

Surface Water Ambient Monitoring Project in the Stanislaus National Forest

Quality Assurance Project Plan

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1.0 Plan Distribution and Approval

Table 1-1. Distribution List and Contact Information

Title	Name	Affiliation	Telephone	QAPP #
Project Manager	John Buckley	CSERC	(209) 586-7440	Revised

QA Officer	Dr. Tom Hofstra	Columbia College	(209) 588-5155	Revised
Technical Advisor	Erick Burres	State Water Board	(213) 576-6788	Revised
Group Rep.	Ben Solvesky	Sierra Forest Legacy	(209) 532-0929	Revised
Group Rep.	Tom Harrington	Central Sierra Audubon	(209) 694-8564	Revised
Tech. Leader	Meg Layhee	CSERC	(209) 586-7440	Revised

Approval Signatures

<u>Title:</u>	<u>Name:</u>	<u>Signature:</u>	<u>Date:</u>
Project Manager	John Buckley	_____	_____
QA Officer	Dr. Tom Hofstra	_____	_____

2.0 Introduction and Overview

The Central Sierra Environmental Resource Center (CSERC) is a non-profit organization that serves as a science-based environmental advocate for nearly 2,000,000 acres within the central region of the Sierra Nevada. For the past 25 years, CSERC has actively monitored livestock grazing, logging, road construction, and other land disturbing activities, particularly on federal lands of the region. CSERC has also served as a community watchdog, reporting a wide range of environmental problems affecting water quality on both public and private lands.

In terms of water monitoring, CSERC staff has assisted the Tuolumne County Resource Conservation District in monitoring local waters to document water quality and to locate contaminate sources entering domestic waterways.

This monitoring plan describes the actions that will be undertaken by CSERC to sample streams during the spring/summer/early fall high-use period on public forest lands to generate new information about water quality and to potentially identify contaminate sources entering waterways across the middle and upper elevations of the Stanislaus National Forest.

Beyond this Introduction the contents of the Plan are organized in the following sections:

- Section 3 describes the roles and functions of the personnel involved in this project.
- Section 4 provides the problem statement and the study question.
- Section 5 describes the data that will generated, the geographic setting of this project, the project timeline and foreseeable constraints.
- Section 6 reiterates measurement data and specifies the Measurement Quality Objectives (MQO).
- Section 7 describes training and lab certification.
- Section 8 describes the documentation and records that will be produced.
- Section 9 reiterates the study question and discusses the project design.
- Section 10 describes the methods used to collect water samples.

- Section 11 describes how samples will be handled, transported, and how the chain of custody will be documented.
- Section 12 describes the instrument used for field measurement and AquaLab's Analytical Methods.
- Section 13 discusses Quality Control measures that will be used to ensure accurate data is produced during this project.
- Section 14 describes necessary field and laboratory equipment inspection and maintenance, and calibration.
- Section 15 describes the inspection of supplies used for sampling.
- Section 16 discusses possible outside sources that may be used as supplemental information.
- Section 17 describes pre and post sampling readiness and data reviews and laboratory data reviews.
- Section 18 describes how data will be checked/reviewed to ensure quality data will be produced.
- Section 19 describes steps that will be taken to verify the project's data for completeness.

3.0 Program Organization

3.1 Involved Parties and Roles

The Project Manager will be responsible for all contract management tasks including invoicing and reporting, management of the laboratory contract, and oversight of project progress. The Technical Leader of this Project is the author of the Monitoring Plan and this QAPP and will be responsible for the scientific integrity of the data collection effort throughout the life of the Project. The Technical Leader also is responsible for technical dialogs with advisors and experts, and for collaboration with other agencies and stakeholders active in the watershed. The Quality Assurance Officer works independently from the Project Manager and Technical Leader and is responsible for the data meeting all quality objectives.

Table 3. 1- Personnel Responsibilities

Name	Organizational Affiliation	Title	Contact Information (Phone/e-mail)
John Buckley	CSERC	Project Manager	(209) 586-7440/ johnb@cserc.org
Meg Layhee	CSERC	Technical Leader	(209) 586-7440/ megl@cserc.org
Tom Hofstra	Columbia Community College	QA Officer	(209) 588-5155/ hofstra@yosemite.cc.ca.us

3.2 Project Manager Role

The Project Manager is responsible for all contract management tasks, including budgets, while

the Technical Leader is responsible for the technical conduct of the proposed project, including the updating of this QAPP. The Quality Assurance Officer is responsible for ensuring that the data collected during the course of this project meets all documented quality objectives (i.e., Data Quality Objectives, Method Quality Objectives, etc.).

3.3 Quality Assurance Officer Role

The role of the Quality Assurance (QA) Officer is to provide independent oversight and review of the quality of the data being generated by the project with respect to the quality that is required. Thus, the QA Officer will be independent from those generating all project information and will not report to the proposed project director or to any of the proposed technical staff. In this role, the QA Officer has the responsibility to require data that is of insufficient quality to be flagged, or not used, or for work to be redone as necessary so that the data meets specified quality measurements. The QA officer is independent from this project and is not involved in generating data.

3.4 Responsible Person for QAPP Update and Maintenance

Meg Layhee is responsible for maintaining and updating the official approved QAPP. Meg Layhee also is the authorized person to make changes to the QAPP.

4.0 Problem Definition/Background

4.1 Problem Statement

The Stanislaus National Forest receives the greatest number of visitors during the summer months (generally extending from June-September). Many thousands of backpackers, hikers, swimmers, campers, and other recreational users utilize water from Forest streams and lakes for drinking, swimming, bathing, etc. However, national forest lands are also managed for livestock grazing and timber production, in addition to recreation. The summer months (generally extending from June-September) are also when cattle are permitted to graze within designated allotments on the Stanislaus National Forest (some allotments allow cattle on in April).

Due to a lack of funding and personnel, local government agencies have not undertaken any consistent water sampling of streams to determine the impact of forest management activities, including livestock grazing, on water quality. Each of those potential threats to water quality could certainly be the focus of water sampling tied to specific locations that may be directly affected by each activity. For livestock grazing activities on forest lands, there is a large body of literature that suggests degraded stream and river water quality is associated with the presence of cattle (Derlet et al., 2008, 2012; Knapp and Nelson, 2015; Myers and Kane, 2011; Myers and Whited, 2012; Wilkes et al., 2011). As recreational uses will most likely continue to rise in the future (White et al. 2016), it is critical that the public and land managers have a better understanding of water quality issues on public lands.

Given CSERC's limited resources to undertake water quality sampling, this project will focus solely on streams affected entirely or primarily by livestock grazing. Before 2009, there was no data available to show if the presence of cattle in the Stanislaus National Forest was negatively impacting the beneficial uses of Forest water bodies used for recreation, wildlife habitat, or downstream domestic drinking water. However, water quality monitoring that CSERC conducted during the summer of 2009 within three grazing allotments on the Stanislaus National Forest demonstrated that the presence of cattle is having a negative impact on surface water quality in the Forest.

This project will be sampling a variety of streams of the Mokelumne, Stanislaus and Tuolumne River watersheds that are located on the Stanislaus National Forest, CA. The watersheds are fed by melting snow pack from the Sierra Nevada mountains, as well as springs and seeps that provide some additional water during the rest of the summer season.

The designated beneficial uses pertaining to recreation, drinking water, and wildlife within the watersheds of the Stanislaus National Forest include (CVRWQCB, 1994): Water Contact Recreation (*REC-1*, uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible); Non-contact Water Recreation (*REC-2*, uses of water for recreational activities involving proximity to water, but where there is generally no body contact with water, nor any likelihood of ingestion of water); Cold freshwater habitat (*COLD*, uses of water that support cold water ecosystems including, aquatic habitats, vegetation, fish, or wildlife, including invertebrates); and Wildlife habitat (*WILD*, uses of water that support terrestrial or wetland ecosystems including vegetation, mammals, birds, reptiles, amphibians, invertebrates or wildlife water and food sources).

These beneficial uses apply to surface waterbodies within the Mokelumne River from the source to Pardee Reservoir, the Stanislaus River from the source to New Melones Reservoir (proposed), and in the Tuolumne River from the source to New Don Pedro Reservoir (CVRWQCB 1994).

