Support for Community Water Quality Monitoring Summary Report

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NOAA CORAL REEF CONSERVATION PROGRAM

Support for Community Water Quality Monitoring Summary Report

Background:
There is increasing recognition that coral reefs on populated coastlines have been degraded by land-based pollutants, or are at risk of degradation. Land-based pollutants include fine sediment, nitrogen, phosphorus, pesticides, metals and other contaminants associated with urban, agricultural and industrial land-use. Symptoms of coral reef degradation include high rates of sediment deposition, phytoplankton and seaweed blooms, coral diseases, and reductions in fish and coral diversity. In the most severe cases, entire coral tracts have been converted to sediment and seaweed-dominated rubble.

Despite the general recognition that good water quality is vital for healthy coral reefs and land-based pollutants are a serious threat, the scarcity of data makes tracking and assessing water quality difficult. In Hawai‘i, several state and federal agencies undertake coastal water quality monitoring. However, these programs have funding, staffing and jurisdictional limits that affect their spatial extent and monitoring frequency, and the range of variables that are measured.

The most extensive monitoring program in state waters is run by Department of Health Clean Water Branch; this program includes periodic sampling of approximately 65 sites on Maui, but none on Lanai or Molokai. Data from the Clean Water Branch are used in the biannual Water Quality and Assessment Report to the US Environmental Protection Agency. The data are also used for adding or removing sites from the state-wide list of impaired marine waters, and for water-quality-related warnings and advisories for contact recreation. The primary focus of the Clean Water Branch marine program is ensuring adequate water quality for contact recreation. For this reason, the monitoring sites are concentrated in shallow water at high-use beaches.

Progress towards community water monitoring at Polanui:
A series of meetings were held with Polanui Hiu leaders and a site visit was conducted by TNC’s Senior Science Advisor, Dr. Scott Larned to understand Polanui Hui's questions and needs regarding sediment and pollutants and their effects on the coral reef. He then developed draft community-based monitoring protocol with recommendations specific to Polanui (see page 5).

After completing and reviewing the draft protocols and through additional discussions with community members and TNC experts, we determined that a site-specific protocol was not ideal for the purposes of the CMMA network communities as it would not be applicable and scale-able to all sites due to the differences between sites and the requirements from EPA/DOH. Therefore, it was decided to increase the scale of the water quality monitoring protocol to Maui County.

Progress towards Maui County wide community water quality monitoring:
To begin the process of developing a larger scale of community water quality monitoring, a meeting was co-sponsored by TNC and the Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS) to further explore the idea. In Kihei, Maui in May 2014, TNC partnered with the Maui Nui Marine Resources Council (MNMRC) and the Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS) to host an introductory workshop focused on needs of community organizations that would like to benefit from coastal water quality monitoring programs. Specific target areas were Honolua Bay, Honokahua Bay, Napili Bay,

Kahekili Herbivore Fishery Management Area, Polanui, Olowalu, Maalaea to ʻĀhihi-Kīnaʻu NAR, Hāna Bay, Maunalei, Lānaʻi, and Kahului Harbor. Twenty-two community members and representatives from key government agencies, including the EPA and Hawaii Department of Health (DOH) attended the workshop, which was focused on island-wide water quality issues. The workshop included presentations from Dr. Carl Berg who leads the DOH-approved community-based monitoring program on Kauaʻi, and EPA and DOH staff, who explained their requirements for using water quality data from community groups.

The most important outcome of the workshop was the positive relationships that were established and the increased understanding of the role of DOH and the use of their standards. The group learned that the main requirement is a DOH approved Quality Assurance Project Plan (QAPP). Represented community organizations also learned that they have several common goals, including using water-quality data from their areas to inform land-use and water management decisions to improve conditions for coral reef and human health, and providing data to regulatory agencies like DOH.

The result of these efforts has been a network of Maui Nui communities now joining together to develop plans for a quality-assured coastal water-quality monitoring program. The community-based program is being developed through the combined efforts of 13 different sites or community groups (Figure 1), the Maui Nui Marine Resource Council, the Hawaiʻi Department of Health, The Nature Conservancy, and the Hawaiian Islands Humpback Whale National Marine Sanctuary.

The community-based coastal water-quality monitoring program developed for Maui Nui increases the number and geographic range of monitoring sites, and expands the distribution of sites within the boundaries of each community group. The program has several objectives:

- Generate accurate water-quality data that meets the quality assurance requirements of the Hawaiʻi Department of Health.
- Make water-quality data available to inform land-use decisions.
- Contribute to statewide & Pacific-wide assessments of coastal water-quality state & trends.
- Increase awareness in communities about the state of their coastal water.
- Foster the management and operation of monitoring programs by community members.
- Facilitate cooperation among community groups and between communities and state and federal agencies.

A Quality Assurance Project Plan (QAPP) was developed by a team led by The Nature Conservancy, Napili Bay and Beach Foundation, NOAA, and University of Hawaiʻi. The QAPP is a technical document with detailed descriptions of the principle investigators, geographic area, questions, purpose, monitoring program design and procedures, instruments, data management, quality assurance and quality control activities, and responsibilities of the participants.

A draft QAPP was submitted to the State of Hawaiʻi's Department of Health, Clean Water Branch (DOH) in June 2015, TNC and partners received comments in February 2016, and made requested revisions. TNC marine science advisor, Kim Falinski, worked with West Maui Ridge to Reef and QAPP partners to complete a pilot test run of the equipment and protocols with volunteers in the initial pilot site.

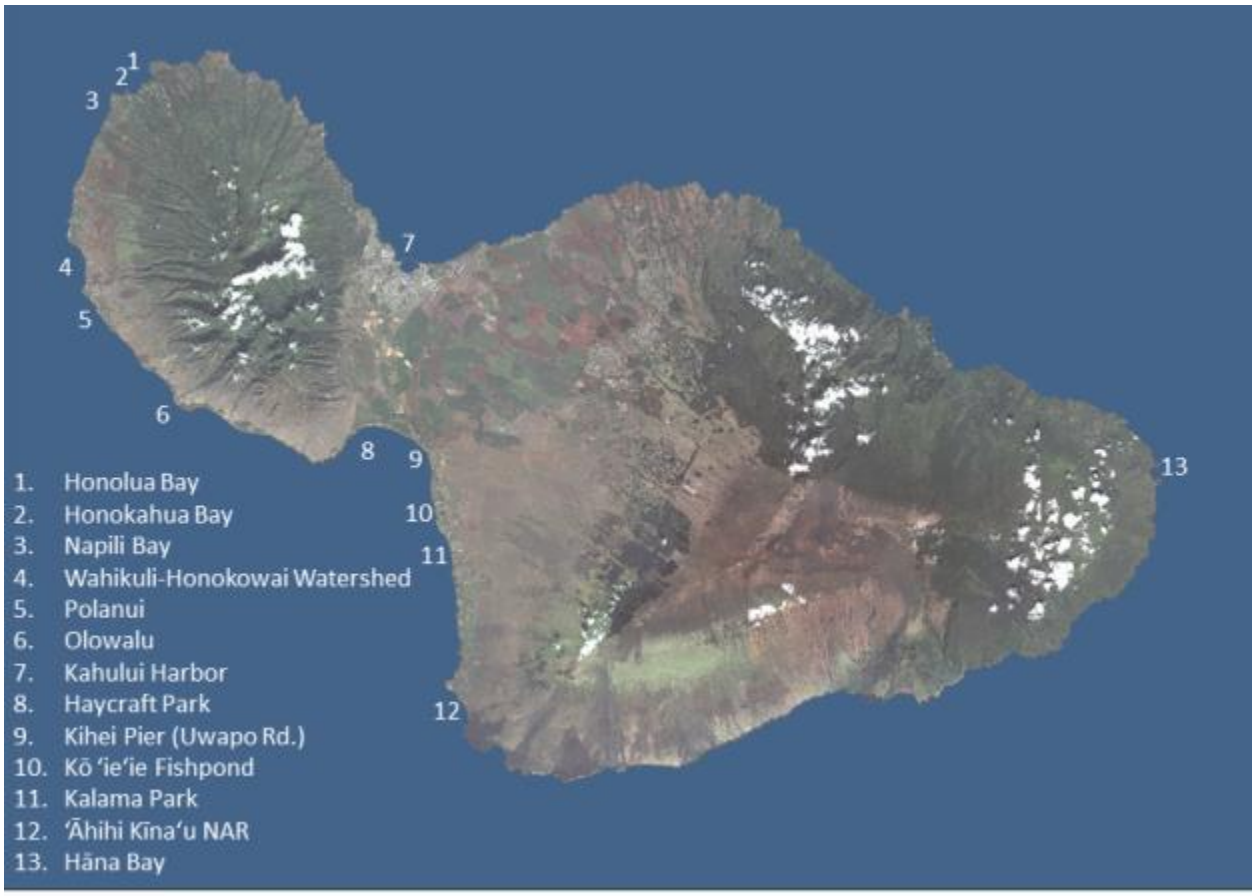

Figure 1. Locations for community-based coastal water-quality monitoring program.

Polanui Water Quality Draft Protocol

Recommended Coastal Water Quality Monitoring for Polanui Hiu

Introduction

Poor coastal water quality poses risks to human health and to the ecological health of coral reefs, seagrass beds and other nearshore ecosystems. Data from water quality monitoring programs are needed to assess these risks. Water quality variables that relate to human health include bacteria such as *Enterococcus* and *Clostridium*, and salinity, which can indicate contaminated stream and groundwater inflows to coastal zones. Variables that relate to ecological health include nitrogen and phosphorus (which can stimulate algal growth), pH (which is related to coral growth) and suspended sediment (which can reduce light penetration and settle on corals).

In large-scale water-quality monitoring programs such as the Department of Health beach monitoring program, a standard set of variables is measured at regular intervals at a large number of sites. Volunteer monitoring programs typically measure a subset of these variables at a small number of sites. The variables selected for volunteer monitoring depend on the specific concerns of the community, equipment availability, laboratory costs, and the accuracy and precision needed to achieve the community's goals.

If the primary concerns of the community relate to human health and recreation, monitoring may focus on fecal indicator bacteria such as *Enterococcus*. Community groups that focus on these variables generally collect water samples and ship them to certified analytical laboratories for processing and quantification. However, some community groups process and quantify their own *Enterococcus* samples; see www.surfrider.org/blue-water-task-force.

If the primary concerns of the community relate to ecological health, monitoring may focus on sediment, nutrients, and other physical and chemical variables. In community groups that focus on ecological health, group members usually measure some variables themselves and ship additional water and sediment samples to laboratories, where other variables are measured.

The effort required to measure different water quality variables varies widely. Some measurements can be made by volunteers onsite, with simple-to-use instruments such as digital thermometers. Other variables can also be measured onsite, but require more training, such as dissolved oxygen. And other measurements must be made in indoor facilities or in a laboratory, using water samples collected in the field. These measurements include concentrations of suspended sediment, bacteria and nutrients.

The cost, accuracy and precision of measurements are all related to the intended use of monitoring data. If the primary aims of a monitoring program are education and community involvement, then inexpensive instruments and test kits are suitable. These kits have the advantage of providing information immediately, although the accuracy and precision of the information may not be high. If the primary aim is to produce high-quality data that can be used in water and land planning and assessment, then the best approach is a combination of volunteer measurements and measurements by certified laboratories. For laboratory measurements, trained volunteers can still collect and deliver samples and receive laboratory reports.

Table 1 shows a list of standard water quality variables, the equipment needed to measure them, and potential roles of community groups in making the measurements.

