SONOMA COUNTY WATER AGENCY

Sonoma County Water Agency

Water Smart Development Guidebook

Approaches to Water Conservation, Water Reuse, and Storm Water Management

SCWA conservation program

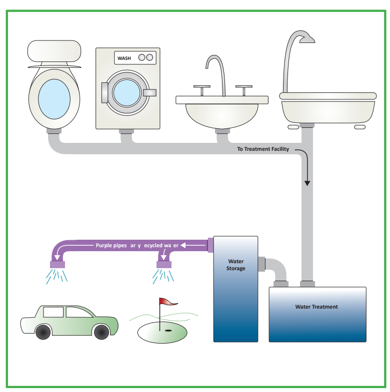

Water Submeter (Santa Clara Valley Water District)

Conservation program

Water Conservation

Rainwater harvesting system

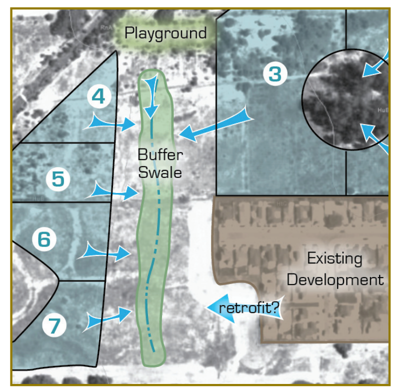

Rain barrels



Generation and use of recycled water

Water Reuse


Green roof at h2hotel in Healdsburg, CA



Drainage management areas


Vegetated swale in parking lot (RMC Water & Environment)

Stormwater Management

Horizon WATER and ENVIRONMENT

December 2013

Water Smart Development Guidebook

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List of Acronyms

AB	Assembly Bill
ABAG	Association of Bay Area Governments
AF, ac-ft	acre-feet
afy	acre-feet per year
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
AWWARF	American Water Works Association Research Foundation
BASIX	Building Sustainability Index
BIG	Build It Green
BMP	Best Management Practice
BO	Biologic Opinion
CBO	Community Based Organization Partnerships
CEC	California Energy Commission
CEQA	California Environmental Quality Act
CFL	compact fluorescent lamp
CII	Commercial, Industrial, and Institutional
CIMIS	California Irrigation Management Information Systems
CSA	Canadian Standards Association
CSD	Community Sanitation District
CUWCC	California Urban Water Conservation Council
CWA	Clean Water Act
DIR	Demand-Initiated Regeneration
DMA	Drainage Management Area
DOE, USDOE	United States Department of Energy
DPH	State Department of Public Health
DWR	Department of Water Resources
EPA, USEPA	United States Environmental Protection Agency
ESA	Endangered Species Act
ET	evapo-transpiration
FCDC	Flood Control and Design Criteria
FEMA	Federal Emergency Management Agency
gpcd	gallons per capita per day
gpd	gallons per day
gpf	gallons per flush
gpm	gallons per minute
gpr	gallons per rack
gpv	gallons per vehicle
HCD	Department of Housing and Community Development
HCP	Habitat Conservation Plans
HECW	High-Efficiency Clothes Washers
HET	High-Efficiency Toilet
HEU	High-Efficiency Urinal
HOA	Homeowners’ Association
IRWM(P)	North Coast Integrated Regional Water Management (Plan)
LADWP	Los Angeles Department of Water and Power
LED	light emitting diode

LID	Low Impact Development
MBR	Membrane Bioreactor
MEP	Maximum Extent Practicable
MG	million gallons
mgd	million gallons per day
MMWD	Marin Municipal Water District
MOU	Memorandum of Understanding
MS4	Municipal Separate Storm Sewer System
NBWRP	North Bay Water Recycling Program
NCCP	natural community conservation plans
NCFCWCD	Napa County Flood Control and Water Conservation District
NMFS	National Marine Fisheries Service
NMWD	North Marin Water District
NPDES	National Pollutant Discharge Elimination System
NSCARP	North Sonoma County Agricultural Reuse Project
NSF	National Sanitation Foundation International
NSW	(Australia) New South Wales Government
O&M	Operations and Maintenance
PAYS	Pay as You Save
PCFCWCD	Placer County Flood Control and Water Conservation District
PG&E	Pacific Gas and Electric Company
PRMD	Sonoma County Permit and Resource Management Division
PSI	pounds per square inch
QWEL	Qualified Water Efficient Landscaper Certificate Program
RWQCB	North Coast Regional Water Quality Control Board
SB	Senate Bill
SCEDB	Sonoma County Economic Department Board
SCEIP	Sonoma County Energy Independence Program
SCGWG	Sonoma County Graywater Working Group
SCVURPPP	Santa Clara Valley Urban Runoff Pollution Prevention Program
SCVWD	Santa Clara Valley Water District
SMCWPPP	San Mateo Countywide Water Pollution Prevention Program
sq mi	square miles
SRJC	Santa Rosa Junior College
SRPCS	Santa Rosa Plain Conservation Strategy
SUSMP	Standard Urban Storm Water Mitigation Plan
SWRCB	State Water Resources Control Board
SZ	Sanitation Zone
TMDL	Total Maximum Daily Load
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
UWMP	Urban Water Management Planning Act
Water Agency	Sonoma County Water Agency
WERF	Water Environment Research Foundation
WW	wastewater

Chapter 1
Introduction & Purpose

1.1 The Opportunity for Water Smart Development

The Sonoma County Water Agency (Water Agency) developed this guidebook to provide the residents of Sonoma County, land developers, city and county planning officials, and environmental regulatory agencies with a reference guide to avoid and minimize potential water resource impacts while planning residential and commercial development.

The three core subjects of this guidebook focus on ways to increase water conservation, increase the use of alternative water sources, and reduce storm water impacts. Commonly, these subjects are investigated and discussed as separate topics. However, this guidebook seeks to integrate these subjects within a single document to highlight potential areas of synergy and mutual benefit between the topics. Developers, planners, and water managers may benefit from considering the potential effects of development projects across the spectrum of water conservation, water reuse, and storm water topics. For example, a rainwater harvesting system or a bio retention swale that collects runoff may provide immediate benefits by reducing storm water – but such treatments may also provide water for irrigation purposes, that in turn, reduces water demand (i.e., conserving potable water).

It is envisioned that this guidebook can provide a basis for individual communities, developers, or water managers to develop their own more detailed action plans for their specific community or project needs.

The multi-objective scope of this guidebook also supports several regional goals and initiatives, including:

- Energy savings and sustainability initiatives, including reduced greenhouse gas emissions, are supported through the water conservation and water reuse approaches of this guidebook.
- Integrated Regional Water Management (IRWM) is supported through the integrated water management strategies promoted in this guidebook.
- Flood management programs are supported by the storm water reduction strategies described in this guidebook.

Low Impact Development (LID) is a planning and design strategy used to avoid and reduce potential harmful water resource impacts associated with residential and commercial development. Most commonly, this approach is focused toward preventing excess runoff generation and water quality impacts associated with development and urban storm water. The Environmental Protection Agency (EPA) defines LID as a sustainable landscaping approach that can be used to replicate or restore natural watershed functions and/or address targeted watershed goals and objectives (http://www.epa.gov/nps/lid). As a strategy, LID provides an opportunity to avoid and reduce water resource and watershed impacts beyond just the management of urban runoff. By integrating land use practices with water resource management, LID approaches can also help reduce water demand.

This guidebook also supports requirements of the National Pollutant Discharge Elimination System (NPDES) Permits for discharges from municipal separate storm sewer systems (MS4) – both the Phase 1 and Phase 2 permits cover urbanized areas within the County. In Sonoma County, the NPDES program is administered by two Regional Water Quality Control Boards (RWQCBs): the North Coast Region (RWQCB Region 1) and the San Francisco Bay Region (RWQCB Region 2).

RWQCB Region 1, NPDES Phase 1 CoPermittees include the City of Santa Rosa and portions of the County of Sonoma and Sonoma County Water Agency within RWQCB Region 1. Phase 2 designees within Region 1 that have elected to become Phase 1 Program Participants include the City Cloverdale, City of Cotati, City of Healdsburg, City of Rohnert Park, City of Sebastopol, the City of Ukiah (Mendocino County), Town of Windsor, and some unincorporated portions of Sonoma County. Following the next renewal of the Phase 1 permit, there are anticipated to be no NPDES Phase 2 designees in the Sonoma County portion of RWQCB Region 1.

RWQCB Region 2 Phase 2 designees include City of Petaluma, City of Sonoma, and portions of the County of Sonoma and Sonoma County Water Agency within RWQCB Region 2. These designees are not be able to join the RWQCB Region 1 NPDES Phase 1 program and are participants in the NPDES Phase 2 program administered by RWQCB Region 2. Further detail on the Phase 1 and Phase 2 MS4 permit designees in Sonoma County is provided in Chapter 4.

The NPDES Phase 1 and Phase 2 MS4 permits include several low impact development (LID) related requirements[1] and specify that LID is the preferred Best Management Practice (BMP) to address storm water runoff and water quality issues associated with development. Additionally, the Phase 1 NPDES Permit (Order R1 2009 0050) requires the development of an LID technical guidance manual. The required LID guidance manual should provide land planners, engineers, and developers with objectives and specifications on how to integrate LID strategies into the project planning and design process. This guidebook is intended to support these requirements. However, it is not the intent of this guidebook to establish enforceable regulations or permit compliance requirements. Direct compliance with the Phase 1 NPDES permit requirements related to LID is primarily guided by the Storm Water Low Impact Development Technical Design Manual developed by the City of Santa Rosa, on behalf of the Phase 1 CoPermittees. The latest

[1] The Phase 1 and Phase 2 NPDES Permits can be reviewed online on the State Water Resources Control Board's Storm Water website: http://www.waterboards.ca.gov/water_issues/programs/stormwater/municipal.shtml.

information on Santa Rosa's manual can be found at the following website: www.srcity.org/stormwaterLID.

The CoPermittee's document contains specific requirements and measures which may be required for some development projects. It is the intent for this guidebook to complement the CoPermittee's Storm Water Low Impact Development Technical Design Manual for discussions of storm water management.

For smaller communities in the county storm water management is regulated under Phase 2 of the NPDES storm water program. The Phase 2 permit includes storm water management requirements such as LID approaches that are similar to those required under the Phase 1 permit. The Water Agency supports county-wide application of LID practices. As such, this document can be a reference guide for Phase 2 communities in establishing or complementing their own LID guidelines and implementation criteria to comply with their NPDES permit requirements.

1.2 Water Resources in Sonoma County

1.2.1 Surface Water

The Russian River watershed drains 1,485 square miles, including much of Sonoma and southern Mendocino counties and provides the majority of the surface water supply for the region. The river travels approximately 110 miles southward from its headwaters to Mirabel Park, and then flows westward to its discharge point at the Pacific Ocean near Jenner. There are seven principal tributaries to the Russian River: the East Fork of the Russian River, Big Sulphur Creek, Mark West Creek, Santa Rosa Creek, Laguna de Santa Rosa, Mayacama Creek, and Dry Creek, as shown in **Figure 1-1**.

Two important reservoir projects (Lake Mendocino and Lake Sonoma) provide water supply storage in the Russian River watershed. Additionally, PG&E's Potter Valley Project diverts Eel River water into the Russian River watershed for power generation. This Eel River water, which is not controlled by the Water Agency, supplements Russian River water flowing into Lake Mendocino. Lake Sonoma and Lake Mendocino also provide important flood control benefits. Under operational agreements with the United States Army Corps of Engineers (USACE), the Water Agency manages the water supply storage in these reservoirs, while the USACE is responsible for flood management activities including reservoir releases when water levels are above the water supply pool (typically during the winter flow season).

Lake Sonoma and Lake Mendocino are operated in accordance with flow criteria established by State Water Resources Control Board (SWRCB) Decision 1610. In Decision 1610, instream flow requirements are targeted to support water supply, recreation, fish, and wildlife needs.

In September 2008, the National Marine Fisheries Service (NMFS) issued a Biological Opinion (BO) that prescribed constraints and obligations for flows in the Russian River. The BO analyzed the impacts of the Water Agency's existing water supply and maintenance activities on three fish species listed under the federal Endangered Species Act. In the BO, NMFS concluded that artificially elevated summertime minimum flows in the Russian River and Dry Creek required by Decision 1610 result in high water velocities that reduce the quality and quantity of rearing habitats for coho salmon and steelhead, among other conclusions. Implementing the BO will require reductions in instream summertime flows in the main stem Russian River, and limit summer releases from Lake Sonoma to Dry Creek (Sonoma County Water Agency 2011a).

In September 2009, the Water Agency filed a petition to permanently change the Decision 1610 minimum instream flow requirements to those recommended in the BO. The petition is currently pending before the SWRCB. The SWRCB will act on the petition after an Environmental Impact Report is prepared in compliance with the California Environmental Quality Act. In the interim, the Water Agency is requesting that instream flows on the Russian River are reduced on an annual basis until the SWRCB addresses the petition for permanent flow changes. The Water Agency assumes when evaluating water supplies available for delivery, that the minimum instream flow reductions required by the BO will be implemented and that the Water Agency will be subject to instream flow constraints in the BO. Because restricting summer releases reduces water delivery capacity, the Water Agency is investigating new water supply and conservation strategies to meet future water demands in a safe, economical, and reliable manner (Sonoma County Water Agency 2011a).

1.2.2 Groundwater

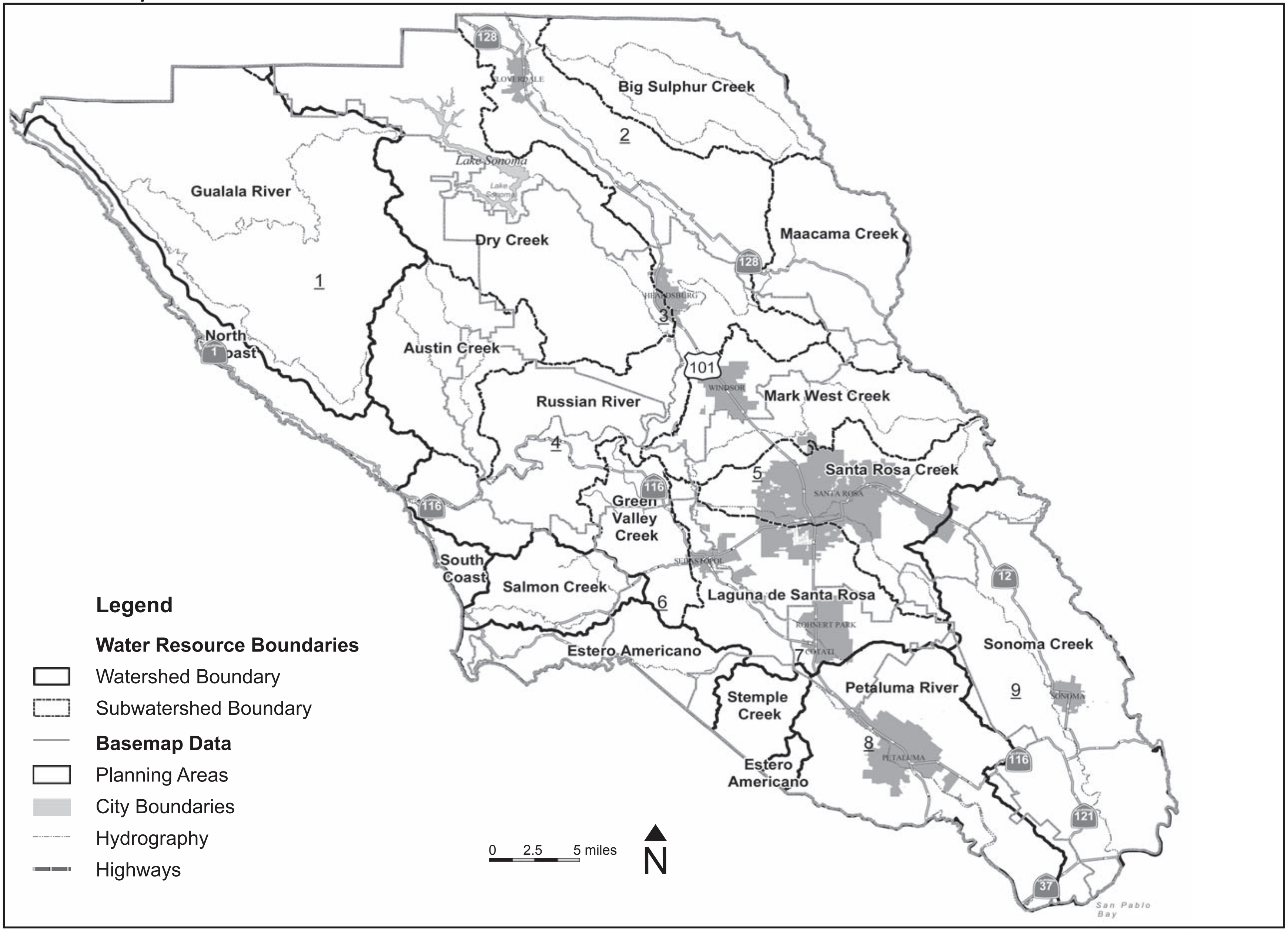
In addition to surface water supplies provided by Lake Mendocino and Lake Sonoma, groundwater is an important water source in Sonoma County. There are eleven separate groundwater basins in Sonoma County (DWR *Bulletin 118,* 2003). The four largest basins include the Santa Rosa Plain (125 sq mi), Petaluma Valley (70 sq mi), Sonoma Valley (70 sq mi), and Alexander Valley (47 sq mi) basins. In terms of geology, the Quaternary alluvial valleys, Tertiary/Quaternary sedimentary formations, and Sonoma Volcanic bedrock of the County can provide good aquifers where porosity and permeability are favorable.