4.2 Study Question and Data Overview

This monitoring effort will provide information about the stream water quality of the Tuolumne, Stanislaus and Mokelumne River watersheds by collecting water samples for bacteriological analysis of *Escherichia coli* (*E. coli*), total coliform, and fecal coliform and how they relate to standards established for fecal coliform under Central Valley Regional Water Quality Control Board's Water Contact Recreation REC-1 beneficial use (CVRWQCB 1994) and *E. coli* under U.S. EPA's recreation. We also assess other stream water quality conditions (e.g., water temperature and conductivity).

The key study question that this project will attempt to answer is:

Does the summertime presence of cattle in the Stanislaus National Forest negatively affect the beneficial uses of water bodies for recreation, drinking water, or wildlife habitat?

Monitoring work will be performed during any weather conditions. Site monitoring and water sampling will begin in April/May (or when roads are open and accessible) and on through

September (or when cattle are removed from the allotment) in order to document water quality before, throughout, and immediately after the livestock grazing period on forest lands.

4.3 Water Quality or Regulatory Criteria

This project will yield bacterial counts data and other water quality measurements to identify if waterbodies in the Stanislaus National Forest meet the Basin Plan water quality objectives for specific beneficial uses for inland surface waters.

Table 4.3 Water Quality Concentration Standards used for this project

Constituent	Inland Surface Waters Quality Objectives
Fecal coliform*	CVRWQCB Water Contact Recreation (REC-1) beneficial use: In areas designated as contact-recreation zones, the fecal coliform concentration based on a minimum of not less than five samples for any 30-day period shall not to exceed a geometric-mean of 200 per 100 ml, nor shall more than 10 percent of the samples in any 30-day period exceed 400 per 100 ml.
<i>E. coli</i> **	USEPA Recreational Water Quality Criteria: In areas designated as contact-recreation zones, <i>E. coli</i> concentration based on a minimum of not less than five samples for any 30-day period shall not to exceed a geometric-mean of 126 per 100 ml, nor shall more than 10 percent of the samples in any 30-day period exceed 235 per 100 ml.

* From *Quality Control Plan for the Sacramento and San Joaquin River Basins*, Basin Plan (CVRWQCB, 1994). Water quality concentration standards for California inland surface waters are promulgated by the U.S. Environmental Protection Agency in Title 40, Section 131.38 of the *Code of Federal Regulations*.

** From U.S. Environmental Protection Agency's *Quality Criteria for Water 1986*. EPA 440/5-86-001.

5.0 Program/Task Description

5.1 Work Statement and Produced Products

The project will only provide a final report due to short duration of the project. No preliminary, interim, or additional reports are planned.

The project will include collecting water samples for laboratory analysis. Samples will be taken during either wet or dry weather.

Station types sampled will include streams and/or flowing water moving through a meadow that joins with a creek or river. Such waters will be sampled at intervals from early May into September. The sampling area will include at a minimum: two tributary streams of the Tuolumne River via the Clavey River, and two tributary creeks that flow directly into the

Tuolumne River.

Sampling techniques for bacteriological examination will include direct filling of sterile containers. Sampling techniques for water temperature and conductivity are measured in the field using a YSI EcoSense EC300. Observations about the weather, water, stream flow, etc, will also be noted on the field data sheet. Photos of each sample site will be taken during every sampling event to visually document the sites throughout the project.

5.2 Constituents to be monitored and measurement techniques

The following conventional analyte pathogens will be measured in water using the Most Probable Number technique: *E. coli*, fecal coliform, and total coliform.

The results for fecal coliform and *E. coli* are the primary purpose for conducting this project. The bacteriological results for total coliform, and any other water chemistry data (e.g., dissolved oxygen, water temperature) are of secondary importance.

5.3 Project Schedule

Each project location will be sampled/monitored a minimum of five times within 30-day period. The total number of sampling events for the entire year will be +/-15 for each site. Stations will be visited prior to cows being brought onto the forest, once cows are on the forest, and just after the cows are removed from the forest. The frequency of sampling events will be weekly or biweekly until at least five samples have been collected in a 30-day period. The planned interval between visits will vary, and the number of samples taken at each site visit (taken 5 minutes apart) will vary as well.

The final laboratory analyses/results should be collected no later than 14 days after the last sample is taken. The statistical analyses and final report for the project will be completed by December of that year.

Table 5-1 Project timeline for major tasks

Task	April/May	June	July	August	Sept
Prepare QAPP					
Select sites, prepare for field work					
Conduct Sampling & analysis for water quality study					
Conduct data analysis					

Prepare Final Report					
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5.4 Geographical Setting

“Located on the western slope of the Central Sierra Nevada, the Stanislaus National Forest contains about 1.1 million acres within its boundary, of which 898,000 acres is National Forest System (NFS) lands. The Forest’s topography is characterized by a series of broad sloping benches separated by river canyons and numerous tributary drainages. The dominant aspect is west towards the Central Valley and Pacific Ocean. Elevation varies from 1,100 feet in the Tuolumne River canyon to 11,575 feet at Leavitt Peak along the Sierra crest. Four major rivers (Merced, Mokelumne, Stanislaus and Tuolumne) occupy deep canyons that drain west into the Central Valley. A fifth river, the Clavey, flows southward into the Tuolumne. Elevation differences in these canyons can range from 1,000 to 2,000 feet within a half-mile or less. Slopes along the river canyons are steep with gradients of 60-100 percent.

The Forest contains a number of small to medium-sized lakes, mostly man-made. Cherry Lake (1,800 acres) is the largest while Pinecrest Lake (300 acres) and Lake Alpine (180 acres) are the most popular for recreational use. The only naturally occurring lakes are at the higher elevations. Granite, the most common rock type on the Forest, is especially evident at the higher elevations. Volcanic rocks once covered much of the Forest, but eroded away in many areas. The Dardanelles and nearby Table Mountain are remnants of these volcanic rock formations.

Forest climate is directly related to elevation. Below 4,000 feet, mild rainy winters and hot dry summers prevail, with an average 30-35 inches annual precipitation. Above 4,000 feet summers are cooler, winters are cold and snowy, and annual precipitation is 40 to 65 inches. Snow accumulates on protected exposures, and surface runoff from snowmelt, which feed the rivers and higher elevation creeks, normally occurs from March through July.

The Stanislaus National Forest contains a mosaic of vegetation distributed and controlled primarily by climate and soil. The dominant vegetation types occur as broad bands oriented northwest to southeast across the Forest occupying general elevation zones. The annual grassland and oak woodland-digger pine vegetation type is found up to about 3,000 feet along the steep sides of the major river canyons where it is confined primarily to the south-facing slopes. The chaparral vegetation type occurs at higher elevations, from about 1,500 to 3,500 feet. Most of the forested land occurs between 3,500 to 7,500, with some as high as 8,500 feet. Evergreen and deciduous hardwoods are scattered throughout all elevation zones. The sub-alpine zone with a mixture of conifers and low growing shrubs exists above 7,500-8,500 feet (USDA 2009, 37-38).”

Project sample sites:

Numerous stream sites have been sampled within the Mokelumne, Stanislaus, Tuolumne, and Merced River watersheds since the start of this monitoring effort in 2009. Additional sample sites may be added at the discretion of the technical leader. The new sample sites may include: sampling a single spot, and/or "above and below" samples (sampling the water above a potential

contaminated area and sampling the water below the potential contaminated area for comparison). The sampling protocol will be the same for any added sampling sites, and maps will be created and added as necessary. Some of the sites sampled are below.

