include the collection of field splits for bacterial testing and the preparation of field blanks. Split samples are prepared by collecting a sample in a large, sterile container and then dividing it into multiple samples for analysis by the volunteer. The precision criterion is that the two volunteer-generated results must be within the R_{log} criteria, which is based on the results of 15 pairs of replicate samples analyzed by program staff. To verify volunteer accuracy, *E. coli* and enterococcus samples of a known range of concentration are obtained from IDEXX Laboratories. Volunteers analyze the sample and the results should be within the acceptable range.

Blanks will be prepared by pouring sterile distilled water into a sterile sample collection container, then subsampling into the appropriate number of replicate sample containers. This is to test both the volunteer sample handling and lab analysis as well as testing for contamination from each new batch of reagent. The result of the analysis from both the volunteer and the lab must be within the MDL for the method of analysis. See Section 14.1 for calculation.

In order to monitor the sampling process, the MBNEP QA Officer will randomly observe sampling processes and compare the actual actions against the sampling SOP.

The bacteria laboratory, the SLO County Public Health Agency Laboratory, is ELAP-certified (Certification # 2114) and undergoes an annual recertification process and biennial inspection. Any data that fails to meet the lab's own measurement quality objectives will be addressed by the laboratory following its own SOPs.

The completeness calculation is as above.

Data that is outside the QC criteria for both types of analysis will be flagged as such in the database and will not be used in subsequent analysis. If this occurs on a consistent basis, volunteer protocols and technique will be reviewed. If necessary, protocols will be revised and volunteers will be re-trained.

Table 14.2.1. Field QC for bacteria monitoring

Matrix: Water		
Sampling SOP: MBVMP Bacteria Monitoring Protocols		
Analytical Parameter(s): <i>E. coli</i> , total coliform, enterococcus		
Analytical Method/SOP Reference: IDEXX Colilert-18 and Enterolert		
# Sample locations: Various. (See Section 6.4)		
Field QC	Frequency/Number per sampling event	Measurement Quality Objective Acceptance Limits
Field Blanks: total coliform, <i>E. coli</i> , enterococcus	One per month	< MDL for target analyte
Field Splits: total coliform, <i>E. coli</i> , enterococcus	10% of total samples	R _{log} criteria

Table 14.2.2. Analytical QC for bacteria monitoring

Matrix: Water		
Sampling SOP: Water Quality Sample Collection and Laboratory Procedure		
Analytical Parameter(s): <i>E. coli</i> , total coliform, enterococcus, fecal/thermotolerant coliform		
Analytical Method/SOP Reference: Enterolert– Standard Methods 9230 D, Colilert-18 – Standard Methods 9223 B Fecal/thermotolerant coliform – Standard Methods 9221E(A1)		
# Sample locations: Various (See Section 6.4)		
Laboratory QC	Frequency/Number	Measurement Quality Objective Acceptance Limits
Reagent Blank Colilert 18	For each new lot of reagent, run a presence/absence test for Colilert 18/24 strains: <i>Escherichia coli</i> ATCC 25922, <i>Klebsiella variicola</i> ATCC 31488, and <i>Pseudomonas aeruginosa</i> ATCC 27853 .	Presence/absence
Enterolert	For each new lot of reagent, run a presence/absence test for Enterolert Strains: <i>Enterococcus faecium</i> ATCC 35667, <i>Serratia marcescens</i> ATCC 43862,	Presence/absence

	and <i>Aerococcus viridans</i> ATCC 10400	
Lab. Duplicate	Upon request from clients	95% confidence interval
Multiple Tube Fermentation (MTF) Lab. Control sample: Negative Control – Fecal/thermotolerant Coliform Positive Control – Fecal/thermotolerant Coliform	For every test, run a negative control for <i>K.aerogenes</i> (ATCC # 13048) For every test, run a positive control for <i>E.coli</i> (ATCC # 25992)	Negative Positive
MTF Media QC: Negative Control – Fecal/thermotolerant Coliform Positive Control – Fecal/thermotolerant Coliform pH	For each new batch of prepared media, run a negative control for <i>K.aerogenes</i> ATCC 13048 For each new batch of prepared media, run a positive control for <i>E.coli</i> (ATCC # 25992) pH is taken and recorded for each new batch of prepared media	Negative Positive
Media Sterility Test	Each new batch of prepared media or each new lot of purchased media	No contamination
Others:	Sterility check on new lots of sterile sample collection containers. Run a growth test with Tryptic Soy Broth. Sterility check on new lots of dilution blanks. Run growth test with Tryptic Soy Broth. Sterility check on new lots of graduated pipettes. Also	No contamination

	with Tryptic Soy Broth.	
Others:	<p>Volume check on each new lot of dilution blanks.</p> <p>Volume check on each new lot of IDEXX sample bottles.</p> <p>Volume check on each new lot of graduated pipettes.</p>	Weight. QC scale with weights calibrated every 5 years.

14.3 Bioassessment monitoring

MBNEP staff accompany volunteers on all sample collection field trips. MBNEP staff receive biennial refresher training from CCRWQCB staff or the California Department of Fish and Wildlife's Aquatic Bioassessment Lab to ensure that all collection methods are correct and up-to-date.

The macroinvertebrate analysis laboratory conducts QA measures for sorting and identifying the sample. Following initial sorting of the sample, 100% of the sorted material is re-sorted by a specially trained sorting QC technician who is never the technician who originally sorted the sample. The QC technician re-sorts the sample until the percent sorting efficacy is 90% or greater. For QA of the identification process, a second taxonomist re-identifies 10% of the samples. A percent similarity is calculated to compare both sets of data. Any discrepancies are discussed by both taxonomists until a consensus is reached. Any data that fails to meet the lab's own measurement quality objectives will be addressed by the laboratory following its own SOPs.

