Monitoring Plan

Petaluma River Watershed Nutrient and Bacteria Impairment Study: Employing the Reachwide Benthos Method for Stream Algae Sampling and Additional Water Column Nutrient and Fecal Indicator Bacteria Measures

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Project Goals

Provide base line data on the quality of wadable fresh water streams in the Petaluma River watershed in support of management decisions in relation to the 303(d) nutrient and pathogen impairment listings, including: 1. An evaluation of impairment status, and 2. Scientific and proposed management next steps.

Background

The Petaluma River was first designated as a “water quality limited” segment of the Region 2 basin in 1975 due to low dissolved oxygen concentrations. In 1982, RWQCB staff observed “dissolved oxygen and nutrient problems…producing seasonal fish kills” and documented concerns regarding elevated fecal coliform levels (SFBRWQCB 1982). Subsequently, the City of Petaluma updated their wastewater treatment plant and ceased to discharge effluent between May and October of each year when freshwater inputs from tributaries do not provide enough flow to flush out potential pollutants (SSCRCD 1999). Though the river is no longer considered to be impaired by dissolved oxygen, it remains on the 303(d) list for Impaired Water Bodies for diazinon, nutrients, pathogens, sediment/siltation (SWRCB 2006), and trash (SFBRWQCB 2009).

In 2009, The Aquatic Science Center (ASC) was contracted by the San Francisco Bay Regional Water Quality Control Board (SFBRWQCB, or ‘Water Board’) to investigate the possibility of water quality impairment in the Petaluma River by three pollutants: sediment/siltation, pathogens, and nutrients. The project goal is to determine if the River is impaired, and if so, to what degree. This project is being completed in 4 parts:

Part 1: Summarize existing data and make comparisons between what is available for Petaluma and what was used for development of TMDLs for similar types of watersheds

Part 2: Build upon lessons learned in other watersheds to determine which specific datasets are essential for determining impairment

Part 3: Collect additional data (presently unfunded for nutrients and pathogens)

Part 4: Provide scientific analysis of potential impairment (presently unfunded for nutrients and pathogens)

The monitoring study proposed herein will complete Part 3 for nutrients and fecal indicator bacteria (FIB) by collecting additional data to support management decisions in relation to the 303(d) nutrient and pathogen impairment listing. The Petaluma CMIA report by the ASC (Ridolfi *et al.,* 2010) describes the climate, goemorpholgy and land use characteristics of the watershed, and summarized nutrient condition based on data from two earlier studies (1991 – 2003). Compared to the Los Osos and Chorro Creeks TMDLs, the Petaluma River has less data for nutrients in terms of number of samples. The percentage of samples in which numeric water quality objectives were exceeded was very high; however these results may be biased by the targeted sampling designs. In conclusion, based on our knowledge of water quality variations and responses in relation to nutrients, it was determined that insufficient data currently exists for determination of the impairment status. In the case of pathogens, the Petaluma CMIA report summarized the FIB conditions within the watershed based on existing data collected by the State Water Board's Surface Water Ambient Monitoring Program (SWAMP) during the dry season in 2006 (SFBRWQCB 2007a). Briefly, water samples were collected weekly for five weeks at four stations in the watershed, including two stations on the Petaluma River mainstem. E. coli results were above water quality objectives at all stations and fecal coliform concentrations were above the objectives at three of the four stations. Similar to the nutrient assessment findings, insufficient data currently exists for determination of the pathogen impairment status. Further monitoring was recommended in the ASC CMIA report to support an assessment of the status of nutrient and pathogen impairment in the Petaluma River watershed. Broadly, the two end-member outcomes could be scientific evidence for impairment for one or both nutrients and pathogens and evidence of no impairment.

This monitoring plan outlines a probabilistic and targeted sampling design to sample benthic algae (periphyton), water column nutrients and fecal indicator bacteria (FIB or pathogens) within the Petaluma River watershed. The study design will include sampling stations within the major agricultural/rural and urban land use areas described in the CMIA report in order to investigate the range of nutrient and pathogen conditions within the targeted sample frame.

The nutrient study will employ two lines of evidence: 1) the recently approved SWAMP Bioassessment Procedures for benthic algae and diatoms (Fetscher *et al*., 2009), 2) conventional water column nutrient and chlorophyll-a assessments. The Benthic Algae protocol is being developed as a tool to evaluate general stream health. As primary producers, algae occupy the base of the food web in aquatic ecosystems and therefore are a crucial component of healthy, functional streams. Many anthropogenic and natural impacts on streams are mediated through algal communities; thus algae can also serve as a tool to assess the overall stream health. Algae are also the biotic community most directly responsive to nutrients. Algal bioindicators therefore have potential for measuring the net effect of nutrients on the ecological health of streams more effectively than traditional methods.

Scientists in southern California are currently developing an index of biotic integrity for diatom and soft-bodied algae species for southern California (Periphyton Index of Biotic Integrity or PIBI). This requires correlation of algal community composition, physical habitat characteristics, and water chemistry parameters across a range of different stream reaches (the full SWAMP algal protocol includes these measures). They are also drafting a set of recommendations for implementing stream algae bioassessments into local, regional, and state monitoring programs. The Petaluma River watershed nutrient assessment study will collect a broad range of data based on the SWAMP algal sampling protocol, and additional water column nutrient measures both in support of using the PIBI, in the future, to further evaluate general stream health within the watershed, and to conduct a separate nutrient impairment assessment based solely on the traditional water column nutrient measures.

The FIB study will follow regulatory guidelines to evaluate results against the geomean water quality standards. This includes taking five samples over a 30-day period at each station. Given the differing nature of the sampling requirements of each pollutant, details of the sampling design for each is outlined separately. The general overarching study design and station allocation is discussed first followed by specific study elements for the Nutrients and FIB studies. Three different study designs are presented at the end with separate 'ball-park' cost estimates associated with each.

Study Design and Station Allocations

The goal of this data collection effort is to collect relatively unbiased, best-effort, environmental samples to characterize benthic algae (periphyton), water column nutrients, and fecal indicator bacteria (FIB) conditions within accessible areas of the Petaluma watershed in support of the TMDL management decisions for the Water Board.

The watershed has a mix of agricultural (pastures for grazing and vineyards), rural (grasslands), and urban/suburban land uses (Figure 1). There is a large region of the Petaluma River that is tidally influenced from the north-Bay with extensive wetlands. The lowest point along the Petaluma River unaffected by tidal influence is located past the railroad in Petaluma, upstream of the Lynch Creek and Petaluma River confluence (SWAMP workplan 2002-2003). This project will conduct benthic algae bioassessments upstream from the regions of tidal-influence, but will collect water column nutrients and FIB throughout the watershed.

A probabilistic (random) design, distributing sampling stations among the major sub-watersheds and land-use types, would provide a statistically-based, unbiased, impairment assessment of the targeted study area. However, a large proportion of the streams in the watershed are on private property, and it is possible that an inordinate number of stations may be inaccessible and drop out of the study design. This could drastically reduce the final extent of the sample area and possibly leave some key land-use types under-represented. A best-effort will be made to sample all major land-use types of targeted streams by making sure enough alternate (oversample) stations are allocated to the project. Additional targeted stations, specifically selected because they might be the most- and least-impacted could be added to the design to make sure that the study characterizes the 'range' of expected conditions in the watershed.

Per agreement, this Monitoring Plan did not include a reconnaissance effort to pre-determine the feasibility of sampling specific sub-watersheds and streams within the Petaluma River watershed. Instead existing GIS data was used to characterize the documented streams within the watershed and allocate stations within each sub-watershed and land-cover type. Enough stations were included in the probabilistic sample draw to be able to drop stations that are not able to be sampled for any reason. In essence, the final extent of the sample frame will be determined by what stream segments can be accessed and sampled during the timeframe of the field-sampling effort.

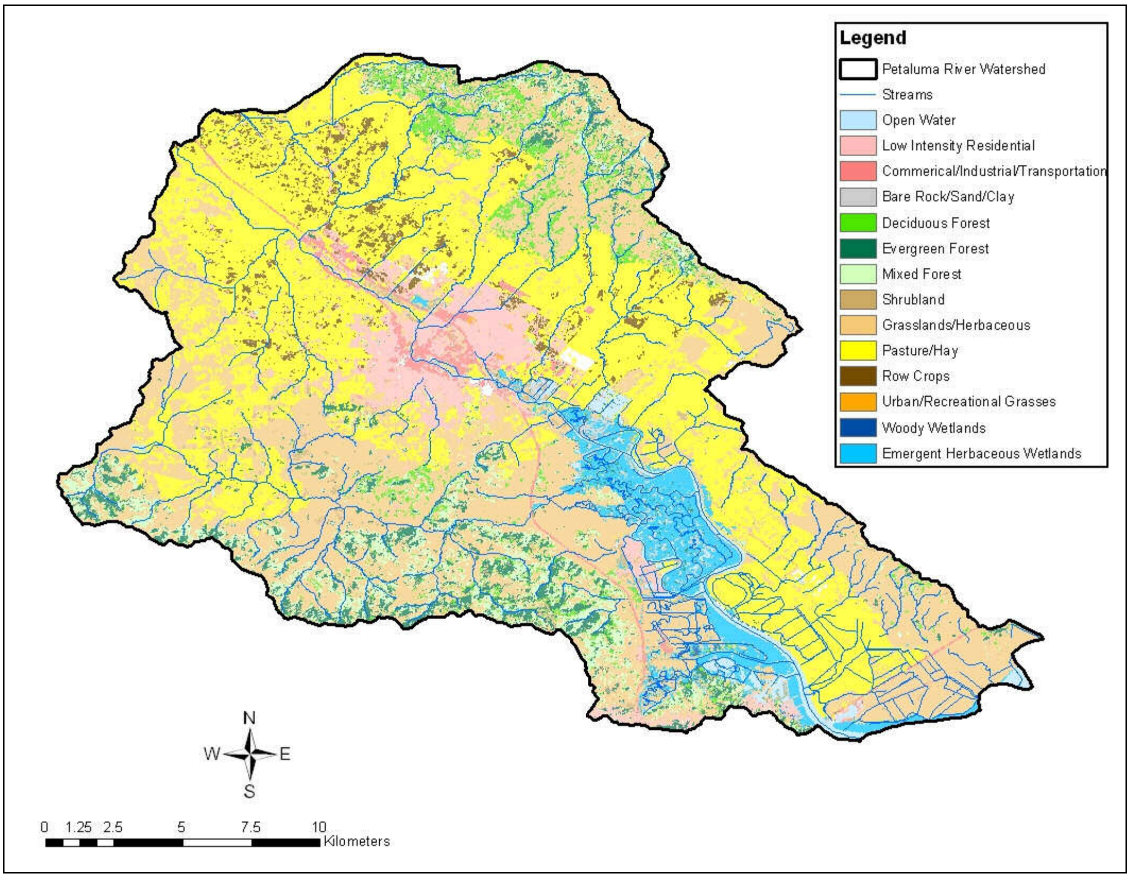

Figure 1. Land-cover types of the Petaluma River Watershed.

Characterizing Stream Segments

In an effort to distribute sampling stations across the range of land-use types within the Petaluma watershed pre-existing GIS information residing at SFEI[1] was used to characterize all documented streams in the USGS NHD Streams layer. Stream segments were assigned the attributes listed in Table 1. Attributes flagged with an "*" were used to proportionally allocate probabilistic stations to the major land-use and segment-specific land-cover categories. Other attributes may be useful in data interpretation. Figure 2 shows a map of the major sub-watersheds by dominant land-use type, lists the major streams, and displays the adjacent land-cover types for individual stream segments.

Table 1. Land-use and other attributes used to characterize the Petaluma River watershed stream-segments.

	Attribute	Description	Attribute Designation
1	Sub-watershed Name*	Small watersheds within the extent of the Petaluma River watershed.	Lynch Creek, Adobe Creek, Stage Gulch, Petaluma River, Rush Creek, Liberty Creek, Upper San Antonio Creek, Lower San Antonio Creek
2	Major land-use type*	Dominant land-use type assigned to the sub-watersheds within the Petaluma watershed extent.	Agricultural, Mixed, Rangeland, Urban
3	Stream Name	Name of stream	Note - only major streams are listed in the NHD, resulting in some missing values.
4	Segment-specific land-cover type*	Land-cover type is assigned to each stream segment based on 30 m resolution 2001 NLCD from USGS. Each stream segment (stream reaches between bifurcations) were assigned the dominant land-cover type of all types intersecting the stream. Individual land-cover types can be aggregated for data analyses. Note that no sampling stations were allocated into the Wetlands land-cover type.	Developed, Open space, Developed, Low intensity (Residential), Developed, Medium Intensity (Residential), Developed, High Intensity (Apartments/Comercial/Industiral), Barren Land, Shrub/Scrub, Grasslands/Herbaceous, Forest, Pasture/Hay, Cultivated Crops, Open Water, Wetlands
5	Proximity to major roads*	Defines if the stream segment is within 1 mile of a major road or not.	<1 Mile = 1, >1 Mile =0

[1] Source of GIS data layers:

Watershed boundaries: Calwater 2.2.1, 2004, California NRCS
Streams: NHD 2002 - U.S. Geological Survey National Hydrology Dataset
Roads: Major U.S. Roads 2002 - National Geography Dataset, ESRI
Land cover: NLCD (National Land Cover Dataset) 2001
Tidal Extent: Historical Baylands (SFEI)

	Attribute	Description	Attribute Designation
		This attribute was used to limit the sample frame to sites that are within 1 mile of a road because sites that are far from a road will be prohibitively expensive to sample.	
6	Tidally influenced*	SFEI used the tidal extent from the Historical Baylands GIS data layer and notes from the SWAMP work-plan 2002 (pg 12 item 7) to assign tidally influenced stream segments. A large portion of the mainstem Petaluma River and parts of the Lower San Antonio Creek are tidally influenced. The algal bioassessment will not be conducted in those river segments. However, water column nutrient and pathogen samples will be collected within this region.	Tidal = 1, Not Tidal = 0
7	Proximity to a dairy or other animal farm	Dairy or beef operations, goat farms and one CAFO (Concentrated Animal Feeding Operation) are identified within the watershed by address. A 1 mile buffer was drawn around these farms (2 mile diameter circles) and stream segments were assigned a binary value based on proximity.	<1 Mile = 1, >1 Mile = 0

