Hui O Ka Wai Ola Quality Assurance Project Plan

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Hui O Ka Wai Ola

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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), West Maui Ridge-to-Reef Initiative, and University of Hawai‘i-Maui College (UHMC), with assistance from NOAA’s Hawaiian Islands Humpback Whale Sanctuary.

The monitoring activities of the Hui O Ka Wai Ola program began in 2016. The overarching goal of the program is to increase the capacity for monitoring water quality in Maui coastal waters by generating reliable data to assess long-term water-quality conditions and detect temporal trends. These data augment the data produced by the HI-DOH-CWB beach monitoring program on Maui. To reach this goal, Hui O Ka Wai Ola is organizing a network of monitoring teams drawn from watershed stewardship groups that operate under the same quality assurance guidelines outlined in this document. The teams are trained in monitoring procedures, and conduct regular monthly monitoring and opportunistic, event-based monitoring at sites in Maui’s coastal waters at predetermined sites. Producing reliable water-quality data requires 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 are 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 consists of monitoring teams, each with a team leader, who are supported by a centralized group that provides project management, data management, and technical advice. Each team monitors or will monitor one of the following sections of Maui coastline: west Maui (Lahaina to Honolua), Southwest Maui (Polanui and Olowalu), South Shore Maui (including Ma‘alaea, Kīhei, and Makena), North Shore Maui (Iao, Kahului and Paia) and Hana. All teams 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.

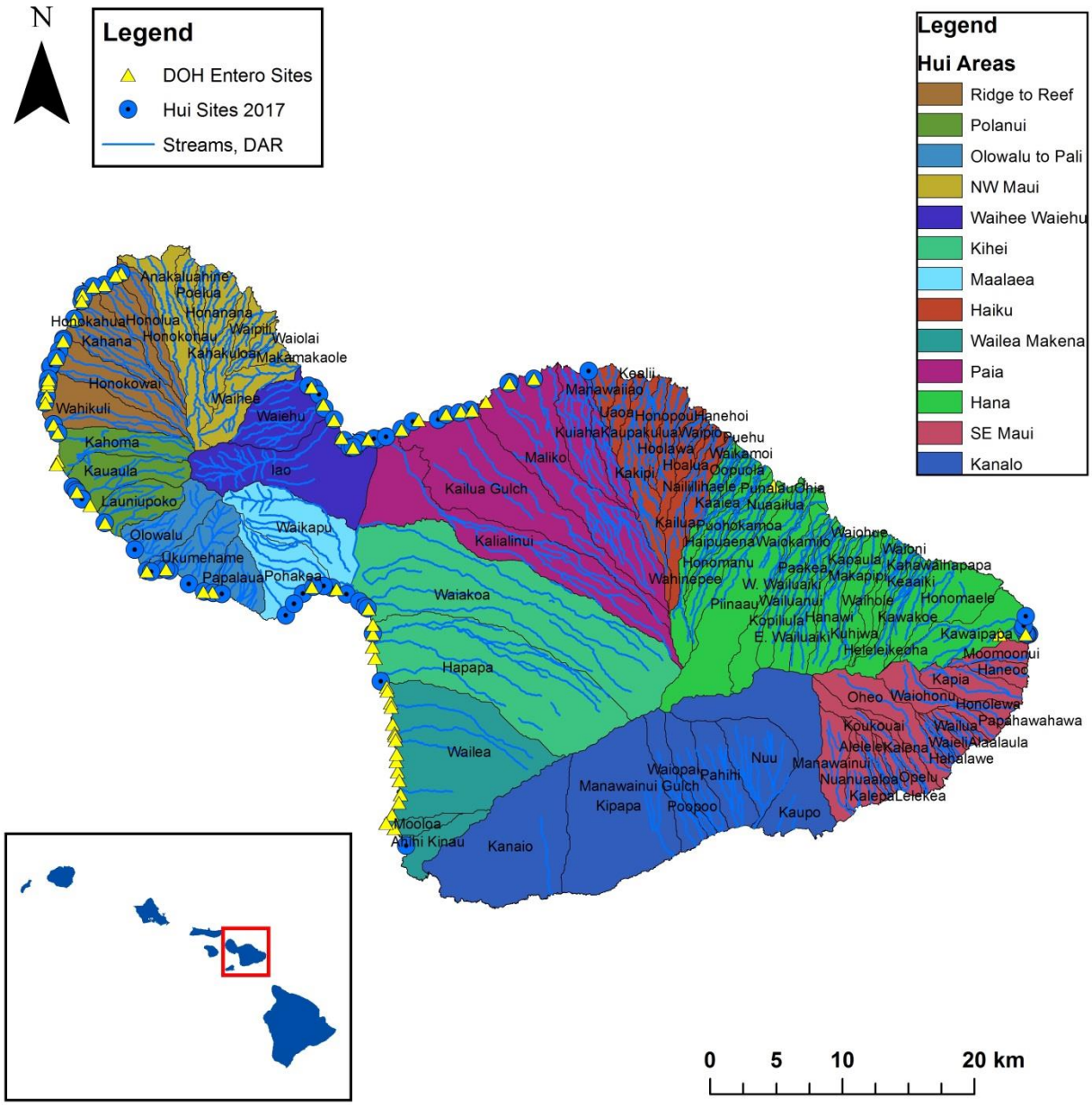

Figure 1-1: Map showing sampling sites, and the sampling zones for each of the participating organizations in Hui o ka Wai Ola. More detailed information about sampling sites can be found in Appendix B.

The primary roles for participants in the Hui O Ka Wai Ola program are Project Manager (PM), Quality Assurance Officer (QA officer), Regional Coordinator, Monitoring Team Leader, Training Leader, Monitoring Team Member, and Science Lead. In general, the PM is responsible for administering and coordinating the program and maintaining records; 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 Regional Coordinator organizes the lab

facilities, shipping and processing of samples; the Monitoring Team Leaders and monitoring teams are responsible for field monitoring, some laboratory analyses. The Training Leader is responsible for preparing and conducting training sessions for new members and doing refresher courses for existing members. In addition, the Hui O Ka Wai Ola project has a steering committee composed of representatives of the organizations that established the project. The steering committee 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 and Table 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.

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, Hawai‘i Marine Program
Kim Falinski	QA Officer, Training Leader	The Nature Conservancy, Hawai‘iHawaii Marine Program
Watson Okubo	Supervisor, Monitoring and Analysis Section, Clean Water Branch	Clean Water Branch, Department of Health
Terence Turuya (retired 2017)	Quality Assurance Manager, Environmental Management Division	Environmental Management Division, Department of Health
Roland Asakura (retired 2017)	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	Regional Coordinator – West Maui	Maui Nui Marine Resource Council, The Nature Conservancy
Roxie Sylva	Monitoring Team Leader – Hāna to Kahului	The Nature Conservancy of Hawai‘i
TBD	Monitoring Team Leader – Mā‘alaea to ‘Āhihi-Kīna‘u	University of Hawai‘i, Maui College
Cathy Maxwell	Monitoring Team Leader – Honolua to Wahikuli	Maui Nui Marine Resource Council, West Maui Ridge-to-Reef Initiative
George Burnette	Monitoring Team Leader – Papalaua to Lāhaina	Maui Nui Marine Resource Council, West Maui
TBD	Data Manager	

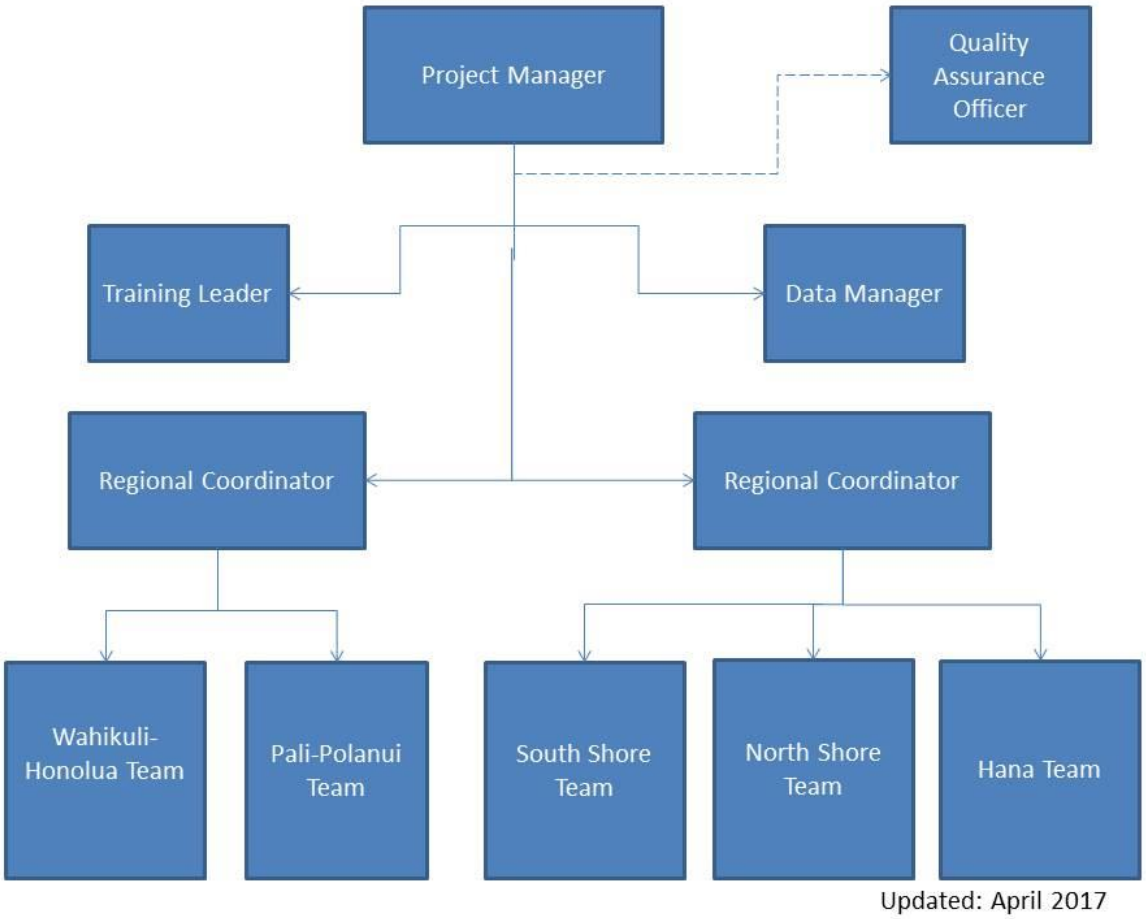

Figure 2-2: Hui O Ka Wai Ola organizational chart

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, TNC, MNMRC, West Maui R2R, the HI-DOH, Lahainaluna High School, and the S-LAB.
- 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).
- Liaise with other monitoring groups and agencies. Represent program at workshops and conferences.
- 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.
- Initiate regular outreach efforts to inform the community about the program and findings.
- Call regular meetings of the steering committee.
- Assist the steering committee with grant proposal preparation and other fundraising efforts.
- Resolve challenges encountered by monitoring teams (e.g., beach access).
- Support the Regional Manager and QA officer, as described below

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.
- Collaborate with both the DOH and the analytical laboratories on changes in protocol or QA/QC steps.
- 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.
- Review and verify data entries provided by the Regional Manager and / or Monitoring Team Leaders, and release the data to the website and Hawaii State Department of Health (DOH).
- Bi-annually meet with all staff members associated with data generation (sample collection, field measurements, lab analysis, data analysis, data reporting, etc.) to review the QAPP.

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

Regional Coordinator

- Coordinate local laboratory facilities, equipment and supply purchases, payments for analytical services and sample shipping, maintain supply inventory, and reorder supplies as necessary.
- Ship or deliver nutrient samples to the SOEST laboratory for analysis
- Oversee calibration of all equipment and keep records of calibration/verification.
- Provide ongoing program oversight to ensure accurate data collection an dentry
- Maintain program membership and contact lists
- Communicate changes in monitoring design to quality assurance officer, as necessary (parameters, procedures, locations).
- Provide and monitor team training in field and laboratory procedures and data entry – with updates as needed.
- Ensure that all waivers are signed and safety measures are in place, understood and practiced.
- Enter field and laboratory data into program database.
- Maintain data records for near real time analysis to determine when there are problems with equipment, or a water quality problem that needs immediate attention.
- Fill in for team leaders as required.
- Ensure that original datasheets are filled out accurately and delivered to the QA Officer on schedule.
- Ensure that samples for laboratory analysis are collected, processed, stored and shipped in accordance with the QAPP and associated SOPs.
- Support the Project Manager and QA officer in trainings by participating in the production of training modules; designing field and laboratory demonstrations; scheduling training days coordinating facilities; present classroom, field and laboratory material to trainees; training Monitoring Team Leaders; and preparing SOPs with the QA officer and MTLs.

Science Lead

- Analyze the data and post updates on the website.
- Write annual report within the first quarter of each year with support from the Project and Regional Coordinators

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 are performed by the Monitoring Team Leaders. Each site has 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 Monitoring Team Leaders (MTLs) are responsible for the volunteer monitoring teams and ensuring data is collected in a timely manner and recorded accurately. Specific responsibilities for the Monitoring Team Leaders are:

- Schedule monitoring dates and times with team members.
- Maintain records of volunteer availability to ensure teams have enough volunteers for each sampling session.
- Ensure that field conditions are safe for team members, and that all volunteers are familiar with first aid kits and procedures.
- Calibrate all equipment according to the schedule laid out in the QAPP. Provide calibration data to the Regional Coordinator.
- Maintain, calibrate and properly store field and laboratory equipment. Conduct pre- and post- checks on field instruments prior to and after the day's sampling.
- Ensure that all field measurements are made in accordance with the QAPP and associated SOPs.
- Ensure that original datasheets are filled out accurately and delivered to the Regional Coordinator on schedule. Maintain copies of all datasheets.
- Store and ship applicable seawater samples for laboratory analysis after collection by Team Members.
- Process sediment samples collected by the volunteer teams in the regional laboratory and provide results to the Regional Coordinator.
- Train new members of the monitoring team using Training Leader training documents and maintain training records.
- Maintain training documentation of team members.
- Ensure that original datasheets are filled out accurately and delivered to the Regional Coordinator on schedule

All staff members associated with data generation (sample collection, field measurements, lab analysis, data analysis, data reporting, etc.) 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 are 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 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 suspended sediment, *Enterococcus*, 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. Laboratory facilities

Laboratory analysis for nutrients are provided by a facility that uses the same methods as the Hui O Ka Wai Ola will use lab services from the School of Ocean and Earth Science and Technology (SOEST), 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, processing and shipping, laboratory quality control. The QA plan for S-LABs is attached as Appendix F.

