Santa Margarita Region Retrofit Program Study

Permit Order No. R9-2010-0016, NPDES No. CAS0108766

Submitted to:

Riverside County Flood Control & Water Conservation District
1995 Market Street
Riverside, CA 92501

Submitted by:

Tetra Tech, Inc.
9444 Balboa Ave, Suite 215
San Diego, CA 92123

FINAL

May 15, 2012

(*This page intentionally blank*)

Executive Summary

This report represents a Retrofit Program Study for the Santa Margarita Region of Riverside County, prepared through Task Order No. 1 dated October 24, 2011, between the Riverside County Flood Control and Water Conservation District (the "District") and Tetra Tech, Inc. This study is in response to the Municipal Separate Storm Sewer System permit, Order No. R9-2010-0016, NPDES No. CAS0108766, Section F.3.d-Retrofitting (the "MS4 Permit"), applicable to the District, County of Riverside, and Cities of Murrieta, Temecula and Wildomar (collectively, the "Copermittees"), which requires the development of retrofit programs that meet the requirements of the MS4 Permit.

The components of this Retrofit Program Study represent an adaptive approach to meeting the requirements of the MS4 Permit. While the Santa Margarita River and its tributaries have been placed on the California 303(d) List of Impaired Waters for multiple pollutants, the Copermittees are in the process of developing and implementing water quality monitoring, data collection, hydrologic modification analysis, and a watershed conditions inventory that will be needed to select and rank specific sites or "areas of development" where structural retrofit projects may be most effective. Moreover, the Copermittees will be simultaneously developing and deploying more aggressive water conservation and over-irrigation prohibitions, which can constitute cost-effective non-structural programs and which have been successful in many watersheds at addressing problems in receiving waters.

Therefore, this Retrofit Program Study provides an adaptive Retrofit Program Framework that will bring together the information and data to be collected during implementation of the Santa Margarita Region programs, and feed that information into the selection and implementation of optimal and efficient retrofit Best Management Practices (BMPs) at appropriate sites and scales. The study also prioritizes the evaluation and application of appropriate non-structural strategies in areas where these approaches can be linked directly to identified pollutant sources or conditions, while establishing a process and framework for the identification of appropriate sites and BMPs for structural retrofit projects that may ultimately be required where non-structural measures are insufficient to address an identified problem. The components of this Retrofit Program Study should be viewed as a set of tools that can be applied and re-combined as the Copermittees' programs evolve and develop, to identify retrofit project needs, priorities, and opportunities, and to select and design appropriate structural or non-structural BMPs that may provide the most cost-effective reduction measures for pollutants or conditions of concern.

The Retrofit Program itself consists of a multi-step process to identify and ultimately prioritize the actions and efforts that are best suited to addressing specific water quality issues in the Santa Margarita Region. The steps in this Retrofit Program enable the Copermittees first to identify water quality, watershed, infrastructure, or other issues or conditions of concern; second to develop context for the issues; and finally to use a series of tools, called the "Retrofit Program Framework," to identify the best strategy or strategies to address them. It is a methodology through which the Copermittees can select appropriate source identification and retrofit strategies for identified water quality or pollutant issues. Beginning with identification of a problem, such as exceedance of a Stormwater Action Level (SAL) or Non-Storm Water Dry Weather Action Level (NAL), an illicit discharge, or dry weather flows, the Framework works through source identification, evaluation of retrofit BMP options based on program jurisdiction (i.e., regulated construction sites vs. agricultural operations with waivers), evaluation of whether non-structural retrofit BMP approaches are sufficient to address the problem, and if necessary evaluation of sites and BMPs for structural retrofit projects. As noted above, the methodology in the Retrofit Program Framework prioritizes the use of non-structural BMPs, which can be implemented far more quickly and often at a much lower cost than structural BMPs.

The four tools comprising the Retrofit Program Framework, which can be used for multiple planning and analysis purposes, are:

(1) **Retrofit Program Framework Diagram (Appendix A)**: This flow chart provides guidance to the process by which the Copermittees can identify the appropriate actions, potentially including retrofits, to address an identified problem or condition

(2) **Land Use Types Maps (Figures 3 and 11) and Development Sequence Map (Figure 18)**: Gaining an understanding of where and when development has occurred in the Santa Margarita Region, particularly in the focus areas along Interstate 15 in the incorporated cities of Temecula, Wildomar, and Murrieta, is important to focusing assessment efforts and eventually to prioritizing areas of development or individual sites for retrofit projects. Detailed land use data from the Southern California Association of Governments (SCAG) through 2008 also has been compiled to enable further pollutant source and retrofit opportunity identification as water quality data and information on the condition of the Santa Margarita Region becomes available. The Land Use Types maps and discussion of the generalized land use types within the Santa Margarita Region are provided as an important tool to focus retrofit and program strategies. The Development Sequence Map documents the extent of land development in the Santa Margarita Region over time from 1984 through 2005, so that older areas of development lacking storm water treatment and control can be identified for further assessment.

(3) **Retrofit BMP Menu (Appendix B)**: The Retrofit Program Framework ties into the BMP Menu, which has been developed to help the Copermittees identify the specific non-structural and structural retrofit BMPs that address various pollutants and issues of concern. Developed in a sortable spreadsheet format, the BMP Menu allows the Copermittees to select from a list of BMP options based on the scale and land use setting of the problem, and on the complexity, cost, and timing of program implementation. The BMP Menu and Table provide resources and links to comparable programs, BMP standards and specifications, and other supporting materials to further support the Copermittees in designing retrofit programs.

(4) **BMP Descriptions and Resources (Appendix C)**: As additional support for retrofit program design, additional description and resources have been provided that outline the basic components or approach involved with each BMP, and then provide links to resources that further support program development and implementation. These resources, which have been drawn principally from local resources such as the California Association of Storm Water Quality Agencies (CASQA) and other regional entities, its applicability to various pollutants or watershed conditions that may need to be addressed, and technical aspects of design and implementation. These resources are intended to provide guidance for the Copermittees' to support program development as their water quality and watershed programs move forward. Notably, many of the fact sheets and resources address implementation options and cooperative strategies taken in other jurisdictions to work with private landowners to implement retrofit BMP projects, which is a condition of the MS4 permit.

Finally, in keeping with the requirements of the MS4 Permit, this Retrofit Program Study includes detailed criteria both for identifying candidate sites that may be suitable for structural retrofit BMPs, and for prioritizing among possible non-structural and structural retrofit BMP projects and sites. The Retrofit Program Framework provides three sets of retrofit BMP criteria, as follows:

- **Non-structural BMP retrofit criteria** for evaluating the cost and pollutant removal effectiveness of non-structural BMPs applicable to a given problem or setting
- **Primary retrofit BMP site screening criteria** that identify potential candidate retrofit sites throughout the Santa Margarita Region for structural BMPs
- **Secondary retrofit BMP screening criteria** that can be used to select among structural BMPs for a retrofit project.

Table of Contents

Executive Summary iii

1 Study Overview 1
1.1 Study Purpose and Approach 1
1.2 Study Area Setting 4
1.2.1 Introduction 4
1.2.2 Tributaries and Receiving Streams 4
1.3 Watershed Listings, Conditions, and TMDLs 7
1.4 Planned Monitoring Program 7
1.5 MS4 Permit Requirements 9
1.5.1 MS4 Permit Requirements 9
1.5.2 Program Framework Approach as a Response to the Permit Requirements 10
1.5.3 Focus on Non-Structural BMPs 11
1.6 Data Compilation Process 11

2 Retrofit Program Study Tools 13
2.1 Using the Program Framework Tools 13
2.2 Land Use Tools: Land Use Types and Development Sequence 13
2.2.1 Land Use Classifications 14
2.2.2 Impervious Surface and Development Sequence Maps 28
2.3 Retrofit BMP Menu (Appendix B) 32
2.4 BMP Descriptions and Resources (Appendix C) 33

3 RETROFIT PROGRAM FRAMEWORK 35
3.1 Introduction 35
3.2 Problem Identification 35
3.3 Source Assessment & Identification 36
3.4 Assess JRMP Program Implementation 39
3.5 Non-Structural Retrofit BMP Evaluation 40
3.5.1 "Problem Output" and Assessing Non-Structural BMPs 41
3.5.2 Rank and Prioritize Possible Non-Structural Retrofit BMPs 41
3.6 Structural Retrofit BMP Evaluation 42
3.6.1 Select Potential Structural BMPs 42
3.6.2 Review BMP Descriptions and Resources for identified potential BMPs 45
3.6.3 Identify public and private candidate areas 45
3.6.4 Rank and Prioritize Potential Structural BMPs 51

References 56

Appendix A. Retrofit Program Framework Diagram A-1

Appendix B. Retrofit BMP Menu B-1

Appendix C. BMP Descriptions and Resources C-1

List of Tables

Table 1. Waterbodies and Impairments in the Santa Margarita Region, 2010 7
Table 2. Pollutants to be Sampled and Stormwater Action Levels (SALs) 8
Table 3. Non-Storm water Dry Weather Action Levels (NALs) 8
Table 4. Principal Watershed Land Use Types and Typical Characteristics 25
Table 5. Observations Potentially Triggering a Retrofit Program Framework Analysis 35
Table 6. Setting and Scale Characterization 37
Table 7. JRMP Program Elements and Example Pollutants/Conditions Potentially Addressed 40
Table 8. Retrofit BMP Program Components 41
Table 9. Retrofit BMP Action Prioritization Criteria: Non-Structural BMPs 42
Table 10. Primary and Secondary Structural BMP Retrofit Criteria 44
Table 11. Public Entities with Publicly-Owned Lands for Evaluation as Potential Retrofit BMP Project Sites 50

List of Figures

Figure 1. Santa Margarita Watershed – Location Map 2
Figure 2. Santa Margarita Watershed – Physiographic Map 3
Figure 3. Santa Margarita Watershed – Sub-Watersheds 5
Figure 4. Santa Margarita Watershed – Tributaries and Impairments 6
Figure 5. Santa Margarita Watershed – Land Use 2008 15
Figure 6. City of Wildomar – Land Use 2008 16
Figure 7. City of Murrieta – Land Use 2008 17
Figure 8. City of Temecula – Land Use 2008 18
Figure 9 County Unincorporated Area Land Use 19
Figure 10 County Unincorporated Land Use 20
Figure 11. Santa Margarita Watershed – Land Use Types 22
Figure 12. Commercial Area, City of Temecula 23
Figure 13. Planned Residential Development (PRD), City of Murrieta 24
Figure 14. Rural Residential Area, County Unincorporated Area 26
Figure 15. Open Space Area Near Long Canyon, City of Temecula 27
Figure 16. Santa Margarita Watershed – 2006 NLCD Impervious Cover 29
Figure 17. Santa Margarita Watershed – 2006 NLCD Impervious Cover 30
Figure 18. Santa Margarita Watershed – Change of the Developed Land: 1984-2005 31
Figure 19. Santa Margarita Watershed – Parcels and Public Lands 46
Figure 19A. Parcels and Public Lands, City of Temecula 47
Figure 19B. Parcels and Public Lands, City of Murrieta 48
Figure 19C. Parcels and Public Lands, City of Wildomar 49
Figure 20. Santa Margarita Watershed – Retrofit Site Map 52
Figure 20A. Santa Margarita Watershed – Retrofit Site Map, City of Temecula 53
Figure 20B. Santa Margarita Watershed – Retrofit Site Map, City of Murrieta 54
Figure 20C. Santa Margarita Watershed – Retrofit Site Map, City of Wildomar 55

Acronyms and Abbreviations

BMPs	Best Management Practices
CASQA	California Association of Stormwater Quality Agencies
EDU	Education
ESA	Environmentally Sensitive Area
GIS	Geographic Information System
HOA	Homeowners Association
HUC	Hydrologic Unit Code
I-15	Interstate 15
ICV	Incentives
IE	Inspection & Enforcement
IPM	Integrated Pest Management
JRMP	Jurisdictional Runoff Management Plan
LID	Low Impact Development
LRS	Literature Review & Study
MEP	Maximum Extent Practicable
mg/L	milligrams per liter
ml	milliliter
µg/L	micrograms per liter
MON	Monitoring
NAL	Non-Storm water Dry Weather Action Level
NHD	National Hydrography Dataset
NLCD	National Land Cover Data
NPDES	National Pollutant Discharge Elimination System
NPM	Most Probable Number
NTU	Nephelometric Turbidity Unit
PRD	Planned Residential Development
PP	Pollution Prevention
PRD	Planned Residential Development
RCFC&WCD	Riverside County Flood Control and Water Conservation District
RES	Restoration
SAL	Stormwater Action Level
SC	Source Control
SCAG	Southern California Association of Governments
SGA	Stream Geomorphic Assessment
SI	Source Identification
SMR	Santa Margarita Region
SPO	Sponsorship
SSMP	Standard Stormwater Mitigation Plan
SUSMP	Standard Urban Stormwater Mitigation Plan
TC	Treatment & Control
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
US EPA	United States Environmental Protection Agency
WQ	Water Quality

(*This page intentionally blank*)

1 Study Overview

1.1 Study Purpose and Approach

Pursuant to Task Order 1 dated October 24, 2011, Tetra Tech, Inc. worked with the Riverside County Flood Control and Water Conservation District ("the District" or "RCFC&WCD"), the cities of Wildomar, Temecula, and Murrieta, and the County of Riverside (collectively, the "Copermittees") on a Retrofit Program Study in the Santa Margarita Region. This study is in response to the Municipal Separate Storm Sewer System permit, Order No. R9-2010-0016, NPDES No. CAS0108766, Section F.3.d-Retrofitting (the "MS4 Permit"). (Figure 1, Santa Margarita Watershed - Location Map, and Figure 2, Santa Margarita Watershed - Physiographic Map)

This Retrofit Program Study presents a set of tools (described in Section 2) through which the Copermittees can both meet the requirements of the MS4 Permit, and presents an adaptive Retrofit Program Framework (described in Section 3) for responding to water quality and watershed condition issues identified through the Receiving Waters and MS4 Discharge Monitoring and Reporting Program, Hydromodification Susceptibility Mapping, and ongoing Jurisdictional Runoff Management Plan (JRMP) activities implemented in the Santa Margarita Region. The retrofit assessment and planning tools presented herein are intended to provide a clear and consistent method of responding to water quality and watershed condition issues that may be identified by the Copermittees, by identifying the sources of these issues, by selecting and prioritizing retrofit candidate sites or areas, and by describing retrofit strategies, including both non-structural and/or structural Best Management Practices (BMPs), where deemed necessary though the implementation of the Retrofit Program Framework. The five tools outlined in Chapter 2 of this report are listed below.

(1) Program Framework Process (Appendix A)
(2) Land Use Types Maps (Figures 3 and 11)
(3) Development Sequence Map (Figure 18)
(4) BMP Menu (Appendix B)
(5) BMP Descriptions and Resources (Appendix C)

Using these tools, the Retrofit Program Framework described in Chapter 3 works through five steps: (1) Identifying watershed issues; (2) Performing source assessments; (3) Evaluating effectiveness of current JRMP program implementation; (4) Assessing Non-Structural BMPs when effective implementation of JRMP program will not resolve the identified issue; and (5) Assessing structural BMPs where the identified issue is contributing to a receiving water impairment or where there is an adopted Total Maximum Daily Load (TMDL) and the non-structural BMPs are insufficient to address the problem. Collectively, this process brings the Copermittees from problem identification through selection and prioritization of an optimal retrofit strategy.

This report is organized in three sections. Chapter 1 provides a brief overview of the Santa Margarita Region, and the terms and conditions of the MS4 Permit relevant to the Retrofit Program Study. Chapter 2 describes the tools that have been developed as part of this study (including the land use setting in the Santa Margarita Region), and provides a recommended method of categorizing general areas of land use for purposes of using the Retrofit Program Framework and Retrofit BMP Menu. Chapter 3 introduces and walks through the Retrofit Program Framework and Retrofit BMP Menu, and refers to the BMP Fact Sheets. Finally, Appendices A through C contain, respectively, a diagram of the Retrofit Program Framework, the Retrofit BMP Menu, and the BMP Descriptions and Resources.

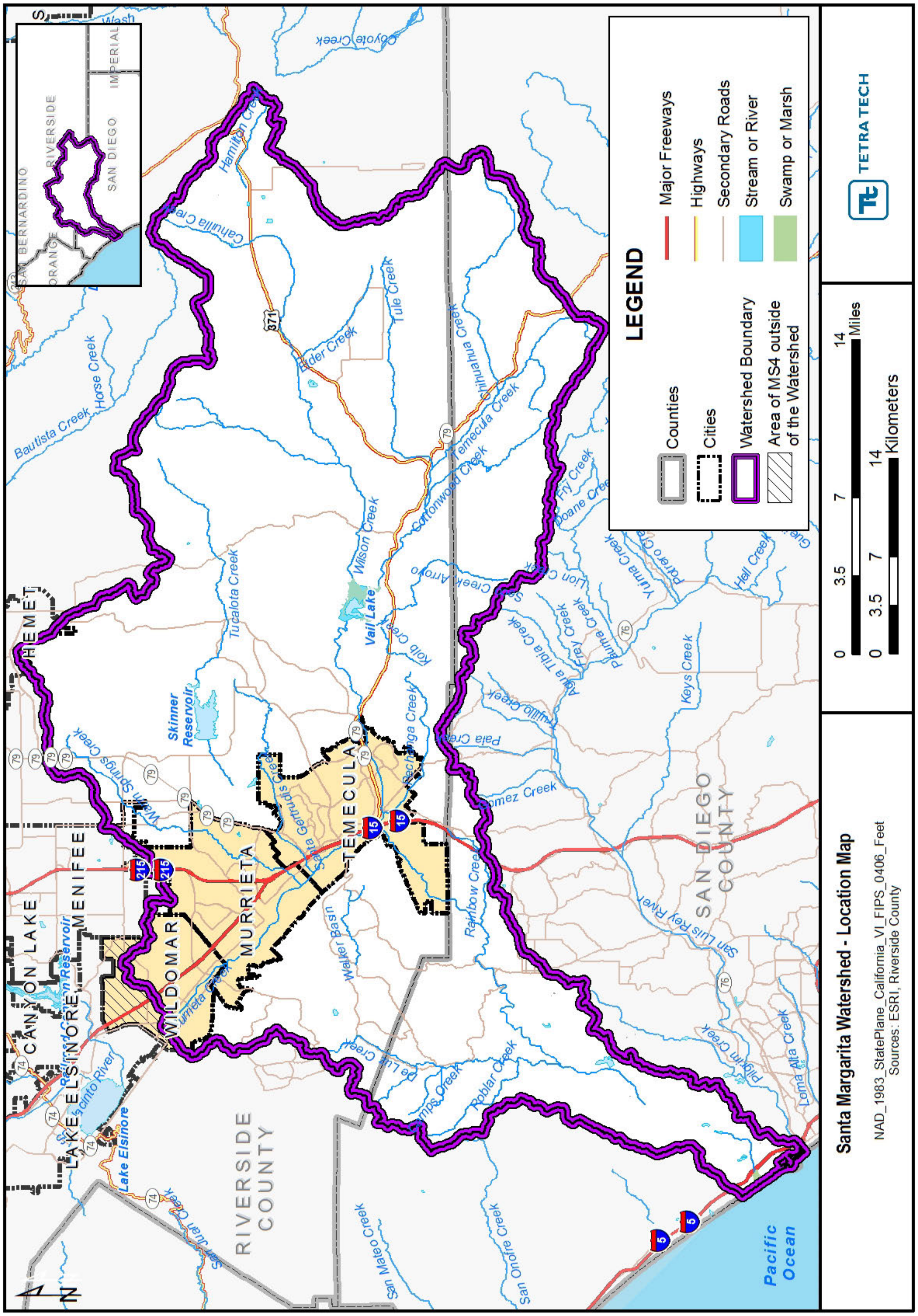


Figure 1. Santa Margarita Watershed – Location Map

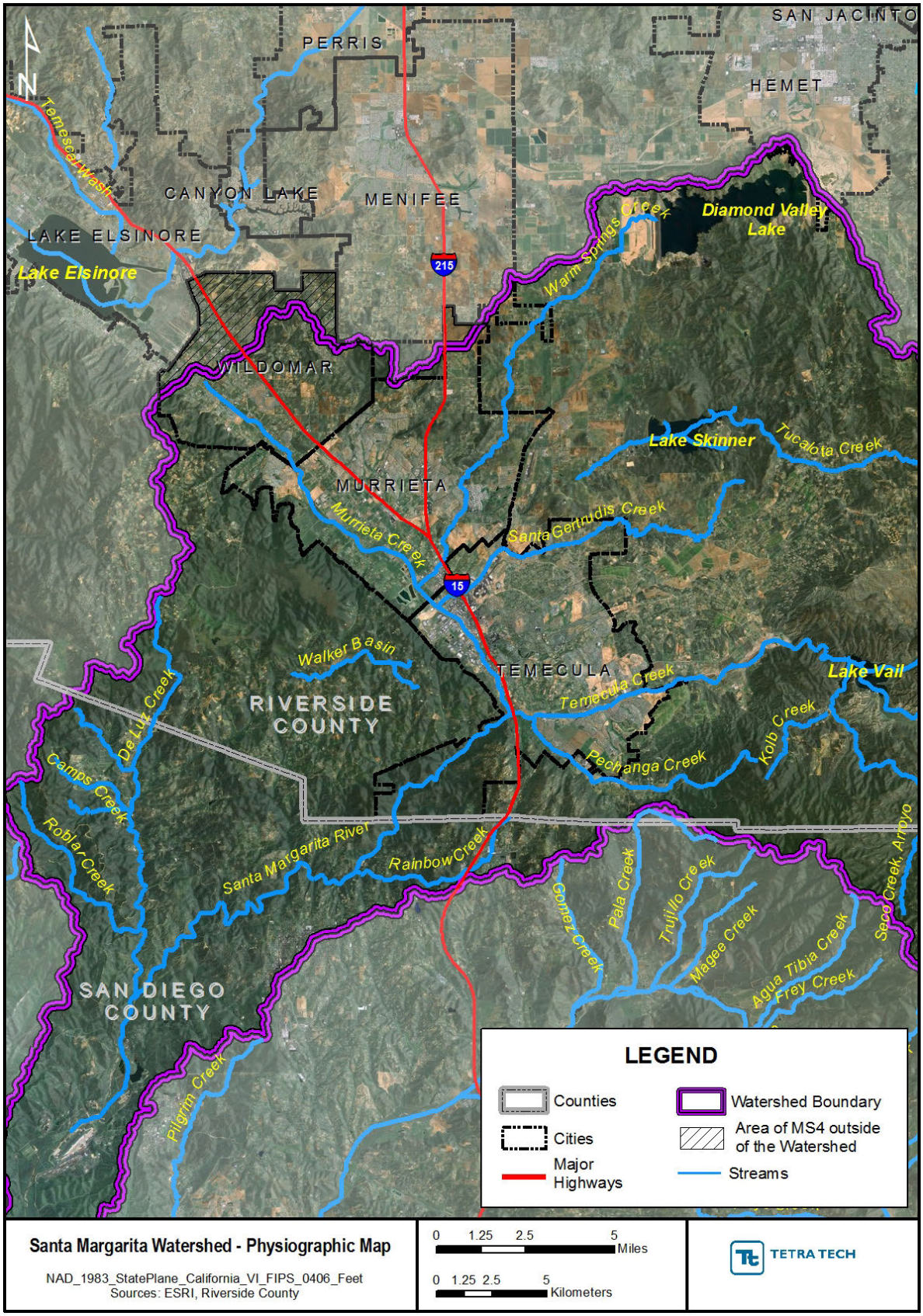


Figure 2. Santa Margarita Watershed – Physiographic Map

1.2 Study Area Setting

1.2.1 Introduction

The Santa Margarita Region, as illustrated in Figure 1 and Figure 2 above, is based on the regulated areas of the MS4 Permit, which includes the cities of Temecula, Murrieta, and Wildomar, as well as unincorporated portions of Riverside County within the Santa Margarita Watershed. A portion of the City of Wildomar drains to the Santa Ana River rather than the Santa Margarita, but is regulated by the San Diego Regional Water Quality Board under the auspices of the Santa Margarita Region permit. The City of Menifee also lies partially within the Upper Santa Margarita River watershed, but it is subject to regulations of Santa Ana Regional Water Quality Control Board and is not included within this Study.

1.2.2 Tributaries and Receiving Streams

In some watersheds and regions, the sub-watersheds with the most significant potential for contributing to impairments and the sites on which structural retrofit BMPs are best suited for pollutant or hydromodification mitigation can be identified in a straightforward manner from a variety of modeling and mapping-based assessments alone. In the case of the Santa Margarita Region, challenges to the standard model-driven process result from a number of data, mapping, and assessment limitations, coupled with the relatively recent nature of both land and storm water program development and a unique land use pattern. (See the discussion in Chapter 2.) Therefore, a number of supplemental analyses of land use spatial and temporal patterns, the Program Framework, and Retrofit BMP Menu, have been developed to help the Copermittees in identifying the most appropriate responses to problems that may be identified as they implement their MS4 permit programs.

The Santa Margarita Region and its sub-watershed structure are shown in Figure 3, Santa Margarita Watershed - Sub-Watersheds. Drainage in the Santa Margarita Region reaches Temecula and Murrieta Creeks, which join to form the Santa Margarita River, which then drains into the lower watershed. Major tributaries of Temecula Creek include Pechanga Creek and Wilson Creek via Vail Lake. Major tributaries of Murrieta Creek include Saint Gertrudis, Tucalota (via Lake Skinner), and Warm Springs Creeks. After the convergence of Temecula and Murrieta Creeks, the Santa Margarita River runs southwest into San Diego County. Major lakes in the watershed include Skinner, Vail, and Diamond Valley Lakes.

Temecula Creek and its tributaries drain approximately 366 square miles. The upper portion of the watershed is controlled by a dam at Vail Lake, and the southern portion of this area is within San Diego County. The upper watershed reaches into the San Jacinto Mountains to the east and the Palomar Mountains to the south. Lower portions of the Temecula Creek drainage area are characterized by rolling hills. Murrieta Creek and its tributaries drain approximately 222 square miles in the northwest portion of the upper Santa Margarita River watershed. The topography of this drainage area includes low rolling hills with the Santa Ana Mountains rising in the south. Lake Skinner is located in the headwaters of the Santa Margarita watershed at the foot of Bachelor Mountain in the Auld Valley, approximately 10 miles northeast of Temecula. It has a drainage area of approximately 51 square miles (sq. mi.) and is fed by five tributaries including Tucalota Creek and the San Diego canal, which delivers imported water from the Colorado River. One third of the watershed (approximately 17 sq. mi.) is protected by open space, mostly within the Southwestern Riverside County Multi-Species Reserve. The lake was created in 1973 and expanded in 1991 and has a current storage capacity of 44,200 acre feet.