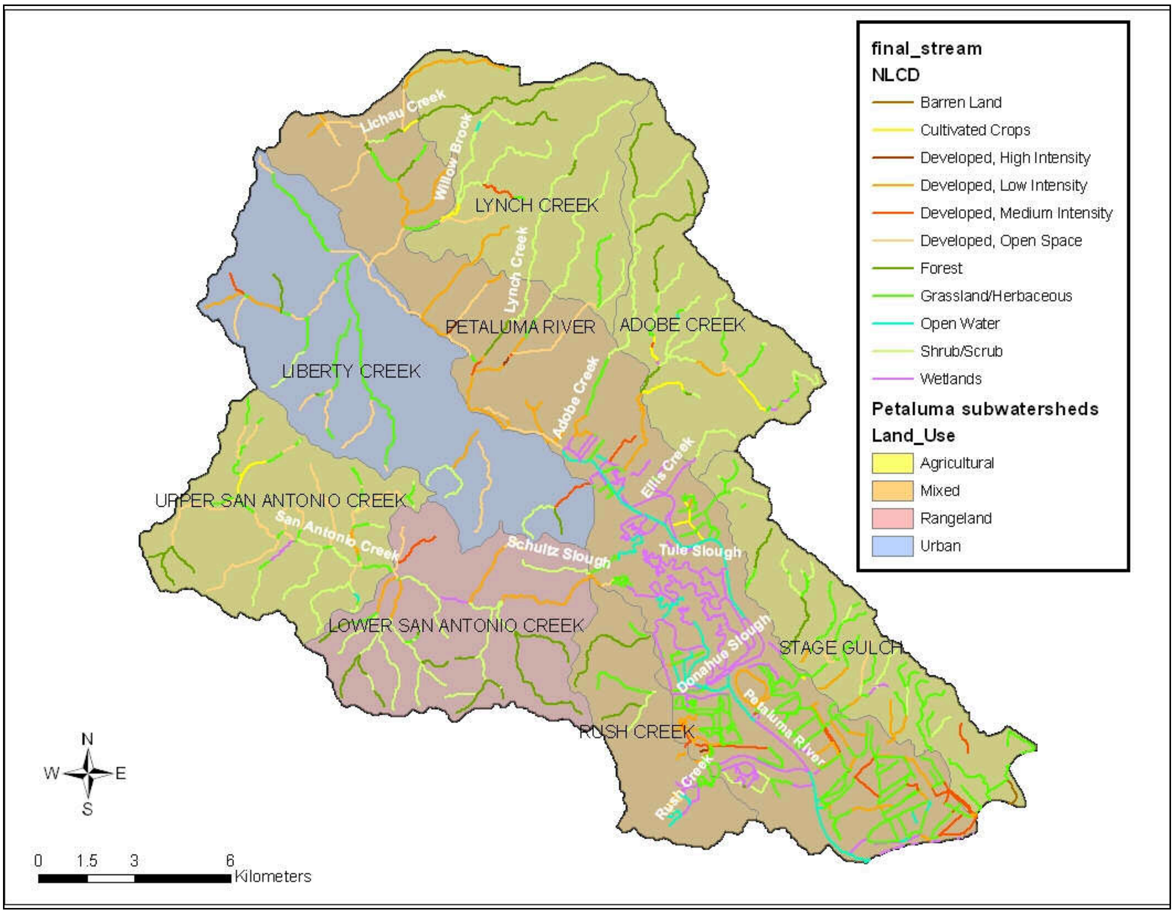

Figure 2. Petaluma sub-watersheds and streams (stream segments are colored by adjacent land-cover types (NLCD- 2001).

Station Allocations

Tony Olsen of the US EPA: NHEERL Western Ecology Division (Corvalis, Oregon) provided the sample draw for the probabilistic sample design element for this Monitoring Plan. The station selection process employs the EPA's Environmental Monitoring and Assessment Program's (EMAP) Generalized Random Tessellation Stratified design (GRTS). The GRTS design is such that sampling sites within different land-use types and across land-use types are not independent of each other. Inferences can be made about the condition of each land-use type and about the whole watershed. The randomly assigned stations were allocated to each stream based on sub-watershed and major land-use types. Only stream lengths that were within a mile of a major (mapped) road were targeted to ensure that the sampling sites are reasonably accessible. Additionally tidally influence stream reaches were targeted separately because the benthic algae bioassessment protocol can only be used in freshwater wadable streams. Additional targeted stations may be added to the study design to include sites that are expected to be impaired or reference sites to try to capture the 'expected range' of impairment within the watershed.

The probabilistic random sample design will allow the project to make inferences about impairment condition within the Petaluma watershed with some amount of statistical confidence. Because the stations will be stratified by major land-use within the sub-watersheds, inferences can be made about impairment conditions between the different categories or conflated to estimate impairment condition within the entire sample frame.

The final sample draw spatially distributed stations in streams across the watershed. However, because this sample draw was based solely on available GIS data, the actual ability to physically sample the targeted stations in active streams will determine the final extent of the sample frame for the study. Limiting factors that may affect the final extent of the sample frame include:

- Water flowing and/or present within the stream transect at the time of sampling (the 100 – 150 meter transect length required by the algal protocol).

  A field reconnaissance of the study area will be made before the initial scheduled field sampling event to determine the presence of water in the streams and level of difficulty of gaining access to targeted stations for sampling.
- Obtaining permission to access stations on private land

  A separate outreach effort could be made to work with the Resource Conservation District (RCD), Friends of the Petaluma River, the City of Petaluma, and Sonoma County Water Agency and/or private land owners to get permission to access targeted random stations.
- Proximity to a road. The extended time required to hike into a distant station with all the sampling equipment may be cost prohibitive. Additionally, the FIB samples have a holding time of six hours.

  The sample frame for this study is limited to sites that are close enough to a major road (by 1 mile) because of time and cost considerations.
- The ability to find and access potential reference sites. It should be noted that staff opinions and those from other studies (SWAMP Workplan 2002-2003) indicate that finding accessible reference stations in the Petaluma watershed will be problematic and may not be feasible (both because of private ownership and because there are few areas unaffected by some form of agriculture or urbanization).

  The Region-2 SWAMP is currently developing reference sites for water quality and stream health assessments in the region. This includes algal-bioassessments and water column nutrients. Richie Creek in the Napa River watershed is the SWAMP reference site that may be a comparable habitat to many streams in the Petaluma River watershed. However, the methods for determining which reference sites are comparable for a study has not been finalized and the SWAMP reference site development project is still in progress at the time of developing this Monitoring Plan.

<u>Sample Size</u>

The final sample size for each component of this study (Nutrients and FIB) will be worked out through discussions with the design team (ASC staff, the Water Board, and other stakeholders). Factors to consider in selecting the final sample size will need to balance cost with being able to make inferences about pollutant impairment with some degree on statistical confidence either within each land-use category or the watershed as a whole. Three sample size examples are presented in the Design Scenarios section below, along with preliminary ("ball-park") costs estimates for each level of effort.

The US EPA Aquatic Resource Monitoring website (http://www.epa.gov/nheerl/arm/) has support tools for developing robust environmental sample designs, and contains a good discussion about how to evaluate the amount of statistical precision one will have based on different sample sizes. Resources from this website can be used to estimate the precision levels of the example study designs presented in the Design Scenarios section.

Nutrients

Sampling Effort

The nutrient study includes a benthic algae bioassessment component and a water column nutrient survey. The benthic algae bioassessment protocol is only applicable to freshwater streams and is conducted during an index period in the dry season (May – September). Therefore the benthic algae bioassessments will only take place in stream reaches above the tidally-influenced region of the watershed. Water column nutrient samples will be collected at all the benthic algae bioassessment stations and will extend into the tidally-influenced region of the watershed since nutrient samples can be collected in estuarine waters. In the tidal region a salinity profile may be used to determine where to sample in order to sample the salinity gradient and help in interpreting potential nutrient sources in that region.

A seasonal component will be included in the Nutrient study whereby water column nutrients will also be sampled in the wet season (January – February). January-February sampling would represent stable-flow wet season conditions, while May – September sampling would represent stable dry season conditions: May indicating a wet season recession (higher water tables and some surface drainage, and September indicating almost entirely ground water processes with minimum point source (or illicit discharge) dilution.

Sample Collection

The SWAMP Algal Bioassessment Procedures includes water column samples that are synoptically collected and analyzed for a suite of nutrients to aid in interpreting the results. This study will augment the recommended suite of water column nutrients measures to include chlorophyll-a for the nutrient impairment assessment. Additional water quality parameters (pH, dissolved oxygen, temperature, conductivity, and turbidity) will be measured and recorded at all stations with a multi-parameter probe. All of these parameters will aid interpretation of the results directly. pH and temperature are necessary for interpretation of any toxicity associated with ammonia, DO will provide an indication of the balance between production and decay of organic matter, conductivity will help to identify geological and soil provinces in relation to phosphorous, and turbidity will help us interpret nutrients (particularly P) in the particulate phase.

Although it is possible to pick and choose data types, to fully address the objectives outlined above, we propose to use the full SWAMP Standard Operating Procedures for Collecting Stream Algae Samples and Associated Physical Habitat and Chemical Data for Ambient Bioassessments in California. (Fetscher *et al.,* 2009). This algal protocol includes complete instructions on the following tasks and measures, including sample collection, handling, and storage for analysis:

- Layout of reach, marking transects, recording GPS coordinates
- Notable field conditions
- Temperature, pH, specific conductance, DO, alkalinity
- Turbidity, Silica
- Water chemistry for lab analysis (see list below)
- Algal Sampling for Taxonomic IDs
- Algal Sampling for Biomass Assessment (Chlorophyll *a* and ash free dry weight (AFDW))
- Wetted Width
- Bankfull Dimensions
- Depth and Pebble Count + CPOM
- Percent Algal Cover (point-intercept with Pebble Count)
- Cobble Embeddedness
- Canopy Cover
- Gradient
- Human Influence
- Bank Stability
- Flow Habitat Delineation
- Discharge
- Photo documentation

Water chemistry parameters will be collected and analyzed in a laboratory to support full interpretation of the algal data:

- Nitrate as N (NO_3)
- Nitrite as N (NO_2)
- Ammonia as N (NH_3)
- Nitrogen, Total (TN)
- Orthophosphate as P (SRP)
- Phosphorous, Total (TPHOS)
- Dissolved Organic Carbon (DOC)
- Chloride (Cl)
- Chlorophyll *a* (Chl-a in water column)
- Suspended Sediment Concentration (SSC in the tidal region)

Specific instructions on the proper techniques for collecting, preserving, and storing the water samples until analysis is detailed in the State Water Board's Quality Assurance Program Plan for the Surface Water Ambient Monitoring Program (SWAMP QAPrP, 2008).

Analyses

Many of the algal protocol measures are direct measures made in the field by trained staff using electronic or hardcopy field sheets. The soft-bodied algae and diatom taxonomy will be conducted by trained taxonomists, familiar with the Statewide Reference study and experts with California taxa. This will minimize taxonomic differences between the Statewide Reference study and other data collected by SWAMP in order to make the data from this study as comparable as possible to other current studies for 'hind casting' the IBI assessment when it is developed. Algae biomass (chlorophyll *a* and AFDW), and water chemistry samples will be analyzed by qualified laboratories using comparable methods to those employed by the Statewide Reference study and SWAMP.

Data Interpretation to Support Impairment Assessment

The Petaluma periphyton and nutrient study report will provide a scientific assessment of nutrient impairment within the freshwater tributaries of the Petaluma River. The first part of the assessment will consist of a nutrient section that will summarize nutrient concentrations, speciation, and relationships between nutrient forms in the context of the major land use types and geo-spatially within the watershed. Nutrient measures will also be compared to relevant regional water quality criteria in support of management decisions in relation to the 303(d) nutrient impairment listing.

The second part of the assessment will characterize the soft-bodied algae and diatom taxa found within the watershed and include a discussion of the distribution of indicator species: some of the diatoms and soft algae are indicators of water quality (e.g. some are sensitive to metals and others to organic enrichment). Currently the only way to use the algal data to evaluate potential nutrient impacts is through what is known about specific indicator taxa and their sensitivity pollutants (pers. com. Fetsher, SCCWRP). The distribution of those indicator species will be discussed. A separate multivariate distribution analysis will also be conducted to further characterize the algal and diatom communities within the watershed.

SFEI is currently working on a project (using state Proposition 50 funds) to map riparian cover in the Petaluma watershed (end date December 2010). Those data may be useful in interpreting the benthic algae and nutrient results since canopy cover may be correlated to algal condition (personal communication with B. Fetscher, SCCWRP).

Possible Additional Steps to Support Algal Bioassessment Tools for California?

The products of this study are intended to be of use specifically to support management of water quality in the Petaluma watershed. However, these tools need to be developed further and verified for use around the state as a management tool. The Algal Bioassessment protocol results may be used in support of evaluating the synoptically collected nutrient data. They may also be used to evaluate the utility of the draft periphyton Index of Biotic Integrity (PIBI), and/or other periphyton bioassessment tools developed for Southern California for Northern California streams. Eventual outcomes of the Algal Bioassessment may include evaluating and potentially adapting the PIBI to

Northern California stream habitats and other parts of the state if warranted. The Algal Bioassessment protocol may be used to evaluate future changes in PIBI scores and/or indicator taxa within the Petaluma watershed related to management actions that may be implemented as a result of the nutrient and/or pathogen impairment assessment process.