Most of the variables measured in water quality monitoring programs concern the causes of ecological degradation, such as excessive sediment and nutrient levels. To be more comprehensive, these programs should include ecological measurements as well as water-quality measurements, so that associations between water quality and ecological conditions can be identified. It is particularly important to identify ecological improvement in response to improvements in water quality, or ecological degradation in response to worsening water quality. For shallow sites like the Polanui reef flat, ecological variables that can be included in a volunteer monitoring program include fish composition and abundance, live coral composition and cover condition, limu composition and cover, and sediment cover and depth.

Repeated monitoring at regular intervals is an important component of water-quality monitoring programs. The water-quality conditions at a site may vary at multiple time scales - between high and low tides, between rainy and dry seasons, and before, during and after urban and agricultural activities (e.g., construction, agricultural tillage and fertilization). Community groups tend to be concerned with long-term water-quality state and long-term trends, not conditions at one instant in time. Repeated monitoring is needed to for accurate assessments of long-term state and for detecting trends. Monitoring at regular intervals ensures that the resulting data are representative of the local weather, stream-flow and land-use conditions (that is, the data are unbiased).

In addition to repeated monitoring at regular intervals, a subset of the total monitoring effort may be reserved for monitoring before, during and after large rainstorms. In many catchments, a large proportion of the annual pollutant load is delivered to coastal waters during a few large storms. High runoff and high stream and stormdrain flow during storms mobilize and transport large quantities of sediment, nutrients, bacteria and other contaminants. Sites used for storm sampling must be limited to those that can be safely accessed during bad weather, and safety measures must be taken to prevent contact with contaminated water. Note that data from targeted storm-monitoring should not be averaged into datasets from regular monitoring, to prevent bias.

Table 1. Water quality monitoring variables, instruments and volunteer roles.

Variable	**Measured in field, ashore or laboratory**	**Instrument**	**Volunteer role**
Water temperature	Field	Digital thermometer on multimeter (or separate thermometer)	Measurement
Salinity	Field	Salinity sensor on multimeter (or separate salinity meter or refractometer)	Measurement & calibration
pH	Field	pH sensor on multimeter (or separate pH meter)	Measurement & calibration
Dissolved oxygen concentration	Field	DO sensor on multimeter (or separate DO meter)	Measurement & calibration
Turbidity	Field	Turbidity sensor on multimeter (or separate tubidimeter)	Measurement & calibration
Suspended sediment concentration	Ashore or laboratory	Vacuum pump, drying oven and balance	Measurement or sample collection for lab analysis
Sediment deposition	Ashore or laboratory	Vacuum pump, drying oven and balance	Measurement or sample collection for lab analysis
Nitrate+nitrite concentration	Laboratory	Laboratory analyzer	Sample collection for lab analysis
Ammonium concentration	Laboratory	Laboratory analyzer	Sample collection for lab analysis
Total nitrogen concentration	Laboratory	Laboratory analyzer	Sample collection for lab analysis
Phosphate concentration	Laboratory	Laboratory analyzer	Sample collection for lab analysis
Total phosphorus concentration	Laboratory	Laboratory analyzer	Sample collection for lab analysis
Phytoplankton chlorophyll concentration	Laboratory	Laboratory analyzer	Sample collection for lab analysis
Enterococcus concentration	Ashore or laboratory	Fluorogenic test kits (such as Enterolert)	Measurement (www.surfrider.org/blue-water-task-force) or sample collection for lab analysis
Clostridium concentration	Laboratory	Laboratory incubation system	Sample collection for lab analysis

Recommendations

Monitoring variables

A. Temperature, DO, pH and salinity to be measured in the field by Polanui Hiu members with a hand-held multimeter.

B. Suspended sediment to be collected in the field and measured ashore by Polanui Hiu members, using a hand vacuum pump, drying oven and balance. Sediment deposition measurements using tube traps are optional.

C. Dissolved inorganic nitrogen (nitrate+nitrite, ammonium) and dissolved reactive phosphorus concentrations to be measured by an analytical lab in samples collected by Polanui Hiu members.

D. Coral composition, coral cover, limu composition, limu cover, sediment cover and depth to be measured by Polanui Hiu members.

Water quality monitoring sites and monitoring frequency

Seven sites should be monitored monthly. Additional sampling dates at the same sites are recommended after rainstorms, when safe. The following list has the locations of seven potential monitoring sites distributed over the Polanui reef flat; these sites should be accessible from Front Street.

Monitoring by Polanui Hiu members will focus on the shallow reef flat, in water depths < 4 ft. The depths of the sites listed below are not known, but alternative sites could be selected and their GPS coordinates recorded. Once selected, the same sites should be used on each water quality sampling date.

Sites from north to south	latitude & longitude
Lahaina Beach Resort, nearshore	20°52'02.09" N 156°40'33.38" W
Lahaina Beach Resort, offshore	20°51'59.43" N 156°40'36.58" W
Central Polanui, nearshore	20°51'53.06" N 156°40'23.10" W
Central Polanui, offshore	20°51'51.45" N 156°40'25.39" W
Beach Access #202, nearshore	20°51'49.04" N 156°40'22.70" W
Beach Access #202, offshore	20°51'47.30" N 156°40'21.01" W
Kauaula Stream, nearshore	20°51'32.09" N 156°40'06.94" W

Note that there is a Department of Health beach monitoring site in Polanui (Site 726, "Lahaina Town #202"), at beach access sign 202, between Kauaula Rd and Aholo Rd. Data from Site 726 consist of temperature, salinity, pH, turbidity, and dissolved oxygen, *Clostridium* and *Enterococcus* concentrations, measured on 3-5 dates per year since September 17, 2008. Nitrogen, phosphorus and suspended sediment are not currently measured at this site.

In addition to the water quality variables, ecological variables could be monitored at the Polanui reef flat sites as noted above. Biannual monitoring (winter and summer) could be used to account for seasonal changes, particularly in limu, sediment and fish. The water quality sampling points can be used as endpoints for ecological monitoring on transects. With a small number of monitoring sites (7), the focus of the ecological monitoring would be changes over time, rather than fine-scaled spatial patterns.

Hui O Ka Wai Ola
Quality Assurance Project Plan

Prepared for:
Hui O Ka Wai Ola

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Emily, Fielding, The Nature Conservancy, Hui o Ka Wai Ola Project Manager

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Acronyms and abbreviations

COC	Chain of custody
CWB	Clean Water Branch
HAR	Hawai‘i Administrative Rules
HI-DOH	State of Hawai’i Department of Health
MNMRC	Maui Nui Marine Resource Council
MPN	Most Probable Number of Colony Forming Units
PM	Project Manager
QAPP	Quality Assurance Project Plan
QA Officer	Quality Assurance Officer
QC	Quality Control
S-LAB	SOEST Laboratory for Analytical Biogeochemistry
SOEST	School of Ocean and Earth Science and Technology
SOP	Standard Operating Procedures
TAG	Technical Advisory Group
TMDL	Total maximum daily load
TNC	The Nature Conservancy
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WRRC	Water Resources Research Center

1. Introduction

This Quality Assurance Project Plan (QAPP) has been prepared for water-quality monitoring along the Maui Island coastline to assist the State of Hawai'i Department of Health Clean Water Branch (HI-DOH-CWB) beach monitoring Program. This document was prepared by members of Hui O Ka Wai Ola, a community-based, quality-assured coastal-monitoring program based on Maui Island. The project was initiated in 2014 by the following partner organizations: The Nature Conservancy (TNC), Maui Nui Marine Resource Council (MNMRC), NOAA Hawaiian Islands Humpback Whale National Marine Sanctuary (HIHWNMS), West Maui Ridge-to-Reef Initiative, University of Hawai'i-Maui College (UHMC) and University of Hawai‘i at Mānoa Water Resources Research Center (WRRC).

The monitoring activities of Hui O Ka Wai Ola program are intended to begin in 2016. The overarching goals of the program are to increase the capacity for monitoring water quality in Maui coastal waters by generating reliable data that can be used to assess long-term water-quality conditions and detect temporal trends. These data will augment the data produced by the HI-DOH-CWB beach monitoring program on Maui. To reach these goals, Hui O Ka Wai Ola is organizing a network of monitoring teams drawn from watershed stewardship groups that will operate under the same quality assurance guidelines outlined in this document. The teams will be trained in monitoring procedures, and will conduct regular monthly monitoring and opportunistic, event-based monitoring at sites in Maui's coastal waters at predetermined sites. Producing reliable water-quality data will require that the teams work with water-quality professionals to operate in accordance with an approved QAPP.

This document defines the scope of the program, sets out the organization and goals of the project, and describes the quality control and quality assurance (QC/QA) procedures that will be used to ensure that data generated in the program are accurate, complete, and representative of actual field conditions. The content and format of this QAPP follows the requirements and guidance of the United States Environmental Protection Agency (USEPA) QA/R-5, EPA Requirements for Quality Assurance Project Plans (U.S. Environmental Protection Agency 2001). Detailed procedures for water-quality monitoring are provided in Standard Operating Procedures (SOPs), which are also included in this document.

2. Project Management

2.1. Project Organization

The Hui O Ka Wai Ola program will consist of four monitoring teams, each with a team leader, who are supported by a centralized group that will provide project management, data management, and technical advice. Each team will monitor one of the following sections of Maui coastline: Māʻalaea to ʻĀhihi-Kīnaʻu, Lahaina to Olowalu, Hāna to Kahului, Honolua to Wahikuli. All teams will use identical calibration, operating and handling procedures (Appendix

A, Standard Operating Procedures) to measure the same suite of water-quality parameters or some subset of the parameter suite based on resources available to each regional team.

The six primary roles for participants in the Hui O Ka Wai Ola program are Project Manager (PM), Quality Assurance Officer (QA officer), Monitoring Team Leader, Training Leader, Monitoring Team Member, and Technical Advisory Group (TAG) member. In general, the PM is responsible for administering and coordinating the program; the QA officer is responsible for data management and program quality assurance and quality control (QA/QC), and management of QAPP review and update; the monitoring team leaders and monitoring teams are responsible for field monitoring, some laboratory analyses, and training of new team members; the training leader is responsible for preparing and conducting training sessions; and, the TAG is responsible for providing guidance on technical issues such as instrumentation and sample processing. In addition, the Hui O Ka Wai Ola project has a working group composed of representatives of the organizations that established the project. The working group is responsible for strategic decisions such as the geographic scope of the project, outreach, and coordinating with community organizations and agencies. Specific responsibilities are set out below. Figure 2.1 and Table 2.1 show the personnel designated for the roles in Hui O Ka Wai Ola.

Note that the PM can seek advice from the supervisor of the HI-DOH-CWB Monitoring and Analysis Section, from the TAG and from the director of the SOEST Laboratory for Analytical Biogeochemistry (S-LAB). The QA Officer can seek advice from the QA Officer at HI-DOH-CWB. The QA Officer operates independently from the PM and the monitoring teams.