Tuolumne River watershed:

1. Bell Creek (Bell Meadow-Bear Lake Allotment) adjacent to Middle Bell Meadow, tributary to the Clavey River which flows into the Tuolumne River.
2. Bourland Creek (control site) just downstream of Bourland Meadow (Upper Hull Allotment), which flows into Reed Creek which then flows into the Clavey River and ultimately to the Tuolumne River.
3. Unnamed tributary of Bell Creek in the Bell Meadow-Bear Lake Allotment that flows through Upper Round Meadow and Lower Round Meadow into Bell Creek, into the Clavey River and finally into the Tuolumne River/
4. Unnamed tributary of Reed Creek that flows through Lower Wolfen Meadow (Jawbone Allotment). The stream runs into the Tuolumne River via the Clavey River via Reed Creek.
5. Bull Meadow Creek flows through Bull Meadow (Jawbone Allotment) and flows into the Tuolumne River via the Clavey River.
6. Jawbone Creek adjacent to Jawbone Meadow (Rosasco Allotment). Jawbone Creek flows directly into the Tuolumne River.
7. Unnamed tributary stream of Jawbone Creek that flows through Boggy Meadow (Rosasco Allotment). Jawbone Creek flows directly into the Tuolumne River.
8. Wet Meadow Spring (Lower Hull Allotment) feeds Hull Creek which flows into the Tuolumne River via the Clavey River.

Stanislaus River watershed:

1. Rose Creek (Rushing Allotment), tributary of the Middle Fork Stanislaus River.
2. Cow Creek downstream of Bull Run Meadow (Herring Creek Allotment), tributary of the Middle Fork Stanislaus River (creek flows into Beardsley Lake).
3. Tributary of Cow Creek downstream of Punch Bowl Meadow (Herring Creek Allotment), tributary of the Middle Fork Stanislaus River..
4. Niagara Creek (Long Valley-Eagle Meadow Allotment) a tributary of the Middle Fork Stanislaus River (creek flows into Donnell Lake).
5. Eagle Creek at downstream end of Eagle Meadow (Long Valley-Eagle Meadow Allotment) tributary of the Middle Fork Stanislaus River.
6. Long Valley Creek (Long Valley-Eagle Meadow Allotment) tributary of Eagle Creek, which flows into the Middle Fork Stanislaus River.
7. Willow Creek (Herring Creek Allotment), tributary of Herring Creek that flows into the South Fork Stanislaus River.
8. Unnamed tributary of Willow Creek (Herring Creek Allotment) at Upper Three Meadow, that flows into Herring Creek that flows into the South Fork Stanislaus River.
9. Herring Creek (Herring Creek Allotment) at Hammill Canyon, tributary of the South Fork Stanislaus River.
10. Unnamed tributary of Herring Creek (Herring Creek Allotment) at Upper Fiddler's Green Meadow, tributary of the South Fork Stanislaus River.
11. Upper South Fork Stanislaus River at Cooper Meadow (Cooper Allotment)

12. Unnamed tributary of Upper South Fork Stanislaus River at Horse and Cow Meadow (Cooper Allotment).
13. Wheats Meadow Creek at Wheats Meadow (Wheats Allotment), tributary of the Middle Fork Stanislaus River.

Mokelumne River watershed:

1. Elbow Creek at the Elbow on Highway 4, tributary of the North Fork Mokelumne River.
2. Unnamed tributary of Elbow Creek downstream of Sheep Meadow, which is within the Mokelumne Wilderness (in the Highland Lakes Allotment). Elbow Creek flows into the North Fork Mokelumne River.
3. North Fork Mokelumne River within the Highland Allotment at numerous locations including at Bloomfield Campground, Lower Gardner Meadow, and Lower Lower Gardner Meadow.
4. Unnamed tributaries of North Fork Mokelumne River (Highland Lakes Allotment) including Bloomfield Campground and Bear Tree Meadow.

Control Sample Sites (both are tributaries of the Tuolumne River):

1. The primary control sample site is Bourland Creek, just downstream of Bourland Meadow (which is not included in a rangeland allotment and thus should not have any livestock grazing). Bourland Creek flows into Reed Creek, which then flows into the Clavey River and ultimately to the Tuolumne River.
2. The sample stream flows through Cottonwood Meadow (which is within the Jawbone/Rosasco Rangeland Allotment), it is a tributary stream of Cottonwood Creek and is entirely within the Tuolumne River watershed. Cottonwood Creek flows into Cherry Lake/Reservoir. Cherry Creek flows into the Tuolumne River. (Note: The sample site associated with Cottonwood Meadow was originally planned to be a grazed sample area. However, due to a new fence around the lower portion of Cottonwood Meadow and around Cottonwood Creek, this area will not be grazed this year and will be used as a supplemental control site.)

Location of all sites sampled between 2011-2016 can be found on the California Environmental Data Exchange Network (CEDEN) website

(<http://ceden.waterboards.ca.gov/AdvancedQueryTool>). Search for “Stanislaus National Forest CSERC” under the “Select Programs” tab on the “Find data” page. Also see Appendix A.

5.5 Constraints

Extreme dry weather would limit or prevent representative sampling at any specific sample site due to low flow and/or harsh conditions that would adversely affect the parameters being monitored.

The six-hour time limit from the field to the lab for the bacteriological samples collected for this project is not a problematic constraint. The field days are planned with this time constraint in mind so that the field crew has ample time to deliver the bacteriological samples to AquaLab. However, if any bacteriological samples arrive past the six-hour time limit to the lab due to an unexpected delay (examples: vehicle issues, personnel injury), the data will either not be used or

it will be flagged as not meeting the time limit if the data is included in the final report.

6.0 Data Quality Objectives and Acceptability Criteria for Measurement Data

The Data Quality Objectives for this project provide quality specifications for the study in question and are listed below.

The key study question to be answered is:

Does the summertime presence of cattle in the Stanislaus National Forest negatively affect the beneficial uses of water bodies for recreation drinking water, or wildlife habitat?

Water contact recreation and aquatic life beneficial uses will be examined were examined using the indicators detailed in Table 6-1 below. Data Quality Objectives (DQOs) for the proposed project will be based on Measurement Quality Objectives (MQOs) for the analyte and organisms listed in Tables 6-1 and 6-2. Data acquisition activities will include laboratory analyses. Table 6-1 lists the MQOs for laboratory analyses. Table 6-2 lists MQOs for field measurements.

Detection Limit

The lowest concentration of an analyte that a specified analytical procedure can reliably detect for indicator bacteria (total coliform, fecal coliform, and *E. coli*) is 2 MPN/100 mL.

Table 6-1 Measurement Quality Objectives for laboratory analyses results

Matrix	Analyte	Unit	Precision*	Completeness
Water	<i>E. coli</i>	MPN/100 ml	<25% difference	Minimum 5 valid samples over a 30-day period
Water	Total Coliform	MPN/100 ml	<25% difference	Minimum 5 valid samples over a 30-day period
Water	Fecal Coliform	MPN/100 ml	<25% difference	Minimum 5 valid samples over a 30-day period

**Precision will be calculated using the relative percent difference (RPD) of field duplicate samples. If the RPD is >25%, the data will be flagged in the QAPP Report, but that data will still be used.*

Table 6-2 Measurement Quality Objectives for field measurements

Matrix	Parameter	Unit	Precision (RSD)*	Accuracy **	Measurement range	Completeness
Water	Specific conductance	µS/cm	10%	+/- 10	0 to 4,999	Minimum 5 valid samples in a 30-d period
Water	Temperature	°C	10%	+/- 10	-10 to 90	Minimum 5 valid samples in a 30-d period

*The Relative Standard Deviation will be used to calculate the Precision as a percentage, the smaller the RSD% the more precise the measurements.

** (Accuracy = average value – true value) true value = buffer solution standardized number, average value = YSI EcoSense EC300 reading of buffer solution.

Precision

The field parameters (specific conductivity and water temperature) are recorded three times at each sample site within five minutes. The precision for the field parameters will be calculated using the three entries by calculating the relative standard deviation (RSD), which will express how much the field measurements deviate as a percentage within that five-minute period of time. The RSD will be calculated for 10% of the total number of site visits (ex. If 80 samples are taken total, the RSD will be calculated for specific conductivity and water temperature for 8 of those samples). RSD is expressed as:

$$RSD = (\text{standard deviation}_{\text{fieldmeasurements}} / \text{absolute value}|\text{mean}_{\text{fieldmeasurements}}|) * 100$$

Field duplicate samples will be collected as a measure of precision. The relative percent difference (RPD) will be calculated for field duplicate samples for total coliform, fecal coliform, and *E. coli*. As discussed in Section 13 Quality Control, 10% of samples taken will be duplicate samples. RPD is expressed as:

$$RPD = (\text{absolute value}[D_{\text{sample}} - D_{\text{duplicate}}] / [(D_{\text{sample}} + D_{\text{duplicate}})/2]) * 100$$

As discussed in Section 13 Quality Control, 10% of samples taken will be field duplicate samples.