Table 14.3.1. Analytical QC for bioassessment monitoring

Matrix: Benthic invertebrates
Sampling SOP: Standard Operating Procedure for Collection of Field Data for Bioassessment of California Wadeable Streams: Benthic Macroinvertebrates, Algae, and Physical Habitat, March 2016 v 2
Analytical Parameter(s): Benthic invertebrates
Analytical Method/SOP Reference: Standard Operating Procedures for Laboratory Processing and Identification of Benthic Macroinvertebrates in California, 2012
Sample locations: Various (See Section 6.4)

14.4 Flow monitoring

Quality assurance and quality control activities for flow monitoring include replicate measurements of flow velocity. RPD values should be within $\pm 25\%$. See above for method of calculation.

In order to monitor the process, the MBNEP QA Officer will randomly observe sampling processes and compare the actual actions against the sampling SOP.

Data that fails to meet the data quality objective will be flagged as such in the database and will not be

used in subsequent analysis. If this occurs, volunteer protocols and techniques will be reviewed. If necessary, protocols will be revised and volunteers will be re-trained.

14.5 Suspended sediment monitoring

For suspended sediment monitoring, samples cannot be split, and replicate samples would not provide any meaningful information. Instead, single-blind samples prepared by the USGS Branch of Quality Systems will be analyzed by MBNEP staff in our laboratory at the minimum on a biannual basis to assess the accuracy and precision of our procedures and equipment. Values should be within ± 1 mg. In addition, blank samples of DI water will be analyzed to ensure that proper sample handling techniques are being used.

14.6 Stormwater Monitoring

MBNEP staff use a combination of training and field notes to ensure sample quality and consistency in the field. Samples are delivered to BC Laboratories for analysis.

BC Laboratories conducts routine QA within sample batches and also for the instruments and protocols used to analyze stormwater samples (Table 14.6.1)

Table 14.6.2. Analytical QC for stormwater monitoring

Matrix: Water		
Sampling SOP: MBNEP Stormwater Monitoring Protocols, BCORG026, BCMET037, BCGEN022, BCORG003, BCORG005		
Analytical Parameter(s): Oil and Grease, Dissolved metals (copper, zinc, lead), Total suspended solids, Total petroleum hydrocarbons (TPH)-Gasoline, Total petroleum hydrocarbons (TPH)-Diesel		
Analytical Method/SOP Reference: Oil and Grease (EPA 1664), Dissolved metals: copper, zinc, and lead (EPA 200.8), Total suspended solids (SM2540D), Total petroleum hydrocarbons (TPH)-Gasoline (EPA 8015), Total petroleum hydrocarbons (TPH)-Diesel (EPA 8015)		
# Sample locations: four (see Section 6.4)		
Laboratory QC	Frequency/Number	Measurement Quality Objective Acceptance Limits
Method Blank	One per batch	<TRL
Reagent Blank	One per lot	<TRL
Instrument Blank	One per day of analysis	<TRL
Lab Duplicate (TSS, Metals and Oil and Grease)	One per batch (10 Samples)	Dissolved metals: RPD \leq 20%

		TSS: RPD \leq 10% Oil & grease: RPD \leq 18% TPH-g: N/A TPH-d: N/A
Lab. Matrix Spike	One per batch (20 Samples TPH-Gasoline /Diesel	Dissolved metals: recovery 70-130% TSS: NA Oil & grease: recovery 78-114% TPH-g: 70-130% TPH-d: 50-120%
Lab. Matrix Spike Duplicate	One per batch (20 Samples TPH-Gasoline /Diesel	Dissolved metals: recovery 70-130%, RPD \leq 20% TSS: NA Oil & grease: recovery 78-114%, RPD \leq 18% TPH-g: 70-130%, RPD \leq 20% TPH-d: 50-120%, RPD \leq 30%
Lab control Sample	One per batch (20 Samples TPH-Gasoline /Diesel	Dissolved metals: recovery 85-115% TSS: NA Oil & grease: recovery 78-114% TPH-g: 85-115% TPH-d: 50-120%

15. INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

15.1 Equipment testing, inspection and maintenance

Field measurement equipment will be checked in accordance with the manufacturer's specifications. This includes battery checks, routine replacement of membranes, and cleaning of conductivity electrodes. All equipment will be inspected when first handed out and when returned from use for damage.

All laboratories maintain their equipment in accordance with its SOPs, which include those specified by the manufacturer and those specified by the method.

MBNEP staff are responsible for equipment inspection, testing and maintenance. Field equipment inspection is carried out prior to each trip in the field. Testing is conducted if equipment appears visibly worn or if volunteers report problems with the equipment upon returning from the field. If deficiencies are found, MBNEP staff will perform the needed maintenance and then re-calibrate and re-inspect the equipment. A pre- and post-calibration will be run to determine if the problem has been fixed. If it has not, maintenance and re-calibration will be conducted. If this does not correct the problem, then the equipment will be taken out of use and sent to the manufacturer for servicing.