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197 **Table 2-1: Key personnel for the Hui O Ka Wai Ola program. TBD: to be designated.**

Name	Project Role	Affiliation
Emily Fielding	Project Manager	The Nature Conservancy, Hawaii Marine Program
Kim Falinski	QA Officer, Training Leader, Technical Advisory Group	The Nature Conservancy, Hawai Marine Program
Watson Okubo	Supervisor, Monitoring and Analysis Section, Clean Water Branch	Clean Water Branch, Department of Health
Myron Honda	Quality Assurance Manager, Environmental Management Division	Environmental Management Division, Department of Health
Roland Asakura	Maui Environmental Health Specialist, Clean Water Branch, Maui District Health Office	Clean Water Branch, Department of Health
Danielle Hull	Analytical Laboratory Manager	SOEST S-LAB, University of Hawai‘i at Mānoa
Dana Reed	Monitoring Team Leader – Lahaina to Olowalu	Maui Nui Marine Resource Council
Roxie Sylva	Monitoring Team Leader – Hāna to Kahului	The Nature Conservancy of Hawaii
TBD	Monitoring Team Leader – Mā‘alaea to ‘Āhihi-Kīna‘u	University of Hawai‘i, Maui College
Dana Reed	Monitoring Team Leader – Honolua to Wahikuli	Maui Nui Marine Resource Council, West Maui Ridge-to-Reef Initiative
TBD	Data Manager	

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Technical Advisory Group	Affiliation
Kim Falinski	The Nature Conservancy
Scott Larned	NIWA New Zealand
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Tracy Wiegner	Marine Science Department, University of Hawai‘i at Hilo
Craig Nelson	Department of Oceanography, University of Hawai‘i at Mānoa
Curt Storlazzi	USGS, Pacific Coastal and Marine Science Center
Patricia Bradley	USEPA, Atlantic Ecology Division
Eric De Carlo	Department of Oceanography, University of Hawai‘i at Mānoa
Wendy Wiltse	USAEPA, Pacific Division
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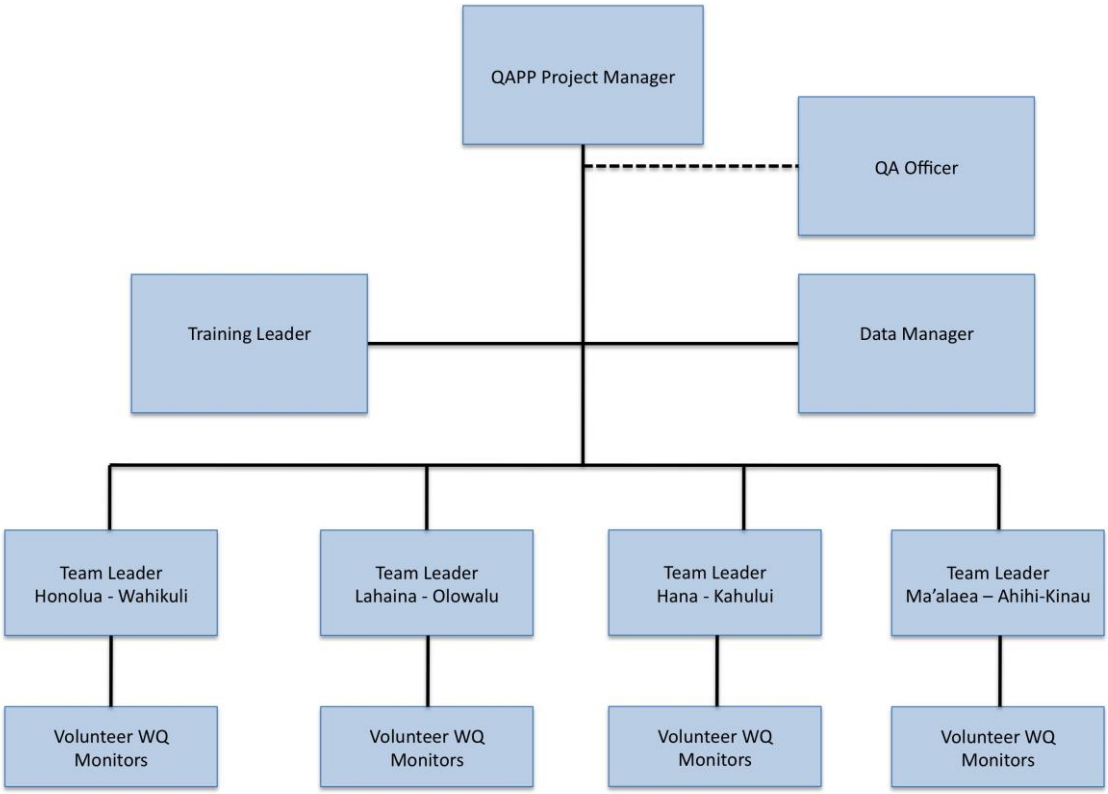

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Craig Nelson – UH Manoa Oceanography
Eric De Carlo – UH Manoa Oceanography
Tracy Wiegner – UH Hilo Marine Sciences
Curt Storlazzi – USGS
Patricia Bradley – EPA
Wendy Wiltze – EPA
Hudson Slay – EPA

Analytical Laboratory

School of Ocean and Earth Science and Technology (SOEST) Lab
Rebecca Briggs

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201 **Figure 2-1: Hui O Ka Wai Ola organizational chart**

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2.1.1. Ongoing project roles

Project Manager

The PM is responsible for administering the project and coordination and communication with partner organizations. Specific responsibilities for the PM are:

- Assist with program start-up, and ongoing communications with community groups, MNMRC, TNC, HI-DOH, HIHWNS and the S-LAB.
- Coordinate facilities, equipment and supply purchases, payments for analytical services and sample shipping, maintain supply inventory, reorder supplies as necessary.
- Coordinate monitoring team training with the training leader, QA Officer, team leaders and community organizations (through the working group).
- Manage permitting and paperwork (e.g., health and safety, boating, volunteer waivers).
- Provide ongoing program oversight (e.g., ensure samples get shipped to analytical lab, data gets reviewed by QA officer and uploaded). Maintain program membership and contact lists.
- Lead changes in monitoring design as necessary (e.g., parameters, procedures, locations).
- Coordinate additions of new groups and new sites to the program, and maintain records of document training class completion.
- Liaise with other monitoring groups and agencies. Represent program at workshops and conferences.
- Assist the working group with grant proposal preparation and other fundraising efforts.
- Resolve challenges encountered by monitoring teams (e.g., beach access).

Quality Assurance Officer

The QA Officer is responsible for ensuring that the project is carried out according to the QAPP. Specific QA Officer responsibilities are:

- Conduct data review, validation and verification, including reviewing data prior to submission to HI-DOH to ensure that all information is accurate and conforms to the QAPP.
- Ensure that all field information is correctly documented.
- Maintain and oversee records (raw data sheets, laboratory reports, chain-of-custody forms, QC checks and calibrations, SOPs, QAPP, laboratory QA/QC plans, training records for monitoring team members).
- Assist in monitoring team training in field and laboratory procedures and data entry.
- Review the QAPP and SOPs twice per year. Identify required procedural changes. Update QAPP as necessary in coordination with DOH.
- Prepare SOPs (with training leaders and monitoring team leaders).

- Ensure that everyone on the distribution list has updated copies of the controlled documents (QAPP, SOPs, laboratory QA/QC plans, etc.).
- Review the field and lab data that has been entered into the database by the Data Manager to help minimize transcription/translation errors.

The QA officer must remain independent of all generation activities, including sample collection, field measurements and laboratory analyses.

Data Manager

The Data Manager is responsible for the data generated by the program, and is a single point of contact for data entry and storage. Initially, the duties assigned to the Data Manager will be performed by the Monitoring Team Leaders. Each site will have a database managed by a single person to enter data. Specific responsibilities for the Data Manager are:

- Enter field and laboratory data into program database.
- Return field and laboratory data sheets to the Program Manager for permanent archive.
- Backup the electronic database weekly.
- Modify the database as required if additional data fields become necessary.

Monitoring Team Leaders

The Team Leaders will be responsible for the volunteer monitoring teams. Four Team Leaders have been designated (Table 2-1). Specific responsibilities for the Monitoring Team Leaders are:

- Schedule monitoring dates and times with team members.
- Ensure that field conditions are safe for team members.
- Maintain, calibrate and properly store field and laboratory equipment.
- Ensure that all field measurements are made in accordance with the QAPP and associated SOPs.
- Ensure that samples for laboratory analysis are collected, processed, stored and shipped in accordance with the QAPP and associated SOPs.
- Ensure that original datasheets are filled out accurately and delivered to the QA Officer on schedule. Maintain copies of all datasheets.
- Store and ship applicable seawater samples for laboratory analysis after collection by Team Members.
- Train new members of the monitoring team using Training Leader training documentation and maintain training records.
- Maintain training documentation of team members.

All staff members associated with data generation (sample collection, field measurements, lab analysis, data analysis, data reporting, etc.) will also review the QAPP. The QAPP reflects the procedures that are actually in use or should be in use by all staff members. Review of the QAPP

by staff members helps to ensure that the procedures used are consistent with what is specified in the QAPP. Review of the QAPP must be performed at least once per year. Any inconsistencies identified by any staff member will be promptly resolved by the QA officer and PM.

Training Leader

The Training Leader is responsible for producing training materials and scheduling and leading training sessions. Specific responsibilities for the Training Leader are:

- Produce training modules consisting of class material and instructor's guide.
- Design field and laboratory demonstrations.
- Schedule training days and coordinate facilities and attendees with the PM.
- Present classroom, field and laboratory material to trainees, including demonstrations.
- Train the Monitoring Team Leaders to train other volunteers locally.
- Prepare SOPs with the QA Officer and the Monitoring Team Leaders.

Monitoring Team Members

The Monitoring Team Members will carry out water-quality monitoring tasks and some laboratory tasks, all under the supervision of the Monitoring Team Leaders. Specific responsibilities of the Team Members are:

- Make field measurements in accordance with the QAPP and associated SOPs.
- Collect, store, and process samples in accordance with the QAPP and associated SOPs.
- Carry out analyses of *Enterococcus*, suspended sediment and other parameters in accordance with the corresponding SOPs.
- Record monitoring information and sample custody information on data sheets and chain-of-custody (COC) forms accurately and completely.
- Complete annual training under the supervision of the Training Leader, and biannual check ups with the Monitoring Team Leader.

2.1.2. Advisory group

Consultation will be provided by the TAG, the HI-DOH Monitoring and Analysis Section Supervisor, the HI-DOH Clean Water Branch QA Officer, and the director of the S-LAB at the School of Ocean and Earth Science and Technology (SOEST) at the University of Hawai‘i at Mānoa.

The TAG currently consists of eight scientists with expertise in water-quality monitoring and data analysis, marine and estuarine biogeochemistry, soil watershed processes, and microbiology. The TAG members have agreed to provide technical advice and training to the PM, QA Officer, and monitoring team leaders. The current TAG members are listed in Table 2.1. The HI-DOH Monitoring and Analysis Section Supervisor will provide advice to the Hui O Ka

Wai Ola PM, and the HI-DOH Clean Water Branch Quality Assurance Officer will provide advice to the Hui O Ka Wai Ola QA Officer.

Strategic planning and consulting will be provided by the Hui O Ka Wai Ola working group. The working group has representatives from the five partner organizations that established the project: The Nature Conservancy, Maui Nui Marine Resource Council, NOAA Hawaiian Islands Humpback Whale National Marine Sanctuary, West Maui Ridge-to-Reef Initiative, and UH-Maui College.

2.1.3. Laboratory facilities

Laboratory analysis services will be provided by the School of Ocean and Earth Science and Technology, Laboratory for Analytical Biogeochemistry (hereafter, S-LAB). The laboratory director of S-LABs has consulted with Hui O Ka Wai Ola to coordinate protocols on nutrient analyses, sample collection, processing and shipping, laboratory quality control.

The regional Maui laboratories will be used by volunteers to prepare and store samples for shipping to the S-LAB laboratory. These regional laboratories will also be used for testing water samples for *Enterococcus*, filtering samples in a clean environment, and determining suspended sediment concentrations (SSC) of the sites under test. Different regional laboratories have been identified to minimize the transport time from sample sites to the regional laboratories. Volunteers sampling at west Maui sites will utilize the microbiology lab at Lahainaluna High School. Volunteers sampling north Maui sites will utilize laboratory facilities at the University of Hawai‘i Maui College.

