

**Tomales Bay Watershed Council Foundation  
Tomales Bay Wetlands Restoration and Monitoring Program  
Proposition 50 Coastal Non Point Source Pollution Program Grant  
SWRCB Agreement # 06-344-552-0**

**Monitoring Plan**

**Version 1.12**

Prepared for  
California State Water Resources Control Board

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## Tomales Bay Wetlands Restoration and Water Quality Monitoring Plan

**Program goal:** This integrated restoration and monitoring program seeks determine long-term trends and to characterize and reduce threats to water quality and critical habitats in the Tomales Bay Watershed as well as to assess the impacts of the Giacomini Wetlands Restoration Project (GWRP) on water quality. Based on the information gathered through this monitoring program, the Council will work to identify water quality problems, to develop solutions to these problems, and to provide support to realize these solutions by working with partners and landowners in the watershed to improve and protect water quality.

### I. Introduction

One of three goals established in the *Tomales Bay Watershed Stewardship Plan: A Framework For Action* (TBWC, 2003) is to ensure water quality in Tomales Bay and tributary streams is sufficient to support natural resources and beneficial uses.

This project will build on the considerable past efforts to characterize water quality conditions in Tomales Bay and its tributaries, and attempt to better identify threats to the watershed. A Source Area monitoring component will allow the TBWCF to identify and quantify water quality problems within the Bay. Fixed-site monitoring will identify long-term water quality trends and the watershed-level response to a wide range of remediation and restoration efforts proposed to improve the quality of Bay waters. One of the proposed restoration efforts that is expected to have a dramatic effect on water quality is the Giacomini Wetland Restoration Project (GWRP), a 563-acre tidal marsh restoration at the head of the Bay. This restoration project is the single most important measure currently proposed to improve water quality within the watershed. As part of the restoration project monitoring, the National Park Service has conducted pre-restoration monitoring within the ranch and areas to be restored, as well as at other natural tidal marshes. Continued monitoring will enable evaluation of the project's role in improving conditions and functions within the Project Area relative to the conditions and functions that existed prior to restoration and at other natural marshes. Under this project, monitoring of this restoration project will continue and will be integrated with that of Source Area and Trend Analysis programs to document the effect of large-scale restoration on water quality within the Tomales Bay watershed.

This nested approach will allow the Program to gauge effectiveness of restoration measures and to identify and prioritize future source reduction, remediation, and restoration projects. Indeed, many regional plans share a common need for the substantial water quality data that this Project will provide. By sharing access to a detailed water quality database, summaries, and analysis, this Project will propel forward plans by numerous local, regional and state organizations.

The Trends and Source Area water quality monitoring program (WQMP) will be implemented by the Tomales Bay Watershed Council Foundation (Council) and the water quality monitoring of the GWRP will be conducted through the Point Reyes National Seashore Association (PRNSA). To meet the technical needs associated with defining the design, monitoring and data management aspects of this program, the Council has created a Water Quality Technical Advisory Committee (WQ TAC). The WQ TAC will continue to oversee the development and implementation of this program to ensure that data is collected in efficient, effective and appropriate ways in order to meet the program objectives.

Implementation of this program by the Council members will be in accordance to their respective statutory mandates, charters, and resource availability. Core partners and committee members include: California Department of Public Health (CDPH); S.F. Bay Regional Water Quality Control Board; Marin County Environmental Health Services; U.C. Cooperative Extension (UCCE); Salmon Protection and Watershed Network (SPAWN); Tomales Bay Agricultural Group; Tomales Bay Shellfish Technical Advisory Committee; Gulf of the Farallones National Marine Sanctuary; California Department of Fish and Game (CDFG); Pacific Coast Science and Learning Center (PCSLC); Point Reyes National Seashore (PRNS); Point Reyes National Seashore Association (PRNSA); California State Parks; Marin Municipal Water District (MMWD); Inverness Public Utility District (IPUD); ranchers; private landowners; shellfish growers; and local non-governmental organizations.

In this plan, water quality is defined as the chemical, physical, and biological characteristics of surface waters (or these characteristics within the water column). Water quality is often described with respect to a specific activity or a legally recognized “beneficial use” like water contact recreation, water supply for residential or agricultural purposes, mariculture, estuarine and wildlife habitats, wetlands, and others. In providing this definition, it is important to remember that the focus on surface water is a starting point with the intended hope that additional monitoring interests can be coordinated to expand the program in the future.

It is the desire of the Council to provide needed water quality information that will assist individuals, organizations and agencies that are responsible for and/or advocating for water quality protection and improvement within the Tomales Bay watershed. The information collected through this program will ultimately be used to increase our collective understanding about the benefits of specific efforts to improve water quality, and our ability to effectively and adaptively manage human impacts on water quality. Data sensitivity is a significant concern amongst both public agencies and various stakeholder groups, and the appropriate use of data, data limitations, etc. will be defined prior to the collection and/or dissemination of any program data. Private property rights will be recognized, statutory responsibilities will be maintained, and voluntary cooperation will be encouraged and protected with data sensitivity considerations.

