Aiea Stream Water Quality Monitoring and Assessment Plan

Executive Summary

The right bank of Aiea Stream just below the Moanalua Freeway is experiencing erosion that threatens adjacent buildings and is to be stabilized using a combination of concrete grout, reinforcement, and rock rip-rap. The stream only flows during rainfall events and is typically dry at the construction site. Standard erosion control BMPs will be augmented by two temporary 36-inch pipes installed in the stream bed to transmit any water from intermittent stream flow events past the project areas disturbed by construction.. Construction will be scheduled to occur during the dry season (June-August) and is anticipated to be completed within 140 working days.

Environmental monitoring of the site will consist of photographic documentation, water quality sampling during flow events, and post-construction physical measurement of any stream erosion downstream of the site. Photographic documentation and water quality sampling will be conducted weekly for up to 10 weeks prior to construction, three times per week during construction, and weekly for up to 2 weeks post construction to include up to 3 stream flow events. The intent of the pre- and post-construction water quality monitoring is to visit the site during up to three rainfall events so that control (upstream) and project impacted (downstream) samples can be collected for comparison purposes. The water quality parameters most likely to be impacted by construction and to be measured include total suspended solids, turbidity, temperature and pH. All field activities will be documented in Field Reports. Field Reports that include water quality samples or that describe potential problems with BMPs will result in the development of an Event Report. Event Reports are forwarded to the DOH and document any problems noted, and steps taken by the contractor to remediate these issues. Downstream erosion monitoring using standard survey techniques will be conducted for up to 2-years in the reach below the construction site.

Aiea Stream Water Quality Monitoring and Assessment Plan

1. Introduction

1.1. Purpose for Monitoring

The goal of the Clean Water Act (CWA) is to minimize pollution of waters of the United States from all types of discharges. Section 401 of the CWA (33 USC 1341) creates a process for states to verify that federally permitted activities or projects will conform to the state's water quality standards. As part of this process, the federal permit applicant generally demonstrates that the potential for pollutant discharge associated with the activity will be avoided and/or minimized through the development and implementation of a Best Management Practice (BMP) plan. Additionally, a water quality monitoring plan is developed as a tool to monitor BMP effectiveness and to verify that any discharges resulting from project activities comply with effluent limitations and water quality standards. This plan serves as the Applicable Monitoring and Assessment Plan (AMAP) for the Aiea Stream Project (project) and has been developed to meet these objectives and to consider the potential long term project impacts. It includes a detailed quality assurance quality control plan and is supported by a discussion of the data quality objectives.

The purpose of this project is to stabilize and reinforce a portion of Aiea Stream's north bank, which is experiencing down-cutting and erosion. The project would utilize a texturized shotcrete facing and soil nailing construction methods to stabilize the bank. During construction the stream water quality could potentially be impacted by soil erosion, the inflow of concrete, concrete wash-water, or oil and grease from construction equipment. This program seeks to monitor the implementation and efficacy of the construction project BMPs in preventing these pollutants from entering the stream, and to document any pollutant events should they occur. In achieving these objectives, water quality monitoring will consist of three phases that are generally distinguished by duration and sampling frequency (See Section 2.1): pre-construction; construction; and post-construction.

The Department of Health (DOH) has expressed concern that stream bank modifications to prevent erosion within the project area could result in increased erosion rates downstream of the project. The stream bed is already known to be experiencing incision, as this project addresses, and it is important not to transfer any erosion potential downstream. The primary concern below the project site is potential erosion to the left (south) bank of the stream below the footing of the existing concrete rubble masonry rock wall. Therefore, this plan outlines steps to be taken to monitor for downstream erosion over a 2-year period of time, post-construction. Erosion monitoring is addressed within this plan as a post-construction activity that is separate from water quality monitoring. Procedures and methods that are specific to this monitoring task are included throughout this AMAP.

1.2. Site Description

The State Department of Land & Natural Resources classifies Aiea Stream (Code 4-03), as an intermittent stream only flowing during active rainfall runoff events with the exception of un-quantified groundwater input near the mouth of the stream well below the proposed project. There are no U.S. Geological Survey (USGS) flow records published for the stream, which has a total length of 3.47 miles and a 1.3 square mile watershed to the project location. The watershed extends to about half-way to the crest of the Koolau Mountains. The stream is on the State's 2006 list of