Table 15.1.1. Testing, inspection, maintenance of sampling equipment and analytical instruments

Equipment / Instrument	Maintenance Activity, Testing Activity or Inspection Activity	Responsible Person	Frequency	SOP Reference
YSI Pro 2030 DO Meter	Inspected periodically throughout monitoring time period	MBNEP staff	Weekly during water quality monitoring effort	Operator manual
YSI Pro 2030 DO Meter	Change membrane	MBNEP staff	As needed, approximately 4 times/year	Operator manual
HACH 2100P, 2100Q Turbidimeters	Inspected periodically throughout monitoring time period.	MBNEP staff	Inspected weekly during water quality monitoring effort.	Operator manual
YSI EXO3 Multi-Parameter Water Quality Sonde	Pre-calibration prior to deployment. YSI measurements taken at deployment and pickup.	MBNEP staff	Each time deployed	MBVMP EXO3 Sonde Protocol
HOBO TidbiT V2 MX2203	Inspected prior to deployment and following retrieval	MBNEP staff	Each time deployed	Operator manual
HACH DR/890 for orthophosphates for Water Quality	Inspected periodically throughout monitoring time period. Monthly, run a sample of reagent of a known PO ₄ concentration. Twice monthly run a blank to test the meter results.	MBNEP staff	Inspected weekly during water quality monitoring effort. Monthly analysis of known reagent and blank.	Operator manual
In-Situ Level TROLL 500 for Water Depth	Inspected when download data. Compare water depth readings to staff gauge reading. Analyze downloaded data for equipment issues.	MBNEP staff	Monthly	Operator manual
Incubators and thermometers for bacteria monitoring	Inspected periodically throughout monitoring time period	MBNEP staff	Monthly	Operator manual

Equipment / Instrument	Maintenance Activity, Testing Activity or Inspection Activity	Responsible Person	Frequency	SOP Reference
ISCO Model 6712 Automated sampler (suspended sediment)	Inspected periodically throughout monitoring time period	MBNEP staff	Each time sampler is deployed.	Operator manual
SeaBird SeaFET V2	Monthly calibration and inspection.	Cal Poly staff	Monthly at minimum or whenever sensor is cleaned	Operator manual

All spare parts, reagents and calibration standards are maintained in the MBNEP equipment room, located adjacent to the MBNEP office. All necessary parts and standards are kept on hand so that equipment can be kept in good repair and properly calibrated. Cal Poly maintains all parts, reagents, and other equipment necessary for operating the SeaBird SeaFET pH sensors.

To ensure that there is no carry-over contamination in the vials and syringes used for water quality analysis, MBNEP staff conducts split analysis for precision on a biannual basis. Samples are split and analyzed in a new vial and in a vial that has been in use and undergone the regular procedure of rinsing with DI water and with sample water prior to use. The acceptability criteria for the two results are the precision criteria described in Table 7.1.2. If the criteria are not met, all affected sample vials and syringes will be replaced with new ones immediately. The split sample procedure will be repeated biannually. Volunteers are trained to emphasize the importance of the cleaning procedures. All glassware, vials and syringes are replaced on a biannual basis.

16. INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

16.1 Field instruments

Water quality field monitoring uses instruments requiring regular calibration. Each calibration is documented and kept in the calibration log.

Table 16.1.1. Testing, inspection, maintenance of field sampling equipment and analytical instruments

Equipment / Instrument	SOP reference	Calibration Description and Criteria	Frequency of Calibration	Responsible Person and Corrective Action
Marsh McBirney Flow Meters, HACH FH950 Flow Meters	MBVMP Equipment Calibration Protocols	Sent to manufacturer for calibration and conditioning Bucket test the meters and zero them	Annually Weekly	MBNEP staff. Manufacturer will continue to repair meter until problems are corrected or meter needs to be replaced. If meter won't zero properly, sensor is cleaned and meter is re-zeroed.
YSI Pro 2030 DO Meter	MBVMP Equipment Calibration Protocols	Internal calibration, verification against Winkler titration. Two	Bimonthly	MBNEP staff. Replace membrane and recondition probe. If this fails, send equipment in for servicing.

Equipment / Instrument	SOP reference	Calibration Description and Criteria	Frequency of Calibration	Responsible Person and Corrective Action
		readings must be within $\pm 20\%$.		
HACH 2100P, 2100Q Turbidimeters	MBVMP Equipment Calibration Protocols	Formazin calibration standards. The acceptable difference between the two readings are: for ≤ 5 NTU (± 2 NTU), for ≤ 25 NTU (± 5 NTU), for ≤ 100 NTU (± 20 NTU), for ≤ 500 NTU (± 50 NTU), for $\leq 1,000$ NTU (± 100 NTU), for $\leq 10,000$ NTU (± 200 NTU), for $\leq 100,000$ NTU (± 300 NTU)	Twice monthly	MBNEP staff. Recalibrate. If cannot be corrected, return to manufacturer for servicing.
HACH DR/890 and DR/900 meters	MBVMP Equipment Calibration Protocols	Run a known calibration standard and DI water to ensure accuracy. Apply reagent correct factor.	Monthly	MBNEP staff. Split samples are sent to laboratory for analysis. See Table 7.1.2 for criteria.
YSI EXO3 Water Quality Sonde; DO Probe	MBVMP EXO3 Sonde Protocol	Internal calibration, verification against Winkler titration and/or YSI Pro 2030 meters. Compared readings must be within $\pm 20\%$.	Each time deployed	MBNEP staff.
YSI EXO3 Water Quality Sonde; pH Probe	MBVMP EXO3 Sonde Protocol	Calibration standards. Reading must be within $\pm 10\%$ of calibration standard.	Each time deployed	MBNEP staff.
Incubator and thermometer (Bacteria Lab)	MBVMP Equipment Calibration Protocols	Log incubator temperature each time remove a batch of trays. Incubator must be from 34.5 to 37°C for the Colilert-18 incubator and $41 \pm 0.5^\circ\text{C}$ for the Enterolert incubator.	Each batch	Volunteers record values. Reviewed by QA Officer. Adjust incubator temperature as needed.
Incubator and thermometers (Bacteria lab)	MBVMP Equipment Calibration Protocols	Replace the certified thermometer in the incubators.	Annually	MBNEP staff.
ISCO Model 6712, automated sampler (suspended sediment)	MBVMP Suspended Sediment Monitoring Protocol	Verify the volume of sample collected by the sampler	Annually	MBNEP staff. Adjust sampler programming as needed.
Fine scale (sediment lab)	MBVMP Suspended	Verify accuracy of scale using calibration weights.	Each time scale is used or	MBNEP staff. Re-calibrate scale. If problem cannot be