## **II. Plan Objectives**

This plan provides direction for a water quality monitoring program with an initial 3-year timeframe. It is envisioned, however, that the design will include monitoring parameters and a sampling regime that can be carried out indefinitely.

Water-Quality Monitoring Project (WQMP) Objectives:

- 1) Provide the watershed community with the required data and analysis to determine improving, constant, or declining trends in bay and tributary water quality;
- 2) Form and maintain a clearinghouse of water quality data and monitoring activities that facilitates effective and efficient use of limited resources;
- 3) Serve as source of information that will direct and promote actions to improve water quality; and
- 4) Provide an understanding of source areas and categories for constituents of concern in the bay and on a sub-watershed and/or tributary scale.

Giacomini Wetland Restoration Project (GWRP) Water Quality Monitoring Objectives:

*This plan addresses the water-quality monitoring objective of the GWRP. For a complete assessment of all long-term monitoring objectives of the GWRP, see complete project literature, including Parsons (2005).*

1. Provide strategic water quality monitoring before, during, and after a phased restoration effort to determine the short- and long-term effects of restoration on water quality within the Project Area and on the amount of contaminants delivered to Tomales Bay.
2. Compare water quality conditions in the Project Area before, during, and after restoration to those of natural undiked tidal marshes in the Tomales Bay and adjacent watersheds to determine the degree of divergence prior to restoration and how well over time conditions in the restored Project Area move toward those of natural marshes after restoration.

**III. Questions to be addressed by this monitoring program:**

Questions to be addressed by this (WQMP) monitoring program:

- 1) What are the natural ranges and the storm, seasonal and annual variability in water quality parameters in the Bay and its tributaries?
- 2) At what locations do parameters fall outside the natural range and to what duration and extent?
- 3) What are the pollutant loadings from controllable and uncontrollable sources and in the watershed, and how do the Bay and tributaries relate in this regard?
- 4) What are the trends in the levels, fate and transport of pollutants in the watershed and the Bay, and how do the Bay and tributaries relate in these regards?
- 5) How effective are actions to reduce pollutant loads?

Questions to be addressed by GWRP water quality monitoring:

1. What is the response to restoration activities with respect to nutrients, pathogen indicators and carbon/productivity indicators?
2. Over time, do conditions within the restored Project Area improve relative to pre-restoration conditions, and do they begin to move closer toward those in natural undiked tidal marshes in the Tomales Bay and adjacent watersheds?
3. Does restoration of the Giacomini wetlands appear to have an effect on the quality of water delivered downstream to undiked natural marshes and Tomales Bay?

## **IV. Program Components**

### **A. Long Term Trend Monitoring**

Trend monitoring will generate water quality data of sufficient duration and representation to assess long-term shifts in water quality within Tomales Bay and its tributaries. There are numerous stakeholder efforts to manage sources of pollution for which feedback is needed to assess impacts and the effectiveness of restoration efforts. There are also regulatory and statutory needs for long-term trend water quality monitoring; these include the Tomales Bay Pathogen TMDL (SFBRWQCB, December 2005), and the Shellfish Lease monitoring by California Department of Public Health (CDPH). Similarly, water quality monitoring results have created the basis for regulatory attention as illustrated by the County of Marin's health advisories at popular beach and swimming areas during the past 6 years. This component of the monitoring program will give the watershed community the needed benchmarks to determine the success of management efforts and efficacy of regulatory policies.

There currently is no long-term comprehensive water quality monitoring at a watershed level. Numerous stakeholders and regulatory agencies have conducted comprehensive monitoring for short duration or for a limited focus on water quality parameters or geographic boundaries. Examples of this sort of water quality monitoring would be the National Park Service's continuing monitoring of Olema Creek, and the Shellfish Technical Advisory Committee's two-year pathogen study on Tomales Bay and its tributaries.

The recent but now terminated efforts of California Department of Fish and Game to monitor ammonia concentrations in Stemple Creek and Tomales Bay watersheds is a relevant example of the type of effort and intended use of the data to be generated for this program. In that case, what was initially perceived as a regulatory threat, quickly evolved into a management tool, and eventually became documentation that the management of pollution sources was having a beneficial impact on water quality.

The lead organization for long-term trend monitoring will be the Tomales Bay Watershed Council. To the greatest extent possible, the Council's efforts will be coordinated with the on-going monitoring programs of its partners.

#### **Parameters**

The water-quality parameters of interest for the long-term Trends monitoring include core parameters: temperature, conductivity/salinity, dissolved oxygen and pH; fecal indicator bacteria: total coliforms, fecal coliforms, *E. coli* and coliphage; nutrient parameters: nitrate, nitrite, ammonia, organic nitrogen, orthophosphate, and total phosphate; and sediment parameters: turbidity, transparency, total suspended solids or suspended sediment concentration.