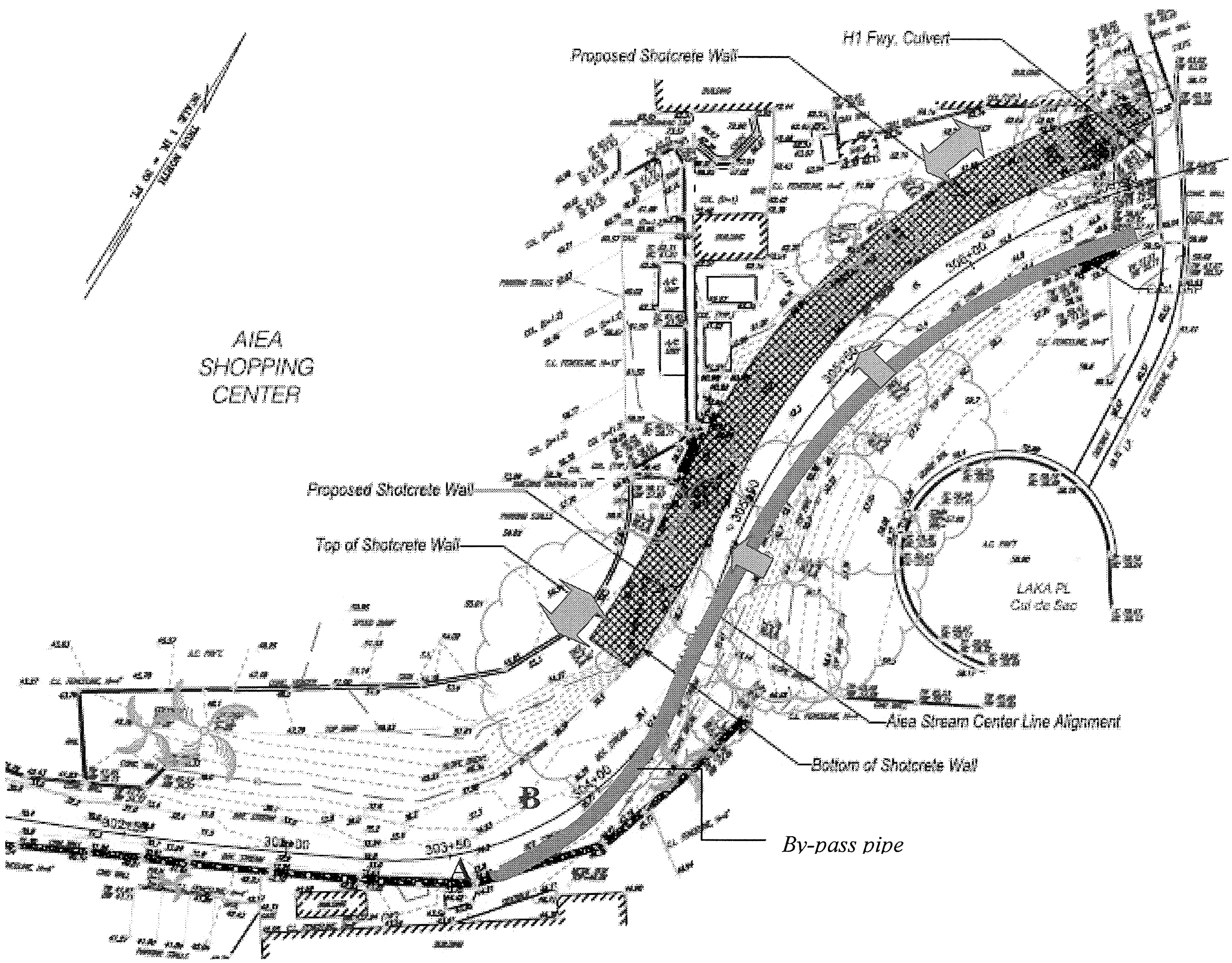

Figure 1 Aiea Stream project site just below Moanalua Freeway. Hatched area on Right bank showing location of bank stabilization structure, with by-pass pipes shown (blue) in the stream bed Left side of bed. By-pass extends from sandbag dam at H-1 freeway culvert outlet to below project site. Six standard project photo locations indicated by green arrows. During flow events , a sample may be collected at the outlet end of a 36"pipe (A), with downstream sample located in flow (B) directly from project site. Flow volumes associated with each sample must be recorded.

water quality limited segments with total nitrogen, nitrate plus nitrite, trash and turbidity listed as the primary water quality criteria of concern. The project is located immediately below the H-1Freeway (Figure 1) (Latitude 21° 22' 45.10", Longtitude 157° 55' 44.26"). The elevation of the stream bed falls from about 45 feet at the exit of the freeway's double- cell box culvert to about 35 feet, 200 feet downstream.

The project site was surveyed previously (2010) by Oceanit to determine the location of the ordinary high water mark (OHWM) to determine U.S. Army Corps of Engineers (USACE) jurisdiction. The OHWM lines are indicated on the site photographs in Figures 2 and 3. The project site is a nontidal stream flowing directly to the East Loch of Pearl Harbor, as previously mentioned, is classified as intermittent by the State of Hawaii, and appears to flow only during either very heavy rainfall events or in response to rainfall directly on the site. There was no water flow at the project site immediately below the H-1 Freeway at the time of inspection even though the preceding days had recorded significant rainfall in the mountains above the site. The site inspection discovered a great deal of trash within the stream bed and banks and numerous storm drain inlets from which this trash and other potential non-point source pollutants could emanate. There were no wetland indicators visible in or adjacent to the project site. This stream reach should be classified as an intermittent tributary to a water of the US from its mouth at Pearl Harbor up past the project site to the end of the reach at the first main bifurcation approximately 1.5 miles above the H-1 Freeway.

This stream bed appears to have undergone a great deal of human-induced change in the past so the long term bed and bank features characteristic of the OHWM in a stable stream are either not present or deemed not reliable. The double-cell box culvert above the site is part of a counter clockwise curve in the stream with the outer (right, facing down stream) culvert completely clear (indicating occasional significant flows) and the left hand culvert significantly filled with 3-feet of bed rubble (indicating a high bed load in the stream). The bed of the stream within the project boundary appears to be undergoing long term degradation, or downward erosion. The OHWM appears to range from about 1.0 to 2.0 feet above the lowest bed in any cross section. The exception to this is within the culvert beneath the freeway where flow speeds are likely much higher and the OHWM lower, as well as directly below the culvert outfall where scouring has left a relatively deep pool. Inspection indicates a cross sectional area below the OHWM of about 9 to 9.5 square feet. Given the roughness of the stream bed and an average flow speed of 5 ft/sec this would appear reasonable to accommodate a flow of 40-50 cubic feet per second during the stream forming flow expected to occur every 1.5 – 2 years.

The right bank proposed for stabilization consists primarily of a bare un-layered (Figure 2) dirt slope consistent with the application of fill on this bank prior to construction of the adjacent structures. During construction, two 36-inch pipes will be installed on the left side of the stream bed from the H-1 Freeway culvert to down below the project site. These pipes will intercept normal storm flow from above the project site and by-pass it to below the project site. The stream bed and bank area where construction will occur are to be isolated with a sand-bag berm and silt fence. The intent of this berm in combination with the by-pass pipes is to isolate any construction impacts away from the storm flow events. There is no drain from the sand-bagged construction site back to the stream. Any water that accumulates within the construction area will either be infiltrated or disposed of offsite as specified in the construction contract documents.