The regional Maui laboratories are 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 Lāhainaluna High School, while volunteers sampling north Maui sites will utilize laboratory facilities at the University of Hawai‘i Maui College.

2.1.3. Data users

The primary users of data generated by Hui O Ka Wai Ola will be HI-DOH CWB, watershed managers and academic partners. In addition, the data are available for public use and data analysis at multiple online locations. Details of data provision and public access are given in Section 5.4.1. 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. The most current version will be available online on the project website.

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 US EPA, 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 includes measurements of physical parameters of coastal waters including temperature, salinity, dissolved oxygen, turbidity and pH. Chemical parameters collected include dissolved nutrient analysis of water samples, analyzed at S-LABs at the University of Hawai‘i at Mānoa. Lastly, biological parameters include bacteria analysis for *Enterococcus*, analysis are 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 include weather conditions, beach use and qualitative water quality notes.

Analytical work follows 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. Water quality standards are adopted from Hawaii Administrative Rule 11-54 for coastal waters. Quality control of the data is 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 5 of this QAPP. Individual samples exceeding the standards specified in HAR 11-54 will be reported to the CWB for possible follow-up action.

This sampling plan covers multiple sites along the Maui Island coast.. Samples are collected from the nearshore environment at locations noted in Appendix B and seen in Figure 1-1. 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 practicablepractical.

3.4. Quality assurance and data quality objectives

The objective 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
- Proper sampling, equipment and analytical procedures are used
- Field and lab volunteers are properly trained
- QC samples such as blanks, spikes and replicates are incorporated in sampling plans
- Sample chain of custody procedures are in place
- Labs analyzing the data follow appropriate QA/QC procedures
- The QA officer performs lab results validation in a timely manner
- Corrective actions are documented and applied when QC measures identify errors, or defects at any point in the data acquisition process.
    - If the sample can be re-analyzed that it

[1] State of California, Department of Water Resources

- 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, 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 (Section 4.1). In addition to standard practices described in Section 4, quality control measures are presented in Section 5 and Appendix D.

Table 3-1. Data Quality Objectives

STEP 1: State the problem Coastal water quality may change with changes in land use and climate, impacting human and ecosystem health. Long term monitoring data sets are needed to evaluate whether there are impacts to nearshore waters.
STEP 2: Identify the goals of the study The long-term study will examine the quality of coastal waters in Maui. Sites will be selected to reflect both minimally impacted and highly impacted sites, and sites where future changes to land use or climate are anticipated.
STEP 3: Identify information inputs • Analyses of regular water samples for nutrients, bacteria and total suspended sediment • In situ testing of water samples for instantaneous measurement of salinity, turbidity, dissolved oxygen, temperature and pH
STEP 4: Define the boundaries of the study • Individual sites (±3m) where water is sampled at the shoreline. Sites are organized into four large units on the island of Maui. Site names and locations are described in Appendix B. • Samples will be taken consistently within 10m of the shoreline at a specific, non-moving location.
STEP 5: Develop the analytical approach The analytical approach will conform to 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.

Each laboratory that handles samples will be covered under its quality assurance plan.

Each sample will be verified for calibration and secondary checks within range, hold times, and transport documentation. Quality control of the data will be monitored through the collection of duplicate samples, matrix spike samples, and laboratory control samples as described in Section 6 of this QAPP.

STEP 6: Specify performance or acceptance criteria

Samples are accepted if all quality assurance and quality control checks are within range of time and value, and protocols have been followed correctly.

STEP 7: Develop the plan for obtaining data and optimizing sample design

Samples will be collected as outlined in this QAPP. Proposed sample locations have been developed based on the sampling objectives. Sample locations are fixed in order to best capture changes over long periods of time (on the order of years), and sampling will be done to capture tidal and moon variability. Additionally, storm sampling will help to capture variability during short term events. The frequency of sampling may be adjusted based on the variability in the data.

PARCC parameters. 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 monitored for quality assurance – precision, accuracy, representativeness, comparability, completeness, and sensitivity – are described below.

Precision is quantified in the field through replicate measurements of physical and chemical parameters, including pH, turbidity, salinity, temperature and dissolved oxygen. The laboratory analyses include replicate measurements, splits and repeated measurements of the same sample to assess the precision of the data.

Accuracy is controlled by adequate calibration and secondary verification. We 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 is verified by comparison with a NIST thermometer.

Measurement error is generated through variation in the operation, calibration and output of sensors and other measurement instruments. For this reason, instruments will be maintained, checked for drift, with a documented precision and accuracy (Table 5-4). Calibration and field instrument check schedules are presented in Tables 5-1 and 5-2 to ensure that the equipment is functioning according to specifications.

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. Each sampling team adheres to the exact sampling sites (± 3m), a regular sampling schedule and the use of sampling/measurement procedures specified in this document.

Comparability is 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 is determined by the use of split samples between the different labs and a reference lab. Changing calibration of instruments has the potential to affect comparability – and so will be noted.

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.

We calculate completeness as the percentage of total samples collected that were analyzed as a whole and for individual parameters and sites. Sampling efforts are either weekly, bi-monthly or monthly, depending on community resources. Completeness will be calculated once per year for each site.

Bias is addressed through careful calibration and field pre and post-verification protocols that test to make sure that probes are not drifting or reading consistently incorrect. Bias is additionally assessed through careful analysis of the data to assess if there are either increasing or decreasing trends that would indicate a sample probe is drifting.

A carefully documented sampling plan, consistent calibration and verification, and quality control measures including duplicates and blanks will ensure that the sampling and analytical bias are minimized and that sample results outside of acceptable ranges are discarded.

4. Measurement and Data Acquisition

4.1. Sampling Design

The following sampling design describes sampling and measurement of four suites of water-quality parameters:

1) **Field parameters** (water temperature, salinity, dissolved oxygen (DO), pH, turbidity),
2) **Nutrient parameters** (ammonia nitrogen (NH4), nitrate + nitrite nitrogen (NNN), dissolved reactive phosphorus (DRP), total dissolved nitrogen and phosphorus (TDN and TDP), dissolved silica).
3) **Sediment parameters** (total suspended sediment concentration (TSS)), and
4) **Bacterial parameters** (*Enterococcus*).

4.1.1. Monitoring sites

Sampling takes place 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 and Olowalu. Additional sites will be selected through consultation with HI-DOH and community groups. The CWB will be informed yearly of all new and eliminated sites. Monitoring sites 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 serves to extend existing data time-series, and provide data for sites that lack sufficient data for assessment. Priority is given to sites that have active management partners interested in the resulting data who share the same data objectives and can commit to this QAPP. Other criteria for site selection include 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,
- 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.

Sites are classified as either Active or Inactive, with Active sites being monitored for at least one of the four suites of parameters on a regular basis.

4.1.2. Sampling schedule

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

The **pre-scheduled monitoring** takes place regardless of current and antecedent weather conditions, unless safety is a concern. This sampling mode produces an unbiased estimate of average water-quality conditions at each site. For each active monitoring team, the constituents to be analyzed and the frequency of the sampling will be pre-determined in six-month year intervals. At minimum, active sites are sampled once every three months, separate from any opportunistic sampling (see below). 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 are taken at the same time of day (for instance at 08:00am) on a predetermined day and time of the month, depending on the weather.

Safety concerns will limit sampling if the conditions are unsafe. Sampling will be delayed by a day or more 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, and will be collected in three successive days after the storm at the same time of day. Hold times will be strictly met for all opportunistic samples.

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. TSS 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 at the beginning of the Appendix.

Water-quality parameters measured in the field and the instruments used for those measurements are listed in Table 4.1. The instruments and sensors in Table 4.1, with the exception of dissolved oxygen, are the same make and model as the instruments used by HI-DOH-CWB. They are currently in production, so replacement parts and repair services are available. For dissolved oxygen, the HIDOH-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 uses 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	ppt 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 turbidimeter	NTU

4.1.4. Laboratory analyses

The S-LAB at the University of Hawai‘i at Mānoa analyses samples for dissolved nutrient and silicate analyses, and particulate analyses for nitrogen and carbon. Results from an annual demostrations of proficiency in the comparison of unknown samples provided by a commercially available, nationally accredited proficiency testing provider are available in Appendix F. The analytical methods used are consistent with the methods specified in the Code of Federal Regulations, Title 40, part 136.

Enterococcus measurements and suspended sediment measurements are analyzed in satellite laboratory facilities on Maui, as described in Section 2.1.2. EPA 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
NH_4	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)	MPN/100mL
Suspended sediment	EPA Method 160.2	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

4.2. Sampling methods

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

For sediment samples, the team collects 500 mL sample for analysis of total suspended sediment.

For nutrient samples, we collect 125 mL bottles at the 0.1m depth for water quality analyses. Dissolved and particulate nutrients are 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) 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 are 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-2.

4.3. Sample handling and custody Requirements

4.3.1. Sample transport

Samples are transported in coolers with ice from the field to the regional laboratory where they are either processed further (*Enterococcus* and SSC) or prepared for shipment to the S-Lab (nutrient analysis). Samples for nutrient analysis are frozen at the local laboratories until they are shipped. Shipments are made using FedEx or similar carrier using blue ice and coolers to keep the samples frozen during transit. Nutrient samples for analysis are delivered to the lab within two weeks of collection. Samples arriving at S-Lab are 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 used for analyzing nutrients are cleaned at the lab using phosphate-free soap and triple-rinsed.

Table 4-3: 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 nutrient 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 nutrient analytical 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 QA officer for resolution of the problem. The discrepancy, its resolution, and the identity of the person contacted must be documented by the laboratory.

In some cases, the sample collector and the sample Maui receiver/laboratory analyst are the same individual, and this will be noted.

4.3.4. Sample labeling

Each sample collected is 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 follows 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, E for *Enterococcus*) – 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 are listed separate from the sample ID.

4.4. Analytical methods

Suspended sediment concentration

Total suspended sediment concentration (TSS) are measured gravimetrically after being dried for 24 hours at 103°C, according to the Manual of Chemical and Physical Methods for Seawater Analysis using a modified EPA method 160.2 protocol. 500-mL samples will be prefiltered to remove large debris and sand-sized particles which are typically found in the surf zone.

Nutrient and silicate analyses

Nutrient and silicate analyses are conducted on an autoanalyzer (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 in accordance with the EPA methods listed in Table 4-2.

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 for 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 is 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 are maintained, checked for drift, with a documented precision and accuracy (Table 5-1).

Table 5-1: 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 turbidimeter	0 – 1000 NTU	± 2 %	0.01 NTU

5.1.1. Field calibration and maintenance

All field calibrations/verifications, quality control measures, and sampling activities are documented on the field data sheets provided.

All field instruments used for the collection of water samples or data for the program are 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.

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 5-2. 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). The instruments are calibrated according to the schedule provided in Table 5-2.

In addition, before and after each day's field sampling effort, pre- and post- check values will be ascertained and compared to the field check range indicated in Table 5-2. If more updated information about a site is available (for instance a site has been sampled continuously and has enough data to provide a smaller interval range), the 95% confidence interval will be used on a site by site basis. If the acceptance criteria are not met in the field, then the data will not be used, and the instrument will be considered for repair or replacement.

Table 5-2: Calibration schedule and field check criteria; The field check criteria is the largest range within the instrument is expected to be functioning correctly.

Instrument	Parameter	Calibration frequency	Secondary 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	Pre- and post-check to ± 3% of 35ppt and 0ppt solution	20 – 38 ppt
Hach HQ40d meter, IntelliCAL LDO101 luminescent/optical DO sensor	Dissolved oxygen	Yearly or as needed	Post-check ± 5 % of pre-check	80 - 120%
Hach HQ40d meter, IntelliCAL PHC101 pH Electrode	pH	Every time equipment is used	Pre- and post-check to ± 3 % of calibration solution	7 - 9
Hach 2100Q turbidimeter	Turbidity	Yearly or as needed	± 5 % of Gelex standards (5, 50, 500 NTU). Deionized/turbidity-free blank < 0.25 NTU	0-1600 NTUs

5.1.2. 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) are collected for each type of analysis. Each replicate will be analyzed as a blind-to-the-lab sample. The accumulated replicate data assesses measurement error in field collection protocol. The replicate samples are given unique sample identification numbers and treated as discrete samples. Samples that differ by more than 10% relative percent difference (RPD) will be discarded. Additionally, sample blanks (distilled water only) are 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 10 NTU, duplicate samples for suspended sediment analysis is automatic. Samples that differ more than 10% RPD will not be included in the database.

The facilities carry out analyses of sample duplicates and blanks as part of a continuous check on performance. Performance records are maintained and are available to HI-DOH-CWB. Where applicable, split sample analyses is carried out with commercial or university analytical laboratories. Discrepancies are addressed as discussed in Section 6.

5.2. Shipping and handling

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

Shipping frozen samples only occurs between Monday and Weds, so that the lab can process the samples when they arrive. In the event a package arrives on the weekend or on a holiday, and is not opened and processed within 24 hours, the samples date will be recorded and the sample flagged for further quality assurance inspection.

5.3. Training requirements

Each monitoring team member receives consistent, documented training. Sites are sampled in pairs to reduce bias in the sampling protocol and to reinforce protocol.

Field team members 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 are required to read the most updated QAPP document. The training is 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 are available to the CWB on request. Field team members 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 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.

5.4. 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 are 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.

5.4.1. Water quality laboratory facilities

Detailed quality assurance information for the nutrient analysis lab is provided in Appendix F.

Instrument maintenance. All instruments are serviced at scheduled intervals necessary to optimize factory specifications. Routine preventive maintenance and major repairs are 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 includes 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 are 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 satellite lab checks 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. Bottles are rinsed three times and dried prior to their reuse in sampling. Between sampling in the field, equipment is rinsed with deionized water.

Inspection for supplies and consumables. Once per year, an inventory of all consumables is 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 are documented in the laboratory notebook for QA review, if necessary.

5.4.2. 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 also checks 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 records 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. 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.

Cleaning protocols. Bottles are rinsed three times and sterilized to their reuse in sampling. Or, if possible, sterile water collection bags will be provided.

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 is noted on each data form. Each lot is 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 is 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.

5.4.1. 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, as described in Appendix F.

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 for 24 hours, the filters are weighed twice and the average recorded in the lab notebook. If there is a difference of more than 10% between the two values, the data will be recorded in the lab notebook but entered with a code in the final database.

Bacterial analysis quality control

Laboratory quality control protocols for bacterial analysis include laboratory blanks and repeated positive readings that is confirmed by a second trained analyst. Lab duplicates are measured every 20 samples, in addition to field duplicates every 20 samples. If the relative percent difference is greater than 10%, the sample will be thrown out.