In addition to these water quality parameters or "response variables", descriptive or "explanatory variables" will be collected. These will include tidal stage, discharge, cumulative precipitation, and possibly others. Because discharge measurements are often time consuming, use of existing stream-gauging stations, rating curves, installation of staff plates and estimates of flow may be deemed

appropriate. Analytical methods will follow accepted procedures such as those outlined in the Standard Methods for the Examination of Water and Wastewater (Clesceri et al., 1998). If there is sufficient funding or demonstrated need, samples will also be analyzed for additional parameters.

### **Methods**

Methods of data and sample collection, handling and analysis will follow standard techniques from USGS National Field Manual (CITE) and SWAMP protocols. Full protocols, including modifications to standard methods, are detailed in the project QAPP and SOP.

Labs will all follow standard and approved analytical protocol. Contract laboratories used for most analyses will be ELAP or CA-ELAP certified for the parameters on interest, except for those conducting specialized analyses for trace-level (ng/L) nutrient, and coliphage analysis. These labs will follow standard protocol and the requirements detailed in this project's QAPP and SOP.

### **Frequency and Duration**

Trend sampling shall be conducted on a weekly basis during the rainy season (late Fall, Winter and early Spring), and twice monthly during summer base flow conditions. This regular sampling will be supplemented by continuous temperature data from long-term sites to analyze diurnal and seasonal variation. The proposed level of sample collection will afford documentation of seasonal and annual changes in water quality. It will also allow for the development of geometric means as required under the San Francisco Bay Basin Plan, which includes Tomales Bay (CRWQCB, 1995). It will not necessarily provide documentation of variability due to storm conditions. This program component will be carried for an initial three years with the anticipation that it will be continued for an additional 20 years if not longer. In the future the data will be evaluated to determine if a reduction of sampling frequency can still provide sufficient data.

### **Sampling Locations**

a. **Tomales Bay sampling locations:** Sampling locations will include four bay sites to represent areas of major impact from freshwater inputs, as well as tidal conditions and separation of the Bay (Fisher et al., 1996). The Council and WQ TAC will re-evaluate Bay sampling locations in consultation with researchers working in Tomales Bay to explore opportunities to identify long-term monitoring sites that may be useful boundary conditions for the model development and operation. These include John Largier of the Bodega Bay Marine Laboratory, the authors of the UC Berkeley Tomales Bay hydrodynamic model (Brennan, M. and Stacey, M. 2005) and through analysis of results and studies from LMER/BRIE research (Smith and Hollibaugh). These sites will be coordinated with the existing monitoring sites in the bay that are used by the California Department of Public Health, Regional Water Quality Control Board, and others. Bay sites will also seek to facilitate evaluation of impacts of restoration on water-quality. Consultation will also help the WQ TAC determine the integration of depth-specific sampling techniques to provide additional monitoring information.

b. **Watershed sampling locations:** Nine to twelve permanent tributary sampling locations will be established. These sites will be coordinated with the four existing gauging stations (mainstem Lagunitas, Olema, Walker, and San Geronimo); East and west shore sites will include sites with human land use activities, and at least one reference stream (e.g.: milepost 36.17 on the east and White Gulch on the west) that flow through sub-watersheds with minimal human land use activities.

**Table 1.0 Long-Term Monitoring Sites.**

Grouping	Site Name	Program Relevance	Site Type	Descriptions
<b>Walker Creek</b>				
	Walker Creek	Trends	Mainstem Stream site	@ Highway 1: TMDL Site
	Walker Creek	Trends	Mainstem Stream site	@ Walker Creek Ranch; USGS stream gauge; TMDL Site
	Keyes Creek	Trends	Tributary: Keyes Creek	@ Walker Crk. Confluence. TMDL Site
<b>Lagunitas Creek</b>				
	Green Bridge	Trends, GWRP	Mainstem Stream site	TMDL Site; USGS stream gauge 1-2 miles upstream.
	Olema Creek	Trends, GWRP	Tributary: Olema Creek	@ Bear Valley Rd. bridge NPS stream gauge; TMDL Site;
	San Geronimo	Trends, Source	Tributary: San Geronimo Creek	Ink Wells or MMWD gauge site; TMDL site or SPAWN monitoring
	Samual P. Taylor	Trends, Source	Mainstem stream site	@ USGS stream gauge; TMDL site
<b>West Shore</b>				
	1 <sup>st</sup> Valley, 2 <sup>nd</sup> Valley	Trends	Stream site	Will consult with IPUD on selection of one or the other
	White Gulch	Trends	Reference Stream site	West shore reference site
<b>East Shore</b>				
	MP 36.17	Trends	Reference Stream Site	East shore reference trib. (Marconi)
	Millerton Creek	Trends	Stream site	@ Highway 1
	Grand Canyon Creek	GWRP	Stream site	@ Highway 1; Coordinated monitoring appropriate to assessment of GWRP
	Tomasini Creek	GWRP	Stream site	@ Highway 1; Coordinated monitoring appropriate to assessment of GWRP
	Wetlands Downstream	Trends, GWRP	Tidally influenced stream site	Main Lagunitas channel downstream of GWRP Project Area; Coordinated monitoring appropriate to assessment of GWRP
<b>Tomales Bay Sites*</b>				
	Bay Site 1 (Outer Bay)	Trends	Outer Bay Site	CDPH Site 2; Will consider CDPH sites 33 or 41; Logistical concerns considered
	Bay Site 2 (Middle Bay)	Trends	Mid-Bay Site	CDPH Site 4
	Bay Site 3 (Inner Bay)	Trends	Inner Bay Site	CDPH Site 11
	Bay Site 4 (Bottom of Wetland)	Trends, GWRP	Wetland/Bay Interface Site	

\* Final locations of Bay sampling sites will be determined through consultation with researchers (see discussion in Tomales Bay Sampling Locations a) above).