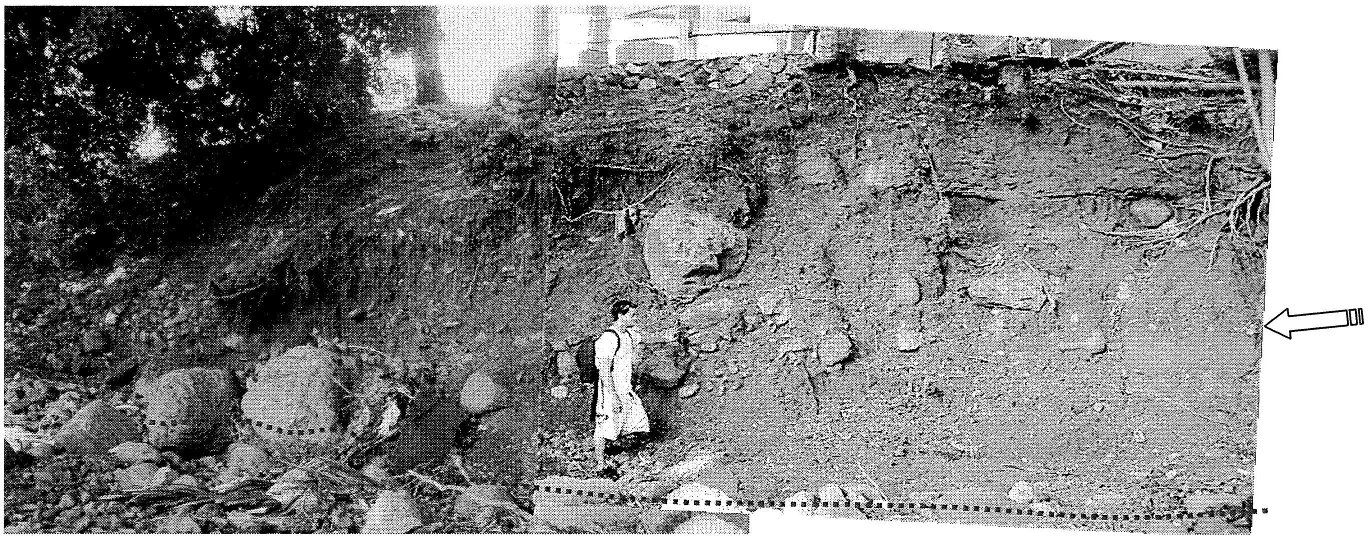

Figure 2 Left Bank (facing up stream) near center of proposed project. Note line of rounded "river rock" embedded in bank from arrow to hand indicating possible historical elevation of a portion of the stream bed. Un-layered dirt and angular rocks above this elevation are indicative of fill. OHWM shown as dotted red line.

Figure 3 Aiea Stream Location 1. Top: Up-stream view showing right bank (left side of photo) proposed for shotcrete stabilization.
Bottom: Downstream view same location. Note line of river rock mid-face on right bank and absence of roots on face of right bank.

2. Sample Quality Assurance and Quality Control (QA/QC)

The procedures outlined in this sample quality assurance and quality control (QA/QC) section are to ensure that:

- Samples are collected, processed, stored, shipped, and analyzed using acceptable standardized procedures.
- Quality of generated data is documented adequately
- Results are reported completely and accurately
- Security of samples and data are maintained at all times

Procedures covered in this QA/QC plan are specific to this individual monitoring plan. This document addresses most of the QA/QC plan elements described in "Guidance for Preparation of Combined Work/Quality Assurance Project Plans for Environmental Monitoring" (U.S. EPA, 1984) and is in accordance with NPDES Stormwater Sampling guidance document EPA 833-B-92-001. The following activities as related to environmental sampling are addressed below:

- Sampling locations
- Sample frequency
- Sampling preparation
- In situ instrumentation
- General maintenance and calibration
- Log keeping
- Sample size
- Sample containers
- Sample preservation
- Sample holding times
- Sample collection
- Sample handling
- Sample labeling
- Chain-of-custody record
- Sample shipping

The following water quality constituents and precision of measurements are recommended to be monitored at the site:

- Water depth (1-inch in situ measurement continuously substitute for flow)
- Turbidity (0.5 Nephelometric Turbidity Units (NTUs))
- pH (0.1 standard units)
- Temperature (0.1°C)
- Oil and Grease (1mg/L) sampled only if visible sheen detected

Because the stream at this location only flows during active rainfall events, placement of in situ water quality meters is not recommended since water quality testing can only be done during these intermittent and infrequent flow events. Assessment of BMP conditions, however, can be conducted in the absence of water flow.

Stream erosion will be monitored through topographic measurement of the stream bed below the project site. A description of this process is given in Section 3.

2.1. Sampling Duration and Frequency

Water quality monitoring samples and erosion data will be taken prior to construction (Pre-Construction), during construction (During Construction Monitoring), and after construction is completed (Post-Construction). The duration and frequency of these samples are detailed in this section.

For erosion monitoring, a baseline survey will be conducted just prior to completion of the project with subsequent surveys conducted at approximate 6-month intervals for 2-years after completion of the project. If during the 2-year monitoring period there is a rainfall event that exceeds a 2-year event (1hr: 1.4" / 6hr: 3" / 24 hr: 4.5"), the stream shall be surveyed as soon as feasible following the event. This survey may substitute for one of the other 6-month surveys.

2.1.1. Pre-Construction

Prior to construction, the site will be visited on up to either 10 occasions or until threesets of water quality data are obtained during a flow event. Sampling will be attempted once a week for up to 10 weeks, or until three successful water samples have been obtained. Photographic documentation of site conditions will be taken during each field visit showing consistent views.

No erosion measurements will be taken pre-construction. Baseline data for the erosion study will be taken once just prior to the end of construction.

2.1.2 During Construction

During construction grab samples will be taken at the discretion of the sampler to document observed water quality conditions when flow is present and if there is a visible differential between upstream and downstream water quality. When there is no flow, photographs will be taken to document the conditions.

Erosion data need not be acquired during construction, except as the above baseline survey.

2.1.3 Post-Construction

At one and two weeks following completion of the project, water quality data (if water is in the stream) and photographic data will be acquired. After completion of the project, the site will be visited at least twice if there are no stream flow events and up to three times if there are stream flow events from which water quality samples can be obtained.

Erosion data will be acquired at approximate 6-month intervals over a period of 2-years. In the event that a 2-year, 6-hour rainfall event (or greater) occurs during the monitoring period a survey will be conducted as soon as feasible following the storm. This storm sample shall replace one of the regular 6-month sample events.

2.2. Sampling Stations

Since the construction site is along a stream, it is assumed that any pollutants will be transferred linearly downstream leaving upstream areas unimpacted. Two sampling locations are therefore proposed both outside the construction perimeter, one upstream and one downstream. The primary

BMP proposed is a pair of 36-inch pipes laid in the stream bed, with the intention to pass the flow of stream water through the construction site isolated within the pipes. The monitoring stations (except for depth) will be placed above the H-1 Freeway and approximately 25 feet below the outlet of the by-pass pipe below the construction site (See "Erosion Control Plan" Appendix B). A single continuous recording depth meter will be placed inside the pipe to quantify stream flow events. This meter will be downloaded weekly and flow information extracted from the data. The site will be visited at least three times during the work week. If a flow event is anticipated during construction hours, the site will be accessed during up to three flow events per week with each visit substituting for one site visit that would normally have been conducted on a day without stream flow. During weekly site visits, measurements of turbidity, temperature, pH and flow volume estimates will be obtained only if there is active flow within the stream. Rainfall data will be collected from the closest publically accessible rain-gage in the watershed. If there is no flow at the site, this shall be noted and sampling shall consist only of photographic documentation.