2.1.4. Data users

The primary users of data generated by Hui O Ka Wai Ola will be HI-DOH CWB. In addition, the data will be made available for public use and data analysis at multiple online locations. Details of data provision and public access are given in Section 5.5.1. Additional data users may include environmental scientists, fishpond operators, community organizations, high-school and college instructors, local and state and federal regulatory agencies, and participants in watershed restoration projects.

2.2. Documentation and records

Controlled documents for the Hui O Ka Wai Ola program include this document and laboratory QA/QC plans. Version control is maintained using a version number and effective date on the cover sheet of each document. This QAPP, any subsequent revisions or addenda, are reviewed and approved by the Project Manager and the QA Officer. When a new version is approved, it is distributed and the old versions are destroyed or marked “Obsolete.” It is the responsibility of the QA Officer to ensure that all relevant project personnel (including everyone on the distribution list) have the most current version. To ensure that they are up-to-date, the QAPP and associated

SOPs must be reviewed twice a year by the QA Officer with guidance from HI-DOH-CWB, and updated as needed.

This QAPP is valid for a period of no longer than five years from the date of approval. If major changes are made, the QAPP must be re-submitted for approval.

3. Problem Definition

3.1. Problem statement

Long term measurements to collect physical and chemical water-quality data are needed to assess current conditions in the coastal waters of Maui Island, to detect and quantify temporal trends in water quality, and to support water-quality management decisions. The suite of water-quality parameters for which data are needed include (but are not limited to) water temperature, salinity, pH, turbidity, dissolved oxygen and dissolved and particulate forms of nitrogen and phosphorus. In addition, data from measurements of fecal indicator bacteria such as *Enterococcus* are needed to assess the suitability of coastal waters for contact recreation. Coastal water quality is affected by the presence and concentration of many other chemical and microbial constituents (e.g., pesticides, dissolved metals, *Staphylococcus, Clostridium*). However, those parameters are out of scope for the Hui O Ka Wai Ola program.

HI-DOH CWB is currently responsible for nearshore water-quality monitoring in Maui coastal waters (hereafter, 'beach monitoring') and identifying water-quality impaired and unimpaired waters. Ongoing beach monitoring is required under the Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000. HI-DOH CWB uses beach-monitoring data for the state's biennial Integrated Water Quality Monitoring and Assessment Report to the USEPA (hereafter, 'integrated report'). The data may also be used for developing TMDLs for impaired water bodies, for assessing restoration and mitigation projects, and for basic environmental research. The most recent Water Quality Monitoring and Assessment Report includes assessments of 160 of 575 marine water-bodies in the state; the small proportion of water-bodies assessed was due to the limited availability of data (HI-DOH CWB 2014). Recent state budget cuts led to a reduction-in-force and position vacancies meaning that fewer coastal sites are monitored and there are less samples collected by CWB staff. The Hui O Ka Wai Ola program is intended to reduce this shortfall. Of the 160 assessed water bodies described in the 2014 integrated report, 85% were designated as impaired as they did not attain state numeric water-quality criteria for at least one or more pollutant. The large proportion of impaired sites provides an indication of the wide-spread water-quality problems in the Hawai'i coastal zone.

3.2. Mission and goals

The mission of Hui O Ka Wai Ola is to generate quality-assured coastal water-quality data, and to provide this data to HI-DOH, other resource agencies, non-governmental organizations, researchers and the public.

Specific goals of Hui O Ka Wai Ola are to 1) increase community capacity for long-term monitoring water quality in Maui coastal waters; 2) generate quality-assured reliable data that can be used to assess coastal water quality conditions and detect temporal trends that can augment HI-DOH CWB beach monitoring program sampling and be compared to state standards; 3) thereby empowering community and government mangers to take action to improve coastal water quality, benefiting the coral reef ecosystem and people alike.

We anticipate that HI-DOH CWB will use data from the Hui O Ka Wai Ola program for preparing integrated reports to USEPA, and potentially for TMDL development.

The Hui O Ka Wai Ola data will be distributed for use by the HI-DOH, non-profit partners, and academic researchers for future analyses.

3.3. Sampling and analysis summary

Data collection will include measurements of physical parameters of coastal waters including temperature, salinity, turbidity and pH. Chemical parameters collected will include dissolved nutrient analysis of water samples, conducted at S-LABs at the University of Hawai‘i at Mānoa. Lastly, biological parameters include bacteria analysis for *Enterococcus*, analysis will be conducted at the regional Maui laboratories as described in this document. External continuous data inputs including rainfall, ocean conditions and stream flow conditions provided by outside agencies. Additional observations will include weather conditions, beach use and qualitative water quality notes.

Analytical work will follow the guidance of the HI-DOH and the EPA as found in the Water Quality Standards Handbook (EPA Section 304(a)). SOPs are included that describe methods for operating and maintaining the equipment required to collect and process the collected water samples. Sampling methods and analytical procedures meet the water quality standards available from U.S. EPA Region IX (Hawaii Administrative Rule 11-54). Quality control of the data will be established through the identification of consistent sampling sites, documentation of uniform procedures, and analysis of duplicate samples and laboratory control samples as described in Section 4.5 of this QAPP. Individual samples exceeding the limits specified in HAR 11-54 will be reported to the CWB for possible follow-up action.

The sampling will be carried out at multiple sites along the northern and western Maui coast, from Kahuli to Ahihi-Kinau. Samples will be collected from the nearshore environment at locations noted in Appendix B. There is no specified end date to sampling, as the project strives to achieve a long term continuous data collection effort, however this QAPP covers a five year period from its approval. After the initial five year period, the QAPP will undergo review before it is re-submitted for approval again. Sites that do not meet HI-DOH water quality standards will be reported to the CWB for evaluation as soon as practicable.

3.4. Quality assurance objectives

The goal of the Hui o Ka Wai Ola QA/QC program is to ensure that all data collected by the Hui volunteers are scientifically sound and of known and documented quality. Integrating quality control procedures into water-related monitoring activities, including collection, analysis, validation, reporting, sample storage, and dissemination of data requires implementation of standardized procedures, adequate documentation, and training of volunteers[1].

The QA/QC Program provides guidance documents and technical training to help ensure that sufficient QA measures are established before sampling. The QA objectives of this effort are:

- Study design is statistically sound (sampling sites are representative of the environment, number of samples have appropriate power)
- Proper sampling, equipment and analytical procedures are used
- Field and lab volunteers are properly trained
- QC samples such as blanks and replicates are incorporated in sampling plans
- Sample chain of custody procedures are in place
- Labs analyzing the data follow appropriate QC procedures
- The QA officer performs lab results validation in a timely manner
- Corrective actions are applied when QC measures identify errors, or defects at any point in the data acquisition process
- The data management system is adequate to ensure archival and retrieval of analytical results with all their metadata

This QAPP describes efforts to reduce sampling and analytical bias through careful selection during the planning process of the sampling locations (Section 4.1), sampling times, sampling amount (volume), sampling frequency (or estimates) and the total number of samples (or estimates) for a given location and careful adherence to the established plan. In addition to standard practices described in Section 4, quality control measures are presented in Section 5 and Appendix D.

The PARCCs parameters are used to describe the quality of analytical data in quantitative and qualitative terms using the information provided by the laboratory quality control information. The PARCCs parameters – precision, accuracy, representativeness, comparability, completeness, and sensitivity – are described below.

Precision

Precision will be quantified in the field through replicate measurements of physical and chemical parameters, including pH, turbidity, salinity, temperature and dissolved oxygen. The laboratory

[1] State of California, Department of Water Resources

analyses will include replicate measurements, splits and repeated measurements of the same sample to assess the precision of the data.

Accuracy

Accuracy is controlled by adequate calibration and verification. We plan to adhere to calibration schedules recommended by manufacturer and intend to verify accuracy before every trip out into the field by using verification standards (pH, salinity) or secondary standards (turbidity meter). Temperature will be verified by comparison with a NIST thermometer if we have one.

Measurement error is generated by variation in the operation, calibration and output of sensors and other measurement instruments. Instruments will be maintained, checked for drift, with a documented precision and accuracy (Table 5-1). Calibration schedules are presented in Tables 5-1 and 5-2 to ensure that the equipment is functioning according to specifications.

Representativeness

Representativeness of the data collected in monitoring projects is considered in the sampling design and field plan, especially in site selection and by sampling at the same time of day. It will not be routinely monitored throughout the project, but will need to be considered when interpreting the data. It is obvious that water flowing past a given location on land is constantly changing in response to inflow, tidal cycle, weather, etc. Periodic collection of data can help develop a better understanding of the variance associated with time series measurements of selected environmental variables. Such data collection can also provide increased resolution and sensitivity to localized and short term effects of storm events.

Comparability

Comparability will be assured by using standardized sampling and analytical methods, units of reporting, site selection procedures, adherence to the specified sampling design, and proper training of lab and field personnel. Analytical comparability will be determined by the use of split samples between the different labs and a reference lab.

The protocols used for nutrient, sediment and bacterial concentrations are described in Section 4. The protocols are specific so as to document the procedures to be reproduced by another laboratory, if necessary.

Completeness

Completeness will be measured as the percentage of total samples collected that were analyzed as a whole and for individual parameters and sites. We anticipate sampling efforts to be either weekly, bi-monthly or monthly, depending on community resources.

4. Measurement and Data Acquisition

4.1. Sampling Design

The following sampling design describes sampling and measurement of the following suite of water-quality parameters: water temperature, salinity, dissolved oxygen (DO), pH, turbidity, ammonia nitrogen (NH4), nitrate + nitrite nitrogen (NNN), dissolved reactive phosphorus (DRP), total dissolved nitrogen and phosphorus (TDN and TDP), particulate nitrogen and phosphorus (PN and PP), dissolved silica, suspended sediment concentration (SSC), and *Enterococcus*.

4.1.1. Monitoring sites

Sampling will take place at predetermined dates and times at sites selected in advance and consistent within 10 m. The sites identified are listed in Appendix B, with the first sites to be sampled focusing on west Maui. Additional sites will be selected through consultation with HI-DOH and community groups. The CWB will be informed of all new and eliminated sites. Monitoring sites will include sites that were formerly part of the HI-DOH beach monitoring program, but discontinued or monitored at a significantly reduced periodicity due to funding cuts. Resumed monitoring at these sites will serve to extend existing data time-series, and provide data for sites that lack sufficient data for assessment. Priority will be given to sites that have active management partners interested in the resulting data. Other criteria for site selection will be priority watersheds and sites in watersheds with CWA Section 319-funded projects already underway.

The following criteria are used to evaluate monitoring sites with community partners:

- Access is safe,
- Location is adjacent to a public access point, or permission to cross private property is granted,
- Samples can be taken in areas of well-mixed water,
- Samples will be representative of a broad area around the sampling point,
- Location corresponds to a CWB monitoring site, particularly a site where monitoring has been discontinued, or monitored at a significantly reduced periodicity
- Location represents an area with high recreational use, high importance for food gathering, or high community concern about perceived water-quality problems, and/or
- Location coincides with environmental research areas with potential for data-sharing.

4.1.2. Sampling schedule

Two general monitoring modes will be used: regularly scheduled monitoring at fixed sites, and unscheduled (opportunistic) monitoring in response to rain and runoff events at affected sites.