Countywide, groundwater is the primary source of water for agricultural uses and is a significant source of water for the population in unincorporated areas of the County. It is estimated that groundwater provides approximately 42% of the net annual water supply in Sonoma County (Sonoma County General Plan 2020 Final EIR, Sonoma County Permit and Resource Management Department 2007). Groundwater provides a significant portion of the water supply for the cities of Sonoma, Sebastopol, Cotati, Rohnert Park, and Petaluma. The Water Agency and the majority of their water contractors also rely on groundwater to supplement their surface water supply. It is estimated that there are over 40,000 groundwater wells in Sonoma County, with 80% of them serving residential purposes and 20% serving agricultural needs (Sonoma County General Plan 2020, Sonoma County 2009).

An increase in impervious surfaces from development occurring over effective infiltrating soils can diminish shallow infiltration, lessen deeper percolation rates and thereby reduce groundwater recharge below. In Sonoma County, the sandy and coarse gravel bed of streams and flood control channels are also important recharge zones. Preserving or enhancing opportunities that promote groundwater recharge is a key strategy for maintaining reliable groundwater resources.

In 2007 a collaborative stakeholder process developed a non-regulatory groundwater management plan for the Sonoma Valley with the goal to locally manage, protect, and enhance groundwater resources for all beneficial uses – and doing so in a sustainable, environmentally sound, economical, and equitable manner. In the Santa Rosa Plain, the USGS has evaluated the groundwater basin including assembling comprehensive data, developing a GIS system, characterizing the groundwater hydrologic budgets, and also developing a surface-groundwater flow model (see the following webpage for updates on the study: http://www.scwa.ca.gov/srgroundwater). Results from the study will provide stakeholders with tools to assist in evaluating the hydrologic impacts of future climate-change scenarios and alternative groundwater management strategies for the basin. Additionally, the study provides the technical foundation for a local non-regulatory groundwater management planning process similar to Sonoma Valley. In support of these types of efforts, this guidebook identifies a range of voluntary water management actions intended to sustain water resources for future generations.

Figure 1-1
Sonoma County Watersheds and Subwatersheds



Source: Sonoma County PRMD, 2005

1.2.3 Recycled Water

Recycled water is highly treated wastewater that is beneficially reused in a variety of non-potable applications such as irrigation of public parks and golf courses. Recycled water is reliable and sustainable and its use helps protect the environment and reduces demand on potable supplies. Recycled water in Sonoma County provides a valuable resource.

As discussed in more detail in Chapter 3 *Alternative Water Sources*, the Subregional Water Reclamation System managed by the City of Santa Rosa treats wastewater from the cities of Santa Rosa, Rohnert Park, Cotati, Sebastopol, and the South Park Community Service District. The subregional facility generates approximately 23,000 acre-feet or 7.5 billion gallons of recycled water per year that is distributed throughout the county for landscaping, agricultural irrigation, and support of geothermal energy generation. Additionally, the City of Petaluma, Forestville Water District, and the Town of Windsor generates recycled water (3,300; 140; and 1,500 acre-feet per year, respectively) for reuse as agricultural or landscaping irrigation (see also Chapter 3, Table 3-4).

The Water Agency also operates sanitation districts and zones throughout the county, some of which provide recycled water for agricultural, forestland, and golf course irrigation. Sanitation agencies that distribute recycled water include the Occidental, Russian River, and the Sonoma Valley County Sanitation Districts, the Airport/Larkfield/Wikiup Sanitation Zone, and the Sea Ranch Sanitation Zone. Approximately 4,400 acre-feet or 1 billion gallons of recycled water is generated by the Sonoma Valley County Sanitation Districts and the Airport/Larkfield/Wikiup Sanitation Zone. As of 2010, a total of over 32,000 acre-feet of recycled water is generated per year in Sonoma County at local wastewater treatment facilities and reused.

Water recycling is an important component of Water Smart Development, particularly for discussions of water supply and water conservation. This guidebook incorporates approaches to protect and extend water supplies through county-wide implementation of water recycling, graywater reuse, and rainwater harvesting actions.

1.2.4 Water Supply Purveyors and Users

Sonoma County Water Agency (wholesale provider)

The Water Agency is the primary wholesale distributor of drinking water for approximately 600,000 residents in Sonoma County and northern Marin County[2]. Based on water delivery data for the past ten years, the annual water supply delivered by the Water Agency water transmission system to all of its users has ranged between approximately 45,000 to 65,000 acre-feet. A summary of current water delivery information in the Water Agency's service area is provided on the Water Agency's website at: http://www.scwa.ca.gov/water-delivery-data/.

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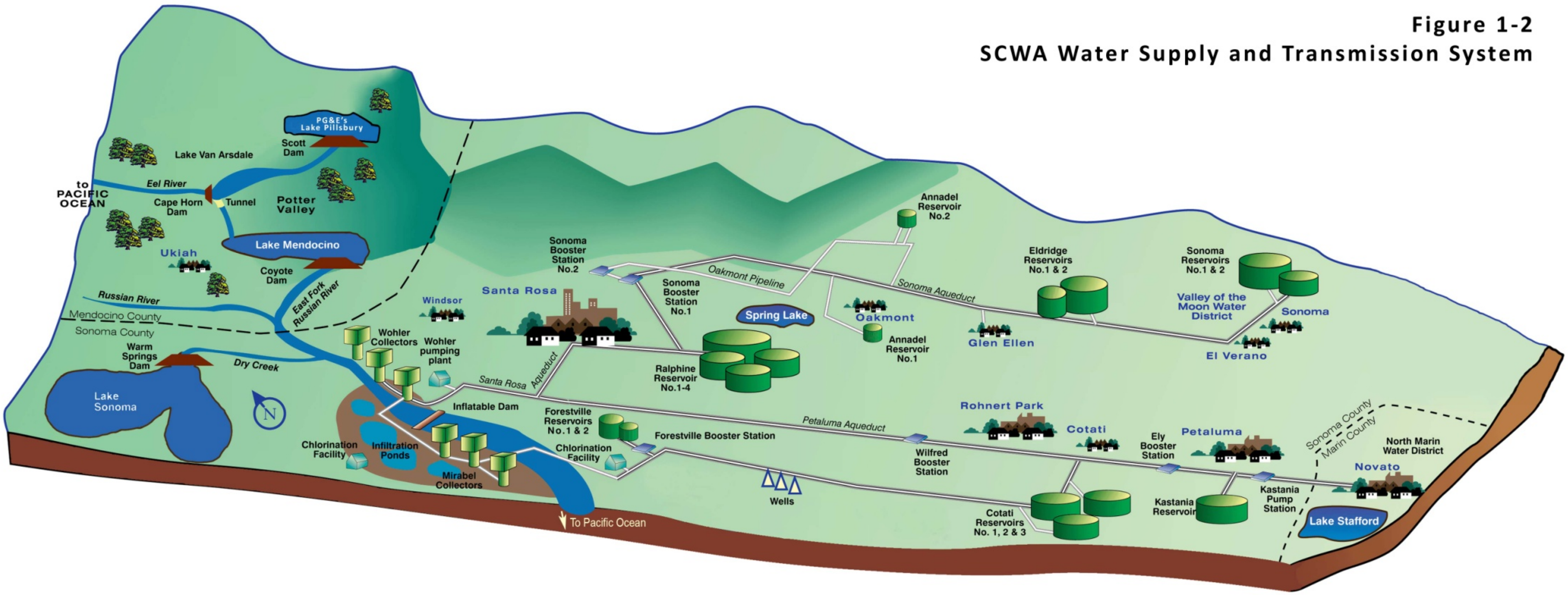
[2] This guidebook focuses predominantly on the Sonoma County portion of the Water Agency's service area. Though the Water Agency does provide water supply to the North Marin Water District and the Marin Municipal Water District, which services Marin County, this guidebook is intended to address the Sonoma County service area.

The Water Agency's primary water supply storage is provided by Lake Mendocino and Lake Sonoma as described above. The Water Agency's transmission system to distribute this water includes diversion and water treatment facilities and an aqueduct system of pipelines, pumps, and storage tanks to deliver water to contractors and customers. The main components of the Water Agency's storage and transmission system are shown in **Figure 1-2**.

The Water Agency operates its transmission system under a water supply permit issued by the State Department of Public Health (DPH). Under this permit, the Water Agency is required to operate and maintain its water supply system in compliance with state water law. This includes requirements to meet state and national standards for drinking water quality and comply with the water quality monitoring requirements and various other conditions and criteria associated with the permit (Sonoma County Water Agency 2009).

Water Smart Development is important to the Water Agency as it provides an integrated strategy to reduce water demand through increased conservation, alternative water sources, and beneficial management of storm water runoff.

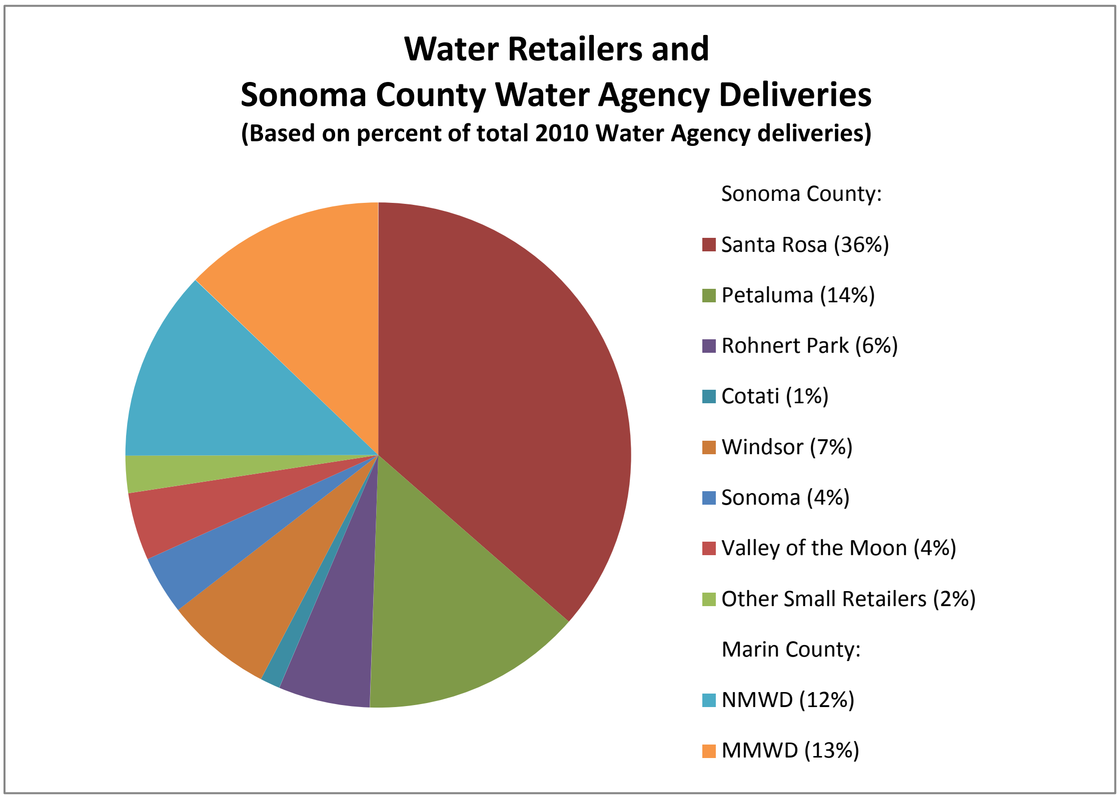
Figure 1-2
SCWA Water Supply and Transmission System



Retail water purveyors

Under an existing water supply agreement, the Water Agency distributes water to seven primary entities in Sonoma County and one entity in Marin County (the North Marin Water District [NMWD]), including cities, towns, and special district contractors who deliver water to end users. The seven Sonoma County entities include the City of Santa Rosa, City of Petaluma, City of Cotati, City of Rohnert Park, Valley of the Moon Water District, City of Sonoma, and the Town of Windsor (see inset map). Each of these entities also has local groundwater sources to supplement their water supply. Annual Water Agency deliveries to these seven Sonoma County entities has ranged between approximately 32,000 - 46,000 acre-feet since 2007. The City of Santa Rosa is the Water Agency's largest water contractor, followed by the City of Petaluma. **Figure 1-3** shows the relative proportion of Water Agency water deliveries to the seven primary Sonoma County contractors. The Water Agency also contracts with the Cal-American Water Company, the Penngrove Water Company, Forestville County Water District, and a few other local organizations to supplement groundwater supplies for those communities. Additionally, the Water Agency provides water supplies to the Marin Municipal Water District (MMWD). The Water Agency and Sonoma County's local water retailers can benefit from many of the conservation, reuse, and storm water strategies described in this guidebook.

Figure 1-3: Chart of Sonoma County Retailers and Comparison of Annual Water Deliveries.



Notes on Figure 1-3: The Sonoma County Water Agency actual water deliveries by customer type is available in Table 3-2 in the 2010 Urban Water Management Plan at: http://www.scwa.ca.gov/uwmp/.

Large public water systems

In Sonoma County there are other communities that are not directly supplied by the Water Agency but are serviced by local water suppliers operating one or more groundwater wells. These suppliers transmit locally derived groundwater, as well as, river underflow. Public water systems that service more than 1,000 connections are referred to as “large” public water systems. Large public water systems in Sonoma County are operated in Cloverdale, Healdsburg, Sebastopol and by Sweetwater Springs, the Bodega Bay (Public Utilities District), and the Sea Ranch Water Company. The communities of Cloverdale, Healdsburg, and Windsor use treated Russian River water extracted via vertical wells adjacent to the river. This water source is considered Russian River underflow (and is a type of surface water resource). The communities of Sebastopol, Sweetwater Springs, and Bodega Bay (Public Utilities District) use groundwater wells, and the Sea Ranch Water Company uses surface water from the Gualala River.

Small public water systems

In Sonoma County there are nearly 500 small public water systems with less than 1,000 connections. Approximately 417 of these are state-regulated small public water systems that have between 15-999 connections. These include the Camp Meeker Recreation and Park District; Occidental Water Company; and the Russian River County Water District. Sonoma County includes another 65 smaller systems with 5-15 connections, that are county regulated. Small water distributors service unincorporated areas of the county, including isolated unincorporated areas within a city. It is uncertain how many very small and local unregulated water systems (with only 2-4 connections) exist in Sonoma County. All small public and community-owned water suppliers are regulated by the State DPH. Smaller and more local agencies and water districts have an important role in setting community Water Smart Development targets that are appropriate for the communities they serve.

Individual users and well owners

Individual homeowners in rural subdivisions and rural residences throughout the county operate their own groundwater wells. These groundwater extractions are not monitored or reliably reported. While it is uncertain exactly how many county residents use privately provided local groundwater resources, it is estimated that there are about 40,000 private wells in Sonoma County, with approximately 80% of the wells used for residential supply and 20% of the wells used for agricultural purposes (Sonoma County General Plan 2020, Sonoma County 2009). Many of the technologies and approaches described in this guidebook are scaled for individual home owners and users.

1.3 Development, Land Use Planning, and Water Use

1.3.1 Sonoma County Land Use Planning Entities

General Plans and the Planning Process

Long-range land use plans, also known as general plans, are mandated by California law for each city and county in the state. A general plan is a legal document which includes specific goals, policies, standards, and/or implementation programs that constitute the formal policy of the County or municipality for land use, development, and environmental quality. The general plan also provides a foundation for more detailed plans such as area specific, community plans, or zoning ordinances. The duration of a general plan's effective timeframe (planning horizon) can vary, but the typical general plan is scoped for a 10-20 year planning horizon from the date of adoption.

At least once every five years, local planning agencies are encouraged to thoroughly review their general plan and revise the plan according to changing needs and priorities. State law requires every city and county to evaluate its *Housing Element* frequently and to revise it no less than every 5 years. The other elements of the general plans may be revised as new information becomes available and as community needs and values change regardless of the planning horizon. If and when a general plan amendment or update is undertaken, formal environmental and public review (CEQA) is required for adoption and implementation.