Field blanks will be collected at a frequency of 5% of the total samples taken during the sampling season, as discussed in Section 13 Quality Control. The standard deviation (SD) will be calculated for all field blank samples taken for bacteriological analysis.

Representativeness

All regular sample sites were selected during the spring season (early May through early June); they are all located at a stream either within or below a meadow. All sites have flowing water (sites are fed either directly from snow-melt, or by a spring or seep coming out of the mountain). Once the sites are selected, the same site will be sampled thereafter, unless the site dries-up.

Then the site will be moved as close as possible down-stream until flowing water is found again and another sample site is chosen. The new sample site will be as representative of the dry sample site as possible (within or below a meadow) and will be sampled for the remainder of the project. There is only one set of field equipment and only one field crew will be sampling for this project at a time. Meg Layhee will oversee and be present for all sampling events to ensure consistency of field crew sampling methods.

Completeness

The minimum number of samples taken for bacteriological analysis for valid results is: at least five samples taken in a 30-day period for each sample site. There will be two separate sets of five samples taken in a 30-day period; one minimum set of five samples before the cows are present in the local area of the Forest and a second minimum set of five samples after the cows are present in the local area of the Forest. More than five samples are planned to be collected at each site for both the "before" and "after" cattle scenario to ensure that there are at least five valid samples collected. Valid samples are those that have been collected using the methods described in the SOP (Appendix D) for this project and that have been delivered to the lab within the six hour time limit.

Comparability

This project will be conducted in the Stanislaus National Forest by CSERC annually. The data collected each year will be comparable to the data collected in previous years, beginning at the projects initiation in 2009. Previous studies conducted in the Sierra Nevada, including the Stanislaus National Forest have shown that water quality degradation has been linked to domestic livestock such as cattle and pack animals (Derlet, Ger, Richards, & Carlson, 2008). However, prior studies have been single point in time analysis. In the Sierra Nevada, no studies have been done comparing water quality before the introduction of summer cattle grazing with water quality after the cattle have been released into summer grazing allotments. No other projects have been conducted in the area by other agencies that we are aware of. However, if CSERC or another group chooses to conduct the same or similar project in the future, the data units and sampling methods should be comparable. The results for fecal coliform are comparable to the Basin Plan standards.

7.0 Special Training Requirements/Safety

The laboratory, AquaLab Water Analysis, has ELAP certification from California (State Certification #1359), and no other training or requirements are necessary for the purposes of this project. Meg Layhee received training from the previous technical advisor, Megan Fiske, who received training from Lindsey Myers who collected water samples under the QAPP since its development in 2009. All other involved staff members have received the basic training needed, and no additional specialized training is needed for this proposed project.

7.1 Training and Certification Documents

AquaLab Water Analysis maintains its own training documents and certification records.

Additional training and certification documentations is not needed for the purposes of the proposed project.

7.2 Training Personnel

All proposed project members already have the required basic training and no additional training is needed for this proposed project (a description of sampling protocol will be provided).

8.0 Documentation/Records and Final Report

8.1 Documentation/Records

Meg Layhee will be responsible for developing, maintaining, and updating the Quality Assurance Project Plan (QAPP). All field data gathered by this project will be recorded on field datasheets and entered/maintained in a digital database. Documentation for analytical data will be kept on file at the laboratory for review during any external audits by outside quality assurance agencies. The laboratory records will include the analyst's comments on the condition of the sample and progress of the analysis, raw data, instrument printouts, and results of calibration and QC checks. All original documentation as well as the QAPP will be held at the Central Sierra Environmental Resource Center office. Upon revision, the replaced QAPPs will be discarded.

John Buckley - the project manager, will oversee the maintenance of all records and will arbitrate any issues related to records retention. All records generated by this project will be stored at the CSERC office. AquaLab Water Analysis's director will be responsible for maintaining and retaining all analytical records, including sample receipt records, chain-of-custody forms, and printed and electronic data from laboratory analyses. Laboratory records generated by this project will be maintained at the CSERC office and AquaLab Water Analysis for five years following project completion. Data files will be maintained without discarding. AquaLab Water Analysis will archive all analytical records generated for this project. John Buckley of the CSERC will be responsible for archiving all other records.

All field operation records will be entered into electronic formats and maintained in a dedicated directory at the CSERC office. Each file will also have at least one back-up copy on CSERC's shared network.

Table 8.1 - Document and Record Retention, Archival, and Disposition

Record Type	Identification Type Needed	Retention	Archival	Disposition
Field Records	Includes: field observations and measurements, site ID, and sample ID.	5 Years	CSERC Office	Recycling
Analytical Records	Includes: receipts, chain	5 Years	CSERC Office	Recycling

	of custody forms, quality control records			
Data Records and Assessment records	Includes: field measurements and laboratory results	5 Years	CSERC Office	Recycling

Field Records will be kept in a folder at the CSERC office for 5 years, after which time they may be recycled if they are no longer needed or valid.

All analytical records including receipts, chain of custody forms, quality and control records will be kept at the CSERC office for 5 years, after which time they may be recycled if they are no longer needed or necessary to retain.

8.2 Final Report

Meg Layhee will be responsible for the final report that will be provided by the end of each year to Erick Burres, Ben Solvesky, Tom Harrington, John Buckley, and Dr. Tom Hofstra.

9.0 Sampling Process Design (Experimental Design)

The study question to be answered is:

Does the summer time presence of cattle in the Stanislaus National Forest negatively impact the beneficial uses of Forest water bodies for recreation, drinking water, or wildlife habitat?

Stations will be located in streams with adequate flow of water. The stations will be selected with the intent of contaminant source identification. The timing of monitoring will start in spring when the water is expected be pristine/high quality in order to document the quality of the water as the season progresses.

The sampling design principles used for this project can be defined as follows: Directed - A deterministic approach in which sample points are selected deliberately based on knowledge of their attributes of interest as related to the environmental site being monitored. The timing when monitoring will occur is during the day when the lab is open (during normal office hours). The season is determined by when the cattle are present in the Forest (which is the summer season).

The CSERC Field Crew will conduct the following activities at each site visit: collect water samples for lab analyses of the concentration of indicator bacteria (*E.coli*, total coliform, and fecal coliform), may measure other water quality parameters (e.g., water temperature, conductivity) and take notes on the weather, relative flow of water, and take pictures of the sample site.

The total number of sampling events for an individual site for the entire year will be +/-15.

Stations will be visited prior to cows being brought onto the forest, once cows are on the forest, and just after the cows are removed from the forest. The frequency of sampling events will be weekly or biweekly until at least five samples have been collected in a 30-day period. The planned interval between visits will vary, and the number of samples taken at each site visit (taken 5 minutes apart) will vary as well..

If a sampling site becomes dry or inaccessible, the field crew will select a new sampling site downstream within the watershed as close to the old sample site as possible. They will select the new site by walking down the stream along which their sample site has dried. The field crew will follow the dried portion of the stream until the stream starts flowing again (with water either from a meadow lower in elevation or a seep or spring) where they will pick a new sample site. The new sample site should be as representative of the dried site as possible. The field crew will continue sampling at this new site until the project is complete.

This study question will not require continuous monitoring.

To avoid non-natural variability and ensure sample accuracy, samples will be taken at the same spot every time (unless the sample site has dried up, then a new sample site will be chosen downstream and will be sampled thereafter). Laboratory samples will be checked for accuracy by taking field duplicates and field blanks using bottled water.

Possible sources of variability and sample inaccuracy and efforts to ensure quality data:

1. Measurement error - Quality Control samples (field duplicates and field blanks) will be taken to ensure laboratory accuracy and that field methods are not contaminating the sample. Field equipment will be maintained with regularly scheduled calibrations, and by calculating the field drift (by checking the calibration with buffer solutions before and after several sample
2. Natural (inherent) variability – Two measurements for water temperature and specific conductance will be taken at each site to compensate for natural variability. To compensate for any natural degradation in water quality (for instance, that may not be associated with the arrival of cattle), a control meadow (no grazing allowed) will be sampled to document any natural water quality variability.
3. Sample misrepresentation - All samples will be collected from the same site (unless the site had to be moved downstream due to lack of flow), from flowing water, 0.1 m under the surface (if stream depth allows), using properly cleaned/sterilized equipment.