Equipment / Instrument	SOP reference	Calibration Description and Criteria	Frequency of Calibration	Responsible Person and Corrective Action
	Sediment Monitoring Protocol	Certification and calibration of scale, as needed.	if drift becomes greater than ± 0.0002 g.	corrected, scale must be sent to the manufacturer for service.
Gross scale (sediment lab)	MBVMP Suspended Sediment Monitoring Protocol	Verify accuracy of scale using calibration weights. Certification and calibration of scale, as needed.	Each time scale is used and if drift becomes greater than ± 0.02 g.	MBNEP staff. Re-calibrate scale. If problem cannot be corrected, scale must be sent to the manufacturer for service.
Oven (sediment lab)	MBVMP Suspended Sediment Monitoring Protocol	Verify accuracy of temperature adjustment using certified thermometer.	Each time oven is started.	MBNEP staff. Adjust oven thermostat so that temperature remains within ± 10 of the desired temperature.
Dessicators (sediment lab)	MBVMP Suspended Sediment Monitoring Protocol	Ensure desiccant is dry.	As begin processing each batch of samples.	MBNEP staff. Bake desiccant in oven at designated temperature for desired time and cool before re-using in desiccator.
HOBO MX2203 Temperature Sensor	MBVMP Continuous Temperature Logger Protocol	Readings verified with calibrated YSI 2030 Pro.	Each time the sensor data are downloaded.	MBNEP Staff. Sent to manufacturer if error is detected.
SeaBird SeaFET pH sensor	SeaBird SeaFET Sensor Deployment and Calibration Procedures	Annual calibration: gel cap replacement, external reference electrode replacement Calibration prior to deployment: compare results to sample analyzed on a spectrophotometric pH instrument Monthly: discrete sample calibration	Various (see previous column)	Cal Poly. Sent to manufacturer if errors are detected.

A calibration log is maintained. See Appendix for a sample. Pre-calibration levels and post-calibration levels are recorded, as well as the name of the person conducting the analysis and the date of calibration. Each piece of equipment is assigned a unique ID number. This number is also recorded in the calibration log, allowing for tracking of performance history for each individual piece of equipment. All equipment maintenance is recorded in a log book to document the date and nature of the maintenance required. Cal Poly maintains all calibration results in a calibration log.

If equipment is not meeting the criteria, it is the responsibility of the MBNEP QA Officer to address the problem. This may include repair or replacement of equipment. All corrective actions are documented in the Calibration Log and the Equipment Maintenance Log.

16.2 Laboratory analytical equipment

Calibration of analytical equipment used by each laboratory is outlined in each laboratory's standard operating procedures and quality assurance documentation. Any deficiencies are addressed by the individual laboratory's QA plan. Laboratories comply with the procedures listed below.

Table 16.2.1. Testing, inspection, maintenance of analytical laboratory instruments

Equipment / Instrument	SOP reference	Calibration Description and Criteria	Frequency of Calibration	Responsible Person
County of San Luis Obispo Public Health Laboratory: Incubators	QA Manual	Read and record temperature in incubators twice a day. Thermometers are certified and ASTM calibrated.	Calibrated annually	All Analysts
County of San Luis Obispo Public Health Laboratory: Tray sealer	QA Manual	Run a tray through the sealer containing water with dye to check for leaks.	Monthly	All Analysts
County of San Luis Obispo Public Health Laboratory: Refrigerator	QA Manual	Read and record temperature once a day. Thermometers are certified and ASTM calibrated.	Calibrated annually	All Analysts
EcoAnalysts: Benthic invertebrates	NA	NA	NA	Gary Lester
BC Labs: Nitrate as N, Orthophosphate as P	BC Labs SOP	External calibration with 6 standards covering the range of sample concentrations prior to sample analysis. At low end, the lowest standard at or near the MDL. Linear regression $r^2 \geq 0.995$. Calibration verification every 10 samples after initial calibration. Standard source different than that used for initial calibration. Recover 90 - 110%.	Nitrate as N: Daily Ortho-phosphate: Once per batch	TMS MC1/JMH
BC Labs: Ammonia as N, Total Nitrogen, Organic Nitrogen, Nitrite as N, Total Kjeldahl Nitrogen, Total Phosphorus	BC Labs SOP	External calibration with 6 standards covering the range of sample concentrations prior to sample analysis. At low end, the lowest standard at or near the MDL. Linear regression ≥ 0.995 . Calibration verification every 10 samples after initial calibration. Standard source different than used for initial calibration. Recovery 90 - 110%.	90 - 110% Daily	JMH/MC1
BC Labs: Turbidity (for QA)	BC Labs SOP BCGEN014	Calibration performed	Quarterly	JTM