The **pre-scheduled monitoring** will take place regardless of current and antecedent weather conditions, unless safety is a concern. This sampling mode will produce an unbiased estimate of average water-quality conditions at each site. For each monitoring team, the constituents to be analyzed and the frequency of the sampling will be pre-determined. At minimum, active sites will be sampled once per month. Some sites might be sampled at a greater frequency during certain seasons or if resources allow for more frequent sampling for that site. in the wet or dry seasons. To minimize bias, samples will be taken at the same time of day (for instance at 10a) on a predetermined day and time of the month, depending on the weather. Sampling will be delayed by a day if there is high surf making sampling unsafe.

Opportunistic monitoring will be used to measure water-quality conditions during and after large, infrequent rainstorms, to generate information about water quality during brown-water periods and about relationships between runoff and water quality. Samples will be collected at the first safe opportunity after the storm has passed.

4.1.3. Field measurements

Instantaneous temperature, salinity, dissolved oxygen (DO), pH, and turbidity measurements will be made at the monitoring sites by the monitoring teams using hand-held instruments. Dissolved and particulate nutrients will be measured at the SOEST Analytical Laboratory in samples collected, filtered and shipped by the monitoring teams. SSC and *Enterococcus* will be measured by the monitoring teams at laboratory facilities on Maui.

Procedures for in situ measurements, and sample collection and processing are described in the SOPs attached to this QAPP. The SOPs related to sample collection, processing and parameter measurements are listed in Table A.1.

Water-quality parameters measured in the field and the instruments used for those measurements are listed in Table 4.1. The instruments in Table 4.1 are intended to be comparable to the instruments used by HI-DOH-CWB. They are currently in production, so replacement parts and repair services are available. The sensor specifications indicate that they are accurate and precise. The primary departure from the HIDOW-CWB instruments is the dissolved oxygen sensor listed in Table 4.1. HIDOW-CWB uses a Clark-type polargraphic sensor with electrolyte and membrane. These sensors require frequent maintenance and calibration, and are affected by variation in water motion, oxygen consumption at the membrane surface, and signal drift. To avoid this issue, the Hui O Ka Wai Ola program will use optical sensors (optodes) that require annual calibration and minimal maintenance, do not consume oxygen, and provide comparable accuracy and precision. The operation, maintenance and calibration of these instruments are set out in Section 4.3 and the operating manuals (Appendix A).

Table 4-1: Field instruments for measurements of in-situ parameters.

Parameter	Method/instrument	Units
Water temperature	NSIT-traceable waterproof digital Thermometer	°C
Salinity/ electrical conductivity	Hach HQ40d meter and IntelliCAL CDC401 conductivity probe	PSU µS/cm
Dissolved oxygen concentration/ % saturation	Hach HQ40d meter and IntelliCAL LDO101 dissolved oxygen probe	mg/L %
pH	Hach HQ40d meter and IntelliCAL PHC101 pH Electrode	pH
Turbidity	Hach 2100Q turbidometer	NTU

4.1.4. Laboratory analyses

The S-LAB at the University of Hawai'i Mānoa will carry out dissolved nutrient and silicate analyses, and particulate analyses for nitrogen and carbon. *Enterococcus* measurements and suspended sediment measurements will be carried out in satellite laboratory facilities on Maui, as described in Section 2.1.3. Methods numbers for the standardized analyses are listed in Table 4.2.

Table 4-2: Analytical methods used in water quality analysis.

Parameter	Method number or description	Method/instrument	Units
NH4	EPA Method 350.1	GF/F-filtered grab samples, SEAL Analytical AA3 autoanalyzer	µg N/L
NNN	EPA Methods 353.2	GF/F-filtered grab samples, SEAL Analytical AA3 autoanalyzer	µg N/L
DRP	EPA 365.1	GF/F-filtered grab samples, SEAL Analytical AA3 autoanalyzer	µg P/L
TDN	UV-Digestion, EPA 353.2, Rev.2	GF/F-filtered grab samples, SEAL Analytical AA3 autoanalyzer	µg N/L
TDP	EPA Method 365.1	GF/F-filtered grab samples, SEAL Analytical AA3 autoanalyzer	µg P/L
Silicate	EPA Method 366.0	GF/F-filtered grab samples, SEAL Analytical AA3 autoanalyzer	µg/L
PN	EPA Method 440.0	GF/F-filters, Exeter Elemental Analyzer	% by mass
PC	EPA Method 440.0	GF/F-filters, Exeter Elemental Analyzer	% by mass
Enterococcus	IDEXX Enterolert instructions	Fluorogenic substrate test (Idexx Enterolert Quanti-tray)	cfu/100ml
Suspended sediment	ASTM Method D3977-97B	Gravimetric, Dried at 103 - 105°C	mg/L

[1] Mean detection limit – reported as three times the standard deviation of the blank (n=15) for autoanalyzer samples

4.1.5. External data sources

Federal agencies will provide four types of external data from gauges and sensors with data recorders: streamflow, rainfall, physical ocean conditions and coastal water quality. Data from these sources will be downloaded from agency websites at yearly intervals to maintain relatively current datasets, and incorporated into the annual reports at the direction of the Project Manager. Additional rain gauges within the watershed may have data that will be included and annotated by source. The primary use of these datasets is to help understand variability in the monthly water-quality data produced by Hui O Ka Wai Ola, therefore, higher frequency downloads are not required. The gauge and sensor locations and station numbers are listed in Table 4.3.

Streamflow data

There are nine USGS-managed flow recorders currently operating on Maui streams, all of which are telemetered. All nine recorders are located above 300 feet elevation due to restrictions on channel morphology and to diversions at lower elevations. Therefore, flow data at the recorders does not represent flow at the coast near beach monitoring sites. However, synoptic and antecedent streamflow data will be useful for explaining variation in instantaneous coast water-quality conditions. Streamflow data will be downloaded quarterly from the USGS National Water Information System database by the Data Manager (http://waterdata.usgs.gov/hi/nwis/rt).

Rainfall data

The National Weather Service compiles data from eight low-elevation rain gauges that are currently operating on the Maui coast between Hana and Kihei. Data from the low-elevation gauges corresponds most closely to rainfall at the beach monitoring sites, due to the steep elevation rainfall gradients in Hawai‘i. Rainfall data will be downloaded from the National Weather Service hydrological data website (http://www.nws.noaa.gov/view/prodsByState.php?state=HI&prodtype=hydro), and the USGS rainfall gauging site at Pu‘u Kukui (http://waterdata.usgs.gov/nwis/uv?site_no=205327156351102).

Ocean condition data

The NOAA National Ocean Service and the Pacific Islands Ocean Observing System (PacIOOS) operate two telemetered monitoring buoys near Maui, one in Kahului Harbor and the other north of Pauwela in water 193 m in depth. Instruments on these buoys measure wind direction and speed, atmospheric pressure, air and water temperature, and wave height, period and direction. Data from these buoys will be downloaded from the National Data Buoy Center (http://www.ndbc.noaa.gov).

PacIOOS also operates two water-quality sensor platforms on the Maui coast, one in Kahului Harbor and the other at Kalama Beach, Kīhei. The Kahului platforms is telemetered and the sensors on the Kīhei platform are downloaded approximately monthly. The sensors measure salinity, water temperature, dissolved oxygen, pH, chlorophyll, turbidity and depth. Data from

the platforms will be downloaded from the PacIOOS data access program (http://oos.soest.hawaii.edu/erddap/index.html).

Table 4-3: Sources of external data. Station numbers in parentheses.

USGS stream gauge	Rain gauge	Ocean buoy	Water quality platform
Oheo (USGS)	Hana Airport (HNAH1)	Pawela offshore (51205)	Kalama Beach, Kihei (NS12)
W. Wailuaiki (16518000)	Haiku (AIKH1)	Kahului Harbor (KLIH1)	Kahului Harbor (NS13)
Hanawi (16508000)	Kahakuloa (KHKH1)		
Waikamoi (16552800)	Mahinahina (MABH1)		
Honopou (16587000)	Lahainaluna (LAHH1)		
Iao (16604500)	Kihei2 (KHIH1)		
Waihee (16614000)	Kahului Airport (HOG)		
Kahakuloa (16618000)	Wailuku (WUKH1)		
Honokohau (1662000)			

4.2. Sampling methods

Instantaneous temperature, salinity, dissolved oxygen (DO), pH, and turbidity measurements will be made at the monitoring sites by the monitoring teams using hand-held instruments. For in situ measurements, water will be collected at 0.1 m below the water surface in a bucket or similar collection device. The bucket will be relocated above the high tide line to a shady place for in situ measurement for safety reasons.

For sediment samples, a 500 mL sample will be collected for analysis of suspended sediment concentration.

For nutrient samples, 125 mL bottles will be collected at the 0.1m depth for water quality analyses. Dissolved and particulate nutrients will be measured, per site sampling specifications, at the SOEST Analytical Laboratory in samples collected, filtered and shipped by the monitoring teams.

For bacterial samples, sterile bags (Whirlpacks) will be used to collect water for *Enterococcus* samples. Sample water will be collected by placing the bags under water, filling and then sealed. SSC and *Enterococcus* will be measured by the monitoring teams at regional laboratory facilities on Maui.

Bottles and buckets will be rinsed three times in the field before each sample is collected.

Procedures for in situ measurements, and sample collection and processing are described in the SOPs attached to this QAPP. The SOPs related to sample collection, processing and parameter measurements are listed in Table A-1.

4.3. Sample handling and custody Requirements

4.3.1. Sample transport

Samples will be transported in coolers with ice from the field to the regional laboratory where they will be either processed further (*Enterococcus* and SSC) or prepared for shipment to the S-Lab (nutrient analysis). Samples for nutrient analysis will be frozen at the local laboratories until they are shipped. Shipments will be made using FedEx or similar carrier using blue ice and coolers to keep the samples frozen during transit. Nutrient samples for analysis will be delivered to the lab within two weeks of collection. Samples arriving at S-Lab will be immediately frozen and processed within 28 days of the sampling date.

4.3.2. Sampling bottles and preservation

Sample containers, volumes, preservation details, and holding times for the near shore chemistry monitoring samples are listed in Table 4.4. The information in Table 4.4 was compiled from the S-Lab requirements and the HI-DOH-CWB Coastal Chemistry Monitoring QAPP.

All sample bottles that will be used for analyzing nutrients will be acid-washed.

Table 4-4: Seawater sample handling and preservation.

Variable	Bottle	Volume	Field preservation	Lab preservation	Holding time
NH_4	Brown HDPE 125ml	80 mL	Filter, transport on ice	Freeze < -20°C	7 d
NNN	Brown HDPE 125ml	80 mL	Filter, transport on ice	Freeze < -20°C	28 d
DRP	Brown HDPE 125ml	80 mL	Filter, transport on ice	Freeze < -20°C	28 d
TDN	Brown HDPE 125ml	80 mL	Filter, transport on ice	Freeze < -20°C	28 d
TDP	Brown HDPE 125ml	80 mL	Filter, transport on ice	Freeze < -20°C	28 d
Silicate	Brown HDPE 125ml	80 mL	Filter, transport on ice	Freeze < -20°C	28 d
PN	GF/F filter	80 mL	Filter, transport on ice	Freeze < -20°C	28 d
PC	GF/F filter	NA	Filter, transport on ice	Freeze < -20°C	28 d
Suspended sediment	HDPE 1 L	500 mL	Transport on ice	Refrigerate < 6°C	60 d
Enterococcus (Collection device)	Sterile Whirl-Paks Nasco B01489WA	7oz	Transport on ice	Refrigerate < 6°C	6 hr
Enterococcus (Sample preparation)	Sterile clear bottle	100 ml	None	Pour into Quantitray for incubation	0 hr

4.3.3. Sample chain-of-custody

A chain-of-custody form is to accompany each set of water samples shipped to the S-LAB for nutrient analyses and to the Maui facilities for *Enterococcus* and suspended sediment analyses. The chain-of-custody form must be signed and dated by the field person who maintained custody of the samples during collection, and also by the person who receives them at the local laboratory. This form then accompanies the samples that are shipped to the S-LAB and is signed and dated by the person shipping the samples and also by the person who receives the samples at the S-LAB. The COC form is attached as Appendix C.