Fecal Indicator Bacteria (FIB)

Sampling Effort

A subset of the probabilistic stations (and additional targeted stations) to be sampled for water column nutrients will be sampled using regulatory sampling protocols required to estimate the geometric mean (geo-mean) bacterial counts. Geo-mean FIB stations are sampled a minimum of five times (at a consistent interval) over a 30-day period. Because of the intensive sampling required by the geo-mean protocol, only a subset of the water column nutrient study sites can be sampled. The current study design scenarios, outlined in the 'Design Scenarios' section, samples only during the dry season. If wet weather sampling is warranted, half the number of FIB sites outlined in the 'Design Scenarios' section could be sampled in the wet and dry season (Summer 2011 and winter 2012 respectively) without a substantial cost difference.

Sample Collection

The sample collection methods will be conducted in accordance with the sample collection and handling methods employed by the SWAMP and described in the *MPSL-DFG_FieldSOP_v1.0: Standard Operating Procedures (SOPs) for Conducting Field Measurements and Field Collections of Water and Bed Sediment Samples in SWAMP* (SWAMP, 2009).

Analyses

The Napa River and Sonoma Creek Pathogen TMDL processes conducted additional studies to characterize fecal coliforms, *E. coli*, and fecal enterococci conditions. Use of these indicators is consistent with state water quality criteria and with federal guidance (USEPA, 2002). The Petaluma River watershed study will characterize the same FIB. Analytical methods will be consistent with the State Water Board's Quality Assurance Program Plan for the SWAMP (SWAMP QAPrP, 2008).

FIB water quality objectives and criteria are listed in the San Francisco Bay Basin (Region 2) Water Quality Control Plan (SFBRWQCB, 2007) for estuarine and freshwater conditions. Table 1 lists the water quality objectives that will be used to evaluate FIB condition within the Petaluma watershed. The geo-mean objectives are the targeted objectives for use in this study. Enterococcus is generally a more reliable indicator in marine or estuarine habitats but will be quantified at all stations and compared to the appropriate regulatory objectives. Results will be reported as the most probable number (MPN/100ml) as recommended in the Basin Plan.

Table 2. San Francisco Bay – Basin Plan Bacterial Water Quality Objectives.

Fecal coliform (Rec-1)	Geometric mean < 200 [a] 90th percentile < 400 [b]
E. coli (US EPA water contact criteria)	Geometric mean < 126 [a] Maximum at lightly used area < 406
Enterococcus (US EPA water contact criteria) Applies to freshwater	Geometric mean < 33 [a] Maximum at lightly used area < 108
Enterococcus[c] (proposed Basin Plan amendment) Applies to marine and estuarine waters	Geometric mean < 35 [a] No sample to exceed 104

[a]Based on a minimum of five consecutive samples collected at approximately equal intervals over a 30-day period.
[b]No more than 10 percent of total samples during any 30-day period may exceed this number.
[c]Proposed Basin Plan amendment Feb.2010 (SFBRWQCB, 2010)

Data Interpretation to Support Impairment Assessment

In support of management decisions in relation to the 303(d) pathogen impairment listing the final report will characterize the level and distribution of FIB within the study area based on the regulatory geo-mean bacterial counts.

Design Scenarios

The design team will determine the final sample design based on cost and the level of effort they are comfortable with for making management decisions related to the current Petaluma River TMDLs for nutrients and pathogens. Three design scenarios presented here represent some trade-offs between cost and getting a large enough sample size to have adequate coverage of the watershed.

50 Random and no Targeted Nutrient Stations with 25 Pathogen Stations

Preliminary discussions with Tony Olsen indicated that having 50 random sites allocated within the watershed would provide about a 12% precision with a 90 percent confidence interval when making an inference about pollutant conditions within the watershed. If one wants to have statistical confidence to make inferences about specific land-use categories or sub-watersheds, then a larger samples size would be needed. Table 2 shows the number of sites allocated to each sub-watershed and the dominant land-use type of each. A general sampling cost estimate for the study design is presented below and a list of site locations and an example sampling schedule is presented.

Table 3a. Number of stations by sub-watershed and land-use type for a 50-site random sample design scenario.

50-site probabilistic design with stratification by major sub-watershed No targeted stations added to design.					
	Upstream		**Downstream**		
Sub-watershed Name ↓ & Type →	**Agricultural**	**Rangeland**	**Mixed**	**Urban**	
Lynch Creek	**6**				
Adobe Creek	**6**				
Stage Gulch	**5**				
Petaluma River & Rush Creek			**9**		
Liberty Creek				**4**	
Upper San Antonio Creek	**6**				
Lower San Antonio Creek		**6**			
Tidally Influenced Petaluma/San Antonio			**8**		
Sub-total Number of Random Sites	23	6	17	4	50
Targeted Stations (expected impacted and reference)					0
Total					**50**

Table 3b. Ball-park cost estimate for the 50-site random sample design scenario.

Sampling Cost Estimate:	**Dry season**	**Wet season**	**Total Cost**
Algal Bioassessment and synoptic Water Column Nutrients (Algae)	42	0	$ 107,772
Algal Bioassessment and synoptic Water Column Nutrients (WC Nutrients)	42	0	$ 22,008
Additional WC Nutrients	8	25	$ 19,445
FIB	25	25	$ 73,500
Targeted Stations - WQ Nutrients	0	0	$ -
Targeted Stations - FIB	0	0	$ -
			$ 222,725
Project Management			$ 24,360
Data Management & Reporting			$ 22,620
Direct Expenses			$ 4,000
			$ 273,705

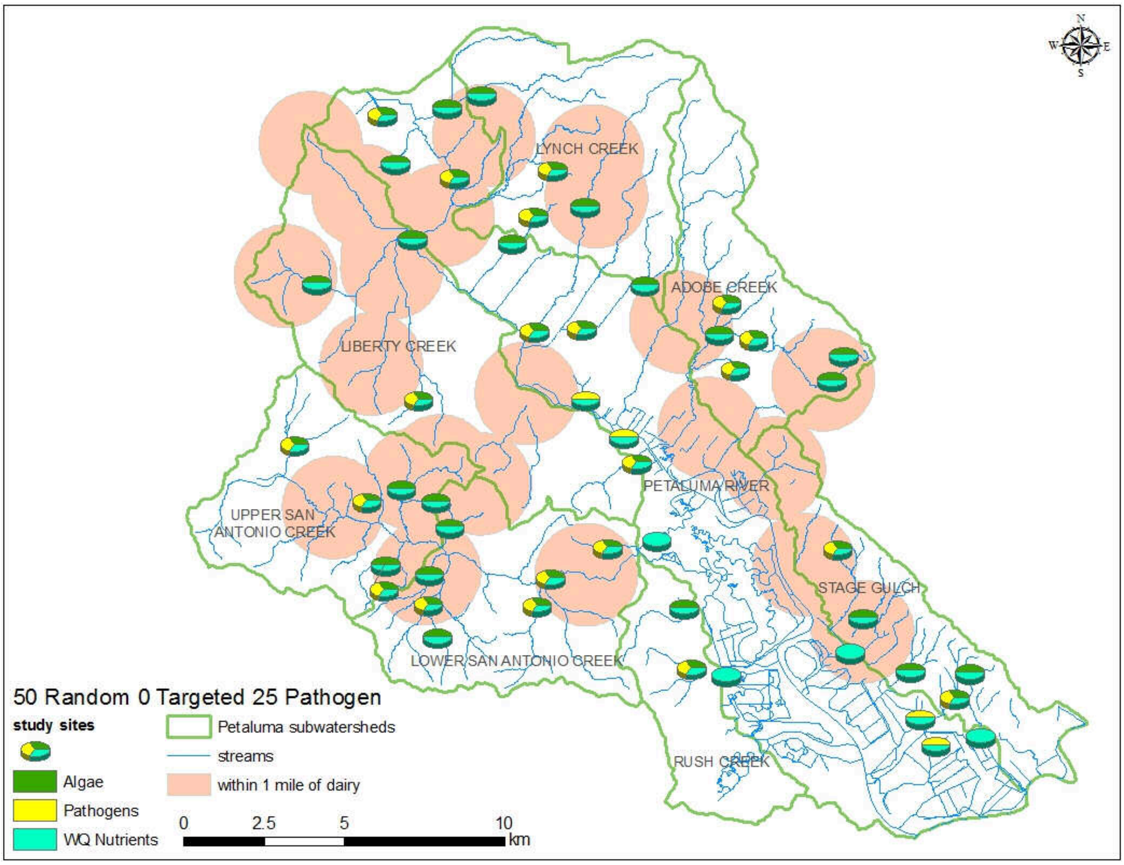

Figure 3. Map of the 50-site random design scenario with 25 pathogen samples and no targeted sites.

Table 3c. Station locations (by stratum) for the 50-site sampling design and an example sampling schedule. Separate sampling crews will need to be responsible for sampling Algae/WQ-nutrients and FIB (pathogens) respectively. 1 and 0 indicate if a parameter group is measured at the listed site (1 = yes, 0 = no).

stratum	*siteID*	*lat*	*long*	*Algae*	*WQ Nutrients*	*Algae & WQ Sample Date*	*Pathogens*	*Pathogen Sample Dates*
Lynch_Creek	PNS-01	38.25122	-122.61749	1	1	Tuesday, July 05, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Lynch_Creek	PNS-02	38.29579	-122.62946	1	1	Wednesday, July 06, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Lynch_Creek	PNS-03	38.28263	-122.63580	1	1	Thursday, July 07, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Lynch_Creek	PNS-04	38.26402	-122.59543	1	1	Friday, July 08, 2011	0	
Lynch_Creek	PNS-37	38.31638	-122.65962	1	1	Monday, July 11, 2011	0	
Lynch_Creek	PNS-38	38.28572	-122.61752	1	1	Tuesday, July 12, 2011	0	
Adobe_Creek	PNS-05	38.24966	-122.55894	1	1	Wednesday, July 13, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Adobe_Creek	PNS-06	38.25963	-122.56603	1	1	Thursday, July 14, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Adobe_Creek	PNS-07	38.24106	-122.56230	1	1	Friday, July 15, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Adobe_Creek	PNS-08	38.23919	-122.52768	1	1	Monday, July 18, 2011	0	
Adobe_Creek	PNS-41	38.24577	-122.52376	1	1	Tuesday, July 19, 2011	0	
Adobe_Creek	PNS-42	38.25077	-122.56846	1	1	Wednesday, July 20, 2011	0	
Stage_Gulch	PNS-09	38.15396	-122.48627	1	1	Thursday, July 21, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Stage_Gulch	PNS-10	38.19118	-122.52407	1	1	Friday, July 22, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Stage_Gulch	PNS-11	38.15743	-122.49704	1	1	Monday, July 25, 2011	0	
Stage_Gulch	PNS-12	38.17205	-122.51428	1	1	Tuesday, July 26, 2011	0	
Stage_Gulch	PNS-45	38.15728	-122.47591	1	1	Wednesday, July 27, 2011	0	
Petaluma_Rush	PNS-13	38.15644	-122.57459	1	1	Thursday, July 28, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Petaluma_Rush	PNS-14	38.18984	-122.60621	1	1	Friday, July 29, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Petaluma_Rush	PNS-15	38.25023	-122.63450	1	1	Monday, August 01, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Petaluma_Rush	PNS-16	38.29294	-122.66445	1	1	Tuesday, August 02, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Petaluma_Rush	PNS-17	38.30991	-122.69088	1	1	Wednesday, August 03, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Petaluma_Rush	PNS-49	38.29648	-122.68581	1	1	Thursday, August 04, 2011	0	
Petaluma_Rush	PNS-50	38.31249	-122.66769	1	1	Friday, August 05, 2011	0	
Petaluma_Rush	PNS-51	38.17347	-122.57818	1	1	Monday, August 08, 2011	0	
Petaluma_Rush	PNS-52	38.27491	-122.64314	1	1	Tuesday, August 09, 2011	0	
Liberty_Creek	PNS-18	38.23007	-122.67502	1	1	Wednesday, August 10, 2011	1	Wednesdays September 14,21, 28 & October 5,12th 2011
Liberty_Creek	PNS-19	38.21456	-122.59659	1	1	Thursday, August 11, 2011	1	Wednesdays September 14,21, 28 & October 5,12th 2011
Liberty_Creek	PNS-20	38.26195	-122.71253	1	1	Friday, August 12, 2011	0	
Liberty_Creek	PNS-21	38.27537	-122.67877	1	1	Monday, August 15, 2011	0	
Upper_San_Antonio_Creek	PNS-23	38.21624	-122.71879	1	1	Tuesday, August 16, 2011	1	Wednesdays September 14,21, 28 & October 5,12th 2011
Upper_San_Antonio_Creek	PNS-24	38.18291	-122.68565	1	1	Wednesday, August 17, 2011	1	Wednesdays September 14,21, 28 & October 5,12th 2011
Upper_San_Antonio_Creek	PNS-25	38.20112	-122.68688	1	1	Thursday, August 18, 2011	1	Wednesdays September 14,21, 28 & October 5,12th 2011
Upper_San_Antonio_Creek	PNS-26	38.20128	-122.67396	1	1	Friday, August 19, 2011	0	
Upper_San_Antonio_Creek	PNS-59	38.18320	-122.68518	1	1	Monday, August 22, 2011	0	
Upper_San_Antonio_Creek	PNS-60	38.20474	-122.68034	1	1	Tuesday, August 23, 2011	0	
Lower_San_Antonio_Creek	PNS-27	38.18074	-122.62619	1	1	Wednesday, August 24, 2011	1	Wednesdays September 14,21, 28 & October 5,12th 2011
Lower_San_Antonio_Creek	PNS-28	38.17293	-122.63069	1	1	Thursday, August 25, 2011	1	Wednesdays September 14,21, 28 & October 5,12th 2011
Lower_San_Antonio_Creek	PNS-29	38.17239	-122.66954	1	1	Friday, August 26, 2011	1	Wednesdays September 14,21, 28 & October 5,12th 2011

stratum	*siteID*	*lat*	*long*	*Algae*	*WQ Nutrients*	*Algae & WQ Sample Date*	*Pathogens*	*Pathogen Sample Dates*
Lower_San_Antonio_Creek	PNS-30	38.18083	-122.66945	1	1	Monday, August 29, 2011	0	
Lower_San_Antonio_Creek	PNS-31	38.19442	-122.66257	1	1	Tuesday, August 30, 2011	0	
Lower_San_Antonio_Creek	PNS-63	38.16329	-122.66595	1	1	Wednesday, August 31, 2011	0	
Tidal	PNS-32	38.13666	-122.48727	0	1	Thursday, September 01, 2011	1	Wednesdays September 14,21, 28 & October 5,12th 2011
Tidal	PNS-33	38.14414	-122.49311	0	1	Friday, September 02, 2011	1	Wednesdays September 14,21, 28 & October 5,12th 2011
Tidal	PNS-34	38.23129	-122.61547	0	1	Monday, September 05, 2011	1	Wednesdays September 14,21, 28 & October 5,12th 2011
Tidal	PNS-35	38.22095	-122.60135	0	1	Tuesday, September 06, 2011	1	Wednesdays September 14,21, 28 & October 5,12th 2011
Tidal	PNS-36	38.19223	-122.58872	0	1	Wednesday, September 07, 2011	0	
Tidal	PNS-68	38.16213	-122.51858	0	1	Thursday, September 08, 2011	0	
Tidal	PNS-69	38.13939	-122.47145	0	1	Friday, September 09, 2011	0	
Tidal	PNS-70	38.15465	-122.56264	0	1	Monday, September 12, 2011	0	

30 Random and 4 Targeted Nutrient Stations with 15 Pathogen Stations

Scott Johnson (of ABC consulting in Southern California) suggested that the minimum sample size for the random stations should be ~30 (this number was used in the San Gabriel Watershed Algae Pilot Study (SCCWRP, 2006[2]).