### **Statistical Analysis**

The data generated from this effort will have a high level of variability. The descriptive variables will be used to normalize concentration results or to calculate flux and load for a given parameter. These steps will allow for comparison of results across the different locations. Admittedly, the comparison of tributary and bay locations requires additional normalization because of the simultaneous influences of discharge and tides. These data will also be valuable as boundary conditions to calibrate and test the UC Berkeley Tomales Bay hydrodynamic model.

Analysis of trends will be conducted graphically and through time series analysis. Graphical analysis will include the representation of concentration, flux, and load values as a function of time. These graphics will provide anecdotal indications of water quality trends including seasonal and annual fluctuations. Time series analysis for upward or downward trends in concentration, flux, and load will be conducted according to Helsel and Hirsch (1995) or other suitable and accepted methods (Hirsch et al., 1991; and Helsel, 1987). This will include nonparametric statistical methods including data transformation to account for lack of normal distribution in the data.

### **B. Source Area Monitoring**

Source area monitoring efforts will be focused on identifying sources and quantities of water pollutants to Tomales Bay and its freshwater tributaries. While Trend monitoring is dependant on long-term sampling at a suite of permanent sampling sites, source area monitoring is both flexible and responsive based on the data collected. The intent of source area monitoring will be to support and prioritize future watershed or sub-watershed water quality improvement efforts, and to document conditions in order to evaluate the effectiveness of past efforts to improve water quality on private and public lands.

Sampling sites will be determined based upon the results of previous sampling and through prioritization of known source areas by the WQ TAC. Source area monitoring will be initially concentrated at the sub-watershed scale, and as needed in the Bay. Additional sampling will be conducted where sources are identified, while sampling will be curtailed in areas where conditions were of less concern. These monitoring activities will compliment the long-term monitoring program to document general trends within the watershed and the Bay, and provide a broader perspective on the effects of restoration projects on water quality within the watershed. Differentiating source areas and land use issues would be valuable for the long-term management of water quality in the Bay and tributaries.

### ***Current Efforts***

The Council just completed a one-year storm water sampling program (Prop. 50) in Woodacre, Point Reyes Station and Tomales. This study collected data on core parameters, fecal indicator bacteria and stormwater indicators. The data from this program provides a better understanding of local storm water system contributions to pollution in the bay, and will be used to determine priority source area sampling locations for this program.

Point Reyes National Seashore currently conducts a source area monitoring program within the boundaries of the Seashore. The intent is to document loading from the various park watersheds, in order to concentrate long-term management and restoration efforts into areas where the watershed will benefit the most. Through this program, the Seashore has identified source areas and management or structural practices intended to reduce pollutant loading to aquatic systems.

The Salmon Protection and Watershed Network (SPAWN) conducted water quality monitoring program that documented conditions and source areas within the San Geronimo watershed. Their efforts, funded through the State 319(h) grant program investigated additional water quality parameters, and the results can be used by the Council WQ TAC to determine sites and target parameters should could be integrated into the project.

The community of Marshall has recently conducted a voluntary septic monitoring program via a partnership between the East Shore Planning Group (ESPG) and the County of Marin. Based on the monitoring results, the ESGP and the County have subsequently developed substantial grant funds for septic improvements in Marshall. Currently, the community and an engineering team are exploring options for septic improvements, feasibility and cost benefits. These studies will allow Marshall and Marin County to collaborate further on decisions regarding the most cost effective use of grants and homeowner finances for septic system improvements and local community septic management.

**Lead(s)**

The lead organization for the source area monitoring program would be the Tomales Bay Watershed Council. These efforts would be coordinated with ongoing monitoring efforts in the watershed including the Tomales Bay Agricultural Group, SPAWN, Point Reyes National Seashore, Regional Water Quality Control Board, and others.

**Monitoring Locations**

The intent of this program is to conduct monitoring at publicly accessible locations, for the purpose of understanding pollutant loading to the bay from different geographic areas. Various organizations through multiple monitoring efforts have conducted water quality sampling at more than 50 locations within the Tomales Bay watershed. Initial sites for source area monitoring will be determined from the results of the 1995-96 and 2000-2001 Tomales Bay Shellfish Technical Advisory Committee (TBSTAC) sampling programs, the Prop 50 TBWC Stormwater Monitoring Plan (2006-2007) and prioritization by the TBWC WQ TAC. After reviewing the existing data, and coordinating with other current efforts, priority areas will be identified for the source area monitoring, and these sites will be grouped according to the primary watersheds (see list below).