When coolers with samples arrive at the Maui facilities and the S-LAB, the sample receiver is to inspect the contents of each cooler, verify that it agrees with the COC, and sign and date the COC form. If any discrepancies are noted, or if laboratory acceptance criteria are not met, the laboratory must contact the PM for resolution of the problem. The discrepancy, its resolution, and the identity of the person contacted must be documented by the laboratory. In many cases, the sample collector and the sample Maui receiver/laboratory analyst are the same individual. If this is the case the COC will be initiated by the sampler/analyst and completed by the analyst who reads the Enterolert results and/or records the SSC results the following day.

4.3.4. Sample labeling

Each sample collected will be labeled with the following information prior to or during the collection of the sample:

a. a unique sample number,
b. sample type,
c. name of collector,
d. date and time of collection, and
e. place of collection

The sample number will follow this code: 3-letter site location code, two-digit year, two-digit month, two-digit day – sample type code (N for nutrients, S for suspended sediment) – sample number. Letters are used for sample duplicates. For instance, a sample at Honokowai Beach Park to be analyzed for nutrients might be: HBP150601-N-1. The initials of the sampler will be listed separate from the sample ID.

4.4. Analytical methods

Suspended sediment concentration

Suspended sediment concentration (SSC) will be measured according to the USGS, 1999, protocol in either the satellite labs or the S-LAB facility.

Nutrient and silicate analyses

For nutrient and silicate analysis, S-LABS uses an AA3 Nutrient Autoanalyzer from Sea Analytical. The S-LAB utilizes methods and procedures outlined by Seal Analytical that are, optimized for the AA3 Nutrient Autoanalyzer; references and procedures for each constituent are listed below.

Ammonium

Ammonium is measured fluorometrically following the method of Kerouel and Aminot (1997). The sample is reacted with o-phthalaldehyde (OPA) at 75°C in the presence of borate buffer and sodium sulfite to form a fluorescent species in a quantity that is proportional to the ammonium concentration. Fluorescence is measured at 460 nm following excitation at 370 nm.

Nitrate and Nitrite

Nitrate and Nitrite are analyzed via the diazo reaction based on the methods of Armstrong et al (1967) and Grasshoff (1983). This automated procedure involves reduction of nitrate to nitrite by a copper-cadmium reductor column. The nitrite then reacts with sulfanilamide under acidic conditions to form a diazo compound, which then couples with N-1-naphthylethylene diamine dihydrochloride to form a purple azo dye. The concentration is determined colorimetrically at 550 nm.

Silicate

Silicate measurement is based on the reduction of silicomolybdate in acidic solution to molybdenum blue by ascorbic acid (Grashoff and Kremling 1983). Oxalic acid is introduced to the sample stream before the addition of ascorbic acid to minimize interference from phosphates. The concentration is determined colorimetrically at 820 nm.

Orthophosphate (DRP)

This automated procedure for the determination of orthophosphate is based on the colorimetric method of Murphy and Riley (1962) in which a blue color is formed by the reaction of orthophosphate, molybdate ion and antimony ion followed by reduction with ascorbic acid at a pH of 1. The reduced blue phospho-molybdenum complex is determined colorimetrically at 880 nm.

Total Phosphorus

Following the method developed by the University of Hamburg in co-operation with the Ocean University of Qingdao, this automated procedure for the determination of dissolved phosphorus in seawater takes place in three stages. First, the sample is irradiated in a UV digestor. In this digestion step organically bound phosphorus is released. Second, acid persulfate is added, which further promotes breakdown of orgniac matter that persists after UV digestion, and polyphosphates are converted to ortho-phosphate by acid hydrolysis at 90°C. Third, the ortho-phosphate is determined by reaction with molybdate, antimony and ascorbic acid, producing a phospho-molybdenum blue complex which is determined colorimetricallyat 880 nm.

Total Nitrogen

Following the procedure developed by the University of Hamburg, inorganic and organic nitrogen compounds are oxidized to nitrate by persulfate under alkaline conditions in an on-line UV digestor. The nitrate is reduced to nitrite in a cadmium column and then determined using the sulfanilamide/NEDD reaction with colorimetric detection at 520 nm.

Particulate N and C

The Exeter Analytical model CE 440 elemental analyzer provides automated analysis of particulate carbon, hydrogen, nitrogen and sulfur following the general methodology outlined by Gordon (1969) and Sharp (1974).

Bacteria concentration

The bacterial concentration protocol follows the Enterolert detection protocol. The Enterolert reagent, based on IDEXX's Defined Substrate Technology**,** is used for the detection of enterococci in water. Enterolert® uses 4-methylumbelliferyl-β-D-glucoside as the defined substrate nutrient-indicator. This compound, when hydrolyzed by enterococcus β- glucosidase, releases 4-methylumbelliferone which exhibits fluorescence under a UV365nm lamp. This reagent system is specifically formulated to achieve optimum sensitivity and specificity in the detection and identification of enterococcus. After 24 hours incubation at 41°C, if enterococcus is present, the reagent should show fluorescence when exposed to a long-wave (365-366 nm) UV lamp. The test should detect one (1) enterococcus in 100 mL of water within 24 hours.

Additional information about the above protocols is found in Appendix A.

5. QA/QC Requirements

5.1. Instrument and equipment maintenance, testing, inspection and calibration

All equipment and instrument maintenance and service, testing, inspection and calibration will be documented in lab notebooks available to the QA officer for review. A summary of the procedures for documenting quality control non-conformances is in Appendix D. Appendix D also presents common data qualifiers used in the final data management system to identify types of non-conformances.

Measurement error is generated by variation in the operation, calibration and output of sensors and other measurement instruments. Instruments will be maintained, checked for drift, with a documented precision and accuracy (Table 4-1). Calibration schedules are presented in Tables 4-5 and 4-6 to ensure that the equipment is functioning according to specifications.

5.2. Sampling

5.2.1. Field calibration and maintenance

All field calibrations/verifications, quality control measures, and sampling activities will be documented in a field log book.

To ensure that field instruments for in situ measurement have acceptably low amount of systematic error/bias, the instruments are to be calibrated following the procedures and at the frequencies specified by manufacturers. The calibration schedule and acceptance criteria for field instruments are summarized in Table 5-1. The field-check acceptance criteria refer to the similarity of measured or indicated values and the reference values (e.g., standard calibration solutions for pH, conductivity and turbidity).

All field instruments used for the collection of water samples or data for the program will be maintained according to the manufacturer's performance specifications and instrument SOPs and the manufacturer instructions in the operating manuals (Table 5-2, Appendix A). The Hach instruments run self-checks when they are powered on. All field equipment is to be visually inspected before use for damage. An inventory of spare parts inventory and extra equipment is to be maintained to minimize effects of equipment problems on sampling schedules. However, funding limitations prohibit the purchase of duplicate Hach instruments, and problems with those instruments may cause delays. Further details on field instrument maintenance and inspection are in the user's manuals.

Table 5-1: Calibration schedule and field check criteria; The field check criteria is the largest range within the instrument is expected to be functioning.

Instrument	Parameter	Schedule	Field-check acceptance criteria	Field check range
NSIT-traceable waterproof digital thermometer	Temperature	None (factory-calibrated)	None	20 - 35°C
Hach HQ40d meter, IntelliCAL CDC401 conductivity probe	Salinity/ conductivity	Quarterly or as needed	± 3% of calibration solution	20 - 38ppt
Hach HQ40d meter, IntelliCAL LDO101 luminescent/optical DO sensor	Dissolved oxygen	Quarterly or as needed	Post-check ± 5 % of pre-check	0 - 100%
Hach HQ40d meter, IntelliCAL PHC101 pH Electrode	pH	Every time equipment is used	± 3 % of calibration solution	6 - 8
Hach 2100Q turbidometer	Turbidity	Yearly or as needed	± 5 % of Gelex standards (5, 50, 500 NTU). Deionized/turbidity-free bank < 0.25 NTU	0-1600 NTUs

Table 5-2: Field instrument performance specifications.

Variable	Instrument	Range	Accuracy	Precision
Water temperature	NSIT-traceable waterproof digital thermometer	50 – 300 °C	± 0.4°C between 0 and 100°C	0.1°C
Salinity & electrical conductivity	Hach HQ40d meter and IntelliCAL CDC401 conductivity probe	0.01 – 200 µS/cm 0 – 42 PSU	± 0.5 µS/cm 0.01 PSU	0.01 µS/cm
Dissolved oxygen concentration & % saturation	Hach HQ40d meter and IntelliCAL LDO101 luminescent/optical DO sensor	0.05 – 20.0 mg/L 0-200 % saturation	± 0.1 (0-8 mg/L) ± 0.2 (>8 mg/L) 1 % saturation	0.01 mg/L
pH	Hach HQ40d meter and IntelliCAL PHC101 pH Electrode	2 - 14	± 0.02	0.001 - 0.1
Turbidity	Hach 2100Q turbidometer	0 – 1000 NTU	± 2 %	0.01 NTU

All bottles, buckets and instruments that are used for sample collection will be washed with phosphate-free soap and rinsed three times after use.

5.2.1. Field duplicates and sample blanks

Replicates and sample blanks. For every 10-20 seawater samples collected per site for nutrient, *Enterococcus* and suspended sediment analysis, one replicate sample (i.e., two samples collected from the same sample site at approximately the same time) will be collected for each type of analysis. Each field replicate will be analyzed as a separate sample. The accumulated replicate data will be used to assess measurement error in field collection protocol. The field replicate samples will be given unique sample identification numbers and treated as discrete samples. Additionally, sample blanks (distilled water only) will be analyzed once every six months per project area to ensure quality in the shipping and processing process.

For opportunistic sampling, or if the turbidity measurement in-field is above 2 NTU, duplicate samples for suspended sediment analysis will be taken automatically.

The facilities will carry out analyses of sample duplicates and blanks as part of a continuous check on performance. Performance records will be maintained and available to HI-DOH-CWB. Where applicable, split sample analyses will be carried out with commercial or university analytical laboratories.

5.3. Shipping and handling

The Maui satellite labs will prepare samples for shipment using standard protocols as described in Section 4.3.1. Each set of samples shipped will be accompanied by a chain of custody form. The form will be filled out on receipt of the analyzing lab for QA nonconformities (broken seals, incorrect temperature on arrival).

Shipping frozen samples will only happen between Monday and Weds, so that the lab can process the samples when they arrive. In the event a package arrives on the weekend, this will be noted on the QA forms.

5.4. Training requirements

Each monitoring team member will receive consistent, documented training, and will sample sites in pairs to reduce bias in the sampling protocol.

Field team members will receive annual training in sampling methods and procedures outlined in this plan and the SOP associated with this plan, and then observed to ensure that protocol is followed consistently. All field team members will be required to read the most updated QAPP document. The training will be documented by the Training Leader, including the name of the trainee, type of training they received (first time or re-training, volunteer sampler or team leader), date and name of the trainer. Training documents will be available to the CWB on request. Field team members will sample sites in pairs as a check to maintain sampling standards.