In addition to Sonoma County itself, there are several municipalities within the Water Agency's jurisdiction that conduct the general planning process. These municipalities and the status of their general plans are shown in **Table 1-1**:

Table 1-1: Sonoma County Land Use Planning Entities and General Plans

Land Use Planning Entity	Adoption Year of Most Current General Plan	General Plan Horizon Year
Sonoma County	2008	2020
City of Cloverdale	1999	2025
City of Cotati	1998	2023
City of Healdsburg	2010	2030
City of Petaluma	2008	2025
City of Rohnert Park	2000	2020
City of Santa Rosa	2009	2035
City of Sebastopol	1994	2014
City of Sonoma	2006	2020
Town of Windsor	1996	2015

Development Review Process

Once overall development patterns are established in the general plan, goals and policies are developed to guide local laws and zoning ordinances. Though anticipated as part of the general plan build-out, all new development is required to comply with adopted policies and zoning ordinances prior to approval. Typically, developers submit project design plans to the appropriate land-use planning entities. Development plans are reviewed to ensure compliance with adopted policies and zoning ordinances. A project design is approved if it fulfills the terms of all applicable regulations. If the development project is compliant, building permits are then issued to the developer which authorizes construction.

Development Planning and Water

An effective general plan appropriately balances and addresses a wide array of issues facing future growth demands. This includes forecasting and strategically planning for a variety of finite resources, among which water supply is paramount. Thorough planning requires close and continuous coordination between land use planners and water supply managers to ensure that future water demand is accurately forecast and that a sustainable supply is secured and achievable. When growth planning fails to consider water supply needs, severe system-wide infrastructure deficiencies emerge, often only treatable with very costly solutions.

In addition to water supply considerations urban development may cause harmful environmental effects including increasing surface runoff, stream erosion, and non-point source pollution while reducing infiltration, soil moisture, and groundwater recharge. These potential effects are described further in Sections 1.3.3 and 1.3.4 below. Good land use planning anticipates such effects and considers on-site approaches to conserve water, reuse water, or lessen storm water runoff. This guidebook presents planning approaches that utilize the site design process to maximize site benefits. The intent is to encourage the use of many feasible individual treatments to maximize conservation and reuse of water and minimize runoff.

Working together, local land use planning agencies and water supply managers can develop strategies to accommodate future development while avoiding potential environmental impacts. This may include setting regional priorities and policies at the countywide scale, as well as targeting more specific requirements and zoning ordinances at the local implementation scale. This guidebook represents a first Sonoma countywide effort to identify and integrate Water Smart planning and treatment approaches for water conservation, water reuse, and storm water management topics.

As shown in Appendix 1, several land use planning agencies in Sonoma County have already adopted specific Water Smart Development policies into their zoning ordinances. Many of these policies are aimed to reduce water demand, increase water conservation, and lessen runoff. Widespread adoption of Water Smart Development strategies and requirements coupled with a planning review process that is practical and solution-oriented can set a path for the County toward informed and balanced development that can be sustained over the long term under changing resource and energy availability.

Communication between developers, planners, and regulators who review and approve projects is a critical step to ensure that such policies are successfully incorporated into a project design. The lack of coordination can result in lost time, increased project costs, and misunderstandings between applicants and permitting agencies.

1.3.2 Sonoma County Population Growth and Water Use

Population Trends

Significant population increases in Sonoma County began in the post-war years of the 1940s and 1950s, mirroring general population increases in California. Growth in the North Bay reflected the completion of the Golden Gate and Richmond-San Rafael bridges, the development and improvement of Highway 101, and the rapid increase in use of the personal automobile. Road and bridge improvements made it possible to quickly and easily transport agricultural goods from Sonoma County to the surrounding marketplace. The expanding economy and population base (**Table 1-2**) fostered other infrastructure improvements, including electrical transmission, water distribution, sanitation, and flood control facilities. Into the 1960s and 1970s, all of these improvements supported a rapidly urbanizing area with large tracts of residential development and commercial growth along key corridors such as Highway 101. The 1980's continued as a high growth period (2.6% annual increase). Sonoma County's population continued growing through the 1990's, though at a lesser rate (1.7% annual increase). This slow-down in annual growth rates are attributed to both regional economics and the gradual build-out of City and County general plans. Figure 1-1 shows the principal cities of Sonoma County.

Table 1-2: Population of Sonoma County

Year	*Sonoma County Population*
1900	38,480
1910	48,394
1920	52,090
1930	62,222
1940	69,052
1950	103,405
1960	147,375
1970	204,885
1980	299,681
1990	388,222
2000	458,614

U.S. Census Bureau 1995, 2000, 2009; ABAG, 2009; Sonoma County 2009; SCEDB 2009.

Changing Land Uses

Agriculture has been a core economic activity in Sonoma County since the founding of the Sonoma Mission (1823). In the 19th century, wheat, apples, pears, cherries, and prunes were first grown from seeds provided by Russian settlers from Fort Ross, and Mexican missionaries introduced olives and grapes to the region. In the post war era, Sonoma County emerged as a regional and state agricultural leader for several goods including Gravenstein apples (peaking in the 1950s), eggs, poultry, and prunes (peaking in the 1960s), and dairy production (through the 1980s). Since the 1970s Sonoma County, like its neighboring Napa County, has become internationally renowned for the quality of its grape and wine production.

Between 1984 and 2006, agricultural land area in Sonoma County decreased 7.6% while urban/developed land uses increased 26.7% during the same period (California Department of Conservation 2006). Overall, the amount of county land dedicated to agriculture remains high, with approximately 463,894 acres (46% of total county area) used for agriculture. Urban lands account for only 7% of the total county area and are concentrated in the southern County and along the Highway 101 corridor. The remaining 47% of non-agricultural or non-urban county land includes open water bodies, forests, riparian areas, mines, and other land uses (California Department of Conservation 2006).

Anticipated Growth

As shown in **Table 1-3**, population in Sonoma County is projected to reach 552,279 by the year 2020 and 622,482 by the year 2035. The annual growth rate between 2010 and 2035 is anticipated to be less than 1% per year, which is measurably less than the historical growth rates (pre year 2000) shown in Table 1-2. By 2020, it is estimated that the nine incorporated cities of Sonoma County will contain 73% of the total population, an increase from 68% in 1990. The City of Santa Rosa will remain the most populated urban area. The cities of Cloverdale and Santa Rosa will undergo the greatest relative population increases by 2035. Populations in the County's unincorporated areas are projected to decrease below 30% of the county's total population through 2035. These trends reflect the city-oriented growth and development policies of the current and previous general plans.

Table 1-3: Sonoma County 2035 Expected Growth

Planning Area/City Urban Area	2010 Population	Projected 2020 Population	Projected 2035 Population	Percent Change from 2010 to 2035 Populations
City of Cloverdale[1]	8,900	11,200	11,900	34%
City of Healdsburg[1]	11,900	12,900	14,300	20%
Town of Windsor[2]	28,134	30,715	33,815	20%
City of Santa Rosa[2]	163,436	204,519	233,520	43%
City of Sebastopol[1]	7,900	9,620	8,300	5%
City of Rohnert Park[2]	43,398	47,900	53,000	22%
City of Cotati[2]	7,711	8,518	9,889	28%
City of Petaluma[2]	60,214	66,376	75,587	26%
City of Sonoma[2]	11,426	12,871	14,471	27%
Unincorporated Areas[1]	158,600	147,660	167,700	6%
County Totals	***501,619***	***552,279***	***622,482***	**24%**

[1] Values were estimated by the Water Agency using the population projections in: ABAG 2009
[2] Source data from the SCWA 2010 UWMP, Table 3-1 (Sonoma County Water Agency 2011b).

Water Use

In California water use varies depending upon land use, population, climate, and other geographic factors. For context, the counties with the highest total water use in the state include Los Angeles, San Diego, Fresno, and San Luis Obispo counties, which use 5.4, 4.4, 3.7 and 3.1 billion gallons per day respectively (USGS 2000). Los Angeles and San Diego counties are two of the most populous in the state, while Fresno and San Luis Obispo counties are two of the highest agricultural producers in the state. In comparison to these four highest water use counties, water use in Sonoma County in 2000 was modest, at 159 million gallons per day. **Table 1-4** shows average daily water use information for Sonoma County in 2000 and 2005.

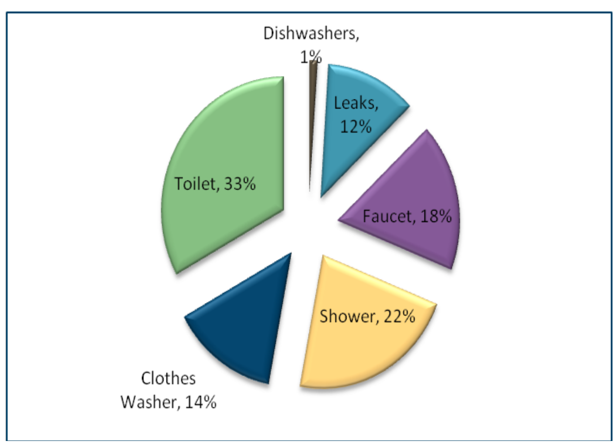
Table 1-4: Average Daily Water Use in Sonoma County, 2000 and 2005

Year	**Sonoma County Population**	**Water Use from Public Supply** (mgd)	**Water Use from Domestic Supplies** (e.g., private wells) (mgd)	**Ave. Industrial Use** (mgd)	**Ave. Irrigation Use** (mgd)	**Ave. Aquaculture Use** (mgd)	**Ave. Livestock Use** (mgd)	**Ave. Daily Use** (surface and ground water) (mgd)
2000	458,614	56	8	7	74	8	6	159
2005	466,477	49	8	0.5	74	6	4	114

USGS 2000, USGS 2005

Table 1-4 is most easily understood reading the columns from left to right. Domestic and commercial water use provided by the Water Agency and other county public water purveyors accounted for about 40 percent of the total average daily water use in both 2000 and 2005 (USGS 2005). Domestic use from local private supplies and wells is much less (8 mgd in 2000 and 2005) than the public supply, but still a significant use. Irrigation is the single largest water use in the County (74 mgd in 2000 and 2005), representing nearly 50 percent of the total average daily water use in 2000 and 65 percent in 2005. Overall, average daily water use dropped substantially, from 159 mgd in 2000 to 114 mgd in 2005 (USGS 2000; USGS 2005). The paragraphs below describe interior and exterior residential and commercial water uses in more detail. Water Smart Development approaches are most applicable for these water uses and these are the water use types that are the focus of the remainder of the guidebook.

Figure 1-4: Indoor Residential Water Use in California



Pacific Institute 2003

Residential Water Use

Residential indoor water use includes water used in apartments, condominiums, single-family homes, and other residences. Water used for residential interior purposes typically includes showers, baths, toilets, dishwashers, clothes washers, and other uses. Residential water use does not include hotel rooms, which are considered a commercial water use.

Figure 1-4 shows the allocation of residential indoor water use in California. Compared to the U.S. national data, Californians use relatively more water for toilets, showers, and faucets and relatively less for clothes washing, baths, and leaks.

These allocations are useful in understanding how to target effective conservation efforts. **Table 1-5** describes water amounts or rates used for the primary residential features shown in Figure 1-4.

Table 1-5: Typical Indoor Residential Water Usage

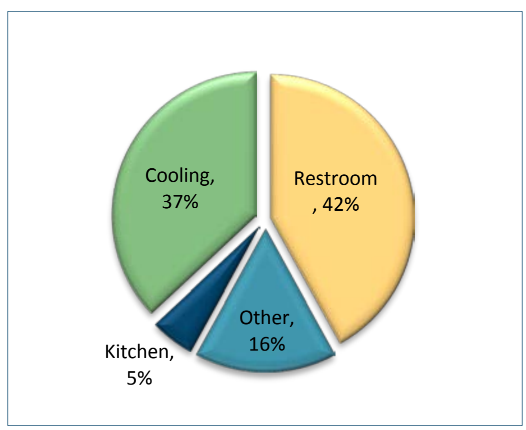
Category	Typical Water Useage
Toilets	Water use in toilets is based on the amount of gallons per flush (gpf) the fixture uses. GPFs can be generally assessed based on year of manufacture (*MWRA 2006; SB 407)*: ▪ Pre-1980: 5 - 7 gpf ▪ 1980-1992: 3.5 gpf ▪ 1993-2014: 1.6 gpf ▪ Beyond-2014: 1.28 gpf or less
Showers	Older showerhead fixtures (generally pre-1992) can use up to 5.5 gallons per minute (gpm). Newer fixtures average 2.2 gpm. The average showertime (8.2 minutes) results in the typical use of 18 gallons during a single shower with a 2.2 gpm fixutre, and up to 45 gallons with older fixtures (*CUWCC 2009)*. Note, baths use approximately 24 gallons per bath (*CUWCC 2009)*.
Faucets	On average, residential faucets use 10.9 gallons of water per day (*AWWARF 1999).* The national average flow rate for residential faucets is 1.3 gpm (*CUWCC 2009).*
Clothes Washers	On average, 15 gallons of water is used per day, per person for washing laudary (*AWWARF 1999)*. The national average load volume for a residential laundry machine is 40 gallons, and the average loads of laundry per day is 0.37 loads *(CUWCC 2009).*
Dishwashers	Residential dishwashers use about 1 gallon of water per person per day *(AWWARF 1999)*. The national average residential dishwasher load volume is 9.3 gallons, with an average frequency of 0.1 loads per person per day *(CUWCC 2009).*
Leaks	Residential water leaks (both indoor and outdoor) waste about 9.5 gallons of water per person, per day nationally *(AWWARF 1999).* A leaking toilet can waste as much as 18,000 gallons per year *(MWRA 2006).*

Commercial Water Use

The primary commercial, institutional, and industrial (CII) water uses include water for office buildings, hotels and restaurants, hospitals and medical offices, educational facilities, government and military facilities, service and manufacturing, and other municipal facilities including public parks, etc.

Total office building water use in California averages 300,000 acre-feet per year, or 300 million gallons per day (Pacific Institute 2003). **Figure 1-5**

Figure 1-5: Water Use in California Office Buildings



Pacific Institute 2003

shows the allocation of average water uses in California office buildings. Cooling (37%) and restroom faucets and toilets (42%) represent nearly 80% of the total office water use. Kitchen and "other" water uses constitute a little over 20% of office water use.

Commercial buildings use a variety of interior fixtures including toilets, urinals, showers, and faucets. Water use information for fixtures used in commercial settings is provided in **Table 1-6**.

Water use at office buildings, hotels, hospitals, commercial washing machines, commercial kitchens, and commercial interior water fixtures vary as described below.

- On average hotels use 30,000 acre-feet of water per year, or 27 million gallons per day (Pacific Institute 2003).
- Hospitals in California use 36,700 acre-feet of water per year, or 33 million gallons per day (Pacific Institute 2003).
- Commercial washers typically use 34 gallons per cycle (AHAM 2006). Dry cleaning and service laundry facilities average 981 gallons of water per day, linen supply averages 977 gallons per day, carpet upholstery averages 984 gallons per day, and industrial launderers average 981 gallons per day (Pacific Institute 2003).
- Water use from commercial dishwashers ranges from 0.28 gpr (gallons per rack) to over 20 gpr. Dishwashers in California restaurants average 2.4 gpr and use approximately 429 gallons of water per restaurant per day (BuildingGreen 2009).

Table 1-6: Typical Water Use for Commercial Fixtures

Fixture	Gallons per day
Office Toilet	7.8
Hotel Toilet	12
School Toilet	6.3
Office Urinal	2
School Urinal	1.6
Hotel Shower	35.2
Office Faucet	0.4
Hotel Faucet	0.6
School Faucet	0.3
Restaurant Faucet	330 (8 sinks)

Pacific Institute 2003

Exterior Water Use

In this guidebook the topic of exterior water use focuses on urban uses including water used outside by households, businesses, and municipalities for irrigation and landscaping, swimming pools, spas, personal car washing, and other outdoor uses.

The proportion of residential and commercial water used for exterior purposes is uncertain. AWWARF (1999) estimated that 59% of residential water use is used for exterior purposes. The Pacific Institute (2003) suggested that exterior water use accounts for 30% to 45% of total household water use. Data on exterior water use is vague for two primary reasons. One, not all outdoor water usage is monitored, and two, exterior usage varies greatly depending on location and climate. While exterior water use may account for 59-67% of total residential water use in dry climates, it may only account for about 22-38% in more moist climates (BuildingGreen 2009).

Water use for landscape irrigation, recreational pools and spas, and outdoor cleaning are summarized below.