Erosion will be monitored along a 200-foot reach of the stream bed immediately below the project site at 6-month intervals for two years after completion of construction.

2.3. Sampling Preparation

This sampling plan is being prepared prior to the sampling activities and will be discussed and/or reviewed by all personnel materially involved in the sampling activity. Any deviation from this sampling plan due to unforeseen site conditions or changes in construction methods must be discussed and submitted to the DOH. Preparation for sampling includes the following activities:

- Determination of sampling locations (see section __.__)
- Written approval from (Department of Transportation) DOT contractor for the selected location
- Written approval from DOH regarding this sampling plan
- Determination of method of sampling and volume required for desired tests
    - Water depth
        - Insitu – Hobo water level loger – or similar +/- 0.5 inch discrimination
        - On site – tape measure at end of pipe center, stream at beginning of riffle
    - pH – Field pH meter +/- 0.1 pH unit
    - Temperature – digital thermometer in pH meter +/- 0.1 C
    - Turbidity – YSI or similar turbidity meter laboratory calibrated
    - Total Suspendid Solids – one liter grab sample, laboratory analyzed by filtration
    - Oil & Grease – visual sheen
        - Insitu sample with lab provided O&G bottle from surface sheen area
- Installation of instruments for sampling
- Review of plans for instrument maintenance
- Preparation of sample bottles
- Preparation of compositing vessels
- Preparation of coolers, ice, and other materials or safety gear specific to job site
- Informing the laboratory regarding a possible sample delivery
- Checking of all special equipment needed for sample collection
- Identification of all sample splits or performance samples to be submitted with the stormwater samples
- Review of all pertinent QA/QC procedures

Planning should ensure that study objectives and their relative importance and priority are understood by all field personnel. This planning will ensure adequate evaluation of impacts of any field modifications to the plan on overall project goals. Contingency plans that include potential problems and their solutions should be outlined. An equipment checklist should be prepared to ensure availability of all tools and supplies. All equipment should be cleaned and stored in working condition after each sampling episode.

Erosion topography measurements must be taken using fixed and surveyed reference marks for continual reference over a 2-year period of time after completion of construction.

2.4. In Situ Instrumentation

Parameters that are frequently measured with in situ instruments are depth, temperature, pH, conductivity, turbidity, dissolved oxygen concentration, and oxidation reduction potential. At the Aiea Stream project site, only a water depth sensor will be installed permanently on site. Other in situ measurements will be taken with a portable measurement device such as the YSI Data Sonde or equivalent. These instruments should be operated in accordance with their respective operations manuals. The following precautions should be taken when transporting and using the equipment in the field:

- Ensure that cables are sufficiently long for operation at sites.
- Ensure that the instrument operating range and accuracy are within acceptable limits for the project.
- Electrical connectors should be waterproof.
- Field calibration of sensors should be possible.
- Instruments should be transported in boxes designed for this purpose.
- Sensors should be rinsed with distilled water after each measurement.
- Optical surfaces should be cleaned with alcohol and lens tissue in between measurements.
- Instruments should be protected from heating and direct sunlight.
- External sensors should be covered and adequately protected whenever the instrument is not being used.
- Instruments should be allowed to warm up before calibration or field use.
- Instruments should be field calibrated at the beginning of each day's measurements.
- Excessive straining should not be placed on electrical cables.

2.5. General Maintenance and Calibration

Routine maintenance inspection of in situ instruments should follow the manufacturer's recommendations. General procedures include:

- All rubber parts that may get immersed should be coated with silicone grease.
- Connectors should be inspected for bent or broken pins, which may cause faulty connections and flooded cables.
- Cables should be inspected for nicks, cuts, abrasions, or other signs of physical damage.
- Seals should be inspected and periodically cleaned and greased to ensure a waterproof fit.
- Desiccant should be inspected and replaced with fresh or reactivated desiccant when necessary.

Factory servicing and calibration should be made annually or when instrument malfunctions cannot be corrected by following the operations manual. Factory calibrations may also be required when certain major components of the system are replaced. Calibration log sheets shall accompany any report that uses data from the instrument. A draft copy of a calibration log sheet is attached to this report (Appendix A).

2.6. Log Keeping

- A sampling log sheet (Appendix A) will be used each time water samples are taken. This log sheet can be combined with the chain-of-custody form where convenient. However, all the following information should be entered:
- Project title
- DOT project number and File No.
- WQC File No.
- Date and time
- Constractor Work in Progress
- Sampling location
- Station number
- Sample number
- Replicate number if applicable
- Weather conditions
- Comments on sample condition
- Comments on sample quality
- Names of members of the sampling crew
- General site conditions
- Photo log

2.7. Sample Container Preparation

Sample containers will be washed with Alconox soap and warm freshwater and rinsed with tap water three times. Next, the containers will be rinsed with distilled water at least twice. After the final rinse, containers will be air-dried and sealed. Sample bottles for oil and grease will be laboratory cleaned, rinsed with hexane, and sealed. The recommended sample sizes, type of containers, preservation, and holding times for samples are listed in Table 1. For the Aiea Stream site, two types of containers shall be available for use at all sampling events 1) TSS, one liter bottle, and 2) Oil & Grease, acid rinsed glass jar.

2.8. Sample Collection

For this site, a "grab sample" will be obtained during one pre-construction visit only if flowing water is available at the site. Subsequent grab samples taken during the active project will be taken at the discretion of the sampler to document observed water quality conditions when flow is present and if there is a visible differential between upstream and downstream water quality. Grab samples will be obtained by removing the sample bottle cap with one gloved hand, while pushing the inverted bottle below the surface of the water with the other gloved hand. Once the bottle is underwater, it will be slowly turned upright allowing sub-surface water to enter. Care must be taken not to allow either surface film or stirred up bottom sediments to enter the bottle.

If there is not sufficient water depth to collect a grab sample in this manner, then the sample will be obtained from a spill point where water naturally falls from one elevation down to the next. In the event that both of the above methods are not practical, then a 6-inch excavation may be created in the flow stream to pool water to be sampled. If a pool is created then the water flowing across the pool shall be allowed to flush the pool for at least 5 minutes prior to obtaining a grab sample. The method used to obtain the sample shall be documented in the field report.