Each sample event will occur during normal business hours, all samples will be kept on ice and delivered to AquaLab within six hours of the time they were taken.

Table 9.1 Sampling day schedule/timeline

Time/hours	Task*
08:00-09:00	Arrive at office, prep for field day by going through checklist.
09:01-10:00	Depart office, drive to furthest sample site from office.
10:01-11:00	Arrive at sample location, collect sample.
11:01-12:00	Drive to next sample location, collect sample.
12:01-13:00	Drive to next sample location, collect sample.
13:01-14:00	Drive to next sample location, collect sample.
14:01-15:00	Drive to AquaLab, fill out Change of Custody form and drop-off samples. Pick-up more sample bottles for next sampling day.
15:01-16:00	Return to CSERC office, unpack equipment for next sampling day.

*This is an approximate timeline and the timing of tasks may vary +/- up to one hour. The field crew aims to have samples to the lab before/around 16:00. The lab stays open until 17:00-18:00 (the field crew will call the lab on a rare occasions when they cannot get a sample to the lab by 17:00).

All information gathered for this project is for informational/assessment purposes only.

10.0 Sampling Methods Requirements

Water samples that are collected for bacteriological testing are collected while wearing sterile gloves and collected in sample bottles sterilized and provided by AquaLab Water Analysis. The bacteriological samples are collected before any other work is done at the site. The sample bottle is filled approximately to 4/5 of capacity, directly from flowing water approximately 0.1 m below the surface.

The sterilized Nalgene bottles provided by AquaLab for the bacteriological testing hold 125 mL of liquid; they are filled to approximately 100 mL with sample water.

The sterilized containers are provided by AquaLab Water Analysis, which has ELAP certification.

The sample containers are marked with a unique 3 digit identifying number with an indelible marker so that the markings will not run or become illegible when collecting the sample. The collection date, time and sampler's names are recorded on the field datasheet (Appendix B) that are kept at the CSERC office, they are also recorded on the Chain-of-Custody (Appendix C) form that is given to AquaLab along with the samples.

If monitoring equipment fails or sampling bottles are contaminated, CSERC Field Crew members will report the problem in the comment section of their field datasheet and will not record data values for any questionable samples. Actions will be taken to replace broken or contaminated sampling bottles prior to the next field visit, no data will be recorded with faulty or contaminated sampling bottles.

All water samples taken for bacteriological samples will be delivered to AquaLab within 6 hours from the time they were taken. The sampler will wear sterile gloves while taking and handling the sample. The sample will be kept in a ziploc bag (to avoid contamination from the ice water),

on ice in a cooler until delivered to AquaLab.

Indicator bacteria (total coliform, fecal coliform, and *E. coli*) and any other water quality parameters are measured using EPA protocols (USEPA 1997). The appropriate sections are: 2.3 Safety Considerations, Chapter 5 Water Quality Conditions-Quality Assurance, Quality Control, and Quality Assessment, 5.3 Temperature, 5.5. 5.9 Conductivity, 5.11 Fecal Bacteria, and Chapter 6 Managing and Presenting Monitoring Data, 6.1 Managing Volunteer Data, 6.2 Presenting the Data, 6.3 Producing Reports.

CSERC will provide the appropriate sections of, *Volunteer Stream Monitoring: A Methods Manual* upon request, or they can be viewed by going to: www.epa.gov (USEPA 1997). Appendix D contains more information about accessing this document.

Meg Layhee will be present for all sampling events to ensure that the field sampling methods will be consistent throughout the project. If the field crew is getting unusual readings for water temperature or specific conductivity, instrument calibration will be rechecked. If the field readings are found to be inaccurate due to equipment failure, they will not be included in the Final Report and the YSI EcoSense will be recalibrated before the next field day.

Table 10-1 Specifications for Sample Handling

Matrix	Parameter	Sample Equip. & Containers*	Minimum Container Amount	Preservative	Holding Time (at 4° C)
Water	<i>E. coli</i>	125 mL (4 oz.) Nalgene bottle	100 mL (3 oz.)	None	Less than 6 hours
Water	Total Coliform	125 mL (4 oz.) Nalgene bottle	100 mL (3 oz.)	None	Less than 6 hours
Water	Fecal Coliform	125 mL (4 oz.) Nalgene bottle	100 mL (3 oz.)	None	Less than 6 hours
Water	Conductivity	YSI EcoSense 300	None	None	Reading taken in stream
Water	Water temperature	YSI EcoSense 300	None	None	Reading taken in stream

*Sample containers are the property of AquaLab

11.0 Sample Handling and Custody

Meg Layhee, Megan Fiske, Julia Stephens, and John Buckley will be responsible for custody of the samples from the time they are taken until they are delivered to Aqualab. (Megan, Julia and John are CSERC staff. Meg Layhee will personally oversee custody responsibility for nearly all, if not all, samples taken.)

Field crews will fill out a field data sheet (Appendix B) for each sampling event. In the field data sheet the following items will be recorded: time of sample collection, sample identification

number, results of field measurements (e.g., water temperature, specific conductance), arrival and departure time from sample site, qualitative description of relevant water flow and weather conditions at the time of sample collection, and a description of any unusual occurrences associated with the sampling event (especially those that could affect sample or data quality).

The field crews will have custody of samples during field sampling and chain-of-custody (see Appendix C) forms will accompany all samples to the analyzing laboratory. Chain-of-custody procedures require that possession of samples be traceable from the time the samples are collected until completion and submittal of analytical results. The analytical laboratory will maintain custody logs sufficient to track each sample submitted and to analyze or preserve each sample within specified holding times.

In the field, all samples will be packed in wet ice, so that they will be kept at approximately 4 deg. C. Transport of the samples to the analytical laboratory will be by staff and/or personal vehicles. As soon as the samples are properly packaged and cooled with ice they will promptly be transported to the analytical laboratory for analysis along with the appropriate chain-of-custody forms.

12.0 Analytical Methods Requirements

Neither in situ nor continuous monitoring methods will be used with this project.

Indicator bacteria (total coliform, fecal coliform, and *E. coli*), water temperature, specific conductivity are measured using EPA protocols (USEPA 1997).

Table 12-1 – Instruments used for Field Measurements

Matrix	Parameter	Instrument	Features	Calibration mode	Available range and units	Resolution for parameter
Water	Specific conductivity	YSI EcoSense EC300	Four-electrode conductivity cell	Manual	0 to 4999 $\mu\text{S}/\text{cm}$	1 $\mu\text{S}/\text{cm}$
Water	Water temperature	YSI EcoSense EC300	Stainless steel thermometer	Non-adjustable	-10 to 90 $^{\circ}\text{C}$	0.1 $^{\circ}\text{C}$

Table 12-2 - Laboratory Analytical Methods and their Performance Criteria

Matrix	Analyte	Method Type/ Principle	Detection Limit	Detection Maximum	Medium Check
Water	<i>E. coli</i>	Multiple Tube Fermentation MPN/100 mL	2 organisms	1,600 organisms	Known Pos/ Neg Cultures
Water	Total coliform	Multiple Tube Fermentation MPN/100 mL	2 organisms	1,600 organisms	Known Pos/ Neg Cultures
Water	Fecal coliform	Multiple Tube Fermentation MPN 100 mL	2 organisms	1,600 organisms	Known Pos/ Neg Cultures

A copy of AquaLab's SOP for Multiple Tube Fermentation is on file at the CSERC office, the analytical standards utilized by this laboratory are derived from "Standard Methods For the Examination of Water and Wastewater", the 19th Edition (APHA 1995). Upon request, CSERC or AquaLab will distribute this document to interested parties.

AquaLab Water Analysis will provide the analyses for samples that are submitted for laboratory analysis. All of the methods that will be used are listed in Table 12-1 with specific method performance criteria.