Table 4a. Number of stations by sub-watershed and land-use type for a 30-site random sample design scenario with 4 additional targeted sites.

Probabilistic design with stratification by major sub-watershed
Add 4 sites near three animal farms (up- and down-stream)

	Upstream		Downstream		
Sub-watershed Name ↓ & Type →	**Agricultural**	**Rangeland**	**Mixed**	**Urban**	
Lynch Creek	**3**				
Adobe Creek	**3**				
Stage Gulch	**2**				
Petaluma River & Rush Creek			**6**		
Liberty Creek				**3**	
Upper San Antonio Creek	**4**				
Lower San Antonio Creek		**4**			
Tidally Influenced Petaluma/San Antonio			**5**		
Sub-total Number of Random Sites	12	4	11	3	30
Targeted Stations (expected impacted and reference)					4
Total					**34**

Table 4b. Ball-park cost estimate for the 30-site random sample design scenario with 4 additional targeted sites.

Sampling Cost Estimate:	**Dry season**	**Wet season**	**Total Cost**
Algal Bioassessment and synoptic Water Column Nutrients (Algae)	25	0	$ 64,150
Algal Bioassessment and synoptic Water Column Nutrients (WC Nutrients)	25	0	$ 13,100
Additional WC Nutrients	5	15	$ 11,785
FIB	15	15	$ 44,100
Targeted Stations - WQ Nutrients	4	4	$ 4,714
Targeted Stations - FIB	4	4	$ 11,760
			$ 149,609
Project Management			$ 21,750
Data Management & Reporting			$ 20,010
Direct Expenses			$ 2,560
			$ 193,929

2 http://www.sccwrp.org/ResearchAreas/Wetlands/WetlandEcologyAndBiogeochemistry/StreamAlgalDynamics/SanGabrielRiverWatershedPilotStudy.aspx

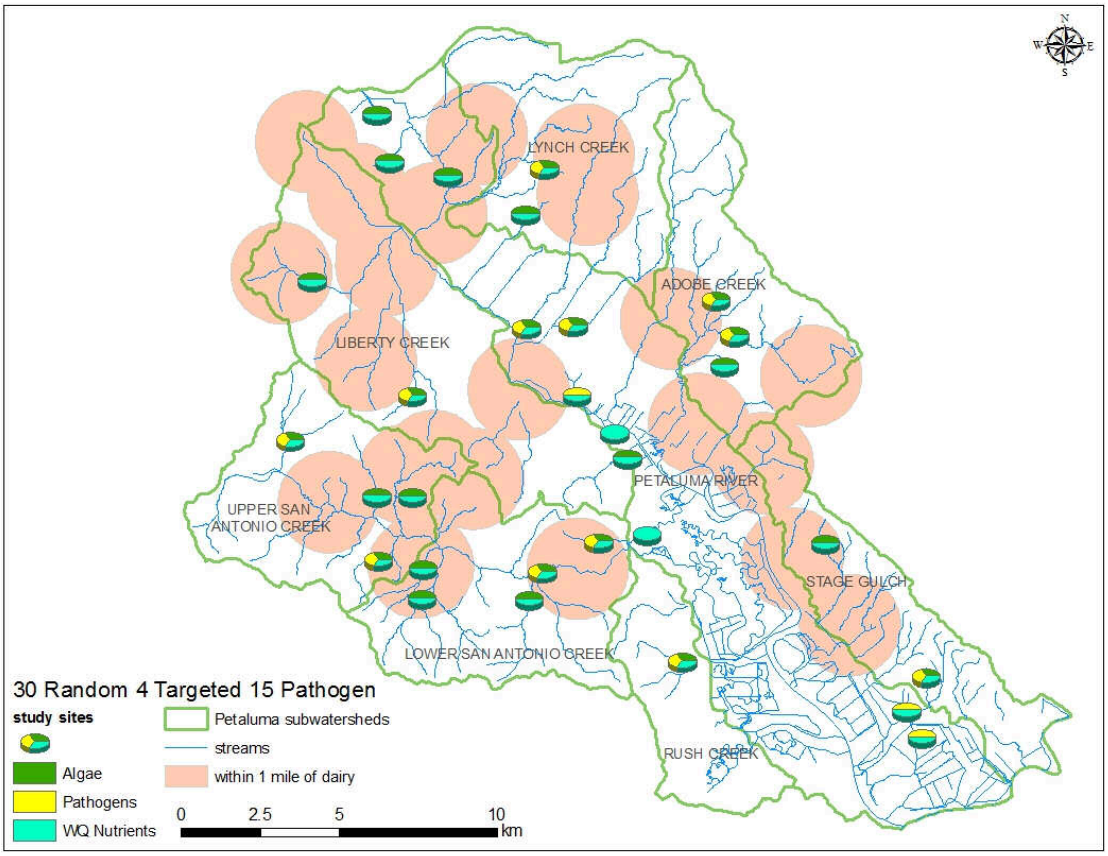

Figure 4. Map of the 30-site random design scenario with 15 pathogen samples (and 4 targeted sites - not shown).

Table 4c. Station locations (by stratum) for the 30-site sampling design and an example sampling schedule. Separate sampling crews will need to be responsible for sampling Algae/WQ-nutrients and FIB (pathogens) respectively. 1 and 0 indicate if a parameter group is measured at the listed site (1 = yes, 0 = no).

stratum	*siteID*	*lat*	*long*	*Algae*	*WQ Nutrients*	*Algae & WQ Sample Date*	*Pathogens*	*Pathogen Sample Dates*
Lynch_Creek	PNS-01	38.25122	-122.61749	1	1	Tuesday, July 05, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Lynch_Creek	PNS-02	38.29579	-122.62946	1	1	Wednesday, July 06, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Lynch_Creek	PNS-03	38.28263	-122.63580	1	1	Thursday, July 07, 2011	0	
Adobe_Creek	PNS-05	38.24966	-122.55894	1	1	Friday, July 08, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Adobe_Creek	PNS-06	38.25963	-122.56603	1	1	Monday, July 11, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Adobe_Creek	PNS-07	38.24106	-122.56230	1	1	Tuesday, July 12, 2011	0	
Stage_Gulch	PNS-09	38.15396	-122.48627	1	1	Wednesday, July 13, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Stage_Gulch	PNS-10	38.19118	-122.52407	1	1	Thursday, July 14, 2011	0	
Petaluma_Rush	PNS-13	38.15644	-122.57459	1	1	Friday, July 15, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Petaluma_Rush	PNS-14	38.18984	-122.60621	1	1	Monday, July 18, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Petaluma_Rush	PNS-15	38.25023	-122.63450	1	1	Tuesday, July 19, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Petaluma_Rush	PNS-16	38.29294	-122.66445	1	1	Wednesday, July 20, 2011	0	
Petaluma_Rush	PNS-17	38.30991	-122.69088	1	1	Thursday, July 21, 2011	0	
Petaluma_Rush	PNS-49	38.29648	-122.68581	1	1	Friday, July 22, 2011	0	
Liberty_Creek	PNS-18	38.23007	-122.67502	1	1	Monday, July 25, 2011	1	Wednesdays August 3,10,17,24 & 31st 2011
Liberty_Creek	PNS-19	38.21456	-122.59659	1	1	Tuesday, July 26, 2011	0	
Liberty_Creek	PNS-20	38.26195	-122.71253	1	1	Wednesday, July 27, 2011	0	
Upper_San_Antonio_Creek	PNS-23	38.21624	-122.71879	1	1	Thursday, July 28, 2011	1	Thursdays August 18,25 & September 1,8 & 15th 2011
Upper_San_Antonio_Creek	PNS-24	38.18291	-122.68565	1	1	Friday, July 29, 2011	1	Thursdays August 18,25 & September 1,8 & 15th 2011
Upper_San_Antonio_Creek	PNS-25	38.20112	-122.68688	1	1	Monday, August 01, 2011	0	
Upper_San_Antonio_Creek	PNS-26	38.20128	-122.67396	1	1	Tuesday, August 02, 2011	0	
Lower_San_Antonio_Creek	PNS-27	38.18074	-122.62619	1	1	Wednesday, August 03, 2011	1	Thursdays August 18,25 & September 1,8 & 15th 2011
Lower_San_Antonio_Creek	PNS-28	38.17293	-122.63069	1	1	Thursday, August 04, 2011	0	
Lower_San_Antonio_Creek	PNS-29	38.17239	-122.66954	1	1	Friday, August 05, 2011	0	
Lower_San_Antonio_Creek	PNS-30	38.18083	-122.66945	1	1	Monday, August 08, 2011	0	
Tidal	PNS-32	38.13666	-122.48727	0	1	Tuesday, August 09, 2011	1	Thursdays August 18,25 & September 1,8 & 15th 2011
Tidal	PNS-33	38.14414	-122.49311	0	1	Wednesday, August 10, 2011	1	Thursdays August 18,25 & September 1,8 & 15th 2011
Tidal	PNS-34	38.23129	-122.61547	0	1	Thursday, August 11, 2011	1	Thursdays August 18,25 & September 1,8 & 15th 2011
Tidal	PNS-35	38.22095	-122.60135	0	1	Friday, August 12, 2011	0	
Tidal	PNS-36	38.19223	-122.58872	0	1	Monday, August 15, 2011	0	
TargetSite1	Target1	pending	pending	0	1	Tuesday, August 16, 2011	1	Thursdays August 18,25 & September 1,8 & 15th 2011
TargetSite2	Target2	pending	pending	0	1	Tuesday, August 16, 2011	1	Thursdays August 18,25 & September 1,8 & 15th 2011
TargetSite3	Target3	pending	pending	0	1	Tuesday, August 16, 2011	1	Thursdays August 18,25 & September 1,8 & 15th 2011
TargetSite4	Target4	pending	pending	0	1	Tuesday, August 16, 2011	1	Thursdays August 18,25 & September 1,8 & 15th 2011

20 Random and 4 Targeted Nutrient Stations with 18 Pathogen Stations

Table 5a. Number of stations by sub-watershed and land-use type for a 20-site random sample design scenario with 4 additional targeted sites.

Probabilistic design with stratification by major sub-watershed
Add 4 sites near three animal farms (up- and down-stream)

	Upstream		Downstream		
Sub-watershed Name ↓ & Type →	**Agricultural**	**Rangeland**	**Mixed**	**Urban**	
Lynch Creek	**2**				
Adobe Creek	**2**				
Stage Gulch	**2**				
Petaluma River & Rush Creek			**5**		
Liberty Creek				**2**	
Upper San Antonio Creek	**2**				
Lower San Antonio Creek		**2**			
Tidally Influenced Petaluma/San Antonio			**3**		
Sub-total Number of Random Sites	8	2	8	2	20
Targeted Stations (expected impacted and reference)					4
Total					**24**

Table 5b. Ball-park cost estimate for the 20-site random sample design scenario with 4 additional targeted sites.