- On average, lawn watering uses approximately 25 gallons of water per irrigation cycle. Landscaping accounts for about 72% of total water use at elementary schools, 38% at office buildings, 16% at hospitals, 10% at hotels, and 6% at restaurants. Golf courses in California use about 300,000 acre-feet of water per year (or 270 MG per day) to irrigate turf areas.
- Residential houses with swimming pools use approximately 58% more exterior water than those without pools. Uncovered pools located in dry areas with high temperatures lose water through evaporation and need to be refilled regularly.
- A garden hose uses between 8-18 gpm. Actions such as washing a car or boat, cleaning the street, or washing off one's driveway with the hose at a constant flow can use hundreds of gallons of water during just one wash session (ACWA 2009).

1.4 Development and Hydrologic Impacts

1.4.1 Development and Storm Water Runoff

Runoff and streamflow represent the dynamic portion of the hydrologic cycle that is in movement across the land surface. Runoff is a broad category and includes a range of flows progressing from very shallow overland flows (or sheetwash), to the initial collection of flows in small rills, to the compounding of streamflow into larger creeks and rivers. Subsurface (or groundwater) hydrology represents the portion of the hydrologic cycle that is in movement or in storage beneath the surface.

Land development alters the quantity, quality, and timing of storm water runoff in ways that may be detrimental to natural water bodies. Land development tends to increase impervious surfaces (roads, parking areas, sidewalks, rooftops, etc.), remove tree and vegetation cover, and compact or remove healthy soils. These changes reduce and disrupt infiltration and water storage processes provided by shallow surface depressions, upper soil layers, shallow subsurface flows, and vegetation uptake and evapo-transpiration. These changes result in increased surface runoff and increased pollutant loadings to receiving waters, while reducing infiltration and groundwater recharge.

Figure 1-6 illustrates components of the hydrologic cycle in hypothetical undeveloped and developed scenarios. The undeveloped left side of Figure 1-6 depicts the processes of precipitation, interception by vegetation, infiltration to soil, shallow subsurface interflow (or throughflow), and percolation to groundwater without urban or agricultural development impacts. The developed scenario shows increased radiant heat from the built environment, reduced vegetation interception, reduced infiltration, increased surface runoff, reduced shallow subsurface interflow, increased runoff in an engineered storm water drainage system, and reduced percolation to groundwater. The storm event hydrograph for the developed landscape has a shorter lag time between precipitation and peak flow, higher peak flow rate, and a reduced baseflow recession compared to the non-developed hydrograph. In the built environment, streams and wetlands may also become wet throughout the year due to the increased release of summer urban flows and irrigation (as compared to extended baseflow in the undeveloped scenario). Water bodies that are “perennialized” in this way may not provide adequate habitat for native species and may contribute to other water quality concerns.

1.4.2 Development and Water Quality

In terms of water quality, a developed landscape increases pollutant loading that quickly enters the storm water system and is delivered directly to downstream receiving waters. The filtering benefits of infiltration, soil pore storage, and deeper percolation are reduced or eliminated. In developing areas, sediment loads may be very high during construction phases and then drastically fall after “build-out” when many upland sediment sources are capped, eliminated, or stored in reservoirs or basins. However, in the urban environment increased runoff and higher peak streamflows may increase channel erosion, and in this way replace upland sediment sources with eroded in-channel sediment sources. This hydromodification process may result in deepened or widened channels and degraded water quality.

To protect water quality and the beneficial uses of water from these effects, storm water runoff is regulated by federal and state agencies. Specifically, the National Pollutant Discharge Elimination System (NPDES) program regulates storm water and other discharges from development. The LID component of the Water Smart approach to development, which is strongly supported by the NPDES program, benefits water quality by reducing the harmful effects of urbanized runoff from its source. Additional information on the NPDES program is provided in Chapter 4, *Reducing Storm Water Impacts*.

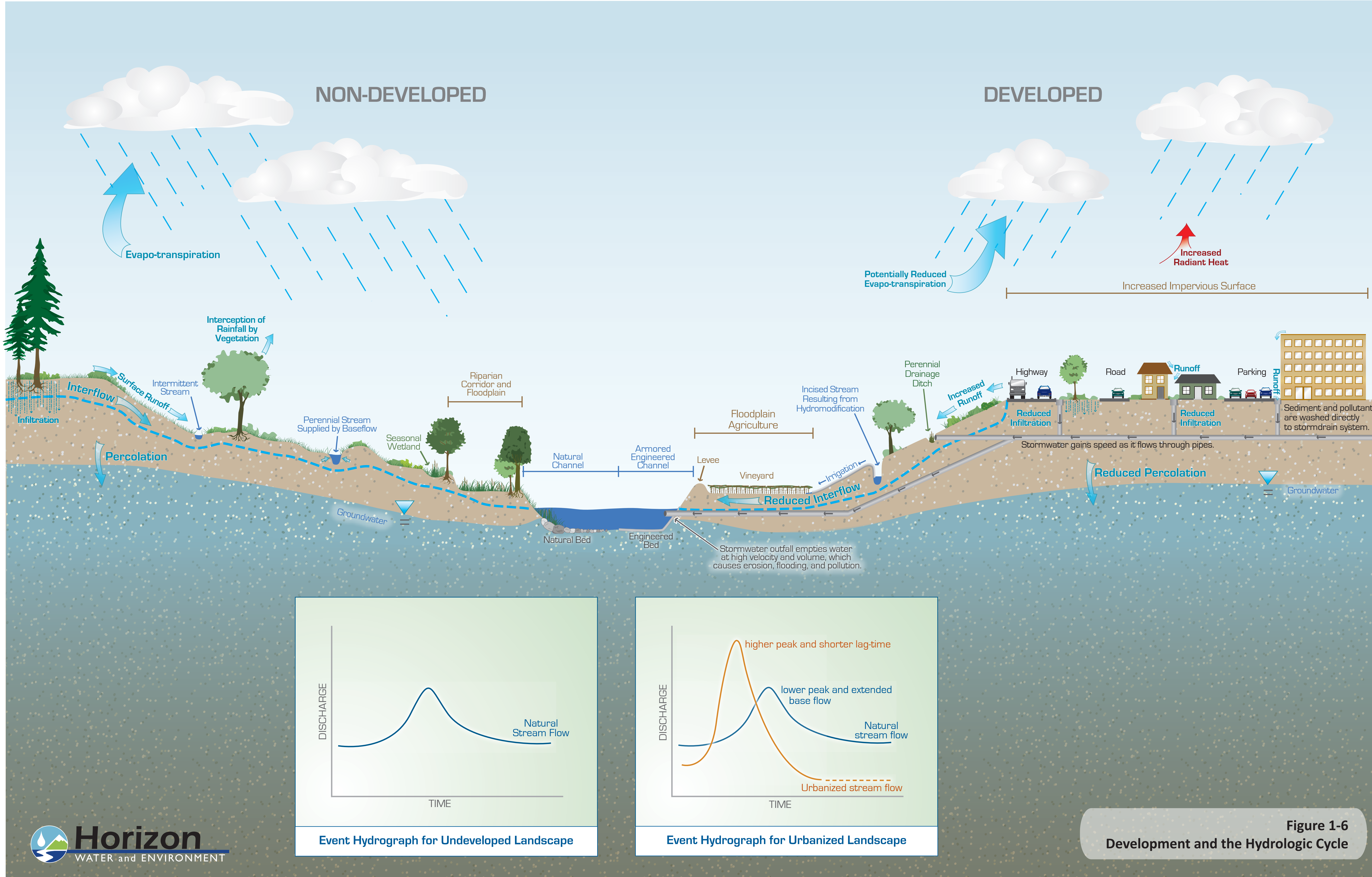


Figure 1-6
Development and the Hydrologic Cycle

1.5 Opportunities to Reduce Environmental Impacts

The remaining chapters of this guidebook focus on describing approaches to enhance water conservation and reuse efforts while also reducing storm water runoff. In this way opportunities to avoid environmental impacts associated with development can be developed. This section summarizes some of the key issues and approaches raised in subsequent Chapters 2, 3, and 4 and also provides a brief overview of those chapters.

Water Conservation (Chapter 2)

Water conservation lessens development impacts by reducing the demand for potable water resources (both surface and groundwater supplies). Through fostering water supply sustainability and lessoning water demand and withdrawals, water conservation approaches reduce environmental impacts by protecting groundwater levels, water quality conditions, base level streamflows, and the riparian vegetation and wildlife supported by water resources.

Water in Sonoma County is highly valued for its economic role in supporting agriculture, commerce, and industry. Because opportunities to secure new or additional water supplies and water rights are limited; reducing water use through conservation provides the most efficient and sustainable approach to provide long-term water supply reliability. In Sonoma County, awareness to promote and apply national and state-level conservation directives locally is increasing. This guidebook encourages additional coordination between water supply wholesalers, retail contractors, local planning officials, and the broader Sonoma County community to achieve greater conservation. Together with water reuse and storm water management approaches (as discussed in this guidebook), water conservation is one of the core Water Smart Development methods to ensure water supply reliability for people and the environment.

Conservation strategies commonly target behavioral practices which promote water use awareness and encourage reduced water use or technology improvements which reduce water use by design. Promotional campaigns and outreach to school children and other residents has proven to be very effective at reducing water consumption. In parallel, technology advances in toilet water use and other fixture efficiency have improved tremendously in the past 20-30 years. However, with continued population growth and additional climatic stresses, achieving water supply and sustainability goals will require increased conservation efforts.

The water conservation topic is fast moving and at the strategic forefront of all water providers in the country, and especially in California. As such, this guidebook will be updated periodically to include current information and recommendations for future conservation efforts.

Chapter 2 of this guidebook, *Reducing Water Use* first describes current state and national conservation standards and policies that guide and direct conservation efforts in Sonoma County. Chapter 2 then describes existing conservation programs in operation in Sonoma

County. The description of current programs provides a basis to identify additional opportunities to conserve beyond the current baseline. As a guide to future developers and development permit reviewers, a brief checklist is provided to encourage implementation of conservation strategies throughout the county.

Alternative Water Sources (Chapter 3)

Alternative water sources reduce potable water use by supplementing potable water with recycled water, recycled graywater, and harvested rainwater. Section 13550 of the California Water Code defines recycled water as water which, as a result of treatment of wastewater, is suitable for a direct beneficial use or a controlled use that would not otherwise occur and is therefore considered a valuable source. Graywater is water that flows out of bathroom sinks, showers, and laundry appliances that can be reused for non-potable uses. Rainwater harvesting is the practice of collecting and storing rainwater for later non-potable use. Use of these three alternative water sources can effectively reduce potable demands on water resources, especially for landscaping and agricultural irrigation practices. As a result of reducing potable water demand, alternative water sourcing provides similar environmental and sustainability benefits as those identified above for water conservation.

Recycled wastewater and graywater are considered beneficial alternative water sources because treated wastewater that would otherwise discharge to streams and water bodies is reused prior to discharge or other release in the hydrologic cycle. Large and continuous discharges of treated wastewater generally negatively impact the water quality and habitats of receiving waters. Erosion and discharge of improperly treated wastewater can heavily degrade a natural system.

With continued population growth and development in Sonoma County, using alternative water sources will become an increasingly important means to reduce impacts associated with treated discharges. Along with water conservation and storm water management, alternative sources are an important approach to consciously utilize existing and valuable water resources.

Chapter 3 of this guidebook provides information on alternative water source efforts underway in the region and identifies future opportunities for expanded water reuse. Currently, many sanitary service districts in the County are treating and providing recycled wastewater for landscape and agricultural irrigation. Additionally, recycled wastewater is used to generate electricity at the Geysers' geothermal wells in northern Sonoma County. More about this water to energy project is discussed in Chapter 3. The future of alternative water source opportunities is rapidly changing, particularly in the regulation of reuse applications. With new and evolving regulations and standards, hopefully new opportunities for alternative water sources will continue to arise, including additional opportunities related to recycled water, graywater, and harvested rainwater.

Storm Water Management (Chapter 4)

LID storm water management is a site design strategy to avoid and minimize hydrologic and water quality impacts associated with development. The strategy emphasizes design practices and techniques that effectively capture, filter, store, evaporate, detain, and infiltrate runoff close to its source. The storm water management approach also seeks to conserve natural resources and preserve ecological functions. The LID concept is based on the premise that storm water management involves more than just preventing flooding, and that runoff is a valuable resource if used wisely. Storm water management recognizes the value of pre-existing hydrologic functions and their influence on the surrounding environment.

LID storm water management relies on four fundamental principles:

1. **Avoid** hydrologic impacts by integrating site topography, soil, and hydrology assets into the site plan and design features.
2. **Conserve** existing soils, vegetation, and hydrologic features.
3. **Minimize** impervious areas and maximize permeability.
4. **Manage** storm water on-site through LID features.

The first two principles emphasize protecting and using existing resources, while the last two principles shift focus to impact management and controls.

Chapter 4 describes several storm water BMP features including biofilters, permeable paving, green roofs, rainwater harvesting systems, subsurface detention and infiltration strategies, and soil amendments. Chapter 4 provides guidance on incorporating these approaches into the site planning process. The combination of using site planning approaches and BMP treatments helps reduce and avoid harmful effects of storm water runoff and water quality impacts resulting from urban development. Chapter 4 also includes a discussion of compliance with NPDES storm water regulations in the county.

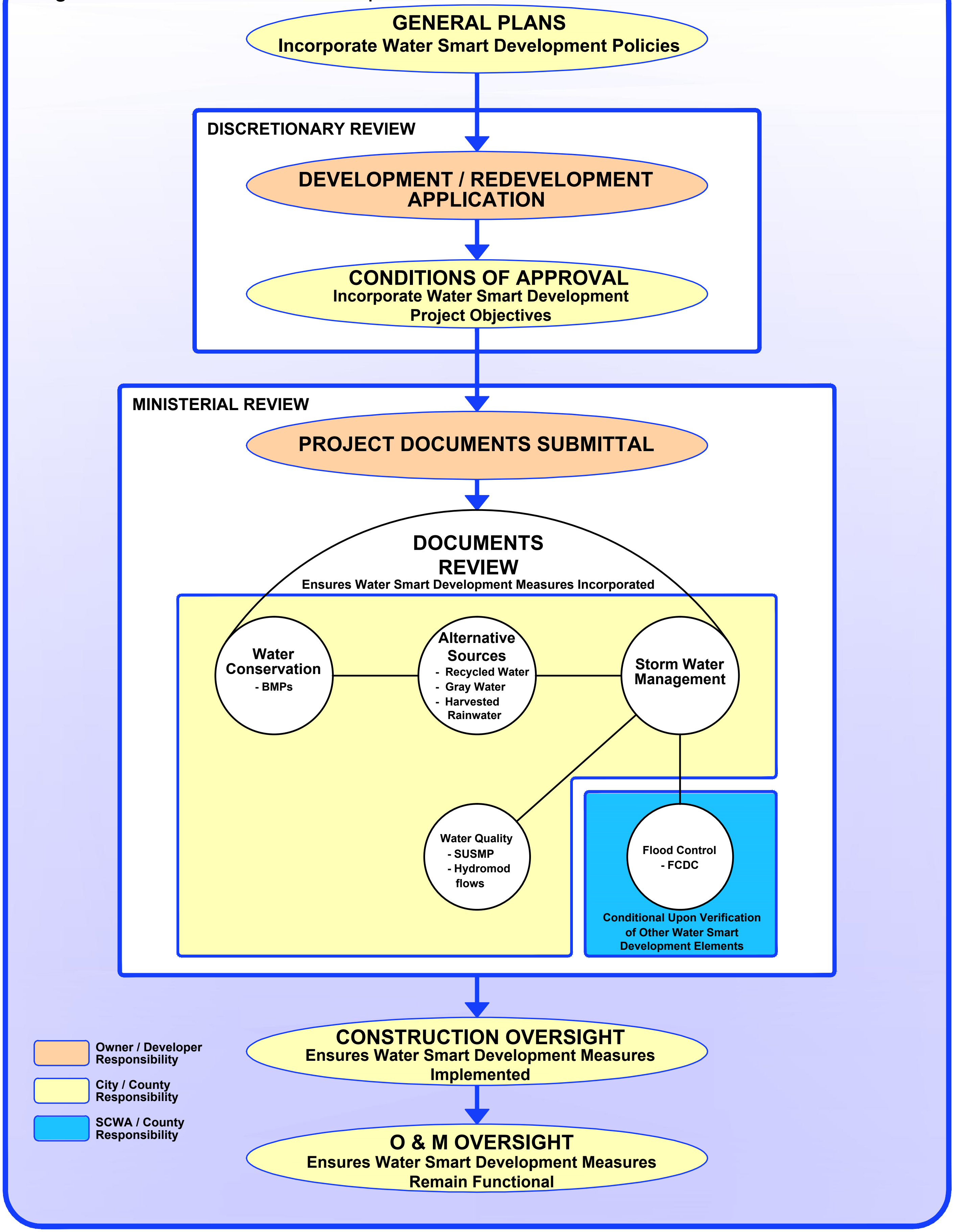
Chapter 4 also presents off-site, retrofit, and regional approaches to manage runoff beyond the immediate project site. The off-site[3] and retrofit approaches consider a range of options and scales. At the simplest level, local off-site solutions may be pursued to mitigate individual projects that do not meet storm water or flood control requirements. This might involve implementing the BMPs and techniques at another local project site or through applying in-lieu fees that support more regional storm water and flood control solutions. Retrofit options are also discussed for situations where it is feasible to modify an existing land use or site design to reduce storm water discharges.