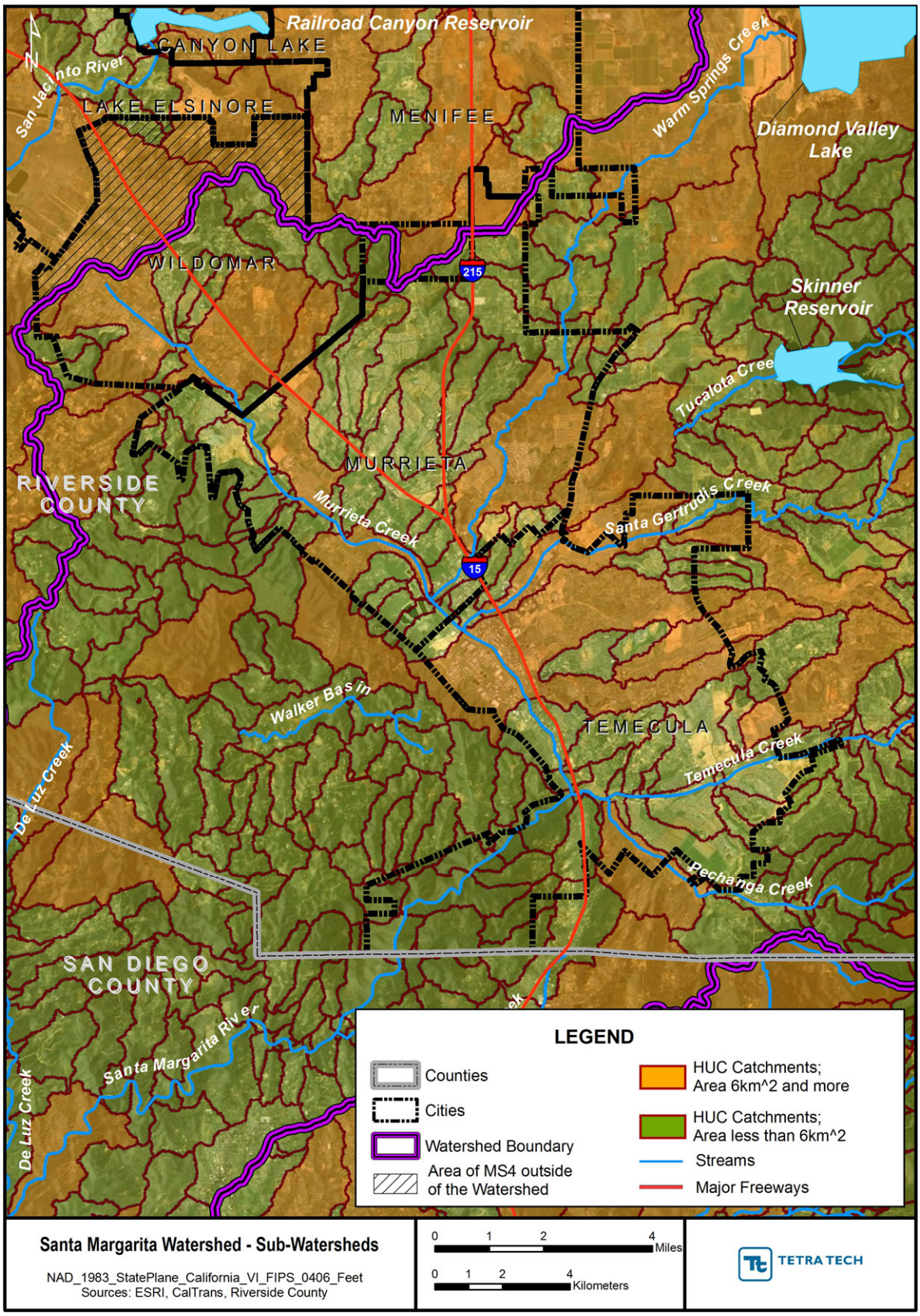


Figure 3. Santa Margarita Watershed – Sub-Watersheds

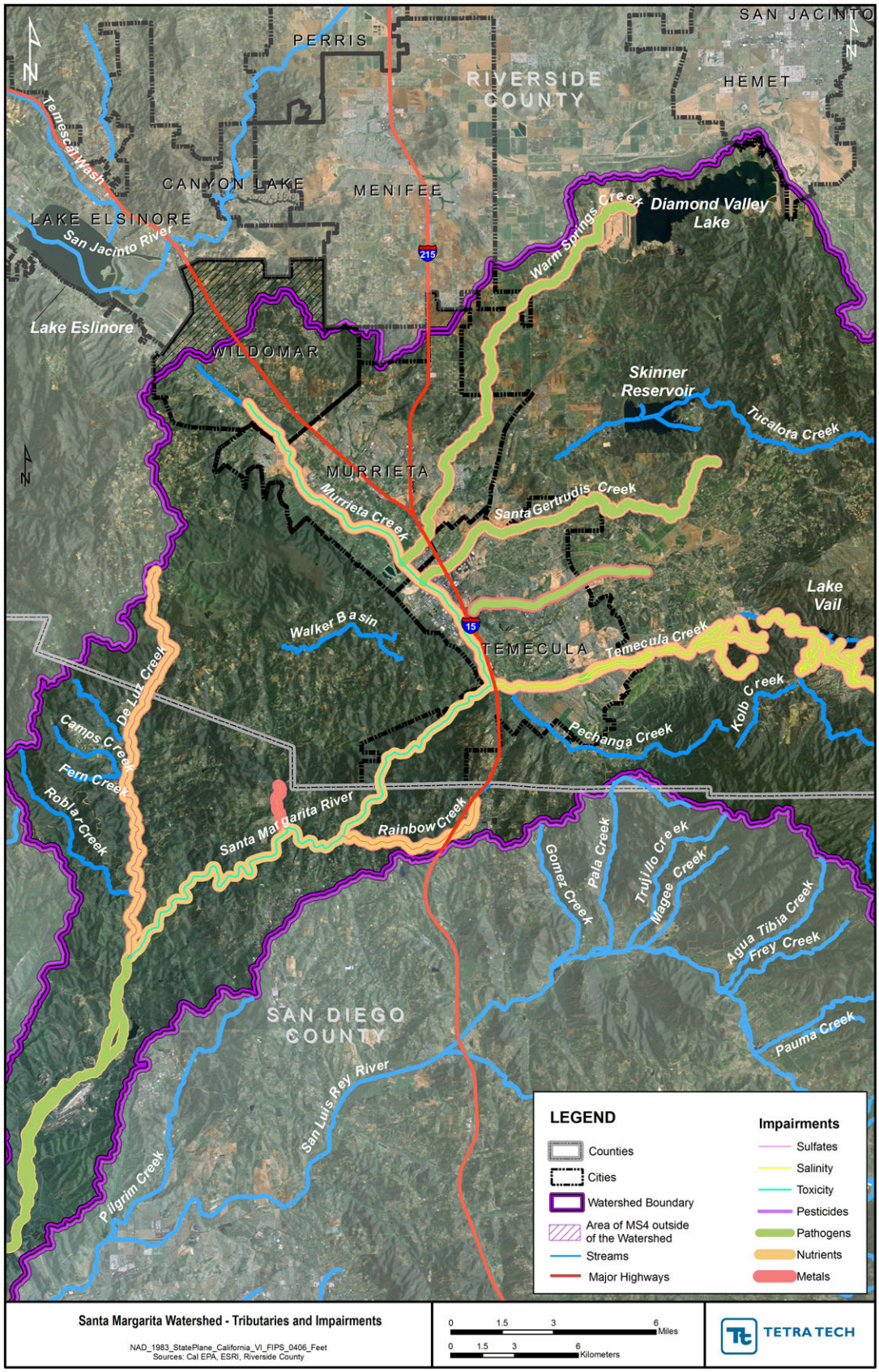


Figure 4. Santa Margarita Watershed – Tributaries and Impairments

1.3 Watershed Listings, Conditions, and TMDLs

The Upper Santa Margarita watershed includes eight waterbodies listed as impaired in the Clean Water Act 303(d) program (Table 1 and Figure 4). Most of the major tributaries and the Upper Santa Margarita River are on the 303(d) list. Among those waterbodies, six are listed for pesticides, three for bacteria, six for metals, seven for nutrients, and five for other pollutants.

Table 1. Waterbodies and Impairments in the Santa Margarita Region, 2010

2010 California 303(d) list of Water Quality Limited Segments

	Long Canyon Creek	Murrietta Creek	Redhawk Channel	Santa Gertrudis Creek	Upper Santa Margarita River	Temecula Creek	Warm Springs Creek
PESTICIDES							
Chlorpyrifos	√	√	√	√		√	√
Diazinon	√		√				
BACTERIA							
E. coli			√	√			√
Fecal Coliform			√	√			√
METALS							
Manganese	√	√	√	√			√
Copper		√	√	√		√	
Iron	√	√	√	√			√
NUTRIENTS							
Nitrogen		√	√				
Phosphorous		√	√	√	√	√	√
Total Nitrogen as N							√
OTHER							
Toxicity		√			√	√	
Sulfates							
TDS			√			√	

1.4 Planned Monitoring Program

The Santa Margarita Region Copermittees implement the Receiving Waters and MS4 Discharge Monitoring and Reporting Program. The monitoring program will be designed to meet the following goals:

- Measure and improve the effectiveness of the Copermittees' runoff management programs
- Identify sources of specific pollutants
- Prioritize drainage and sub-drainage areas that need management actions
- Provide information to implement required BMP improvements

The monitoring program will include measurements of pollutants discharged from representative major MS4 outfalls, comparison to critical concentrations (Action Levels), and source identification monitoring. The monitoring will include wet weather and dry weather scenarios, with slightly different protocols for each.

In wet weather, the Stormwater Action Levels (SALs) will be applied to flows monitored during the first 24 hours of discharge. As currently planned, the SAL for nutrients and metals will be as listed in Table 2. Bacteria, pesticides, and other pollutants will also be monitored and, if appropriate, compared to yet-to-be-established SALs. In response to a SAL exceedance, the Copermittees will continue to perform focused monitoring to identify its sources. The Copermittees will consider the magnitude, frequency, and number of constituents exceeding SALs when prioritizing and reacting to SAL exceedances. Other pollutants noted below, for which a SAL is not established, will be addressed in the context of the MS4 permit program as a whole.

Table 2. Pollutants to be Sampled and Stormwater Action Levels (SALs)

Measured Pollutant	SAL (if established)
Turbidity	128 NTU
Total Hardness	
pH	
Specific Conductance	
Temperature	
Dissolved Oxygen	
Total Phosphorous	1.46 mg/L
Nitrate and Nitrite	2.6 mg/L
Hydrocarbons	
Pesticides	
Bacteria	
Cadmium	3 µg/L
Copper	127 µg/L
Lead	250 µg/L
Zinc	976 µg/L

For the Non-Storm water Dry Weather Action Levels (NALs), the monitoring program will include MS4 outfall sampling when the preceding 72 hours have been dry. Effluent samples will undergo analytical laboratory analysis for constituents with assigned NALs (Table 3). In response to an exceedance of an NAL, the Permittee(s) having jurisdiction will investigate and seek to identify the source of the exceedance in a timely manner.

Table 3. Non-Storm water Dry Weather Action Levels (NALs)

Parameter	Units
Fecal Coliform	200 MPN/ 100 ml average monthly. No more than 10 percent of total samples may exceed 400 per 100 ml during any 30-day period.
Enterococci	33 MPN/ 100 ml average monthly
Turbidity	20 NTU
pH	Between 6.5 to 8.5 standard units at all times
Dissolved Oxygen	Not less than 5 mg/L in WARM waters Not less than 6 mg/L in COLD waters
Total Nitrogen	1 mg/L maximum daily
Total Phosphorous	0.1 mg/L maximum daily
Methylene Blue Active Substances	0.5 mg/L maximum daily
Iron	0.3 mg/L maximum daily
Manganese	0.05 mg/L maximum daily

Parameter	Units
Cadmium	µg/L = exp(0.7852[ln(hardness)] -2.715)
Chromium III	µg/L = exp(0.8190[ln(hardness)] + .6848)
Chromium IV	16 µg/L maximum daily and 8.1 average monthly
Copper	µg/L = exp(0.8545[ln(hardness)] - 1.702)
Lead	µg/L = exp(1.273[ln(hardness)] - 4.705)
Nickel	µg/L = exp(.8460[ln(hardness)] + 0.0584)
Silver	µg/L = exp(1.72[ln(hardness)] - 6.52)
Zinc	µg/L = exp(0.8473[ln(hardness)] + 0.884)

1.5 MS4 Permit Requirements

1.5.1 MS4 Permit Requirements

The MS4 Permit represents a substantial change in permitting strategy and approach to land use regulation, from the MS4 permits of even a few years ago. Standards for identifying and managing hydromodification risk, a strong emphasis on implementing site-scale Low Impact Development (LID) BMPs through the land development permitting process, new design standards stressing infiltration and naturalized treatment, and tie-ins to overall watershed restoration strategies can necessitate a fresh and thorough look at BMP retrofit opportunities. As outlined in the MS4 Permit, the Retrofit Program Study for the Santa Margarita Region is intended not just to identify and rank candidate sites for retrofitting, but also to ensure that selected retrofit BMPs support an overall, multi-benefit strategy for watershed restoration.

This Retrofit Program Study responds directly to Section F.3.d-Retrofitting of the MS4 Permit, which requires the Copermittees to develop and implement a retrofitting program. Retrofits, as applied to storm water management, may best be described as the design and application of structural or non-structural practices which treat poorly- or un-controlled storm water runoff from existing impervious surfaces, reduce existing sources of storm water pollution, or remediate existing adverse physical, geomorphic, or habitat conditions in a watershed. Through this Retrofit Program Study, the Copermittees are charged with developing a process to identify and prioritize possible retrofit BMP projects, as well as areas of existing development that may be contributing to impairments or adverse conditions within which retrofit BMP projects could be beneficial (Figure 4, Santa Margarita Watershed - Tributaries and Impairments). This Retrofit Program Study presents an adaptive approach to meet these requirements, recognizing and incorporating efforts now underway in the Santa Margarita Region to identify and respond to water quality and watershed issues of concern.

Finding D.3.h of the MS4 Permit summarizes the goals and basis for conducting this type of evaluation, emphasizing the need to evaluate privately owned lands to identify and eventually implement retrofit BMP projects.

> D.3.h. Retrofitting existing development with storm water treatment controls, including LID [Low Impact Development], is necessary to address storm water discharges from existing development that may cause or contribute to a condition of pollution or a violation of water quality standards. Although SSMP [Standard Storm water Mitigation Plan] BMPs are required for redevelopment, the current rate of redevelopment will not address water quality problems in a timely manner. Cooperation with private landowners is necessary to effectively identify, implement and maintain retrofit projects for the preservation, restoration, and enhancement of water quality.

Provision F.3.d of the MS4 Permit further requires development of a retrofit program that will:

> ...reduce impacts from hydromodification, promote LID, support riparian and aquatic habitat restoration, reduce the discharges of storm water pollutants from the MS4 to the [Maximum Extent Practicable], and prevent discharges from the MS4 from causing or contributing to a violation of water quality standards.

Subsection (1) of the MS4 Permit then requires the Copermittees to identify candidate areas of private development within municipal, residential, commercial and industrial development, with priority given to (a) Areas of development that generate pollutants of concern identified in a TMDL[1], or an Environmentally Sensitive Area (ESA); (b) Receiving waters that are channelized or otherwise hardened; and (c) Areas of development tributary to receiving waters that are channelized or otherwise hardened. As will be discussed in Chapter 2 of this Retrofit Program Study, the extent and nature of the land use pattern in the Region presents a number of challenges in prioritizing among very similar land uses that meet these criteria, and as such, a great deal of refinement based on future water quality and hydromodification data is anticipated in the Copermittees' approach to meeting these permit conditions.

In addition, Copermittees are also asked to look at opportunities for altering flood control BMPs to incorporate water quality improvements, and to support regional mitigation projects where on-site retrofit BMPs are less feasible. Given the substantial opportunities for non-structural BMP implementation that would address "low-hanging fruit" conditions such as over-irrigation and dry weather flows, and the opportunity to examine lower-cost measures such as impervious surface disconnection and rainwater harvesting in the Santa Margarita Region's residential and commercial areas, structural mitigation steps of this nature have been de-emphasized as primary retrofit strategies in this study. As discussed in the Program Framework section, the Copermittees have prioritized data collection and non-structural retrofit BMPs as the most important short- to mid-term steps to meet the MS4 Permit requirements, and move towards improved water quality.

1.5.2 Program Framework Approach as a Response to the Permit Requirements

The **Retrofit Program Framework** is a standardized decision support process for formulating solutions to water quality and hydromodification problems that the Copermittees may identify in the Santa Margarita Region. It is a planning tool for assessing problems in catchments and drainages, and for identifying the most appropriate and cost-effective management measures that can address those problems. The solutions can be specific to land use types and may be applicable at different scales. It is meant to be applicable in a variety of common situations observable in the Santa Margarita Region.

The Program Framework was conceptualized based on requirements of the MS4 Permit, which specifies that solutions must both address specific pollutants and problems and be broadly applicable across the Santa Margarita Region. From that perspective, the best method for meeting the requirements was to devise a methodology that could be applied at these different scales as needed. The Retrofit Program Framework and supporting tools – Land Use Analysis, Retrofit BMP Menu, Retrofit Criteria, and BMP Descriptions and Resources - were thus developed based on the starting points, perceived alternatives, and desired outcomes. The alternatives revolve around confidence in identification of pollutant sources and feasibility of implementing different types of BMPs.

The Retrofit Program Framework provides a consistent process for making decisions. The process is broadly applicable, and will add clarity and defensibility when specific problems are identified and solutions are proposed. The Retrofit Program Framework is a decision support system for assessing

[1] At the present time no TMDLs relevant to the Retrofit Study have been adopted for the Santa Margarita Region.

problems in catchments, drainages, and waterbodies, and for addressing common impairments and pollutants with BMPs. Following the process and using the associated tools will result in BMP solutions that will, when applied, provide a strategic way to cost-effectively improve water quality and physical habitat in the impaired waterbodies and will meet the requirements and intent of the MS4 Permit.

1.5.3 Focus on Non-Structural BMPs

The Retrofit Program Framework focuses on assessing and deploying non-structural solutions before considering more costly structural approaches. Non-structural options usually are less expensive to apply, present fewer issues for gaining local approval, and are less likely to require dedication of property, and therefore allow impaired waters restoration to begin far more quickly. The non-structural BMPs include research, monitoring, education, planning for LID, incentive programs, source identification, inspection and enforcement, and source control and management. When the potential non-structural BMPs are shown to be not adequate or not possible, then the structural BMPs can be considered.

1.6 Data Compilation Process

Because of the non-traditional approach to this Retrofit Program Study, the data compiled consisted of a variety of strategies, including the use of publicly available GIS sets, site investigations and discussions with the Copermittees, review of historic aerial photography, limited field reconnaissance, development of new GIS data layers based on aerial photography, and specific requests of the Copermittees.

Data were targeted that related to the percentage of impervious cover by sub-watershed; sub-watershed size; soil types; land use types; slopes; drainage networks and their densities; stream channel conditions; storm water treatment facility size, type and location; and open space or public parcels. These types of information can be combined and assessed to identify sub-watersheds with a high probability of contributing to pollutant loading, and specific sites that have characteristics suitable for implementation of retrofit BMPs. Data that were not readily available were requested early in the process from the District and Copermittees (Technical Memorandum, November 14, 2011). In the following list of requested data types, some types were ultimately unavailable or incomplete. Copermittees

Data Requested through RBF:

- Locations and as-built plans of sub-regional flood control facilities other than those maintained by the District
- Local and sub-regional storm drain networks
- Vacant lands/parcels
- Drainage area boundaries as well as any sub-watershed mapping
- Local drainage studies
- Storm drain master plans
- Flow data, rainfall data, and stream gauges
- Habitat restoration projects
- Designated Environmentally Sensitive Areas (ESA)

Additional Specific Data Requests:

- MS4 boundaries, including the most recent changes in the jurisdictional boundaries
- Local drainages or sub-watersheds in addition to existing basin plan Hydrologic Unit Code (HUC) delineations
- High-resolution topography or aerial photos other than the County's versions
- Future land use and zoning maps

- Information on extent of hardened or concrete channel bottoms, especially in city-owned channels
- Spreading grounds other than flood control basins

2 Retrofit Program Study Tools

2.1 Using the Program Framework Tools

One of the key objectives of this Retrofit Program Study is to develop a process wherein the Copermittees can integrate retrofit strategies into their Jurisdictional Runoff Management Programs (JRMPs) over time. To facilitate this, the Program Framework Tools described in this section were developed to provide guidance and criteria through which each Copermittee can characterize watershed conditions and issues, and develop a cost- and environmentally-effective retrofit strategy and approach. The purpose, development process, and recommended use of each Program Framework Tool are described in the sections that follow.

The Program Framework process is encapsulated in the diagram in Appendix A. This is a process responding to identified water quality issues with management options which can include possible retrofit BMPs that address the pollutants or issues of concern. The process provides BMP options that consider practical aspects of assessment, program development, legal authority and jurisdiction, and other factors.

Use of the Retrofit Program Framework is triggered by the "walk-through" process outlined in Section 3.2 below. The Retrofit BMP Menu, shown in table format in Appendix B, also is provided to the Copermittees as a sortable spreadsheet, with non-structural and structural BMPs cross-referenced by their applicability to different land use types and jurisdictional settings, and their effectiveness at addressing pollutants and watershed conditions of concern. The Land Use Types map (Figure 11), discussed in Section 2.2 of this Report, characterizes and maps four distinct land use types within the watershed, and provides a useful means of identifying and ranking potential BMPs. This map indicates the areas of each of the four land use types as described in Section 2.1.1 and Table 4. Table 4 presents the Land Use Types and Settings Description, which are incorporated into the BMP Menu as critical factors for selecting BMPs suited to the land use setting, and to the property ownership and management setting, where a water quality issue is identified. The Development Sequence Map (Figure 18) provides information on the age of development, which is useful for prioritizing retrofits and identifying areas that may lack contemporary storm water treatment and control, as discussed in Section 2.2.2.

The Retrofit BMP Criteria are listed in Tables 9 and 10 for selected non-structural or structural BMPs. For structural BMPs, Figure 20 represents the initial GIS application of the primary retrofit BMP criteria to sites in the Santa Margarita Region, indicating the number and distribution of sites that meet the basic criteria as structural retrofit BMP project sites. The Structural Retrofit BMP Criteria (Table 10) are to be used once potential BMPs have been identified through the Retrofit BMP Menu process. Application of the retrofit BMP criteria to the potential non-structural or structural BMPs from the Retrofit BMP Menu will enable the Copermittees to sort and prioritize appropriate BMPs. Finally, the Retrofit BMP Descriptions and Resources in Appendix C provide guidance for program or design development for the selected retrofit BMP(s) from Appendix B.

2.2 Land Use Tools: Land Use Types and Development Sequence

The distribution, nature, and intensity of land development, land use, and impervious cover are fundamentally related to watershed health and function, pollutant loading, and the opportunities for retrofit BMPs and water quality treatment.

The Santa Margarita Region presents a unique and distinctive land use pattern that offers both challenges and opportunities for retrofit analysis. Intensive land development between roughly the late 1980s and

2007-8 occurred in a relatively concentrated area, as described in this section, resulting in a relatively high and consistent level of imperviousness across sub-watersheds and notably very little open land (and even less public open land) within the developed footprint of the watershed. Consisting principally of Planned Residential Developments (PRDs) built in phases with very similar planning layouts, and shopping centers with common management and parking, these developments are physically similar. However, depending upon the time of permitting entitlements, the developments may have widely varying degrees of storm water treatment and control.

To support the implementation and effectiveness of the Retrofit Program Framework, the two tools described in this section provide the Copermittees with a way to evaluate the distribution of land use and land cover in the watershed, and to take a "time-series" look at where and when the Santa Margarita Region's development footprint expanded between 1985 and 2012. The first tool described in Section 2.2.1 is the Land Use Types methodology and map (Figure 11), which establish four land use categories the Copermittees can use to aid with source identification. These same four land use categories are used to sort and select recommended BMPs in the Retrofit Program Framework and Retrofit BMP Menu described in more detail in Section 3. These categories are intended as a basis for program development that can be integrated with more detailed analysis, using emerging GIS and watershed assessment data, as the Copermittees implement their water quality and watershed programs.

The second tool is the Development Sequence Map (Figure 18), which shows the location and expansion of developed areas in the watershed from 1980 through 2010. Because storm water treatment and control methods were phased in with development over this period, this tool provides a way to determine which areas within a jurisdiction and within various tributary watersheds developed first, and which may indicate the presence of discharges that do not have contemporary treatment and control measures. It offers a way to prioritize retrofit actions to target those areas that are oldest and thus less likely to have incorporated treatment and control.

2.2.1 Land Use Classifications

To begin the analysis, the sub-watershed areas were evaluated with respect to the level of development density within each one, the presence and position of publicly-owned lands, and the position of the sub-watersheds and public lands relative to the Santa Margarita River and its tributaries. Figure 3 shows the catchments or sub-watersheds in the study area that have been used as the basis for analysis. The Santa Margarita Region's sub-watersheds are characterized by a relative high density and degree of development, particularly on the east side of Interstate 15 (I-15), with mixed residential and commercial development in the lower-lying areas along Murrieta Creek and I-15, and principally residential development in areas moving away from Murrieta Creek and I-15. The land use and land cover profile of the Santa Margarita Region, particularly the focus area along the I-15 corridor that bisects Temecula, Murrieta and Wildomar, is distinctive and especially relevant to the structure of a retrofit analysis and the Program Framework. The existing pattern of land use and development in the Santa Margarita Region and in each municipality is shown in Figures 5 through 8.

The Santa Margarita Region is notable for the consistency of development types and patterns in commercial and residential areas across the three municipalities and unincorporated areas (Technical Memorandum dated January 18, 2012). Despite some variability, this consistency is important for focusing source assessments and identifying potential retrofit strategy options as a result of implementation of the Retrofit Program Framework. The Santa Margarita Region features large areas of four common categories of development, each of which is prone to certain water quality or pollutant-generating issues, and each of which lends itself to certain types of retrofit BMPs (Figure 11, Land Use Types). The four types of development, which are listed as "land use areas" in the Retrofit BMP Menu and Appendix C, are described in turn below and in Table 4.