**Table 2.0 Prioritized List of Potential Source Areas (WQ TAC, Oct. 2007):**

<b>Priority or Year</b>	<b>Source Watershed</b>	<b>Known Issues/ Area Comments</b>
2007-2008	Heart’s Desire	Potential direct management response.
2007-2008	San Geronimo	Potential to build on recent SPAWN monitoring and TBWC storm-water sampling to refine location of source area drainages.
Potentially Summer 2008	Lawson’s Landing	Development of septic system plan underway. Will consider sampling design approaches Jan/Feb ‘08
To be	Keyes Creek	Priority area for Shellfish TAC

reevaluated in January 2008 for selection of next Source Area Monitoring subwatersheds.	Chileno Creek	
	Grand Canyon	
	Tomasini Creek	Some potential landfill management issues; direct influence on GWRP
	1 <sup>st</sup> & 2 <sup>nd</sup> Valley Creeks	Small drainages, easy public access
	Haggerty Gulch	
	Fish Hatchery Creek	
	Quarry Gulch	
	Stormwater Sampling Networks	In Tomales, Pt. Reyes Station and Woodacre

**Parameters**

Potential water-quality parameters of interest for the Source Area monitoring include core parameters: temperature, conductivity/salinity, dissolved oxygen and pH; fecal indicator bacteria: total coliforms, fecal coliforms, *E. coli* and coliphage; nutrient parameters: nitrate, nitrite, ammonia, organic nitrogen, orthophosphate, and total phosphate; sediment parameters: turbidity, transparency, total suspended solids or suspended sediment concentration; and stormwater pollution indicators: Methyl Blue Activated Substances (MBAS); oil and grease, total metals, and volatile organic compounds.

In addition to these water quality parameters or “response variables”, descriptive or “explanatory variables” will be collected. These will include tidal stage, discharge, cumulative precipitation, and possibly others. Because discharge measurements are often time consuming, installation of staff plates and estimates of flow may be deemed appropriate. Analytical methods will follow accepted procedures such as those outlined in the Standard Methods for the Examination of Water and Wastewater (Clesceri et al., 1998) and detailed in the project QAPP. Target parameters will be determined and modified as we learn more about the system and the issues in the Tomales Bay watershed. If there is sufficient funding or demonstrated need, samples will also be analyzed for additional parameters.

**Frequency and Duration**

The source area monitoring program will target storm season runoff events when nonpoint source pollution loading is most prevalent. This would include three to four storm events per winter season at sites to capture nonpoint source loading information, and additional sampling upstream of sites that show high levels of loading. In addition, a summer sampling event will also be conducted to document seasonal differences in the parameters. Stream discharge should also be measured in conjunction with water quality sampling. In this manner, loading may be estimated for different watersheds and subwatersheds. Because discharge measurements are often time consuming, installation of staff plates and estimates of flow may be deemed appropriate.

**Site reconnaissance and documentation**

Once sites are selected, they will be spatially documented using GPS, photographs, and a narrative description of site access. Field sampling protocols are well established and will vary based upon the actual equipment used in the monitoring effort. Laboratory analysis is standardized by

analytical method, but program sampling protocols and handling procedures will be similar to those identified in the long-term monitoring plan and detailed in the program SOP.

### **Statistical data analysis and interpretation**

Data analysis related to the source area monitoring program should provide information that may be used to identify priority watersheds for implementation of water quality improving practices. Comparative sample concentrations and loading estimates for the various sampling location should be evaluated to determine watersheds and sub-watersheds where further sampling is needed. TBWCF will coordinate data analysis and interpretation with the intent of using information to focus watershed outreach and management efforts.

### **Watershed outreach and coordination**

Results of the source area sampling program will be used to advise outreach and prioritization of water quality management measures supported by partners that are working on the ground to address water quality issues on public and private lands (e.g. the TBSTAC, Marin RCD, SPAWN, PRNS, NRCS, Marin County, and others).

## **C. Giacomini Wetland Restoration Water-Quality Monitoring**

The Giacomini Wetland Restoration Project (GWRP) is a 613-acre tidal marsh restoration at the head of the Bay. This restoration project is the single most important measure currently proposed in Tomales Bay. As part of the monitoring program for the restoration project, the National Park Service has conducted pre-restoration monitoring within the ranch and areas to be restored, as well as at other natural tidal marshes, to enable better evaluation of how well restoration improves conditions and functions within the Project Area relative to the conditions and functions that existed prior to restoration and exist in other natural marshes. Under this project, monitoring of these areas will continue and will be integrated with that of Source Area and Trend Analysis programs to allow a broader perspective on the effect of large-scale restoration on water quality within the Tomales Bay watershed.

Water-quality monitoring has been conducted within the Project Area and in reference wetlands since February 2002 through the National Park Service. This monitoring provides data to characterize the pre-restoration water-quality in the Project Area, adjacent areas, natural undiked marshes and provides the comparative basis for during and post-restoration water-quality monitoring to be conducted as part of this project.