[3] The intent for this Guidebook is to include discussion of opportunities for off-site, retrofit, and watershed scale, regional projects that support the broad water resource objectives of Water Smart Development. These broader objectives may or may not address or fully align with NPDES Permit requirements for offsetting impacts of on-site development. Agencies with project approval authority should be contacted directly to obtain guidance for specific NPDES permitting requirements.

1.6 Development Review Process

Figure 1-7 graphically depicts how Water Smart strategies can be incorporated into the development review process. At the municipal and regional scale, city and county general plans incorporate Water Smart policies to guide land uses and measures to reduce impacts. Specific practices or objectives are then integrated into new development or redevelopment project plans during the discretionary review process. Similarly, ministerial review for issuance of building permits, grading permits, etc. will be subject to governing agency review for compliance with Water Smart requirements. Figure 1-7 is color-coded to indicate which entities may have primary responsibility for overseeing the different steps of the process. Figure 1-7 may not specifically illustrate the exact process for every municipality in Sonoma County, but is offered as a general representation of an adaptable process that could be integrated into current practices.

Figure 1-7 Water Smart Development Review Process



The Water Smart Development Guidebook does not provide specific design parameters for the purposes of regulatory or permit compliance, nor does it recommend or exclude specific Water Smart features. Agencies with ministerial review responsibilities should be contacted directly to obtain guidance for specific Water Smart features that may require additional permitting coordination. Project approval authority is the responsibility of the appropriate governing agency. For example, for projects that require a building permit, project plans should be submitted to the local city or county development or permit review department for guidance on application of specific LID features into the site design.

In the ministerial review section of Figure 1-7, the project review process includes local flood control evaluation. The Water Agency's Flood Control Design Criteria Manual (FCDC) is the standard reference in the County for hydrology and hydraulics, providing criteria for the design of waterways, channels, and closed conduits. With the exception of the city of Healdsburg (which does not use the FCDC), all plans in the County submitted for hydrology/hydraulic review are subject to FCDC standards.

1.7 Approaches to Implement Water Smart Development Guidelines and Reduce Local Water Use

The most effective way to implement Water Smart Development practices is for individual communities to develop their own local Water Smart Development action plans that reflect the needs and desires of the local community. Local action plans should be flexible, accommodate for local conditions and priorities, and should include quantifiable targets for conservation, alternative sources, and storm water goals. The purpose of this guidebook is to provide local communities within Sonoma County a common reference that describes and identifies various treatments and measures for these topics. There are several ways for local communities to develop their own action plans. Below are three possible approaches:

Community Develops Reduction Target from Allowable Baseline Use Assessment

In this approach the local community will establish what the current allowable baseline water use is based on the current plumbing code and existing landscape ordinances. This provides the community with an allowable baseline that complies with current ordinances. From this baseline the local community would then set a water use reduction target (i.e. 15%, 20%, 30%) beyond the requirements of current state directives[4] and local codes and ordinances.

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[4] As discussed further in Chapter 2, Senate Bill X7-7 was passed in November 2009 to establish a statewide goal of reducing urban per capita water use by 20% by December 31, 2020. The bill requires all water suppliers that are subject to the Urban Water Management Planning Act to develop an interim and final water use target to achieve 20% statewide reduction in urban water use per capita by 2020. The targets must be set by July 2, 2011 and included in each water suppliers' water management plan.

<u>Community Develops Daily Allotment Based On Available Supply</u>

In this approach the community establishes a reliable estimate of the amount of water supply that is available for the community. The amount of water supply should be sustainable over the longer term. During the design and review of new development projects, land use planners and developers will need to demonstrate that the local water supply will accommodate the new development's water demand needs. Typically this can be measured as a daily allotment available for new development.

<u>Reduced Connection Fees for Compliance</u>

Through ordinances and local planning/zoning guidelines, the local community can establish a list of approved and recommended Water Smart Development measures. If the developer can demonstrate implementation of these measures (typically during the design review process), then the project's water connection fee can be reduced. The local community can set how such fee reductions would occur. In this approach the developer may have flexibility in selecting which options to implement from the locally approved measures.

As described above, the role of this guidebook is to provide a common reference document for the communities in Sonoma County to develop their own local action plans based on their specific needs. The methods to implement such measures locally will be determined by the individual communities. The local community may choose to follow one of the above processes, or draft their own approach that might be quite different but still achieves their local objectives. For example, one community may have high infiltration rates which enables the practical use of on-site LID type features to reduce runoff and promote infiltration and local groundwater supply reliability, whereas another community, due to poorly draining soils may have limited opportunities for practical LID approaches that rely on soil infiltration. In such areas, other approaches not relying on high soil infiltration capacity may need to be considered.

Whichever approach a local community takes to implement Water Smart Development practices, some method of accounting for the potential water savings and benefits should be developed. **Table 1-7** provides an introductory template to identify and account for water savings associated with water conservation, alternative water sources, and storm water management measures.

In the Water Smart Development accounting template of Table 1-7, treatments supported by the community are listed, unit water savings per treatment are identified, and net annual water savings can be estimated. The unit water savings applied to individual projects are totaled for the year to calculate the net annual water savings. This value can then be compared to the percent reduction target established in the community's action plan. Such an accounting template provides a snapshot of how much water the community saved that year through implementing Water Smart Development measures. Local communities can develop their own accounting methods which reflect their unique implementation plans.

In addition to the water savings accounting worksheet provided in Table 1-7, Appendix 3 contains three example checklists to guide the development plan review process. Planning checklists for the water conservation, alternative water sources, and storm water management topics are provided in Appendix 3. These checklists, or similar checklists prepared by individual communities, can be used by planners and developers to identify how projects use or apply Water Smart Development treatments to meet the local water conservation targets and goals. The checklists walk the developer through the site planning and implementation processes that are described in this guidebook. In responding to the questions in each of the three checklists the developer or project applicant can document which features are incorporated into the project design and the reasoning behind the proposed project design. Land use planners can review the information in the checklists and consider the responses during the project approval process. In contrast to Table 1-7 which is community based, the checklists of Appendix 3 are project based and can be used to track water savings tracking per individual project. The checklists of Appendix 3 can be used to inform the overall community accounting of Table 1-7.

Table 1-7: Example Water Savings Accounting Worksheet (annual totals for entire city/service district)

Water Smart Development Features	Estimated Savings per Unit	Estimated Number of Units Installed	Estimated Annual Water Savings	Percent of Local Target Goal
1. Water Conservation				
Educational and Outreach Programs				
Use of conservation targets in advertising and communications				
Increased public involvement in conservation initiatives				
Land Use Planning and Design for Conservation				
Development Site Planning				
Development sited to emphasize conservation (shading, wind aspect, etc.)				
Development located near source of recycled water				
Site and Building Layout Design				
Kitchens and bathrooms located closest to the water heater				
Landscaping designed to maximize irrigation efficiency				
Building Fixtures and Appliances – at minimum, must comply with local building code and Water Efficient Landscape Ordinance				
Development included high efficiency toilets and urinals				
Development included high efficiency showerheads				
Development included high efficiency kitchen and sink faucets				
Development included high efficiency clothes washing machines				
Development included high efficiency dishwashers				
Development included automatic rain shutoff controller for irrigation sprinklers				
Retrofit and Equipment Upgrades				
Commercial and Medical Appliances				
Installed commercial dishware sensors in restaurants and commercial kitchens				

Table 1-7: Example Water Savings Accounting Worksheet (annual totals for entire city/service district)

Water Smart Development Features	Estimated Savings per Unit	Estimated Number of Units Installed	Estimated Annual Water Savings	Percent of Local Target Goal
Upgraded water-efficient x-ray, vacuum pump, sterilizers, exhaust hoods, and water filters in medical facilities				
Alternative faucets and toilets				
Upgraded water-efficient faucets and toilets in businesses				
Automatic car washes retrofitted to increase water use efficiency				
2. Alternative Water Sources				
Rainwater Harvesting Systems				
Graywater Systems				
Clothes Washer Systems				
Simple Systems (less than 250 gallons per day)				
Complex Systems (more than 250 gallons per day)				
Water Recycling				
Urban Uses (indoor and outdoor)				
Other Uses (habitat enhancement)				
3. Storm Water Management				
Green Roofs				
Groundwater Recharge Functions				
Biofilters				
Permeable pavement				
Detention basins				
Totals				

Chapter 2
Reducing Water Use

2.1 Introduction and Need

Water in California, and particularly Sonoma County, serves essential health and societal needs, and supports agriculture, commerce, and industry. Because opportunities to secure new or additional water supplies and water rights are limited, reducing water use through conservation is the most efficient and sustainable approach to providing long-term water supply reliability. The drought conditions of 2007-2009 and increasing environmental considerations highlight the importance of water conservation.

The Sonoma County Water Agency (Water Agency) is committed to effectively manage the resources in its care for the benefit of people and the environment in its service area. In support of this mission, the Water Agency's 2013 Strategic Plan identifies water conservation as a key strategy for providing a reliable water supply over the long term. Promoting and coordinating water conservation efforts with its water contractors is an important approach to assist the Water Agency in maintaining water supply reliability within Sonoma County.

This chapter is organized into three sections. Section one describes state and national conservation standards and policies that help guide and direct conservation efforts; section two describes the existing Sonoma County conservation programs; and section three describes additional opportunities to conserve more water beyond the current baseline. The sub-sections of this chapter include:

- 2.2 State Conservation Directives
- 2.3 National Conservation Standards
- 2.4 Existing Sonoma County Programs to Reduce Interior Water Use
- 2.5 Existing Sonoma County Programs to Reduce Exterior Water Use
- 2.6 Conservation Implementation and Enforcement in Sonoma County
- 2.7 Opportunities for Additional Conservation
- 2.8 Estimating Potential Water Savings

Following the state and national standards described in Sections 2.2 and 2.3, Sections 2.4 – 2.6 together describe existing water use and conservation programs in Sonoma County. In this guidebook, a significant effort has been made to accurately describe and identify the extent of existing conservation programs. This is important for several reasons, including that it provides a basis for understanding what is already occurring and what more can be done. What additional conservation efforts can be achieved? This topic is the focus of the final two sub-sections of the Chapter. Section 2.7 identifies opportunities to increase water savings through implementation of new programs, technologies, and policies. Lastly, Section 2.8 seeks to summarize and quantify historic, present, and future water conservation efforts as a means to frame future conservation directions and policy development.

2.2 State Conservation Directives

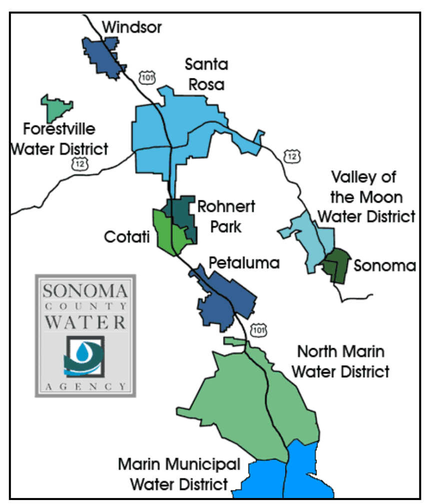
This section describes statewide water conservation programs, policies, and legislation that help guide local efforts in Sonoma County. Responsible water use and conservation has been promoted by the State of California and its Department of Water Resources (DWR) and State Water Resource Control Board (SWRCB) since the late 1970's following the severe 1976-1977 drought. The California Constitution and Water Code require that the State's water resources be used beneficially to the fullest extent possible, and that waste, unreasonable use, or unreasonable methods of water use be prevented. A number of legislative bills have been passed to address declining water supplies and efficient water use. These key legislative actions are described below.

Urban Water Management Planning Act

The California State Legislature enacted the Urban Water Management Planning Act (UWMP) in 1983. The Act requires every urban water supplier that directly or indirectly serves greater than 3,000 customers (or provides greater than 3,000 acre-feet annually) to adopt and submit an urban water management plan to DWR at least once every 5 years. These plans help water suppliers ensure that they have sufficient water supplies to meet the long-term needs of water customers during normal, dry, and multiple-drought years. A water shortage contingency plan is a component of the overall assessment and outlines stages of action for demand reduction by up to 50%.

As mandated by the 1983 UWMP Act, the Water Agency and local water retailers have prepared urban water management plans. These UWMPs are generally available from each entity's website. Sonoma County water retailers that must meet the requirements of the Act and release UWMPs updates include:

- City of Cotati
- City of Healdsburg
- City of Petaluma
- City of Rohnert Park
- City of Santa Rosa
- City of Sonoma
- Sonoma County Water Agency
- Sweetwater Springs Water District



- City of Sebastopol
- Valley of the Moon Water District
- Town of Windsor

As part of the UWMP development process, the Water Agency prepared and adopted a water conservation plan. This plan seeks to reduce water demand by over 9,800 AFY by 2030 (Jasperse pers. comm.). Additionally, in 2008 the Water Agency completed a detailed water demand analysis which evaluated various levels of water conservation efforts in order to project future reductions in water demand (Brown and Caldwell 2008). This report is discussed further in Section 2.8 *Estimating Potential Water Savings*.

Demand Management Measures (AB 1420)

In February 2007, Assembly Bill 1420 was passed to approve funding to implement water demand management measures described in local Urban Water Management Plans. The UWMPs require urban water suppliers to describe their current or planned water demand management measures. Under AB 1420, state water management grants or loans sponsored by DWR, SWRCB, and the California Bay-Delta Authority will provide funding to implement demand management projects including surface or groundwater storage, recycling, desalination, water conservation, water supply reliability, and water supply augmentation programs. DWR reviewed the Water Agency's 2010 UWMP and determined the Water Agency is currently implementing the BMPs consistent with AB 1420 (Sonoma County Water Agency 2011).

Statewide Water Conservation Goal

In November 2009, the Governor approved Senate Bill x7-7 (SBx7-7) establishing a statewide goal of 20 percent reduction in urban per capita water use by December 31, 2020. The bill requires every urban retail water supplier subject to the Urban Water Management Planning Act to develop a 2015 interim and a 2020 final water use target. To develop the 2020 water use target, water suppliers must first calculate their average gross water use. In an effort to standardize calculation of average gross water use and 2020 water use targets, SBx7-7 includes specific methods for water suppliers to use in calculating these values.

The bill states that the water use baseline, reported in gallons per capita per day (gpcd), be determined using one of the following methods:

1. a continuous 10-year period ending no earlier than December 31, 2004, and no later than December 31, 2010; or
2. a 15-year continuous period ending no earlier than December 31, 2004, and no later than December 31, 2010, if at least 10% of 2008 demand was met through recycled water use.

SBx7-7 outlines four methods to determine water use targets:

1. Assume the water use target equals eighty percent of the baseline per capita daily water use; or
2. Assume the water use target is the per capita daily water use calculated as the sum of the following performance standards:
    a. 55 gallons per capita daily indoor residential water use; plus
    b. Landscape irrigation standard of the local Model Water Efficient Landscape Ordinance; and
    c. 10-percent reduction in use from the baseline commercial, industrial, and institutional water uses by 2020; or
3. Assume the water use target equals ninety-five percent of the applicable Hydrologic Region Target, as set forth in the State Water Resource Control Board's draft *20x2020 Water Conservation Plan* (dated April 30, 2009); or
4. Use the Provisional Target Method developed in accordance with Water Code section 10608.20(b)(4). Details on this provisional method are included in Appendix D of Section M in the Department of Water Resources *Guidebook to Assist Urban Water Supplies to Prepare a 2010 Urban Water Management Plan*.

Each water supplier is responsible for determining its chosen method and reporting this method in their 2010 Urban Water Management Plan. Regardless of the chosen method, SBx7-7 states that per capita water use reduction should not be less than 5%. By 2015, 50% of the 2020 goal would need to be met by urban retail water suppliers. The Water Agency's contractors have developed water use targets in their individual UWMPs. If the 2020 target is not met, non-compliant urban water suppliers will not be eligible for state-sponsored water grants or loans beginning in 2021.

CALGREEN Building Code

The CALGREEN Code, the nation's first statewide green building standards code, became effective January 1, 2011. In 2007, Governor Schwarzenegger directed the California Building Standards Commission to adopt green building standards for residential, commercial, and public building construction for incorporation into 2010 building code updates.