Sampling Cost Estimate:	**Dry season**	**Wet season**	**Total Cost**
Algal Bioassessment and synoptic Water Column Nutrients (Algae)	17	0	$ 43,622
Algal Bioassessment and synoptic Water Column Nutrients (WC Nutrients)	17	0	$ 8,908
Additional WC Nutrients	3	18	$ 12,374
FIB	18	18	$ 52,920
Targeted Stations - WQ Nutrients	4	4	$ 4,714
Targeted Stations - FIB	4	4	$ 11,760
			$ 134,298
Project Management			$ 19,140
Data Management & Reporting			$ 20,010
Direct Expenses			$ 2,400
			$ 175,848

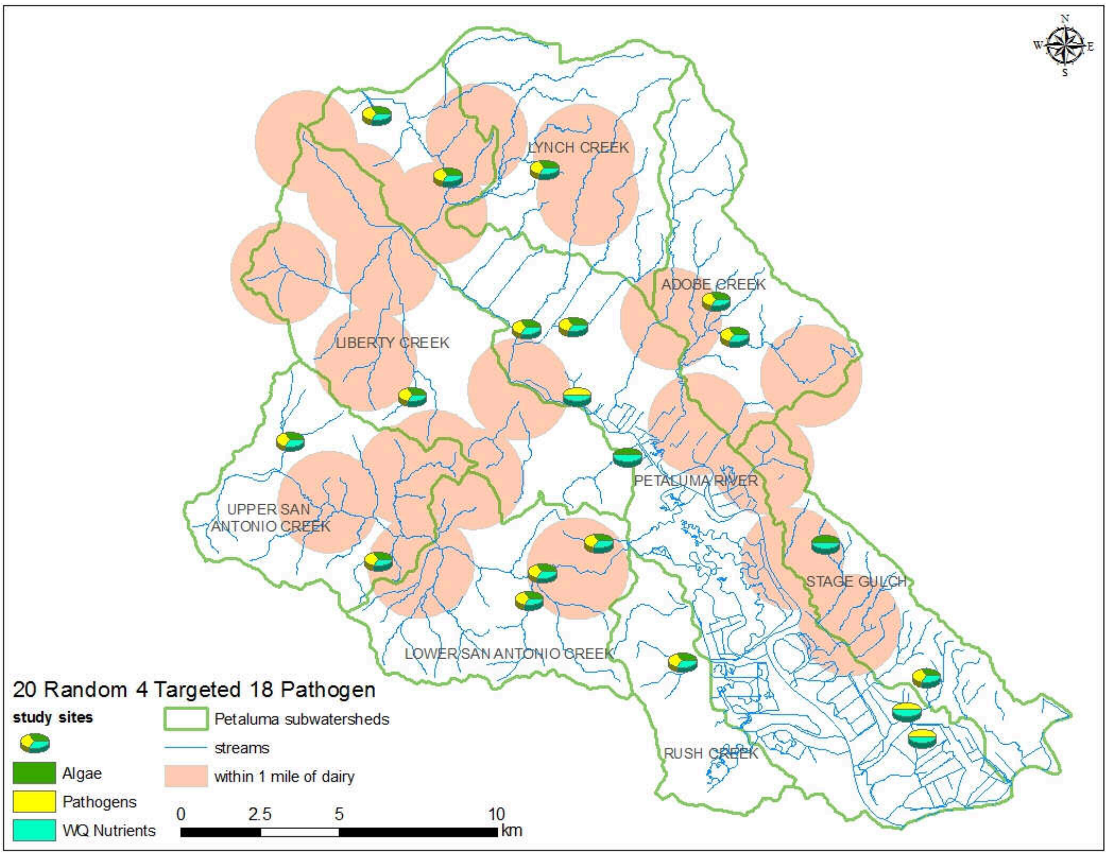

Figure 5. Map of the 20-site random design scenario with 18 pathogen samples (and 4 targeted sites - not shown).

Table 5c. Station locations (by stratum) for the 20-site sampling design and an example sampling schedule. Separate sampling crews will need to be responsible for sampling Algae/WQ-nutrients and FIB (pathogens) respectively. 1 and 0 indicate if a parameter group is measured at the listed site (1 = yes, 0 = no).

stratum	*siteID*	*lat*	*long*	*Algae*	*WQ Nutrients*	*Algae & WQ Sample Date*	*Pathogens*	*Pathogen Sample Dates*
Lynch_Creek	PNS-01	38.25122	-122.61749	1	1	Tuesday, July 05, 2011	1	Thursdays July 21,28 & August 4,11,18th 2011
Lynch_Creek	PNS-02	38.29579	-122.62946	1	1	Wednesday, July 06, 2011	1	Thursdays July 21,28 & August 4,11,18th 2011
Adobe_Creek	PNS-05	38.24966	-122.55894	1	1	Thursday, July 07, 2011	1	Thursdays July 21,28 & August 4,11,18th 2011
Adobe_Creek	PNS-06	38.25963	-122.56603	1	1	Friday, July 08, 2011	1	Thursdays July 21,28 & August 4,11,18th 2011
Stage_Gulch	PNS-09	38.15396	-122.48627	1	1	Monday, July 11, 2011	1	Thursdays July 21,28 & August 4,11,18th 2011
Stage_Gulch	PNS-10	38.19118	-122.52407	1	1	Tuesday, July 12, 2011	0	
Petaluma_Rush	PNS-13	38.15644	-122.57459	1	1	Wednesday, July 13, 2011	1	Thursdays July 21,28 & August 4,11,18th 2011
Petaluma_Rush	PNS-14	38.18984	-122.60621	1	1	Thursday, July 14, 2011	1	Thursdays July 21,28 & August 4,11,18th 2011
Petaluma_Rush	PNS-15	38.25023	-122.63450	1	1	Friday, July 15, 2011	1	Thursdays July 21,28 & August 4,11,18th 2011
Petaluma_Rush	PNS-16	38.29294	-122.66445	1	1	Monday, July 18, 2011	1	
Petaluma_Rush	PNS-17	38.30991	-122.69088	1	1	Tuesday, July 19, 2011	1	
Liberty_Creek	PNS-18	38.23007	-122.67502	1	1	Wednesday, July 20, 2011	1	Thursdays July 21,28 & August 4,11,18th 2011
Liberty_Creek	PNS-19	38.21456	-122.59659	1	1	Thursday, July 21, 2011	0	
Upper_San_Antonio_Creek	PNS-23	38.21624	-122.71879	1	1	Friday, July 22, 2011	1	Tuesdays August 2.9,16,23 & 30th 2011
Upper_San_Antonio_Creek	PNS-24	38.18291	-122.68565	1	1	Monday, July 25, 2011	1	Tuesdays August 2.9,16,23 & 30th 2011
Lower_San_Antonio_Creek	PNS-27	38.18074	-122.62619	1	1	Tuesday, July 26, 2011	1	Tuesdays August 2.9,16,23 & 30th 2011
Lower_San_Antonio_Creek	PNS-28	38.17293	-122.63069	1	1	Wednesday, July 27, 2011	1	
Tidal	PNS-32	38.13666	-122.48727	0	1	Thursday, July 28, 2011	1	Tuesdays August 2.9,16,23 & 30th 2011
Tidal	PNS-33	38.14414	-122.49311	0	1	Friday, July 29, 2011	1	Tuesdays August 2.9,16,23 & 30th 2011
Tidal	PNS-34	38.23129	-122.61547	0	1	Monday, August 01, 2011	1	Tuesdays August 2.9,16,23 & 30th 2011
TargetSite1	Target1	pending	pending	0	1	Tuesday, August 02, 2011	1	Tuesdays August 2.9,16,23 & 30th 2011
TargetSite2	Target2	pending	pending	0	1	Tuesday, August 02, 2011	1	Tuesdays August 2.9,16,23 & 30th 2011
TargetSite3	Target3	pending	pending	0	1	Tuesday, August 02, 2011	1	Tuesdays August 2.9,16,23 & 30th 2011
TargetSite4	Target4	pending	pending	0	1	Tuesday, August 02, 2011	1	Tuesdays August 2.9,16,23 & 30th 2011

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Appendix A: Survey Design

Monitoring Plan Contact
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Description of Survey Design
Target population: All streams and rivers within one (1) mile of a road within the Petaluma watershed.

Sample Frame: Sample frame provided by Sara Lowe

Survey Design: A Generalized Random Tessellation Stratified (GRTS) survey design for a finite resource was used. The GRTS design includes reverse hierarchical ordering of the selected sites.

Strata: Streams and rivers were categorized into eight (8) strata based on subwatershed and tidal influences: Non-tidal streams and rivers in Lynch Creek, Adobe Creek, Stage Gulch, Petaluma & Rush, Liberty Creek, Upper San Antonio Creek, and Lower San Antonio Creek and Tidal streams and rivers.

Sample Size: The sample size is four (4) for Lynch Creek, Adobe Creek, Stage Creek, and Upper San Antonio Creek. The sample size is five (5) for Petaluma & Rush, Liberty Creek, Lower San Antonio Creek, and Tidal. The number of sites near dairies/animal operations is proportional to the stream length within each stratum.

Panels: Base and OverSamp panels

Site Use: Assume the base design has 50 sites. Sites are listed in siteID order and must be used in that order within each stratum. All sites that occur prior to the last site used must have been evaluated for use and then either sampled or reason documented why that site was not used. As an example, if 50 sites are to be sampled and it required that 61 sites be evaluated in order to locate 50 stream sites able to be sampled, then the first 61 sites in siteID order would be used.

It is also permissible to replace sites within each stratum.

Sample Frame Summary

Summary of sample frame stream length in km.

	Agricultural	Mixed	Rangeland	Urban	Sum
Lynch_Creek	42.3	0	0	0	42.3
Adobe_Creek	28.3	0	0	0	28.3
Stage_Gulch	31.4	0	0	0	31.4
Petaluma_Rush	0	54.4	0	0	54.4
Liberty_Creek	0	0	0	45	45
Upper_San_Antonio_Creek	40.8	0	0	0	40.8
Lower_San_Antonio_Creek	0	0	38.7	0	38.7
Tidal	12.5	187.9	0	0	200.4
Exclude	35.5	63.7	8.7	0	107.9
Sum	190.7	306	47.4	45	589.1

	NearDairy	FarDairy	Sum
Lynch_Creek	38.4	4	42.3
Adobe_Creek	20.4	7.9	28.3
Stage_Gulch	17.4	14	31.4
Petaluma_Rush	29.1	25.3	54.4
Liberty_Creek	40.6	4.5	45
Upper_San_Antonio_Creek	31.4	9.4	40.8
Lower_San_Antonio_Creek	28.3	10.3	38.7
Tidal	63.4	137	200.4
Exclude	7.8	100.1	107.9
Sum	276.7	312.4	589.1

Site Selection Summary

Number of sites by stratum and land use type. Includes base and oversample sites.

Stratum	Agricultural	Mixed	Rangeland	Urban	Sum
Adobe_Creek	24				24
Liberty_Creek				30	30
Lower_San_Antonio_Creek			30		30
Lynch_Creek	24				24
Petaluma_Rush		30			30
Tidal		30			30
Stage_Gulch	24				24
Upper_San_Antonio_Creek	24				24
Sum	96	60	30	30	216

Description of Sample Design Output

The output is provided as a shapefile for the sites. Note that the ".dbf" file may be read in Excel.

The attributes are as follows:

Variable Name	Description
SiteID	Unique site identification (character)
Latitude	In NAD83
Longitude	In NAD83
mdcaty	Multi-density categories used for unequal probability selection
weight	Weight (in km), inverse of inclusion probability, to be used in statistical analyses
stratum	Strata used in the survey design
panel	Identifies base sample by panel name and Oversample by OverSamp
EvalStatus	Site evaluation decision for site: TS: target and sampled, LD: landowner denied access, etc (see below)
EvalReason	Site evaluation text commment
auxiliary variables	Remaining columns are from the sample frame provided

Projection Information

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GEOGCS["GCS_North_American_1983",
DATUM["D_North_American_1983",
SPHEROID["GRS_1980",6378137.0,298.257222101]],
PRIMEM["Greenwich",0.0],
UNIT["Degree",0.0174532925199433]],
PROJECTION["Albers"],
PARAMETER["False_Easting",0.0],
PARAMETER["False_Northing",-4000000.0],
PARAMETER["Central_Meridian",-120.0],
PARAMETER["Standard_Parallel_1",34.0],
PARAMETER["Standard_Parallel_2",40.5],
PARAMETER["Latitude_Of_Origin",0.0],
UNIT["Meter",1.0]]

Evaluation Process

The survey design weights that are given in the design file assume that the survey design is implemented as designed. Typically, users prefer to replace sites that can not be sampled with other sites to achieve the sample size planned. The site replacement process is described above. When sites are replaced, the survey design weights are no longer correct and must be adjusted. The weight adjustment requires knowing what happened to each site in the base design and the over sample sites.

EvalStatus is initially set to “NotEval” to indicate that the site has yet to be evaluated for sampling. When a site is evaluated for sampling, then the EvalStatus for the site must be changed. Recommended codes are:

EvalStatus Code	Name	Meaning
TS	Target Sampled	site is a member of the target population and was sampled
LD	Landowner Denial	landowner denied access to the site
PB	Physical Barrier	physical barrier prevented access to the site
NT	Non-Target	site is not a member of the target population
NN	Not Needed	site is a member of the over sample and was not evaluated for sampling
Other codes		Many times useful to have other codes. For example, rather than use NT, may use specific codes indicating why the site was non-target.

Statistical Analysis

Any statistical analysis of data must incorporate information about the monitoring survey design. In particular, when estimates of characteristics for the entire target population are computed, the statistical analysis must account for any stratification or unequal probability selection in the design. Procedures for doing this are available from the Aquatic Resource Monitoring web page given in the bibliography. A statistical analysis library of functions is available from the web page to do common population estimates in the statistical software environment R.

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Web Pages

Aquatic Resource Monitoring http://www.epa.gov/nheerl/arm

Appendix B: Station Information

The Monitoring Plan was designed to sample up to 50 randomly allocated sites. Sites must be sampled in sequential order within each sub-watershed to maintain the random sample design. If a targeted site is not able to be sampled then one notes the reason for failure and goes to the next available site in the sequence by stratum. All sequential sites sampled (or attempted to be sampled) are used when making statistical estimates of water quality condition, so it is important to keep track of the sampling effort information. The map below lists the site IDs of the 50 stations outlined in the current plans design scenarios. The table on the following pages contains all stations allocated to this project including the oversample sites that may be sampled if targeted sites are inaccessible.