Additionally, the media will be tested for each batch by inoculating intentionally for *Enterococcus*.

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	Within 10%
Lab blank	Once per group of samples	<5% of the total range
Lab mid-level calibration	Once per sample run	Within 5%
Standard reference material		Within 5%
Method detection limit	As needed by lab	
Suspended sediment concentration analysis		
Field duplicate	When turbidity >2 NTU	Within 10%
Repeated weighing	Every sample	Within 5%
Bacterial analysis		
Field duplicate	Every 20 samples	Within 10%
Lab reagent blank	One per group of samples	<10 MPN
Lab duplicate	Every 20 samples	Within 10%
Repeated measures	Positive samples checked by second trained analyst	Within 3%

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	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%

5.5. 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 is created specifically for this ongoing project. Hui O Ka Wai Ola will store data in a Microsoft Access database based on the HIDOH water quality database. The database will be saved in the cloud for continual back-up.

5.5.1. Documentation standards

The PM, QA Officer, monitoring teams and Hui o Ka Wai Ola lab analysts 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, initialed and dated.
- 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 (and the change must be initialed and dated).
- The reason for the change must be documented.

5.5.2. Field data management

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

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 returns the signed data sheets with the coolers and clean 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 reports are 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. Field data (pH, turbidity, salinity, DO and temperature), including the results of pre and post verification checks, is 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. 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.

5.5.3. 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.

5.5.4. 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.

5.5.5. Reporting

Hui o Ka Wai Ola Interim reports will be produced and distributed in January (data collected from July-December) and July (data collected from January-June). A year-end report will be produced and distributed in January of the following year. 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.

5.6. 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 and documented 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 5-1) 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. The data will remain in the database but will not be reported to the HI-DOH.

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 consulted, and if the problem persists more than once, members will be re-trained.

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

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

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Appendix List

Appendix A- Standard Operating Procedures

- Appendix A-1 Preparation
- Appendix A-2 Calibration of field instruments
- Appendix A-3 Field measurements with hand-held instruments
- Appendix A-4 Nutrient sample processing
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Appendix B – Site List

Appendix C – Forms for sampling and analysis

Appendix D – Quality control guide

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Appendix F – S-LABs QAPP; Proficiency tests of S-LABS

Version Notes

v21

February 2017

- Clarified that monitoring methods are following the methods specified in HAR 11-54. This included changing the name of the sediment analyses to Total Suspended Solids (instead of SSC), although functionally the procedure is the same.
- Changed tense from future to present
- Replaced Myron Honda with Terence Teruya as the DOH Quality Assurance officer
- Updated site map with divisions and new sites
- Added pre and post field equipment checks to the data forms, as a responsibility of the team leaders.
- Fully added S-LABs QAPP to this version
- Deleted language about external data sources

v22

April 2017

- Added signature page!
- Added Data Quality Objectives per Terry Teruya's request
- Updated organizational chart.
- Slightly reworded the opportunistic sampling section
- Added Surfrider North Shore sites
- "Working group" changed "steering committee" in Roles and Responsibilities
- Removed reference to a technical advisory group (TAG) and the members therein. The group had not functioned in this capacity over the last 3 years. Consultation of process will be left to consultation with the DOH QA Officer and Program Manager directly.

Appendix A: Standard Operation Procedure
Field Sampling with Hand-held Instruments

Introduction

The mission of Hui O Ka Wai Ola is to generate quality-assured coastal water-quality data, and to provide this data to HIDOH, 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 HIDOH-CWB beach monitoring program sampling; 3) thereby empowering community and government mangers to take action to improve coastal water quality, benefiting the coral reef ecosystem and people alike.

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Chapter 1: Preparation

Safety

One of the most critical considerations for a citizen monitoring program is the safety of its volunteers. All volunteers are trained in safety procedures and should carry a set of safety instructions and the phone number of their monitoring team leader. Safety precautions cannot be overemphasized.

The following are some basic safety rules. At the site:

- Always monitor with at least one partner. Always let your monitoring team leader know where you are, when you intend to return, and what to do if you do not come back at the appointed time. Do not rely on cell phones, as a site may lack adequate reception.
- Know any important medical conditions of team members (e.g., heart conditions or allergic reactions to bee stings).
- Listen to weather reports. Never compromise your safety if severe weather is predicted or if a storm occurs while at the site.
- Use caution when entering the water. Never turn your back to the surf and waves. You should not be sampling in water greater than knee deep. If you are uncomfortable with the level of surf and are concerned for your safety do not go in the water! The most important thing is your safety. Data can be collected at another time.
- If you drive, park in a safe location. Ensure your car does not pose a hazard to other drivers and do not block traffic.
- Never cross private property without the permission of the landowner. For sites requiring access via private property, Hui O Ka Wai Ola will obtain permission for our volunteers but you may need to check-in before you monitor such a site.

Field equipment pickup

Before packing up the equipment, check the calibration log to ensure that all calibrations are up to date on the meters and the probes. In addition, make sure the battery power for each meter is sufficient for the field sampling session. If necessary, put new batteries in the meters and reset the date and time before leaving the regional laboratory.

In addition to the measurement equipment, collect supplies that may be required for collection and measurement of the in-situ water quality parameters (Chapter 3), for water quality filtration (Chapter 4) and for packaging samples for *Enterococcus* analysis (Chapter 5). The following list can serve as a guideline:

1. 1.5 gallon bucket
2. 100 ml bottles for turbidity samples
3. Distilled water
4. Field guide and equipment user manuals
5. Field notebook
6. Data sheets and clipboard
7. Chain of custody forms
8. Cooler with blue ice
9. Ziplocks for chain of custody forms
10. Extra batteries for meters
11. Pens for filling in data sheets, sharpies for writing labels
12. Label tape
13. Kim-wipes and paper towels
14. Gloves

15. Scissors
16. Camera
17. First aid kit

The following equipment is necessary for **in-situ measurements**:

1. Digital thermometer
2. Hach 2100Q turbidimeter
3. Hach HQ40d meter with the following electrodes:
    a. IntelliCAL LDO101 DO sensor
    b. IntelliCAL CDC401 conductivity probe
    c. IntelliCAL PHC101 pH electrode

The following equipment is necessary for **field water sample collection for nutrient sampling**:

1. Sample bottles (clear, HDPE, 125mL, acid-washed)
2. Filters (GF/F, 25mm)
3. 60-mL syringe with luer locks

The following equipment is necessary for collecting bacterial information with the Enterolert system:

1. Whirlpack bags
2. Gloves

Labeling

Any samples that will be brought back to the local laboratory either for testing or shipping to an analysis lab must be labeled. It is always best to label bottles and samples *before* you get to the field, if possible. Hui O Ka Wai Ola has a strict labeling scheme to prevent sample mix-ups.

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 might be: HBP150601-N-1. The initials of the sampler will be listed separate from the sample ID. For field measurements, list the sample number at the top of your sheet.

Observations

On the field data sheet, include observations including the tidal information, time of day, wind speed (see Table 1) and direction and wave state. Note the moon phase if possible, and the number of swimmers in the water near the sample site.
Note the nearest **low tide** for tidal information.

Table 1: Beaufort wind scale

Estimating Wind Speed			
knots		**Effects Observed at Sea**	**Effects Observed on Land**
under 1	calm	Sea like a mirror	Calm; smoke rises vertically
1-3	light air	Ripples with appearance of scales; no foam crests	Smoke drift indicates wind direction; vanes do not move
4-6	light breeze	Small wavelets; crests of glassy appearance, not breaking	Wind felt on face; leaves rustle; vanes begin to move
7-10	gentle breeze	Large wavelets; crests begin to break, scattered whitecaps	Leaves and small twigs in constant motion; light flags extended
11-16	moderate breeze	Small waves 2-4 feet high, becoming longer; numerous whitecaps	Dust, leaves, and loose paper raised up; small branches move
17-21	fresh breeze	Moderate waves 4-8 feet high taking longer form; many whitecaps; some spray	Small trees in leaf begin to sway
22-27	strong breeze	Larger waves 8-13 feet high forming; whitecaps everywhere; more spray	Larger branches of trees in motion; whistling heard in wires

Chapter 2: Calibration

PRINCIPLE:

Calibration and verification are essential to the quality assurance program, and are performed regularly.

A. Calibration

Calibration involves adjusting the instrument to read a true value. This is usually done by digitally adjusting the instrument per the instruction manual. Each sensor is calibrated according to the schedule presented in Table 2. Only standards that have not expired will be used. Calibration values before and after the calibrations will be recorded in a lab notebook, along with calibration coefficients associated with each sensor.

Table 2: Calibration schedule for each of the five field parameters measured.

Instrument	Parameter	Schedule	Calibration standards
NSIT-traceable waterproof digital thermometer	Temperature	None (factory-calibrated)	n/a
Hach HQ40d meter, IntelliCAL CDC401 conductivity probe	Salinity/ conductivity	Quarterly or as needed	0 ppt, 35 ppt
Hach HQ40d meter, IntelliCAL LDO101 luminescent/optical DO sensor	Dissolved oxygen	Yearly	Air (100% saturation)
Hach HQ40d meter, IntelliCAL PHC101 pH Electrode	pH	Monthly	Buffer solutions at pH 4, 7, 10
Hach 2100Q turbidometer	Turbidity	Yearly or as needed	Stable Cal calibration standards (20, 100, 800 NTU); Deionized/turbidity-free bank < 0.25 NTU

B. Verification

Instrument verification uses secondary standards or known values to assess whether the instrument is still performing within a specified range. Verification does not change the readings of the instrument.

Sensors are verified before and after each week's sampling efforts (within 7 days) and logged on the form presented in Appendix C.

The Hach 2100Q turbidimeter should be checked with the secondary Gelex standards before and after each field session.

Table 3: Verification for each of the five field parameters measured.

Instrument	Parameter	Field-check acceptance criteria
NSIT-traceable waterproof digital thermometer	Temperature	Within 1C of the NIST value
Hach HQ40d meter, IntelliCAL CDC401 conductivity probe	Salinity/ conductivity	± 3% (for a 35 ppt sample)
Hach HQ40d meter, IntelliCAL LDO101 luminescent/optical DO sensor	Dissolved oxygen	Between 80 and 120%
Hach HQ40d meter, IntelliCAL PHC101 pH Electrode	pH	± 5 % of calibration solution
Hach 2100Q turbidometer	Turbidity	± 5 % of Gelex standards (5, 50, 500 NTU). Deionized/turbidity-free bank < 0.25 NTU

B. METHODS: VERIFICATION

Because turbidity is a sensitive parameter, turbidity is field-verified before and after each sampling day. Temperature, pH, DO and salinity are verified in the lab at the beginning and end of each week of sampling. The following instructions are to be repeated for all probes verified.

Turbidimeter verification check

1. Use the Gelex secondary standards to perform QC check of the turbidimeter.
2. Handle the Gelex standards by the lid. Avoid touching the sides of the glass vial.
3. Power the turbidimeter on, insert the calibrated Gelex standard into the well, close the door on the sample cell, and push the READ button.
4. Record the reading on the data sheet for that particular Gelex standard.
5. Repeat the process with all three of the Gelex standards.
6. Insert a sample cell with distilled water into the turbidimeter and take a reading of the distilled water to use as a field blank. Record this reading on the data sheet.

Water quality probe verification check

1. Use the check standards on the pH (page 49 in the user's manual), conductivity (page 65 in the user's manual), and dissolved oxygen probes (air) to verify the probes are within standards before leaving the regional laboratory.

If any of the acceptance criteria are not met:

1. Try again. Attempt verification again using the same secondary standards.
2. If the second verification fails, the probe may have a physical or chemical defect. Contact the lab manager. Do not use the probe for field work until the issue is resolved.
3. Continue on with the next probe or instrument. If that also fails, there could be an issue with the instrument or with the standards.

Chapter 3: Water collection for in-situ measurements

PRINCIPLE:

It is important that the water collection for in situ measurements happens at the *same place, same time* and from the *same pool of water* each time.

MATERIALS AND EQUIPMENT

- 1.5 gallon bucket
- Sample bottles

METHODS:

1. Submerge the bucket/bottle 6 to 12 inches below the surface facing into the oncoming waves.

2. Cap the turbidity bottle while it is still under the water.

PROCEDURAL NOTES:

General sampling techniques for in-situ measurements:

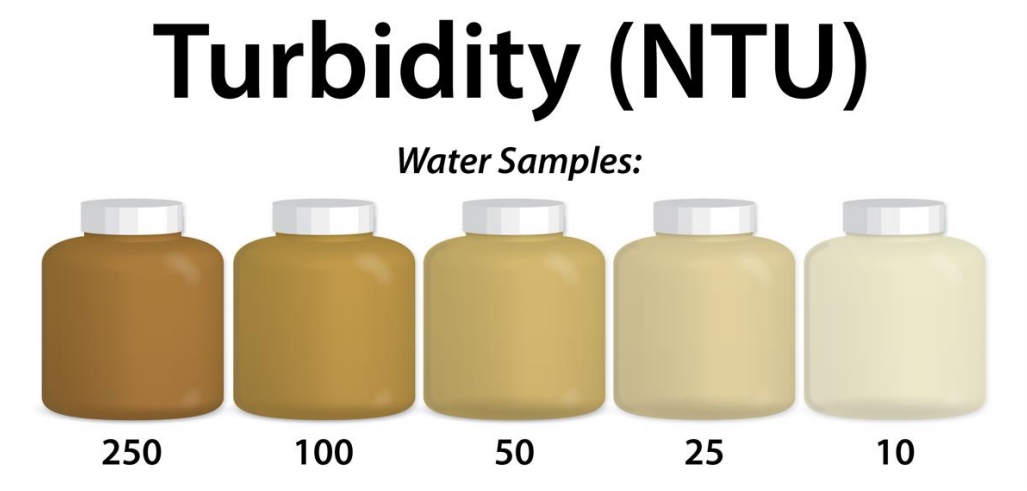
Because it can be hazardous to stand in the ocean where the surf is breaking while attempting to use a hand-held meter, water for four of the in-situ measurements ***will be collected in a 1.5 gallon bucket and taken back away from the ocean to conduct the measurements for temperature, salinity, pH, and dissolved oxygen*.** Water for the turbidity measurements will be collected in a smaller bottle that can be re-agitated to provide the most accurate turbidity measurements.

In general, you should always collect water samples with the water moving towards you. Always face away from the shoreline at a depth no more than knee deep and rinse the bucket/turbidity bottle three times with the water to be tested. When collecting the sample, avoid disturbing any silt that may have settled on the bottom.