The CALGREEN Code is a comprehensive and uniform regulatory code for all residential, commercial, hospital and school buildings, ensuring that every new building in California is built using environmentally advanced construction practices. These measures include provisions for material conservation, energy efficiency, environmental quality, and water efficiency and conservation.

Like California's building code provisions that regulate construction projects throughout the state, the mandatory CALGREEN code provisions are inspected and verified by local and state building departments.

Divisions 4.3 and 5.3 *Water Efficiency and Conservation* of the 2010 Green Building Standards Code require:

- 20 percent mandatory reduction in indoor water use (with voluntary goal standards for 30, 35 and 40 percent reductions included in Appendix A4 and A5);
- Weather or soil-moisture based irrigation systems for residential outdoor landscaping;
- Development of a water budget for nonresidential landscape irrigation;
- Separate meters or submeters for indoor and outdoor potable water use for new water service for landscaped areas between 1,000 square feet and 5,000 square feet; and
- Irrigation controllers and sensors (weather or soil moisture based) for outdoor irrigation of nonresidential landscape.

The following are CALGREEN mandatory standards for plumbing fixtures and fixture fittings for all new buildings:

Table 2-1: CALGREEN Plumbing Fixtures and Fixture Fittings Standards

Standards for Plumbing Fixtures and Fixture Fittings –Required Standards	
Water closets (toilets) – flushometer valve-type single flush, maximum flush volume	ASME A 112.19.2/CSA B45.1 - 1.28 gal (4.8 L)
Water closets (toilets) – flushometer valve-type dual flush, maximum flush volume	ASME A 112.19.14 and U.S. EPA WaterSense Tank – Type High-Efficiency Toilet Specification - 1.28 gal (4.8 L)
Water closets (toilets) – tank type	U.S. EPA WaterSense Tank-Type High-Efficiency Toilet Specification
Urinals, maximum flush volume	ASME A 112.19.2-CSA B45.1 - 0.5 gal
Urinals, nonwater urinals	ASME A 112.19.19 (vitreous china) ANSIZI24.9-2004 or IAPMO Z124.9 (plastic)
Public lavatory faucets Maximum flow rate – 0.5 gpm (1.9 L/min)	ASME A 112.18.1/CSA B125.1
Public metering self-closing faucets Maximum water use – 0.25 gal (1 L) per metering cycle	ASME A 112.18.1/CSA B125.1
Residential bathroom lavatory sink faucets: Maximum flow rate – 1.5 gpm (5.7 L/min)	ASME A 112.18.1/CSA B125.1

American Society of Mechanical Engineers (ASME), American National Standards Institute (ANSI), Canadian Standards Association (CSA)

High Efficiency Toilet Standards (AB 715)

In October 2007 the State adopted Assembly Bill 715 (AB 715) to establish new water use standards for toilets and urinals. Effective January 2014, all toilets and urinals sold or installed in California shall be 1.28 gallons per flush and 0.5 gallons per flush, respectively. A timeframe is outlined for manufacturers to report compliance based on models sold in California. The schedule mandates that 50% of toilets and urinals installed in the state meet the requirements by January 1, 2010, 67% by January 1, 2011, 75% by January 1, 2012, 85% by January 1, 2013, and 100% by January 1, 2014.

Statewide Retrofit on Resale (SB 407)

In October 2009, a senate bill was passed to impose a state mandated, local program to inspect and require that all building fixtures meet specific water use criteria prior to resale of a property. The bill establishes a 2014 requirement that all residential, multifamily and commercial buildings be equipped with high efficiency fixtures prior to the local building department issuing the final permit approval for building alterations/improvements of the property. All non-compliant plumbing fixtures must be replaced by property owners by 2017 for single family homes and 2019 for commercial and multifamily homes. By 2017, a seller or transferor of residential, multifamily or commercial real property must disclose to a purchaser or transferee, in writing, whether the property includes non-compliant plumbing.

Water Conservation in Landscaping Act (AB 325, AB 2717, AB 1881)

Recognizing that landscape irrigation comprises the single largest water use component in many developments, Assembly Bill (AB) 325 was passed in 1990 to promote the design, installation, and maintenance of water-efficient landscapes. A model landscape ordinance was drafted to help local land use agencies adopt or develop their own ordinances. Conservation goals, compliance mechanisms, and specific enforcement actions were left to local agencies and not outlined in the model ordinance. In 2001 the State reviewed the implementation of AB 325 and found a majority of land use agencies (90%) had adopted an ordinance, but that the ordinances were weakly structured with very little monitoring or enforcement actions (Western Policy Research 2001).

As a result of the AB 325 review process, AB 2717 was passed in 2004 to evaluate and recommend water use efficiency approaches for urban irrigated landscapes. The bill directed the California Urban Water Conservation Council (CUWCC) to convene a stakeholder task force composed of public and private agencies. The Task Force adopted a comprehensive set of 43 recommendations and concluded that the Department of Water Resources (DWR) should revise the Model Water Efficient Landscape Ordinance and upgrade the California Irrigation Management Information System (CIMIS).

The Water Conservation in Landscaping Act of 2006 (AB 1881) enacts many of the CUWCC Landscape Task Force recommendations, including requiring DWR to update the model landscape ordinance. AB 1881 requires local agencies to adopt the updated model ordinance (or equivalent) by January 1, 2010, or it would be automatically adopted by statute. Also, the bill requires the California Energy Commission (CEC), in consultation with DWR, to adopt, by regulation, performance standards and labeling requirements for landscape irrigation equipment, including irrigation controllers, moisture sensors, emission devices, and valves to reduce the wasteful, uneconomic, inefficient, or unnecessary consumption of energy or water (DWR 2009).

Model Water Efficient Landscape Ordinance

As a result of Assembly Bills 2717 and 1881, the *Model Water Efficient Landscape Ordinance* was updated in September 2009 and became effective on January 1, 2010.

The Model Ordinance requires submittal of a *Landscape Documentation Package* to the local planning agency as part of project plan or design review.

> *The Model Water Efficient Landscape Ordinance requires a Landscape Documentation Package including*: a completed water efficient landscape worksheet, a soil management report, a landscape design plan, an irrigation design plan, a grading design plan, and irrigation and maintenance schedules.

The Model Ordinance applies to:

- New construction and rehabilitated landscapes for public agency and private development projects (developer-installed single-family and multi-family projects) with a landscape area equal to or greater than 2,500 square feet (5,000 square feet if homeowner-installed) that require a building or landscape permit, plan check, or design review.
- Existing landscapes installed before January 1, 2010 with a dedicated or mixed use water meter and over one acre in size.
- Cemeteries (new and rehabilitated cemeteries over one acre in size must complete the water-efficient landscape worksheet; a landscape and irrigation maintenance schedule; irrigation audit, irrigation survey, and irrigation water use analysis performed by a certified landscape irrigation auditor; and prevent runoff from target landscape areas)

In compliance with the state law, Sonoma County collaborated with the Water Agency, cities, landscaping contractors, landscape architects, and other interested parties to develop a version of the State Water Efficient Landscape Ordinance that would meet or exceed the legislation, while at the same time provide a standardized or similar ordinance for adoption across the region. The City of Santa Rosa and other cities in Sonoma County have adopted or intend to adopt this Ordinance for their jurisdictions. The County of Sonoma adopted the Ordinance on December 8, 2009 for all unincorporated areas of Sonoma County. The Sonoma County Water Efficient Landscape Ordinance and the version adopted by the City of Santa Rosa are available at their respective websites.

Membership in California Urban Water Conservation Council

The Sonoma County Water Agency became a member of the California Urban Water Conservation Council (CUWCC) in June 1998. The CUWCC was created to promote collaboration between water utilities, environmental groups, and other interested parties in an effort to increase water conservation statewide. Through a signed memorandum of understanding (MOU) with CUWCC, the Water Agency pledged to (a) implement specific Best Management Practices (BMPs) as described in the MOU, (b) expedite reasonable water conservation measures in urban areas,

> *The Sonoma County Water Agency is the only wholesale water agency in the state to have 100% of its retail water agencies signatories to the California Urban Water Conservation Council and committed to implementing best management practices for water conservation. (Water Agency 2008)*

and (c) estimate water conservation savings from proven and reasonable conservation measures. The Water Agency implements all of the CUWCC's wholesale BMPs and some retail BMPs on behalf of some of its water retailers. All the Water Agency's retailers are signatories to the CUWCC MOU and are actively implementing the BMPs.

California Water Plan

In 1957, DWR began publishing the *California Water Plan* to describe current water supplies, water usage, and future water demand. The California Water Plan is updated every five years and has a planning horizon of 30 to 50 years.

The California Water Plan identifies opportunities and challenges to balancing the state's water supply and demand and is primarily a strategic guidebook for implementation statewide. The plan presents data gathered over the previous five years and evaluates water supplies for agricultural, urban, and environmental water uses. The plan identifies gaps between water supply and uses. It also identifies existing and proposed statewide water demand and supply augmentation programs and projects to address statewide needs.

Integrated Regional Water Management (IRWM)

Integrated Regional Water Management (IRWM) is an initiative identified in the 2005 California Water Plan Update (DWR 2005). Its purpose is "to promote integrated regional water management to ensure sustainable water uses, reliable water supplies, better water quality, environmental stewardship, efficient urban development, protection of agriculture, and a strong economy."

The IRWM initiative supports the fostering of regional partnerships, development and implementation of integrated regional water management plans, and diversification of regional water portfolios. The program is overseen by the DWR and SWRCB, which issue Proposition 84 grant funding for local support of the IRWM initiative. The Water Agency has been an important regional partner for both the San Francisco Bay and North Coast IRWM efforts.

2.3 National Conservation Standards

Besides California-based conservation efforts, it is also useful to recognize nationally-targeted conservation programs. To encourage efficient water and energy use throughout the nation, federal regulatory agencies established programs to set conservation standards and provide conservation education and training programs. **ENERGY STAR** is a joint program of the U.S. Environmental Protection Agency (USEPA) and the U.S. Department of Energy (USDOE). The program was introduced by the USEPA in 1992 as a voluntary labeling program designed to identify and promote energy-efficient products to reduce greenhouse gas emissions (USEPA 2009a). Only products that meet strict energy efficiency guidelines set by the USEPA and the USDOE can carry the ENERGY STAR label. The ENERGY STAR label is included on over 60 product categories, including major appliances, office equipment, lighting, home electronics, new homes, and commercial/industrial buildings.

ENERGY STAR-labeled products deliver the same or better performance as comparable models. The USEPA estimates that families can save about a third of their energy bill by purchasing ENERGY STAR labeled products (USEPA 2009a). In addition to devices which are simply energy saving (CFL or LED light bulbs, low-energy computer monitors, etc.), the program has also greatly influenced the widespread use of technological innovations that are both water and energy-efficient, including dishwashers, high efficiency clothes washers, on-demand tankless water heaters, and more.

WaterSense is a partnership program sponsored by the USEPA. Similar to the ENERGY STAR program, the USEPA created WaterSense to serve as a national product label to help Americans identify high-performance, water-efficient products and to support professional certification programs that embrace and encourage the use of water-efficient design. The USEPA establishes the minimum requirements for efficiency and performance in order to earn the WaterSense label. Products bearing the WaterSense label are generally 20 percent more water-efficient than similar products in the marketplace (USEPA 2009b).

The WaterSense program has the ability to influence a broader audience, including manufacturers, retailers and distributors, promotional partners, and landscape irrigation professionals through WaterSense certification training and partnership programs. In collaboration with WaterSense partners, the USEPA hopes to encourage water-efficient behaviors and increase the popularity of water-efficient products.

Table 2-2 compiles current national efficiency standards for residential and commercial water-using fixtures and appliances, including standards established by the ENERGY STAR and WaterSense programs (USEPA 2008a).

Table 2-2: Water-Using Fixtures and Appliances Standards

Water Use	Standard for Residential Use	Standard for Commercial Use
Toilets	Currently (2013), the U.S. efficiency standard for new residential toilets is 1.6 gallons per flush (gpf). The WaterSense standard for new toilets is 1.28 gpf with 350 grams of waste removal.	Commercial toilets - 1.6 gallons per flush (gpf). Commercial urinals - 1.0 gpf. WaterSense urinals – 0.5 gpf or less
Showers	Maximum water output of 2.2 gallons per minute (gpm) at a pressure of 80 pounds per square inch (psi). Standards for WaterSense fixutres are 2.0 gpm at 80 psi.	No standards have been established for commercial showerheads.
Water Use	**Standard for Residential Use**	**Standard for Commercial Use**
Faucets	Bathroom faucets - 2.2 gpm at 60 psi or less WaterSense standards: - maximum 1.5 gpm at 60 psi - minimum of 0.8 gpm at 20 psi Kitchen faucets – 2.2 gpm	Commercial bathroom faucets - Maximum of 0.5 gpm at 60 psi Commercial kitchen faucets – 2.2 gpm
Clothes Washing Machines	Less than 8 gallons of water per cycle, per cubic foot. Energy Star standards are less than 4.5 gallons per cycle per cubic foot.	Maximum of 9.5 gallons per cycle, per cubic foot
Dishwashers	On January 1, 2010, new standard dishwashers must operate at less than or equal to 6.5 gallons per cycle, and new compact dishwashers must operate at 4.5 gallons per cycle or less. Effective July 1, 2011, the requirement reduces to 5.0 gallons per cycle and 3.5 gallons per cycle, respectively. Standards for WaterSense fixtures are less than 4.25 gallons per cycle.	Energy Star standards for both high- and low-temperature dishwashers as follows: High-Temperature: 0.70 gallons per rack Low-Temperature: 1.0 gallons per rack

2.4 Existing Sonoma County Programs to Reduce Interior Water Use

This section presents an overview of existing conservation programs for interior water use in Sonoma County. These existing efforts represent a 2010 baseline condition for indoor water use practices and existing conservation programs. This section is organized as follows:

2.4.1 Interior-focused Educational Programs

2.4.2 Interior Water Use Assessment and Equipment Installation Programs

2.4.3 Interior Rebate and Discount Programs

2.4.1 Interior-focused Educational Programs

Residential Educational Programs

Educating the public about the importance of using water wisely is essential to achieving water conservation goals. People can change their water use behavior when provided with accurate consumption information. This is especially true when residents will benefit from potential cost savings. A commitment to conservation is also strengthened when residents have a shared and broader understanding about water needs for Sonoma County. To achieve this, the Water Agency and other local retailers maintain public information programs that use multiple strategies to convey information. Printed mailings are used to disseminate information, including pamphlets, brochures, newsletters, and bill inserts. These printed materials seek to set voluntary goals and highlight conservation programs and tips for water reduction and conservation. Other media approaches including traveling exhibits, special events like the County Fair, information centers, public television, radio, print, slide/films, and video advertising conservation campaigns are also used to inform the public (Sonoma County Water Agency 2009).

The Water Agency and local retailers all maintain web pages dedicated to water conservation. These pages list and summarize voluntary reduction goals and provide references for customers, including water reduction tips, conservation rebate and incentive programs, and links to other information sources. Some retailers, such as the City of Santa Rosa and the City of Petaluma, have interactive conservation calculators to help customers estimate savings using different methods to reach conservation goals.

In addition to these broad-based communications, the Water Agency and some local retailers also respond to requests from individual consumers, businesses, and organizations that want water education and conservation information. Upon request, public or conference speakers and tour leaders are available to educate individuals and organizations about water conservation. Water Agency staff gives presentations to community groups, neighborhood associations, and other interested parties about water conservation. The Water Agency offers free environmental education programs for schools within their service area. These programs are designed to support California education standards while fostering water conservation and environmental stewardship. There are a variety of activities available for school children of all ages, including assembly programs, watershed field trips, recess activities, and classroom presentations.

Sonoma County Water Agency Community Outreach Programs:

✓ **2006 and 2007 Summer Water Wisely Campaign**

In an effort to reach out to local children and promote outdoor water conservation, the Water Agency devised two characters to promote water conservation efforts. Lola the ladybug and Wilson the worm are the Water Agency's water conservation mascots or "spokes-bugs." They appeared in television and radio commercials, newspaper ads, billboard ads, movie theater ads, and on websites. The messages were provided in both English and Spanish.

✓ **2008 Less is More Campaign**

The Less is More conservation campaign was initiated in 2008 to educate the community about the Water Agency's water supply system and the need to protect it. The campaign promotes a list of top 10 water conservation tips that incorporate water-saving measures for indoors and outdoors. The "Less is More" slogan and information were relayed to the public via websites, movie theater ads, radio spots, newspaper articles and ads, bus panels, mall posters, and information brochures – in English and Spanish languages.

✓ **2009 Save our Water Campaign**

In 2009, the Water Agency began participating in the statewide "Save Our Water" campaign.   The Water Agency's campaign advertisements included additional radio ads, bus panel ads, mall banners, movie theater ads, and weekly water storage updates in Sonoma and Marin counties as part of a statewide effort.