Prior to a staff member's independent performance of a procedure, a quantitative comparison should be conducted when possible and applicable to ensure that the trainee results are comparable to those of an experienced staff member. Documentation of this training should be provided to the Training Leader. Specifically, field team members will have training in the following field activities:

- Water grab sampling and processing (manual);
- Instrument operation, calibration/verification checks, and routine maintenance (for the Hach HQ40D multi-parameter probe and Hach 2100Q turbidimeters);
- Sample filtering, including weighing and drying filters, for SSC
- Idexx Quanti-tray System operation and procedures for measuring *Enterococcus* levels
- Data recording and summarization procedures;
- Sample handling and chain of custody procedures; and,
- General and project-specific safety.

Training records for all Hui O Ka Wai Ola volunteers are maintained by the Training Leader. The addition of new personnel will require training documentation. The Monitoring Team Leader is responsible for scheduling and arranging refresher courses when applicable.

5.5. Laboratory analyses

General. The floor and work surfaces of the laboratory facility must be non-absorbent, easy to clean and disinfect. Each laboratory should have sufficient and clean storage/work space. All food and drinks are prohibited in the laboratory work area. Each laboratory should have adequate ventilation, facilities, and safety protocols.

Thermometers. Thermometers should be graduated in 0.5 ° C or less. Incubator thermometers should be graduated at 0.2 °C or less. All laboratory thermometers should be calibrated semiannually against a NIST certified thermometer, and the results documented. Both the NIST thermometer and the thermometer being calibrated should be immersed in water to avoid rapid fluctuations while reading. Allow at least 5 minutes for stabilization. Each calibrated thermometer should be tagged with the following information: date of calibration, NIST reading, thermometer reading, correction factor, and technician initials.

5.5.1. Water quality laboratory facilities

Instrument maintenance. S-LAB will prepare and follow a maintenance schedule for each instrument used to analyze samples collected from the watershed areas. All instruments will be serviced at scheduled intervals necessary to optimize factory specifications. Routine preventive maintenance and major repairs will be documented in a maintenance logbook. An inventory of items to be kept ready for use in case of instrument failure will be maintained and restocked as needed. The list of spare parts will include equipment replacement parts subject to frequent failure, parts that have a limited lifetime of optimum performance, and parts that cannot be obtained in a timely manner.

Refrigerators and drying ovens. Refrigerator units must be maintained between 0 - 6 ºC. The temperature should be checked and recorded on the temperature log sheet once per day on each day of use (depending on the laboratory and frequency of analysis). The refrigerator unit should be cleaned monthly and all materials identified and dated. All outdated materials should be disposed of properly and no food or drinks should be stored in the refrigerator unit. Similarly, ovens for drying filters will be inspected before each use to ensure cleanliness.

Analytical balances. Analytical balances will be calibrated once per year, and certified as necessary by national certification boards. All maintenance records will be kept on file.

Reagent water. For the reagent water system, the lab will check daily the TOC (ppb) and MOhms. This is observed for passable standards prior to using water (18.2 MOhms, and <4 ppb TOC). Monthly, the system is checked for volume of water through each filter, rejection feed on the feed water, and temp of feed water. The S-LAB maintains three, six, and twelve month upkeep protocols documented for the reagent water maintenance.

Cleaning protocols. An acid-washing protocol to ensure clean bottles for analyses will entail soaking for a minimum of 24 hours in 0.1N HCl bath, and will be performed at S-LABs or the

satellite labs. Bottles will be rinsed three times and dried prior to their reuse in sampling. Between sampling in the field, equipment will be rinsed with deionized water.

Inspection for supplies and consumables. Once per year, an inventory of all consumables will be conducted to evaluate the physical condition of bottles, hoses and equipment. Any equipment that is substandard will be discarded. Chemical reagents will be discarded properly if past their expiration date. These inspections will be documented in the laboratory notebook for QA review, if necessary.

5.5.2. Bacterial testing laboratory facilities and equipment

Incubators

Incubators should be maintained at 41 ± 0.5 ºC for Enterolert® method of analysis. The uniformity of the temperature should be established. The temperature should be checked at least once daily and recorded in the laboratory log, on each day of use. A lab technician will also check the temperature as the samples are read. If applicable, the thermometers should be placed on the highest and lowest shelves and immersed in liquid. If the incubator is out of acceptable range for more than 2 hours, the samples should be discarded and reported as "temperature out of range". Preventative maintenance is completed and recorded in equipment maintenance log book.

Autoclave

For each cycle, the technician will record the date, contents, sterilization time, pressure, temperature, and technician initials in an autoclave log. The autoclave performance will be tested for each run using sterility tape, only if the Quanti-Trays will be reused. At least once during each month the autoclave is being used, appropriate biological indicators should be used to determine effective sterilization. Preventative maintenance is performed and recorded in the equipment maintenance log book.

Sealer

The Quanti-Tray 2000 sealer is checked on a monthly basis using 100 mL of water mixed with a dark colored dye or bromescol purple to ensure adequate sealing of the quanti-trays. If dye is observed outside of the wells, the sealer is serviced by a technician before use. All quality checks and maintenance are recorded on the Sealer QC Log Sheet. The long-wave ultraviolet bulb should produce a wavelength of 365 nm. Quality checks can be completed by reading the positive controls.

Consumables

Each lot of Enterolert® media will be used before the listed expiration date and stored in a cool (20-30°C) dry place out of direct sunlight. The expiration date of the media will be noted on each data form. Each lot will be quality checked using a positive culture to ensure growth of the target organism, and all Quanti-Tray cells must exhibit fluorescence and the expected reaction to the target organism. Each lot of media is also tested using two negative controls to demonstrate the media does not support the growth of non-target organisms. Each laboratory also processes one blank (distilled water and media) for each group of samples processed. The data quality objective for blanks is <10 MPN. For each laboratory 10% of the laboratory samples are duplicated and the RPD regularly assessed.

Reagent water

Each lot of reagent water either distilled water or water from deionization units is quality checked yearly and must meet the following criteria:

- Conductivity > 0.5 megaohms resistance or less than 2 micromhos cm^{-1} (microsiemens cm^{-1}) at 25°C.
- Total chlorine < 0.1 mg L^{-1} residual.

Conductivity will be reported each time a batch of distilled water is processed. Chlorine residuals will be tested annually using test kits (for instance, the Hach chlorinity test kit).

Water to be used in bacteriological analyses will not be stored for more than 60 days before use.

5.5.1. Analytical lab quality control: replicates, standards and blanks:

A summary of quality control activities is presented in Table 5-3.

Target levels for accuracy and precision (expressed as relative percent difference) provide measurement quality objectives, and are presented in Table 5-4.

Target levels for suspended sediment concentration are from American Society for Testing and Materials (1997).

Enterolert specifications and target levels for *Enterococcus* are from the Enterolert User's guide.

Nutrient and silicate analyses

The S-LAB, responsible for analyzing for nutrient and silicate parameters, has a formal quality control program. Each sample run includes a blank and mid-level calibration duplicates every 10-15 samples. Values that are out of range are corrected on site before the sample results are finalized. Results of the blanks and mid-level calibration duplicates will be noted in the lab report when sample results are reported. In addition, the % recovery of the mid standards will be calculated for each run. During each run, the lab will also test quality control samples collected from station ALOHA. The data from these samples is used to ensure precision between individual runs. Finally, during the run standardized nutrient seawater reference material from

the National Meteorology Institute of Japan (NMIJ) is analyzed and the data is provided on the run sheet.

Suspended sediment analyses

During the pre-weighing of the filters, each filter will be weighed twice and the average used as the initial weight. Post filtration, and after the samples have been dried, the filters will also be weighed twice and the average recorded in the lab notebook.

Bacterial analysis quality control

Laboratory quality control protocols for bacterial analysis include laboratory blanks and repeated positive readings that will be confirmed by a second trained analyst. Lab duplicates will be measured every 20 samples, in addition to field duplicates every 20 samples. Additionally, the media will be tested for each batch by inoculating intentionally for both

Table 5-3: Quality control sampling activities in laboratory and field, with frequencies

QC Sample or Activity used to Assess Measurement Performance	Frequency	Measurement Performance Criteria
In situ parameters		
Bench calibration (turbidity, pH)	Before every group of samples	Table 5-1
Field blank (turbidity)	After every group of samples	<0.1 NTU
Repeated samples	▪ Temperature: If there is a difference of 1ºC or greater between any of your three measurements ▪ pH: If there is a difference of 0.2 or greater between any of your three measurements ▪ Conductivity: If there is a difference of greater than 10 uS between any of your three measurements ▪ Dissolved Oxygen: If there is a difference of 0.4 ppm or greater between any of your three measurements ▪ Turbidity: If there is a difference of 0.2 NTU or greater between any of your three measurements	
Historical trend analysis	Every 5 sampling events	Baseline average is not trending
Nutrient analysis		
Field duplicate	Every 20 samples	
Lab blank	Once per group of samples	
Lab mid-level calibration	Once per sample run	
Standard reference material		
Method detection limit	As needed by lab	
Suspended sediment concentration analysis		
Field duplicate	When turbidity >2 NTU	
Repeated weighing	Every sample	
Bacterial analysis		
Field duplicate	Every 20 samples	
Lab reagent blank	One per group of samples	<10 MPN
Lab duplicate	Every 20 samples	
Repeated measures	Positive samples checked by second trained analyst	

Table 5-4: Acceptable analytical methods and quality control acceptance criteria. RPD: relative percent difference, based on duplicate samples.

Parameter	Method number or description	Method/instrument	Units	Minimum Detection Limit[1]	Sensitivity resolution	Accuracy
S-LAB Analyses						
NH4	EPA Method 350.1	GF/F-filtered grab samples, SEAL Analytical AA3 autoanalyzer	µg N/L	1.0 µg N/L	< 20% RPD	80% - 120%
NNN	EPA Methods 353.2	GF/F-filtered grab samples, SEAL Analytical AA3 autoanalyzer	µg N/L	0.8 / 2.4 µg N/L	< 20% RPD	80% - 120%
DRP	EPA 365.1	GF/F-filtered grab samples, SEAL Analytical AA3 autoanalyzer	µg P/L	0.56 µg P/L	< 20% RPD	80% - 120%
TDN	UV-Digestion, EPA 353.2, Rev.2	GF/F-filtered grab samples, SEAL Analytical AA3 autoanalyzer	µg N/L	0.8 / 2.4 µg N/L	< 30% RPD	80% - 120%
TDP	EPA Method 365.1	GF/F-filtered grab samples, SEAL Analytical AA3 autoanalyzer	µg P/L	0.56 µg P/L	< 30% RPD	80% - 120%
Silicate	EPA Method 366.0	GF/F-filtered grab samples, SEAL Analytical AA3 autoanalyzer	µg/L	9.8 / 35.7 µg/L	< 20% RPD	80% - 120%
PN	EPA Method 440.0	GF/F-filters, Exeter Elemental Analyzer	% by mass			99%
PC	EPA Method 440.0	GF/F-filters, Exeter Elemental Analyzer	% by mass			93-99%
Enterolert lab analyses						
Enterococcus	IDEXX Enterolert instructions	Fluorogenic substrate test (Idexx Enterolert Quanti-tray)	cfu/100ml	<10 MPN	1 MPN	95%
Sediment analyses						
Suspended sediment	ASTM Method D3977-97B	Vacuum filtration	mg/L	0.001 mg	0.2 mg/L	90% - 110%

5.6. Data Management

Field and analytical data collected from this project are critical to assess water quality in the study area, assess risks to human health and the environment, and, if necessary, recommend mitigation measures in the form of waste load allocations where required. An information management system is necessary to ensure efficient access to these data, and will be created specifically for this ongoing project.