Measurements on water samples should be made in a shady area if possible, avoiding direct sunlight. The samples should be tested as quickly as possible once the water is removed from the water body being sampled.

Turbidity measurements

A turbidity meter consists of a light source that illuminates a water sample and a photoelectric cell that measures the intensity of light scattered at a 90 degree angle by the particles in the sample. It measures turbidity in nephelometric turbidity units (NTU). The meter can measure turbidity over a wide range from 0 to 1000 NTUs. These values can jump into hundreds of NTUs during runoff or flood events.



MATERIALS AND EQUIPMENT:

- Hach 2100Q turbidimeter
- Distilled water in squirt bottle
- Cloth to clean sample bottles

METHODS:

1. Review the general techniques for turbidity measurements in the turbidimeter user guide as required. Pay particular attention to handling of the sample cell to avoid compromising the measurements.

2. Empty the distilled water from a clean sample cell.

3. Gently agitate the water sample to be tested to ensure that any sediment that may have fallen out of suspension is re-suspended in the sample.

4. Rinse the clean sample cell 3 times with the water sample, taking care to handle the sample cell by the top of the cell to avoid getting fingerprints on the sample cell glass.

5. Fill the sample cell to the line taking with the water to be sampled.

6. Insert the sample cell into the turbidimeter sample compartment with the arrows lined up on the cell and the meter.

7. Close the instrument sample compartment door.

8. Make sure the instrument is measuring in NTUs and averaging is on.

9. Press the READ button and record the reading on the data sheet.

10. Remove the sample cell from the instrument compartment and discard the water sample. Rinse the sample cell 3 times with distilled water, taking care to avoid getting water on the outside of the sample cell. Any excess water can be gently blotted with a Kim-wipe cloth. Fill the sample cell to the line with distilled water and test the distilled water to ensure the sample cell is clean. The reading should be < 0.1 NTU. If necessary, repeat the rinse and re-test until the cell is clean. Sample cells should be stored with distilled water.

PROCEDURAL NOTES:

- The turbidimeter (Hach 2100Q) should be placed on a dry flat surface while making measurements.

Grab samples:

How to collect a "grab" sample for turbidity

- If needed, label the bottle with the site number, date, time and your name or initials. Use waterproof pen.
- Remove the cap from the bottle just before sampling. Avoid touching the inside of the bottle or the cap. In high flows, use a sampling pole. Rinse the sampling bottle on the pole 3 times prior to decanting water into sample bottle.
- It is best to collect samples while standing on a rock. If you need to wade, try to disturb as little bottom sediment as possible. Be careful not to collect water that contains bottom sediment. Collect the water sample in front of you (towards the ocean).
- Hold the bottle near its base and immerse it (opening upwards) below the water surface. Collect a water sample 6 to 12 inches (~0.3m) beneath the surface or mid-way between the surface and the bottom if the water level is shallow.
- Turn the bottle underwater into the current and away from you in an upstream direction. Fill the bottle completely and make sure there is no headspace in the container.
- Check off the test on your appropriate field data sheet and record the time. This is important because it tells the monitoring coordinator that this sample has been collected from your site.
- The hold time for turbidity is 24 hours

Salinity (Conductivity), pH and Dissolved Oxygen

PRINCIPLE:

Salinity (Conductivity)

Salinity is a key factor affecting the physical make-up of an estuary, and is defined as the concentration of dissolved salts in the water, usually expressed in parts of salt per thousand parts of water (ppt). Seawater averages 35 ppt (3.5% by weight) in the open ocean and 27 to 33 ppt (2.7 to 3.3% by weight) in coastal waters. Fresh water contains few salts - drinking water usually has a salinity of less than 0.5 ppt. A liter of Casco Bay water would typically contain 28 to 34 grams of dissolved salts. In other words, a quart would contain about an ounce of salts.

The surface salinity levels within the Bay, especially near the coast, vary with many factors, including the tides and the volume of fresh water flowing into the Bay. Salinity tends to decrease in the spring when heavy rainfall, the release of groundwater, and melting snow combine to greatly increase the amount of fresh water flowing in. In late summer and fall, particularly during periods of drought, higher levels of salinity may extend farther up some reaches of the estuary as the fresh water flow decreases. Some decreases in salinity can be attributed to human activities which reduce the water-holding capacity of the land (such as paving or removal of vegetation) or directly accelerate fresh water discharge (such as storm sewers). On the other hand, excessive withdrawals of water from the fresh water portion of a tributary (for agricultural use, drinking water, etc.) can elevate salinity near the mouth of this tributary.

Salinity levels also vary vertically from top to bottom. In general, salinity increases with depth. The fresh water coming down river is less dense than the heavier seawater, so the entering fresh water tends to float on top of the seawater and may not mix immediately. The volume of entering fresh water is also the greatest closest to land. The net result is a wedge of lighter fresh water lying over the heavier seawater, with poorly defined edges that are continually mixed by wind, waves, and tides. In shallow waters, the mixing of top and bottom layers can obscure this "wedge" completely.

Dissolved Oxygen

Dissolved oxygen (DO) is one of the most important indicators of the quality of water for aquatic life. It is essential for the basic metabolic processes of animals and plants inhabiting our coastal waters. Dissolved oxygen is measured in milligrams per liter (mg L^{-1}). When oxygen levels fall below about 3 to 5 mg L^{-1}, fish and many other marine organisms are stressed and some can not survive. Dissolved oxygen is a particularly sensitive constituent because other chemicals present in the water, certain biological processes, and physical factors such as temperature and water clarity exert a major influence on its availability throughout the year.

The maximum amount of oxygen water can hold depends a great deal on its temperature and salinity. A DO test (using a meter or chemical kit) tells you how much oxygen is dissolved in the water, but it does not tell you how much oxygen the water is capable of holding at the temperature and salinity at which it was tested. Warmer water holds less dissolved oxygen; as water approaches its boiling point, it can hold almost no oxygen. Dissolved oxygen also decreases with increasing salinity. When water holds all the dissolved oxygen that it can at a given temperature and salinity, it is said to be 100 percent saturated with oxygen. If water holds only half that amount of DO at the same temperature and salinity, it is said to be 50 percent saturated. The table below shows this relationship for various temperatures and salinities.

Table 3: Potential dissolved oxygen levels in milligrams per liter (mg/l) at sea level

TEMPERATURE	SALINITY			
°C	FRESH WATER 0 PPT	BRACKISH WATER 5 PPT	NEARSHORE WATER 32 PPT	OPEN OCEAN 35 PPT
0	14.6	14.1	11.6	11.3
5	12.8	12.4	10.3	10.1
10	11.3	11.0	9.2	9.0
15	10.2	9.9	8.4	8.3
20	9.2	9.0	7.6	7.5
25	8.4	8.2	7.0	6.9
30	7.6	7.4	6.2	6.1

pH

pH is a measure of how acidic or basic a solution is. Pure distilled water has a pH of 7.0 and is said to be neutral - but pure distilled water is rarely found in nature. The pH values of natural waters are controlled by the salts and gases dissolved in them. Seawater typically has a pH of 8.1 to 8.3. Because its pH is greater than 7.0, it is said to be basic or alkaline (the two terms are synonymous). The pH of seawater is fairly stable because it's highly buffered - that is, the water contains pairs of ions which react to damp down changes in pH (for more information on buffers, see the box on page 19).

The strong buffering and constant motion of seawater tend to minimize variations in pH. Short-lived, local variations may be caused by intense phytoplankton blooms, or at locations where industrial discharges and sewer outflows enter the ocean, or where there are large influxes of fresh water. Natural fresh water typically has a lower pH than seawater. Rain water usually has a pH of 5.6 to 5.8. Because its pH is less than 7.0, even unpolluted rain water is said to be acidic. So-called "acid rain" has an even lower pH due to atmospheric pollutants.

pH is defined as the negative logarithm of the concentration of hydrogen ions; the higher the concentration, the lower the pH. In any given aqueous solution, a certain proportion of water molecules dissociate to form hydrogen (H+) and hydroxyl (OH-) ions:

$$H2O \rightarrow H^{+} + OH^{-}$$

Materials and Equipment

- Hach HQ40D probe

Methods:

Before attaching any probes, make sure the date and time are set correctly on the Hach HQ40d meter. If the date and time are not set properly before the probes are attached for the first time, the probes will retain the incorrect date and time for the remainder of their service lives. Therefore it is essential that the date and time be checked before starting to use the meter. Without connecting the probes to the meter, place all 3 probes in the bucket with the collected water sample so that the probes come to the ambient temperature of the sample. Allow the probes to sit in the water for at least 5 minutes before connecting them to the meter to take measurements of the sample. While the probes are soaking in the sample, the turbidity measurements can be made.

Review the instructions in the users manual for the hand-held meter and data probes as required.

1. Two probes at a time can be attached to the meter. **Begin with the pH and conductivity/salinity probes.**

2. Switch the meter display so that the pH probe data i**s displayed. To measure the pH, place the probe in** the sample and press the GREEN/RIGHT key under Read. Once the measurement has stabilized, the lock icon will appear and you can record the measurement on the data sheet.

3. Simultaneously, the conductivity probe can be placed in the sample. Once the pH reading has stabilized switch the meter to display the conductivity probe. To measure salinity, press the GREEN/RIGHT key under Read. When the measurement has stabilized, the lock icon will appear and you can record the measurement on the data sheet.

4. Remove the probes from the water sample and rinse the probe with distilled or de-ionized water. Blot the probes with a Kimwipe to remove any remaining water droplets. Place the pH probe back in the 3M KCl solution vial. Make sure to wipe any water that might have gotten on the meter off and store the meter and probes back in their case for transport.

5. **Be sure to log your results both in the field notebook**

Water temperature

PRINCIPLE:

Water temperature in Hawaii fluctuates with the season, as shown in Table 2 (in Fahrenheit). Given the frequency of bleaching events in 2015 and 2016, collecting water temperature can help track localized variations between sites.

Table 4: Water Temperature Table of the Hawaiian Island Coast

Location	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
Honolulu Oahu Island	76	76	76	78	79	80	80	81
Hilo Hawaii Island	72	71	72	72	74	74	75	75
Kahului Maui Island	75	75	76	78	79	79	80	80
Kawaihae Hawaii Island	77	77	78	79	80	81	81	80
Mokuoloe, Oahu Island	74	74	75	77	79	79	80	80
Nawiliwili Kauai Island	77	77	78	79	81	82	82	83

MATERIALS:

- Hach WQ40D
- Digital thermometer

METHODS:

1. **Presoak:** Presoak the thermometer with 1” of water, in the shade, upright in a container for at least 10 minutes, with the power off. Be sure the water level stays below the digital display on the thermometer.

2. **Take measurements**: Preferably dip the thermometer into the water. If the sample is being taken directly from the water, stand so that a shadow is cast upon the site for temperature measurement. If you are using a sampling arm, acquire a fresh sample of river water, stand in the shade, and stir gently. The thermometer should be held by its top and immersed into the water. Allow the thermometer to stabilize for at least one minute, then without removing the thermometer from the water, read the temperature to the nearest 0.1°Cand record.

3. The digital thermometer should be used for quality control of the Hach temperature meter, and follow the same process described above.

PROCEDURAL NOTES:

Note: It is best to begin soaking the thermometer in and leave it while the rest of the measurements are taken – up to 10 to 15 minutes – to get an accurate reading. If one waits longer, the water will equilibrate with the air temperature.

Keep the bucket out of the sun to more accurately measure temperature.

Data quality

When to take a 4th measurement:

- 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

The cap of the pH probe always needs to be filled with 3M KCl solution to keep the sensor moist.

Chapter 4: Nutrient sample processing

PRINCIPLE:

"Nutrients" describe nitrogen and phosphorus-based compounds that are used by microalgae and bacteria for growth. The coastal waters of Hawaii are considered to be nutrient-limited – meaning that nutrients are the limiting factor for the growth of phytoplankton. Measuring nutrient concentrations accurately can help to track potential sources of nutrients.

Nutrients in Hawaii are often sorbed on to sediments, so it is important to filter the sample to remove the potential for sediments to bind to nutrients. For this reason, we also use acid washed bottles in order to minimize binding with the side walls of the bottle.

MATERIALS AND EQUIPMENT

- 125 mL HDPE acid-washed sample bottle
- In laboratory or field filtration equipment, including filter, filter forceps, filter housing and vacuum device.

METHODS:

1. Collect a sample from the wash zone (approximately knee height) in the 125 mL HDPE sample bottles, as directed above.

Filter the sample into the bottle being used for water quality (nutrient) analysis.

2. Hook up a 60-mL syringe to a prepared Swinx filter housing with filter.

3. Prepare an acid-washed 125-mL HDPE bottle to collect the filtrate into.

4. Place a filter in the filter housing using forceps (this can either be a Nalgene 500mL rig or a 25mm Swinnex holder combined with a 60-mL syringe.

For Nalgene rig:

5. Pour ~ 250 mL of the sample water into the reservoir atop the filter rig, and begin pumping until vacuum occurs and flow is continuous. Vacuum pumping can either be with a hand pump or with a vacuum pump. In either case, make sure that the vacuum line is attached to the filter housing.

6. Make sure that the seal is working. Add an additional 250 mL until the total 500 mL sample is processed. Collect ~80mL of the filtrate (bottom part) into the 125 mL bottle. Label the sample as described in Chapter 1.

7. Once the entire 50 mL volume has passed through the filter, disassemble the filter rig

For Swinnex hand filtration:

8. Place a filter (white, not blue paper) in the Swinnex with forceps. Be sure that the o-rings are in place. Use a smalled spray of DI water to make sure the filter stays in place.

9. Remove the plunger for a 60mL syringe, and attached the Swinnex on the syringe. Carefully pour 50mL of water to be filtered in the syringe. Use the plunger to filter the water into a 125mL bottle.

If particulate N and C are to be analyzed:

a. Using a set of tweezers, carefully fold the 0.2um filter and place in a folded up piece of aluminum foil. The foil can then be placed in a plastic filter holder or Ziploc bag for labeling.

b. Label the filter with P for particulate N and particulate C. Label the filtrate (the water that has been filtered) using N for the sample type code.

Store the sample:

10. Store the nutrient sample upright at -20°C in a cooler with wet or blue ice – after frozen it does not need to be upright anymore.

11. Store the filter and sample once back in the regional laboratory in a freezer kept at -20°C.

12. Record the temperature of the water and other specifications in the log book and on the chain of custody form. Copy the salinity from the in-situ measurement and volume of the sample.