AquaLab staff will be responsible for any corrective actions that may be needed in the event of methods failure to produce. If a method fails to provide reliable data for any reason, including analyte or matrix interferences, instrument failures, etc., then the involved samples will be analyzed again if possible. The laboratory's SOP for handling these types of problems will be followed. When a method fails to provide reliable data, then the laboratory's SOP for documenting method failures will be used to document the problem and what was done to rectify it.

After analysis of the project's samples have been completed by the laboratory they will be disposed of in compliance with all federal, state, and local regulations. The laboratory has standard procedures for disposing of its waste, including left over sample materials.

Turn around times for sample analyses will be as fast as possible based on the laboratory's work load. However, the turn around times will not exceed the holding times limit necessary for reliable results. The laboratory understands and has agreed to meet the turn around times needed for our proposed sample analyses.

13.0 Quality Control

To ensure Measurement Quality Objectives are met for laboratory analyses results, the field crew will collect field blanks.

Field blanks - Field blanks provide basic information for field handling, transport, and storage operations. They will be collected to evaluate whether contaminants have been introduced into

the samples during sample collection due to exposure from ambient conditions or from the sampling containers. These blanks will be obtained by pouring deionized water into a sampling container at the sampling location. Field blanks will be preserved, packaged, and sealed exactly like the surface water samples and will be submitted blind to the lab. Two field blanks per season will be collected.

Field Duplicates - Field duplicate samples provide precision information on all steps after sample acquisition. These samples will be collected as duplicates at designated sample locations by filling two distinct sample containers side-by-side. The field duplicate samples will be preserved, packaged, and sealed in the same manner described for the surface water samples. A separate sample number and station number will be assigned to each duplicate and the samples will be submitted. If the duplicate samples have a RPD of 25% or higher, the data will be flagged in the QAPP Report, but that data will still be used.

Table 13-1 Frequency of Checks for Sample Integrity, Laboratory Accuracy, Laboratory Precision, and Process Reproducibility

Matrix	Parameter	Field Blank Frequency	Field Duplicate Frequency
Water	Fecal bacteria	1 in 20 samples (5% of samples)	1 in 10 samples (10% of samples)

Background samples will also be taken, they provide a comparison between the concentrations or levels of the target parameters in the project's environmental samples with samples from an earlier time that is known or believed to be uncontaminated (i.e., to contain the target parameters at "natural" concentrations or levels. This is necessary in order to differentiate between the project on-site contribution and the off-site natural contribution to the parameter's concentrations or levels. Background samples will be the first round of sampling (5 samples in a 30-day period) taken before cattle are allowed into the Forest. They will be taken as close to the expected entry date of the cattle as possible to ensure that the second round of samples (another 5 samples in a 30-day period) are documenting the variations in data caused by the cattle (when present) and not the natural stream fluctuations. The analyses to be conducted on the background samples will be the same as that for the other project samples. A control sample from a pristine location (no cattle grazing allowed) will also be taken using the same sampling protocol for comparison/background purposes.

If the MQOs (see Section 6 for further discussion) are not met for the samples taken for lab analysis the results will still be included in the final report and will be flagged as not meeting the desired precision level. For the purposes of this project, the main interest is when/if the fecal coliform levels exceed the water quality standards set in the Basin Plan. Therefore, even if the desired precision level is not achieved, the information will still be valuable for looking at trends in quality of the water.

If the MQOs (Table 6-1, see Section 6 for further discussion) are not met for the field measurements the results will be flagged as not meeting the desired precision or accuracy level, but will still be included in the final report. However, data with erroneous readings where

equipment failure is suspected will be thrown out and not included in the final report.

14.0 Instrument/Equipment Testing, Inspection, Maintenance and Calibration Frequency

14.1 Instrument/Equipment Testing, Inspection, Maintenance

Field measurement equipment will be checked for operation in accordance with manufacturer's specifications. This includes battery checks and routine replacement and/or cleaning of parts as specified by the manufacturer. All equipment will be inspected for damage when first employed and again when returned from use. Maintenance logs will be kept and each piece of equipment will have its own log that documents the dates and description of any problems, the action(s) taken to correct problem(s), maintenance procedures, system checks, follow-up maintenance dates, and the person responsible for maintaining the equipment.

Laboratory measurement equipment will be maintained in accordance with the lab's Standard Operating Procedures (SOPs). This includes procedures specified by the manufacturer and also any that are specified by the methods used. Maintenance logs will be kept and each piece of equipment will have its own log that documents the dates and description of any problems, the action(s) taken to correct problem(s), maintenance procedures, system checks, follow-up maintenance dates, and the person responsible for maintaining the equipment.

14.2 Instrument/Equipment Calibration and Frequency

AquaLab Water Analysis management or designated staff will be responsible for Section 14 instrument/equipment calibration and frequency for the appropriate laboratory equipment. This will include documenting and checking that the specified calibration procedures were performed for each of the selected parameters being measured.

Meg Layhee will be responsible for calibrating/maintenance of the field instrument/equipment, and inspection of bottles received from AquaLab. This will include maintaining the logs that document what was done, who did the work, and when the work was done as described in the narrative and in Table 14-1 and 14-2 below.

Table 14-1 Field Instrument Calibration and Quality Checks Frequency

Matrix	Analyte	Instrument kind	Instrument name or type	Freq of calibration & Accuracy checks	Freq of Repeated Field Measurements
Water	Specific conductivity	Multi-meter	YSI EcoSense EC300	1 per month	3 measurements for each sample event
Water	Water temperature	Multi-meter	YSI EcoSense EC300	1 per month	3 measurements for each sample event

Table 14-2 Calibration Schedule

Month	Calibration location and personnel
May	YSI EcoSense EC300 conductivity calibrated by Meg Layhee using calibration solution* at CSERC office
June	YSI EcoSense EC300 conductivity calibrated by Meg Layhee using calibration solution* at CSERC office
July	YSI EcoSense EC300 conductivity calibrated by Meg Layhee using calibration solution* at CSERC office
August	YSI EcoSense EC300 conductivity calibrated by Meg Layhee using calibration solution* at CSERC office
September	YSI EcoSense EC300 conductivity calibrated by Meg Layhee using calibration solution* at CSERC office
October	YSI EcoSense EC300 conductivity calibrated by Meg Layhee using calibration solution* at CSERC office

*YSI EcoSense EC300 conductivity probe is calibrated using conductivity calibration solution 1,000 μ S (1 mS).

15.0 Inspection/Acceptance for Supplies

Meg Layhee will also be responsible for the visual inspection and acceptance of supplies obtained for AquaLab, and also of field equipment (YSI EcoSense EC300). Field equipment will be visually inspected before and after a sample event to verify that it is not damaged, is working properly, and has adequate battery life remaining. The supplies from the lab will be examined for damage, and replaced when they are found damaged. Selected critical supplies are: sterile bottles for bacteria samples.

All supplies will be examined for damage as they are received and then again as they are

obtained for use with the proposed project. Containers will be inspected for breakage and proper sealing of caps. Reusable supplies (e.g., coolers and safety equipment) will be examined for acceptable cleanliness and reuse. Any supplies deemed to be in unacceptable condition would be replaced. The laboratory's requirements for supplies and consumables are described in their QA Manual.

16.0 Non-direct Measurements (External Data)

It is not expected that external sources of data will be used to supplement the information produced by this project. No specific external data sources have been identified yet. If needed, literature searches will be conducted

Background data will be used in comparison purposes, or to supplement the monitoring data that will be measured and documented for this project.

Data Quality Indicators (DQIs) will be used to judge whether the external data meets acceptance criteria. These include, for example, precision, accuracy, representativeness, comparability, completeness, bias, and sensitivity.

Any external data that fails to meet acceptance criteria will not be used in the proposed project. If and when external data does not meet acceptance criteria it will, at the very least, be flagged as such. Flagged data may possibly be used under some conditions but its use will be limited and clearly designated.

As noted above, there are no expectations that external sources of data will be used to supplement the information produced by this project.