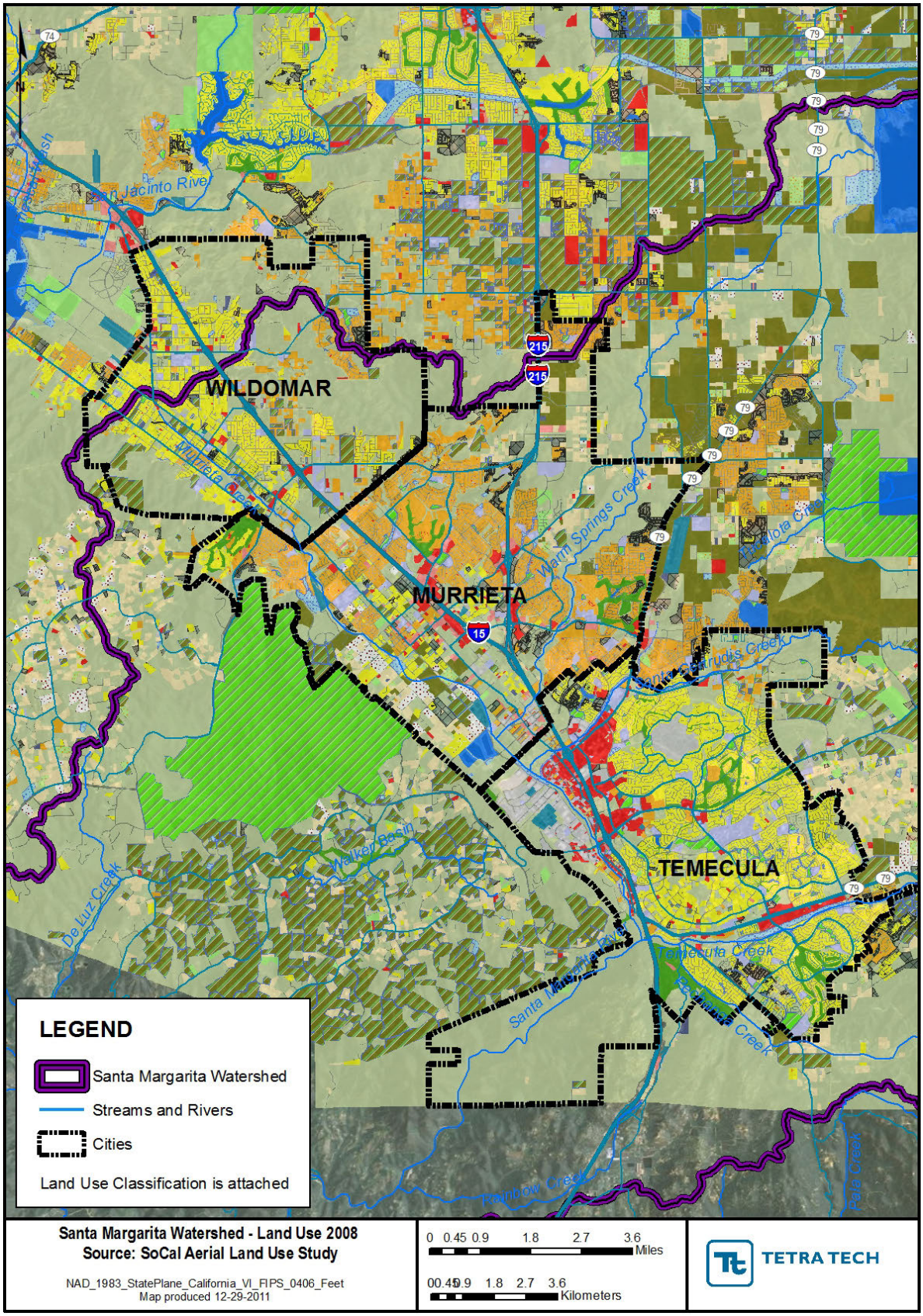


Figure 5. Santa Margarita Watershed – Land Use 2008

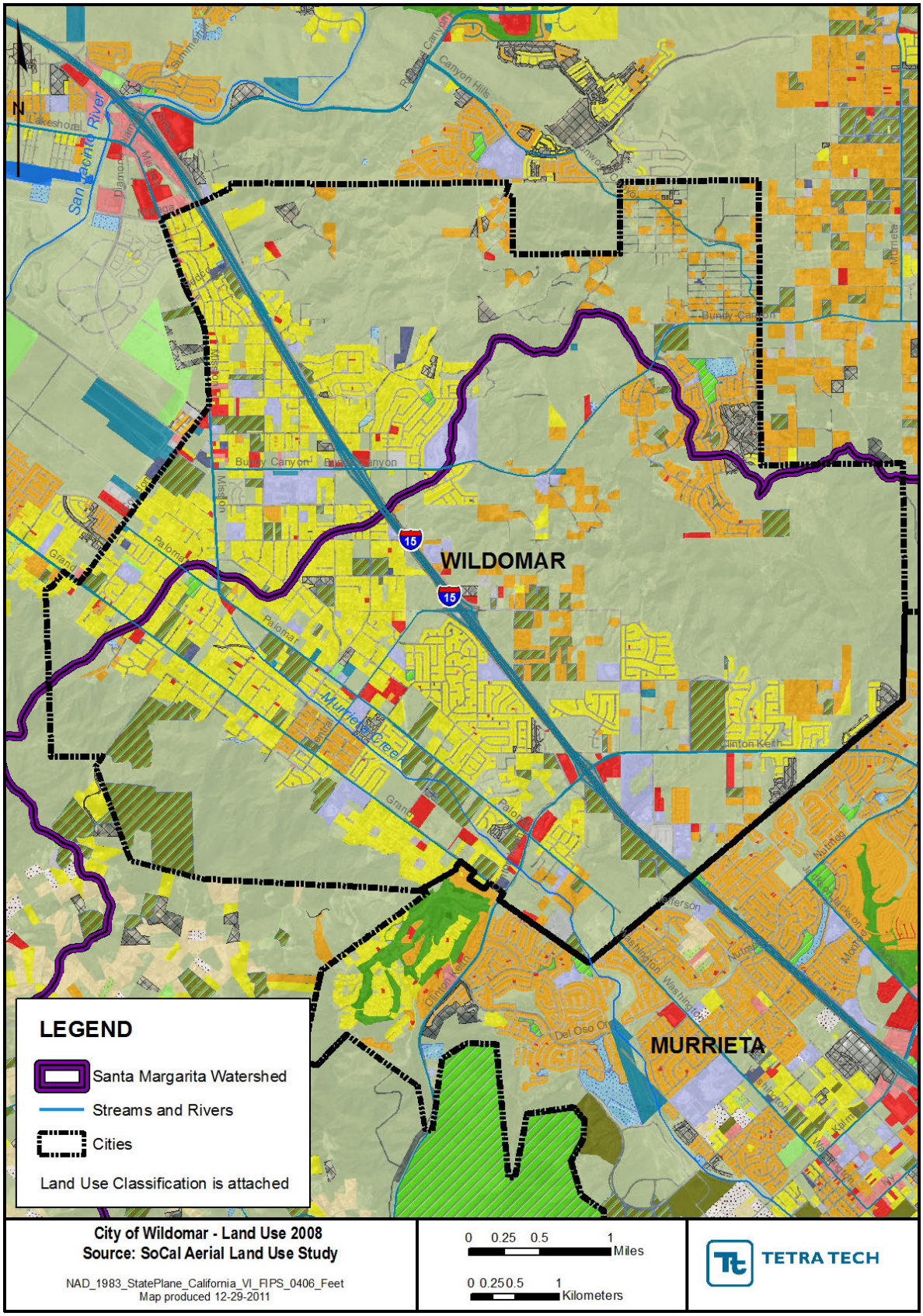


Figure 6. City of Wildomar – Land Use 2008

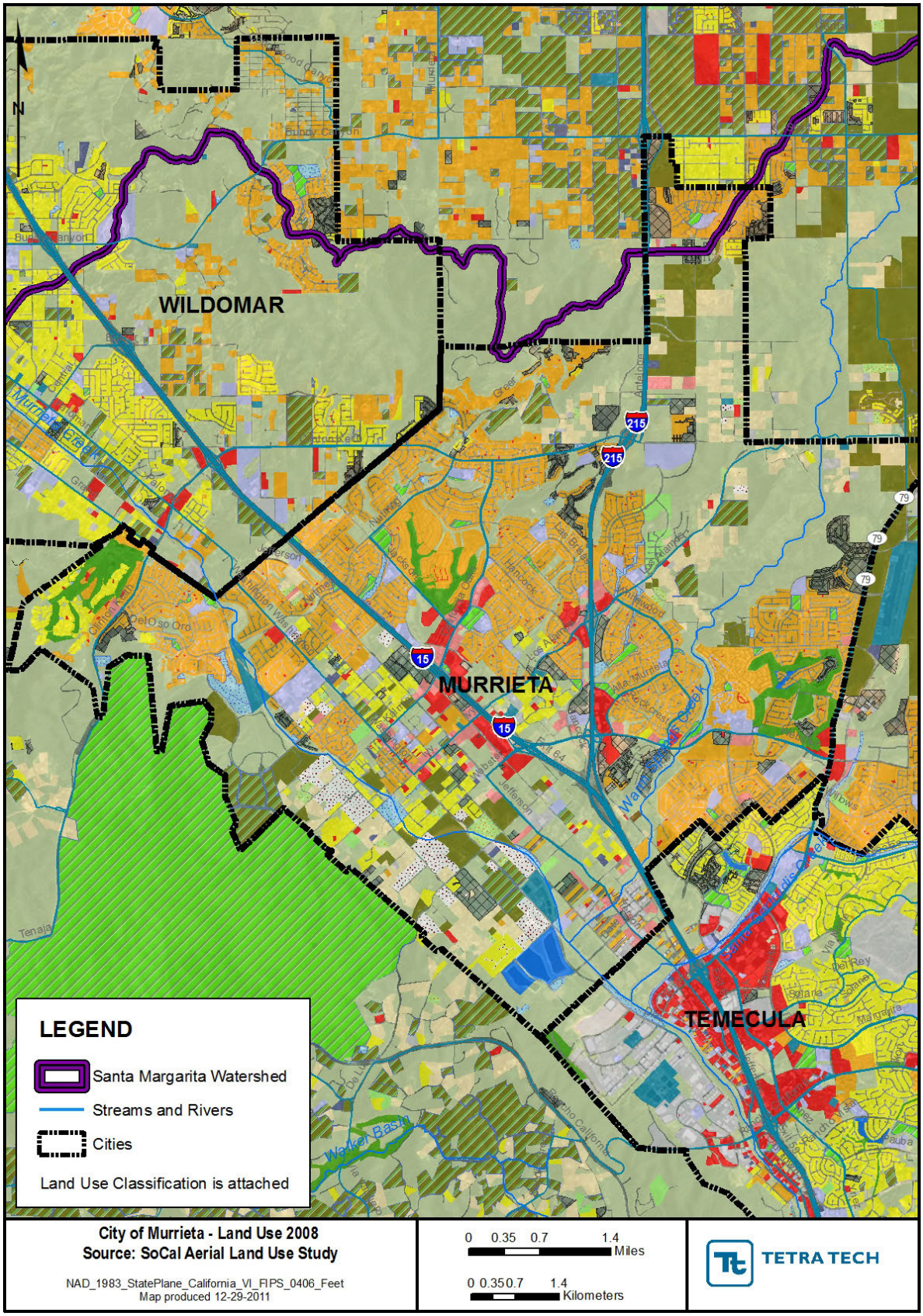


Figure 7. City of Murrieta – Land Use 2008

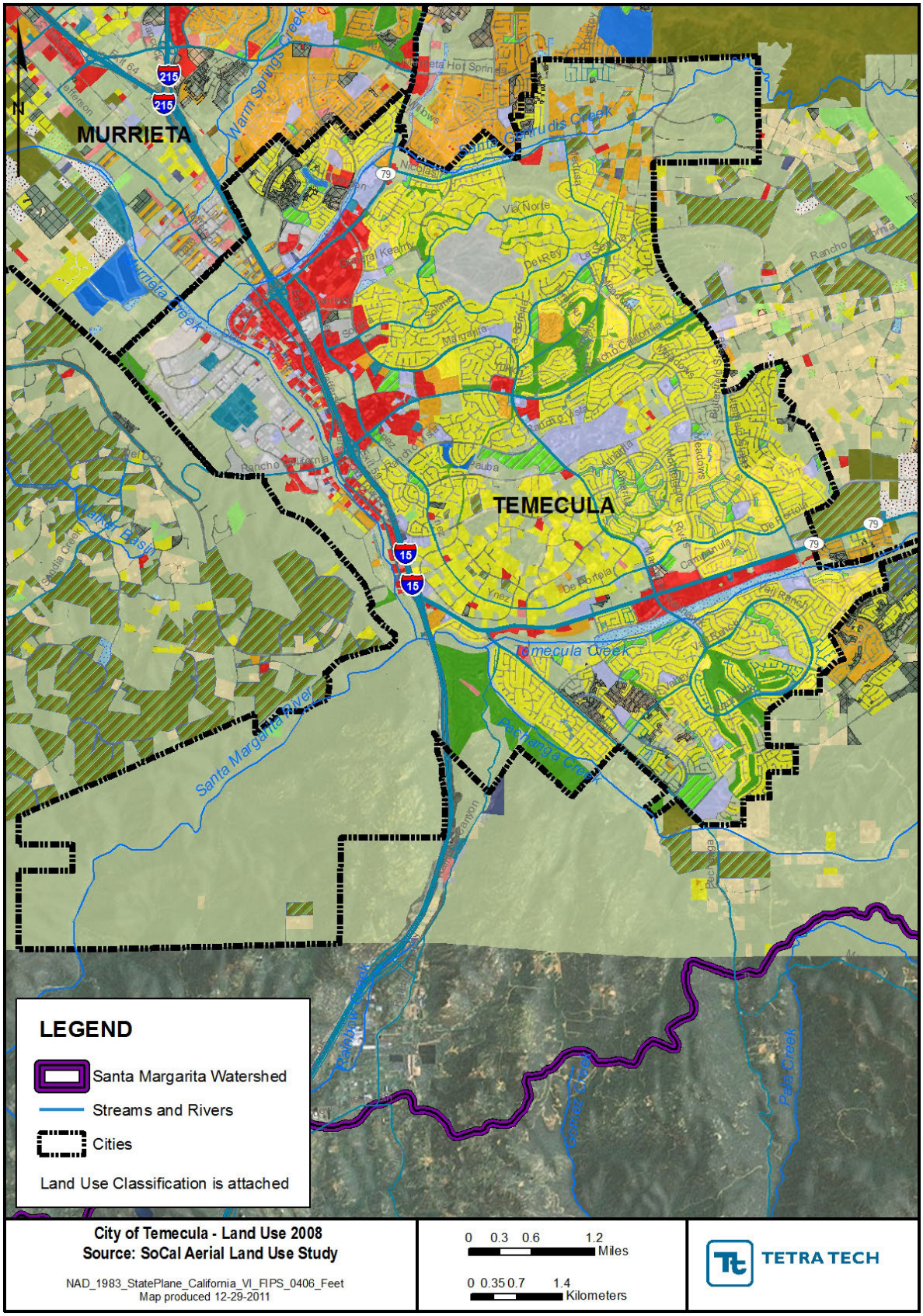


Figure 8. City of Temecula – Land Use 2008

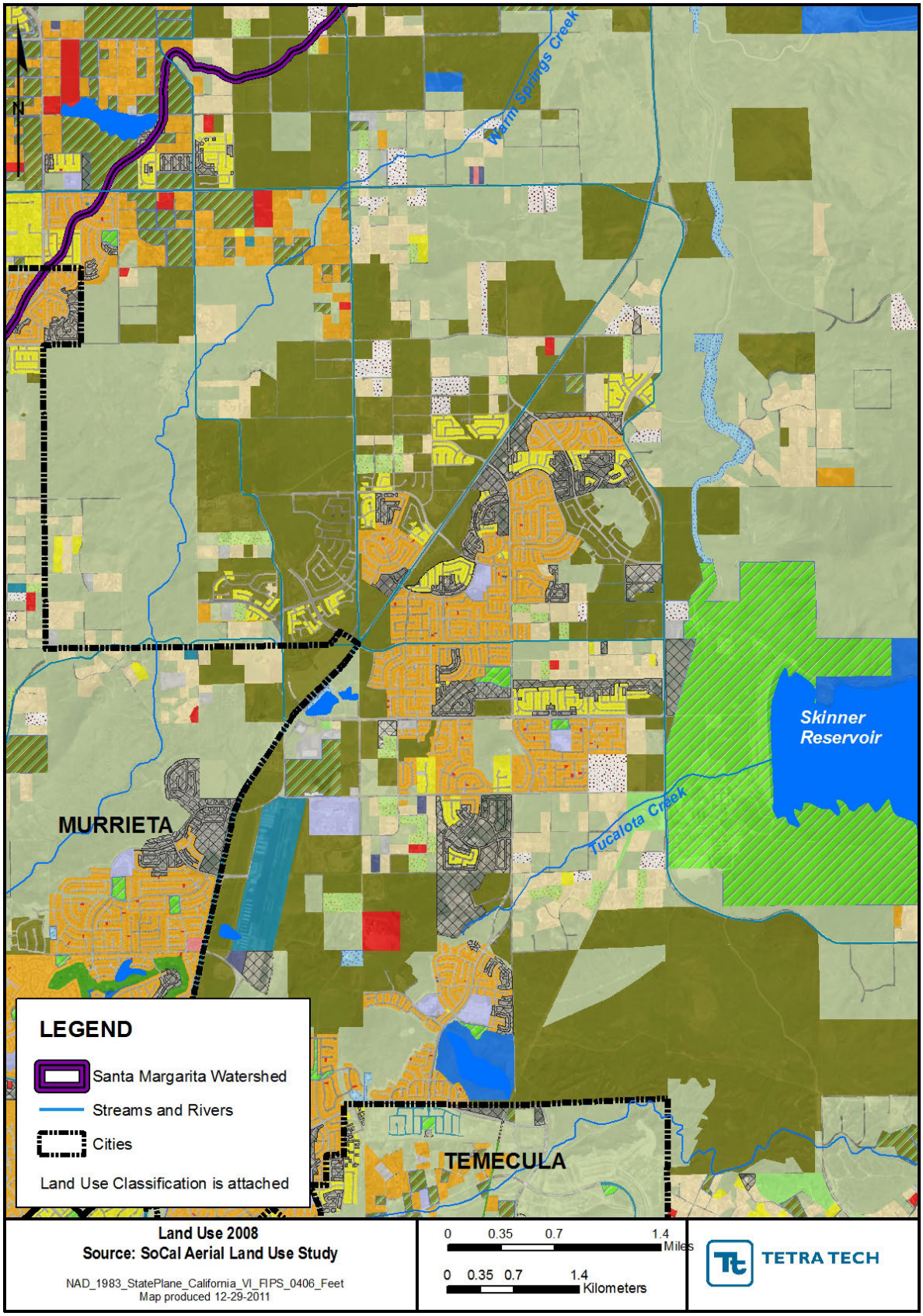


Figure 9 County Unincorporated Area Land Use

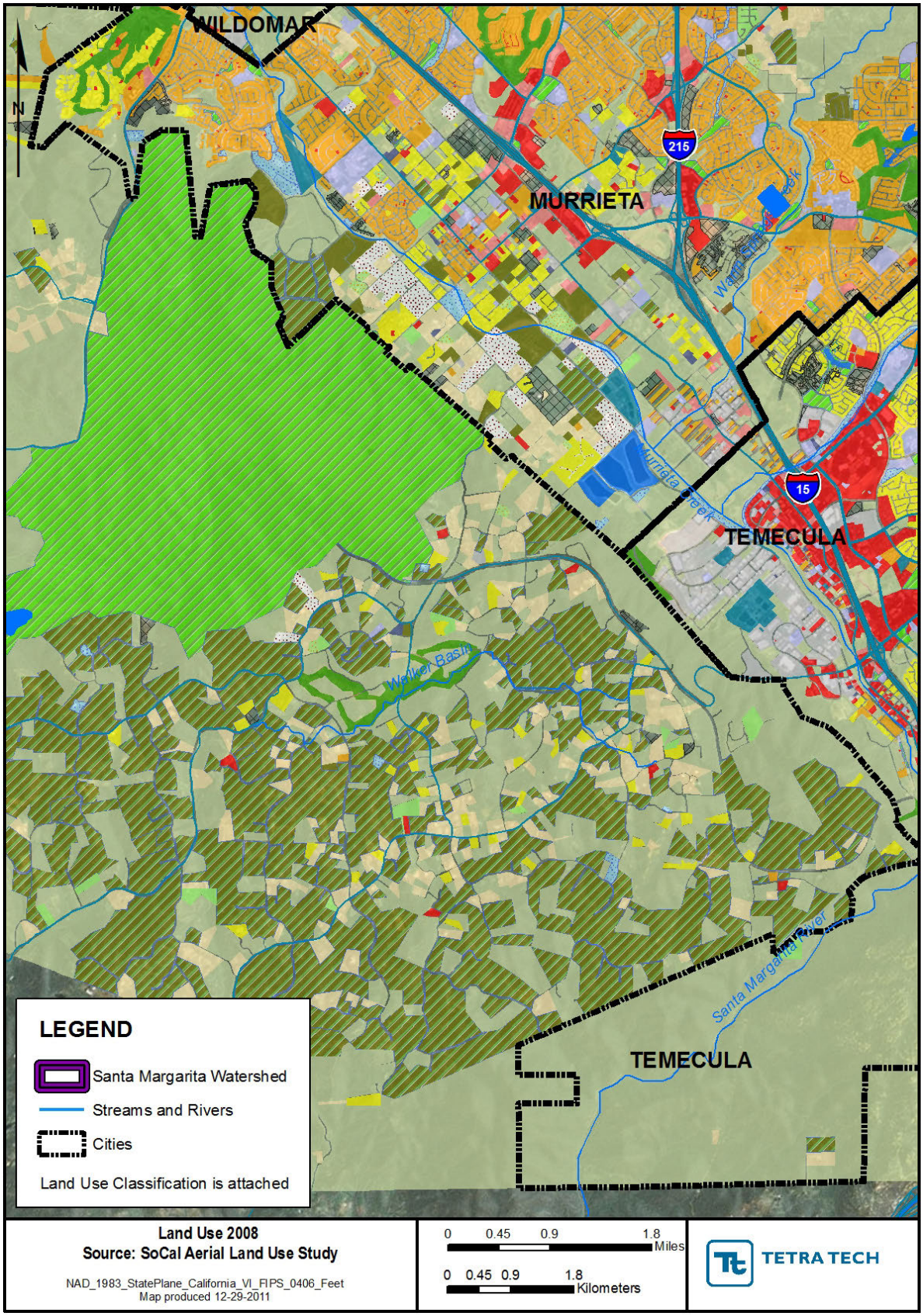


Figure 10 County Unincorporated Land Use

Commercial center development: Areas of commercial and mixed industrial development located principally along I-15 and the arterial roadways paralleling the freeway. A variety of commercial and industrial land use patterns and settings are found in the Santa Margarita Region, principally in areas flanking I-15. This pattern is typical of arterial shopping center development, including "big box" retail and other multi-tenant buildings. These commercial areas are characterized by a relatively high percentage of imperviousness per tax parcel (approximately 55% to 75%), large areas of flat rooftops and surface parking, and connectivity to the MS4. Largely because of the time period in which the Region's commercial land uses were developed, most are found in the relatively flat, valley area at the base of the watershed along Murrieta Creek and I-15, where drainage from the uphill residential areas is conveyed into the Creek.

This pattern does present a physical opportunity for potential future retrofit BMPs, as this development pattern is characterized by large zoning setback areas and expansive parking areas that may be suitable for storm water retrofits (Figure 12, Commercial Area, City of Temecula) such as those described in the BMP Menu. Many of these areas are characterized by typical commercial development features such as large setbacks (generally required by zoning) along rear and side property lines, expansive parking areas serving multiple properties, little common or publicly-owned open space within the commercial districts, varying degrees of storm water treatment and control, and similar soil conditions. As such, almost any one commercial district in the area could be an equally valid candidate for private development retrofit BMP projects as any other. Therefore, identification and prioritization of these areas for potential implementation of retrofit BMP projects will depend largely upon the results of the source assessment portion of the Retrofit Program Framework, as well as very localized factors (such as soil conditions, economic conditions, drainage issues, planned capital programs, and upcoming redevelopment) that need to be assessed in detail with local planning and development staff.

Planned residential development (PRD): Master-planned residential neighborhoods developed after roughly 1980, with uniform or near-uniform lot sizes, street profiles of 28 to 32 feet in width (with curbs and drains), individual irrigated lawn areas, and in most cases a high degree of connected impervious surface area with roof drains draining to impervious areas such as driveways.

The residential development patterns in the Santa Margarita Region are typical of such PRD areas, with PRD subdivisions characterized by residential lots of approximately one-eighth to one-quarter acre (5,000 to 10,000 square feet), municipal drainage, water and sewer infrastructure, curbed and drained streets, and community open space or park areas (which may or may not be public). Many tributaries of Murrieta Creek and Temecula Creek run through or between PRDs, making the potential impact of MS4 facilities on these tributaries especially important in retrofit planning (Figure 13, Aerial View of PRD Area, City of Murrieta).

From GIS analysis and a brief review of pertinent provisions of the Copermittees' zoning ordinances, it appears these PRDs typically have a residential density of four to six units per acre. Moreover, the pattern of available open space in these PRDs consists of (a) "common open space," land set-asides within the developments, few of which are publicly owned, and (b) a limited area of buffer along drainages and streams. This land use pattern results in fewer available options for engineering conventional retrofit BMP projects on public lands.

Rural residential: Areas with residential development with single-family or small agricultural (i.e., "ranchette") buildings on lots of one-half to five acres; in areas outside the MS4, with roads principally draining to swales (Figure 14, Rural Residential Area, County Unincorporated Area). Extensive rural residential areas are found in the County unincorporated areas.