PROCEDURAL NOTES:

- The above procedure can be done in the field or in the lab, but the lab may be a more controlled environment and easier to work in.
- Be careful of changing water conditions when collecting sample. Wear gloves to prevent contamination.
- To collect the sample water for nutrient analysis use a 1-L HDPE bottle that you can pour into smaller bottles.
- For suspended sediment, use a 500-mL HDPE bottle.
- Remove the cap from the bottle just before sampling.
- Avoid touching the inside of the bottle or the cap.
- In high flows, use a sampling pole.
- Rinse the sampling bottle on the pole 3 times prior to decanting water into sample bottle.
- Collect the sample from wading depth. Try to disturb as little bottom sediment as possible. Be careful not to collect water that contains bottom sediment. Stand facing upstream. Collect the water sample in front of you (upstream).

- Hold the bottle near its base and immerse it (opening upwards) below the water surface. Collect a water sample 6 to 12 inches beneath the surface or mid-way between the surface and the bottom if the stream reach is shallow.
- Turn the bottle underwater into the current and away from you in an upstream direction. Fill the bottle completely and make sure there is no headspace in the container.

QUALITY CONTROL PROCEDURES

- Collect split field samples every 20 samples.

Chapter 5: Suspended-sediment sample processing

PRINCIPLE:

Sediments act as both primary and secondary pollutants in the coastal environment. Sediments, especially fine sediments, can reduce water clarity and reduce the amount of light that is available for photosynthesis in coral reef ecosystems.

The suspended sediment concentration (SSC) method described here accounts for both terrestrial and marine-originated sediments. SSC in the coastal zone can also include suspended solids of biological origin.

The reason we are interested in suspended sediment as a variable is that we want to correlate the turbidity measurements we are doing with field instruments in real time with laboratory data.

MATERIALS AND EQUIPMENT:

- 500 mL filtration units
- 47 mm filters (GF/F)
- Drying oven at 70°C
- Analytical balance
- Filter forceps
- 47mm petri dishes
- Aluminum foil

PROCEDURE:

1. Collect the sample as described above for nutrient analysis. For suspended sediment, use a 500-mL or 1000-mL HDPE bottle.

2. After the sample is collected, store the sample on ice until the sample is either

    a. Shipped to S-LABS for analysis or

    b. Analyzed in a satellite lab on Maui.

    The procedure below describes the protocol for all laboratories.

Prepare the filters:

3. Pre-weigh a 47 mm GF/F filter using the analytical balance. Weigh each filter three times, and record each value. Store the filter in a dry place and use within one week. Humidity can affect the weight of the filters.

4. Place the pre-weighed filter in its own 47 mm petri dish or similar plastic container.

5. Write the average of the three values on the cover of the petri dish.

Filter the sample:

6. Use the filter forceps to place a pre-weighed 45um filter on the filter pad of the filtration unit.

7. Use a small drop of deionized water to wet the filter.

8. Secure the unit together by twisting the top on to the bottom of the unit.

9. Attach the vacuum tubing to the unit and turn on the vacuum. Listen or look for possible leaks.

10. Pour the entire bottle (~500mL) into the top portion of the rig. Use the vacuum pump to create suction.

    a. Measure the filtrate and record the exact amount filtered. Note that the filter itself with absorb some amount of water and this will be corrected in the final data analysis.

    b. If there is an additional 500 mL, empty the bottom part of the rig into the sink (this is waste) and use the same filter to filter the next 500 mL.

11. Turn off the vacuum and release the pressure slowly by opening one of the small valves.

12. Using forceps, collect the filter in an aluminum foil piece by folding it first in quarters. Write the sample number of the foil using the special pen that can go into the oven.

Dry the sample in the oven:

13. Store the aluminum foil package in a plastic container for filters and dry for 24 hours at 70°C.

Weigh the sample

14. Samples should be allowed to cool and stabilize after being removed from the oven.

15. Weigh the samples three times on an analytical balance, recording the value on the appropriate form or lab notebook.

16. For a single filter, wait an hour and record a new value. If the value disagrees more than 10% from the original weight, wait until the samples acclimate to the lab and stabilize in weight.

PROCEDURE NOTES

- Gloves are recommended to maintain the quality of the samples.

- If the vacuum is not suctioning correctly, check the various o-rings that are part of the filtration units.

QUALITY CONTROL PROCEDURES

- For each sample site, duplicates will be analyzed.
- Samples will be weighed three times before and after drying. An average of each will be used in the final calculation.
- Blanks will be run every 20 samples. Blanks that have readings above the resolution of the scale will be have readings discarded, and the QA officer and lab manager will be notified.

REFERENCES

Standard Methods for Examination of Water and Wastewater, 18th Edition, APHA.

Chapter 6: *Enterococcus* sample collection and measurement using the IDEXX Enterolert and Quanti-tray system

PRINCIPLE:

Importance of Bacteria
Enterococcus bacteria are generally not harmful by themselves but do indicate the possible presence of pathogenic (disease-causing) bacteria, viruses, and protozoans that also live in human and animal digestive systems. Elevated levels of these bacteria can cause health problems (including ear infections, stomach upset and urinary tract infections in women), cloudy water, unpleasant odors, and an increased oxygen demand (the amount of oxygen consumed by microorganisms in breaking down waste). The EPA recommends *Enterococcus* as an indicator of health risk from water contact in recreational waters.

MATERIALS:

- Sterile 100 mL sample bottle or whirlpack
- Cooler with blue ice
- Enterolert™ (Idexx) reagent snap-packs
- 90 mL sterile DI water blanks
- Quanti-Tray 51-well trays
- Quanti-Tray heat sealer

METHOD:

Collect a Bacteria Sample:

1. Label the bottle or Whirlpack with the site number, date, time and your name.

2. Remove the cap from the bottle just before sampling. Avoid touching the inside of the bottle or the cap. If you accidentally touch the inside of the bottle, please report it to the monitoring coordinator and write it on data sheet. Our sterile bottles sometimes contain a pellet of sodium thiosulfate. This is for tap water samples, not river water samples. It can be left inside. Its presence is not important.

3. Wade in and try not to disturb the bottom or collect water with bottom sediment. Stand facing the water, or collect while kneeling on a rock.

4. Hold the bottle near its base and immerse it into the vertical water column with the opening upward. Collect a water sample 8 to 12 inches beneath the surface or mid-way between the surface and the bottom if the stream reach is shallow.

5. Turn the bottle underwater into the current and away from you in an upstream direction.

6. Fill to the black line. Do not fill the bottle completely so that the sample can be shaken just before analysis. Recap the bottle carefully, remembering not to touch the inside.

7. If you are assigned a WhirlPak, be sure it is labeled and wear gloves.

8. Tear off the top seal on the perforated line. Pull the short White tabs to open the pak; tightly grab the yellow tabs and fill the pak with river water facing upstream, in the middle of the water column. It must be filled to the 4 oz line.

9. Holding the yellow tabs, spin the pak away from you to close the opening, pull tight and TWIST the yellow tabs tightly to seal the pak. Hold the pak upside down and squeeze gently, NO WATER should leak out.

10. Store the pak upright in the cooler to avoid leaking.

11. Indicate bacteria collected on your field data sheet with the time collected.

12. Place samples in the cooler with blue ice for transport to the local Maui lab.

Bacterial Sample Processing with Enterolert:

1. Turn on IDEXX Quantitray sealer. Allow about 10 minutes for it to warm-up. Sealer is ready when the green light is lit on the front of the sealer.

2. Check the incubator temperature and adjust if not 41°C ± 0.5°C

3. Wash hands with soap and water and don powder-free disposable gloves for protection.

4. Sterilize laboratory working surface with isopropyl alcohol.

5. Place unopened seawater sample bottles or cups with unopened WhirlPaks on work surface. Be sure each sample container is marked with the sample source location. (Samples must be no older than 6 hours and must have been stored on ice.)

6. Place unopened 100 mL sterile sample bottles on work surface and label each with the corresponding sample source location.

7. Remove the correct number of Enterolert media packets from refrigerator storage and place on the work surface.

8. Process each sample and corresponding laboratory data sheet separately.

9. Fit a new sterile pipette to the pipette gun. Open a seawater sample container and transfer 10 ml of sample water to the corresponding sterile 100 ml sample bottle to make a 1:10 dilution. (*If you must put the bottle cap down, place it open side down on the sterile work surface.*) Place the pipette on the work surface in case you have to make a second attempt with THIS sample.

10. Add 90 ml of distilled or deionized water to the sample bottle. (Fill to the 100 ml line.)

11. Take one Enterolert packet, tap it to settle contents, and snap it open away from you. (*Do not breathe any Enterolert dust.*) Add the contents to the sample bottle, being careful not to insert your fingers or the packet into the bottle.

12. Replace the bottle cap and gently swirl the bottle until the Enterolert dissolves. (*About one minute.*) Do not shake the bottle and make bubbles.

13. Mark a Quantitray with the following information. Use a marking pen to avoid puncturing the fragile Quantitray backing. (*If this step is performed in advance for all of the samples, be sure to match the sample with the proper Quantitray.*)

    - Sampler's name
    - Tester's name
    - Date
    - Time collected
    - Sample site
    - Time into incubator
    - Time out of incubator (Next day)

    Results next day:

    - Number of positive small wells
    - Number of positive large wells

    MPN * number from IDEXX MPN Table 10 x MPN

    * MPN = Most Probable Number of Colony Forming Units

14. After the Enterolert has dissolved, open the sample bottle. Pick up the appropriate Quantitray in one hand and gently bow it to form a gap between the cells and the backing. The backing tab may be used to assist this, but do not insert fingers into the Quantitray. (*If the backing rips, it will not seal.*) Gently pour the sample into the Quantitray. Gently tap the Quantitray to remove any bubbles.

15. Place the Quantitray on top of the sealer's orange rubber mat. Run the mat and Quantitray through the sealer with the small wells first.

16. If the Quantitray seals without damage, discard the pipette and the remaining seawater sample, and return to **step 9** for the next sample, if any.

17. Place the sealed Quantitray(s) in the 41°C ± 0.5°C incubator for 24 hours (28 hours maximum). At this point, the Quantitrays are biohazardous material.

Clean up:

18. Clean the work area and dispose of gloves, sample bottles, pipettes, and empty packets in regular trash. Turn off the Quantitray sealer. (Note: Pipettes can be autoclaved and reused.

19. Remove the Quantitrays from the incubator and read each one with an ultraviolet lamp. Mark each positive (blue) cell with a marking pen and record the number of small and large positive cells.

Read the data after 24-28 hours:

20. Read the results by placing a 6-W, 365 nm wavelength UV light within 5 in of the tray in a darkened environment. Blue fluourescence indicates the presence of enterococci.

21. Read the IDEXX MPN Table by going across to the right by the number of positive small cells and down by the number of positive large cells. Record this number as the MPN.

22. Multiply by 10 the MPN just entered (to account for the dilution). This is the real MPN because you diluted the sample during preparation. Record the date and time read.

23. Transfer all of the data from each Quantitray to the corresponding laboratory data sheet.

Clean up:

24. Place used Quantitrays in standard red biohazard bags for autoclaving and disposal.

25. Ensure that the work area is clean and the ultraviolet light is turned off.

PROCEDURE NOTES:

- Wearing gloves is mandatory to prevent sample contamination and for your safety for either container.
- Be sure that the UV light is facing away from your eyes and towards the tray.
- If the sample is inadvertently incubated over 28 hours with out observation, the following guidelines apply: Lack of fluorescence after 28 hours is a valid negative. Fluorescence after 28 hours is an invalid test result.

QUALITY ASSURANCE:

The following QC should be performed on each lot of Enterolert reagent. Organisms used for Enterolert QC:

- *Enterococcus faecalis* ATCC 29212
- *Enterococcus faecium* ATCC 35667

- *Serratia marcescens* ATCC 8100
- *Aerococcus viridans* ATCC 11563

Chapter 7: Shipping and Handling

Sample delivery to the laboratory:

All samples collected in the field should be put on ice in the cooler as soon as they are collected. These samples should be brought to the local laboratory as soon as all of the assigned sample sites have been tested for the day. If enterococcus samples have been collected, they must be brought to the local laboratory for testing as soon as possible. The total time between collection and testing of enterococcus should not exceed 6 hours. Samples collected for nutrient analysis should also be stored on ice as soon as they are collected and filtered. Nutrient samples will be frozen once they are brought to the local laboratory until they are shipped to the analysis laboratory. Samples collected for suspended sediment will be processed at the local laboratory and should also be kept on ice until brought to the local laboratory.

The regional team leader is responsible for shipping nutrient samples to the analysis laboratory. Samples will be shipped to the S-Lab within 14 days of collection to ensure they are received and analyzed within the specified holding times for each analyte. The team leader will include the shipping number on the chain of custody form when the samples are shipped. Samples will be shipped frozen with blue ice in coolers to preserve the samples for analysis.

Receipt and logging of sample:

In the laboratory, the sample custodian inspects the condition and seal of the sample and reconciles label information and seal against the chain of custody record before the sample is accepted for analysis. After acceptance, the custodian assigns a laboratory number, logs sample in the laboratory log book and stores it in a secured storage room or cabinet or refrigerator at the specified temperature until it is ready for analysis. Once the sample is in the laboratory, the supervisor or analyst is responsible for its care and custody.

Disposal: Hold samples for the prescribed amount of time for the project or until the data have been reviewed and accepted. Document the disposition of samples. Ensure that disposal is in accordance with local, state, and U.S. EPA approved methods.