Equipment / Instrument	SOP reference	Calibration Description and Criteria	Frequency of Calibration	Responsible Person
		Secondary standard check	Daily	
BC Labs: Oil & Grease	BCORG026	N/A	N/A	MAM
BC Labs: Dissolved Copper, Dissolved Zinc, Dissolved Lead	BCMET037	External calibration with 3 standards covering the range of sample concentrations prior to sample analysis. At low end, the lowest standard at or near the MDL. Linear regression $r^2 \geq 0.995$. Calibration verification every 10 samples after initial calibration. Standard source different than that used for initial calibration. Must pass in order to continue the analysis.	As needed	ARD
BC Labs: Total Petroleum Hydrocarbons (TPH)-Gasoline, Total Petroleum Hydrocarbons (TPH)-Diesel	BCORG003 BCORG005	External calibration with 6 standards covering the range of sample concentrations prior to sample analysis. At low end, the lowest standard at or near the MDL. Linear regression $r^2 \geq 0.995$. Calibration verification every 10 samples after initial calibration. Standard source different than that used for initial calibration. Must pass in order to continue the analysis.	As needed	TDH BUP
BC Labs: Total Suspended Solids	BCGEN022	Sample /Sample Duplicate	N/A	JKS
Morro Bay-Cayucos Wastewater Treatment Plant Lab: autoclave	Morro Bay-Cayucos Wastewater Treatment Plant Laboratory QA Manual	Run a vial of geobacillus stereothermophilus spores through an autoclave cycle. Place in incubator along with an unautoclaved vial. The unautoclaved vial should change color due to cell growth and the autoclaved one should not.	Monthly	Steve Aschenbrener
Morro Bay-Cayucos Wastewater Treatment Plant Lab: autoclave	Morro Bay-Cayucos Wastewater Treatment Plant Laboratory QA Manual	Place autoclave tape on items to be treated. Tape should change color if temperature reaches 121 °C.	Each batch of broth	Steve Aschenbrener

Equipment / Instrument	SOP reference	Calibration Description and Criteria	Frequency of Calibration	Responsible Person
Morro Bay-Cayucos Wastewater Treatment Plant Lab: autoclave timer	Morro Bay-Cayucos Wastewater Treatment Plant Laboratory QA Manual	Run batch with two timers, one certified, to ensure accuracy.	Quarterly	Steve Aschenbrener
Morro Bay-Cayucos Wastewater Treatment Plant Lab: autoclave thermometer	Morro Bay-Cayucos Wastewater Treatment Plant Laboratory QA Manual	Run batch with two thermometers, one which holds the maximum temperature reached during the autoclave run.	Each batch	Steve Aschenbrener

17. INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

Supplies will be examined for damage as they are received. The following supplies will receive additional checks as follows.

Conductivity and turbidity standards will be checked by comparing their readings with those generated by the current lot of standards. Standards must agree exactly.

Bacterial media will be checked with a sterility check. New batches of media will be used to run a bacteria test using sterile distilled water as the sample. The results should be below the method detection limit.

Each new batch of nutrient and bacteria media will be tested using distilled water as the sample. The results should be below the method detection limit.

All analytical laboratories used by the program maintain a supply inspection and acceptance SOP, which are available from the laboratories upon request.

MBNEP staff, overseen by the MBNEP QA Officer, are responsible for receipt of all consumables and supplies. All supplies are stored in the MBNEP equipment room adjacent to the office. MBNEP staff track supplies and ensure that they are reordered in a timely fashion. All supplies are stored per the manufacturer's recommendations.

Cal Poly inspects and stores all supplies and standards pertaining to bay pH monitoring.

18. NON-DIRECT MEASUREMENTS (EXISTING DATA)

The primary source of non-direct data to this project is the CCRWQCB, which collects data under a SWAMP-approved QAPP, and thus its validity is well-documented. Only data that had undergone CCRWQCB's own approval process would be used. Data is typically provided in a CEDEN-compatible database format. This data would be used in combination with MBNEP data. For details see the MBNEP EMP. The data would need to meet the data quality objectives laid out in Section 7.

The other potential sources of data listed below provide data that would be used anecdotally. If data was to be used for program decision-making, it would be considered based on details provided in data collection protocols. The MBNEP QA Officer would conduct internal audits of the precision, accuracy, bias and completeness to determine if the data would be acceptable for incorporation into its analysis. Outside data is not incorporated into the Access database. Methods of data collection and analysis would be analyzed to ensure that they met the MBNEP's acceptability criteria. Data that did not meet the MBNEP's own criteria laid out in Section 7 would be analyzed separately so that it did not become intermixed with data that had met acceptance criteria.

If that data had confidentiality constraints on it, it would be used without revealing the exact location of sample collection.

These other sources include (but are not limited to):

- California Men's Colony Wastewater Treatment Plant
- California Polytechnic State University, San Luis Obispo student project data
- California Polytechnic State University, San Luis Obispo research data
- Resource Conservation District maintenance and monitoring records
- Point Blue
- Applicable Environmental Impact Report data
- County of San Luis Obispo Environmental Health Department and Department of Public Works
- Los Osos Community Services District
- Surfrider
- California Department of Fish and Wildlife
- California Department of Parks and Recreation
- US Fish and Wildlife Service
- California Native Plant Society
- California Department of Public Health
- City of Morro Bay

19. DATA MANAGEMENT

Upon completion of fieldwork, volunteers or MBNEP staff check over datasheets for completeness and any obvious errors. As datasheets come in from the field, MBNEP staff will review them for any obvious omissions or errors. Data is then entered into the appropriate computerized system, either the Excel or Access database. Upon completion of data entry, a different MBNEP staff member than the one who originally entered that data reviews all entered data to ensure its accuracy and completeness. Once this is complete, the original paper copy datasheets are filed. The database is backed up on an external hard drive and uploaded to cloud storage each night.