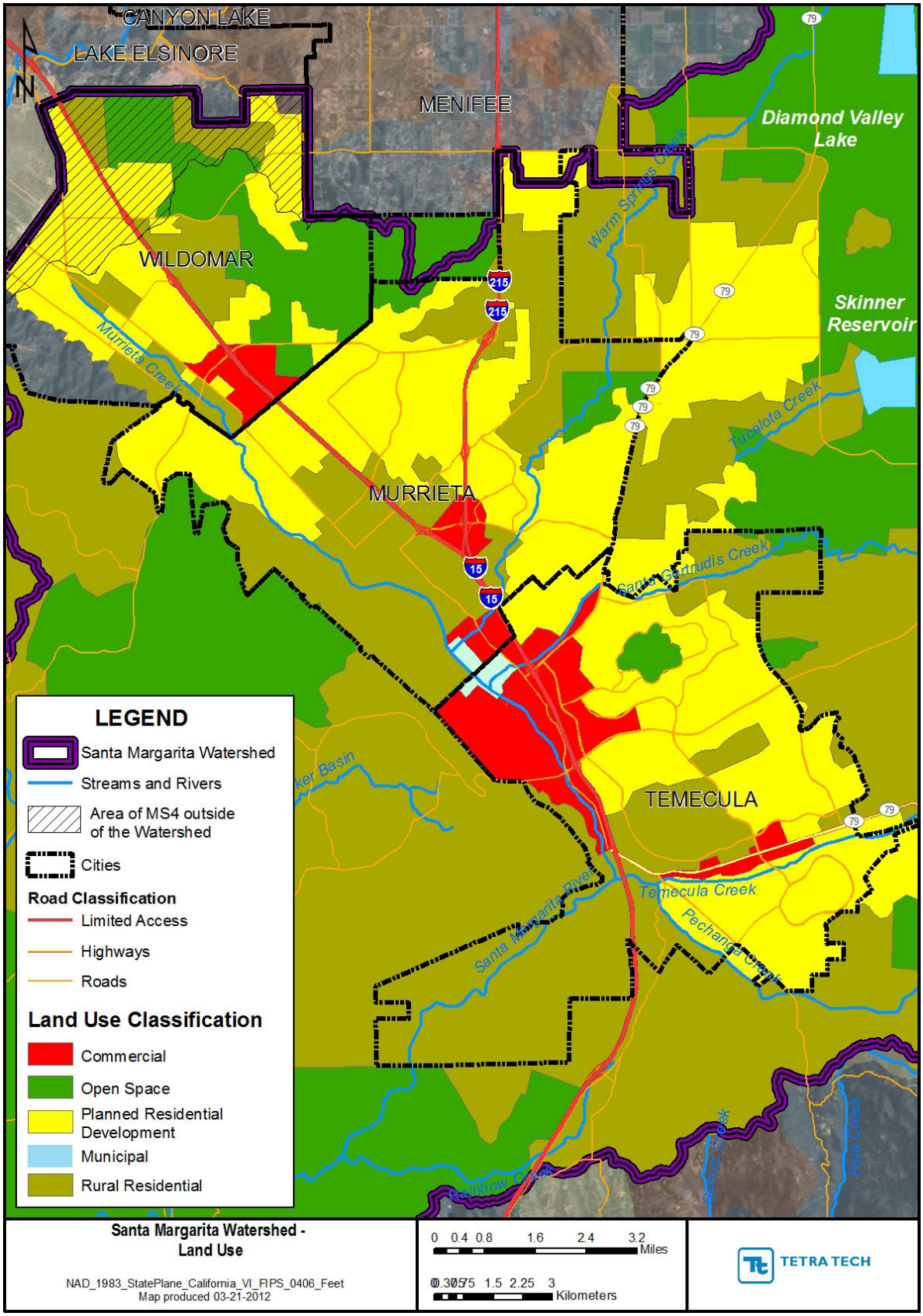


Figure 11. Santa Margarita Watershed – Land Use Types

Figure 12. Commercial Area, City of Temecula

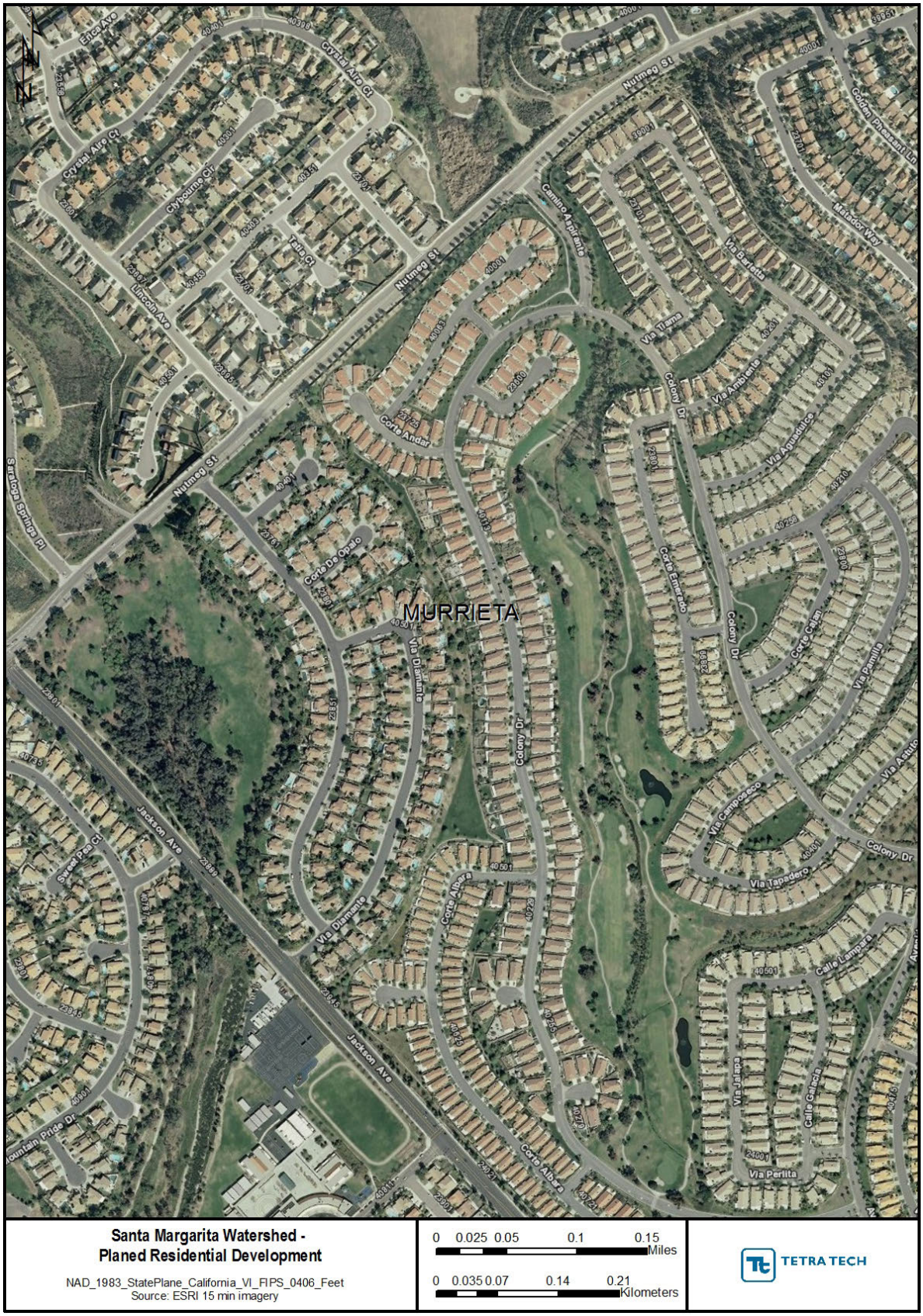


Figure 13. Planned Residential Development (PRD), City of Murrieta

Open Space: Areas of agricultural activity, conservation or other undeveloped land, and residential lots averaging greater than five acres. Many different types of undeveloped or open space areas are found throughout the Santa Margarita Region, including Long Canyon, several golf courses, and conservation areas adjacent to residential neighborhoods along Murrieta Creek. However, with the exception of permanently conserved parcels (i.e., parks and dedicated open space) located along the banks of Murrieta Creek and tributaries, most of the larger contiguous tracts of open space are found at the fringes of the Santa Margarita Region's limits of development, and few sizeable tracts are found within the extents of the developed areas (Figure 15, Open Space Area near Long Canyon, City of Temecula).

Table 4. Principal Watershed Land Use Types and Typical Characteristics

	Land Use Types*			
Characteristics	**Commercial Center**	**Planned Residential Development (PRD)**	**Rural Residential**	**Open space**
Land uses	Highway, commercial, shopping center, light industrial/ distribution	High-density residential (@4 to 6 units/acre)	Residential on 1-5 acre parcels, agricultural	Open, agriculture, very low-density residential
Typical % impervious by parcel*	70%	40%	20%	<5%
Degree of connectivity to MS4	High	High	Medium-low	Low
Area without structures?	Surface parking, required landscape areas	Yards, private common open space, parks	Private land, yards, roadside swales	Private land, public conservation
Possible water quality conditions or concerns	Trash, auto-related uses; hydromodif-ication, buffer encroachment	Hydromodification from pre-Water Quality (WQ) development, buffer encroachment	Agricultural inputs, hydromodification from buffer encroachment, rural road runoff	Erosion; nutrients and pesticides from golf courses and active recreation areas
Potential pollutants:	Metals, bacteria (trash), pesticides, Total Dissolved Solids (TDS), Toxicity	Pesticides, nutrients, bacteria, TDS, Toxicity	Nutrients, pesticides, bacteria (on-site systems)	Bacteria
Other possible pollutants	Sediment, oil & grease, organics	Sediment	Sediment	Sediment

**Derived from visual inspection of aerial photographs, GIS land use analysis, and municipal zoning codes*

Figure 14. Rural Residential Area, County Unincorporated Area

Figure 15. Open Space Area Near Long Canyon, City of Temecula

2.2.2 Impervious Surface and Development Sequence Maps

Most sub-watersheds in the Santa Margarita Region (SMR) have a relatively similar degree of development density and imperviousness, particularly in the residential areas that drain to the tributary creeks. Therefore, the degree of treatment and control incorporated into a development area at the time of construction becomes important to help the Copermittees in source identification efforts. The degree of treatment and control also becomes a potential criterion for assigning priority for retrofit BMP implementation. Along with categorizing land uses and their distribution in the watershed through the Land Use Types tool, the Copermittees can assess the distribution and intensity of development in terms of both the distribution of impervious surfaces within the SMR, and the point in time when areas were developed. The maps of impervious cover (Figure 17, Santa Margarita Watershed – 2006 NLCD Impervious Cover) and the area's Development Sequence Map (Figure 18, Santa Margarita Watershed – Change of the Developed Land: 1984-2005) provide this piece of the Program Framework, as discussed below.

The available impervious surface information for the study area consists of 30-meter National Land Cover Database (NLCD) data from 2006. The map in Figure 17 indicates the percentage of each 30-meter grid cell that was impervious in 2006. Figure 17 also shows the median of impervious percentage of all cells in each sub-watershed.

Those sub-watersheds with the highest median percent impervious cover, shaded in darker orange-red, generally can be assessed as a higher priority when conducting source assessments. However, given the lack of detail on imperviousness in catchments of relatively small size, this mapping should be considered along with other factors where prioritization is concerned. Other issues, such as documented NAL or SAL exceedances, observed over-irrigation, or a development footprint from an earlier phase of the area's development (such as described in 2.2.3 below), can be considered along with information on imperviousness.

In the absence of more refined impervious cover data, this Retrofit Program Study has addressed the evaluation of the development patterns in the sub-watersheds over time to identify the sub-watersheds that would have been developed with different levels of storm water treatment and control. Figure 18 shows the results of the 'time lapse' analysis of development extents. This figure was developed from visual assessment of the extent of land development as shown on historic aerial photographs that the District provided to Tetra Tech. The figure is intended to show the general extents of development by time period, and to provide a strong visual indicator of where development likely occurred before the inclusion of different types of storm water treatment and control with land development. As shown on Figure 18, since the early 1980s, the extent of land development has increased significantly from its original footprint, when it was confined chiefly along the I-15 corridor and the main streets of the historic centers along Murrieta Creek. With each subsequent stage of development, the extent of development increased. Most notably, until the period between 2000 and 2005, the extent of development was clustered around the original centers at the bottom of the Santa Margarita Region and consisted in large part of infill within or adjacent to existing developed areas. Depending upon the timing of development entitlements, areas developed between 1985 and 2000 would have had varying degrees of storm water treatment and control imposed, with later entitled phases more likely to have contemporary controls. Between 2000 and 2005, by contrast, the extent of development in the upper reaches of the tributaries increased significantly. Development at this later period is more likely to have incorporated storm water quality treatment controls.

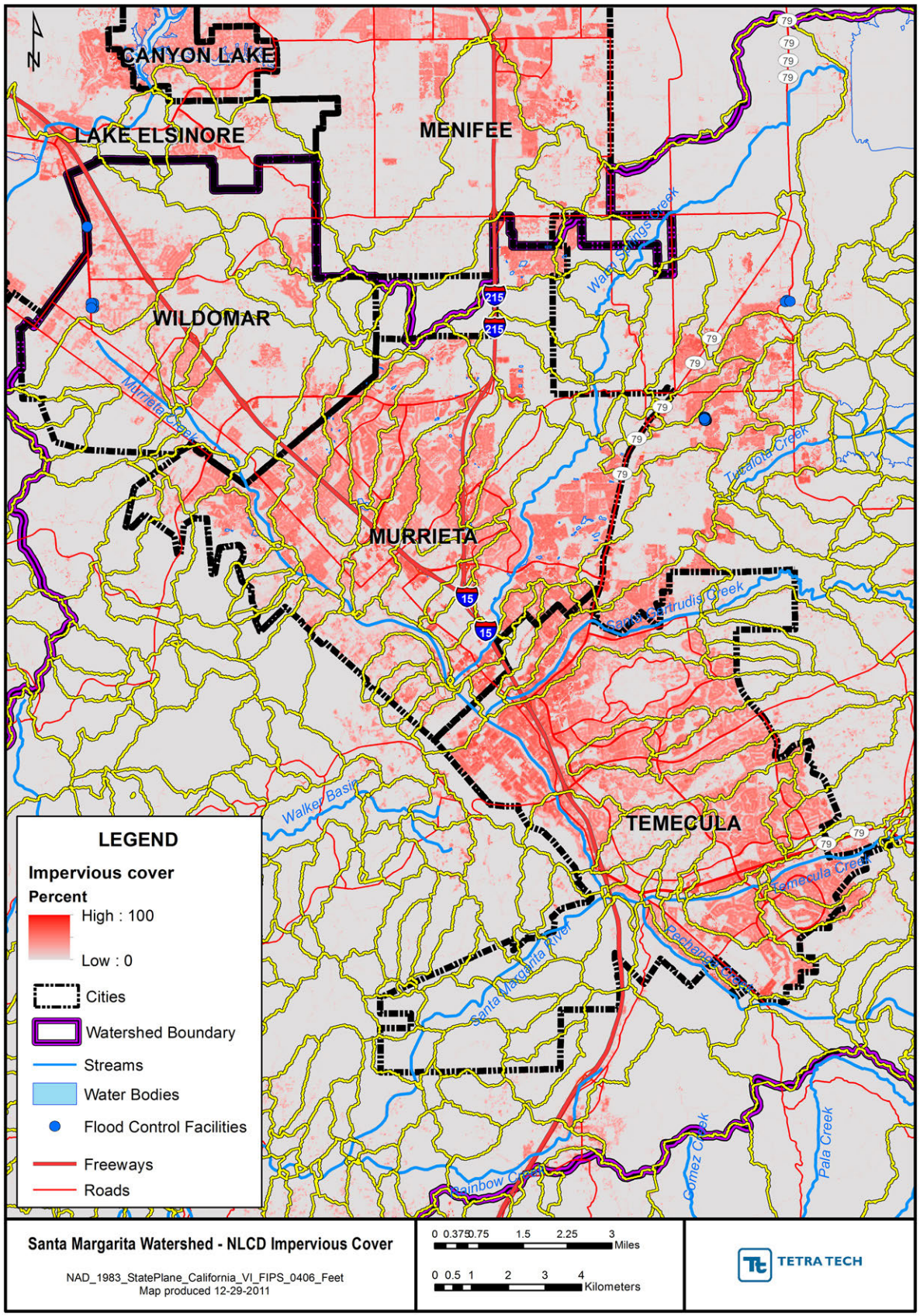


Figure 16. Santa Margarita Watershed – 2006 NLCD Impervious Cover

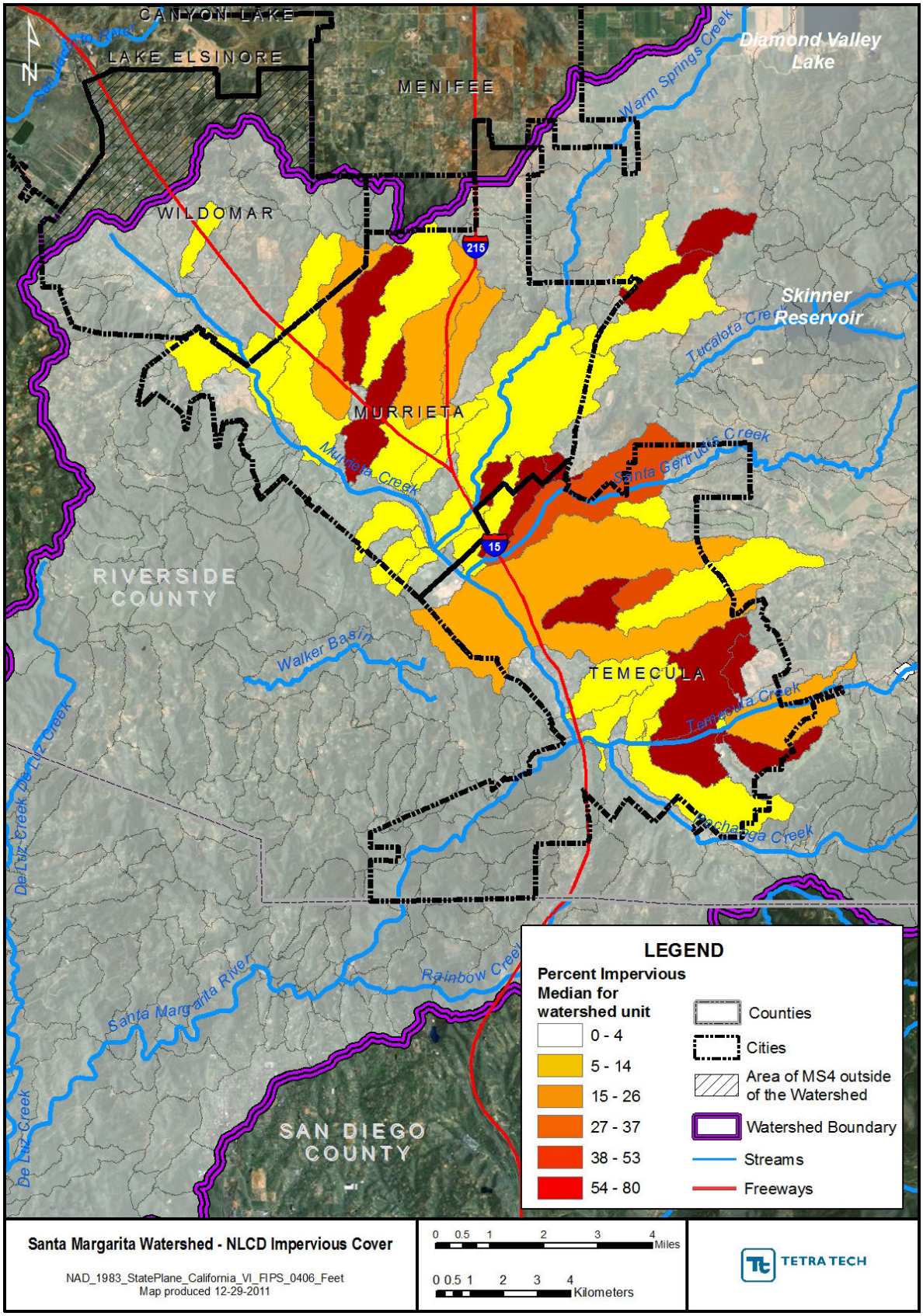


Figure 17. Santa Margarita Watershed – 2006 NLCD Impervious Cover

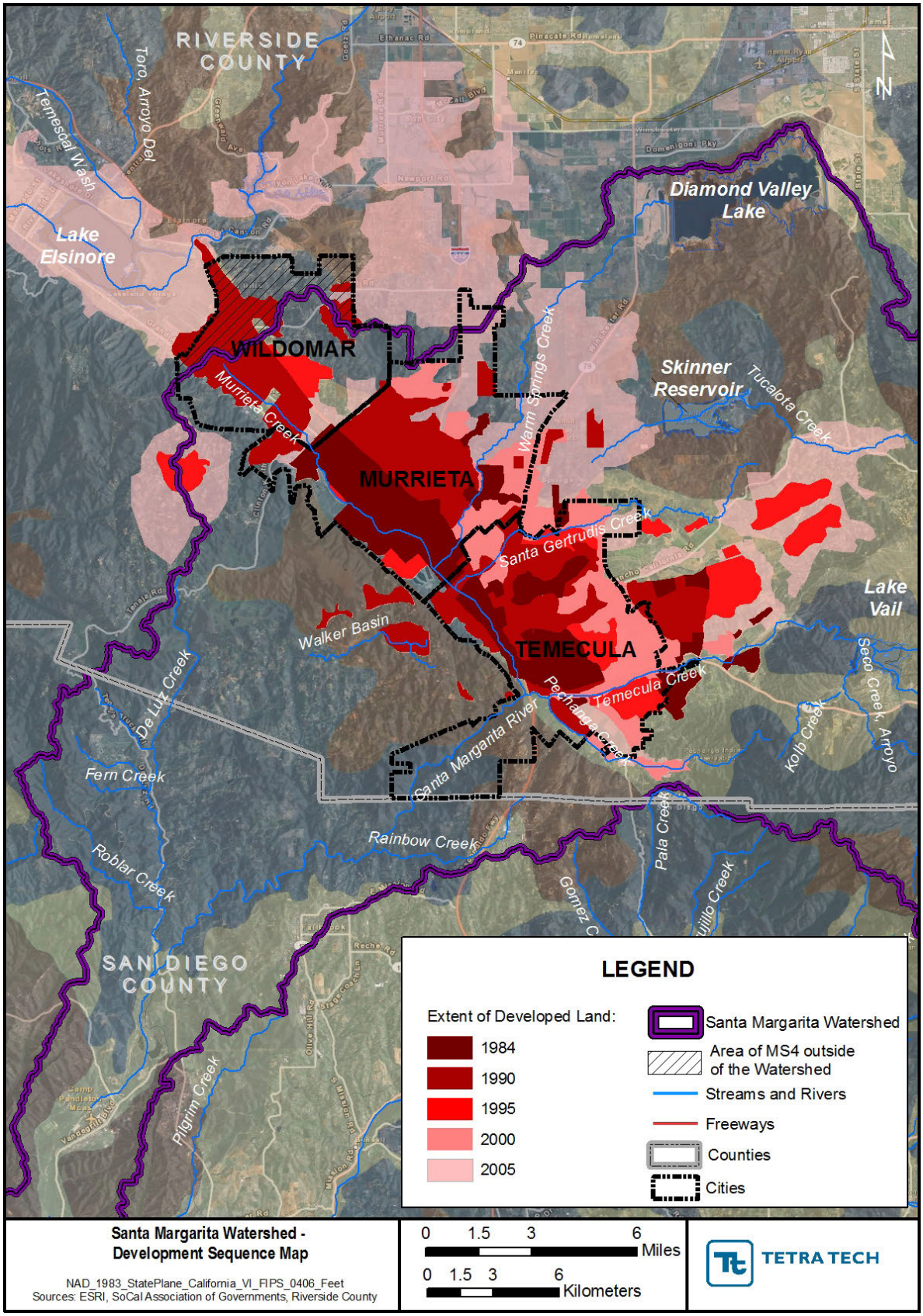


Figure 18. Santa Margarita Watershed – Change of the Developed Land: 1984-2005

When responding to an identified problem as described in the Retrofit Program Framework, this assessment, together with supplemental field work as needed, will assist the Copermittees in further prioritizing areas of existing development for retrofits. In using this map, it is intended that the Copermittees can identify areas of earlier development, which should then be cross-referenced to permits, plans, and drawings on file in the jurisdiction to determine what types of storm water treatment and control were incorporated during various phases. As a key example, those areas constructed without water quality and volume controls, or without any controls, can then be identified and given consideration for priority retrofits that may address volume control and potential hydrologic modification issues. While not a precise measure of the potential impact of development on watershed hydrology and water quality, this assessment is one tool for focusing on locations where additional evaluations, such as Stream Geomorphic Assessments (SGAs), may be conducted.

2.3 Retrofit BMP Menu (Appendix B)

The Retrofit BMP Menu (Appendix B) provides an extensive list of storm water management approaches that have been used in communities throughout the U.S. to manage storm water pollution, whether proactively to prevent pollution, or as retrofits and remedial measures in areas with water quality and storm water management issues. The Retrofit BMP Menu provides a guide to the expected applicability and effectiveness of different approaches to different problems, conditions and pollutants; their usefulness in different land use types and settings, as described in Section 2.2.1 and Figure 11 of this Study; and their usefulness at different scales and in different political or administrative settings (i.e. rural residential areas with individually-owned properties versus high-density shopping centers with common management). It is intended to be used in Step 4 of the Program Framework illustrated in Appendix A, once Copermittees have evaluated the nature of the identified problem and their own JRMP implementation effectiveness and determined that additional retrofit measures are needed.

The Retrofit BMP Menu was developed by Tetra Tech, Inc. The expected effectiveness of each BMP at removing various pollutants in the table (e.g. bacteria, nutrients, etc.) is based on the research completed by and best professional judgment of Tetra Tech engineers and planners completing the BMP Menu. However for those structural BMPs included in the Riverside County Design Manual for Low Impact Development Best Management Practices (the "Design Manual"), the expected effectiveness in the BMP Menu reflects data from the Design Manual. When problems are identified that trigger use of the Retrofit Program Framework, and the Copermittees have characterized the problem and its setting (See Section 3.3 and Section 2.2 above), the information in the Retrofit BMP Menu is intended to enable the Copermittees to filter out any BMPs that may not be useful for that pollutant, land use setting, scale and management environment, and to arrive at a focused list of BMPs that are directly applicable to the problem and setting at hand. Section 3.3 and Table 7 of this Report provide the Copermittees with the recommended approach to using the Retrofit BMP Menu to develop a specific list of targeted BMPs. Furthermore, it is expected that in many cases, the ultimate nonstructural retrofit could incorporate several BMPs, such as enforcement, education, and pollution-preventing retrofits such as covering outdoor trash enclosures; the Menu provides a starting point to consider both individual and combinations of BMPs that best address the problem, setting, and available resources for the Copermittees.

Structural vs. Non-Structural BMPs: The Retrofit BMP Menu is divided into structural and non-structural BMPs. For purposes of the Menu, "structural" BMPs are defined as those that involve the engineering practices of designing and building structural treatment and control facilities to improve water quality. Non-structural reduction strategies are defined as those actions and activities intended to reduce storm water pollution that do not involve construction of a physical component or structure to filter and treat storm water. This definition encompasses measures such as erosion repairs, stream buffer plantings and enhancement, constructing water resource mitigation sites in conjunction with capital projects (particularly transportation system projects that affect wetland areas), and implementing

landscape-based measures such as turf conversion that involve construction and earth moving, but whose constructed functions are not exclusively limited to storm water filtration or treatment "Non-structural" practices encompass a wide range of actions; some non-structural BMPs could include:

- Adopting laws or regulations banning the use of specific pollutants
- Conducting general public outreach and education
- Performing structural solutions by stabilizing eroding slopes or augmenting stream buffer areas

2.4 BMP Descriptions and Resources (Appendix C)

The final tool in the Retrofit Program Framework is the table of BMP Descriptions and Resources that comprises Appendix C. In this table, each of the BMPs from the Retrofit BMP Menu is described in greater detail with links to resources for program development, such as fact sheets, case studies, and guidance documents. These Descriptions and Resources are intended to be used in Step 5 of the Program Framework as illustrated in Appendix A; once the Copermittees have used the Retrofit BMP Menu to come up with a list of appropriate BMPs, the Descriptions and Resources will provide references and supporting information for program definition and development and, ultimately, for retrofit implementation.

Resources and links in the Table were compiled by Tetra Tech, Inc. Wherever possible, fact sheets from CASQA and other Southern California sources were used. However, relevant and useful examples from other municipalities in the United States and Canada, the US Environmental Protection Agency (US EPA), and watershed organizations also were included.

Actual retrofit program development will, ultimately, be done locally by the Copermittee and will reflect their priorities, resources, and political setting. Nonetheless the resources in Appendix C can offer many examples and starting points for how other municipalities and jurisdictions have approached similar problems. The Copermittees may wish in particular to contact program staff whose initiatives are described in these resources and references to gain the benefit of their knowledge of the costs, logistics, and lessons learned from different approaches.