### **Lead(s)**

The lead organization for the Giacomini Wetland Restoration Water-Quality Monitoring Program would be the Point Reyes National Seashore Association. These efforts would be coordinated with ongoing monitoring efforts in the watershed including the Point Reyes National Seashore, USGS, Regional Water Quality Control Board, and others.

### **Identify monitoring locations**

The intent of this program is to conduct monitoring at key sites, for the purpose of understanding the effect of restoration efforts on pollutant concentrations within the Project Area and on pollutant loading to the bay from different geographic areas. Sampling of field parameters is conducted at 35 sampling sites in the Project Area and 16 sampling sites in the three (3) reference wetlands. Monitoring of four (4) creek and tidal channel sampling sites within both the Walker Creek and Limantour Study Areas began in April 2002. Eight (8) creek, tidal channel and pond sampling sites in the undiked Lagunitas Creek Study Area were added in April 2003. The East Pasture Study Area has 14 sampling sites within waterways that include Tomasini Creek, duck ponds, flooded mud flats, and drainage ditches and/or remnant sloughs that are currently used for storing irrigation waters. The West Pasture Study Area has 14 sampling sites in Fish Hatchery Creek, small drainages, remnant sloughs, seep areas, and ponds. There are another five (5) sampling sites in the portion of Lagunitas Creek between the East and West Pasture Study Areas. Two (2) sampling sites were added in Olema Marsh in 2004. Sampling sites were chosen to be spatially representative of the Study Area, with the exact sampling locations chosen haphazardly (Parsons, 2005).

**Table 3.0 Giacomini Wetland Restoration Program Monitoring Sites**

<u>Site</u>	<u>Description</u>	<u>Lab Samples</u>	<u>X</u>	<u>Y</u>
<b>EAST PASTURE</b>				
EP DD1	East Pasture Drainage Ditch - upstream		516223.40	4212974.66
EP DD2	East Pasture Drainage Ditch	y	515993.44	4213316.63
EP DD3	East Pasture Drainage Ditch - downstream		515883.23	4213662.17
EP OS1	East Pasture Old Slough - upstream		516266.90	4213688.38
EP OS2	East Pasture Old Slough	y	515787.31	4214160.82
EP OS3	East Pasture Old Slough - downstream		515548.41	4214583.81
EP Panne (new)	East Pasture Panne		516027.67	4214477.39
EP Panne (old)	East Pasture Panne		516113.19	4214492.06
EUC 1	East Pasture Eucalyptus Creek upstream	y	516607.07	4213489.40
EUC 2	East Pasture Eucalyptus Creek downstream		516286.56	4213682.43
TOM 1	Tomasini Creek (Upstream)	y	516655.92	4213699.99
TOM 1.5	Tomasini Creek		516387.69	4213697.72
TOM 2	Tomasini Creek		516292.51	4213701.49
TOM 3	Tomasini Creek	y	516128.08	4214524.24
TOM 4	Tomasini Creek (Downstream)		515557.34	4214598.11
New Duck Pond	East Pasture		515879.05	4213640.72
<b>LAGUNITAS CREEK BETWEEN EAST &amp; WEST PASTURE</b>				
LAG 1	Lagunitas Creek, most upstream - Green Bridge)	y	517088.45	4213024.11
LAG 2	Lagunitas Creek		516426.56	4212841.81
LAG 3	Lagunitas Creek		515830.38	4212804.17

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LAG 4	Lagunitas Creek		515684.84	4214041.07
LAG 5	Lagunitas Creek	y	515138.95	4214667.49
LAG 6	Lagunitas Creek, most downstream, off undiked marsh		514990.60	4215216.37
<b>OLEMA MARSH</b>				
OM 1	Olema Marsh - culvert on BV Rd where BV Creek enters	y	516687.33	4212269.92
OM 2	Olema Marsh - culvert on Levee Rd where BV Creek exits	y	516428.94	4212803.68
<b>WEST PASTURE</b>				
FIS 1	Fish Hatchery Creek - most upstream	y	515313.49	4213659.21
FIS 2	Fish Hatchery Creek	y	515260.68	4214168.94
FIS 3	Fish Hatchery Creek		515145.92	4214290.04
FIS 4	Fish Hatchery Creek		514914.98	4214438.35
FIS 4.5	Fish Hatchery Creek		514838.83	4214444.06
FIS 5	Fish Hatchery Creek -s of N Levee		514726.77	4214530.10
LUCC 1	Lucchesi Creek into Freshwater Marsh	y	515142.71	4213989.95
LUCC 2	Lucchesi Creek into Freshwater Marsh		515105.07	4214042.65
WP Culv	West Pasture Culvert off SFD		515526.89	4213386.94
WP OS0	West Pasture Old Slough, most upstream (flows out Gredjansky (sp?) property)		515491.61	4213683.15
WP OS1	West Pasture Old Slough		515543.71	4213935.90
WP OS2	West Pasture Old Slough, near bend	y	515276.88	4214223.86
WP Panne 1	West Pasture near NE corner		515051.90	4214667.02
WP Panne 2	West Pasture near spillway		514776.65	4214555.04
WP Seep	In the Freshwater Marsh	y	514947.45	4214171.57
WP TDCRK	West Pasture tidal creek, just south of the North Levee		514772.88	4214523.05
<b>REFERENCE WETLAND SITES</b>				
LIM 1	Limantour Marsh, upstream on muddy hollow creek	y	510135.57	4209269.89
LIM 2	Limantour Marsh, downstream on muddy hollow creek	y	509905.40	4209159.64
LIM 3	Limantour Marsh tidal Creek	y	510033.05	4209070.67
LIM 5/Pond	Limantour Marsh pond		510139.65	4209035.68
WCM 1	Walker Creek Marsh, most inland, on tidal creek	y	506522.20	4229873.60
WCM 2	Walker Creek main channel	y	506448.47	4229830.95