17.0 Assessments and Response Actions

17.1 Readiness Reviews

Meg Layhee will review all field equipment, containers, and paperwork to ensure that everything is ready prior to each sampling event. Before every sampling event a readiness review will be conducted by checking a list of everything that is needed to sample. It is important that all field equipment be clean and ready to use when it is needed. Therefore, prior to using all sampling and/or field measurement equipment, each piece of equipment will be checked to make sure that it is in proper working order. Adequate supplies of all bottles, labels, waterproof pens, etc. will be checked before each field event to make sure that there are sufficient supplies to successfully support each sampling event. It is important to make sure that all field activities and measurements are properly recorded in the field. Therefore, prior to starting each field event, necessary paperwork such as the field datasheet, chain of custody record forms, etc. will be checked to ensure that sufficient amounts are available during the field event. In the event that a problem is discovered during a readiness review it will be noted in the field notes and corrected

before the field crew is deployed. If actions are taken to correct the problem will also be documented with the problem in the field notes.

17.2 Post Sampling Event Reviews

Meg Layhee will be responsible for post sampling event reviews. Any problems that are noted will be documented along with recommendations for correcting the problem. Post sampling event reviews will be conducted following each sampling event when the field data is entered into a database in order to ensure that all information is complete and any deviations from planned methodologies are documented. Post sampling event reviews will include field sampling activities and field measurement documentation in order to help ensure that all information is complete. Post sampling reviews are important to ensure that data collected is consistent from the first sampling event to the last and to ensure that all data collected is useable.

17.3 Laboratory Data Reviews

Meg Layhee will be responsible for reviewing the laboratory's data for completeness and accuracy. The data will also be checked to make sure that the specified methods were used and that all related QC data were provided with the sample analytical results. Laboratory data reviews will be conducted following receipt of each data package from a laboratory in order to ensure that all information is complete and any deviations from planned methodologies are either corrected or the reasons for change are documented. Any laboratory data that is discovered to be incorrect or missing will immediately be reported to the laboratory's QA officer. The laboratory's QA manual details the procedures that will be followed by laboratory personnel to correct any invalid or missing data. The project director has the authority to request re-testing if a review of any of the laboratory data is found to be invalid or if it would compromise the quality of the data and resulting conclusions from the proposed project.

18.0 Data Review, Verification, and Validation Requirements

Defining data review, verification, and validation procedures helps to ensure that project data will be reviewed in an objective and consistent manner. Data review is the in-house examination to ensure that the data have been recorded, transmitted, and processed correctly. Meg Layhee will be responsible for data review. This includes checking that all technical criteria have been met, documenting any problems that are observed and, if possible, ensuring that deficiencies noted in the data are corrected.

In-house examination of the data produced from the proposed project will be conducted to check for typical types of errors. This includes checking to make sure that the data have been recorded, transmitted, and processed correctly. The kinds of checks that will be made will include checking for data entry errors, transcription errors, transformation errors, calculation errors, and errors of data omission.

Data generated by project activities will be reviewed against method quality objectives (MQOs)

that were developed and documented in Section 6. This will ensure that the data will be of acceptable quality.

QA/QC requirements were developed and documented in Sections 12-14 and the data will be checked against this information. Checks will include evaluation of field blank results. This will ensure that the data produced by this project will be as accurate and complete as possible.

Field data consists of all information obtained during sample collection and field measurements, including that documented in field log books and/or recording equipment, photographs, and chain of custody forms. Checks of field data will be made to ensure that it is complete and consistent. Meg Layhee will enter all information recorded on the field datasheets into a Microsoft Excel workbook; any missing or unclear information will be resolved at this time. The Excel workbook for each sample site will be saved in a file along with the pictures of that sample site for that day. Once CSERC receives the bacteriological analysis from AquaLab, the results will be recorded in the appropriate Excel workbook. The lab report is also checked for completeness at this time.

Lab data consists of all information obtained during sample analysis. The laboratory QA/QC Officer in accordance with the lab's internal data review procedures will perform initial review of laboratory data. However, once CSERC receives the lab data then we will perform independent checks to ensure that it is complete and consistent.

Data verification is the process of evaluating the completeness, correctness, and conformance / compliance of a specific data set against the method or procedural specifications. We will conduct data verification, as described in Section 6 and 13, Meg Layhee will be responsible for data verification.

Data validation is an analyte- and sample-specific process that evaluates the information after the verification process (i.e., determination of method, procedural, or contractual compliance) to determine analytical quality and any limitations. Meg Layhee will be responsible for data validation.

Data will be separated into three categories for use with making decisions based upon it. These categories are: (1) data that meets all acceptance requirements, (2) data that has been determined to be unacceptable for use, and (3) data that may be conditionally used and is noted and flagged as so.

19.0 Validation / Verification Methods and Reconciliation with Data Quality Objectives

19.1 Validation / Verification Methods

Defining the methods for data verification and validation helps to ensure that project data are evaluated objectively and consistently. For the proposed project many of these methods have been described in 19.2 of this section. Additional information is provided below.

All field datasheets for the proposed project will be checked visually against the Excel workbook datasheet copy, Meg Layhee will conduct all of these reviews and record the date of the review. The review and re-check will be conducted before any MQOs are calculated (as discussed in section 6).

All of the laboratory's data will be checked as part of the verification methodology process. Meg Layhee will conduct reviews of all laboratory data for verification of their accuracy. Any errors in data entry will be corrected; outliers and inconsistencies will be flagged for further review, or discarded, and all calculations will be double-checked. Problems with data quality will be discussed in the QAPP report.

Any data that is discovered to be incorrect or missing during the verification or validation process will immediately be reported to the Project Director. If errors involve laboratory data then this information will also be reported to the laboratory's QA officer. The laboratory's QA manual details the procedures that will be followed by laboratory personnel to correct any invalid or missing data. Meg Layhee will be responsible for reporting and correcting any errors that are found in the data during the verification and validation process.

If there are any data quality problems we will try to identify whether the problem is a result of project design issues, sampling issues, analytical methodology issues, or QA/QC issues (from laboratory or non-laboratory sources). If the source of the problems can be traced to one or more of these basic activities then efforts will be made to immediately resolve the problem.

19.2 Reconciliation with Data Quality Objectives

Information from field data reports (including field activities, post sampling events, and corrective actions), laboratory data reviews (including errors involving data entry, transcriptions, omissions, and calculations and laboratory audit reports), will be used to determine whether or not the project's objectives have been met.

Laboratory data will be statistically analyzed for precision, and completeness to ensure that the project's goals are met (as discussed in Section 6). The field and laboratory statistical data will be compared against the measurement quality objectives (MQOs) documented in Section 6. If the MQOs are not met, data may be flagged or discarded.

Data from all monitoring measurements will be summarized in tables. In addition, data that shows significant changes over time during the monitoring period will be plotted in graphs and charts.

Limitations will be clearer as the project progresses.

The above evaluations will provide a comprehensive assessment of how well the project meets its objectives. No other evaluations will be used.

Meg Layhee will be responsible for reporting project reconciliation at the end of the project. This will include measurements of how well the project objectives were met. All information will be

checked by the Project Manager and the QA Officer.