(*This page intentionally blank*)

3 RETROFIT PROGRAM FRAMEWORK

3.1 Introduction

The Retrofit Program Framework, diagrammed in Appendix A, is a standardized decision support process for formulating solutions to water quality and hydromodification problems identified in the Santa Margarita Region. It is a system which the Copermittees can use for guidance in utilizing the tools described in Chapter 2 of this study, to assist with tracking down sources of, and identifying potential solutions for, identified water quality problems. The solutions can be specific to land use types at different scales. The Framework is meant to be applicable to a variety of common situations observable in the Santa Margarita Region. The process is illustrated as a series of steps with decision points that lead to resolutions to identified water quality issues.

The Retrofit Program Framework is intended to enable Copermittees to select the most situation-appropriate and cost-effective methods to manage identified problems. It focuses first, as previously noted, on non-structural retrofit BMPs, which have the advantage of enabling more rapid implementation. Non-structural BMPs are especially important and appropriate in the SMR as the Copermittees have very limited authority or ability to require retrofits on lands they do not own or control, and a very limited amount of publicly-owned or controlled land to work with. Non-structural retrofit BMPs also have the advantage of being able to be implemented in cooperative partnerships through Homeowners Associations (HOAs) and commercial center managers, as noted in the Retrofit BMP Menu. With the prevalence of commonly-managed shopping centers and subdivisions in the watershed, focusing on these types of BMPs will increase the potential ease of implementation. The Program Framework also identifies specific structural BMP options appropriate to each of the land use settings and appropriate to different organizations or authorities (e.g., HOA-managed areas versus rural residential settings), in order to help the Copermittees understand which approaches are more likely to succeed.

3.2 Problem Identification

The first step in the Retrofit Program Framework is to delineate a clearly defined problem and source area that needs to be analyzed for potential retrofit solutions. To identity issues triggering a Retrofit Program Framework evaluation, the Copermittees can utilize the Receiving Waters and MS4 Discharge and Monitoring and Reporting Program, and other watershed management activities such as irrigation runoff prohibitions. The potential issues are listed in Table 5 below, and correspond to the "Problem or Condition (NAL/SAL Exceedance)" column headings in the BMP Menu, Appendix B.

Table 5. Observations Potentially Triggering a Retrofit Program Framework Analysis

Irrigation Runoff	
Hydrologic modification/channel instability	Illicit Connection/Discharge
Metals	Pesticides
Organics	Nutrients
Oil & grease	Bacteria
Sediment	

3.3 Source Assessment & Identification

As part of the JRMP, the Copermittees implement a source identification program when illicit discharges are detected or when action level exceedances are detected. The Retrofit Program Framework capitalizes on this permit requirement, and incorporates these source identification activities as a key element. In this step of the Retrofit Program Framework, the Copermittee having jurisdiction of the outfall and/or location where the Retrofit Program Framework evaluation was triggered, will conduct a source assessment to determine its source. Table 6 and the discussion in this Section are intended to provide guidance on the source assessment and a framework for organizing the information collected.

The Copermittee first should implement the source identification steps described in relevant section(s) of their JRMPs, principally to identify whether the problem appears to have a single or few defined points of origin, or whether the problem appears to be resulting from multiple, diffuse sources in the drainage area. Visual observation[2] from the point where the problem occurred and moving upstream is, in most cases, the first and most useful approach to examining the area and evaluating whether there are obvious potential sources, such as poorly managed trash areas, encampments, deteriorated storm water treatment systems or ponds, or actively eroding streambank areas, that are likely sources of the problem.

The Copermittee responsible also should characterize the Land Use Type and Site Setting & Control conditions related to the identified issue. Each of the conditions listed below is important to determine which "Land Use Type" and "Site Scale & Control" headings in the Retrofit BMP Menu will apply. The following features of the setting where the problem occurred should be detailed in the source identification effort, and Table 6 provides additional details and guidance to structure the information gathered:

- The ownership and management of the site or sites within the area where the problem has occurred
- The scale and nature of the contributing drainage area and drainage network, using municipal GIS, land use maps and observations
- The presence of typical sources or causes of the condition of concern in the contributing drainage area identified through municipal and Southern California Association of Governments (SCAG) land use data (as illustrated in Figures 5-8), such as agricultural, nursery, or golf course uses, or high-density development with limited storm water treatment and control (initially identified through the Development Sequence map, Figure 18)
- Origin of the observed problem on a contained, single-owner site, which will lead to a more straightforward assessment of BMP and implementation options
- The degree of connectivity of the area's impervious surfaces to the MS4 or surface water, from visual assessments or, where possible, GIS and orthophotos
- The presence and nature of storm water treatment and control BMPs in the contributing drainage area, identified initially through the Development Sequence map as well as orthophotos and municipal GIS
- Whether the observed problem is observed, or likely to have, a diffuse or a point source

[2] For an example of a program of visual observation to identify point and diffuse sources, see the Charles River Watershed Association's "Find It & Fix It" program: http://www.crwa.org/projects/METwMyRWA/shoreline_survey/ProjectArea.html

Table 6. Setting and Scale Characterization

Setting where the problem was detected	Scale of the contributing area	Likely pollutant source & its ownership/ management	Degree of connected imperviousness	Degree of treatment & control present
In-stream	Watershed or greater (i.e., atmospheric deposition, natural process, wildlife bacterial contribution)	Many (>100) public and private property owners, no common ownership or management	High, with most roof and footing drains tied directly into MS4 or surface water, most surfaces curbed and drained	None, with drainage directly to MS4 and surface water via catch basins or drains and pipes
Within the connected MS4 (i.e., outfall, drainage pipe, catch basin, Sedimentation, or flood control basin)	Sub-watershed (channel instability, wet weather pollutant flows	Multiple private and public property owners, no common ownership or management	Moderate connectivity, some areas with sheet flow through vegetated areas	None, with drainage to surface water via wetland or overland flow through vegetation
Adjacent or tributary to the stream or MS4 (e.g., problem observed in or near a public road, roadside swale, commercial or municipal area with connected impervious cover)	Neighborhood or "Area of Development" within a sub-watershed	Defined area (i.e., neighborhood or commercial center, no common owner or management but few property owners)	Lower connectivity, some houses/buildings do not have gutters, more surfaces drain to vegetation before discharging	Separators or similar mechanical treatment only
Contained on or directly attributable to an individual site (e.g., illicit connection to the MS4, SUSMP or construction BMP violation, un-managed trash enclosure, runoff from outdoor storage area)	Sub-area, but multi-property	Multiple private and public property owners, common management or ownership (i.e., HOAs)	Low degree of connectivity, with most surfaces draining to a vegetated area	Flood control or sedimentation basins
	Single property or site	Individual site ownership or common control		WQ treatment and control (i.e., enhanced detention basins, LID)

The characterization options for the land use settings and scales, which feed into the Retrofit BMP Menu (Appendix B), are described in Table 6 below. These assessments and categories are not defined in numerical terms (i.e., percent of imperviousness in drainage area), as they are intended specifically to guide the selection and development of non-structural BMPs that work in the particular social, jurisdictional, and land use setting where the problem has arisen. Therefore, this table is not an exhaustive characterization, but can guide the Copermittees in assessing conditions important to retrofit BMP selection and program design. This approach gives greater scope and flexibility to the Retrofit Program Framework to address the wide variety of issues and conditions that may arise.

The information in this table has multiple uses in selecting retrofit BMPs. The scale of the contributing area is important to both selecting a BMP and determining its likely cost. Outreach and education, for example, requires a different program design if directed at a single neighborhood rather than a large area with multiple neighborhoods or land uses. Similarly, the ownership and management of the land area where the problem likely is originating is critical to BMP retrofit design. Situations in which an HOA or single property manager controls matters such as trash collection, irrigation systems, or landscape maintenance would be approached initially through contact with the common association or manager. An area with fragmented property ownership (such as a single-family rural residential area without any association or a commercial area of single lots) requires a much different approach to contact and program design.

Finally, understanding the degree of treatment and control BMPs associated with the drainage area is especially important to this Retrofit Program Framework when assessing the likely source of an observed problem and considering structural BMP options. As noted in Chapter 2, a key difference among PRDs in the Santa Margarita Region, and their likely land use impacts and retrofit BMP options, is the time when the PRD was entitled and built. This timing determines whether the development included water quality BMPs, or indeed any storm water treatment and control BMPs at all. The time of development is thus helpful in assessing the likelihood that an upstream PRD area is contributing to hydrologic modification or other water quality issues. The planning and permitting offices of the Copermittees are especially important in helping to document the degree of treatment and control BMPs present.

Understanding and characterizing the upstream and contributing land use types is especially important to this Retrofit Program Framework, since each land use type is associated strongly with potential water quality issues and pollutants, and is also associated with certain appropriate non-structural and structural BMPs. Each land use type also is associated strongly with the likely structure, layout, and ownership or management of available open lands on which retrofit BMPs could hypothetically be constructed. As described in detail in Section 2.2.1 and Figure 11, the Retrofit BMP Menu is organized around the following four chief land use types in the study area:

- **Commercial center development:** Areas of commercial and mixed industrial development located principally along I-15 and the arterial roadways paralleling the freeway. These areas are characterized by a relatively high percentage of imperviousness per tax parcel (approximately 55% to 75%), large areas of flat rooftops and surface parking, and connectivity to the MS4.
- **Planned residential development (PRD):** Master-planned residential neighborhoods, which may include public or private parks, common open space, and community facilities, developed after roughly 1980 with uniform or near-uniform lot sizes, street profiles of 28 to 32 feet in width (with curbs and drains), individual irrigated lawn areas, and in most cases a high degree of connected impervious surface area with roof drains tied into the MS4. Based on GIS analysis and the Copermittees' zoning ordinances, these PRDs typically have a residential density of four to six units per acre.

- **Rural residential:** Areas with residential development with single-family or small agricultural (i.e., "ranchette") buildings on lots of one-half to five acres; in areas outside the MS4, with roads principally draining to swales.
- **Open Space:** Areas of agricultural activity, conservation or other undeveloped land, and residential lots averaging greater than five acres.

In addition, the presence of publicly-owned lands, public rights-of-way, and municipal facilities in the area of concern or sub-watershed also must be noted, in part to determine potential sources and in part to determine whether publicly-controlled lands could be available for retrofit BMP projects if and when necessary. While typically more important to structural than nonstructural BMPs, some BMPs may be best suited to public lands within a particular land use setting, or may be able to be demonstrated and initiated there (e.g., irrigation reduction, integrated pest management (IPM), and installation of pet waste bag dispensers in public parks).

3.4 Assess JRMP Program Implementation

Once the problem and setting have been characterized, the Step 3 is to assess the Copermittee's JRMP program implementation relative to the pollutant or condition, its likely source, the land use and management setting, and the Copermittee's responsibilities and initiatives that may or should be able to address the issue. The purpose of this step is to assess whether the Copermittee may be able to mitigate the problem or condition through more effective or complete implementation of its existing authorities and programs in the JRMP, or if supplemental actions – retrofits – may be required.

Since JRMPs and their implementation principally are managed and implemented by Copermittees and their own program staff, the Copermittees are best suited to evaluate the adequacy of JRMP activities in addressing pollutants and conditions identified. This step is not a quantifiable process, and will rely to a large extent on the best professional judgment of Copermittees and staff to identify potential gaps in JRMP activities, and the degree to which additional resources or retrofit strategies will be needed.

Table 7 below provides a brief overview of how different JRMP program elements may relate to different pollutants or conditions of concern in different land use type settings (from Section 2.2.1 and Figure 11).This step anticipates that the Copermittee will (1) identify which JRMP program elements could potentially be applicable to the identified pollutant or condition, given the land use type and problem setting, (2) assess the status of JRMP implementation relative to the approved workplan in the area of concern, (3) determine whether current and planned implementation activities are likely to address the pollutant or condition; and (4) make some assessment as to whether the past and planned activities are robust enough, and at a large enough geographic scale relative to the problem or condition, to have a positive impact on source reduction.

Table 7. JRMP Program Elements and Example Pollutants/Conditions Potentially Addressed

Program Element	Pollutants/Conditions Potentially Addressed	Land Use Types (from Fig. 11)	Example pollutant/concern & JRMP Evaluation Question
Development Planning	Hydromodification, oil & grease, bacteria	Commercial center, PRD, open space (recreation)	**Bacteria:** What standards apply to trash enclosure areas for new development? Have these been applied and enforced within the area?
Construction	Hydromod, turbidity/sediment	Any	**Turbidity:** What are the results of recent construction inspections in the area of concern? Have all sites in the area been inspected?
Municipal Activities	Any	Public land/ROW or Municipal Facility	**Metals:** Have good housekeeping procedures been completed & documented at all municipal facilities? Are any public construction projects or major maintenance taking place in the contributing drainage area? Have these been inspected in the past year?
Commercial/ Industrial	Any	Commercial center, open space (recreation)	**Pesticides:** Are typical sources of the pollutants of concern (i.e. uncovered storage of pesticides, over-irrigation of landscaped strips) covered in the JRMP inspection checklists? Have these issues been noted on inspections of properties in the area of concern?
Residential	Any (metals, organics less likely)	PRD, rural residential	**Dry weather or nuisance flows:** Have JRMP-related activities included outreach on over-irrigation through water bills and other direct communication with residents in the past year?
Public Education	Irrigation runoff, illicit discharge, oil & grease, sediment, pesticides, nutrients, bacteria	Commercial center, PRD, rural residential, open space (recreation)	**Nutrients:** Has there been recent outreach on fertilizer use? Have local retailers and landscape contractors been engaged in providing information on proper amounts and application of fertilizers?

3.5 Non-Structural Retrofit BMP Evaluation

If the results of Steps 1, 2 and 3 in the Program Framework indicate that supplemental action is needed as a retrofit, the Program Framework next calls for use of the Retrofit BMP Menu (Appendix B) and supporting Descriptions and Resources (Appendix C) to evaluate non-structural program options that can supplement JRMP implementation and address the problem or condition of concern. After working through the factors in the Table 6 and the JRMP evaluation in Table 7, the key factors used in the BMP Menu (Appendix B) – problem or condition, land use type, and site scale & control - will be documented. The next steps and recommended use of the Retrofit BMP Menu are outlined in the subsections that follow. Initially, non-structural BMPs will be the first approaches evaluated, but the Retrofit BMP Menu is used in the same manner along with site selection if structural BMPs are considered, as described in Section 3.6 below.

3.5.1 "Problem Output" and Assessing Non-Structural BMPs

Once the source identification has been performed and the Permittee has determined that continued implementation of the existing JRMPs will not address the issue, the next step is to evaluate the possible non-structural BMPs that could be applied. Using the information from the problem identification and the source assessment, the Copermittees can use the BMP menu to select applicable BMPs given the identified issue and land use setting. The procedure for using the BMP Menu is to sort the spreadsheet to find those BMPs that have a symbol in each of the appropriate cells for the problems and conditions, land use type, and site scale and control columns. This can be done electronically using the "sort" function in Microsoft Excel, or manually by identifying BMPs with a mark in each applicable cell. Once the list of applicable BMPs that are suitable to the pollutant/condition, land use type, and site scale and control conditions is available, the BMP Descriptions and Resources in Appendix C can be reviewed to outline the options, costs and constraints that may apply to a particular BMP. Where multiple BMPs may potentially address a particular problem, the criteria listed below in Table 8 can be used to rank and prioritize which actions may be pursued; however, as noted in Section 2, in some cases a combination of BMPs, such as education and outreach with incentives, may be the most efficient or cost-effective approach.

Table 8. Retrofit BMP Program Components

Ability to Implement	Applicability to Target Audience/Likely Pollutant Source	Cost & resources needed
Issue falls within existing regulatory authority, simple administrative enforcement.	BMP addresses identified polluters directly.	Can be done within existing staff time plan and resources.
Within existing authority, longer-term enforcement or adjustment to ordinance needed.	BMP addresses association or affected property owners in general area directly.	Resources can be found within other budget or staff resources available to program (e.g. partnership, support agreement).
Enforcement or authority lies with other agency outside Copermittee.	BMP addresses single category of polluters, focused target audience.	Additional resources need approval, which creates uncertainty and lead time.
New authority needed	BMP is general to the area or issue.	Requires grant or other outside support, with long lead time.
No authority other than education and outreach		No apparent source for needed funds & staff

3.5.2 Rank and Prioritize Possible Non-Structural Retrofit BMPs

Table 9 presents a set of retrofit criteria for BMP selection that emphasize cost effectiveness and rapid implementation, and can be used to prioritize among identified BMPs and actions that may address the problem or condition of concern. These criteria also can help identify which BMPs should be implemented first if there are several BMPs that match up with the condition, land use setting, and site scale or control. To use the non-structural criteria, the Copermittees will need to prepare a basic, preliminary outline of the non-structural BMP. These outlines can be derived in part from the BMP Descriptions and Resources in Appendix C, but also from the Copermittees' JRMP reported activities, the Implementation Agreement, and local ordinance and enforcement activities. As illustrated in the Retrofit Program Framework Diagram (Appendix A), where non-structural BMPs have been determined to be necessary to address identified issues, the Copermittees can include the results of the evaluation(s) in their work plan for the following year.

Table 9. Retrofit BMP Action Prioritization Criteria: Non-Structural BMPs

Pollutant removal and regulatory status	The BMP's effectiveness in reducing the condition or pollutant of concern, *with priority given to BMPs which have High Pollutant Removal Effectiveness*
Ability to address area of development lacking storm water treatment & control	The potential effectiveness of the BMP in addressing areas developed before contemporary storm water treatment and control standards, as identified by municipal, County and District staff and from historic aerial photography, *with priority given to areas developed before water quality controls were incorporated into storm water treatment requirements*
Addressing "low hanging fruit" issues	The ability of the BMP to address "low hanging fruit" conditions, such as broken or readily adjusted irrigation systems, unenclosed trash areas, or uncovered automotive service areas, *with priority given to BMPs and sites with readily addressed problems*
Cost and level of effort needed to implement	The potential cost and program complexity of the BMP, *with priority given to efforts that can be achieved within existing, funded regulatory programs*
Cost effectiveness of the BMP	Cost effectiveness of the BMP, as estimated by the responsible CoPermittee, *with priority given to BMPs with greater cost effectiveness*
Impervious cover and land use pattern in sub-watershed	Impervious cover and land use pattern in the sub-watershed, *with priority given to BMPs addressing areas or conditions with higher degrees of impervious cover and greater connection to the MS4 and surface waters*
Land ownership and management control & contact	Evidence of the ability to develop a partnership with the landowner or manager to implement the BMP, *with priority given to projects that can be accomplished in partnership with a common association, property manager, or other point of contact*
Number of issues/ conditions potentially addressed by BMP	The number of potential pollutants or conditions addressed by the BMP given the setting and expected extent of implementation, *with priority given to BMPs addressing multiple issues*
Potential to coordinate/leverage other public investments	The potential to coordinate BMP implementation with planned incentive, development and/or capital projects, *with priority given to projects that leverage or coordinate with other public investments*

3.6 Structural Retrofit BMP Evaluation

If the Retrofit Program Framework analysis does not yield any non-structural BMPs to address the identified issue, the Framework provides options for different levels and approaches for structural BMP retrofits that could be implemented to address a TMDL Waste Load Allocation. Here, additional Retrofit Criteria focused on site identification and selection will apply.

3.6.1 Select Potential Structural BMPs

In the same manner as for the non-structural BMPs described above, the Retrofit Program Framework includes primary and secondary screening criteria for identifying locations and approaches for structural BMPs. Once sites are selected through use of the primary and secondary criteria in Table 10 and Figure 19 below, structural BMPs can be evaluated based on the pollutant reduction effectiveness of each one, as shown in the Appendix B Retrofit BMP Menu, and the physical and engineering conditions specific to the site or area of development. The Copermittees can proceed to select appropriate and most cost-effective

BMPs from the Retrofit BMP Menu using the same methodology of sorting the table by problems/conditions, land use types, and site scale and control, as described in Section 3.5.2 above. Once this selection process is complete, the Copermittees may review the resource links and comparable programs in the Descriptions and Resources (Appendix C), including the LID measures illustrated in the Riverside County Design Manual for Low Impact Development Best Management Practices. Additional description of structural BMP types and prioritization strategies is provided below.

Site-scale retrofits: Where a problem is site-specific, or where an opportunity is confined to an individual site or parcel, the retrofit evaluation process can move directly to selecting the best site-specific approach (e.g., inspection, education and outreach, or enforcement) or a structural retrofit, if non-structural methods do not apply. Structural retrofits on individual sites would be selected from the Retrofit BMP Menu based on the pollutant or watershed condition, and then tailored to the particular land use setting (i.e., commercial center, PRD, rural residential, open space or public), site conditions (i.e., soils, slopes, site features, drainage network, and vegetation) and opportunity (e.g., volume reduction, pollution prevention, or buffer restoration). Examples of site-specific structural retrofits may include, but are not limited to, the following:

- Retrofits of trash enclosures to prevent wet and dry weather flows, exclude wildlife, and contain trash effectively
- Removal of excess impervious surfaces that are affecting runoff volumes and rates, or conveying pollutants to the MS4 or surface waters
- Replacement of impermeable parking lot surfacing with permeable materials, in areas where increased infiltration is practical and recommended
- Restoration and repair of storm drain outfalls and buffer areas along channels or surface waters using strips of land behind commercial facilities and buildings
- Green roof retrofits
- Replacement of roofing materials or drain diversion where roofing materials are identified as the source of a pollutant of concern (e.g., metals)
- Turf conversion or substitution
- Irrigation system repairs or replacement

Distributed-scale retrofits: In other areas of the Santa Margarita Region where a problem is more diffuse or site-specific opportunities are more limited, the Copermittees may consider implementing programs to encourage a series of distributed site-specific retrofits, including LID measures. These techniques often can make use of public rights-of-way and public facilities to install "green street" approaches, or can include incentive programs for BMPs, such as rainwater harvesting and reuse, or small-scale bioretention or constructed wetland treatment areas. Measures at this scale may include those listed below.

- Low-flow diversion
- Addition of mechanical separators to remove sediment and other particles from storm water
- Pavement replacement with permeable materials
- Rainwater harvesting and reuse
- Installation of underground storage galleries
- "Green street" retrofits, which may be done at a watershed or sub-watershed scale
- "Pocket" constructed or gravel wetlands
- Retrofit of existing basins to achieve water quality treatment
- Implementation of other distributed LID measures
- Stream buffer or channel restoration

Table 10. Primary and Secondary Structural BMP Retrofit Criteria

PRIMARY SCREENING CRITERIA – GIS based	
Land ownership & control	The presence of open land owned and controlled by Copermittees and likely cooperating public entities
Groundwater contamination	No known groundwater contamination issues
Soil types	Soil types, *with priority given to areas and sites with better-drained soils* (classification of A or B).
Slopes	95% of parcel area has slopes of less than 15%.
SECONDARY SCREENING CRITERIA–GIS and Site Evaluations	
Pollutant removal and regulatory status	The BMP's effectiveness in reducing the condition or pollutant of concern, *with priority to BMPs addressing pollutants listed in a TMDL for the affected waterbody*
Address areas lacking storm water treatment & control	The potential effectiveness of the BMP in addressing areas developed before contemporary storm water treatment and control standards, as identified by Permittee staff and from historic aerial photography, *with priority given to areas developed before water quality controls were incorporated into storm water treatment requirements*
Addressing "low-hanging fruit" issues	The ability of the BMP to address "low hanging fruit" conditions, such as broken or readily adjusted irrigation systems, unenclosed trash areas, or uncovered automotive service areas, *with priority given to BMPs and sites with readily addressed problems*
Availability of lands easily repurposed for retrofits	The presence of excess or underutilized parking, fields, flat roofs, or stream channel or tributary areas which are not in active or economic use by the property owner, and which may be incorporated into a retrofit BMP project design, as determined by GIS evaluation, parcel and ownership data, staff input, and field assessments, *with priority given to areas or sites with viable space for retrofit implementation that does not reduce economic or active use by the owner*
Cost effectiveness	Cost effectiveness of the BMP, as estimated by the responsible Copermittee, *with priority given to BMPs with greater cost effectivness*
Degree of connected impervious cover in treated area	The degree of connection of impervious cover to the MS4 or surface waters, *with priority given to areas and sites with greater connected impervious cover*
Land ownership and management control & contact	Evidence of the ability to develop a partnership with the land owner or manager to implement the BMP, *with priority given to projects that can be accomplished in partnership with a common association, property manager, or other point of contact*
Number of issues/ conditions potentially addressed by BMP	The number of potential pollutants or conditions addressed by the BMP given the setting and expected extent of implementation, *with higher priority given to BMPs addressing multiple conditions*
Percent imperviousness in the associated watershed	The degree of imperviousness in the drainage area(s) contributing to the problem or problems, determined from 2006 NLCD data or more recent updates as available, *with priority given to sub-watersheds or contributing areas with a higher percentage of impervious cover relative to the total sub-watershed area*
Potential to coordinate/leverage other investments	The potential to coordinate BMP implementation with planned incentive, development, and/or capital projects, *with priority given to projects that leverage or coordinate with other public investments*
Proximity to identified problems	Proximity and degree of connectivity to the MS4 and surface waters, *with priority to sites directly connected to surface waters or drainage areas where the issue or problem has occurred*
Restoration of hardened channels	The presence of hardened channels, *with priority given to retrofit BMP projects that would include restoration of natural channel or floodplain areas*

Regional or sub-watershed-scale retrofits: Where site-specific or distributed BMPs and LID applications are insufficient to address a pollutant or condition, regional or multi-property scaled BMPs can be used if and when a site provides adequate capacity for a larger treatment facility. As these are generally the most expensive types of BMPs, requiring the greatest amount of project management, permitting and environmental analysis, and lead time for implementation, this Retrofit Program Framework recommends regional BMPs as the final option for evaluation by the Copermittees. Nonetheless, there are often sites and conditions that lend themselves effectively to regional BMPs, relieving the need to deal with individual properties or sites to address problems with a larger scale. Where appropriate, regional retrofit BMP designs may include the following:

- Infiltration or detention basins
- Retrofit of existing flood control basins to provide water quality treatment
- Constructed wetlands
- Addition of storage in areas of hydromodification

3.6.2 Review BMP Descriptions and Resources for identified potential BMPs

As with the non-structural BMPs described in Section 3.5, Appendix C also provides BMP Descriptions and Resources for structural BMPs that may be considered in the Santa Margarita Region. Many of these are drawn from the Riverside County Design Manual, and others from CASQA; others include case studies of where and how structural BMPs were used to achieve different water quality objectives, including meeting Wasteload Allocations under TMDLs.