Suspended sediment data is stored in an Access database which is maintained at the Sediment Laboratory at Cuesta College, located at Highway 1, San Luis Obispo, CA. All sample-related data is stored in the database. Twice monthly during times of sample processing, an Access query is run to generate a paper copy of all relevant data to provide a hard copy. The database is backed up twice a month during periods when samples are being processed and stored off-site.

When data is received from the analytical laboratories, MBNEP staff reviews the data and then enters it into the appropriate electronic data management system or uploads the electronic data delivery report from the lab. Upon completion of the data entry, an MBNEP staff member reviews all entered data to ensure its accuracy and completeness. Once this is completed, the paper copy report is filed. The database is backed up on an external hard drive and uploaded to cloud storage each night.

The data management protocols are outlined in an SOP titled MBVMP Data Management Protocols (see Appendices).

All Cal Poly-generated data is stored on the Cal Poly OneDrive server and backed up to the cloud.

As SOPs are updated, the date of the update is inserted in the document footer so that users can be sure that they are using the most recent version.

Data is analyzed periodically for various reports or data summaries generated for agencies, non-profits

and other users of the data. The majority of this analysis is conducted with Access, Excel and ESRI ArcGIS. This analysis is conducted by MBNEP staff and is overseen by the MBNEP QA Officer. The data has been loaded to the California Environmental Data Exchange Network (CEDEN) and is available for download by CCRWQCB CCAMP staff and others.

The MBNEP contracts with an independent contractor to provide server maintenance and upkeep. As our primary data management system is a CEDEN-compatible database, MBNEP staff relies on guidance from CEDEN staff to inform us of the requirements of both hardware and software for properly maintaining the CEDEN-compatible database.

GROUP C: ASSESSMENT AND OVERSIGHT

20. ASSESSMENTS & RESPONSE ACTIONS

To ensure that the QAPP is being implemented as approved, the QC procedures outlined in Section 14 are conducted. The MBNEP QA Officer is responsible for this assessment. Progress or problems are reported to the RWQCB QA Officer. These assessments include review of calibration logs, review of QA data from the laboratories, audits of field and laboratory activities, and review of all data management activities. These activities are all on-going and happen at least on a quarterly basis. The approximate schedule for these activities is in March, June, September and December of each year.

While no formal external assessments are planned, any problems or issues are shared with the RWQCB QA Officer and advice is sought to correct the problem.

Corrective actions noted during a field or laboratory audit would be addressed through a review of the SOP and re-training of staff or volunteers. Actions to address calibration problems or QA data from the laboratories would be addressed by the MBNEP QA Officer and might include repair or maintenance to a piece of equipment, review of SOPs, re-training of staff or volunteers, or replacement of a problematic piece of equipment. Corrective actions for data management issues would include review of SOPs and retraining of VMP staff to correct any problems.

Laboratory personnel are responsible for assessing laboratory QC results and implementing any necessary corrective actions.

The MBNEP QA Officer has the authority to halt all sampling and analytical work by the MBNEP staff or volunteers as well as any of the analytical laboratories with which it contracts.

Cal Poly is responsible for all QA issues related to bay pH monitoring, including review of calibration logs, review of QA data, audits of field and lab activities, and review of data.

21. REPORTS TO MANAGEMENT

MBNEP staff and volunteers are in constant communication with the MBNEP QA Officer and any issues, discrepancies or problems would immediately be reported.

The MBNEP staff and MBNEP QA Officer create an annual detailed QA analysis. This QA analysis will outline any results that did not meet the QC objectives. Any outstanding issues are discussed with the RWQCB QA Officer.

SOPs are updated continuously throughout the year. Once a year, a QAPP update will be submitted to the RWQCB and EPA QA Officers for their review and approval. It will include all of the updates to SOPs and QA procedures.

For the bay pH monitoring, Cal Poly will produce a report which will includes QA information such as accuracy and precision estimates.

Table 21.1. QA management reports

Type of Report	Frequency (daily, weekly, monthly, quarterly, annually, etc.)	Projected Delivery Dates(s)	Person(s) Responsible for Report Preparation	Report Recipients
Data Summary Report and Memos	Annually	Variable	MBNEP Program Manager	Project partners
Calibration Log	Annually	Variable	MBNEP Program Manager	Maintained on-site
QAPP Update	Annually	Variable	MBNEP QA Officer	RWQCB QA Officer, EPA QA Officer

GROUP D: DATA VALIDATION AND USABILITY

22. DATA REVIEW, VERIFICATION, AND VALIDATION REQUIREMENTS

All raw data, data entry, calculations, and data analysis are reviewed and verified by the MBNEP QA Officer. All data received by laboratories are also reviewed by the MBNEP QA Officer or a trained staff person. Information such as chain of custody forms are also reviewed to ensure that all hold times, sample preservation requirements, etc. have been met.