✓ **2013 20 Gallon Challenge**

The Water Agency, through the Sonoma-Marin Saving Water Partnership, implemented the 20 Gallon Challenge from May 2013 to November 2013. The 20 Gallon challenge was prompted by Lake Mendocino water storage levels being the lowest they have been since the 1970s when a major drought gripped most of the state. The campaign encouraged residents to "take the pledge" to save at least 20 gallons of water per day and enter for a chance to win water-conserving prizes, such as high efficiency clothes washers and toilets, landscape design, and graywater or rainwater catchment systems. Visit www.20gallons.org for more information.

These outreach efforts support the CUWCC-Water Agency MOU and statewide directives described in Section 2.2 above.

Commercial Educational Programs

In addition to the outreach and educational approaches described above, which generally apply to residential users, several additional informational programs are directed to commercial enterprises. These include conferences for business leaders and conservation articles for a variety of business publications, which are provided through a cooperative partnership between the Water Agency and the Sonoma County Economic Development Board. Additionally, the Water Agency is a partner of the Sonoma County Business Environmental Alliance (BEA), whose mission is to promote responsible environmental practices by local businesses through business-to-business communication and support. Through annual meetings and workshops, the BEA provides water conservation resources targeted at the commercial sector. More information on BEA's outreach efforts is available on their website: http://www.sonoma-county.org/bea.

Sonoma County Green Business Program is a partnership of government agencies and utilities that assists, recognizes, and promotes local organizations, focusing on small- to medium-sized consumer-oriented businesses that volunteer to operate in a more environmentally responsible way. To be certified, participants must be in compliance with all environmental regulations and meet program standards for conserving resources, preventing pollution, and minimizing waste. Certified green businesses receive recognition through a ceremony hosted by the Sonoma County Board of Supervisors; listing on the Sonoma Green Business Program and the Bay Area Green Business Program websites; media coverage, promotional events, and special recognition; window decals, certificates, and promotional materials for the business; and the Green Business logo to use in advertising. More information on this program and certification requirements is available on their website: http://www.sonoma-county.org/sonomagreen.

GreenPlumbers is a certificate program offered worldwide by the Master Plumbers and Mechanical Services Association, and it is gaining recognition in Sonoma County. Goals of the program are to provide specific training for local plumbers for water and energy conservation services and provide special recognition for trained personnel. The program offers accreditation in environmental and technical issues, including solar hot water systems, water-efficient technologies, and inspection report services. GreenPlumbers-certified staff can increase business marketability and comply with requirements of some green business programs. Greater detail about this program is available at the GreenPlumbers website: http://www.greenplumbersusa.com.

2.4.2 Interior Water Use Assessment Programs

Section 2.4.2: Interior Water Use Assessment Programs
- Residential Use Assessments
- Commercial Use Assessments

Residential Use Assessments

Most water retailers in the Water Agency service area provide free indoor water use surveys for service area customers. These programs are designed to help residents identify sources of water waste and improve interior water efficiency. The surveys include: evaluating indoor water using appliances, checking plumbing fixtures for leaks, measuring flow rates of all showerheads and faucets, and checking toilet flush volumes.

During the home assessment, residents are given information about appliance and fixture rebate programs available in their service area (including high efficiency toilets, clothes washers, etc.). Once the home survey is completed, a summary report is given that describes the current water use status and specific water savings recommendations for the specific home. To participate, residents must contact their water providing agency and schedule an appointment.

Free Water Saving Devices
SCWA and other Sonoma County water retailers offer free low flow and water saving devices including faucet aerators, efficient showerheads, toilet flappers, and dye tabs to check for toilet leaks.

The following examples highlight relatively simple, yet significant, potential savings afforded by home water use assessment programs. These water savings are estimated by the California Urban Water Conservation Council (CUWCC 2009):

- A family of four can save 1,700 gallons of water per year by simply installing low-flow kitchen and bathroom aerators.
- Fixing faucet leaks can save anywhere between 190-3,290 gallons per month.
- Fixing silent toilet leaks and can save up to 30-500 gallons of water per month.

Petaluma s Certified Water Conserving Residence Program
The Certified Water Conserving Residence program was developed as a collaborative effort between the City of Petaluma's Water Resource and Conservation Department and the North Bay Association of Realtors in order to increase participation in the City s water use survey program. This program is designed for home sellers to market their house as water efficient and free of leaks, both indoors and outdoors.

To obtain certification, homeowners must participate in a water use survey and implement all priority one recommendations identified in the survey. Upon implementation of the priority one items and completion of a post installation survey, the homeowner will receive a certificate stating that the home is certified by the City of Petaluma as a water conserving residence. The certificate is valid for 5 years.

Commercial Use Assessments

Similar to the residential programs described above, commercial water use assessments are offered through local water retailers at no charge. The Sonoma County Business Environmental Alliance promotes this service for commercial customers located within the Water Agency's service area.

Free Devices for Commercial Users

Free water saving devices for commercial users include hose nozzles, faucet aerators, and showerheads.

The City of Petaluma offers free water conservation signs for hotels and restaurants. Signs can be placed in guest rooms or on table tops and encourage patrons to conserve water by re using towels and bedding and by making special requests for water.

Water conservation can lower business costs by reducing water, wastewater, and energy expenses. Participation in the water use assessment generally includes staff interviews to discuss operational or business-related water uses, a walk-through tour of the business or facility, and a leak/flow rate evaluation of indoor water fixtures. Once completed, a written description of water use patterns is provided with recommendations to increase efficiency for the business. Based on the site findings, water retailers offer financial incentives (usually in the form of rebates) or free devices to offset the cost of implementing conservation recommendations. To participate, businesses must contact their local water provider to schedule an appointment.

2.4.3 Interior Rebate and Discount Programs

Section 2.4.3: Interior Rebate and Discount Programs

- Water Efficiency Toilet Programs
- Clothes Washer Rebate Programs
- Other Commercial Equipment Rebate Programs
- Municipal Water Efficient Technology Programs

High Efficiency Toilet Programs

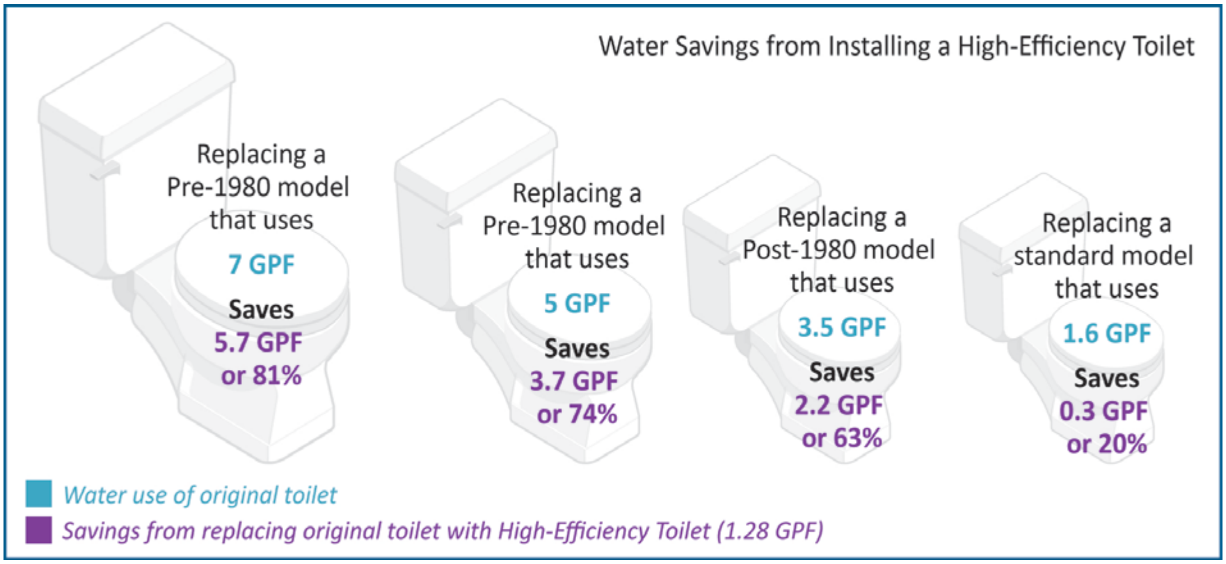
Residential

As introduced in Chapter 1, toilets account for about 33% of residential indoor water consumption in California (Pacific Institute 2003). Toilet replacement programs are available to those who wish to replace older toilets with new high-efficiency models. High-efficiency toilets (HET) go beyond the current national standard of 1.6 gallons per flush (gpf) and use 1.28 gallons or less per flush. The latest HET models use only 0.8 gpf (BuildingGreen 2009). In general, replacing older toilets can result in significant water savings. For example, replacing a typical 3.5 gallon toilet with a HET model can save a family of four 11,096 gallons of water per year (MWRA 2012). **Figure 2-1** illustrates water savings from using a high-efficiency toilet as compared to older models.

Water Conservation Fact:

If every US home replaced all toilets with HETs, the yearly estimated savings would be 640 billion gallons or two weeks of flow over Niagara Falls. (USEPA 2008b)

Figure 2-1: Chronology of Toilet Water Use and Savings



Toilet rebate programs are implemented by all water retailers and sanitation districts and zones within the Water Agency's service area. The rebate amount and qualifications vary by retailer, but generally provide $50 to $150 per fixture and require an inspection of the fixture prior to or after installation. In addition to rebate offers, sanitation districts and zones operated by the Water Agency have also offered "direct install" or free installation of the fixture.

Commercial High Efficiency Toilet Programs

Commercial toilet replacement programs are similar to residential programs: they aim to replace older toilets with high-efficiency models. Commercial toilet replacement programs conducted by water retailers and sanitation districts and zones within the Water Agency service area offer between $50 and $300 per fixture and may provide free installation. Urinals are another common source of excessive water consumption in commercial buildings. While the national standard for urinals set in 1994 is 1 gallon per flush, older fixtures can use up to 5 gpf. Newer, high-efficiency urinal (HEU) models now range from 0 (no-water urinals) to 0.125 gpf. The potential annual water savings per HEU is estimated at roughly 16,000 – 23,000 gallons for an office setting, and 10,600 – 15,000 gallons for school restrooms. The higher savings estimates are based on savings compared to no-water urinals (MMWD 2009). Agencies that currently provide rebates for installation of HEUs include the City of Petaluma, City of Santa Rosa, City of Rohnert Park, and all Water Agency-operated sanitation districts and zones. Rebates provided vary up to $450 per HEU and free installation may also be provided.

Dual flush toilets allow variable flushing rates: 1.28 1.6 gpf for solids and 0.8 1.1 gpf for liquids. ***Dual flush toilets are installed in many of SCWA s office facilities.***

Clothes Washer Rebate Programs

Residential

Water retailers throughout Sonoma County offer rebates for residential high-efficiency clothes washers (HECW). The program only credits HECWs that are listed as "Tier 3" on the Consortium for Energy Efficiency's Clothes Washer Qualifying List. Residential HECWs can save up to 50% of the water used and 65% of the energy used as compared to conventional, top-loading machines (NMWD 2009). The total rebate amount offered varies slightly with individual retailers, and generally provides \$75 to \$125 per HECW. Rebates are often supplemented by the Pacific Gas and Electric Company (PG&E) and federal and state grant programs.

Commercial and Multi-Family Washer Rebate Programs

Similar to the rebate program for residential HECWs described above, a commercial program is also available for businesses and multi-family residential complexes seeking to replace older washing machines. Replacing washers in laundromats, multi-family properties, and businesses/institutions with on-site laundry services can lead to substantial water and energy savings. Commercial washer rebate programs typically provide rebates only where the HECWs meet the Consortium for Energy Efficiency's standards for commercial, family-sized water initiative. Commercial HECWs can save up to 30% water use and 50% energy use compared to conventional top-loading machines used in commercial applications (CEE 2009). The total rebate amount offered per unit varies with retailers and generally provides between \$125 and \$450 per HECW. Again, commercial washer rebate programs are commonly supplemented by PG&E and grant funding.

> ***Water Conservation Fact:***
> *By replacing an old clothes washer with a new high efficiency washer a family can save 5,100 gallons of water per year. (City of Cotati)*

Other Commercial Equipment Rebate Programs

Beyond the rebates for toilets and washers described above, water retailers and sanitization districts and zones within the Water Agency's service area provide additional rebate offers for the following commercial appliances. These include:

- Water-efficient ice machines (up to \$600)
- Connectionless food steamers (up to \$600)
- Medical equipment steam sterilizers (up to \$700)
- Dry vacuum pumps (up to \$250)
- Water brooms (up to \$700)
- Cooling tower pH controllers (up to \$1,500)
- Connectivity controllers (up to \$5,000)

Restaurant/Laundromat Rate Discounts

The cities of Santa Rosa and Petaluma offer discounts for wastewater connection fees for restaurants and laundromats that install and use the most water-efficient hardware, fixtures, and appliances. In Petaluma, applicants are eligible for a 50% reduction in the wastewater connection fee upon city approval. A similar fee reduction for businesses in the City of Santa Rosa is determined on an individual basis.

Sonoma County Energy Independence Program (SCEIP)

The County of Sonoma SCEIP program also provides property owners the opportunity to finance the installation of high efficiency toilets, low flow shower heads, bathroom sink aerators, rain cisterns, hot water recirculation systems and on-demand hot water systems, demand initiated or instantaneous hot water heaters, demand initiated water softeners, and hot water pipe installation. Financing for commercial upgrades are provided for pre-rinse spray valves, waterless or high-efficiency urinals, and bathroom sink aerators.

Municipal Water-Efficient Technology Programs

Under its Water-Efficient Technologies Program, the Town of Windsor offers financial incentives (up to $10,000) to commercial, industrial, and institutional water customers to implement process and equipment changes that reduce water use by at least 50,000 gallons per year. Rebate amounts vary based on sustained water savings achieved.

- For water only service accounts, the rebate amount is $4.50 per thousand gallon reduction in water use per year - or 50% of the project cost (excluding labor), whichever is less.
- For water and sewer accounts, the rebate amount is $11.40 per thousand gallon reduction in water use per year - or 50% of the project cost (excluding labor), whichever is less.
- Maximum rebate is $10,000 per project.

The City of Santa Rosa sponsors a Sustained Reduction Rebate Program, which offers rebates of $200 for every 1,000 gallons of sustainable reduction in water use and wastewater flow that is achieved through measures other than toilet/faucet/showerhead replacement. Additional information about how to participate in this program is available by contacting the City's Water Conservation Department.

Sanitation districts and zones operated by the Water Agency sponsor a similar sustainable reduction rebate program. Rebates are offered for every gallon of water saved. For example, the Sonoma Valley County Sanitation District rebates $3.56 for each gallon saved, while the Occidental County Sanitation District rebates 20 cents for each gallon saved.

The City of Petaluma offers a customized Commercial, Industrial and Institutional (CII) water savings incentive program, which provides financial incentives for CII accounts that have participated in the City's free Water Use Assessment Program (see discussion above on *Water Use Assessment Programs – Commercial Use Assessments*). After the commercial water use assessment has been completed, the City will analyze the recommendations of the findings report and determine if the site qualifies for a financial incentive. Financial incentives will be provided after analyzing the cost-benefit ratio of each proposed project. Incentives are tailored to each site, depending upon varying water savings potentials.

2.5 Existing Sonoma County Programs to Reduce Exterior Water Use

This section describes existing conservation programs to reduce outdoor water use in Sonoma County and is organized according to the following three sub-sections:

2.5.1 Outdoor Water Educational Programs

2.5.2 Exterior Water Use Assessment and Equipment Installation Programs

2.5.3 Exterior Rebate and Discount Programs

2.5.1 Outdoor Water Educational Programs

Section 2.5.1: Outdoor Water Educational Programs
- Residential focused Education Programs
- Commercial focused Education Programs
- Programs that Focus on Simple Outdoor Water Saving Tips

The same approach to educating the public about the importance of using water wisely indoors is also applied to outdoor water use. Several of the outreach and educational programs mentioned above in Section 2.4 are also applied to outdoor water conservation education. However, the Water Agency and its retailers also broadcast information specific to exterior conservation. In addition to website links to other outdoor water savings ideas and tips, the following outdoor water tools are available online for interested parties:

- Educational videos and tutorials are offered on the City of Petaluma and the North Marin Water District websites.
- The City of Santa Rosa's website includes a water use efficiency calculator to determine the appropriate irrigation needs for specific landscapes. Using this calculator, customers can easily input landscape type and area information and receive instant results showing both outdoor water goals and actual water use for the past two years. Based on the differences between actual use and appropriate use, individuals can

California Irrigation Management Information Systems (CIMIS) *is a network of over 120 automated weather stations operated throughout the state by DWR. Within Sonoma County, CIMIS stations are located in Bennett Valley, Healdsburg, Santa Rosa, Petaluma, Valley of the Moon, and Windsor. These stations are used to predict the local area water needs. More information on station locations and data is found with the appropriate water retailer or the CIMIS online information center: http://wwwcimis.water.ca.gov/cimis/info.jsp.*

implement different measures to conserve or more efficiently use water to reach goals.