Selecting structural BMP sites and approaches, and negotiating the financing, land access, and maintenance agreements involved in a successful project, is complex, demanding, specific to each site and watershed issue, and often requires years to move from concept through construction. In reviewing the Descriptions and Resources, and evaluating structural BMPs, case studies from other communities with long-standing retrofit programs and multiple BMPs may be especially valuable. The Copermittees in the Santa Margarita Region have relatively new storm water programs, and relatively little experience with structural retrofits. Areas such as Prince George's County, Maryland, Fairfax County, Virginia, and Chittenden County, Vermont have implemented multiple structural retrofits and monitored these BMPs over time. Case studies from these areas provide examples of how standard engineering approaches such as constructed wetlands and infiltration basins can be tailored and located strategically, often through public-private partnerships, to meet regulatory requirements and achieve water quality improvement.

The remaining sections of this Program Framework provide recommendations and observations regarding the selection of retrofit sites and options for achieving (and incentivizing) public-private partnerships to implement retrofit BMPs. It is essential to bear in mind that any program must be developed locally by the Copermittee as situations are developed, using the steps, framework and resources in this Report.

3.6.3 Identify public and private candidate areas

3.6.3.1 Identification of Potentially Available Public Lands

Publicly-owned and managed lands, such as parks, conservation areas, and public facilities, are often the first areas considered for retrofit BMP projects. However, the jurisdiction owning and controlling the lands must be willing to enable use of a portion of the facility for storm water management purposes, which can in some instances conflict with the underlying public use. To complete this study, the Copermittees were asked to identify which public entities' lands were recommended for evaluation as potential retrofit BMP project sites. Figure 19 (including versions 19A, 19B, and 19C specific to Temecula, Murrieta and Wildomar) and Table 11 below identify the publicly-owned lands that have been included as potentially available for retrofit BMP projects, for purposes of this study. These should be used as screening-level guidance, as they provide an overview of the extent and position of publicly-owned lands within the Santa Margarita Region.

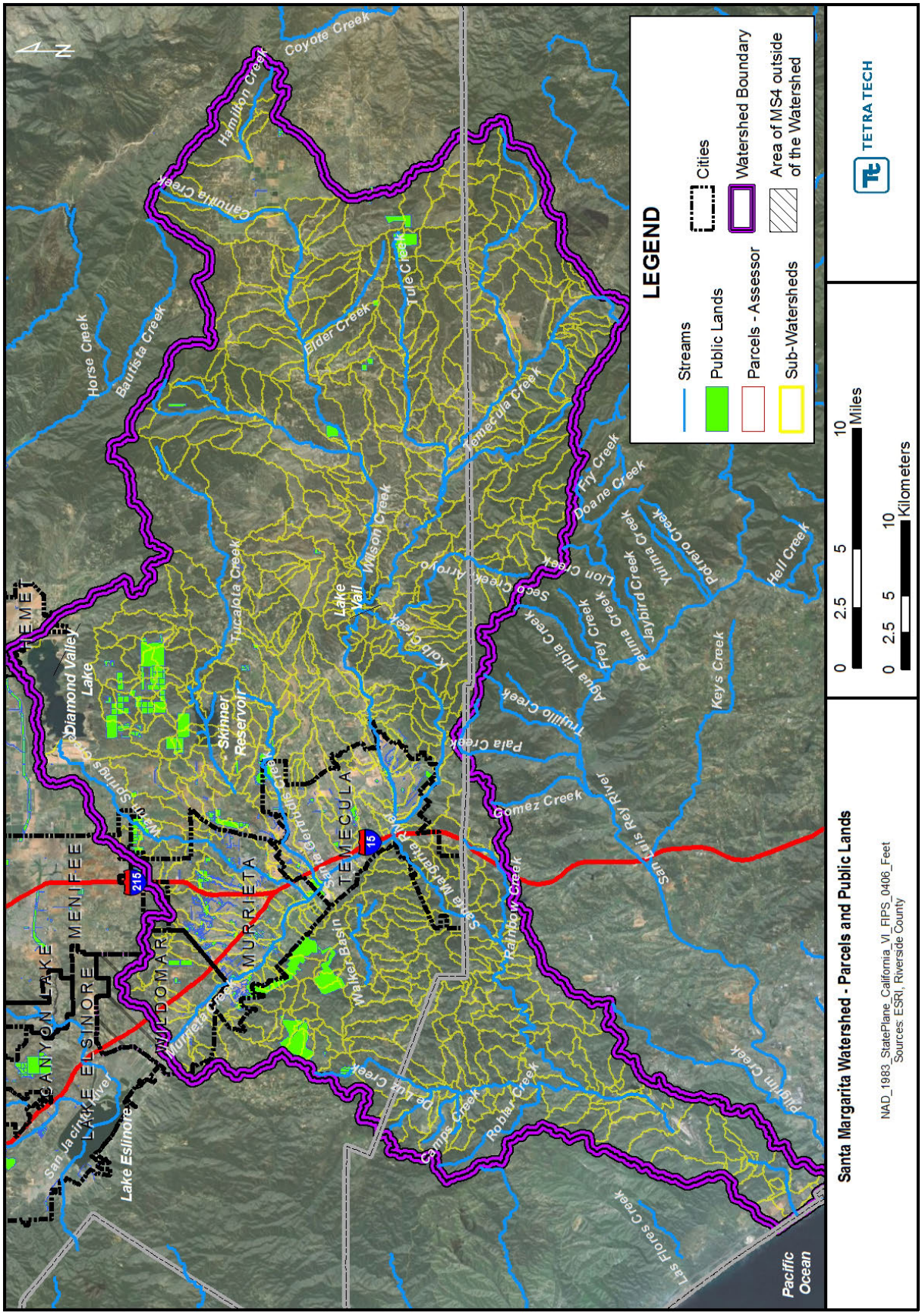


Figure 19. Santa Margarita Watershed – Parcels and Public Lands

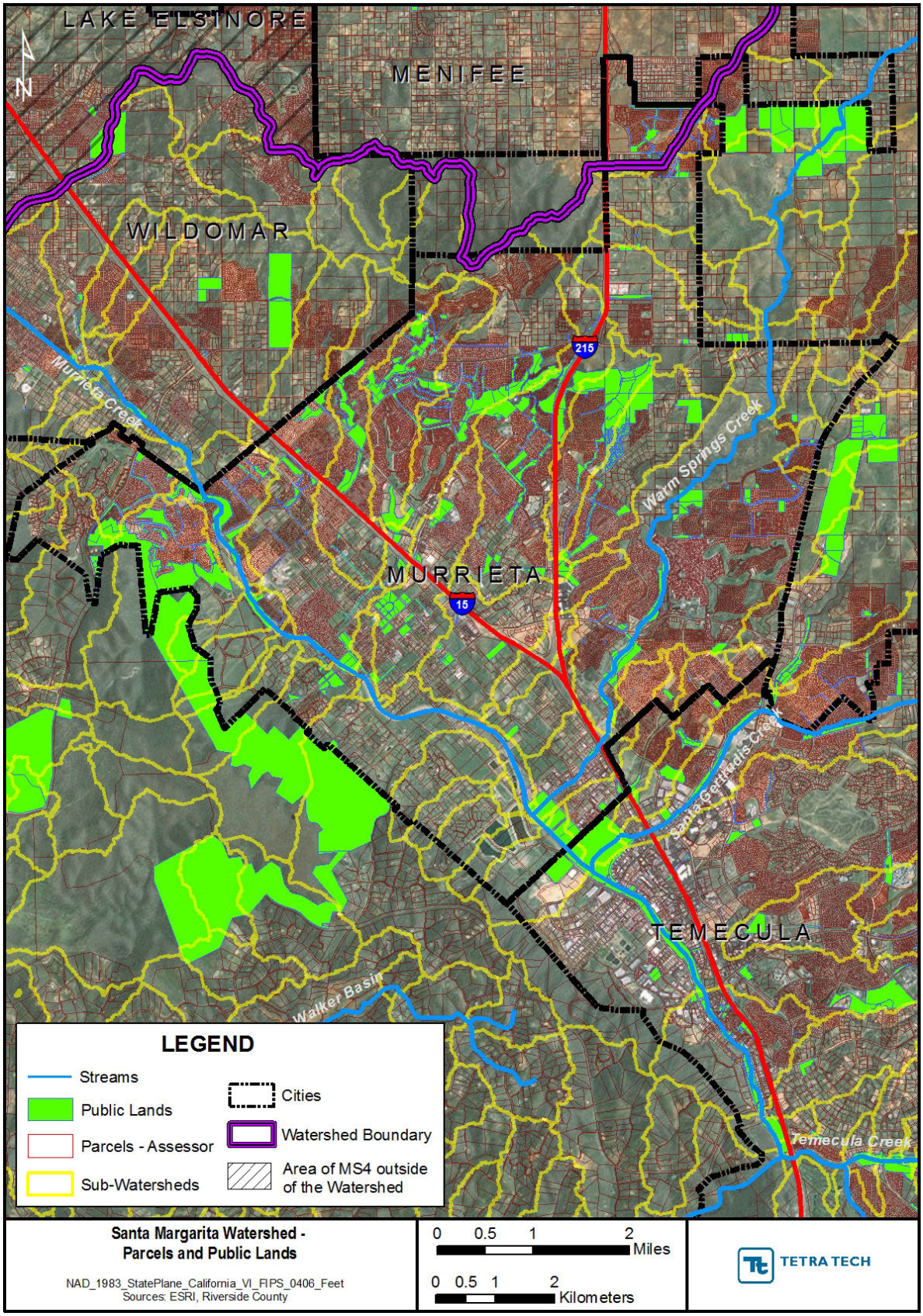


Figure 19A. Parcels and Public Lands, City of Temecula

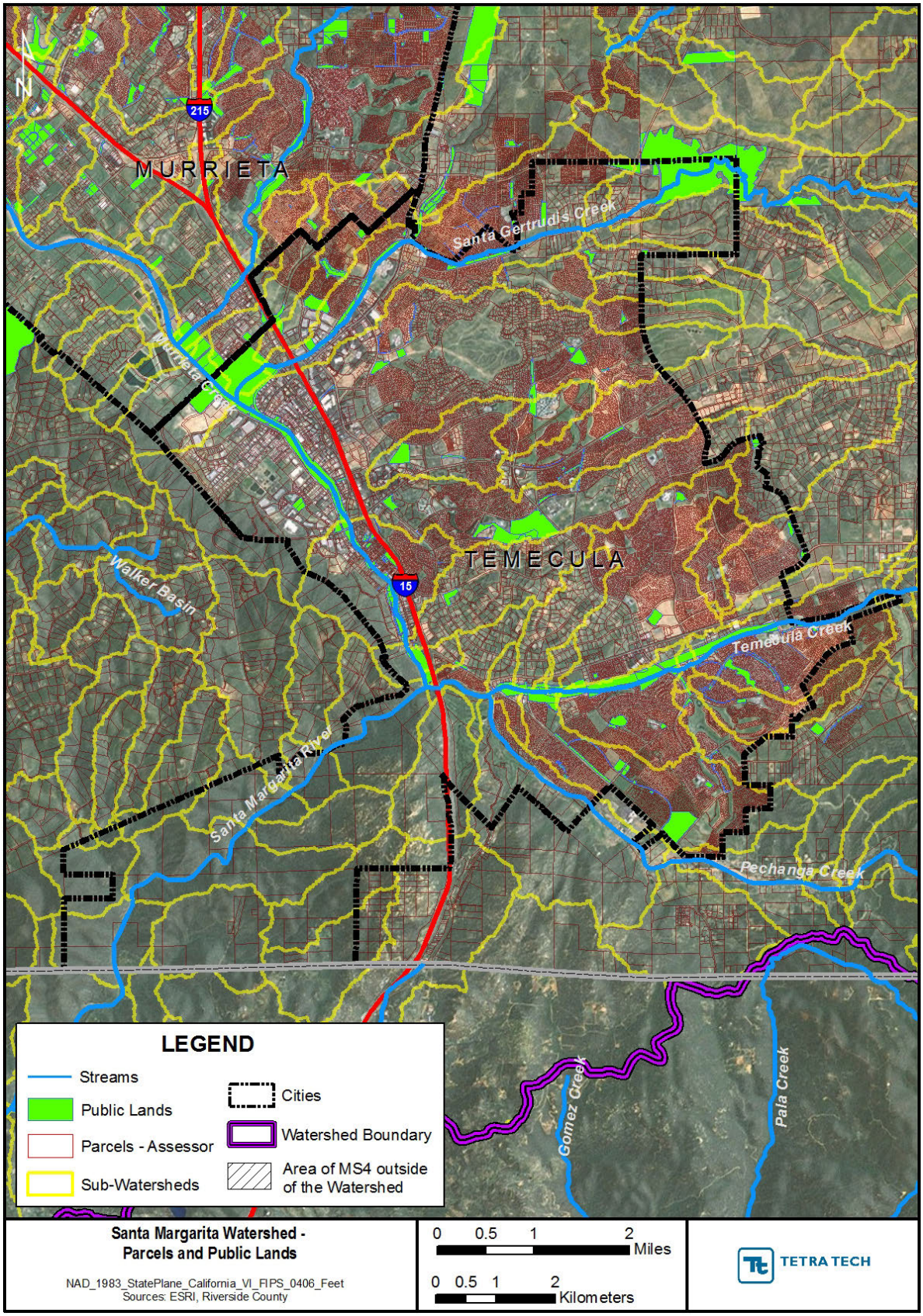


Figure 19B. Parcels and Public Lands, City of Murrieta

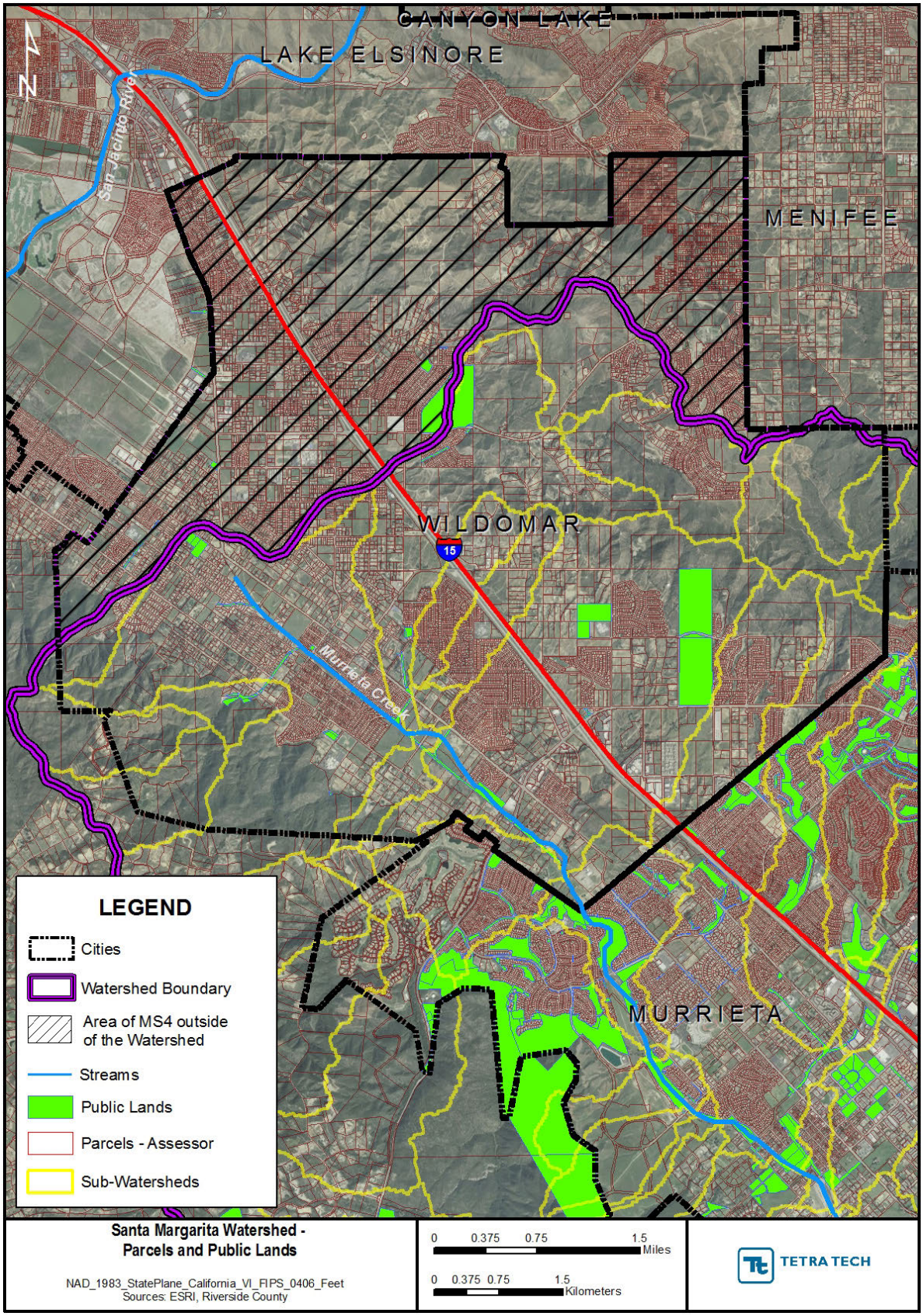


Figure 19C. Parcels and Public Lands, City of Wildomar

Table 11. Public Entities with Publicly-Owned Lands for Evaluation as Potential Retrofit BMP Project Sites

Wildomar	Murrieta	Temecula	Riverside County & Other Public Agencies
City of Wildomar	City of Murrieta	City of Temecula	RCFC&WCD
	Murrieta Fire Protection District	City of Temecula Community Service District (Parks)	Riverside County Multiple Species Habitat Conservation Agency
	City of Murrieta Redevelopment Agency		Riverside County Regional Park & Open Space District
			Riverside County Redevelopment Agency
			Riverside County Service Area #143

3.6.3.2 Identification of Areas of Private Developments

Areas on privately owned lands may, in many cases, offer the most appealing sites for constructing retrofits from a technical and engineering perspective. It is also possible (and in some cases likely) that privately owned and controlled land and developments may be an important component of the identified watershed problem, and/or be contributing to a pollutant load, that requires a retrofit. As a component of the problem identification (Steps 1 through 3), the Copermittees may wish to note which private development areas, if any, are likely to be contributing to the problem or condition, and which have land areas that could potentially be utilized as retrofit areas in the event a public-private partnership, or a requirement pertinent to the private land area, can be implemented. Such land areas should include open areas along property lines that cannot be developed due to zoning or utility setback requirements; parking lots, particularly if excess or under-used parking areas are present; existing storm water treatment or flood control ponds; homeowner or property owner association common lands; areas inside culs-de-sac or along parkways; and landscaped strips along property lines or roadways. Any of these areas may, depending upon site and watershed conditions, be suitable for a structural retrofit.

Privately-owned and controlled land and areas may become part of a structural retrofit project through several different mechanisms, any of which is entirely dependent upon the regulatory and political structures in place and the community's relationship with the private property owner(s) involved. Retrofits on private property can be achieved through any or a combination of:

- **Regulatory requirements** through SUSMP, zoning, landscaping, building codes, irrigation standards, or other municipal codes; these may be *prospective* (i.e. applied to new development or redevelopment only) or *retrofit* requirements (i.e. requiring phased or immediate retrofits of existing developed areas such as parking lots, landscaped areas, or trash enclosures).
- **Special district or area programs**, where a combination of funding, incentives, or regulations are applied to a specific area of a watershed or municipality to accomplish a defined outcome, often a specific load reduction or demonstration project[3].
- **Incentive programs**, which provide some sort of financial compensation to property owners engaging in a specific behavior or activity, such as rainwater harvesting, converting landscapes to xeriscape or low-water-use plantings, retrofitting irrigation systems to improve efficiency and reduce dry weather runoff, or in some cases, making land available for structural BMPs to treat runoff from existing developed surfaces. In communities that charge storm water fees, the fee

[3] The City of Portland, OR Seven Corners Storm water Retrofit Area program is an example of this approach: http://www.portlandonline.com/bes/index.cfm?a=260702&c=50868

program may incorporate a financial incentive provision for structural retrofits[4]; in others, water departments provide rebates and incentives for water-conserving storm water retrofit measures such as installation of rain barrels and irrigation system retrofits[5].

- **Land or easement purchases** or other arrangements for the use of private property to treat storm water runoff, whether through the purchase or donation of an easement to use private land for public retrofit BMPs, or a Development Agreement that incorporates storm water treatment retrofits into development or redevelopment of a private site as part of a larger agreement between the municipality and developer[6].

Fundamentally, in evaluating whether and how to accomplish retrofits on private property, and for ranking or otherwise selecting among retrofit projects, the Copermittees must consider whether the need to use private property is site-specific or area-wide. Site-specific retrofits generally involve negotiations with one or a handful of private property owners to determine a suitable financial or other (often development-related) agreement to incorporate retrofits into a project or site; area-wide incentives and partnerships generally are achieved through utility programs or grant-funded initiatives to promote adoption of a particular retrofit approach, such as rain barrels or converting lawns to xeriscape. The BMP Descriptions and Resources in Appendix C include many additional case studies and references where private land has been incorporated into a retrofit project.

3.6.4 Rank and Prioritize Potential Structural BMPs

The following are the site selection Retrofit BMP Criteria that are recommended for use within sub-watershed or regional areas where problems have been identified that cannot be dealt with through non-structural means, or where a single site or pollutant source has been identified that lends itself to a structural retrofit BMP project. Unlike non-structural BMPs, the form and function of structural retrofit BMP projects depends entirely on the location, size, and characteristics of individual sites, and the physical conditions in the associated drainage area. Typically, retrofit BMP project sites (whether private or public) are selected based on their position in a watershed with a specific pollutant or condition of concern. In the absence of defined load reduction targets, in-stream or channel condition concerns, or flow targets, the Primary Screening Criteria in Table 10 are used to identify publicly-owned sites that (based on GIS criteria) potentially could support structural BMP retrofit projects if and when a structural project is deemed appropriate. (See Figures 20, 20A, 20B, and 20C.) These sites meet basic physical criteria for locating retrofits, subject to detailed site investigations and engineering evaluations.

The Secondary Screening Criteria in Table 10 are to be used once a problem is identified, run through the Retrofit Program Framework, and found to be appropriate for a structural retrofit BMP project. The sites in the contributing drainage area or sub-watershed that were identified through the Primary Screening Criteria and shown in Figures 20, 20A, 20B, and 20C can then be evaluated individually to rank or select among potentially appropriate sites or "areas of development" for retrofitting.

[4] A notable example is the City of Philadelphia, PA (http://actrees.org/site/resources/research/financing_storm water_retrofits_in_philadelphi.php)
[5] The City of San Diego and City of Long Beach provide regional examples of water bill-based retrofit incentives: http://www.sandiego.gov/water/conservation/resrainwaterharvesting.shtml and http://www.lblawntogarden.com/
[6] The City of South Burlington, VT Bartlett Brook Storm water Treatment System is an example of a complex agreement (including an easement donation/purchase) with a private land owner for a multi-benefit retrofit BMP: http://www.sburlstorm water.com/projects/bartlett.shtml