2.9. Sample Handling

Samples will be capped, placed into resealable plastic bags, and then placed on ice in a cooler for transport to a laboratory. After sample collection, proper sample handling will ensure that changes in the constituents of interest are minimized and will guard against errors when shipping and analyzing samples. Recommended sample sizes, type of containers, sample preservation, and storage requirements for each variable will be followed. The following table will be referenced to ensure quality assurance and quality control in sample handling.

Table 1. Recommended sample sizes, containers, preservation, and holding times for samples[1]

Measurement	Minimum Sample Size[2] (mL)	Container Polyethylene (P) Glass (G)	Preservative[3]	Maximum Holding Time
pH	25	P,G	None	Analyze Immediately[4]
Temperature	1,000	P,G	None	Measure Immediately[4]
Turbidity	100	P,G	Cool, 4°C	48 Hours
Total Suspended Solids	1,000	P,G	Cool, 4°C	7 Days
Biochemical Oxygen Demand	1,000	P,G	Cool, 4°C	48 Hours
Oil and Grease	1,000	Glass only	Cool, 4°C H_2SO_4 to pH<2	28 Days
Nitrogen				
Ammonia–N	400	P,G	Cool, 4°C H_2SO_4 to pH<2	28 Days
Total Kjeldahl– N	500	P,G	Cool, 4°C H_2SO_4 to pH<2	28 Days
Nitrate + Nitrate–N	100	P,G	Cool, 4°C H_2SO_4 to pH<2	28 Days
Phosphorous (Total)	50	P,G	Cool, 4°C H_2SO_4 to pH<2	28 Days
Priority Pollutant Metals				
Mercury	100	P,G	HNO_3 to pH<2	28 Days
Metals, except Mercury	100	P,G	HNO_3 to pH<2	6 Months
Priority Pollutant Organic Compounds				
Extractable Compounds (Includes phthalates, nitrosamines, organo chlorine pesticides, PCBs, nitroaromatics, isophorone, polynuclear aromatic hydrocarbons, haloether, chlorinated hydrocarbons, phenols, and TCDD)	4,000	G only, TFE-lined cap	Cool, 4°C 0.008% $Na_2S_2O_3$[5] Store in the dark	7 Days until extraction 40 Days after extraction
Purgeable Compounds (volatile organic compounds)	40	G only, TFE-lined septum	Cool, 4°C 0.008% $Na_2S_2O_3$	7 Days[6]

[1] Reference : Adapted from U.S. EPA (1979b, 1984)

[2] Recommended field sample sizes for one laboratory analysis. If additional laboratory analyses are required (e.g., replicates), the field sample size should be adjusted accordingly.

[3] Sample preservation should be performed immediately upon sample collection. For composite samples, each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, the samples should be maintained at 4□C until compositing.

[4] Immediately means as soon as possible after the sample is collected, generally within 15 minutes. (U.S. EPA, 1984)

[5] Should only be used in the presence of chlorine residual.

[6] Holding time and preservation technique of purgeable compounds are based on the use of U.S. EPA Method 624 for screening all priority pollutant "volatiles," including acrolein and acrylonitrile. If analysis of acrolein and acrylonitrile is found to be of concern, a separate subsample should be preserved by adjusting the pH to 4–5; and the sample should then be analyzed by U.S. EPA Method 603.

Measurement	Minimum Sample Size[2] (mL)	Container Polyethylene (P) Glass (G)	Preservative[3]	Maximum Holding Time
Total and Fecal Coliform Bacteria	250-500	P,G	Cool, 4°C 0.008% $Na_2S_2O_3$	6 Hours
Enterococcus Bacteria	250-500	P,G	Cool, 4°C 0.008% $Na_2S_2O_3$	6 Hours

2.9.1. Field Procedures

It is important throughout any sampling and analysis program to maintain the integrity of the sample from time of collection to the point of data reporting. This should be achieved by using chain-of-custody procedures that ensure procession and handling of samples to be traced from collection to the final destination. Proper chain-of-custody documentation includes:

- Field Logbook
- Sample Labels
- Chain-of-Custody Records
- Measurement of pH and Temperature
- Sample Shipment Method

2.9.2. Field Logbook

All pertinent information on field activities and sampling efforts should be recorded in the field logbook. A field data sheet will be provided for the sampling site (See Section 2.6 Log Keeping).

2.9.3. Sample Labels

Sample labels must be waterproof and must be securely fastened to the outside of each sample container to prevent mis-identification of samples. Labels must contain at least the sample number, preservation technique, date and time of collection, sample location, and name of sample collector. Labels should be marked with indelible ink.

2.9.4. Chain-Of-Custody Records

A chain-of-custody record must accompany every group of samples. Each person who has custody of samples must sign the form and ensure that the samples are not left unattended unless secured properly. Sample containers should be closed properly and sealed during handling.

2.9.5. Field Measurement of pH and Temperature

pH and temperature will be determined as soon as possible after the sample is taken, within 15 minutes if possible. Any time lag beyond this 15-minute interval will be logged. A field pH and digital temperature meter calibrated to a standardized laboratory meter will be available to the field crew at all times. pH samples are to be taken from a separate 20 milliliter aliquot poured from the primary sample container to avoid any possible contamination.

2.9.6. Sample Shipment Method

All preserved samples should be shipped as soon as possible after completion and preparation of samples. Samples should be shipped in accordance with the following:

- Shipping containers should be in good shape and capable of withstanding rough handling during shipping.

- Samples should be packed tightly.
- Dividers must separate all glass containers.
- Empty space within shipping boxes should be filled so that sample containers are held securely.
- Samples should be packed with sufficient blue ice to ensure proper sample temperature during transport.
- All containers must be leakproof. Adequate absorbent material should be placed in the shipping container in a quantity sufficient enough to absorb all the liquid.
- All samples should be accompanied by a sample analysis request. Variables to be analyzed by the laboratory and total number and kind of samples shipped should be listed on the request sheet. The laboratory must acknowledge receipt of shipment by signing and dating the form, and returning a copy to the shipping person.
- A chain-of-custody record for each shipping container should be filled out completely and signed.
- The original chain-of-custody record and sample analysis request should be protected from damage and placed inside the box. A copy of each record should be returned by the shipping party.
- The custody seal should be attached so that the shipping box cannot be opened without breaking the seal.
- For shipping water samples:
    - A "This End Up" label should be attached to each side of the shipping container to ensure that the sample jars are transported in an upright position.
    - A "Fragile Glass" label should be attached to the top of the shipping box to minimize damage to the samples.
- Shipping containers should be sent out by a carrier that will provide a delivery receipt. This will confirm that the contracted laboratory received the samples and will also serve as a backup to the chain-of-custody record.
- All shipping should be paid when samples are handed over to the carrier to avoid confusion and possible rejection of package by the contract laboratory.