5.6.1. Documentation standards

The PM, QA Officer, monitoring teams and the S-LAB have written procedures for all activities related to the collection, processing, analysis, reporting, and tracking of water-quality data. This documentation must be in either the SOPs or QA manual, and must be readily available to field and laboratory personnel. The documentation of field and laboratory activities must meet the following requirements:

- Data must be documented directly, promptly, and legibly.
- All reported data must be uniquely traceable to the raw data through sample identification numbers that are on each sample as labels, and recorded in the field and laboratory log books.
- All data reduction formulas (such as dilutions) must be documented and include the initials of the data collector.
- Handwritten data must be recorded in ink, and changes crossed out and initialed.
- All original data records include, as appropriate, a description of the data collected, units of measurement, unique sample identification (ID) and station or location ID (if applicable), name (signature or initials) of the person collecting the data, and date of data collection.
- Any changes to the original (raw data) entry must not obscure the original entry.
- The reason for the change must be documented.

5.6.2. Field data management

All field activities must be conducted using the data collection procedures described in this document and the accompanying SOPs.

Log book. The Monitoring Team Leader will keep a bound field notebook that accompanies the volunteers to every sampling. The Monitoring Team Leader will maintain documentation of sampling, logging, and field measurements, and will note any variance from SOPs. All information pertinent to a field survey or sampling will be recorded. At a minimum, the log book will include the following: purpose of sampling; location of sampling point; name of field contact; type of samples taken; and method, date, and time of preservation. Additional qualitative

information includes wind (speed and direction), sea state, number of visitors in the beach, moon phase and tidal phase will also be noted as appropriate. The log book will also provide suspected sample composition, including concentrations; number and volume of sample(s) taken; description of sampling point and sampling method; date and time of collection; collectors sample identification number(s). The log book will be protected and kept in a safe place.

Data sheets. Monitoring teams use the field data sheets developed for the program (Appendix C) to document sample collection and field measurements. The originals of the field data sheets are photocopied twice by the Monitoring Team Leaders when field work is completed. The original datasheets go to the QA Officer, and an additional copy is kept with the field team. The analytical lab will return the signed data sheets with the coolers and acid-washed sample bottles. In addition to the field data sheets, the QA Officer requires reports from the S-LAB with nutrient data, and from the monitoring teams with suspended sediment data and bacterial data. These will be stored electronically and in hard copy with the QA Officer.

COC forms. The monitoring teams also fill out COC forms with spaces provided to indicate who relinquished and who received the samples and when. The use of COC forms is set out below in Section 5. The COC form is attached as Appendix C. A COC form will be used for each laboratory that samples are sent to.

Data upload. Qualitative field data (pH, turbidity, salinity, DO and temperature) first recorded into a field log book will be entered remotely into a spreadsheet (MS Excel or Google Spreadsheets) in a way that will be compatible with the EPA and HI-DOH database guidelines, acknowledging that the spreadsheet is only accessible to the Team Leaders and QA officer. Current technology (c 2016) allows for Google Forms to be used to upload data without having access to the full database. Hard data sheets will be copied and then passed to the Quality Assurance officer, once the data is entered electronically for verification.

QA review. The QA Officer will review the field sheets monthly, and review the entered data, compare a subset of the electronic data to the original data sheets, and correct entry errors. Range checks and other QA/QC methods will be performed before accepting the dataset. Upon entering the data the QA officer will sign and archive the field data sheets. A set of codes will be used to acknowledge if there are QA flags. The data will be coded as P for preliminary until the QA checks are performed and the data is accepted, upon which the A code will be used.

5.6.3. Analytical laboratory data management

Each laboratory will keep a notebook or digital system to register incoming samples.

When samples are received at the laboratory, the laboratory technician will inspect the sample containers and custody records, and verify sample integrity and preservation (temperature). The technician will reconcile the information on the chain-of-custody forms with the sample bottles received. The sample custodian will document any anomalies and report them to the laboratory project manager, who will contact the QA officer. Anomalies will be resolved with the Hui o Ka

Wai Ola QA officer. The information on the COC forms will then be entered into the laboratory's information management system.

The S-LAB will report results directly to the QA Officer. The QA Officer will verify sample identification information, review the chain-of-custody forms, document the measurement performance objective for quality control samples and identify/code the data appropriately in the database.

Samples will be tracked from the time of receipt through each stage of sample preparation, analysis, and final reporting using the laboratory's information management system correlated to the unique label identifier associated with each sample. The laboratory will be responsible for tracking all QC parameters and sample results by sample delivery group. Any data that exceed the specified QC limits specified for this project will be documented. QC anomalies that directly affect data quality will immediately be communicated to the QA Officer.

Bacterial testing. Both the SSC and the *Enterococcus* results are read and recorded on the laboratory data sheet that is initiated on sample day and completed when read the following day by that day's sampling team.

5.6.4. Access

All data will be open-access once it has been approved by the QA Officer. Preliminary data will be available with codes indicating its status before it has been through the QA process to project partners.

5.6.5. Reporting

Hui o Ka Wai Ola Interim reports will be produced and distributed in May (data collected from January-April) and September (data collected from May-August). A year-end report will be produced and distributed in January of the following year (data collected from September-December, as well as full-year results). The PM is responsible for all report production and distribution. Reports will be forwarded to the distribution list noted at the beginning of this document. Summaries of all reports, highlighting the assessment results, project status, and volunteer achievements, will be distributed to all volunteers and watershed partners.

Raw data will be provided to HI-DOH-CWB in electronic form at least once per year so that it can be included in the 305(b) report. Appropriate quality assurance information may be provided on request.

5.7. Assessment and Oversight

All Hui o Ka Wai Ola field and laboratory data are reviewed by the PM and QA Officer to determine if the data meet QAPP objectives. Review protocols for the QA officer are described in Section 6. In addition, personnel at HI-DOH who are not directly connected to this project will

also be contacted to review data once a year, if necessary. Decisions to reject or qualify data are made by the QA Officer.

Review of Hui o Ka Wai Ola field activities is the responsibility of the Monitoring Team Leaders in conjunction with the PM and the QA Officer.

Performance evaluations. Each monitoring team will be accompanied and their performance evaluated by the PM or QA Officer once a year. If possible, volunteers in need of performance improvement will be retrained on-site by the Training Leader during the evaluation. In addition, monitoring team members will attend yearly training renewal workshops. All training and re-training will be documented, including the name of the trainee, name of the trainer, type of training, and date.

Technical systems review. If errors in sampling techniques are consistently identified, a thorough and systematic onsite qualitative audit will be conducted of facilities, equipment, volunteers, training and record keeping. In some cases, retraining may be scheduled more frequently. Field and laboratory activities may be reviewed by state quality assurance officers as requested. Systems and data quality audits are performed by the QA Officer twice yearly. Any identified procedural problems will be corrected based on recommendations from the QA Officer.

All data review and validation results for both field and laboratory activities must be documented and maintained on file. All activities (including procedures and anticipated results) not conforming to the specifications of this QAPP must be identified and corrective actions implemented. A responsible member of the team, with approval by the QA Officer, will document and keep hard copies of all assessments and response actions (i.e., corrective actions). Documentation includes, at minimum, identification of the sampling/field measurement site, sampling/measurement date and time, sampler's name, description of the non-conforming issue, corrective action taken to remedy the situation, follow-up actions (if applicable), final decision, and approval by the QA Officer. Data verification and validation reports (if issues are identified) or acknowledgment of data verification and validation (if no issues are identified), signed by the QA Officer and PM must be incorporated into all reports submitted to HI-DOH.

6. Data Quality Assessment

The data quality assessment process will use standardized forms to summarize each sample.

6.1. Data validation and verification methods

Once the data have been entered into the Hui o Ka Wai Ola database, the QA Officer will print out the data and proofread it against the original data sheets. Errors in data entry will be corrected. Outliers and inconsistencies will be flagged for further review, or discarded. Problems with data quality will be discussed in the interim and final reports to data users. The data management system will be designed to ensure archival and retrieval of analytical results with all their metadata.

6.1.1. Field Parameters Verification

If a result does not pass QA/QC, the Monitoring Team Leaders will make the initial identification of procedure that did not conform to the SOPs or QAPP protocol, and take corrective action to ensure that protocols are followed.

As part of standard field protocols, any sample readings out of the expected range (Table 4-5) will be reported to the Monitoring Team Leaders and to the QA Officer. A second sample or reading will be taken as soon as possible to verify the initial reading. If the data is outside the normal range, then the data will be noted (flagged) on the data sheet. We will take further actions to trace any sources of error, and to correct those problems. Outliers that result from errors found during data verification will be identified and corrected; outliers that cannot be attributed to errors in sampling, measurement, transcription, or calculation will be clearly identified in project reports.

Samples or field measurements that do not pass QA/QC will be documented with the following information: sample/measurement identification, sample location, sampling date, name of sampler, reason for QA/QC failure, and corrective action taken.

6.1.2. Laboratory Data Verification

For water samples, if an error is detected in the collection, storage or shipping of the samples, the QA Officer and Monitoring Team Leader will be notified. Upon receiving the data sheets and results from the laboratory, the QA Officer will identify any results where holding times have been exceeded, sample identification information is incorrect, samples were inappropriately handled, or calibration information is missing or inadequate. Such data will be marked as unacceptable by the QA Officer and will be coded to include this information in the electronic database.

6.2. Reconciliation with data quality assurance objectives

As soon as possible after each sampling event, calculations and determinations for precision, completeness, and accuracy will be made and corrective action implemented if needed. If data quality indicators do not meet the project's specifications, data may be discarded and resampling may occur. The cause of failure will be evaluated. If the cause is found to be equipment failure, calibration/ maintenance techniques will be reassessed and improved. If the problem is found to be monitoring team error, team members will be retrained.

For analytical samples, the QA officer will document each of the QC samples and the QC purpose (controlling bias, accuracy, etc). If the data quality objectives are not met, additional QC samples will be used to identify where in the process there is room for improvement or changes.

Any limitations on data use will be detailed in both interim and final reports, and other documentation as needed. If failure to meet project specifications is found to be unrelated to

equipment, methods, or sample error, specifications may be revised for the next sampling season. Revisions will be submitted to the state quality assurance officers for approval

7. References

ASTM (American Society for Testing and Materials). 1997. Standard test methods for determining sediment concentration in water samples (ASTM Designation: D-3977-97). ASTM, West Conshohocken, Pennsylvania.

HI-DOH-CWB (State of Hawai'i Department of Health Clean Water Branch). 2014. State of Hawaii water quality monitoring and assessment report. http://health.hawaii.gov/cwb/files/2014/11/Final-2014-State-of-Hawaii-Water-Quality-Monitoring-and-Assessment-Report.pdf

U.S. Environmental Protection Agency (2001). EPA Requirements for Quality Assurance Project Plans. EPA QA/R5; EPA/240/B-01/003; EPA, Office of Environmental Information: Washington, DC, 2001. http://www.epa.gov/quality/qs-docs/r5-final.pdf.

Environmental Protection Agency; Volunteer Stream Monitoring: A Methods Manual; **http://www.epa.gov/owow/monitoring/volunteer/stream/**

South Yuba River Citizens League. Water Quality Monitoring Field Procedures Manual. Feb 2012. 7th Edition.

U.S. Geological Survey, 1999, Sediment laboratory quality assurance project: U.S. Geological Survey, Office of Water Quality, Branch of Quality Systems, accessed from https://bqs.usgs.gov/slqa/ on March 18, 2016.