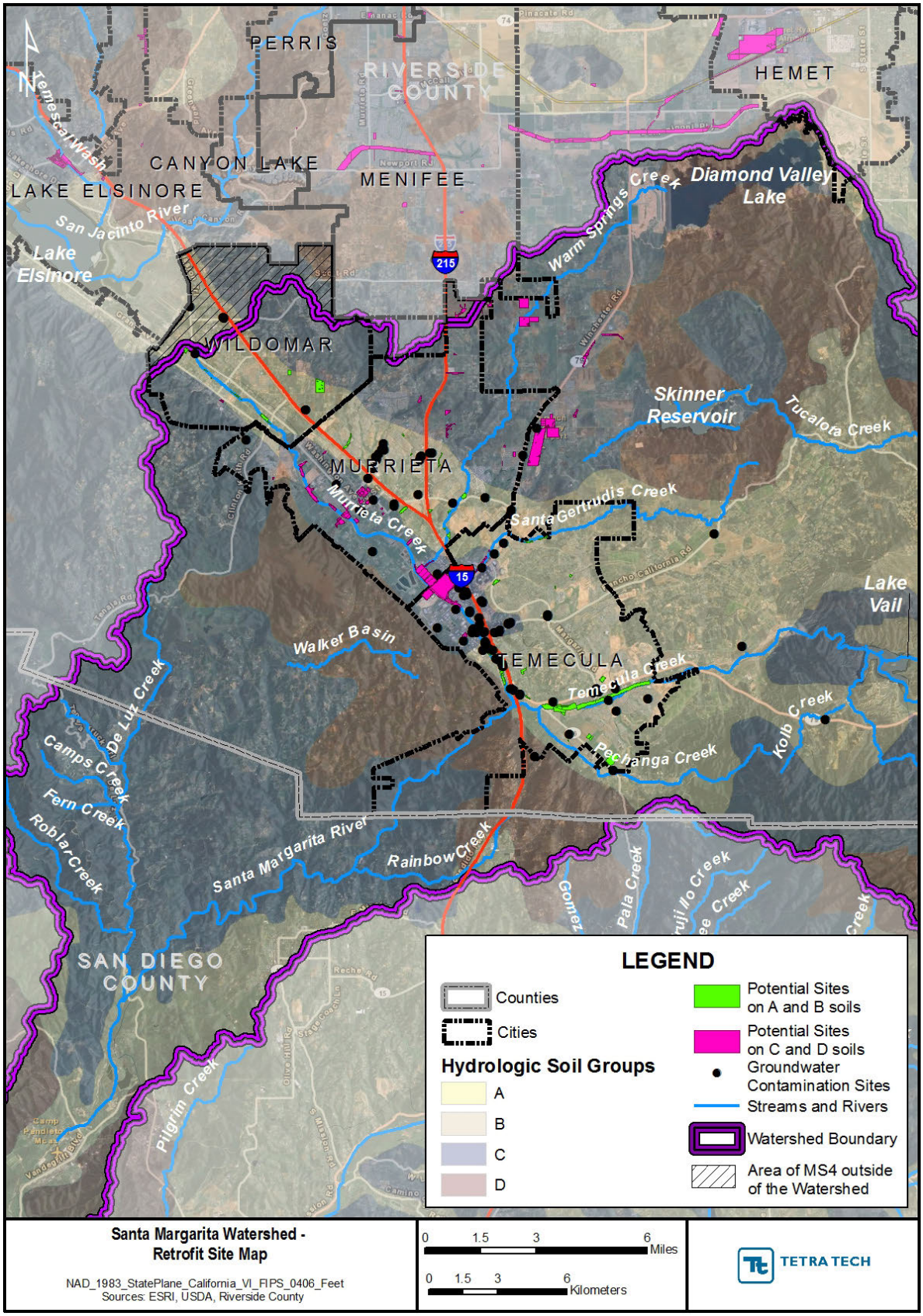


Figure 20. Santa Margarita Watershed – Retrofit Site Map

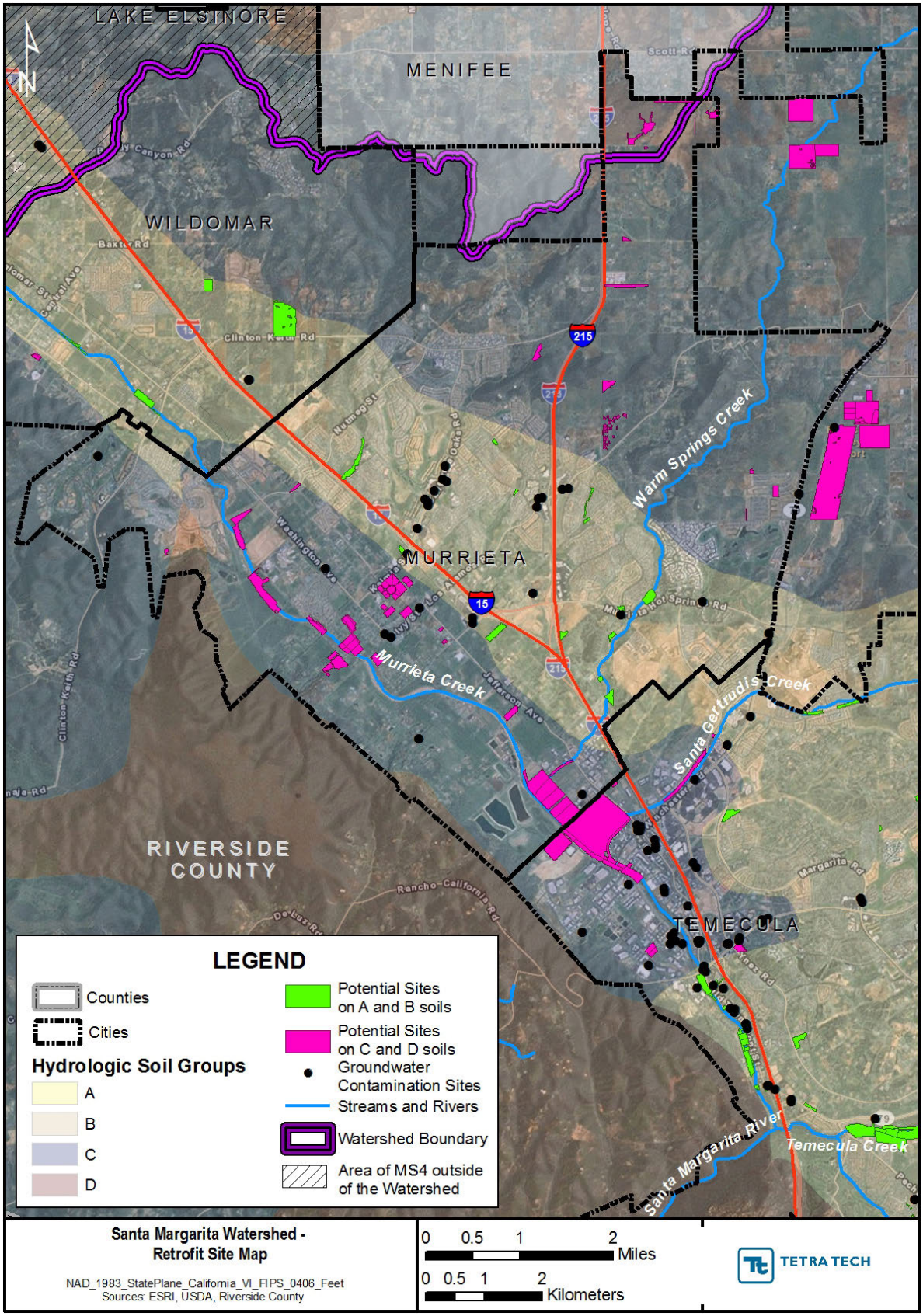


Figure 20A. Santa Margarita Watershed – Retrofit Site Map, City of Temecula

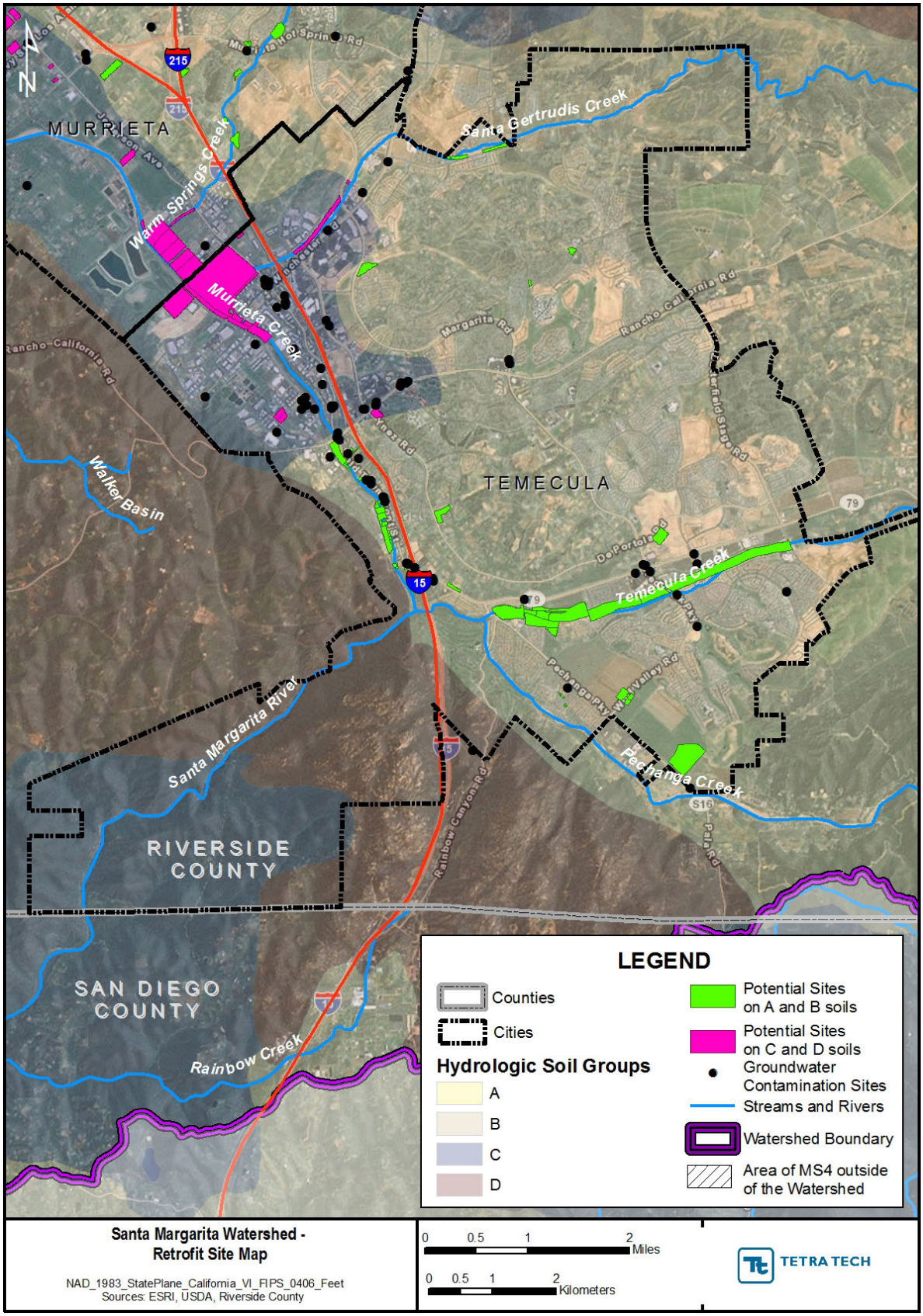


Figure 20B. Santa Margarita Watershed – Retrofit Site Map, City of Murrieta

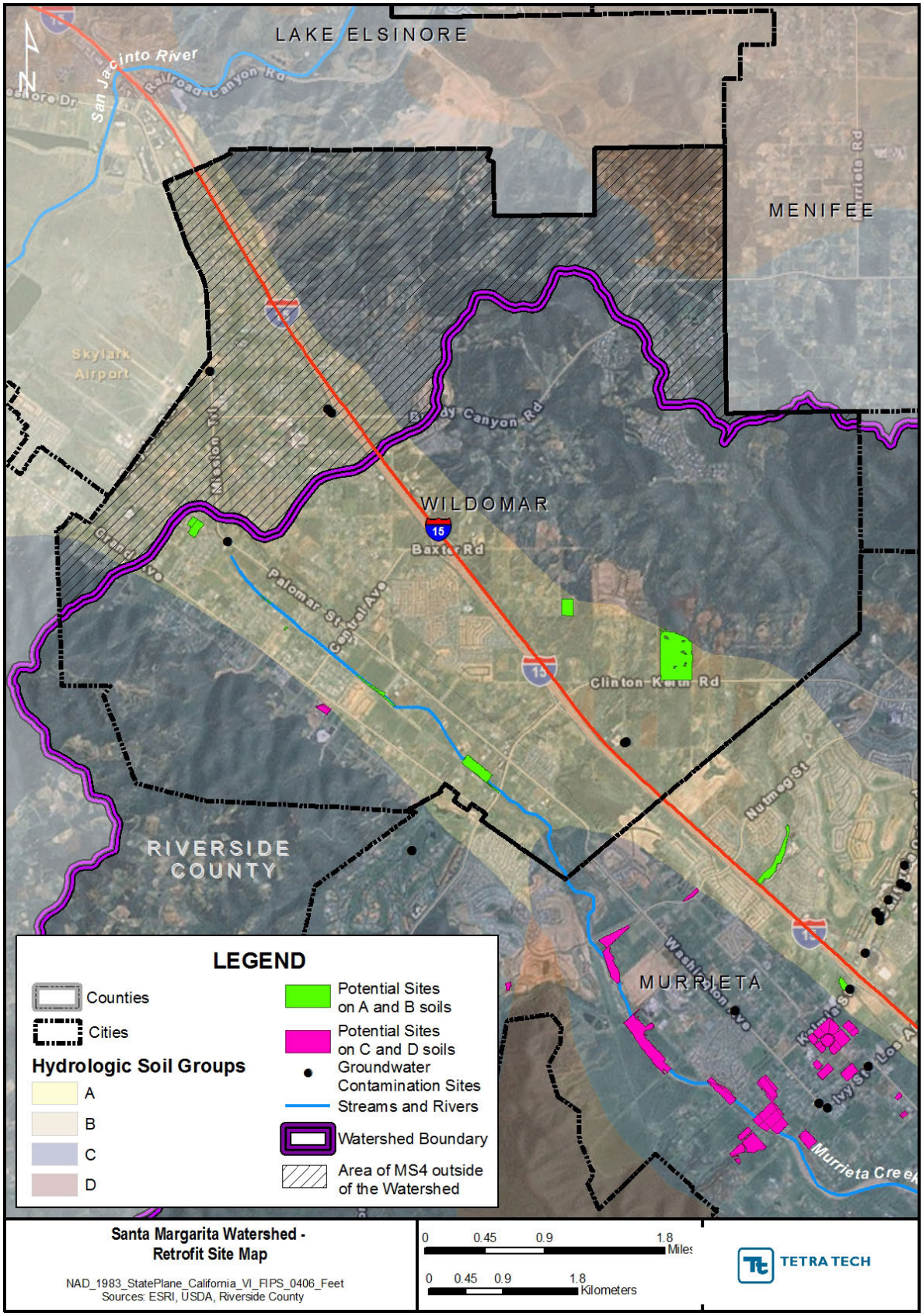


Figure 20C. Santa Margarita Watershed – Retrofit Site Map, City of Wildomar

References

City of Temecula, CA. Storm water Management Plan. July 2005.

City of Murrietta, CA. Storm water Management Plan. July 2005.

Riverside County Flood Control and Water Conservation District. January 2012. Santa Margarita Watershed NPDES Municipal Storm water Permit (NPDES No. Cas0108766) Individual Annual Report for District Fiscal Year 2010-2011 (*filename*: _FY10-11 District Annual Report Final (body).pdf)

Riverside County Flood Control and Water Conservation District. Riverside County Design Handbook for Low Impact Development Best Management Practices. February 2012.

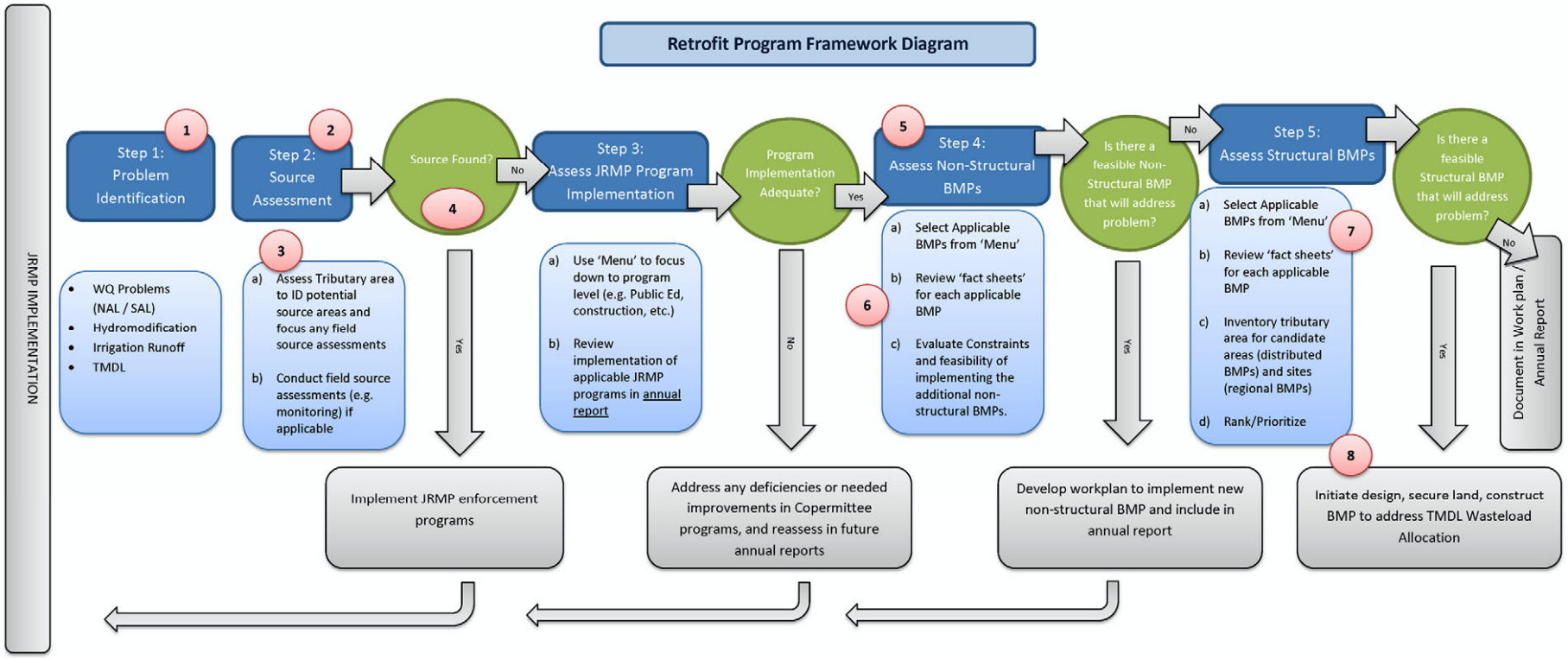
California Regional Water Quality Control Board, San Diego Region. Waste Discharge Requirements for Discharges from the Municipal Separate Storm Sewer Systems (MS4s) Draining the County of Riverside, the Incorporated Cities of Riverside County, and the Riverside County Flood Control and Water Conservation District within the San Diego Region. Order No. R9-2010-0016, NPDES No. CAS0108766. November 10, 2010

State of California. 2010 California 303(d) list of Water Quality Limited Segments. State Water Resources Control Board, 2010.

Technical Memorandum January 18, 2012: Santa Margarita Watershed Retrofit Study: Retrofit Criteria and Initial Concepts. From Juli Beth Hinds (Tetra Tech). To Claudio Padres, Robert Vasquez (Riverside County Flood Control & Water Conservation District) (*filename*: 1-18-12 TECH MEMO Riverside Retrofit Study - Santa Margarita- Text Only.docx)

Technical Memorandum November 14, /2011: Retrofit Study Data Request. From Juli Beth Hinds and Merrill Taylor (Tetra Tech). To Amy McNeill (Riverside County Flood Control & Water Conservation District) *filename*: 11-14-11 Data Request Memo - SANTA MARGARITA RPs - Final.docx)

Appendix A. Retrofit Program Framework Diagram


Retrofit Program Framework Diagram
JRMP IMPLEMENTATION
1
Step 1: Problem Identification
WQ Problems (NAL / SAL)
Hydromodification
Irrigation Runoff
TMDL
2
Step 2: Source Assessment
3
a) Assess Tributary area to ID potential source areas and focus any field source assessments
b) Conduct field source assessments (e.g. monitoring) if applicable
Source Found?
4
No
Yes
Implement JRMP enforcement programs
Step 3: Assess JRMP Program Implementation
a) Use 'Menu' to focus down to program level (e.g. Public Ed, construction, etc.)
b) Review implementation of applicable JRMP programs in annual report
Program Implementation Adequate?
No
Address any deficiencies or needed improvements in Copermittee programs, and reassess in future annual reports
Yes
5
Step 4: Assess Non-Structural BMPs
6
a) Select Applicable BMPs from 'Menu'
b) Review 'fact sheets' for each applicable BMP
c) Evaluate Constraints and feasibility of implementing the additional non-structural BMPs.
Is there a feasible Non-Structural BMP that will address problem?
Yes
Develop workplan to implement new non-structural BMP and include in annual report
No
Step 5: Assess Structural BMPs
7
a) Select Applicable BMPs from 'Menu'
b) Review 'fact sheets' for each applicable BMP
c) Inventory tributary area for candidate areas (distributed BMPs) and sites (regional BMPs)
d) Rank/Prioritize
Is there a feasible Structural BMP that will address problem?
Yes
8
Initiate design, secure land, construct BMP to address TMDL Wasteload Allocation
No
Document in Work plan / Annual Report

Appendix B. Retrofit BMP Menu

			Problem or Condition (NAL/SAL Exceedance)										Land Use Type:					Site Scale & Control			
Non-Structural BMPs	BMP TYPE	Dry Weather BMP Only	Irrigation Runoff	Hydromod/channel instability	Illicit Connection/Discharge	Metals	Organics	Oil & Grease	Sediment	Pesticides	Nutrients	Bacteria	Commercial Center	PRD (with Association)	Rural Residential	Open space	Public Land/ROW or Municipal Facility	Individual Site & Ownership/Control	Neighborhood or Center, common management / HOA	"Area of Development" or defined sub-drainage, no common management	Sub-watershed scale, no defined site(s) or areas
Community-based social marketing	EDU		√		√	○	○	○	○	○	○	○	✠	✠	✠				♦	♦	♦
Construction education & outreach	EDU		√						●		○	○	✠	✠	✠			♦	♦	♦	♦
General pollution prevention outreach and education	EDU		√		√	○	○	○	○	○	○	○	✠	✠	✠				♦	♦	♦
Targeted Staff Training	EDU		√		√	○	○	○	○	○		○					✠	x	x	x	x
Residential pet waste education & outreach	EDU										○	●		✠	✠		✠	♦	♦	♦	♦
Restaurant outreach	EDU				√			●				○	✠					♦	♦		
Landscape & gardening contractor outreach	EDU		√						●	●	○	○	✠	✠	✠	✠	✠	♦	♦	♦	♦
Equestrian outreach	EDU								○		○	●			✠	✠		♦	♦	♦	♦
Trash & recycling contractor outreach	EDU					○	○	○	○		○	●	✠	✠	✠		✠	♦	♦	♦	♦
Yard & landscape waste education & outreach	EDU								○	●	●		✠	✠	✠			♦	♦	♦	♦
Rebates and incentives for irrigation system improvements	ICV	√	√						○	●	○		✠	✠	✠	✠			♦	♦	♦
Water efficiency incentives	ICV	√	√							●	○		✠	✠	✠	✠				♦	♦
Code and ordinance amendment to facilitate LID implementation	LRS			√		○	○		●	○	●	●	✠	✠			✠		♦	♦	♦
Geographically-Targeted Inspections	IE		√		√			●		●	●		✠	✠	✠	✠	✠	♦	♦	♦	

			Problem or Condition (NAL/SAL Exceedance)											Land Use Type:					Site Scale & Control			
Non-Structural BMPs	BMP TYPE	Dry Weather BMP Only	Irrigation Runoff	Hydromod/channel instability	Illicit Connection/Discharge	Metals	Organics	Oil & Grease	Sediment	Pesticides	Nutrients	Bacteria	Commercial Center	PRD (with Association)	Rural Residential	Open space	Public Land/ROW or Municipal Facility	Individual Site & Ownership/Control	Neighborhood or Center, common management / HOA	"Area of Development" or defined sub-drainage, no common management	Sub-watershed scale, no defined site(s) or areas
Enforcement referrals	IE		√		√	○	○	○	○	○	○	○	✠	✠	✠	✠		♦	♦	♦	
Targeted food-related facility inspections	IE				√			●				●	✠					♦	♦	♦	
Targeted auto-related facility inspections	IE				√	●	○	●					✠					♦	♦	♦	
Targeted metals-using facility (i.e. roofing, welding) inspections	IE				√	●							✠		✠	✠		♦	♦	♦	
Targeted animal-related facility inspections	IE				√				●	●	●	●	✠		✠	✠		♦	♦	♦	
Targeted municipal facility inspections	IE				√	○	○	○	○	○	○	○					✠	x	x	x	x
Targeted landscaping & nursery facility inspections	IE								●	●	●	○	✠		✠	✠		♦	♦	♦	
Mobile business education & enforcement	IE	√			√		●	●		○		○	✠	✠	✠			x	x	x	x

			Problem or Condition (NAL/SAL Exceedance)										Land Use Type:					Site Scale & Control			
Non-Structural BMPs (Continued)	BMP TYPE	Dry Weather BMP Only	Irrigation Runoff	Hydromod/channel instability	Illicit Connection/Discharge	Metals	Organics	Oil & Grease	Sediment	Pesticides	Nutrients	Bacteria	Commercial Center	PRD (with Association)	Rural Residential	Open space	Public Land/ROW or Municipal Facility	Individual Site & Ownership/Control	Neighborhood or Center, common management / HOA	"Area of Development" or defined sub-drainage, no common management	Sub-watershed scale, no defined site(s) or areas
Pet waste bag dispenser programs & outreaach	PP										○	●		✠	✠	✠	✠		♦	♦	
Community-based trash clean ups	PP					○		○		○		○	✠	✠	✠	✠	✠			♦	♦
Household hazardous waste collection	PP						○	○		○				✠	✠				♦	♦	♦
Turf substitution for pesticide reduction	PP	√	√						○	●	●		✠	✠			✠	♦	♦	♦	
In-stream transient encampment removal	PP										○	●	x	x	x	x	x	x	x	x	x
RV pumpouts	PP	√			√						○	●	✠	✠	✠	✠				♦	♦
Integrated pest management (IPM) practices	PP									●			✠	✠	✠	✠	✠	♦	♦		
Vehicle & power washing BMPs	PP	√			√	○	○	●	○			○	✠	✠	✠	✠	✠	♦	♦	♦	♦
Bacterial Source Identification Studies	MON				√						○	●	✠	✠	✠	✠	✠		♦	♦	♦
Source identification studies	MON		√		√	○	○	○	○	○	○	○	✠	✠	✠	✠	✠	♦	♦	♦	♦
TMDL monitoring	MON		√	√	√	○	○	○	○	○	○	○	✠	✠	✠	✠	✠			♦	♦
Copper Brake Pad alternative legislation	SC					●							x	x	x	x	x	x	x	x	x
Roof material replacement	SC					●	○						✠	✠	✠		✠	♦	♦		
Street and parking lot sweeping	SC			√		●		○	●		●	○	✠	✠			✠	♦	♦	♦	♦

			Problem or Condition (NAL/SAL Exceedance)										Land Use Type:					Site Scale & Control			
Non-Structural BMPs (Continued)	BMP TYPE	Dry Weather BMP Only	Irrigation Runoff	Hydromod/channel instability	Illicit Connection/Discharge	Metals	Organics	Oil & Grease	Sediment	Pesticides	Nutrients	Bacteria	Commercial Center	PRD (with Association)	Rural Residential	Open space	Public Land/ROW or Municipal Facility	Individual Site & Ownership/Control	Neighborhood or Center, common management / HOA	"Area of Development" or defined sub-drainage, no common management	Sub-watershed scale, no defined site(s) or areas
Improved street sweeper technology	SC			√		●		○	●		●	○	✠	✠			✠	♦	♦	♦	♦
Catch basin inlet cleaning	SC				√	●			●		○	○	✠	✠			✠	♦	♦	♦	
Groundwater inflow prevention	SC	√							○		○	○	✠	✠			✠	♦	♦	♦	
Erosion and sediment control repairs	SC			√					●		○	○	✠	✠	✠	✠	✠	♦	♦	♦	
Sanitary sewer & septic system management	SC	√			√						●	●	✠	✠	✠	✠		♦	♦	♦	♦
Animal facility management BMPs	SC										○	●	✠		✠	✠		♦			
Ag & manure management BMPs	SC								○	○	●	●			✠	✠		♦	♦	♦	
Land conservation	RES			√					●	○	○				✠	✠					♦
Stream & riparian habitat enhancement & restoration	RES			√					●	○	○	○	✠	✠	✠	✠	✠	♦	♦	♦	
Natural-bottom channel restoration	RES			√					●		○	○	x	x	x	x	x	x	x	x	x

Medium to high removal efficiency or directly addresses pollutant	●	PP	Pollution Prevention	IE	Inspection & Enforcement	RES	Restoration
		LID	Low Impact Development	ICV	Incentives	SI	Source Identification
Low removal efficiency or indirectly addresses pollutant	○	TC	Treatment & Control	SC	Source control	EDU	Education
Not effective at pollutant removal or unknown efficiency	Blank	LRS	Literature Review & Survey	SPO	Sponsorship	MON	Monitoring

			Problem or Condition (NAL/SAL Exceedance)										Land Use Type:					Site Scale & Control				
Structural BMPs	**BMP TYPE**	**Dry Weather BMP Only**	**Irrigation Runoff**	**Hydromod/channel instability**	**Illicit Connection/Discharge**	**Metals**	**Organics**	**Oil & Grease**	**Sediment**	**Pesticides**	**Nutrients**	**Bacteria**	**Commercial Center**	**PRD (with Association)**	**Rural Residential**	**Open space**	**Public Land/ROW or Municipal Facility**	**Individual Site & Ownership/Control**	**Neighborhood or Center, common management / HOA**	**"Area of Development" or defined sub-drainage, no common management**	**Sub-watershed scale, no defined site(s) or areas**	***Notes***
Infiltration Basins	LID			√		●	●	●	●	●	●	●	✠	✠	✠	✠	✠	♦	♦	♦		Flexible retrofit type; can be tailored to many sites & settings
Infiltration Trenches	LID			√		●	●	●	●	●	●	●	✠	✠	✠	✠	✠	♦	♦	♦		
Permeable Pavement	LID			√		●	●	●	●	●	●	●	✠	✠	✠	✠	✠	♦	♦			
Water harvesting & reuse	LID			√		●	●	●	●	●	●	●	✠	✠	✠	✠	✠	♦	♦	♦	♦	also applies to incentive programs to encourage retrofits
Bioretention facilities	LID			√		●	●	●	●	●	●[1]	●	✠	✠	✠	✠	✠	♦	♦			Potential BMP in PRDs with public streets >24'. [1] - M to H removal efficiency if soil media depth is 24 to 36 inches deep.
Extended detention facilities	LID			√		●	●	●	●		○[2]	●	✠	✠	✠	✠	✠	*x*	*x*	*x*	*x*	[2]-Low removal effectiveness for soild type C and D. Medium for soil type A and B.
Sand filter basins	LID			√		●	●	●	●		○[3]	●	✠	✠	✠	✠	✠	♦	♦	♦		[3]-Medium removal Effectiveness where san filter layer is increased to 36 inches.