Data will be reviewed against the measurement quality objectives in Section 7 and separated into one of the following categories: data meeting all MQOs, data failing precision criteria, or data failing to meet accuracy criteria. Data meeting all MQOs is usable for future analysis. Data in the last category is not usable. For data failing the precision category, the following actions will be taken based on the type of data. For bacteria, data failing the R_{log} criteria will not be used. For orthophosphates, readings of 0.33 mg/L or less that fail the criteria will be retained. Higher readings that fail will be rejected. Orthophosphate data that falls below the project quantitation limit (PQL) of 0.33 mg/L as PO_4 will be flagged in the database in the QAComments field as being less than the PQL. All other water quality parameters will follow the precision criteria listed in Table 7.1.2 and if they are not met, the data are rejected. Each failing value will be flagged as such in the database so it can easily be excluded from all data analysis. For suspended sediment data, sample results that are invalid due to errors during processing or data management will be removed from the sediment monitoring database and will not be used in any data analysis. All decisions regarding data validation will be performed by the MBNEP QA Officer.

Cal Poly is responsible for the review, verification, and validation of the bay pH data. The discrete pH samples will be used to assess error by establishing an error envelope for the sensor time-series calculated as a function of the discrete pH error. The data will be used to create time series anomaly plots to identify periods of sensor conditioning, drift, fouling, and failure. It will also be used to create property-property plots to examine the agreement between the sensor pH and independent reference pH values from the discrete samples. For absolute differences in sensor and discrete sample results of greater than 0.1 pH units, the data would be discarded from further analysis.

23. VERIFICATION AND VALIDATION METHODS

All data records will be checked visually prior to data entry into either the Access database, the Excel files or other electronic formats. Any corrections will be written directly on the datasheet. MBNEP staff will conduct all reviews and a different MBNEP staff member will review all datasheets and all data entry into Access, Excel and other electronic formats. Laboratory QA Officers will perform checks of all of their records. All submittals by laboratories will be reviewed by MBNEP staff. Any questions with the data submitted by the laboratories will be addressed with the appropriate laboratory personnel who verify the data. Once any issues have been resolved, the data can be loaded into the Access database, Excel database and other electronic formats.

Data validation is conducted by the MBNEP QA Officer and is done by a manual review of the data. The MBNEP QA Officer is responsible for verifying and validating all datasheets, chain of custody forms, maintenance logs and calibration logs. The MBNEP QA Officer also validates the data entry into the CCAMP database and other electronic formats, as well as any calculations.

Issues will be noted. Reconciliation and correction will be done by a committee composed of the MBNEP QA Officer and MBNEP staff with input, if applicable, from laboratory directors and from the RWQCB QA Officer. Any special notes or decisions regarding data usability will be entered in the 'Notes' column of the Access or Excel database. If it has been determined that the data should not be used in future calculations, it will be flagged as such in the electronic format.

Data validation is conducted by Cal Poly for the bay pH data, per analysis described in the Section 22. Issues are noted, reconciled, and corrected by Cal Poly.

24. RECONCILIATION WITH USER REQUIREMENTS

The overall goal of this monitoring effort is to track long-term trends in the Morro Bay estuary and its watershed, as well as assess effectiveness of implementation efforts. The specific goals of the monitoring are laid out in Section 5.2. The monitoring was designed to include sampling locations, methods and frequency to assist in addressing these goals. However, MBNEP-generated data will not be adequate for completely addressing all of these goals and is expected to be supplemented by other sources.

Uncertainty regarding the data will be assessed with data verification and validation procedures as outlined in Sections 22 and 23. The project requires adequate data to address its goals, and the completeness criteria indicate whether this data will be adequate. The completeness criteria are the most essential in determining whether the collected data provide enough information to answer the original questions asked. Long-term trend data is required, with no gaps in the data collection and consistent sample collection and handling.

All data with limitations on its data use are flagged in our database. If requests are received for program data or analysis, those questionable data records will not be included.

All data will be analyzed for outliers and trends. Data is summarized in graphs and charts and presented on an annual basis in data summary memos that are made publicly available. All trends, anomalies and relationships are discussed in the report. Adequate information on sample design will be provided to inform users of limitations in data use.

All data is collected, managed and maintained in a SWAMP-compatible manner. All historic data for water quality, flow, bacteria and bioassessment has been submitted to CEDEN via the Regional Data Center. Data is submitted to CEDEN on a quarterly basis.

Bay pH data will be submitted to the Water Board rather than CEDEN, as the data portal cannot currently accept continuous monitoring data. Only data that meets QA criteria will be submitted.

References

BC Laboratories. QAPP & QAPM Quality Manual. January 13, 2015.