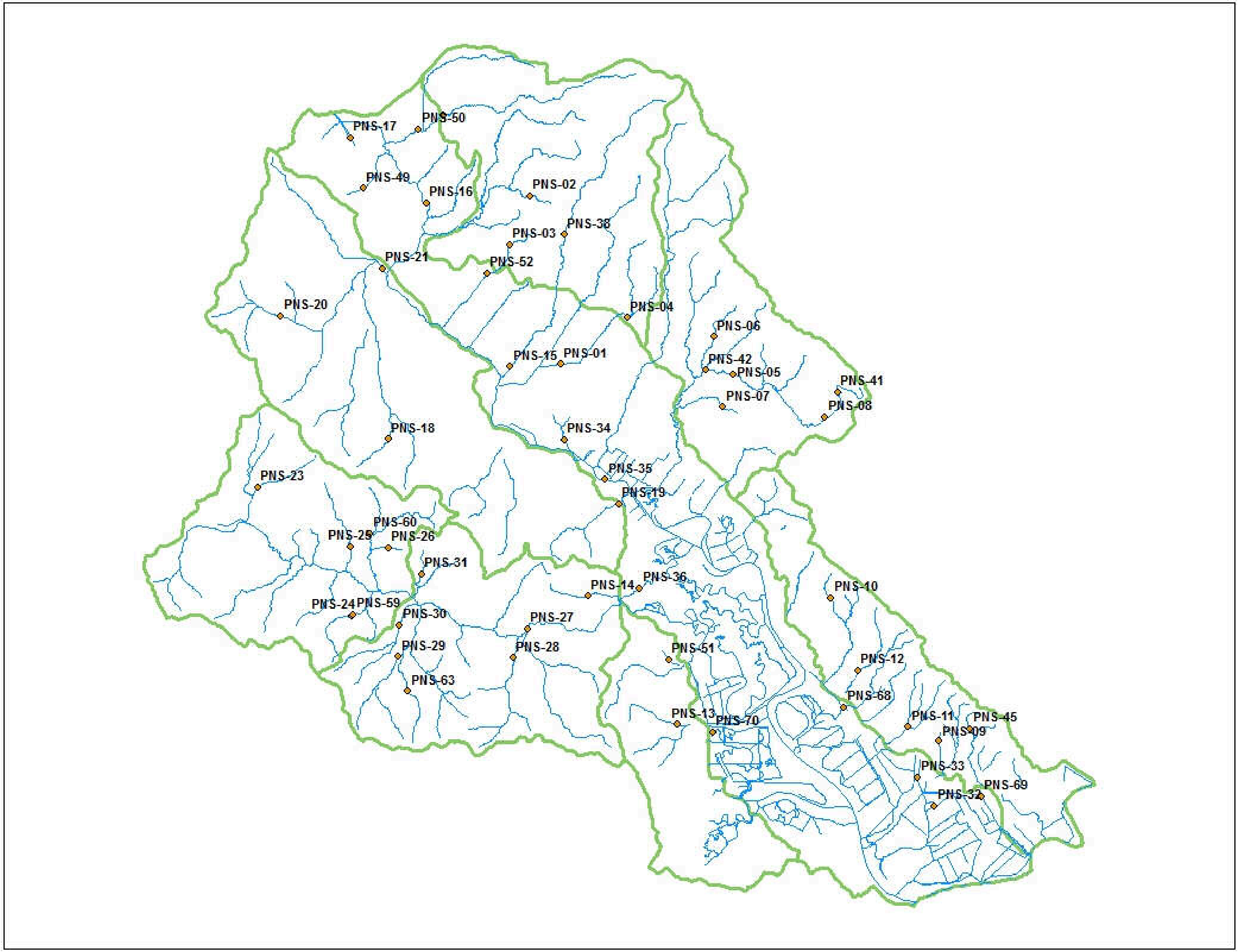

Figure B-1. Map of sites with siteIDs for the first 50 targeted sites described in the Design Scenarios section.

Petaluma Watershed Nutrient Study-Station Information (includes base and oversample sites)

	stratum	latitude	longitude	Land_Use	Tidal	Category	Dairy	Roads	NLCD	CDFPWSNAME	panel	wgt	mdcaty	LengthKM
PNS-05	Adobe_Creek	38.24966	-122.55894	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Developed, Low Intensity	Adobe_Creek	Base	7.070645	Equal	1.215000
PNS-06	Adobe_Creek	38.25963	-122.56603	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Adobe_Creek	Base	7.070645	Equal	1.393000
PNS-07	Adobe_Creek	38.24106	-122.56230	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Grassland/Herbaceous	Adobe_Creek	Base	7.070645	Equal	0.120000
PNS-08	Adobe_Creek	38.23919	-122.52768	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Wetlands	Adobe_Creek	Base	7.070645	Equal	0.286000
PNS-089	Adobe_Creek	38.24582	-122.52273	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Grassland/Herbaceous	Adobe_Creek	OverSamp	7.070645	Equal	0.129000
PNS-090	Adobe_Creek	38.24047	-122.56111	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Forest	Adobe_Creek	OverSamp	7.070645	Equal	0.215000
PNS-091	Adobe_Creek	38.25311	-122.56688	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Adobe_Creek	OverSamp	7.070645	Equal	2.986000
PNS-092	Adobe_Creek	38.26290	-122.55196	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Adobe_Creek	OverSamp	7.070645	Equal	2.986000
PNS-093	Adobe_Creek	38.24556	-122.57490	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Forest	Adobe_Creek	OverSamp	7.070645	Equal	1.220000
PNS-094	Adobe_Creek	38.22715	-122.55604	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Adobe_Creek	OverSamp	7.070645	Equal	2.049000
PNS-095	Adobe_Creek	38.27553	-122.57438	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Forest	Adobe_Creek	OverSamp	7.070645	Equal	1.712000
PNS-096	Adobe_Creek	38.24743	-122.54646	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Developed, Open Space	Adobe_Creek	OverSamp	7.070645	Equal	0.158000
PNS-097	Adobe_Creek	38.24090	-122.53879	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Cultivated Crops	Adobe_Creek	OverSamp	7.070645	Equal	1.378000
PNS-098	Adobe_Creek	38.22925	-122.54486	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Adobe_Creek	OverSamp	7.070645	Equal	2.049000
PNS-099	Adobe_Creek	38.24837	-122.54090	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Grassland/Herbaceous	Adobe_Creek	OverSamp	7.070645	Equal	0.824000
PNS-100	Adobe_Creek	38.25097	-122.56606	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Adobe_Creek	OverSamp	7.070645	Equal	0.906000
PNS-101	Adobe_Creek	38.23700	-122.53545	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Cultivated Crops	Adobe_Creek	OverSamp	7.070645	Equal	1.378000
PNS-102	Adobe_Creek	38.25052	-122.56872	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Adobe_Creek	OverSamp	7.070645	Equal	0.072000
PNS-103	Adobe_Creek	38.26436	-122.55163	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Adobe_Creek	OverSamp	7.070645	Equal	2.986000
PNS-104	Adobe_Creek	38.26032	-122.56566	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Adobe_Creek	OverSamp	7.070645	Equal	1.393000
PNS-41	Adobe_Creek	38.24577	-122.52376	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Adobe_Creek	OverSamp	7.070645	Equal	1.555000
PNS-42	Adobe_Creek	38.25077	-122.56846	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Adobe_Creek	OverSamp	7.070645	Equal	2.986000
PNS-43	Adobe_Creek	38.24367	-122.56551	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Cultivated Crops	Adobe_Creek	OverSamp	7.070645	Equal	1.657000
PNS-44	Adobe_Creek	38.28111	-122.57342	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Forest	Adobe_Creek	OverSamp	7.070645	Equal	1.712000
PNS-141	Liberty_Creek	38.28250	-122.69560	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Grassland/Herbaceous	Liberty_Creek	OverSamp	9.009021	Equal	2.799000
PNS-142	Liberty_Creek	38.23208	-122.66803	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Grassland/Herbaceous	Liberty_Creek	OverSamp	9.009021	Equal	2.620000
PNS-143	Liberty_Creek	38.21797	-122.63218	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Developed, Open Space	Liberty_Creek	OverSamp	9.009021	Equal	3.270000
PNS-144	Liberty_Creek	38.30109	-122.71545	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Developed, Open Space	Liberty_Creek	OverSamp	9.009021	Equal	0.760000
PNS-145	Liberty_Creek	38.27289	-122.68779	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Grassland/Herbaceous	Liberty_Creek	OverSamp	9.009021	Equal	0.773000
PNS-146	Liberty_Creek	38.23096	-122.67490	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Developed, Open Space	Liberty_Creek	OverSamp	9.009021	Equal	2.097000
PNS-147	Liberty_Creek	38.21149	-122.63413	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Developed, Open Space	Liberty_Creek	OverSamp	9.009021	Equal	3.270000
PNS-148	Liberty_Creek	38.26056	-122.70789	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Forest	Liberty_Creek	OverSamp	9.009021	Equal	1.321000
PNS-149	Liberty_Creek	38.25988	-122.68047	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Grassland/Herbaceous	Liberty_Creek	OverSamp	9.009021	Equal	1.040000
PNS-150	Liberty_Creek	38.23519	-122.69881	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Developed, Open Space	Liberty_Creek	OverSamp	9.009021	Equal	0.663000
PNS-151	Liberty_Creek	38.21065	-122.64431	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Shrub/Scrub	Liberty_Creek	OverSamp	9.009021	Equal	1.390000

Petaluma Watershed Nutrient Study-Station Information (includes base and oversample sites)

	stratum	latitude	longitude	Land_Use	Tidal	Category	Dairy	Roads	NLCD	CDFPWSNAME	panel	wgt	mdcaty	LengthKM
PNS-152	Liberty_Creek	38.26106	-122.70937	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Developed, Low Intensity	Liberty_Creek	OverSamp	9.009021	Equal	1.217000
PNS-153	Liberty_Creek	38.26857	-122.69028	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Developed, Open Space	Liberty_Creek	OverSamp	9.009021	Equal	1.546000
PNS-154	Liberty_Creek	38.22155	-122.66874	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Grassland/Herbaceous	Liberty_Creek	OverSamp	9.009021	Equal	2.620000
PNS-155	Liberty_Creek	38.20763	-122.61394	Urban	NonTidal	NonDairy_Urban	FarDairy	NearRoad	Shrub/Scrub	Liberty_Creek	OverSamp	9.009021	Equal	1.875000
PNS-156	Liberty_Creek	38.26374	-122.72768	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Developed, Low Intensity	Liberty_Creek	OverSamp	9.009021	Equal	1.378000
PNS-157	Liberty_Creek	38.25180	-122.69849	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Grassland/Herbaceous	Liberty_Creek	OverSamp	9.009021	Equal	0.875000
PNS-158	Liberty_Creek	38.21725	-122.65169	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Shrub/Scrub	Liberty_Creek	OverSamp	9.009021	Equal	1.172000
PNS-159	Liberty_Creek	38.19982	-122.61648	Urban	NonTidal	NonDairy_Urban	FarDairy	NearRoad	Shrub/Scrub	Liberty_Creek	OverSamp	9.009021	Equal	1.875000
PNS-160	Liberty_Creek	38.26278	-122.72249	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Developed, Open Space	Liberty_Creek	OverSamp	9.009021	Equal	1.503000
PNS-18	Liberty_Creek	38.23007	-122.67502	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Developed, Open Space	Liberty_Creek	Base	9.009021	Equal	2.097000
PNS-19	Liberty_Creek	38.21456	-122.59659	Urban	NonTidal	NonDairy_Urban	FarDairy	NearRoad	Developed, Medium Intensity	Liberty_Creek	Base	9.009021	Equal	1.470000
PNS-20	Liberty_Creek	38.26195	-122.71253	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Developed, Low Intensity	Liberty_Creek	Base	9.009021	Equal	1.217000
PNS-21	Liberty_Creek	38.27537	-122.67877	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Developed, Open Space	Liberty_Creek	Base	9.009021	Equal	0.492000
PNS-22	Liberty_Creek	38.24505	-122.68878	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Grassland/Herbaceous	Liberty_Creek	Base	9.009021	Equal	1.336000
PNS-54	Liberty_Creek	38.25424	-122.68475	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Grassland/Herbaceous	Liberty_Creek	OverSamp	9.009021	Equal	1.221000
PNS-55	Liberty_Creek	38.21941	-122.64405	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Developed, Low Intensity	Liberty_Creek	OverSamp	9.009021	Equal	1.523000
PNS-56	Liberty_Creek	38.21342	-122.60123	Urban	NonTidal	NonDairy_Urban	FarDairy	NearRoad	Developed, Medium Intensity	Liberty_Creek	OverSamp	9.009021	Equal	1.470000
PNS-57	Liberty_Creek	38.30311	-122.71717	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Developed, Open Space	Liberty_Creek	OverSamp	9.009021	Equal	0.760000
PNS-58	Liberty_Creek	38.25749	-122.68380	Urban	NonTidal	Dairy_Urban	NearDairy	NearRoad	Grassland/Herbaceous	Liberty_Creek	OverSamp	9.009021	Equal	1.221000
PNS-177	Lower_San_Antonio_Creek	38.18787	-122.66475	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Developed, Open Space	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	0.242000
PNS-178	Lower_San_Antonio_Creek	38.16629	-122.66706	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Shrub/Scrub	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	3.049000
PNS-179	Lower_San_Antonio_Creek	38.16939	-122.66136	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Shrub/Scrub	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	0.973000
PNS-180	Lower_San_Antonio_Creek	38.17213	-122.62164	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Forest	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	4.038000
PNS-181	Lower_San_Antonio_Creek	38.18112	-122.64570	Rangeland	NonTidal	NonDairy_Range	FarDairy	NearRoad	Wetlands	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	0.968000
PNS-182	Lower_San_Antonio_Creek	38.17304	-122.68321	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Forest	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	1.289000
PNS-183	Lower_San_Antonio_Creek	38.15618	-122.68263	Rangeland	NonTidal	NonDairy_Range	FarDairy	NearRoad	Forest	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	1.588000
PNS-184	Lower_San_Antonio_Creek	38.17573	-122.62989	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Shrub/Scrub	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	1.591000
PNS-185	Lower_San_Antonio_Creek	38.18474	-122.65358	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Shrub/Scrub	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	1.510000
PNS-186	Lower_San_Antonio_Creek	38.17123	-122.67038	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Shrub/Scrub	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	1.313000
PNS-187	Lower_San_Antonio_Creek	38.15187	-122.66806	Rangeland	NonTidal	NonDairy_Range	FarDairy	NearRoad	Forest	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	0.636000
PNS-188	Lower_San_Antonio_Creek	38.17347	-122.63055	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Shrub/Scrub	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	1.591000
PNS-189	Lower_San_Antonio_Creek	38.19717	-122.65309	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Developed, Medium Intensity	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	1.656000
PNS-190	Lower_San_Antonio_Creek	38.17048	-122.66925	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Shrub/Scrub	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	3.049000
PNS-191	Lower_San_Antonio_Creek	38.18458	-122.63417	Rangeland	NonTidal	NonDairy_Range	FarDairy	NearRoad	Developed, Low Intensity	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	2.170000
PNS-192	Lower_San_Antonio_Creek	38.16931	-122.60420	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Forest	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	2.285000