Appendix B: Site list

Hui ID	Area	Location Name	DOH Storet No	Lat	Long
2001	Northwest Maui	Honolua	000707	21.013058	-156.638340
2002	Northwest Maui	Mokuleia	000721	21.011111	-156.642560
2003	Northwest Maui	Fleming North DT beach park	000674	21.005000	-156.650840
2004	Northwest Maui	Oneloa	000722	21.004056	-156.658940
2005	Northwest Maui	Fleming South Kapalua Bay	000650	20.998636	-156.666670
2006	Northwest Maui	Napili (south end)	000723	20.994222	-156.667417
2007	Northwest Maui	Napili (north end)		20.996580	-156.666140
2008	Northwest Maui	Ka'opala	000692	20.981967	-156.673080
2009	Northwest Maui	Pohaku 2		20.968376	-156.681003
2010	Northwest Maui	Pohaku	000724	20.967083	-156.681390
2022	Polanui	505 Front Street		20.867320	-156.676050
2023	Polanui	Lindsey Hale		20.864850	-156.673740
2024	Polanui	Lahaina Town	000726	20.863560	-156.672970
2025	Polanui	Makila Point		20.858840	-156.669330
2026	Olowalu to Pali	Olowalu surf break		20.823780	-156.631500
2027	Olowalu to Pali	Olowalu shore front	000663	20.809160	-156.622890
2028	Olowalu to Pali	Camp Olowalu		20.809860	-156.613690
2029	Olowalu to Pali	Mile Marker 14		20.809150	-156.606610
2030	Olowalu to Pali	Teen Challenge	000697	20.810050	-156.608900
2031	Olowalu to Pali	Ukumehame Bridge		20.799830	-156.592440

2032	Olowalu to Pali	Ukumehame Beach	000698	20.794480	-156.581420
2033	Olowalu to Pali	Papalaua	000728	20.793480	-156.574920
2034	Olowalu to Pali	Papalaua Pali		20.792690	-156.568720
2035	South Maui	Ahihi Kina'u		20.618450	-156.437480
2036	South Maui	Kalama Park	000679	20.731220	-156.453880
2037	South Maui	Kō'ie'ie Fishpond	000712	20.763870	-156.459080
2038	South Maui	Kihei Pier	000701	20.781150	-156.462830
2039	South Maui	Haycraft Park	000687	20.796570	-156.501730
2040	North Shore Maui	MECO		20.797023	-156.494285
2041	North Shore Maui	Kahului Harbor Canoe Hale		20.892119	-156.469484
2042	North Shore Maui	Kahului Harbor Pier1 and Pier 2		20.895767	-156.465103
2043	North Shore Maui	Kahului Harbor Pier 2 stream		20.894046	-156.467804
2044	North Shore Maui	Boat ramp		20.896339	-156.477878
2045	North Shore Maui	Kahului WWRF		20.897078	-156.456264
2046	North Shore Maui	Harbor lights DOH site	000706	20.891374	-156.473608
2047	North Shore Maui	DOH site 2	000654	20.891308	-156.471494
2048	North Shore Maui	Waihee Kalepa	000668	20.933892	-156.503223
2049	North Shore Maui	Waiehu Golf course		20.927878	-156.495496

2050	North Shore Maui	Waiehu stream	000667	20.918357	-156.491816
2051	North Shore Maui	Wailuku stream	000690	20.910498	-156.484707
2052	North Shore Maui	Kaa point		20.898254	-156.447280
2053	North Shore Maui	Papaula	000708	20.908397	-156.427644
2054	North Shore Maui	Sugar Cove		20.909365	-156.409301
2055	North Shore Maui	Wawau	000700	20.912710	-156.403140
2056	North Shore Maui	Kailua nui	000689	20.913837	-156.393691
2057	North Shore Maui	McGregor Point		20.777306	-156.522318
2058	North Shore Maui	Beach		20.785001	-156.516267
2059	North Kihei	Waterfront	000659	20.792030	-156.509604
2060	North Kihei	Kealia river mouth		20.795668	-156.488647
2061	North Kihei	Kealia		20.791179	-156.477859
2062	North Kihei	Sugar Beach		20.785885	-156.468678
2063	North Kihei	Waiohuli		20.782492	-156.464369
2064	Hana	Hana Bay Wharf		20.755772	-155.982094
2065	Hana	Helene Hall Cesspool Discharge		20.755292	-155.983369
2066	Hana	Pavilion		20.755339	-155.983733
2067	Hana	Ranch/Residential Runoff		20.756103	-155.984572

2068	Hana	Hana Kai Condo	20.759664	-155.986628
2069	Hana	Holoinawawae Stream	20.761517	-155.985908
2070	Hana	Hana Landfill Discharge	20.768078	-155.984278
2071	WM Ridge to Reef	Kaanapali Shores	20.949331	-156.691124
2072	Polanui	Launiupoko	20.842360	-156.653035
2073	Olowalu to Pali	Peter Martin Hale	20.808444	-156.619697
2074	Polanui	Puamana	20.859233	-156.669442
2075	North Maui, Surf	Pe'ahi shoreline	20.940953	-156.299172
2076	North Maui, Surf	K Bay	20.942239	-156.318086
2077	North Maui, Surf	Maliko Bay	20.936194	-156.339161
2078	North Maui, Surf	Hookipa Beach Park E	20.934069	-156.356622
2079	North Maui, Surf	Hookipa Beach Park W	20.933519	-156.357594
2080	North Maui, Surf	Mama’s Beach	20.929565,	-156.367104
2081	North Maui, Surf	Kuau Bay	20.922344	-156.374183
2082	North Maui, Surf	Paia Bay	20.915669	-156.385783
2083	North Maui, Surf	Baldwin Beach	20.913989	-156.393739
2084	North Maui, Surf	Baby Beach	20.912772	-156.402925
2086	North Maui,	Kanaha Beach	20.903278	-156.435917

	Surf			
2089	North Maui, Surf	Kahului Harbor	20.891192	-156.473478
2092	North Maui, Surf	Waihe'e Beach Park	20.932534	-156.498876

APPENDIX C: FORMS

BACTERIAL SAMPLING:

Team:	Samplers:	Date:	Start time:	Finish time:

Sample No	Location Name	Time Collected	Time Processed (into incubator)	Time Read (out of incubator)	# of positive small wells	# of positive large wells	MPN * #Idexx table	10* MPN	Comments	Grab sample?

Transport comments: Laboratory / Address where analyzed:

☐ Temperature of incubator (in) ☐ Temperature of incubator (out)

Date of media expiration:

FIELD EQUIPMENT VERIFICATION (PRE/POST A WEEKLY SAMPLING):

Session No:	Verifiers:	Pre date:	Pre time:	Post: Date:	Post time:

QA/QC Check	Inst #	Probe #	Last Cal Date	Verification Standard		PRE: Verification Value		POST: Verification Value		Acceptable Range (Check range)	Comments/ Notes	QA?
Temperature			n/a							± 1°C of NIST	Within 1°C	
			n/a									
			n/a									
Salinity										± 3%, blank	33.95 – 36.05	
Dissolved Oxygen				100%						Post-check ± 5 % of pre-check (0-100%)	80 – 120 %	
pH				7	10					± 3 % of calibration solution (6-8)	6.79 – 7.21	

Notes:

Sensor No: _____ Instrument No: _____

QA /QC Check	Last cal date	Time	Cal Standard	Cal Value
Turbidity, Stable Cal			20	
			100	
			800	
			20	
			100	
			800	
Salinity			0	
			35	
Dissolved Oxygen			100	
pH			4	
			7	
			10	

Sensor No: _____ Instrument No: _____

QA /QC Check	Last cal date	Time	Cal Standard	Cal Value
Turbidity, Stable Cal			20	
			100	
			800	
			20	
			100	
			800	
Salinity			0	
			35	
Dissolved Oxygen			100	
pH			4	
			7	
			10	

Sensor No: _____ Instrument No: _____

QA /QC Check	Last cal date	Time	Cal Standard	Cal Value
Turbidity, Stable Cal			20	
			100	
			800	
Temperature	n/a		n/a	
Salinity			0	
			35	
Dissolved Oxygen			100	
pH			4	
			7	
			10	

Sensor No: _____ Instrument No: _____

QA /QC Check	Last cal date	Time	Cal Standard	Cal Value
Turbidity, Stable Cal			20	
			100	
			800	
			20	
			100	
			800	
Salinity			0	
			35	
Dissolved Oxygen			100	
pH			4	
			7	
			10	

IN-SITU READINGS:

Team:	Samplers:	Instrument #	Probe #s	pH	DO	Salinity	Date:	Start time:	Finish time:
R2R		40d:	40d:						
		2100q	2100q						

Location Name	Time	Temp (C)	Sal (ppt)	DO (mg/L)	DO Saturation (%)	pH	Turbidity[1] (NTU)			Comments		
										Waves	Swimmers	Wind
Pohaku RPO												
Kaanapali Shores RKS												
Airport Beach RAB												
Canoe Beach RCB												
Wahikuli RWA												

Turbidity Verification									Comment
Pre:	**Blank:**		**Low: 0-10**		**Med: 10-100**		**High: 100-1000**		
Post:	**Blank:**		**0-10**		**10-100**		**100-1000**		

COASTAL AND ENVIRONMENTAL CONDITION NOTES

Most recent low tide (Lahiana station)

Moon: 2

Cloud Cover:

Wind conditions (general):

Rain Conditions (general):

WATER QUALITY SAMPLING:

Team:	Samplers:	Date:	Start time:	Finish time:

Sample No	Location Name	Time	Vol (mL)	Nutrient Bottle?	SSC ?	Quality control notes	Grab sample?
RPO161129-N-1	Pokahu		125	X		Washed, rinsed syringes; acid washed bottles; 0.7 um filters; washed rinsed filter holders	☐
RPO161129-S-1	Pokahu		500		X		☐
RKS161129-N-1	Kaanapali Sh		125	X		Washed, rinsed syringes; acid washed bottles; 0.7 um filters; washed rinsed filter holders	☐
RKS161129-N-2	Kaanapali Sh		125	X		Washed, rinsed syringes; acid washed bottles; 0.7 um filters; washed rinsed filter holders	☐
RKS161129-S-1	Kaanapali Sh		500		X		☐
RAB161129-N-1	Airport Beach		125	X		Washed, rinsed syringes; acid washed bottles; 0.7 um filters; washed rinsed filter holders	☐
RAB161129-S-1	Airport Beach		500		X		☐
RCB161129-N-1	Canoe Beach		125	X		Washed, rinsed syringes; acid washed bottles; 0.7 um filters; washed rinsed filter holders	☐
RCB161129-S-1	Canoe Beach		500		X		☐
RWA161129-N-1	Wahikuli		125	X		Washed, rinsed syringes; acid washed bottles; 0.7 um filters; washed rinsed filter holders	☐
RWA161129-S-1	Wahikuli		500		X		☐
							☐
							☐
							☐
							☐
							☐

CHAIN OF CUSTODY:

Teams:	Samplers:	Start Date:	Finish Date

	Sampler Initials	Sample No	Location Name	Vol (mL)	Nutrient Bottle?	Filtered?	SSC?	Quality control notes	Grab sample?
1									☐
2									☐
3									☐
4									☐
5									☐
6									☐
7									☐
8									☐
9									☐
10									☐
11									☐

	Relinquished by (Print):	Signature	Date and Time	Delivery Method (circle)
Maui Lab				Hand-over Car FedEx Other
Packager / Transport				Car Flight FedEx Other
Receiver				Hand-over Car FedEx Other

Transport comments:

Preparation/Analyses requested: ☐ Filtration ☐ Dissolved inorg nutrients ☐ Dissolved organic nutrients
☐ Suspended sediment concentration
☐ Other

Received by (Name, Facility): Date and Time Received: Date and Time Package Opened:

☐ Fully frozen
☐ Partially frozen
☐ Not frozen

☐ Improper sample container
☐ Seal broken (sample # _____)

APPENDIX D: QUALITY CONTROL INFORMATION TO BE EVALUATED DURING DATA QUALITY ASSESSMENT

The Hui o Ka Wai Ola QA officer will evaluate all laboratory reported QC information and non-conformances in accordance with this guidance. Non-conformances that are noted in the semi-annual and annual report. QC reviews conducted by the QA officer are documented for all datasets that are evaluated, and the evaluation is available to the HIDOH available on request.

The information below summarizes standard, required deliverables to obtain data. The QC information that is reviewed during the data quality assessment by the QA officer includes, but is not limited to the following:

Standard Deliverables

Field Report Inspection

Goal: Determine if all field worksheets are provided and complete for each sample:
Tasks: Review field data sheets

Laboratory Report Inspection

Goal: Determine if all laboratory deliverables are provided and complete:
Tasks:

- Review the laboratory report to determine that the following items are present for all sample batches:
  - Narrative identifying QC non-conformances;
  - Analytical results;
  - Chain of Custody Form; and,
  - Quality control results, including but not limited to:
    - Method Blanks;
    - Laboratory Control Samples (LCS);
    - Surrogates (as appropriate for method); and,
    - Other QC results and information provided in the laboratory report.

- Review the laboratory narrative to identify QC non-conformances:
  - Review the narrative for significant findings (i.e., QC non-conformances that could affect usability of the reported results) and request additional information from the laboratory, if applicable.

- Review the Chain of Custody Form for completeness and correctness:

  - Review Chain of Custody Form to ensure form is complete and correct;
  - Verify sample identification numbers and collection information;
  - Verify that there is an acceptance signature for each relinquished signature documenting the delivery of the samples to the laboratory facility. Check for errors in noted dates and times;
  - Contact the laboratory for help or clarification if needed.

Chain of Custody (COC) Evaluation

Goal: Evaluate the information presented on the Chain of Custody Form to determine if any QC issues or nonconformances are present.
Tasks:

- Determine whether Handling Time was met;
- Determine if samples appropriately preserved/refrigerated/iced; and,
- Determine if samples were received by the laboratory an appropriate temperature.

Sample Result Evaluation

Goal: Determine if sample results have been properly reported.
Tasks: Evaluate the sample results:

- Determine that reporting limits (RLs) were noted;
- Verify that concentrations greater than the RL were reported;
- Verify that concentration reported below the RLs are qualified
- Verify that results for aqueous samples are reported in mg/L;
- Check dilution factor to see if a dilution was performed and if so, the RL adjusted accordingly;;
- Determine that RLs are less than, or equal to the regulatory criteria; and,
- Determine if sample results are provided for the each requested analysis

Sample Preservation and Holding Times Evaluation

Goal: Determine if samples were preserved properly and analyzed within holding times.
Tasks:

- Review the chain of custody and or narrative to determine if the samples were preserved in accordance with the requirement of the QAPP.

- Review the narrative to determine if the holding time specified in the QAPP was met.

Method, Field or Trip Blank Evaluation

Goal: Determine the existence and magnitude of contamination resulting from laboratory or field activities.
Task: Review all blank data and narratives for possible contamination.

Field Duplicates and Laboratory Duplicates

Goal: Evaluate Precision
Task: Review all duplicate sample information.

Laboratory Control Samples Evaluation

Goal: Evaluate accuracy of laboratory method.
Task: Review the narrative to determine if nonconformances were noted in the laboratory narrative.

Common Data Qualifiers

Inorganics:

- P The data is provisional and has not yet been quality controlled
- A The data is accepted, with or without qualifiers
- H The sample exceeded holding times
- Q QC analyses are outside control limits. This includes sample receipt issues, sample containers or sample preservation. An explanatory note should be included in a comments section.
- B There was a nonconformance with the field or lab blanks for a group of samples. The analyte is found in the associated method blank.
- D The reported value is from a dilution greater than 1.
- U1 The result was less than the MDL.
- U2 The sample exceeded the calibration range.