For this project, all samples will be held in a cooler within individual waterproof ("Zip-loc") plastic bags on wet ice and delivered within 24 hours to a qualified local laboratory for testing.

2.10. Laboratory Procedures

All samples will be analyzed by a laboratory certified by the State Department of Health to undertake these analyses. Laboratory procedures for analyses of State Water Quality Standards parameters will conform to the Hawaii Revised Statutes Chapter 54-11-10 as described in the *Handbook for Analytical Quality Control in Water and Wastewater Laboratories*, EPA 600/4-79-019.

Specific to this sampling effort the following laboratory tests will be conducted:

Total Suspended Solids (TSS)
Oil and Grease

Turbidity

3. Erosion Monitoring

Upon the restoration of Aiea Stream following the completion of the slope repair/stabilization and removal of temporary BMPs an initial erosion monitoring survey comprised of six cross sections as indicated in Appendix C will be surveyed. Benchmarks of suitable durability will be established on either side of each cross section at an elevation approximately 5 feet above the stream bed elevation. Shots between these benchmarks will be taken along each cross section at intervals of approximately 1 foot to an accuracy within 1/100th foot in elevation. Plots of the cross sections will be developed based upon this data to serve as a baseline measurement for future evaluation of vertical bed shifts for Aiea Stream.

At 6 month intervals for a period of 2 years after the initial erosion monitoring survey, surveys will be taken at the same cross sections (total of 5 surveys including the initial survey). The cross sections developed for each subsequent erosion monitoring survey will be compared against the initial erosion monitoring survey to determine the degree of changes in stream bed elevation (see Section 5.2.6 for evaluation methodology).

In addition to cross section elevation data, photographs will be taken during each survey event at each cross section looking in the downstream direction to photo-document existing geomorphology of the stream.

4. Reporting

4.1. Field Reports (FR)

FRs to include prints of supporting photographs and any field measurements taken will be completed by the field Site Monitor (SM) on the day of the sample event. FRs will be submitted to the HDOT Resident Engineer (RE) electronically before the end of the business day on a standard form and include all information and observations including pertinent photographs, and chain-of-custody forms from any samples taken during the field event. HDOT's Water Quality Monitoring and Assessment consultant will review the FR and use its discretion to contact the Contractor's Construction Site Manager (CSM) relative to any observations relative to construction activities that may impact water quality. RE will then document any communications with the CSM, amend the FR and transmit it electronically to the DOH within one business day of receipt of pertinent information from the SM.

4.2. Event Reports (ER)

Once laboratory results are received by HDOT's consultant, they will be interpreted in terms of State Water Quality Standards and construction activities at the project site during the time the sample was taken, amended to the FR to create an ER and again transmitted to the RE. The RE will be responsible for alerting the construction manager of any apparent water quality violations or other issues of concern and to forward this information to the DOH within one business day of receipt. ERs will include the FR from each sample event plus the results of laboratory analyses from that event with description of any variance in analytical procedures or questionable results as it relates to construction practices at the time of sampling. ERs will only be written when either there is an active stream flow event at the project site from which water quality samples are obtained, or there is some activity noted in the FR that is likely to adversely impact water quality should a stream flow event occur. ERs involve contact and discussion with the CSM and are transmitted to the DOH electronically within 1 business day of receipt of the pertinent information from the SM.

4.3. Final Report

A Final report will consist of a summary of all FRs and ERs and tabulation and statistical analyses of data referenced to appropriate permit designated or State water quality standards. A summary section will interpret the data in terms of appropriate standards and make recommendations for modifications to succeeding sampling plans. The final report will be compiled by HDOT and its consultant within 30 days following receipt of the final post construction FR and associated laboratory results from these site visits. This report will be delivered as a printed copy with electronic file backup to the DOH.

5. Data Quality Objectives

The Data Quality Objectives (DQO) process was developed as a planning tool. The DQO process helps determine when enough data of sufficient quality has been collected to enable accurate decision-making. In the case of work on bridges or other structures within or over the riparian corridor of a stream the data collected primarily relate to the maintenance of water quality within and downstream of the project boundaries. Alternative data collection scenarios are analysed using the following seven steps of the DQO process:

1. State the problem
2. Identify the decision
3. Identify inputs
4. Define boundaries
5. Develop a decision rule
6. Specify limits on decision errors
7. Optimize the design

This process is detailed below in specific reference to the sampling plan described above for the Aiea Stream bank stabilization project.

5.1. State the Problem

The purpose of the construction monitoring effort will be to determine the effectiveness of the BMPs in preventing the introduction of pollutants to the stream outside of the BMPs. The pollutants of primary concern are the sediments from the bank which could induce high turbidity in downstream waters, the possible introduction of petroleum products from construction machinery, and the introduction of lime from concrete used at the site which would cause a rise in pH of downstream waters.

Streams are dynamic by nature and experience has shown that “fixing” an erosion problem at one site may transfer that problem downstream to another site. The purpose of the post-construction erosion monitoring is to verify that erosion rates are not increased in the downstream reach immediately below the project.

5.2. Identify the Decision

The purpose of the monitoring program is to document the introduction of any of the specifically identified pollutants into the stream resulting from construction activities and to provide feed-back to the contractor such that activities that led to these pollution or potential pollution events can be modified to prevent further similar occurrences. The decision to be made is whether or not the construction activity is contributing significantly to pollution within the stream. The pollutants of primary consideration include lime (a strong base impacting pH), soil (as measured by turbidity) and petroleum products associated with construction machinery. Field data to be collected include site photographs, turbidity of upstream and downstream water, pH of upstream and downstream water, and oil and grease. Since the stream does not typically flow through this reach, neither a regular time table nor specific action level can be pre-determined for water quality.

Although turbidity measurements can quantify the relative amount of silt in the stream both up and downstream of the project area, the equipmentneeds to be continually submerged, which is not feasible at this site. If there is a significant silt plume from the site, for instance, it will be both visible and traceable to its source. If during a stream flow event any turbidity plumes are noted to emanate from the construction area, then this is an actionable event and appropriate steps should be taken to identify the source and control these flows both in the current and any future flow events. Any turbidity plume should be documented photographically and a 1-liter grab sample obtained from the center of the plume with a control sample (physical and field turbidity) taken above the project. If turbidity below the site in the visible silt plume is greater than 230 NTU and 20-percent higher than the upstream sample, then this shall be considered an actionable event.