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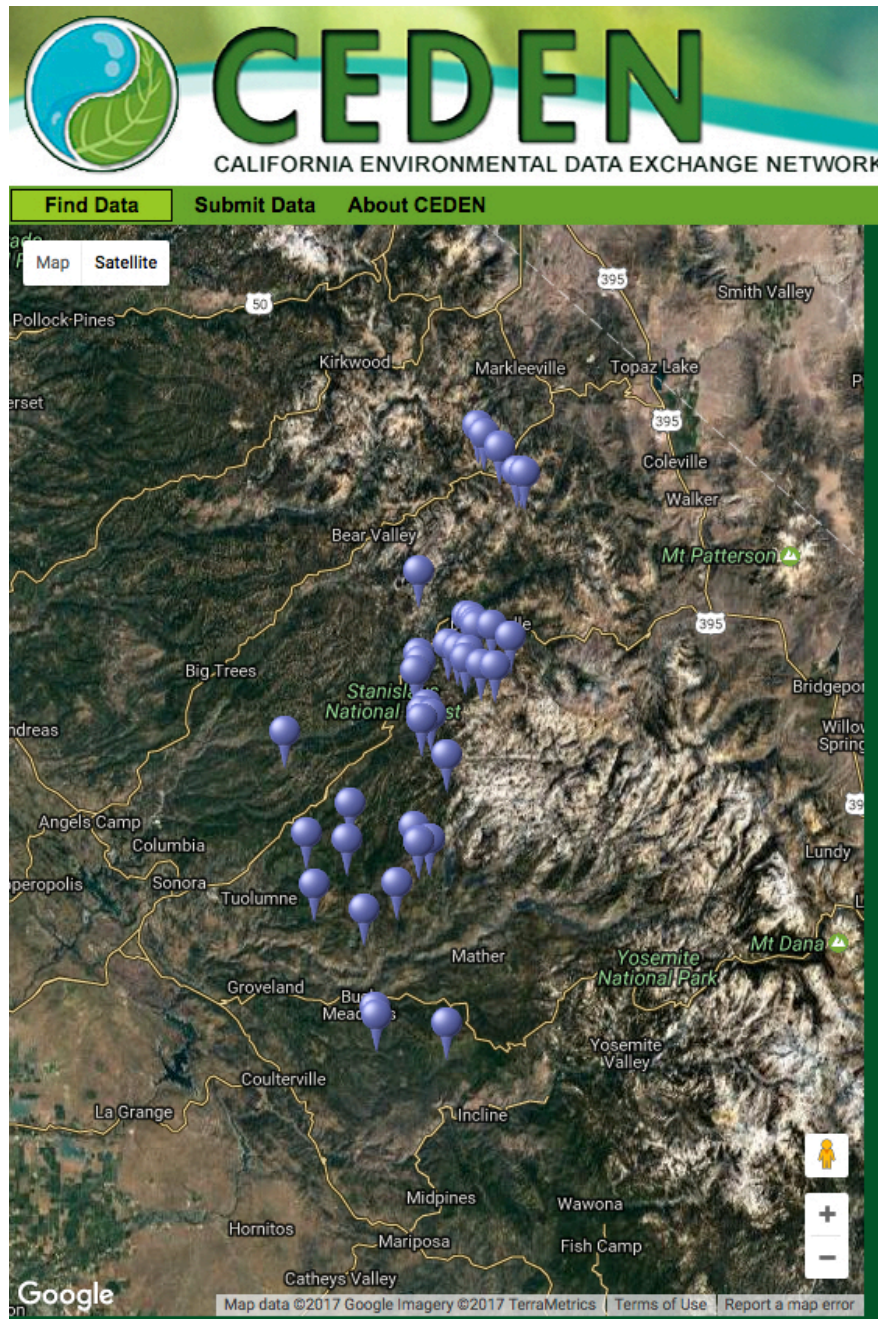
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Sunohara, M., Topp, E. Lapen, D.R. 2011. Associations among pathogenic bacteria, parasites, and environmental and land use factors in multiple mixed-use watersheds. *Water Research*, 45(18)5807-5825.

Appendix A: Location of sampling sites on the Stanislaus National Forest between 2011-2016 can be found on the California Environmental Data Exchange Network (CEDEN) website (<http://ceden.waterboards.ca.gov/AdvancedQueryTool>).



Appendix B: Field Form

Field Data Sheet for Water Quality Monitoring										
Surface Water Ambient Monitoring Project in the Stanislaus National Forest										
Waterbody:			Arrival time:			datum:				
Location ID:			Depart time:			gps device:				
Samplers:			lat:			camera:				
Date:			lon:			precip in last 24 hr?				
Site Observations:			Precipitation: None; Misty; Foggy; Drizzle; Rain; Snow							
Cloud Cover: None; Partly Cloudy; Overcast			Wind: Calm; Breezy; Windy							
Water Murkiness: Clear Water; Cloudy Water (>4" visibility); Murky (<4" visibility)										
Flow (relative): Very Low; Low-very low; Low; Med-low; Medium; High-med; High; Very High										
In-stream features: algae; aquatic plants; leaf litter; oily sheen; foam; trash; Other:										
Dominant understory:			Dominant overstory:							
Dominant streambed: bedrock; boulder; cobble; gravel; sand; fines			Reach type: riffle; run; pool							
Bank disturbance: Pocking; Chiseling; Sloughing; Other										
Cattle present: Yes No			Cattle manure: Instream; Streambank; Upland; Absent							
Cattle # and location:										
Recreational activity: Yes; No; describe: swim; campsite; trail; other:										
Pack stock present: Yes; No			Pack stock manure: Present; Absent							
Wildlife present: Yes; No; describe:			Pack stock manure: Instream; Bank; Upland; Other:							
Site Observation Comments:										
Field Measurements:			location of readings:							
Instrument ID		Parameter		Unit		Reading 1		Reading 2		Reading 3
canopy cover (# points covered)				Up:		RR:		Dwn:		RL:
wetted width (ft):										
start at RR		loc. 1	loc. 2	loc. 3	loc. 4	loc. 5	loc. 6	loc. 7	loc. 8	loc. 9
water depth (ft)										
dist. from bank (ft)										
		loc. 11	loc. 12	loc. 13	loc. 14	loc. 15	loc. 16	loc. 17	loc. 18	loc. 19
water depth (ft)										
dist. from bank (ft)										
Bacteria Sample:										
Container ID/type		Time		Container ID/type		Time		Container ID/type		Time
1)				3)				5)		
2)				4)				6)		
Bacteria Sample Comments:										
Sample color: None; Amber; Yellow; Green; Brown; Gray; Other								Sample arrival time at AquaLab:		
Sample odor: None; Algae smell; Chlorine; Sulfide; Sewage; Other										
Photos:		pic time, bearing, and description						pic description		
pic 1		pic 2						pic 3		
pic 4		pic 5						pic 6		
pic 7		pic 8						pic 9		
General Comments:										

Entered into dBase by: date: dBase check: date:

Appendix C: Chain of Custody Form

AquaLab Water Analysis P.O. Box 356 Twain Harte CA 95383										State Certification # 1359 (209) 586-3400 Fax: (209) 586-1492														
BACTERIOLOGICAL EXAMINATION OF WATER																								
CENTRAL SIERRA ENVIRONMENTAL RESOURCE COUNCIL PO BOX 396 TWAIN HARTE CA 95383										(e) MEGL@CSERC.ORG														
Phone: MEG LAYHEE 586 7440										Date:					Sampler:									
Source 1) Surface/ Spring 2) Well Head 3) Well Distribution										4) Reservoir 5) Distribution 6) Treatment Plant					Reason A) Routine B) Repeat C) Special					Type C) Total Coliform F) Fecal Coliform H) Heterotrophic Plate Count E) <i>E. coli</i>				
Collection Data										Five Portions sm 9221					Presence/Absence sm 9223B									
Lab ID Bottle ID	Time	Location	CL2	Source	Reason	Type	Vol mL	# Positive Tubes						Coliform			CFU mL 35 C @ 48HR							
								Prsmpt		Confirmed				P/A or MPN										
								24	48	24	24	48	48	#	Total	Fecal		E. coli						
Notification/Comments/Transported @ < 10 degree C										Set-Up: Date/Time/By:														
										Completed: Date/By:														

Appendix D: Standard Operating Procedures

Protocols for measuring pH, water temperature, specific conductivity, and fecal

bacteria are measured using protocols outlined in the EPA document, Volunteer Stream Monitoring: A Methods Manual.

The appropriate sections are:

2.3 Safety Considerations,

Chapter 5 Water Quality Conditions-Quality Assurance, Quality Control, and Quality Assessment,

5.3 Temperature,

5.9 Conductivity,

5.11 Fecal Bacteria, and

Chapter 6 Managing and Presenting Monitoring Data,

6.1 Managing Volunteer Data,

6.2 Presenting the Data,

6.3 Producing Reports.

CSERC will provide the appropriate sections of, Volunteer Stream Monitoring: A Methods Manual upon request, or they can be viewed by going to: www.epa.gov and searching for:

USEPA 1997. Volunteer Stream Monitoring: A Methods Manual. EPA 841-B-97-003.

Office of Water, U.S. Environmental Protection Agency, Washington, DC.

<https://www.epa.gov/sites/production/files/2015-06/documents/stream.pdf>