Bacterial:

- MB1 Too numerous to count
- MB2 Target organism not detected in method blank
- T1 Sample incubation time exceeded the method requirement
- T2 Sample incubation time was shorter than the method requirement

This list was adapted from the Arizona Department of Health Services and the USEPA Contract Laboratory Program Statement of Work for Inorganic Superfund Methods

APPENDIX E

GLOSSARY OF QUALITY ASSURANCE AND RELATED TERMS

Acceptance criteria — Specified limits placed on characteristics of an item, process, or service defined in requirements documents. (ASQC Definitions)

Accuracy — A measure of the closeness of an individual measurement or the average of a number of measurements to the true value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations; the EPA recommends using the terms *"precision"* and *"bias"*, rather than "accuracy," to convey the information usually associated with accuracy. Refer to *Appendix D, Data Quality Indicators* for a more detailed definition.

Activity — An all-inclusive term describing a specific set of operations of related tasks to be performed, either serially or in parallel (e.g., research and development, field sampling, analytical operations, equipment fabrication), that, in total, result in a product or service.

Assessment — The evaluation process used to measure the performance or effectiveness of a system and its elements. As used here, assessment is an all-inclusive term used to denote any of the following: audit, performance evaluation (PE), management systems review (MSR), peer review, inspection, or surveillance.

Audit (quality) — A systematic and independent examination to determine whether quality activities and related results comply with planned arrangements and whether these arrangements are implemented effectively and are suitable to achieve objectives.

Audit of Data Quality (ADQ) — A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality.

Authenticate — The act of establishing an item as genuine, valid, or authoritative.

Bias — The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value). Refer to *Appendix D, Data Quality Indicators*, for a more detailed definition.

Blank — A sample subjected to the usual analytical or measurement process to establish a zero baseline or background value. Sometimes used to adjust or correct routine analytical results. A sample that is intended to contain none of the analytes of interest. A blank is used to detect contamination during sample handling preparation and/or analysis.

Calibration — A comparison of a measurement standard, instrument, or item with a standard or instrument of higher accuracy to detect and quantify inaccuracies and to report or eliminate those inaccuracies by adjustments.

Calibration drift — The deviation in instrument response from a reference value over a period of time before recalibration.verify, and recognize the competence of a person, organization, or other entity to perform a function or service, usually for a specified time.

Chain of custody — An unbroken trail of accountability that ensures the physical security of samples, data, and records.

Characteristic — Any property or attribute of a datum, item, process, or service that is distinct,

describable, and/or measurable.

Check standard — A standard prepared independently of the calibration standards and analyzed exactly like the samples. Check standard results are used to estimate analytical precision and to indicate the presence of bias due to the calibration of the analytical system.

Collocated samples — Two or more portions collected at the same point in time and space so as to be considered identical. These samples are also known as field replicates and should be identified as such.
Comparability — A measure of the confidence with which one data set or method can be compared to another.

Completeness — A measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct, normal conditions. Refer to *Appendix D, Data Quality Indicators,* for a more detailed definition.

Confidence Interval — The numerical interval constructed around a point estimate of a population parameter, combined with a probability statement (the confidence coefficient) linking it to the population's true parameter value. If the same confidence interval construction technique and assumptions are used to calculate future intervals, they will include the unknown population parameter with the same specified probability.

Confidentiality procedure — A procedure used to protect confidential business information (including proprietary data and personnel records) from unauthorized access.

Configuration — The functional, physical, and procedural characteristics of an item, experiment, or document.

Conformance — An affirmative indication or judgment that a product or service has met the requirements of the relevant specification, contract, or regulation; also, the state of meeting the requirements.

Consensus standard — A standard established by a group representing a cross section of a particular industry or trade, or a part thereof.

Contractor — Any organization or individual contracting to furnish services or items or to perform work.

Corrective action — Any measures taken to rectify conditions adverse to quality and, where possible, to preclude their recurrence.

Data Quality Assessment (DQA) — The scientific and statistical evaluation of data to determine if data obtained from environmental operations are of the right type, quality, and quantity to support their intended use. The five steps of the DQA Process include: 1) reviewing the DQOs and sampling design, 2) conducting a preliminary data review, 3) selecting the statistical test, 4) verifying the assumptions of the statistical test, and 5) drawing conclusions from the data.

Data Quality Indicators (DQIs) — The quantitative statistics and qualitative descriptors that are used to interpret the degree of acceptability or utility of data to the user. The principal data quality indicators are bias, precision, accuracy (bias is preferred), comparability, completeness, representativeness.

Data Quality Objectives (DQOs) — The qualitative and quantitative statements derived from the DQO Process that clarify study's technical and quality objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions.

Data Quality Objectives (DQO) Process — A systematic strategic planning tool based on the scientific method that identifies and defines the type, quality, and quantity of data needed to satisfy a specified use. DQOs are the qualitative and quantitative outputs from the DQO Process.

Data reduction — The process of transforming the number of data items by arithmetic or statistical calculations, standard curves, and concentration factors, and collating them into a more useful form. Data reduction is irreversible and generally results in a reduced data set and an associated loss of detail.

Data usability — The process of ensuring or determining whether the quality of the data produced meets the intended use of the data.

Deficiency — An unauthorized deviation from acceptable procedures or practices, or a defect in an item.

Demonstrated capability — The capability to meet a procurement's technical and quality specifications through evidence presented by the supplier to substantiate its claims and in a manner defined by the customer.

Design — The specifications, drawings, design criteria, and performance requirements. Also, the resultof deliberate planning, analysis, mathematical manipulations, and design processes.

Design change — Any revision or alteration of the technical requirements defined by approved and issued design output documents and approved and issued changes thereto.

Design review — A documented evaluation by a team, including personnel such as the responsible designers, the client for whom the work or product is being designed, and a quality assurance (QA) representative but excluding the original designers, to determine if a proposed design will meet the established design criteria and perform as expected when implemented.

Detection Limit (DL) — A measure of the capability of an analytical method to distinguish samples that do not contain a specific analyte from samples that contain low concentrations of the analyte; the lowest concentration or amount of the target analyte that can be determined to be different from zero by a single measurement at a stated level of probability. DLs are analyte- and matrix-specific and may be laboratory-dependent.

Distribution — 1) The appointment of an environmental contaminant at a point over time, over an area, or within a volume; 2) a probability function (density function, mass function, or distribution function) used to describe a set of observations (statistical sample) or a population from which the observations are generated.

Document control — The policies and procedures used by an organization to ensure that its documents and their revisions are proposed, reviewed, approved for release, inventoried, distributed, archived, stored, and retrieved in accordance with the organization's requirements.

Duplicate samples — Two samples taken from and representative of the same population and carried through all steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variance of the total method, including sampling and analysis. See also *collocated sample*.

Environmental conditions — The description of a physical medium (e.g., air, water, soil, sediment) or a biological system expressed in terms of its physical, chemical, radiological, or biological characteristics.

Environmental data — Any parameters or pieces of information collected or produced from measurements, analyses, or models of environmental processes, conditions, and effects of pollutants on human health and the ecology, including results from laboratory analyses or from experimental systems representing such processes and conditions.

Environmental data operations — Any work performed to obtain, use, or report information pertaining to environmental processes and conditions.

Environmental monitoring — The process of measuring or collecting environmental data.

Environmental processes — Any manufactured or natural processes that produce discharges to, or that impact, the ambient environment.

Environmental programs — An all-inclusive term pertaining to any work or activities involving the environment, including but not limited to: characterization of environmental processes and conditions; environmental monitoring; environmental research and development; the design, construction, and operation of environmental technologies; and laboratory operations on environmental samples.

Environmental technology — An all-inclusive term used to describe pollution control devices and systems, waste treatment processes and storage facilities, and site remediation technologies and their components that may be utilized to remove pollutants or contaminants from, or to prevent them from entering, the environment. Examples include wet scrubbers (air), soil washing (soil), granulated activated carbon unit (water), and filtration (air, water). Usually, this term applies to hardware-based systems; however, it can also apply to methods or techniques used for pollution prevention, pollutant reduction, or containment of contamination to prevent further movement of the contaminants, such as capping, solidification or vitrification, and biological treatment.

Estimate — A characteristic from the sample from which inferences on parameters can be made.

Evidentiary records — Any records identified as part of litigation and subject to restricted access, custody, use, and disposal.

Expedited change — An abbreviated method of revising a document at the work location where the document is used when the normal change process would cause unnecessary or intolerable delay in the work.

Field blank — A blank used to provide information about contaminants that may be introduced during sample collection, storage, and transport. A clean sample, carried to the sampling site, exposed to sampling conditions, returned to the laboratory, and treated as an environmental sample.

Field (matrix) spike — A sample prepared at the sampling point (i.e., in the field) by adding a known mass of the target analyte to a specified amount of the sample. Field matrix spikes are used, for example, to determine the effect of the sample preservation, shipment, storage, and preparation on analyte recovery efficiency (the analytical bias).

Field split samples — Two or more representative portions taken from the same sample and submitted for analysis to different laboratories to estimate interlaboratory precision.

Financial assistance — The process by which funds are provided by one organization (usually governmental) to another organization for the purpose of performing work or furnishing services or items. Financial assistance mechanisms include grants, cooperative agreements, and governmental interagency agreements.

Finding — An assessment conclusion that identifies a condition having a significant effect on an item or activity. An assessment finding may be positive or negative, and is normally accompanied by specific examples of the observed condition.

Goodness-of-fit test — The application of the chi square distribution in comparing the frequency distribution of a statistic observed in a sample with the expected frequency distribution based on some theoretical model.

Grade — The category or rank given to entities having the same functional use but different requirements for quality.

Graded approach — The process of basing the level of application of managerial controls applied to an item or work according to the intended use of the results and the degree of confidence needed in the quality of the results. (See also *Data Quality Objectives (DQO) Process*.)

Guidance — A suggested practice that is not mandatory, intended as an aid or example in complying with a standard or requirement.

Guideline — A suggested practice that is not mandatory in programs intended to comply with a standard.
Hazardous waste — Any waste material that satisfies the definition of hazardous waste given in 40 CFR 261, "Identification and Listing of Hazardous Waste."

Holding time — The period of time a sample may be stored prior to its required analysis. While exceeding the holding time does not necessarily negate the veracity of analytical results, it causes the qualifying or "flagging" of any data not meeting all of the specified acceptance criteria.

Identification error — The misidentification of an analyte. In this error type, the contaminant of concern is unidentified and the measured concentration is incorrectly assigned to another contaminant.
Independent assessment — An assessment performed by a qualified individual, group, or organization that is not a part of the organization directly performing and accountable for the work being assessed.
Inspection — The examination or measurement of an item or activity to verify conformance to specific requirements.

Internal standard — A standard added to a test portion of a sample in a known amount and carried through the entire determination procedure as a reference for calibrating and controlling the precision and bias of the applied analytical method.

Laboratory split samples — Two or more representative portions taken from the same sample and analyzed by different laboratories to estimate the interlaboratory precision or variability and the data comparability.

Limit of quantitation — The minimum concentration of an analyte or category of analytes in a specific matrix that can be identified and quantified above the method detection limit and within specified limits of precision and bias during routine analytical operating conditions.

Management — Those individuals directly responsible and accountable for planning, implementing, and assessing work.

Management system — A structured, nontechnical system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for conducting work and producing items and services.

Management Systems Review (MSR) — The qualitative assessment of a data collection operation and/or organization(s) to establish whether the prevailing quality management structure, policies, practices, and procedures are adequate for ensuring that the type and quality of data needed are obtained.
Matrix spike — A sample prepared by adding a known mass of a target analyte to a specified amount of matrix sample for which an independent estimate of the target analyte concentration is available. Spiked samples are used, for example, to determine the effect of the matrix on a method's recovery efficiency.
Mean (arithmetic) — The sum of all the values of a set of measurements divided by the number of values in the set; a measure of central tendency.

Mean squared error — A statistical term for variance added to the square of the bias.

Measurement and Testing Equipment (M&TE) — Tools, gauges, instruments, sampling devices, or systems used to calibrate, measure, test, or inspect in order to control or acquire data to verify conformance to specified requirements.

Memory effects error — The effect that a relatively high concentration sample has on the measurement of a lower concentration sample of the same analyte when the higher concentration sample precedes the lower concentration sample in the same analytical instrument.

Method — A body of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, quantification), systematically presented in the order in which they are to be executed.

Method blank — A blank prepared to represent the sample matrix as closely as possible and analyzed exactly like the calibration standards, samples, and quality control (QC) samples. Results of method blanks provide an estimate of the within-batch variability of the blank response and an indication of bias introduced by the analytical procedure.

Mid-range check — A standard used to establish whether the middle of a measurement method's calibrated range is still within specifications.

Mixed waste — A hazardous waste material as defined by 40 CFR 261 Resource Conservation and Recovery Act (RCRA) and mixed with radioactive waste subject to the requirements of the Atomic Energy Act.

Must — When used in a sentence, a term denoting a requirement that has to be met.

Nonconformance — A deficiency in a characteristic, documentation, or procedure that renders the quality of an item or activity unacceptable or indeterminate; nonfulfillment of a specified requirement.

Objective evidence — Any documented statement of fact, other information, or record, either quantitative or qualitative, pertaining to the quality of an item or activity, based on observations, measurements, or tests that can be verified.

Observation — An assessment conclusion that identifies a condition (either positive or negative) that does not represent a significant impact on an item or activity. An observation may identify a condition that has not yet caused a degradation of quality.

Organization — A company, corporation, firm, enterprise, or institution, or part thereof, whether incorporated or not, public or private, that has its own functions and administration. **Organization structure** — The responsibilities, authorities, and relationships, arranged in a pattern, through which an organization performs its functions.

Outlier — An extreme observation that is shown to have a low probability of belonging to a specified data population.

Parameter — A quantity, usually unknown, such as a mean or a standard deviation characterizing a population. Commonly misused for "variable," "characteristic," or "property."

Peer review — A documented critical review of work generally beyond the state of the art or characterized by the existence of potential uncertainty. Conducted by qualified individuals (or an organization) who are independent of those who performed the work but collectively equivalent in technical expertise (i.e., peers) to those who performed the original work. Peer reviews are conducted to ensure that activities are technically adequate, competently performed, properly documented, and satisfy established technical and quality requirements. An in-depth assessment of the assumptions, calculations, extrapolations, alternate interpretations, methodology, acceptance criteria, and conclusions pertaining to specific work and of the documentation that supports them. Peer reviews provide an evaluation of a subject where quantitative methods of analysis or measures of success are unavailable or undefined, such as in research and development.