			Problem or Condition (NAL/SAL Exceedance)											Land Use Type:					Site Scale & Control				
Structural BMPs	**BMP TYPE**	**Dry Weather BMP Only**	**Irrigation Runoff**	**Hydromod/channel instability**	**Illicit Connection/Discharge**	**Metals**	**Organics**	**Oil & Grease**	**Sediment**	**Pesticides**	**Nutrients**	**Bacteria**	**Commercial Center**	**PRD (with Association)**	**Rural Residential**	**Open space**	**Public Land/ROW or Municipal Facility**	**Individual Site & Ownership/Control**	**Neighborhood or Center, common management / HOA**	**"Area of Development" or defined sub-drainage, no common management**	**Sub-watershed scale, no defined site(s) or areas**	***Notes***
Green street filtration BMPs	LID			√		○	○	○	●	○	●	●					✠	♦	♦	♦		Potential BMP in PRDs with public streets >24'; also applies to incentive programs to encourage retrofits
Commercial green roof projects	LID			√		○	○		●	○	●	●	✠					♦		♦		Potential incentive/partnership option in commercial centers; also applies to incentive programs to encourage retrofits
Constructed treatment wetlands	LID			√		○	○		●	○	●	●			✠	✠		♦	♦		♦	typically requires more land than available in high-density settings
Downspout disconnections	LID			√		○	○		○	○	○	○	✠	✠	✠		✠	♦	♦	♦		also applies to incentive programs to encourage retrofits
Rain garden, xeriscaping and turf conversion projects	LID		√	√		○	○		●	○	●	●	✠	✠				♦	♦	♦		also applies to incentive programs to encourage retrofits
Pavement/impervious surface removal and re-vegetation	LID			√		○	○	○	●	○	○	○	✠	✠	✠		✠	♦				also applies to incentive programs to encourage retrofits

			Problem or Condition (NAL/SAL Exceedance)										Land Use Type:					Site Scale & Control				
Structural BMPs	**BMP TYPE**	**Dry Weather BMP Only**	**Irrigation Runoff**	**Hydromod/channel instability**	**Illicit Connection/Discharge**	**Metals**	**Organics**	**Oil & Grease**	**Sediment**	**Pesticides**	**Nutrients**	**Bacteria**	**Commercial Center**	**PRD (with Association)**	**Rural Residential**	**Open space**	**Public Land/ROW or Municipal Facility**	**Individual Site & Ownership/Control**	**Neighborhood or Center, common management / HOA**	**"Area of Development" or defined sub-drainage, no common management**	**Sub-watershed scale, no defined site(s) or areas**	***Notes***
Flood control facility retrofit	TC			√					●		●	○	x	x	x	x	x	x	x	x	x	
Trash enclosure & drainage retrofits	TC						○	○			○	●	✠	✠			✠	♦				
Dry weather flow diversion	TC	√				○	○	○	○	○	○	●	x	x	x	x	x	♦	♦	♦	♦	
Trash segregation BMPs	TC							○					✠	✠			✠	♦	♦	♦		
Sediment controls	TC					○	○		●		○	○	✠	✠	✠	✠	✠	♦	♦	♦	♦	i.e. supplemental forebay
Catch basin inlet bacteria treatment BMPs	TC					●		○	●		●	○	✠	✠			✠	♦	♦	♦		
Hydrodynamic Separator Installation	TC							●	●				✠	✠	✠	✠	✠	♦	♦	♦	♦	
Hydromodification BMPs	TC			√		○	○		●		○	○	✠	✠	✠	✠	✠	♦	♦	♦	♦	

Medium to high removal efficiency or directly addresses pollutant	●	PP	Pollution Prevention	IE	Inspection & Enforcement	RES	Restoration
		LID	Low Impact Development	ICV	Incentives	SI	Source Identification
Low removal efficiency or indirectly addresses pollutant	○	TC	Treatment & Control	SC	Source control	EDU	Education
Not effective at pollutant removal or unknown efficiency	Blank	LRS	Literature Review & Survey	SPO	Sponsorship	MON	Monitoring

Appendix C. BMP Descriptions and Resources

Non-Structural BMPs	Program/BMP Description	Resources and Fact Sheets
Community-based social marketing	Create effective community programs to foster sustainable behavior and to change behavior in ways that will mitigate water quality impacts.	www.csc.noaa.gov/digitalcoast/_/pdf/social_marketing.pdf; Think Blue San Diego - http://www.sandiego.gov/thinkblue/; EPA NPS Conference Proceedings: http://www.epa.gov/owow/NPS/outreach2009/pdf/proceedings_2009-06-18.pdf; www.epa.gov/owow/NPS/proceedings2003npsconf.pdf; Quick ref: www.csc.noaa.gov/digitalcoast/_/pdf/social_marketing.pdf
Construction education & outreach	Build effective education and outreach programs for construction site stormwater management; target rural road & project education in RR areas	Sample fact sheet: http://www.sbcountystormwater.org/_PDF/fact_sheets/Fact_sheet_Construction.pdf; other references: http://www.cabmphandbooks.com/; http://cfpub.epa.gov/npdes/stormwater/swppp.cfm
General pollution prevention outreach and education	Develop education and outreach programs that use effective mechanisms and programs to engage the public's interest in preventing and mitigating stormwater pollution	http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=115
Targeted Staff Training	Provide training to appropriate municipal staff that discusses the problem, and common sources to the problem, and advises on how to help address the problem through their everyday duties	City of Del Mar. Education and Staff Training: www.delmar.ca.us/Government/JURMP/Sec06Municipal.pdf
Residential pet waste education & outreach	Conduct a pet waste education and outreach campaign, and make pet waste dispensers available in public parks & common areas	County of San Diego -http://www.sdcounty.ca.gov/dpw/watersheds/residential/pets.html; Pet Waste Dispenser Bag Effectiveness Assessment, WURMP Project ID SDR-A-13A, San Diego River WURMP Fy2011 Appendix A, page 20 - http://www.projectcleanwater.org/images/stories/Docs/San-Diego-River/SDR_WURMP_FY1011Appendices.pdf; http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-06-35.pdf
Restaurant outreach	Develop outreach programs targetted at preventing pollutants from restaurant operations (i.e. food waste, grease, cleaning fluids, mop water, trash) from entering storm drain systems	City of Escondido: http://www.escondido.org/Data/Sites/1/media/pdfs/Utilities/CityPretreatmentProgram.pdf; http://www.cabmphandbooks.com/ - Food Service Facilities (in the IndustrialCommercial handbook); Sample fact Sheet: http://www.sbcountystormwater.org/_PDF/gov_out/Food%20&%20Restaurants.pdf; Example of a grease ordinance: http://www.lagunabeachcity.net/cityhall/wq/fog/default.asp
Landscape & gardening contractor outreach	Develop outreach programs targetted at landscape and gardening contractors that emphasize site design considerations (i.e. maximizing natural water storage & infiltration capacity and preventing erosion) and pollution prevention strategies (i.e. encourage use of natural, non-toxic alternatives to fertilizers, herbicides and pesticides)	Sample factsheets: www.cabmphandbooks.com/documents/development/sd-10.pdf; http://www.sbcountystormwater.org/_PDF/brochures/bmp_landscape.pdf; http://www.sbcountystormwater.org/_PDF/fact_sheets/Fact_sheet_Home_&_Garden.pdf; EPA Greenscapes: http://www.epa.gov/epawaste/conserve/rrr/greenscapes/index.htm

Non-Structural BMPs	Program/BMP Description	Resources and Fact Sheets
Equestrian outreach	Develop outreach programs targetted at equestrian and livestock owners that emphasize proper collection and storage of manure, integrated pest management plans and water drainage designs that are non-erosive and divert runoff away from the livestock area	Sample factsheets: http://www.sbcountystormwater.org/_PDF/brochures/Horse-Manure-BMP_Brochure.pdf; http://www.projectcleanwater.org/index.php?option=com_sobi2&sobi2Task=sobi2Details&catid=123&sobi2Id=38&Itemid=168
Trash & recycling contractor outreach	Develop outreach programs targetted at preventing pollutants from trash and recycling contractors (i.e. dumpsters, litter control, and waste piles) from entering storm drain systems	Sample factsheets: www.cabmphandbooks.com/Documents/Development/SD-32.pdf; www.cabmphandbooks.com/Documents/Municipal/SC-75.pdf; www.cabmphandbooks.com/Documents/Industrial/SC-34.pdf
Yard & landscape waste education & outreach	Develop education and outreach programs on strategies for proper management of landscape waste (i.e. grass clippings, leaves, tree and shrub trimmings, organic mulch and plant materials from vegetable and flower gardens); options include grasscycling, composting and proper fertilization	Sample fact sheet: www.ianrpubs.unl.edu/live/g1855/build/g1855.pdf
Rebates and incentives for irrigation system improvements	Promote use of more efficient irrigation systems through incentive programs, such as Monte Vista Water District's Free Landscape Irrigation Evaluation program (http://www.mvwd.org/ps.watchthewater.cfm?ID=185)	Sample fact sheet: www.cabmphandbooks.com/Documents/Development/SD-12.pdf; Example: http://www.mvwd.org/ps.watchthewater.cfm?ID=185
Water efficiency incentives	Promote use of water conservation practices through incentive programs, such as Monte Vista Water District's Rebates and Incentives programs for high efficiency toilets, showerheads and aerators, water softener removal, etc. (http://www.mvwd.org/ps.watchthewater.cfm?ID=118)	Examples - http://www.mvwd.org/ps.watchthewater.cfm?ID=118; http://www.socalwatersmart.com/; EPA Water Conservation Practices for Homeowners: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=2
Integrated watershed planning	Research examples of how other entities have successfully developed flexible, integrated frameworks for watershed management that address biophysical, social, and economic issues affecting water resources and their use; work towards integrating formal planning requirements and on-ground implementation strategies	Example: http://www.carlsbadwatershednetwork.net/AH/AHWMPFinal_08-25-08.pdf; EPA: cfpub.epa.gov/watertrain/pdf/modules/Watershed_Management.pdf; success stories include the Santa Monica Bay Restoration Project & Playa Vista Freshwater Marsh

Non-Structural BMPs	Program/BMP Description	Resources and Fact Sheets
Code and ordinance amendment to facilitate LID implementation	Research examples of how other entities have facilitated LID implementation through code and ordinance amendments, such as San Jose's MRP provision (C.3.c. Low Impact Development) that requires that each Regulated Project treat 100% of the design storm runoff with LID (http://www.sanjoseca.gov/planning/stormwater/). Another good resource is the book "Better Site Design: A Handbook for Changing Development Rules in your Community."	EPA workshops - http://water.epa.gov/learn/training/wacademy/training.cfm; Example: http://www.sanjoseca.gov/planning/stormwater/; Other references: National LID Atlas (http://clear2.uconn.edu:8080/lidmap/index_original.php); Better Site Design: A Handbook for Changing Development Rules in your Community – this provides case studies of communities that illustrate the BSD principles (book)
SUSMP and code enforcement	Improve or augment code enforcement with more frequent or comprehensive investigations to ensure installation of BMPs with new development and proper operation and maintenance thereafter	Enforcement and inspection best practices: University of Minnesota Stormwater Treatment Assessment & Maintenance, http://stormwaterbook.safl.umn.edu/; Ohio DEP education for municipal storm water inspections, http://www.excalvisual.com/products.pl?ProductID=58;
Geographically-Targeted Inspections	Conduct more frequent inspections at facilities that have high potential to cause stormwater pollution based on geographical considerations (i.e. are located in close proximity to sensitive water bodies)	
Enforcement referrals	Ensure that websites and public communication clearly outline cases where the public is encouraged to call and report illicit discharges to the MS4	
Targeted food-related facility inspections	Conduct more frequent inspections at food-related facilities (i.e. restaurants, food processing plants, etc.) that have high potential to cause stormwater pollution	
Targeted auto-related facility inspections	Conduct more frequent inspections at auto-related facilities (i.e. repair shops, fueling stations, car washes, etc.) that have high potential to cause stormwater pollution	

Non-Structural BMPs	Program/BMP Description	Resources and Fact Sheets
Targeted metals-using facility inspections	Conduct more frequent inspections at facilities that use metals and that have high potential to cause stormwater pollution. This includes many industries - auto related, landscape, waste handling, etc.	
Targeted animal-related facility inspections	Conduct more frequent inspections at animal-related facilities (i.e. animal shelters, commercial kennels, livestock operations, etc.) that have high potential to cause stormwater pollution	
Targeted municipal facility inspections	Conduct more frequent inspections at municipal facilities (i.e. vehicle and equipment storage, material handling and storage) that have high potential to cause stormwater pollution	
Targeted landscaping & nursery facility inspections	Conduct more frequent inspections at landscape and nursery facilities that have high potential to cause stormwater pollution	
Mobile business education & enforcement	Conduct an inventory of mobile businesses (i.e.surface power washing/steam cleaning, exterior paint preparation, pest control services, etc.), disseminate information regarding appropriate standards and BMPs, conduct inspections and enforce applicable ordinances and regulations; can address through business licensing	Examples: http://www.escondido.org/Data/Sites/1/media/pdfs/Utilities/BMPMobileBusinesses.pdf; http://www.lagunabeachcity.net/cityhall/wq/mobile_businesses.asp
Pet waste bag dispenser programs & outreach	Conduct a pet waste education and outreach campaign, and make pet waste dispensers available in public parks & common areas	http://www.sdcounty.ca.gov/dpw/watersheds/residential/pets.html; Pet Waste Dispenser Bag Effectiveness Assessment, WURMP Project ID SDR-A-13A, San Diego River WURMP Fy2011 Appendix A, page 20 - http://www.projectcleanwater.org/images/stories/Docs/San-Diego-River/SDR_WURMP_FY1011Appendices.pdf; http://des.nh.gov/organization/commissioner/pip/publications/wd/documents/wd-06-35.pdf
Community-based trash clean ups	Create community programs to raise public awareness about the benefits of a litter-free environment, such as Green Up day in Vermont (http://www.greenupvermont.org/)	http://www.donttrashcalifornia.info/; http://www.greenupvermont.org/
Household hazardous waste collection	Conduct an outreach campaign to educate the public on proper disposal of household hazardous wastes; help to publicize hazardous waste collection events	Sample fact sheet: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=3

Non-Structural BMPs	Program/BMP Description	Resources and Fact Sheets
Turf substitution for pesticide reduction	Reduce pesticide and water use by promoting the conversion of turf/grass to artificial turf or natural landscape	http://www.fmlink.com/article.cgi?type=Sustainability&title=Natural%20Landscaping%20and%20Artificial%20Turf%3A%20Achieving%20Water%20Use%20and%20Pesticide%20Reduction&pub=BuildingGreen&id=40602&mode=source
In-stream transient encampment removal	Remove encampments from stream areas; set up alternate areas where transients can encamp in relative safety, without the fear of violating laws and ordinances, and receive services as long as they follow facility rules	San Jose trash clean-up pilot progra with homeless residents: http://yosemite.epa.gov/opa/admpress.nsf/d0cf6618525a9efb85257359003fb69d/334b2ebd848bd7b3852578aa00704209!OpenDocument
RV pumpouts	Develop education and outreach programs on proper pumpout locations and techniques	Mission Bay Example: http://www.sandiego.gov/thinkblue/public-education/mb-outreach.shtml
Integrated pest management (IPM) practices	Develop education and outreach programs on IPM practices for the home, garden, and workplace and encourage municipalities to adopt IMP practices (i.e. in their landscaping and buildings and grounds maintenance, etc.)	EPA factsheet: http://www.epa.gov/pesticides/factsheets/ipm.htm
Vehicle & power washing BMPs	Promote use of BMPs through education and outreach programs targetted at water conservation practices and at preventing pollutants (i.e. metals, oil and grease, solvents, phosphates, and suspended solids) from entering stormwater conveyance systems	Fact sheets: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=96; www.cabmphandbooks.com/Documents/Development/SD-33.pdf; http://www.emd.saccounty.net/EnvComp/WP/Stormwater4.html; http://www.sbcountystormwater.org/_PDF/SBC_Residential_Car_Washing_Handout.PDF
Bacterial Source Identification Studies	Conduct studies to identify sources of bacterial contamination and recommend appropriate actions and activities to eliminate the input of those sources	Example: www.sandiego.gov/stormwater/pdf/mbayfinal04.pdf
Source identification studies	Conduct studies to identify sources of urban runoff that adversely impact the water quality of receiving waters, develop appropriate management actions to eliminate the pollutant(s) and ensure compliance with necessary permit requirements	San Diego Region source ID monitoring program and framework: http://www.projectcleanwater.org/pdf/science_mon/source_id_monitoring_design_framework.pdf
TMDL monitoring	Monitor the effectiveness of TMDLs that are implemented (this requires monitoring prior to implementation to establish a baseline)	

Non-Structural BMPs	Program/BMP Description	Resources and Fact Sheets
Copper Brake Pad alternative legislation	Source reduction, whether through an out-right ban or a phased program, is ultimately the most effective means of removing a pollutant from the region's surface waters. The Brake Pad Partnership represents an opportunity for the copermittees to become involved with the regional effort aimed at reducing pollutant deposition from automobile brake pads	Brake Pad Partnership: http://www.suscon.org/bpp/index.php
Roof material replacement	For new construction and renovation, promote the use of alternative building materials that reduce potential sources of pollutants in stormwater runoff by eliminating compounds that can leach into runoff, reducing the need for pesticide application, reducing the need for painting and other maintenance, and/or by reducing the volume of runoff.	www.cabmphandbooks.com/documents/development/sd-21.pdf
Street and parking lot sweeping	Ensure that proper equipment and proper programs (i.e. sweeping frequency, seasonal variation) are being used	www.cabmphandbooks.com/Documents/Municipal/SC-70.pdf; EPA: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=99&minmeasure=6
Improved street sweeper technology	If able, invest in newer technologies, such as the new vacuum technology; it is significantly better than either mechanical or even regenerative air sweepers and achieves a level of pollutant removal that is frequently better than all other BMPs - ttp://www.elibrary.dep.state.pa.us/dsweb/Get/Document-67981/5.9.1%20BMP%20Streetsweeping.pdf)	http://www.seattle.gov/util/Services/Drainage_&_Sewer/Keep_Water_Safe_&_Clean/Street_Sweep_Project/QuestionsAnswers/; http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-67981/5.9.1%20BMP%20Streetsweeping.pdf
Catch basin inlet cleaning	Ensure that catch basins are being maintained properly, which includes periodic cleaning of inlets	Fact sheets: www.portlandonline.com/bes/index.cfm?a=149532&c=43858; www.cabmphandbooks.com/Documents/Municipal/SC-74.pdf
Groundwater inflow prevention	Evaluate sewer systems to determine the quantity of inflow and infiltration, determine their sources and develop a cost effective corrective action plan	http://www.kingcounty.gov/environment/wastewater/II/What.aspx; http://www.globalw.com/support/inflow.html

Non-Structural BMPs	Program/BMP Description	Resources and Fact Sheets
Erosion and sediment control repairs	Typically, using a combination of erosion and sediment control measures is the most effective strategy for preventing sediment from leaving project sites and potentially entering storm drainage systems	http://www.cabmphandbooks.com/Documents/Construction/Section_3.pdf
Sanitary sewer & septic system management	Ensure proper maintenance of sewer systems through inspections and clearing/cleaning of debris (i.e. remove trash, leaves, sediment, and wipe up liquids, including oil spills), and provide the public with household wastewater education materials	http://www.cabmphandbooks.com/Documents/Municipal/SC-76.pdf; EPA Household Wastewater Education Materials: http://cfpub.epa.gov/npdes/wastewatermonth.cfm
Animal facility management BMPs	Promote use of management BMPs through education and outreach programs	http://www.cabmphandbooks.com/Documents/Industrial/AnimalCareandHandlingFacilities.pdf; EPA: http://www.epa.gov/agriculture/anafobmp.html
Ag & manure management BMPs	Promote use of livestock waste management BMPs through education and outreach programs	http://www.dem.ri.gov/programs/bnatres/agricult/pdf/barnyardbmp.pdf
Land conservation	Land conservation can indirectly contribute to water quality protection. For example, if property along stream corridors and shorelines is protected through conservation easements, the land can act as a vegetated buffer that filters-out pollutants from stormwater runoff. The effectiveness of this strategy depends on factors such as the width of the easement and in what vegetated state the easement is maintained.	http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=85
Stream habitat enhancement & restoration	Promote stream habitat enhancement and restoration projects; these are intended to restore or increase the productive capacity of aquatic or riparian habitat	www.dfg.ca.gov/fish/resources/habitatmanual.asp; http://www.env.gov.bc.ca/wld/instreamworks/downloads/Habitat.pdf
Natural-bottom channel restoration	Promote projects that restore natural-bottom channels; these are intended to restore benthic habitats that support aquatic organisms and help restore the balance between incoming, stored, and transported sediment over the range of flow (i.e., natural stream simulation)	http://www.sanantonioriver.org/proj_benefits/benefits.php; http://ag.arizona.edu/azwater/awr/marapr08/arroyo2008winter.pdf; http://www.vtfishandwildlife.com/library/Reports_and_Documents/Aquatic%20Organism%20Passage%20at%20Stream%20Crossings/_The%20Vermont%20Culvert%20Aquatic%20Organism%20Passage%20Screening%20Tool.pdf

Structural BMPs	Program/BMP Description	Existing Resources/Fact Sheets
Infiltration Basins	Construction of structural treatment and control measures	http://rcflood.org/LID.aspx
Infiltration Trenches		http://rcflood.org/LID.aspx
Permeable Pavement		http://rcflood.org/LID.aspx
Water harvesting & reuse		http://rcflood.org/LID.aspx
Bioretention facilities		http://rcflood.org/LID.aspx
Extended detention facilities		http://rcflood.org/LID.aspx
Sand filter basins		http://rcflood.org/LID.aspx
Green street filtration BMPs		EPA Street Design & Patterns: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=128 Los Angeles: http://www.environmentla.org/pdf/Green%20Street%20BMP%20matrix_1-6-09.pdf
Constructed treatment wetlands		www.cabmphandbooks.com/Documents/Industrial/TC-21.pdf; http://water.epa.gov/type/wetlands/restore/upload/2004_09_20_wetlands_pdf_ConstructedW_pr.pdf
Commercial green roof projects	Commercial green roof projects can be applied to new construction or retrofitted to existing construction. Some municipalities are encouraging green roof development with tax credits, density credits, or allowing a small impervious credit to be applied to other structural BMP requirements	http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=114; Green roof research program at Michigan State University: http://www.hrt.msu.edu/greenroof/#Benefits of green roofs
Downspout disconnections	Reduce the amount of stormwater that goes into the MS4 by promoting downspout disconnections through education and incentives programs (i.e. Portland's Downspout Disconnection Program safely disconnected over 56,000 downspouts between 1993 and 2011 - http://www.portlandonline.com/bes/index.cfm?c=54651)	http://www.portlandonline.com/bes/index.cfm?c=54651; http://water.epa.gov/infrastructure/greeninfrastructure/gi_what.cfm
Rain garden, xeriscaping and turf conversion projects	Reduce the amount of stormwater that goes into the MS4 by promoting water-efficient landscapes through education and incentives programs (i.e. the cash-for-grass program in Las Vegas - http://www.lvrj.com/news/turf-rebate-program-sees-success-116586443.html)	http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm?action=factsheet_results&view=specific&bmp=72; http://www.epa.gov/WaterSense/docs/water-efficient_landscaping_508.pdf

Structural BMPs	Program/BMP Description	Existing Resources/Fact Sheets
Pavement/impervious surface removal and re-vegetation	Programs to incentivize removing excess pavement, such as under-utilized parking areas, driveways that exceed required or useful width, abandoned sites, etc. and treatment of the site to naturalize soil conditions and establish vegetative cover.	Example of Incentive program: http://ddoe.dc.gov/node/122602
Flood control facility retrofit	Physical adjustments to outlet structures and other components of flood control facilities to change discharge rates and/or add treatment and control for water quality rather than volume only.	http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P1000OI9.txt
Trash enclosure & drainage retrofits	Physical improvements to areas where trash and trash containers are stored (such as covers, full-height opaque enclosures on all sides, gates, etc.) to prevent stormwater from coming into contact with trash, retain trash within the enclosure so it is not mobilized, and keep any runoff from trash containers out of the MS4 through grading and drainage improvements or diversion of flows to the sanitary system	www.cabmphandbooks.com/Documents/Municipal/SC-34.pdf
Dry weather flow diversion	Physical removal of dry-weather flows within the MS4 to the sanitary sewer system for treatment, whether through gravity flow or pumping	http://cordc.ucsd.edu/projects/asbs/documents/papers/Final%20UCSD% 20SIO%20Monitoring%20Report%2007-28-2011.pdf
Trash segregation BMPs	Installation of baffles, grates, or other physical mechanisms for keeping trash out of the MS4 or surface waters	http://www.cabmphandbooks.com/Documents/Municipal/SC-34.pdf
Sediment controls	Installation of sediment forebays to provide settling prior to discharge into the MS4, a surface water, or another storm water BMP	http://www.maine.gov/dep/land/stormwater/stormwaterbmps/vol3/chapter3.pdf; http://www.omafra.gov.on.ca/english/engineer/facts/89-167.htm
Catch basin inlet bacteria treatment BMPs	Where appropriate, promote use of BMPs that have been shown to effectively remove bacteria from stormwater effluent (i.e. catch basin inlets, media filters, retention ponds & bioretential cells); this could potentially be done through capital projects	Other: http://www.pcwp.tamu.edu/docs/lshs/end-notes/indicator%20bacteria%20removal%20in%20stormwater%20bmps%20in%20charlotte,%20nc-3678140698/indicator%20bacteria%20removal%20in%20stormwater%20bmps%20in%20charlotte,%20nc.pdf

Structural BMPs	Program/BMP Description	Existing Resources/Fact Sheets
Hydrodynamic Separator Installation	Installation of mechanical separators, such as swirl separators, to reduce the amount of sediment in storm water flows.	http://water.epa.gov/scitech/wastetech/upload/2002_06_28_mtb_hydro.pdf
Hydromodification BMPs	Design and installation of any number of different treatment and control approaches to control the rate of discharge to mimic, as possible, the natural discharge of storm event flows into surface waters and protect the physical integrity of the receiving water and stream system.	http://qcode.us/codes/imperialbeach/view.php?topic=8-8_32-8_32_160&frames=on; http://www.epa.gov/owow/NPS/hydromod/pdf/Chapter_8_Modeling_web.pdf