Petaluma Watershed Nutrient Study-Station Information (includes base and oversample sites)

	stratum	latitude	longitude	Land_Use	Tidal	Category	Dairy	Roads	NLCD	CDFPWSNAME	panel	wgt	mdcaty	LengthKM
PNS-193	Lower_San_Antonio_Creek	38.16372	-122.67646	Rangeland	NonTidal	NonDairy_Range	FarDairy	NearRoad	Forest	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	0.727000
PNS-194	Lower_San_Antonio_Creek	38.17560	-122.67297	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Grassland/Herbaceous	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	0.512000
PNS-195	Lower_San_Antonio_Creek	38.19650	-122.62529	Rangeland	NonTidal	NonDairy_Range	FarDairy	NearRoad	Developed, Open Space	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	0.944000
PNS-196	Lower_San_Antonio_Creek	38.15247	-122.60886	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Forest	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	4.038000
PNS-27	Lower_San_Antonio_Creek	38.18074	-122.62619	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Shrub/Scrub	Lower_San_Antonio_Creek	Base	7.733046	Equal	0.721000
PNS-28	Lower_San_Antonio_Creek	38.17293	-122.63069	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Shrub/Scrub	Lower_San_Antonio_Creek	Base	7.733046	Equal	1.591000
PNS-29	Lower_San_Antonio_Creek	38.17239	-122.66954	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Shrub/Scrub	Lower_San_Antonio_Creek	Base	7.733046	Equal	1.313000
PNS-30	Lower_San_Antonio_Creek	38.18083	-122.66945	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Developed, Low Intensity	Lower_San_Antonio_Creek	Base	7.733046	Equal	1.438000
PNS-31	Lower_San_Antonio_Creek	38.19442	-122.66257	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Developed, Open Space	Lower_San_Antonio_Creek	Base	7.733046	Equal	1.276000
PNS-63	Lower_San_Antonio_Creek	38.16329	-122.66595	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Shrub/Scrub	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	3.049000
PNS-64	Lower_San_Antonio_Creek	38.17135	-122.68690	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Forest	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	1.289000
PNS-65	Lower_San_Antonio_Creek	38.17377	-122.66553	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Shrub/Scrub	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	0.973000
PNS-66	Lower_San_Antonio_Creek	38.17155	-122.61520	Rangeland	NonTidal	Dairy_Range	NearDairy	NearRoad	Forest	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	2.285000
PNS-67	Lower_San_Antonio_Creek	38.18305	-122.63619	Rangeland	NonTidal	NonDairy_Range	FarDairy	NearRoad	Developed, Low Intensity	Lower_San_Antonio_Creek	OverSamp	7.733046	Equal	2.170000
PNS-01	Lynch_Creek	38.25122	-122.61749	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Developed, Open Space	Lynch_Creek	Base	10.584121	Equal	3.519000
PNS-02	Lynch_Creek	38.29579	-122.62946	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Developed, Medium Intensity	Lynch_Creek	Base	10.584121	Equal	1.329000
PNS-03	Lynch_Creek	38.28263	-122.63580	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Developed, Low Intensity	Lynch_Creek	Base	10.584121	Equal	2.194000
PNS-04	Lynch_Creek	38.26402	-122.59543	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Developed, Open Space	Lynch_Creek	Base	10.584121	Equal	3.519000
PNS-073	Lynch_Creek	38.26493	-122.61309	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Lynch_Creek	OverSamp	10.584121	Equal	4.212000
PNS-074	Lynch_Creek	38.27977	-122.61784	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Lynch_Creek	OverSamp	10.584121	Equal	5.983000
PNS-075	Lynch_Creek	38.29453	-122.64389	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Lynch_Creek	OverSamp	10.584121	Equal	1.380000
PNS-076	Lynch_Creek	38.33075	-122.63139	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Developed, Low Intensity	Lynch_Creek	OverSamp	10.584121	Equal	3.945000
PNS-077	Lynch_Creek	38.26116	-122.62270	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Lynch_Creek	OverSamp	10.584121	Equal	5.983000
PNS-078	Lynch_Creek	38.28080	-122.60228	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Lynch_Creek	OverSamp	10.584121	Equal	4.212000
PNS-079	Lynch_Creek	38.29721	-122.63445	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Developed, Medium Intensity	Lynch_Creek	OverSamp	10.584121	Equal	1.329000
PNS-080	Lynch_Creek	38.28515	-122.63016	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Developed, Low Intensity	Lynch_Creek	OverSamp	10.584121	Equal	2.194000
PNS-081	Lynch_Creek	38.27349	-122.59438	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Grassland/Herbaceous	Lynch_Creek	OverSamp	10.584121	Equal	2.639000
PNS-082	Lynch_Creek	38.29602	-122.61256	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Lynch_Creek	OverSamp	10.584121	Equal	5.983000
PNS-083	Lynch_Creek	38.32513	-122.66546	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Developed, Low Intensity	Lynch_Creek	OverSamp	10.584121	Equal	3.945000
PNS-084	Lynch_Creek	38.29129	-122.64541	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Cultivated Crops	Lynch_Creek	OverSamp	10.584121	Equal	1.224000
PNS-085	Lynch_Creek	38.26566	-122.59282	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Lynch_Creek	OverSamp	10.584121	Equal	1.933000
PNS-086	Lynch_Creek	38.30930	-122.64196	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Lynch_Creek	OverSamp	10.584121	Equal	3.067000
PNS-087	Lynch_Creek	38.33109	-122.65708	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Developed, Low Intensity	Lynch_Creek	OverSamp	10.584121	Equal	3.945000
PNS-088	Lynch_Creek	38.27816	-122.63751	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Developed, Low Intensity	Lynch_Creek	OverSamp	10.584121	Equal	2.194000
PNS-37	Lynch_Creek	38.31638	-122.65962	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Forest	Lynch_Creek	OverSamp	10.584121	Equal	3.812000

Petaluma Watershed Nutrient Study-Station Information (includes base and oversample sites)

	stratum	latitude	longitude	Land_Use	Tidal	Category	Dairy	Roads	NLCD	CDFPWSNAME	panel	wgt	mdcaty	LengthKM
PNS-38	Lynch_Creek	38.28572	-122.61752	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Lynch_Creek	OverSamp	10.584121	Equal	5.983000
PNS-39	Lynch_Creek	38.28700	-122.64358	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Developed, Open Space	Lynch_Creek	OverSamp	10.584121	Equal	2.092000
PNS-40	Lynch_Creek	38.26443	-122.62052	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Lynch_Creek	OverSamp	10.584121	Equal	5.983000
PNS-121	Petaluma_Rush	38.15034	-122.57571	Mixed	NonTidal	NonDairy_Mixed	FarDairy	NearRoad	Shrub/Scrub	Petaluma_Rush	OverSamp	10.872624	Equal	0.949000
PNS-122	Petaluma_Rush	38.29861	-122.68351	Mixed	NonTidal	Dairy_Mixed	NearDairy	NearRoad	Developed, Open Space	Petaluma_Rush	OverSamp	10.872624	Equal	1.983000
PNS-123	Petaluma_Rush	38.31409	-122.68934	Mixed	NonTidal	NonDairy_Mixed	FarDairy	NearRoad	Developed, Open Space	Petaluma_Rush	OverSamp	10.872624	Equal	1.730000
PNS-124	Petaluma_Rush	38.24718	-122.59220	Mixed	NonTidal	Dairy_Mixed	NearDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	OverSamp	10.872624	Equal	1.290000
PNS-125	Petaluma_Rush	38.16079	-122.58737	Mixed	NonTidal	NonDairy_Mixed	FarDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	OverSamp	10.872624	Equal	2.306000
PNS-126	Petaluma_Rush	38.26080	-122.65893	Mixed	NonTidal	Dairy_Mixed	NearDairy	NearRoad	Developed, Open Space	Petaluma_Rush	OverSamp	10.872624	Equal	2.521000
PNS-127	Petaluma_Rush	38.25082	-122.64063	Mixed	NonTidal	NonDairy_Mixed	FarDairy	NearRoad	Developed, Open Space	Petaluma_Rush	OverSamp	10.872624	Equal	1.017000
PNS-128	Petaluma_Rush	38.18103	-122.60915	Mixed	NonTidal	Dairy_Mixed	NearDairy	NearRoad	Developed, Low Intensity	Petaluma_Rush	OverSamp	10.872624	Equal	3.671000
PNS-129	Petaluma_Rush	38.27924	-122.66883	Mixed	NonTidal	Dairy_Mixed	NearDairy	NearRoad	Developed, Open Space	Petaluma_Rush	OverSamp	10.872624	Equal	1.723000
PNS-13	Petaluma_Rush	38.15644	-122.57459	Mixed	NonTidal	NonDairy_Mixed	FarDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	Base	10.872624	Equal	2.306000
PNS-130	Petaluma_Rush	38.29339	-122.65511	Mixed	NonTidal	Dairy_Mixed	NearDairy	NearRoad	Developed, Low Intensity	Petaluma_Rush	OverSamp	10.872624	Equal	2.860000
PNS-131	Petaluma_Rush	38.25525	-122.64834	Mixed	NonTidal	NonDairy_Mixed	FarDairy	NearRoad	Developed, Open Space	Petaluma_Rush	OverSamp	10.872624	Equal	1.017000
PNS-132	Petaluma_Rush	38.18073	-122.61285	Mixed	NonTidal	Dairy_Mixed	NearDairy	NearRoad	Developed, Low Intensity	Petaluma_Rush	OverSamp	10.872624	Equal	3.671000
PNS-133	Petaluma_Rush	38.30151	-122.67376	Mixed	NonTidal	Dairy_Mixed	NearDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	OverSamp	10.872624	Equal	1.437000
PNS-134	Petaluma_Rush	38.31440	-122.69478	Mixed	NonTidal	NonDairy_Mixed	FarDairy	NearRoad	Developed, Open Space	Petaluma_Rush	OverSamp	10.872624	Equal	0.260000
PNS-135	Petaluma_Rush	38.23404	-122.59778	Mixed	NonTidal	NonDairy_Mixed	FarDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	OverSamp	10.872624	Equal	0.796000
PNS-136	Petaluma_Rush	38.17246	-122.57487	Mixed	NonTidal	NonDairy_Mixed	FarDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	OverSamp	10.872624	Equal	0.051000
PNS-137	Petaluma_Rush	38.29038	-122.66428	Mixed	NonTidal	Dairy_Mixed	NearDairy	NearRoad	Developed, Low Intensity	Petaluma_Rush	OverSamp	10.872624	Equal	1.227000
PNS-138	Petaluma_Rush	38.31160	-122.66956	Mixed	NonTidal	Dairy_Mixed	NearDairy	NearRoad	Forest	Petaluma_Rush	OverSamp	10.872624	Equal	0.472000
PNS-139	Petaluma_Rush	38.24862	-122.62683	Mixed	NonTidal	NonDairy_Mixed	FarDairy	NearRoad	Developed, High Intensity	Petaluma_Rush	OverSamp	10.872624	Equal	0.316000
PNS-14	Petaluma_Rush	38.18984	-122.60621	Mixed	NonTidal	Dairy_Mixed	NearDairy	NearRoad	Shrub/Scrub	Petaluma_Rush	Base	10.872624	Equal	2.344000
PNS-140	Petaluma_Rush	38.28007	-122.58070	Mixed	NonTidal	Dairy_Mixed	NearDairy	NearRoad	Shrub/Scrub	Petaluma_Rush	OverSamp	10.872624	Equal	4.973000
PNS-15	Petaluma_Rush	38.25023	-122.63450	Mixed	NonTidal	NonDairy_Mixed	FarDairy	NearRoad	Forest	Petaluma_Rush	Base	10.872624	Equal	1.419000
PNS-16	Petaluma_Rush	38.29294	-122.66445	Mixed	NonTidal	Dairy_Mixed	NearDairy	NearRoad	Developed, Low Intensity	Petaluma_Rush	Base	10.872624	Equal	1.227000
PNS-17	Petaluma_Rush	38.30991	-122.69088	Mixed	NonTidal	NonDairy_Mixed	FarDairy	NearRoad	Developed, Open Space	Petaluma_Rush	Base	10.872624	Equal	0.883000
PNS-49	Petaluma_Rush	38.29648	-122.68581	Mixed	NonTidal	Dairy_Mixed	NearDairy	NearRoad	Developed, Open Space	Petaluma_Rush	OverSamp	10.872624	Equal	1.983000
PNS-50	Petaluma_Rush	38.31249	-122.66769	Mixed	NonTidal	Dairy_Mixed	NearDairy	NearRoad	Forest	Petaluma_Rush	OverSamp	10.872624	Equal	0.472000
PNS-51	Petaluma_Rush	38.17347	-122.57818	Mixed	NonTidal	NonDairy_Mixed	FarDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	OverSamp	10.872624	Equal	0.662000
PNS-52	Petaluma_Rush	38.27491	-122.64314	Mixed	NonTidal	NonDairy_Mixed	FarDairy	NearRoad	Developed, Low Intensity	Petaluma_Rush	OverSamp	10.872624	Equal	2.147000
PNS-53	Petaluma_Rush	38.25111	-122.64091	Mixed	NonTidal	NonDairy_Mixed	FarDairy	NearRoad	Developed, Open Space	Petaluma_Rush	OverSamp	10.872624	Equal	1.017000
PNS-09	Stage_Gulch	38.15396	-122.48627	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Developed, Low Intensity	Stage_Gulch	Base	7.850901	Equal	1.228000
PNS-10	Stage_Gulch	38.19118	-122.52407	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Grassland/Herbaceous	Stage_Gulch	Base	7.850901	Equal	0.025000