WCM 3	Walker Creek tidal creek near bay	y	506233.80	4229457.99
WCM 5	Walker Creek tidal channel, south side		506514.97	4229604.72
WCM 6	Walker Creek tidal channel, south side		506512.08	4229474.61
FIS 6	Fish Hatchery Creek - n of N Levee		514711.72	4214558.33
FIS 7	Fish Hatchery Creek		514694.31	4214705.14
FIS 8	Fish Hatchery Creek - most downstream site, on undiked marsh	y	514473.77	4215069.44
UM1	Undiked Marsh	y	514758.30	4214635.03
UM2	Undiked Marsh		514961.67	4214853.42
UM3	Undiked Marsh		514830.78	4214949.58
UM4	Undiked Marsh	y	514806.29	4215130.02
UM5	Undiked Marsh	y	514564.19	4215025.98
UM Pond	Undiked Marsh (north of the Giacomini property)		514952.62	4214816.65

### **Parameters**

The monitoring program includes collection of field sampled parameters and laboratory analyzed parameters. The water quality monitoring constituents will include field collected parameters (e.g. temperature, DO, conductivity, pH, etc.) as well as analytical lab analysis (e.g. fecal indicator bacteria, nutrients, sediment and carbon/productivity indicators).

The GWRP water-quality monitoring will be conducted quarterly in January, April, July and October. Monitoring activities are conducted during a neap tide series, and, in tidally-influenced stations is timed to the extent possible with low or ebb tides. For logistical reasons, sampling sites have also usually been monitored at around the same time of day during each sampling event. This constraint may minimize our ability to detect diurnal variation in certain variables (Parsons, 2005). Stream discharge is also measured in conjunction with water quality sampling. With discharge, loading is estimated for different areas or reaches of creeks upstream, within, and downstream of the Project Area.

### **Site reconnaissance and documentation**

Selected sites are spatially documented using GPS, photographs, and a narrative description of site access. Field sampling protocols are well established and will vary based upon the actual equipment used in the monitoring effort. Laboratory analysis is standardized by analytical method, but program sampling protocols and handling procedures will be similar to those identified in the long-term Trends monitoring plan.

### **Statistical data analysis and interpretation**

Data analysis related to the GWRP should provide information that may be used to determine the impacts of restoration activities on water-quality in the Project Area and downstream of the Project Area. PRNSA will coordinate data analysis and interpretation with the intent of using information to evaluate restoration efforts.

#### **D. Quality Assurance (QA) and Quality Control (QC) for Water Quality Data**

All QA/QC procedures will be performed pursuant to the project QAPP which follows the State Water Resources Control Board's Quality Assurance Project Plan (QAPP) for the Surface Water Ambient Monitoring Program (SWAMP). These procedures are outlined in the California State Water Resources Control Board, Division of Water Quality, December 2002: *Quality Assurance Management Plan for the State of California's Surface Water Ambient Monitoring Program, 1st Version*. This includes sample collection and handling, as well as sample analysis. All data collection and handling procedures are described in detail in the project SOP (see QAPP appendix).

#### **E. Documentation of Baseline Conditions and Formation of a Database**

One of the goals of this project is to research, collect and compile reliable baseline data describing the concentrations of contaminants in the waters of Tomales Bay and tributary streams. This will be accomplished through the development of a water-quality database that is compatible with data being generated in ongoing studies of Tomales Bay and tributary streams; which will include past and current water quality information, and the identification of gaps that need to be filled. The establishment and population of a water quality monitoring database for the entire watershed, and the capacity to analyze data and to develop trends, will benefit the agencies and organizations that are currently collecting data, and those responsible for tracking and protecting water quality.

##### ***1. Current Efforts***

More than a dozen agencies and/or organizations are currently collecting or planning to collect water quality data on Tomales Bay and within the watershed (see attached table). These efforts to characterize baseline water quality are hampered by the lack of a single database and analysis protocol for all WQ data currently collected on the bay, its watersheds and sub-watersheds. Thus, a central database is needed for data storage and comprehensive analysis. The TBWC has already contacted and gained agreement from most of the groups collecting water quality. Each has agreed to contribute electronic copies of their data to a central database coordinated by the TBWC.