In the event that a stream flow event occurs during or within 12-hours following a cement pour within the stream bed or bank, then water quality samples (including pH) shall be taken both above and below the site. A rise in pH of over 1.0 pH units downstream will be constituted as an actionable event.

If oil and grease are introduced to the construction site and/or to the stream from motorized construction equipment this is likely to be noted as an oily sheen on the water. Thre presence of an oily sheen on the water within the construction site is the basis for an ER. The presence of an oily sheen on the water outside the construction zone is the basis for both an ER, water quality sample, and may be an actionable event. .An Actionable Event (AE) documented in a FR will always trigger the development of an ER. Specific remediation actions that result from the ER will vary according to the type of event and are discussed in each section below.

5.2.1. Site Photographs

Site photographs will be obtained at least weekly from standardized locations as shown in Figure 1. Additional photographs indicating representative construction activities shall also be included in the report. One purpose of these photographs is to show the presence, up-keep and impact of site BMPs. Any event that demonstrates the positive effect of a BMP should be documented. Similarly any failure of a BMP should be documented along with an indication as to how the BMP could be improved. Any photograph of a failed or improperly installed BMP shall result in an AE. AEs triggered by other parameter measurements (pH, turbidity, oil & grease sheen) shall also be documented with photographs. As part of the 2-year post construction monitoring, two-hundred feet of the stream bed and bank below the project will be surveyed to document any incision or accretion along this reach. Any significant finding (as noted in Sections 5.2.3 – 5.2.6) documented through photographic evidence should result in an ER which will involve documentation of discussions between the RE and the CSM to resolve any potential water quality issues.

5.2.2. Water Depth

Since the stream at the project site only flows during active rainfall events, the greatest chance for pollution to downstream (off-project) locations is during these infrequent flow events. However, during these flow events it is highly likely that water coming into the stream from upstream locations does not meet State water quality standards. It is also likely given the flashy short term nature of these events, that it will not be possible to obtain representative upstream and downstream samples during the majority of these flows. It is important, therefore to document the frequency and relative magnitude of these flow events. A simple pressure sensor will be installed near the end at the bottom of one of the two by-pass pipes and a second installed outside the pipe with both set to record readings at 15 minute intervals. The difference in pressure readings between the two sensors will be related to water depth within the pipe and an algorithm developed to roughly correlate flow depth with volume.

This data stream will indicate the frequency and relative magnitude of flow events at the site and validate contractor site activity logs. Seeing that part of the sampling protocol calls for the contractor to notify the sampler in the event of a major existing or anticipated flow event, these actual flow records will validate the contractor's abilities to follow through on this commitment. Action based upon water depth information is only warranted if there appears to be no action on the part of the site foreman to notify the monitoring personnel in the event of significant in-stream flow events.

Water depth is not a parameter of direct interest as a potential pollutant and will not result in an actionable event.

5.2.3. pH

Uncured concrete contains a significant quantity of lime, which has a very high pH, and has the capability to adversely increase pH of surface water into which it comes in contact. It is important to measure pH in water downstream of the site if any flow events occur within 12 hours of a significant concrete pour. In the event that a rainfall event shortly after a concrete pour results in ponded water within the project enclosure, this water shall not be discharged into the stream or storm drains. This water may be allowed to infiltrate or be pumped out and trucked to a permitted waste water treatment facility or an HDOT RE accepted infiltration site. The purpose of downstream monitoring is to assure that the high-pH water is contained within the construction barrier. In the event that downstream water increases more than 1.0 pH units above ambient, the source of the contamination must be located, documented, and controlled. A pH increase greater than 1.0 in downstream water is an AE and will result in an ER. The ER will document discussions between the RE and the CSM relating to the like source of pH contaminant and methods used to control further releases.

5.2.4. Turbidity

Turbidity results from the suspension of particles in the water. Turbidity from the construction site is most likely to result from erosion of soil caused by direct mechanical disturbance or secondary erosion by rainfall over disturbed surfaces. It is very likely that rainfall events will result in highly turbid water within the containment sand bag barrier (BMP) surrounding the construction site. The purpose of monitoring is to assure that the turbidity is contained by the BMPs and does not migrate downstream. If the downstream water turbidity is visibly more turbid (based on photographs) or measures more than 20% greater than upstream water and the downstream turbidity is greater than 230 NTU, then the Event Report must include information relative to the likely source of the turbid water and make recommendations to control the pollutant source. If the source cannot be determined or controlled, then construction shall be halted until the downstream turbidity returns to within 20% of the upstream water or is less than 230 NTUs.

5.2.5. Oil and Grease

An oil or grease spill will be defined to have occurred based solely upon visual observation of a sheen on the water outside of the construction sand-bagged area. A water sample will only be obtained if there is visual evidence of sheen and will assist only in the quantification of the problem. The presence of a sheen on the water inside or outside the construction area will be documented photographically and will be included in the resultant ER. The ER will include information on discussions between the RE and the CSM relative to the likely source of the petroleum contaminant and measures taken to remediate the condition and prevent further spills.

5.2.6. Erosion

If, during the two-year period of post-construction erosion monitoring, comparison between baseline survey and subsequent surveys reveals a change of more than 4.0 cubic foot per linear foot of bed material, then the DOT shall evaluate photo documentation of the cross sections to determine if an erosion issue exists. Should an erosion issue be identified, the DOT will determine an appropriate course of action.

5.3. Identification of Inputs

Inputs to the decision making process are documented through photography and supported through in situ sampling to include water depth, pH, turbidity when there is water flow, and oil & grease sampling when there is visual evidence of sheen on the water.

5.3.1. Site Photographs

The primary purpose of the site photographs is to document the presence and efficacy of on site BMPs. Decisions based upon photographic evidence are primarily qualitative in nature and are based upon the experience and knowledge of the monitoring professional. Typically photographs that are taken at a set location every week tend to display long term trends (vegetation overgrowth, slow erosion, loss of cover) that may not be evident from single inspections. This information is valuable to site managers to up-keep BMPs over the term of the construction project. Other photographs demonstrating BMP successes or failures serve to provide a weekly check for the CSM and assist the contractor in the development of weekly BMP management and upkeep chores. During active stream flow events, visual evidence of turbidity plumes emanating from the construction site can be documented photographically and need not be validated with direct turbidity measurements.

5.3.2. Water Depth

Water depth only serves to document the occurrence and relative magnitude of stream flow events. This metric is only a decision tool in the event that project supervisors do not inform project monitoring personnel when active flow events occur.