Petaluma Watershed Nutrient Study-Station Information (includes base and oversample sites)

	stratum	latitude	longitude	Land_Use	Tidal	Category	Dairy	Roads	NLCD	CDFPWSNAME	panel	wgt	mdcaty	LengthKM
PNS-105	Stage_Gulch	38.14918	-122.47294	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Grassland/Herbaceous	Stage_Gulch	OverSamp	7.850901	Equal	0.884000
PNS-106	Stage_Gulch	38.18028	-122.50691	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Grassland/Herbaceous	Stage_Gulch	OverSamp	7.850901	Equal	2.180000
PNS-107	Stage_Gulch	38.15198	-122.48589	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Developed, Low Intensity	Stage_Gulch	OverSamp	7.850901	Equal	1.228000
PNS-108	Stage_Gulch	38.16552	-122.50201	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Grassland/Herbaceous	Stage_Gulch	OverSamp	7.850901	Equal	0.203000
PNS-109	Stage_Gulch	38.21450	-122.54344	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Stage_Gulch	OverSamp	7.850901	Equal	1.025000
PNS-11	Stage_Gulch	38.15743	-122.49704	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Shrub/Scrub	Stage_Gulch	Base	7.850901	Equal	0.363000
PNS-110	Stage_Gulch	38.19061	-122.52386	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Stage_Gulch	OverSamp	7.850901	Equal	0.928000
PNS-111	Stage_Gulch	38.15193	-122.48072	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Developed, Low Intensity	Stage_Gulch	OverSamp	7.850901	Equal	0.931000
PNS-112	Stage_Gulch	38.19428	-122.52631	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Stage_Gulch	OverSamp	7.850901	Equal	0.813000
PNS-113	Stage_Gulch	38.21226	-122.53467	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Stage_Gulch	OverSamp	7.850901	Equal	1.025000
PNS-114	Stage_Gulch	38.16865	-122.50988	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Developed, Open Space	Stage_Gulch	OverSamp	7.850901	Equal	0.942000
PNS-115	Stage_Gulch	38.16385	-122.47913	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Grassland/Herbaceous	Stage_Gulch	OverSamp	7.850901	Equal	0.736000
PNS-116	Stage_Gulch	38.15786	-122.47640	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Grassland/Herbaceous	Stage_Gulch	OverSamp	7.850901	Equal	1.176000
PNS-117	Stage_Gulch	38.18656	-122.51731	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Grassland/Herbaceous	Stage_Gulch	OverSamp	7.850901	Equal	0.585000
PNS-118	Stage_Gulch	38.17804	-122.50266	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Grassland/Herbaceous	Stage_Gulch	OverSamp	7.850901	Equal	0.278000
PNS-119	Stage_Gulch	38.15697	-122.49744	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Developed, Low Intensity	Stage_Gulch	OverSamp	7.850901	Equal	0.485000
PNS-12	Stage_Gulch	38.17205	-122.51428	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Developed, Open Space	Stage_Gulch	Base	7.850901	Equal	0.270000
PNS-120	Stage_Gulch	38.16099	-122.47688	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Grassland/Herbaceous	Stage_Gulch	OverSamp	7.850901	Equal	1.176000
PNS-45	Stage_Gulch	38.15728	-122.47591	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Grassland/Herbaceous	Stage_Gulch	OverSamp	7.850901	Equal	1.176000
PNS-46	Stage_Gulch	38.18607	-122.51794	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Grassland/Herbaceous	Stage_Gulch	OverSamp	7.850901	Equal	0.585000
PNS-47	Stage_Gulch	38.15502	-122.48624	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Developed, Low Intensity	Stage_Gulch	OverSamp	7.850901	Equal	1.228000
PNS-48	Stage_Gulch	38.17232	-122.49362	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Developed, Open Space	Stage_Gulch	OverSamp	7.850901	Equal	1.530000
PNS-197	Tidal	38.16487	-122.51097	Mixed	Tidal	Tidal	NearDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	OverSamp	40.074741	Equal	1.063000
PNS-198	Tidal	38.15708	-122.55507	Mixed	Tidal	Tidal	FarDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	OverSamp	40.074741	Equal	1.035000
PNS-199	Tidal	38.21758	-122.59344	Mixed	Tidal	Tidal	FarDairy	NearRoad	Wetlands	Petaluma_Rush	OverSamp	40.074741	Equal	1.048000
PNS-200	Tidal	38.12436	-122.48796	Mixed	Tidal	Tidal	FarDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	OverSamp	40.074741	Equal	0.108000
PNS-201	Tidal	38.16494	-122.54088	Mixed	Tidal	Tidal	NearDairy	NearRoad	Wetlands	Petaluma_Rush	OverSamp	40.074741	Equal	2.586000
PNS-202	Tidal	38.15565	-122.55683	Mixed	Tidal	Tidal	FarDairy	NearRoad	Wetlands	Petaluma_Rush	OverSamp	40.074741	Equal	1.550000
PNS-203	Tidal	38.21070	-122.57453	Mixed	Tidal	Tidal	NearDairy	NearRoad	Wetlands	Petaluma_Rush	OverSamp	40.074741	Equal	0.900000
PNS-204	Tidal	38.14057	-122.49601	Mixed	Tidal	Tidal	FarDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	OverSamp	40.074741	Equal	0.517000
PNS-205	Tidal	38.16021	-122.52693	Mixed	Tidal	Tidal	NearDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	OverSamp	40.074741	Equal	0.071000
PNS-206	Tidal	38.22909	-122.60106	Mixed	Tidal	Tidal	FarDairy	NearRoad	Developed, Low Intensity	Petaluma_Rush	OverSamp	40.074741	Equal	0.169000
PNS-207	Tidal	38.13406	-122.48151	Mixed	Tidal	Tidal	FarDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	OverSamp	40.074741	Equal	1.169000
PNS-208	Tidal	38.12847	-122.50410	Mixed	Tidal	Tidal	FarDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	OverSamp	40.074741	Equal	0.696000
PNS-209	Tidal	38.17851	-122.54793	Mixed	Tidal	Tidal	NearDairy	NearRoad	Wetlands	Petaluma_Rush	OverSamp	40.074741	Equal	3.449000

Petaluma Watershed Nutrient Study-Station Information (includes base and oversample sites)

	stratum	latitude	longitude	Land_Use	Tidal	Category	Dairy	Roads	NLCD	CDFPWSNAME	panel	wgt	mdcaty	LengthKM
PNS-210	Tidal	38.19728	-122.57965	Mixed	Tidal	Tidal	FarDairy	NearRoad	Open Water	Petaluma_Rush	OverSamp	40.074741	Equal	1.898000
PNS-211	Tidal	38.13015	-122.46753	Mixed	Tidal	Tidal	FarDairy	NearRoad	Developed, Medium Intensity	Petaluma_Rush	OverSamp	40.074741	Equal	0.676000
PNS-212	Tidal	38.13115	-122.56249	Mixed	Tidal	Tidal	FarDairy	NearRoad	Wetlands	Petaluma_Rush	OverSamp	40.074741	Equal	1.264000
PNS-213	Tidal	38.16735	-122.56320	Mixed	Tidal	Tidal	FarDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	OverSamp	40.074741	Equal	0.259000
PNS-214	Tidal	38.19167	-122.54626	Mixed	Tidal	Tidal	NearDairy	NearRoad	Open Water	Petaluma_Rush	OverSamp	40.074741	Equal	1.020000
PNS-215	Tidal	38.12485	-122.48024	Mixed	Tidal	Tidal	FarDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	OverSamp	40.074741	Equal	0.279000
PNS-216	Tidal	38.14245	-122.54732	Mixed	Tidal	Tidal	FarDairy	NearRoad	Developed, Low Intensity	Petaluma_Rush	OverSamp	40.074741	Equal	0.913000
PNS-32	Tidal	38.13666	-122.48727	Mixed	Tidal	Tidal	FarDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	Base	40.074741	Equal	0.487000
PNS-33	Tidal	38.14414	-122.49311	Mixed	Tidal	Tidal	FarDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	Base	40.074741	Equal	0.999000
PNS-34	Tidal	38.23129	-122.61547	Mixed	Tidal	Tidal	FarDairy	NearRoad	Developed, Low Intensity	Petaluma_Rush	Base	40.074741	Equal	0.786000
PNS-35	Tidal	38.22095	-122.60135	Mixed	Tidal	Tidal	FarDairy	NearRoad	Open Water	Petaluma_Rush	Base	40.074741	Equal	1.456000
PNS-36	Tidal	38.19223	-122.58872	Mixed	Tidal	Tidal	FarDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	Base	40.074741	Equal	1.006000
PNS-68	Tidal	38.16213	-122.51858	Mixed	Tidal	Tidal	NearDairy	NearRoad	Cultivated Crops	Petaluma_Rush	OverSamp	40.074741	Equal	0.156000
PNS-69	Tidal	38.13939	-122.47145	Mixed	Tidal	Tidal	FarDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	OverSamp	40.074741	Equal	1.139000
PNS-70	Tidal	38.15465	-122.56264	Mixed	Tidal	Tidal	FarDairy	NearRoad	Grassland/Herbaceous	Petaluma_Rush	OverSamp	40.074741	Equal	0.781000
PNS-71	Tidal	38.20774	-122.55982	Mixed	Tidal	Tidal	NearDairy	NearRoad	Cultivated Crops	Petaluma_Rush	OverSamp	40.074741	Equal	0.081000
PNS-72	Tidal	38.11514	-122.49687	Mixed	Tidal	Tidal	FarDairy	NearRoad	Wetlands	Petaluma_Rush	OverSamp	40.074741	Equal	0.317000
PNS-161	Upper_San_Antonio_Creek	38.20611	-122.72021	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Grassland/Herbaceous	Upper_San_Antonio_Creek	OverSamp	10.191529	Equal	0.614000
PNS-162	Upper_San_Antonio_Creek	38.21544	-122.69493	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Developed, Open Space	Upper_San_Antonio_Creek	OverSamp	10.191529	Equal	2.988000
PNS-163	Upper_San_Antonio_Creek	38.19807	-122.70616	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Grassland/Herbaceous	Upper_San_Antonio_Creek	OverSamp	10.191529	Equal	0.320000
PNS-164	Upper_San_Antonio_Creek	38.19164	-122.68275	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Upper_San_Antonio_Creek	OverSamp	10.191529	Equal	1.069000
PNS-165	Upper_San_Antonio_Creek	38.22976	-122.71915	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Grassland/Herbaceous	Upper_San_Antonio_Creek	OverSamp	10.191529	Equal	0.482000
PNS-166	Upper_San_Antonio_Creek	38.20106	-122.68033	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Developed, Open Space	Upper_San_Antonio_Creek	OverSamp	10.191529	Equal	0.688000
PNS-167	Upper_San_Antonio_Creek	38.19042	-122.69331	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Upper_San_Antonio_Creek	OverSamp	10.191529	Equal	2.449000
PNS-168	Upper_San_Antonio_Creek	38.18979	-122.67156	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Grassland/Herbaceous	Upper_San_Antonio_Creek	OverSamp	10.191529	Equal	1.139000
PNS-169	Upper_San_Antonio_Creek	38.21915	-122.72147	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Grassland/Herbaceous	Upper_San_Antonio_Creek	OverSamp	10.191529	Equal	0.493000
PNS-170	Upper_San_Antonio_Creek	38.20821	-122.67352	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Developed, Open Space	Upper_San_Antonio_Creek	OverSamp	10.191529	Equal	2.116000
PNS-171	Upper_San_Antonio_Creek	38.18309	-122.70128	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Upper_San_Antonio_Creek	OverSamp	10.191529	Equal	2.449000
PNS-172	Upper_San_Antonio_Creek	38.18869	-122.71262	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Grassland/Herbaceous	Upper_San_Antonio_Creek	OverSamp	10.191529	Equal	0.144000
PNS-173	Upper_San_Antonio_Creek	38.19922	-122.69897	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Grassland/Herbaceous	Upper_San_Antonio_Creek	OverSamp	10.191529	Equal	0.289000
PNS-174	Upper_San_Antonio_Creek	38.21191	-122.67722	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Developed, Open Space	Upper_San_Antonio_Creek	OverSamp	10.191529	Equal	0.123000
PNS-175	Upper_San_Antonio_Creek	38.18147	-122.67856	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Open Water	Upper_San_Antonio_Creek	OverSamp	10.191529	Equal	0.275000
PNS-176	Upper_San_Antonio_Creek	38.19048	-122.71486	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Developed, Open Space	Upper_San_Antonio_Creek	OverSamp	10.191529	Equal	3.277000
PNS-23	Upper_San_Antonio_Creek	38.21624	-122.71879	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Cultivated Crops	Upper_San_Antonio_Creek	Base	10.191529	Equal	0.967000
PNS-24	Upper_San_Antonio_Creek	38.18291	-122.68565	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Upper_San_Antonio_Creek	Base	10.191529	Equal	1.565000

Petaluma Watershed Nutrient Study-Station Information (includes base and oversample sites)

	stratum	latitude	longitude	Land_Use	Tidal	Category	Dairy	Roads	NLCD	CDFPWSNAME	panel	wgt	mdcaty	LengthKM
PNS-25	Upper_San_Antonio_Creek	38.20112	-122.68688	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Developed, Open Space	Upper_San_Antonio_Creek	Base	10.191529	Equal	2.988000
PNS-26	Upper_San_Antonio_Creek	38.20128	-122.67396	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Upper_San_Antonio_Creek	Base	10.191529	Equal	0.185000
PNS-59	Upper_San_Antonio_Creek	38.18320	-122.68518	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Shrub/Scrub	Upper_San_Antonio_Creek	OverSamp	10.191529	Equal	1.565000
PNS-60	Upper_San_Antonio_Creek	38.20474	-122.68034	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Developed, Open Space	Upper_San_Antonio_Creek	OverSamp	10.191529	Equal	0.688000
PNS-61	Upper_San_Antonio_Creek	38.21671	-122.71817	Agricultural	NonTidal	NonDairy_Ag	FarDairy	NearRoad	Cultivated Crops	Upper_San_Antonio_Creek	OverSamp	10.191529	Equal	0.967000
PNS-62	Upper_San_Antonio_Creek	38.20194	-122.68746	Agricultural	NonTidal	Dairy_Ag	NearDairy	NearRoad	Developed, Open Space	Upper_San_Antonio_Creek	OverSamp	10.191529	Equal	2.988000