##### ***2. Lead(s)***

The Water-Quality Program Manager will lead efforts to establish and populate a database with past and current water-quality monitoring data from the Tomales Bay watershed. The Project will use a version of the National Park Service's Water Resources Division (WRD) water-quality database NPSTORET. This database is an MS Access-based relational database, with robust metadata requirements that meet or exceed the requirements for EPA's STORET database, and is compatible with the SWRCB's SWAMP database.

##### ***3. Subtasks***

Establish database, define metadata, collect data from existing programs, summarize baseline data, and produce analyses. Preliminary analyses of legacy data will include graphs and cursory statistical analysis of trends (over time and grouped by season) of all WQ variables by site. Data will also be presented to aid analysis of whether additional data collection sites and frequencies are required to fully describe the water quality patterns in the watershed. Metadata including QA/QC will be maintained on all data sources as well as the database as a whole.

## **F. Database Maintenance and Management**

Maintain and regularly update the water quality database. Provide a clearinghouse for use by landowners, stakeholders, regulatory agencies, watershed managers and the general public through such media as the Internet (web page), published reports, and readily available, computer searchable database. Inclusion and dissemination of water quality data will respect data sensitivity defined by the partners and respective monitoring programs that have developed this data.

### **1. Current Efforts**

No unified database exists for all of Tomales Bay watershed. This section addresses the maintenance of the database that will be established as an initial step in this program.

### **2. Lead(s)**

The Water-Quality Program Manager will act as the data management lead in establishing, populating and maintaining the TBWC WQ database. Technical support and assistance for importing legacy data will be provided by staff at the Pacific Coast Science and Learning Center (PCSLC) through the Point Reyes National Seashore Association (PRNSA).

### **3. Subtasks**

Data from partner groups collecting data will be transferred to the Tomales Bay WQ database quarterly with summary reports and trends for all variable reported on the web and electronic (PDF) copies to all interested parties. Analyses and reports will be as in Task 1 above. Individual requests for particular analyses will be performed by the database manager or, if more complex, data will be provided to a WQ specialist of the Council's choosing.

The WQ database will be maintained in Microsoft Access and reside at the PCSLC with weekly backups to local server and CD-ROMs stored off site. The WQ database will be linked to a GIS of Tomales Bay's habitats and species (in development at PCSLC) to investigate spatial relationships between WQ, habitats, species, and land use.

## **G. Information dissemination and outreach**

Information that is gathered through the monitoring program will be used to increase the community's understanding of water quality problems in the watershed including the impacts of septic systems, recreation, agriculture, sewage ponds, the landfill, mines, and

other human activities. Additionally, this program will support coordination and cooperation amongst the various partners that are collecting water quality data to ensure timely and effective information dissemination about water quality monitoring results to agencies, organizations, bay users and communities in the Tomales Bay watershed via electronic posting of results, regularly published reports, press releases, etc.

### ***1. Current efforts***

Current efforts to disseminate information about water quality in the Tomales Bay watershed include:

- Written reports compiled independently by agencies and organizations to summarize their data and findings on an irregular basis (e.g. as projects end, as annual reports are due, as funding cycles require, etc.);
- Posting of Marin County recreational water quality monitoring at [http://california.earth911.org/usa/WaterQuality/default.asp?beach\\_id=888&cluster=6041](http://california.earth911.org/usa/WaterQuality/default.asp?beach_id=888&cluster=6041) on a regular basis;
- Water contact advisories that are posted by Marin County or State Parks when State Water Quality Standards are exceeded at locally popular swimming holes and beaches in the watershed;
- Press releases/media coverage issued by agencies and organizations; and
- Water quality summaries/brief mention in newsletters that are produced and distributed locally.

### ***2. Lead***

The Tomales Bay Watershed Council Foundation will be the lead organization to provide a clearinghouse for coordinating and disseminating information from the Tomales Bay Watershed Water Quality Monitoring Program via its Water Quality and Outreach committees. The Council's partners will provide outreach support by bringing this information to their constituencies, staff and/or members.

## **LIST OF ACRONYMS**

CDFG	California Department of Fish and Game
CDPH	California Department of Public Health
GWRP	Giacomini Wetland Restoration Program
IPUD	Inverness Public Utility District
LMER	Land Margin Ecosystems Research
MMWD	Marin Municipal Water District
PCSLC	Pacific Coast Science and Learning Center
PRNS	Point Reyes National Seashore
PRNSA	Point Reyes National Seashore Association
QAPP	Quality Assurance Project
QA/QC	Quality Assurance/Quality Control
RTC	Romberg Tiburon Center (SFSU)
RWQCB	Regional Water Quality Control Board

SPAWN	Salmon Protection and Watershed Network
SOP	Standard Operating Procedure
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
TMDL	Total Maximum Daily Load
TBWCF	Tomales Bay Watershed Council Foundation
WQMP	Water Quality Monitoring Program (TBWCF)
TBSTAC	Tomales Bay Shellfish Technical Advisory Committee
TBWRMP	Tomales Bay Wetland Restoration and Monitoring Project (“the Project”)
UCCE	University of California Cooperative Extension
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
WQ TAC	Water-Quality Technical Advisory Committee (TBWCF)

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