- Black, R. 2010. Response of algal metrics to nutrients and physical factors and identification of nutrient thresholds in agricultural streams. Environmental Monitoring Assessment, doi: 10.1007/s10661-010-1539-8.
- Bresnahan, P. J. J., Martz, T. R., Takeshita, Y., Johnson, K. S., and LaShomb, M. (2014). Best practices for autonomous measurement of seawater pH with the Honeywell Durafet. Methods Oceanogr. 9, 44–60. doi: 10.1016/j.mio.2014.08.003
- CDFW. California Department of Fish and Wildlife Aquatic Invasive Species Decontamination Protocol. October 16, 2013.
- Central Coast Regional Water Quality Control Board. 2011. Water Quality Control Plan, Central Coast Region (Basin Plan).
- Central Coast Water Quality Control Board. 2017. Order No. R3-2017-0042. Waste Discharge Requirements, National Pollutant discharge Elimination System (NPDES) General Permit for Discharges with Low Threat to Water Quality.
- Central Coast Regional Water Quality Control Board. 1995. Quality Assurance Project Plan for Non-Point Source Pollution and Treatment Measure Evaluation for the Morro Bay Watershed.
- EPA. 2012. Recreational Water Quality Criteria. EPA 820-F-12-058.
- Herbst, David, et al. Sediment Deposition Relations to Watershed Land Use and Sediment Load Models Using a Reference Stream Approach to Develop Sediment TMDL Numeric Targets for the San Lorenzo River and Central Coast California Streams. January 2011.
- Kapsenberg L, Bockmon EE, Bresnahan PJ, Kroeker KJ, Gattuso J-P and Martz TR (2017) Advancing Ocean Acidification Biology Using Durafet® pH Electrodes. Front. Mar. Sci. 4:321. doi: 10.3389/fmars.2017.00321
- Merkel and Associates, Inc., 2017. 2017 Morro Bay Comprehensive Baywide Eelgrass Inventory. August 2017.
- Morro Bay National Estuary Program. 2012. Comprehensive Conservation and Management Plan. Morro Bay National Estuary Program, Morro Bay, California.
- Morro Bay National Estuary Program. 2000. Comprehensive Conservation and Management Plan. Vol. II Environmental Monitoring Plan. Morro Bay National Estuary Program, Morro Bay, California.
- Moyle, Peter. 2002. Inland Fishes of California. University of California Press.
- Ode, Peter. 2016. Standard Operating Procedure for the Collection of Field Data for Bioassessments of California Wadeable Streams: Benthic Macroinvertebrates, Algae, and Physical Habitat. 2016 v2. California Department of Fish & Wildlife, Aquatic Bioassessment Laboratory.
- Sea-Bird Scientific (2018). User manual: SeaFET sensor, pH and optional CTD-DO. Document No. SeaFET170601
- Sea-Bird Scientific (2018). Technical Note: Best Practices for the SeaFET™ V2: Optimizing pH Data Quality.
- Shoup, D.E. and D.H. Wahl. 2009. The effect of turbidity on prey selection by piscivorous largemouth bass. Transactions of the American Fisheries Society, 138:1018-1027.
- Sigler et al. 1984. Effects of chronic turbidity on density and growth of steelhead and coho salmon. Transactions of the American Fisheries Society, 113:142-150.
- Spratt, J.D. 1989. The distribution and density of eelgrass, *Zostera marina*, in Tomales Bay, California. *California Fish and Game* 75(4), 204-12.
- SWAMP. Standard Operating Procedures for Laboratory Processing and Identification of Benthic

Macroinvertebrates in California. October 2012.

SWRCB. California Environmental Data Exchange Network Field Data Submission Guidance Document. August 2013.

SWRCB. California Environmental Data Exchange Network Chemistry Data Submission Guidance Document. August 2013.

SWRCB. Surface Water Ambient Monitoring Program Measurement Quality Objectives: Field Measurements in Fresh and Marine Waters. January 2013.

SWRCB. Surface Water Ambient Monitoring Program Measurement Quality Objectives: Nutrients in Fresh and Marine Waters. January 2013.

SWRCB. Surface Water Ambient Monitoring Program Measurement Quality Objectives: Indicator Bacteria in Fresh Water. January 2013.

Thom, R.M., 1990. A review of eelgrass transplanting projects in the Pacific Northwest. Northwest Environ. Jour., 6:121-137.

Thorne-Miller, B., M.M. Harlin, G. B. Thursby, M. M. Brady-Campbell, and B. A. Dworetzky. 1983. Variations in the distribution and biomass of submerged macrophytes in five coastal lagoons in Rhode Island, USA. Bot. Mar. **26**: 231-242.

2005. Standard Methods for the Examination of Water and Wastewater. Microbiology precision of quantitative methods.

Standard Test Methods for Determining Sediment Concentration in Water Samples. ASTM D- 3977-97. Re-Approved in 2002.

Williamson, R.1994. The Establishment of Nutrient Objectives, Sources, Impacts, and Best Management Practices for the Pajaro River and Llagas Creek. San Jose State University.

Worcester, K., D. Paradies, M. Adams. 2010. Interpreting Narrative Objectives for Biostimulatory Substances for California Central Coast Waters. Technical Report.

YSI Incorporated. Pro 2030 User Manual. November 2010.

Acronym List

Acronym	Definition
CCAMP	Central Coast Ambient Monitoring Program
CCMP	Comprehensive Conservation & Management Plan
CCRWQCB	Central Coast Regional Water Quality Control Board
CDPH	California Department of Public Health
CEDEN	California Environmental Data Exchange Network
CWA	Clean Water Act
DI	Deionized
DO	Dissolved oxygen
ELAP	Environmental Laboratory Accreditation Program
EMP	Environmental Monitoring Plan
EPA	Environmental Protection Agency
GPS	Global Positioning System
ISS	Inferometric sidescan sonar
MBNEP	Morro Bay National Estuary Program
MBVMP	Morro Bay Volunteer Monitoring Program
MDL	Minimum Detection Limit
MPN	Most Probable Number
MQO	Measurement Quality Objective

Acronym	Definition
MTF	Multiple Tube Fermentation
NTU	Nephelometric turbidity units
PQL	Project Quantitation Limit
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
RPD	Relative Percent Difference
RWQCB	Regional Water Quality Control Board
SET	Surface elevation table
SM	Standard Method
SOP	Standard Operating Procedure
TMDL	Total Maximum Daily Load
UAV	Unmanned aerial vehicle
USGS	United States Geological Survey
USGS SLQA	United States Geological Survey Sediment Lab Quality Assurance
VMP	Volunteer Monitoring Program