Performance Evaluation (PE) — A type of audit in which the quantitative data generated in a measurement system are obtained independently and compared with routinely obtained data to evaluate the proficiency of an analyst or laboratory.

Pollution prevention — An organized, comprehensive effort to systematically reduce or eliminate pollutants or contaminants prior to their generation or their release or discharge into the environment.

Precision — A measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions expressed generally in terms of the standard deviation. Refer to *Appendix D, Data Quality Indicators,* for a more detailed definition.

Procedure — A specified way to perform an activity.

Process — A set of interrelated resources and activities that transforms inputs into outputs. Examples of processes include analysis, design, data collection, operation, fabrication, and calculation.

Project — An organized set of activities within a program.

Qualified data — Any data that have been modified or adjusted as part of statistical or mathematical evaluation, data validation, or data verification operations.

Qualified services — An indication that suppliers providing services have been evaluated and determined to meet the technical and quality requirements of the client as provided by approved procurement documents and demonstrated by the supplier to the client's satisfaction.

Quality — The totality of features and characteristics of a product or service that bears on its ability to meet the stated or implied needs and expectations of the user.

Quality Assurance (QA) — An integrated system of management activities involving planning, implementation, assessment, reporting, and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client.

Quality Assurance Program Description/Plan — See *quality management plan*.

Quality Assurance Project Plan (QAPP) — A formal document describing in comprehensive detail the necessary quality assurance (QA), quality control (QC), and other technical activities that must be implemented to ensure that the results of the work performed will satisfy the stated performance criteria. The QAPP components are divided into four classes: 1) Project Management, 2) Measurement/Data Acquisition, 3) Assessment/Oversight, and 4) Data Validation and Usability. Requirements for preparing QAPPs can be found in EPA QA/R-5.

Quality Control (QC) — The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality. The system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against "out of control" conditions and ensuring the results are of acceptable quality.

Quality control (QC) sample — An uncontaminated sample matrix spiked with known amounts of analytes from a source independent of the calibration standards. Generally used to establish intra laboratory or analyst-specific precision and bias or to assess the performance of all or a portion of the measurement system.

Quality improvement — A management program for improving the quality of operations. Such management programs generally entail a formal mechanism for encouraging worker recommendations with timely management evaluation and feedback or implementation.

Quality management — That aspect of the overall management system of the organization that determines and implements the quality policy. Quality management includes strategic planning, allocation of resources, and other systematic activities (e.g., planning, implementation, and assessment) pertaining to the quality system.

Quality Management Plan (QMP) — A formal document that describes the quality system in terms of the organization's structure, the functional responsibilities of management and staff, the lines of authority, and the required interfaces for those planning, implementing, and assessing all activities conducted.

Quality system — A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required quality assurance (QA) and quality control (QC).

Radioactive waste — Waste material containing, or contaminated by, radionuclides, subject to the requirements of the Atomic Energy Act.

Readiness review — A systematic, documented review of the readiness for the start-up or continued use of a facility, process, or activity. Readiness reviews are typically conducted before proceeding beyond project milestones and prior to initiation of a major phase of work.

Record (quality) — A document that furnishes objective evidence of the quality of items or activities and that has been verified and authenticated as technically complete and correct. Records may include photographs, drawings, magnetic tape, and other data recording media.

Recovery — The act of determining whether or not the methodology measures all of the analyte contained in a sample. Refer to *Appendix D, Data Quality Indicators,* for a more detailed definition.
Remediation — The process of reducing the concentration of a contaminant (or contaminants) in air, water, or soil media to a level that poses an acceptable risk to human health.

Repeatability — The degree of agreement between independent test results produced by the same analyst, using the same test method and equipment on random aliquots of the same sample within a short time period.

Reporting limit — The lowest concentration or amount of the target analyte required to be reported from a data collection project. Reporting limits are generally greater than detection limits and are usually not associated with a probability level.

Representativeness — A measure of the degree to which data accurately and precisely represent a characteristic of a population, a parameter variation at a sampling point, a process condition, or an environmental condition. See also *Appendix D, Data Quality Indicators.*

Reproducibility — The precision, usually expressed as variance, that measures the variability among the results of measurements of the same sample at different laboratories.

Requirement — A formal statement of a need and the expected manner in which it is to be met.
Research (applied) — A process, the objective of which is to gain the knowledge or understanding necessary for determining the means by which a recognized and specific need may be met.

Research (basic) — A process, the objective of which is to gain fuller knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications toward processes or products in mind.

Research development/demonstration — The systematic use of the knowledge and understanding gained from research and directed toward the production of useful materials, devices, systems, or methods, including prototypes and processes.

Round-robin study — A method validation study involving a predetermined number of laboratories or analysts, all analyzing the same sample(s) by the same method. In a round-robin study, all results are compared and used to develop summary statistics such as interlaboratory precision and method bias or recovery efficiency.

Ruggedness study — The carefully ordered testing of an analytical method while making slight variations in test conditions (as might be expected in routine use) to determine how such variations affect test results. If a variation affects the results significantly, the method restrictions are tightened to minimize this variability.

Scientific method — The principles and processes regarded as necessary for scientific investigation, including rules for concept or hypothesis formulation, conduct of experiments, and validation of hypotheses by analysis of observations.

Self-assessment — The assessments of work conducted by individuals, groups, or organizations directly responsible for overseeing and/or performing the work.

Sensitivity — the capability of a method or instrument to discriminate between measurement responses representing different levels of a variable of interest. Refer to *Appendix D, Data Quality Indicators,* for a more detailed definition.

Service — The result generated by activities at the interface between the supplier and the customer, and the supplier internal activities to meet customer needs. Such activities in environmental programs include design, inspection, laboratory and/or field analysis, repair, and installation.

Shall — A term denoting a requirement that is mandatory whenever the criterion for conformance with the specification permits no deviation. This term does not prohibit the use of alternative approaches or methods for implementing the specification so long as the requirement is fulfilled.

Significant condition — Any state, status, incident, or situation of an environmental process or condition, or environmental technology in which the work being performed will be adversely affected sufficiently to require corrective action to satisfy quality objectives or specifications and safety requirements.

Software life cycle — The period of time that starts when a software product is conceived and ends when the software product is no longer available for routine use. The software life cycle typically includes a requirement phase, a design phase, an implementation phase, a test phase, an installation and check-out phase, an operation and maintenance phase, and sometimes a retirement phase.

Source reduction — Any practice that reduces the quantity of hazardous substances, contaminants, or pollutants.

Span check — A standard used to establish that a measurement method is not deviating from its calibrated range.

Specification — A document stating requirements and referring to or including drawings or other relevant documents. Specifications should indicate the means and criteria for determining conformance.

Spike — A substance that is added to an environmental sample to increase the concentration of target analytes by known amounts; used to assess measurement accuracy (spike recovery). Spike duplicates are used to assess measurement precision.

Split samples — Two or more representative portions taken from one sample in the field or in the laboratory and analyzed by different analysts or laboratories. Split samples are quality control (QC) samples that are used to assess analytical variability and comparability.

Standard deviation — A measure of the dispersion or imprecision of a sample or population distribution expressed as the positive square root of the variance and has the same unit of measurement as the mean.

Standard Operating Procedure (SOP) — A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps and that is officially approved as the method for performing certain routine or repetitive tasks.

Supplier — Any individual or organization furnishing items or services or performing work according to a procurement document or a financial assistance agreement. An all-inclusive term used in place of any of the following: vendor, seller, contractor, subcontractor, fabricator, or consultant.

Surrogate spike or analyte — A pure substance with properties that mimic the analyte of interest. It is unlikely to be found in environmental samples and is added to them to establish that the analytical meyhod has been performed properly.

Surveillance (quality) — Continual or frequent monitoring and verification of the status of an entity and the analysis of records to ensure that specified requirements are being fulfilled.

Technical review — A documented critical review of work that has been performed within the state of the art. The review is accomplished by one or more qualified reviewers who are independent of those who performed the work but are collectively equivalent in technical expertise to those who performed the original work. The review is an in-depth analysis and evaluation of documents, activities, material, data, or items that require technical verification or validation for applicability, correctness, adequacy, completeness, and assurance that established requirements have been satisfied.

Technical Systems Audit (TSA) — A thorough, systematic, on-site qualitative audit of facilities, equipment, personnel, training, procedures, record keeping, data validation, data management, and reporting aspects of a system.

Traceability — The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical constants or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project.

Trip blank — A clean sample of a matrix that is taken to the sampling site and transported to the laboratory for analysis without having been exposed to sampling procedures.

Validation — Confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use have been fulfilled. In design and development, validation concerns the process of examining a product or result to determine conformance to user needs. See also *Appendix G, Data Management.*

Variance (statistical) — A measure or dispersion of a sample or population distribution.

Verification — Confirmation by examination and provision of objective evidence that specified requirements have been fulfilled. In design and development, verification concerns the process of examining a result of a given activity to determine conformance to the stated requirements for that activity.

SOEST Lab for Analytical Biogeochemistry

Quality Assurance Project Plan

October 1, 2016

1. Introduction

Do you have a normal introduction to the history of the lab?

2. Project Management

The laboratory is managed under the guidance of the University of Hawaii at Manoa, School of Ocean and Earth Sciences. The lab is staffed by a lab manager and a minimum of one technician.

Data is stored in multiple spreadsheets that are backed up to the cloud.

3. Measurement and Data Acquisition

The S-LAB at the University of Hawai'i Mānoa analyses samples for dissolved nutrient and silicate analyses, and particulate analyses for nitrogen and carbon. Results from an annual demostrations of proficiency in the comparison of unknown samples provided by a commercially available, nationally accredited proficiency testing provider are available attached to this report.

3.1. Analytical methods

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. The EPA methods used are presented in Table 1.

Table 1: Analytical methods used in water quality analysis.

Parameter	Method number or description	Method/instrument	Units
NH_4	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

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

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 digester. In this digestion step organically bound phosphorus is released. Second, acid persulfate is added, which further promotes breakdown of organic 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).

4. QA/QC Requirements

4.1. Instruments and equipment

Instrument maintenance. S-LAB prepares and follows a maintenance schedule for each instrument used to analyze samples collected from the watershed areas. All instruments are serviced at scheduled intervals necessary to optimize factory specifications. Routine preventive maintenance and major repairs are 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 includes 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 are inspected before each use to ensure cleanliness.

Analytical balances. Analytical balances are 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 checks 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. Bottles are rinsed three times and dried prior to their reuse in sampling.

Inspection for supplies and consumables. Once per year, an inventory of all consumables is 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 are documented in the laboratory notebook for QA review, if necessary.

4.2. Laboratory Analyses

The S-LAB has a formal quality control program that includes blanks, known standards, duplicates and range checks. Each sample run includes a blank and mid-level calibration duplicates every 10-15 samples. Values that are out of range, as presented in Table 1, are corrected on site before the sample results are finalized. Results of the blanks and mid-level calibration duplicates are noted in the lab report when sample results are reported. In addition, the % recovery (RPD) of the mid standards is calculated for each run.

During each run, the lab also tests 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.

4.3. Assessment and Oversight

The S-LAB analysis program is externally evaluated annually for proficiency by ERA. Parameters that are evaluated include salinity, pH, inorganic nutrients and organic nutrients. The results of the most recent proficiency test are always available upon request.

Table 2: 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%

5. Data Quality Assessment

5.1. Reconciliation with data quality assurance objectives

As soon as possible after each lab run, calculations are 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.

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 are detailed in both interim and final reports, and other documentation as needed.

ERA
A Waters Company

Final Report Results For Laboratory SOEST Laboratories for Analyti

ERA
A Waters Company

2009 TNI Evaluation Report

Study: **WP-260**

ERA Customer Number: **S953278**

Laboratory Name: **SOEST Laboratories for Analyti**

Inorganic Results

WP-260 2009 TNI Evaluation Final Complete Report

A Waters Company

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EPA ID: Not Reported
ERA Customer Number: S953278
Report Issued: 10/31/16
Study Dates: 09/12/16 - 10/27/16

TNI Analyte Code	Analyte	Units	Reported Value	Assigned Value	Acceptance Limits	Performance Evaluation	Method Description	Analysis Date	Z Score	Study Mean	Study Standard Deviation	Analyst Name
WP pH (cat# 577, lot# P260-977)												
1900	pH	S.U.	7.41	7.44	7.24 - 7.64	Acceptable	EPA-842-B-06-003 pH Metrohm titrando	10/27/2016	-0.874	7.46	0.0554	
WP Simple Nutrients (cat# 584, lot# P260-505)												
1515	Ammonia as N	mg/L	6.197	6.17	4.83 - 7.53	Acceptable	SEAL ANALYTICAL: G-171-96 (MT19) 14	10/26/2016	0.0673	6.17	0.445	
1820	Nitrate + Nitrite as N	mg/L	4.823	4.75	3.88 - 5.57	Acceptable	SEAL ANALYTICAL: G-172-96 (MT19) 15	10/26/2016	0.0865	4.80	0.221	
1810	Nitrate as N	mg/L		4.75	3.82 - 5.65	Not Reported				4.80	0.262	
1870	ortho-Phosphate as P	mg/L	2.533	2.73	2.32 - 3.14	Acceptable	SEAL ANALYTICAL: G-297-03 (MT19) 3	10/26/2016	-1.36	2.72	0.134	
WP Complex Nutrients (cat# 579, lot# P260-525)												
1795	Total Kjeldahl Nitrogen	mg/L	14.519	13.8	10.2 - 17.0	Acceptable	SEAL ANALYTICAL: G-218-98 (MT23) 10	10/24/2016	0.880	13.6	0.989	
1910	Total phosphorus as P	mg/L	2.83	2.81	2.30 - 3.30	Acceptable	SEAL ANALYTICAL: G-219-98 (MT23) 11	10/25/2016	-0.276	2.87	0.161	
WP Turbidity (cat# 893, lot# P260-777)												
2055	Turbidity	NTU	5.45	5.06	3.85 - 6.24	Acceptable	EPA 180.1 2 1993	10/27/2016	0.290	5.31	0.476	

CERTIFICATE OF EXCELLENCE

In recognition of the quality of your laboratory in proficiency testing for

WP-260

SOEST Laboratories for Analyti

is issued this certificate of achievement by ERA. This laboratory has been recognized as a Laboratory of Excellence for achieving 100% acceptable data in this study which included 548 participating laboratories. This achievement is a demonstration of the superior quality of the laboratory in evaluation of the standards listed below.

Complex Nutrients

pH

Simple Nutrients

Turbidity

Patrick Larson
Quality Officer

S953278