5.3.3. pH

pH is rarely useful as a decision making metric because it tends to range widely in low-flow streams and is quickly buffered in high-flow streams. However, because the project involves spraying concrete over a relatively large area on the stream bank, it is reasonable to take precautions. In the event that there is rainfall within 12 hours of the wet concrete being placed, pH should be measured in the bypass and project effluent flow. If the effluent (leakage) from the containment area is more than 1.0 pH units higher than the by-pass flow, then remediation should be considered as this degree of pH change can adversely impact stream fauna.

5.3.4. Turbidity

Turbidity is used here primarily as an indicator of excess sediment being introduced into the water as a result of construction activities. It is not likely that State Standard Water Quality levels are ever attained at this location. If the construction activity has no impact on stream sediment load than the turbidity of water above the project site should be substantially the same as water below the site. As turbidity tends to vary widely in a running stream with values of 50-100 NTUs as not unusual, a substantial difference between upstream and downstream turbidity should be required to infer an impact from construction activities in the absence of visual or photographic evidence. A turbidity differential of 20%s is provisionally selected as an adequate difference between upstream and downstream values to warrant action. Nationally, an effluent standard of about 230 NTUs is being developed and this value is used as the high end of acceptable turbidity values below the site. This means that during occasions when there is significant stream flow resulting in natural stream turbidity in excess of 230 NTU, then construction activities at the site should be haulted. Note that visual observation of turbidity plumes is a separate indicator of turbidity documented photographically and need not be verified by turbidity measurements.

5.4. Study Boundary

The site is defined as a linear system with a single upstream and a single downstream decision point. For ease and safety of sampling, the upstream decision point may be sampled at the outlet of the diversion pipe if in the expert opinion of the sampler this water is representative of the upstream conditions. The downstream site should be selected below the project boundary.. No sampling (other than observational or photographic) is to be conducted within the project boundary or sandbag barrier.

5.5. Decision Rule

The rationale for the decisions has been developed in the sections above, with a summary statement provided here.

Any of up to three rainfall events that result in water flow within the stream during any work week shall result in an effort to collect water samples for the analyses of pH, turbidity, and TSS. When water quality results are received back from the laboratory they are to be interpreted and forwarded to the RE for inclusion in an ER. Any AE (O&G sheen, BMP problem, turbidity observation) documented in a FR shall result in the generation of an ER. Every ER shall include documentation of communication between the RE and the CSM relative to the contents of the report and any contractor actions supported by the report contents. All ERs will be forwarded to the DOH for review and administrative action if warrented.

5.5.1. Site Photographs

If site photographs document a BMP that is inadequate or in need of maintenance, this shall be noted in the FRand shall result in development of an ER. .

If site photographs document the presence of a turbidity plume emanating from the site, this shall be noted in the FR and shall result in development of an ER.
If site photographs document the presence of a sheen on the water surface **inside** the BMP sand bag (or other) barrier this shall be noted in the FR and shall result in development of an ER.

If site photographs document the presence of a sheen on the water surface **outside** the BMP sand bag barrier in the stream, and oil & greas sample will be taken, shall be noted in the FR and shall result in development of an ER.

5.5.2. Water Level

If water level data indicates that there have been significant flow events during working hours then this information will be included in the FR, but will not necessarily generate an ER.

5.5.3. pH

If the pH of water in the stream bed below (outside) the containment BMP is noted to have a pH more than 1.0 pH units above ambient this shall be noted in the FR and shall result in development of an ER.. Note that if water within the containment barrier is found to have a high pH, it may not be discharged into the stream or storm drains but may be dewatered into a containment truck for permitted disposal at a waste water treatment facility or infiltrated at an appropriate site.

5.5.4. Turbidity

If, during a stream flow event, the turbidity of water downstream of the containment sand bag barrier is more than 20% above the water emanating from the diversion pipe or is higher than 230 NTU, then this shall be noted in the FR and shall result in development of an ER.If the stream is running and the turbidity below the construction site is greater than 230 NTU than construction shall be haulted until the turbidity decreases to below 230 NTU or stream flow stops.

5.6. Limits on Decision Errors

Errors are inevitable when conducting a sampling and analysis project. Human error, to some degree occurs throughout the process. Error in automated techniques for analyzing samples is also inevitable. Proper calibration of analytical instruments, proper handling of samples in the lab, and carefully following laboratory procedures are of vital importance. The steps necessary to minimize errors and produce good quality data have evolved into quality assurance/quality control (QA/QC) programs that give guidelines for minimizing error in sampling and analysis projects. Quality assurance (QA) is a set of operating principles that are designed to produce data of know and defendable quality. QC programs include certification of operator competence, analysis of externally supplied turbidity and pH standards to ensure concentrations are what they should be, calibration with standards, and analysis of duplicates (commonly 10% replication of the total sample number).

Once all effort has been made to minimize error, all error has not eliminated, it has only been reduced as much as possible. From here, it is important to understand the error is still associated with the sampling and analysis plan and with the natural variability inherent in natural systems.

In the context of the Aiea Stream project, the data sources and decisions are relatively simple and straight forward. Decisions based upon visual observation and photographic evidence is qualitative in nature, but relatively definitive and rarely disputed. If pH becomes a concern due to on-site measurements, it would be prudent to immediately re-take the measurements at several locations and confirm calibration of the instrument. If high pH readings (>1.0 pH units as measured against the by-passed stream water) persist with repetitive measurement the site supervisor should be immediately informed. Turbidity readings in streams naturally fluctuate widely. If downstream measurements approach 20%s greater than upstream readings, then at least 2 additional measurements should be taken and a standard deviation of the mean calculated. If the mean is within 1 standard error of the mean (SEM) of 20 NTUs than additional samples should be taken, up to a total of 12 paired samples until the mean falls above or below the 20-NTU cut-off. In cases such as these it may be appropriate to use a field calibrated tubidity meter rather than transporting each water sample to a laboratory for analyses. If after the 12th paired sample the mean cannot be determined to be statistically below 20% differences, then it will be assumed that it is greater, this will be reflected in the FR, and ER resulting in the likely cessation of active construction.

5.7. Optimizing the Design

No preliminary data collection plan should be considered to be without fault or without room for improvement. As the construction plan progresses it is required that some of the weekly photograph locations will need to change. In the event of a change in construction plans or unanticipated runoff control issues, it is likely that the sample sites will change or that new sample sites will be added. Each change in the sampling plan design will be documented in the weekly reports and discussed in the final report.