- Sonoma County Water Agency hosts the contents of the Water Wise Gardening CD for Sonoma and Marin Counties on its conservation webpage. This informational website provides extensive lists of plants specifically adapted to the local climate, virtual garden tours, and offers tips and ideas for creating water-efficient landscapes.

- California Irrigation Management Information Systems (CIMIS) stations provide evapo-transpiration (ET) data characterizing on-site evaporation conditions. This data allows individuals to manage landscape irrigation by matching watering times and amounts with the current ET rates. The City of Santa Rosa offers a turf-time phone line and website which provides current weekly watering recommendations based on real-time information from Santa Rosa's CIMIS station.

Exterior water use education is also provided through public demonstration gardens and local classes and seminars. Local demonstration gardens are operated by the City of Cotati (La Plaza Garden), the City of Santa Rosa (Luther Burbank Home and Gardens and at the City's Municipal Services Center South Building), City of Petaluma, City of Sonoma, and Town of Windsor. These gardens are open to the public and provide examples of trees, plants, and groundcovers that are especially suited to the local climate.


A low water demand garden

Water seminars are held on a regular basis by the City of Santa Rosa, City of Petaluma, City of Sonoma, and the Valley of the Moon Water District. These seminars usually include demonstrations and presentations about installing and using drip or efficient irrigation equipment, and about selecting and managing low water use plants suitable to the local climate.

Commercial-focused Educational Programs

Several informational programs specifically directed to commercial customers are also offered in addition to those described above (e.g., Sonoma County Economic Development Board, the Sonoma County Business Environmental Alliance, GreenPlumbers). This includes the Qualified Water Efficient Landscaper Certificate Program (QWEL), which is supported by the Water Agency and its retailers. QWEL is one of two approved USEPA WaterSense Irrigation Auditor training programs in the nation, and was developed in cooperation with the California Landscape Contractors Association, the Water Agency, City of Santa Rosa, and Santa Rosa Junior College. The Program provides training for local landscape professionals to reduce landscape water demand by incorporating greater water efficiency in landscape design, maintenance, and operation. In order to receive certification, landscapers are required to attend educational classes that are based on the principals of proper plant selection for the local climate, irrigation system design and maintenance, and irrigation system programming and operation. QWEL graduates are posted on supporting agencies' websites and listed on brochures mailed out to customers. More information on the program can be found on the QWEL website at: http://www.qweltraining.com/.

Bay Friendly Landscaping is a holistic approach to gardening and landscaping that works in harmony with the natural conditions of the San Francisco Bay Watershed. Bay-Friendly practices foster soil health, conserve water and other valuable resources while reducing waste and preventing pollution. In 2010, the Russian River Friendly Landscaping Guidebook was also developed for the North Bay using Bay Friendly Landscaping as a model.

The City of Santa Rosa, City of Petaluma, City of Sonoma, and the Valley of the Moon Water District also offer professional landscape workshops throughout the year to provide demonstrations and presentations on efficient irrigation equipment, and selection and management of drought-tolerant plants.

Programs that Focus on Simple Outdoor Water Savings Tips

The outreach and educational programs described above typically provide easily understood and achievable tips to save water outdoors. **Table 2-3** below shows the City of Cotati's outdoor water conservation guidance. This guidance is also generally representative of other municipal efforts in the County.

Table 2-3: City of Cotati's Outdoor Water Conservation Guidance

City of Cotati <http://www.ci.cotati.ca.us/sections/services/water-conservation-tips.cfm#outdoor>	
Irrigation	▪ Direct downspouts and other runoff towards shrubs and trees, or collect and use for your garden. ▪ Check your sprinkler system frequently and adjust sprinklers so only your lawn is watered and not the house, sidewalk, or street. ▪ Use sprinklers for larger areas of grass. Water small patches by hand to avoid waste. ▪ Minimize evaporation by watering during the early morning hours, when temperatures are cooler and winds are lighter. ▪ Adjust watering schedules each week to match seasonal weather conditions and landscape requirements and set watering cycles to shorter periods according to the season. ▪ Install a rain shut-off device on your automatic sprinklers to eliminate unnecessary watering. ▪ Use a screwdriver as a soil probe to test soil moisture. If it goes in easily, don't water. ▪ Teach your family how to shut off your automatic watering systems. Turn sprinklers off if the system is malfunctioning or when a storm is approaching. ▪ Check outdoor faucets, pipes, and hoses for leaks. ▪ Report significant water losses from broken pipes, fire hydrants or errant sprinklers to the property owner. ▪ Know where the master water shut-off valve for your home is located.

Lawn care	▪ Aerate your lawn. Punch holes in your lawn about six inches apart so water will reach the roots rather than run off the surface. ▪ Adjust lawn mowers to a higher setting. Longer grass shades root systems and holds soil moisture better than a closely clipped lawn. ▪ Regularly weed lawn and garden areas. Weeds compete with other plants for nutrients, light, and water.
Plant placement and care	▪ Plant during the spring or fall when the watering requirements are lower. ▪ Landscape with low water demand trees, plants and groundcovers. ▪ Group plants with the same watering needs together. ▪ More plants die from over-watering than from under-watering. Be sure only to water plants when necessary. ▪ Use drip irrigation for shrubs to apply water directly to the roots. ▪ Leave lower branches on trees and shrubs and allow leaf litter to accumulate on top of the soil. This keeps the soil cooler and reduces evaporation. ▪ While fertilizers promote plant growth, they also increase water consumption. Instead, start a compost pile. Using compost when planting adds water-holding organic matter to the soil. ▪ Use a layer of organic mulch around plants to reduce evaporation and save hundreds of gallons of water a year. ▪ Use ice cubes to water hanging baskets, planters, and pots to eliminate water overflow.
Other outdoor tips	▪ Avoid use of recreational water toys that require a constant flow of water (e.g., Slip ‘n Slides). ▪ Use a broom instead of a hose to clean driveways or sidewalks and save up to 80 gallons of water every time. ▪ Check evaporative cooling systems annually for higher efficiency. Also, direct the water drain to a flowerbed, tree, or your lawn. ▪ Equip ornamental water features (fountains and ponds) with recirculating water systems and avoid spraying water into the air. Trickling or cascading fountains lose less water to evaporation. ▪ Install covers on pools and spas and check for leaks around your pumps, especially if you have an automatic refilling device. And when backwashing your pool, consider using the water on your landscaping. ▪ Check water meter readings and bills to track water usage.

City of Cotati 2009

2.5.2 Exterior Water Use Assessment and Equipment Installation Programs

Section 2.5.2: Exterior Water Use Assessment and Equipment Installation Programs
- Water Use Assessments
- Free Outdoor Water saving Devices

Water Use Assessments

Generally conducted during the interior water use assessments (Section 2.4 above), outdoor water use assessments are also provided free of charge by the majority of water retailers in Sonoma County. The following items are evaluated for efficiency and general condition:

Residential irrigation water use accounts for nearly 33% of the total water use during peak summer months (MMWD 2009)

Survey technicians teach customers how to read water meters so they can keep track of water usage. Once the assessment is completed, a summary report is provided that describes the current water use status and specific water savings recommendations. Customers may also receive a free custom irrigation schedule based on site-specific landscape conditions. Exterior water use assessments are conducted at residences and commercial business properties.

Based on the assessment results, retailers may offer financial incentives (usually in the form of rebates or discounts) to help offset the cost of implementing conservation recommendations.

Free Outdoor Water-saving Devices

The use of automatic shut-off nozzles for outdoor water hoses is promoted as a simple conservation technique. Several retailers, including the cities of Petaluma, Santa Rosa, Sonoma, and the Valley of the Moon Water District, offer these devices free of charge to service area customers.

Automatic shut-off water hose nozzle

The City of Petaluma also lends free catch cans to help customers determine the distribution efficiency of their irrigation systems. By placing the catch-cans within the irrigated area, customers are able to estimate how evenly water is being distributed. By ensuring that water is being applied uniformly, system run-time can be reduced.

Catch-cans (QWEL 2009)

2.5.3 Exterior Rebate and Discount Programs

Section 2.5.3: Exterior Rebate and Discount Programs
- Efficient Irrigation Programs
- Other Rebate Programs

Efficient Irrigation Programs

Water retailers offer multiple programs designed to improve the efficiency of landscape irrigation and reduce exterior water use. These programs include turf-removal/conversion, landscape amendments, and efficient irrigation system installation, and each are discussed below. Generally, a common component of these programs is an initial consultation, usually in the form of a use assessment or audit.

Landscape Equipment Rebate Programs

One of the CUWCC BMPs involves implementation of a rebate program for replacement of landscape equipment with more efficient equipment. Eligible equipment includes water pressure-regulating devices, check valves, sub-meters, smart controllers (weather-based), moisture and flow sensors, high-efficiency sprinkler nozzles, rain shut-off devices, and soil conditioners and amendments.

The amount and restrictions for rebates vary throughout the county. The Valley of the Moon Water District's *Landscape Equipment Rebate* program provides rebates of up to 100% for the installation of recommended improvements if water savings are demonstrated.

Residential Turf Conversion Programs

Turf conversion programs (typically referred to as "Cash for Grass" programs) offer water customers cash in exchange for reducing the amount of lawn area in their landscapes. Though specific requirements for the newly converted area may vary, typically lawns may not be converted into new swimming pools, building extensions, patios, decks, other hardscape features, or areas that include high-water use plants. In addition, the existing sprinkler system must be removed or replaced with drip systems or independent irrigation systems.

Soil Moisture Sensor (Delta-T Devices 2007)

To verify that the conversion area is eligible, an inspection is conducted to confirm that the existing lawn is healthy and regularly watered with a sprinkler system (dead or already removed lawns do not qualify for the rebate).

Turf conversion programs often include rebates to upgrade the existing irrigation system and post-conversion landscape. Items eligible for these rebate programs include drip irrigation systems and mulch.

Rebate amounts vary by water retailer from $0.50 to $1 per square foot of turf removed. Some programs have maximum rebate limits. Some programs offer up to $350 in rebates for upgrades to irrigation systems.

The City of Petaluma implements an example of this type of program. Their "Mulch Madness" program offers free mulch, compost, cardboard, drip irrigation supplies, and free native plants to customers who commit to sheet mulching their existing turf. The free drip irrigation conversion kit includes all necessary materials to convert a pop-up spray system into a drip system. More information on this program is available at: http://cityofpetaluma.net/wrcd/mulch-madness-program.html.

Commercial Turf Conversion Programs

Fewer turf conversion programs are currently offered for commercial customers. However, these programs are virtually identical to those described above for residential customers. The major exception is that the maximum rebate allotments are generally much higher for commercial applications. For example, the City of Santa Rosa's program offers up to $2,500 and the City of Sonoma offers $3,000 rebates for replacement of turf.

Smart Irrigation Controller Programs

Rotating Nozzle (Central Basin Municipal Water District 2009)

Weather-based irrigation controllers (smart controllers) are an effective technology for reducing outdoor water use. Smart controllers operate based on weather data and site information, including plant type and sprinkler system output, to automatically adjust watering times and frequency. Use of smart controllers can reduce landscape water use by upwards of 30% (NMWD 2009). The City of Petaluma offers up to $900 rebate for commercial and multi-family residential accounts and requires rain sensors and 2-year minimum operation of smart control devices on-site. The Sonoma Valley County Sanitation District and the Airport/Larkfield/Wikiup Sanitation Zone have both offered a rebate of 50% of total project cost for commercial customers to install these devices.

City of Sonoma Energy and Water Efficiency Loan Program

The City of Sonoma has a program that enables businesses and residents to borrow money for water conservation improvements. Outdoor improvements are also eligible under this program including: high efficiency irrigation systems, evapotranspiration systems, smart irrigation controllers, and recycled water use.

Sonoma County Energy Independence Program (SCEIP)

The County of Sonoma partnered with the Water Agency to launch this program in late March 2009. As discussed previously under Section 2.4.3, SCEIP is a financing mechanism through the County to help home and building owners finance energy and water efficiency retrofits. The program provides financing for permanent installation of interior and exterior water conserving devices. Visit the website at www.sonomacountyenergy.org for the eligible improvements list.

Landscape Budget Programs

Landscape budgets for commercial/industrial customers can help identify actual irrigation needs for their specific landscape composition. This program goes beyond simple use audits and establishes definitive water goals for irrigation.

All water retailers within the Water Agency's service area have developed landscape water budgets for most dedicated irrigation accounts. The budgets are compiled from measurements of irrigated turf and shrubs at the site and based on the calculated area and local evapotranspiration data. The budget allows maintenance staff to compare landscape water use with water needs and prioritize audits at the poorest-performing sites. Some cities send notices to their dedicated irrigation accounts about their water budget performance. The City of Santa Rosa uses water budget-based billing to encourage watering efficiency.

The City of Santa Rosa's *Irrigation Efficiency Rebate* program offers rebates to commercial customers who have a dedicated irrigation meter and have completed a landscape-specific irrigation budget for the property. Rebates are issued based on how closely monthly irrigation water use matches the calculated water budget.

Rebates for Separate Water Meters for Landscaping

Installing separate water meters for indoor and outdoor water use can have the following advantages:

- ability to monitor irrigation water use separate from indoor water use;
- isolate location of leaks easier;
- receive monthly updates on irrigation water use efficiency; and
- ensure that wastewater charges will only be assessed on water that flows through the indoor meter.

To encourage use of split meters by commercial customers, the City of Santa Rosa offers a 100% reimbursement of the costs associated with installing a separate meter for irrigation water use (not including labor). Reimbursement includes: the Encroachment Permit, Building Permit, City of Santa Rosa meter and processing fee, backflow device, and pressure regulating device. Once the application is submitted and approved, the applicant may complete the service split and submit the receipts for reimbursement.

Other Rebate Programs

Residential Pool Cover Program

Using a pool cover regularly can reduce evaporation by 90 to 95 percent (MMWD 2009). According to the Marin Municipal Water District's website, an average pool (18 feet x 36 feet) loses about 1 inch of water per week in the peak of summer if it is not covered. This can lead to an annual water loss of 7,000 gallons.

The North Marin Water District offers a 25% rebate (up to $50) for purchasing approved pool covers. Most water retailers within the Water Agency's service area recommend installing pool covers. Pool cover rebate programs have not been established in Sonoma County because many retailers have found that such programs historically have not been cost effective.

2.6 Water Conservation Implementation and Enforcement in Sonoma County

Most of the planning agencies within the Water Agency's service area have incorporated water conservation policies into their general plans and city and county codes. Similarly, local water providers have adopted water conservation regulations and ordinances. These measures provide the authority to implement and enforce water conservation actions, particularly within planned future growth areas. In general, the Water Agency's water retailers have adopted water waste and non-essential water use policies, landscaping standards, and emergency water shortage policies (refer to **Appendix 1** for a detailed review of these local policies and standards). Additionally, as discussed in Section 2.2, some local communities have adopted Water Efficient Landscape Ordinances and the State's model landscape ordinance is in effect (since January 2010) for local agencies that have not adopted their own Water Efficient Landscape Ordinance. A copy of the County's ordinance can be reviewed online at: http://www.sonoma-county.org/prmd/docs/landscape_ord/index.htm.

Local agency policies and standards are commonly applied to new projects (both public and private) that require either a building permit, conditional use permit, design review by the city or county, or a utilities certificate from a local municipality. The following project types are subject to conformance with these policies and standards: office, commercial, industrial and institutional landscaping, park and greenbelt landscaping, and developer-installed landscaping for multi-family residential and in-common areas. In general, single-family home backyards have not been subject to these policies and standards.

To comply with these local water use requirements, verification is needed at the following project stages: preliminary design review, final design review, building permit/plan check, and completion of installation. The project review and approval process may vary, but, ultimately, applicants must obtain approval for final site design plans that include the conservation measures before construction may begin. Once the project is complete, an inspection may be conducted to check for compliance and proper installation of water use features.

Typically, these water use policies and standards do not apply to registered historical sites, ecological restoration projects that do not require permanent irrigation systems, properties irrigated with private well water, or properties irrigated with recycled water or zoned for agricultural cultivation. However, owners of these excluded properties are encouraged to implement efficient landscape water use practices.

The full details of the project approval requirements are available directly from the water retailer and/or the appropriate planning agency (most information is accessible online).

2.7 Opportunities for Additional Water Conservation

This section describes additional water conservation opportunities that could be implemented to supplement or augment existing programs and are well suited to Sonoma County. These opportunities were researched from other successful programs implemented throughout California, the nation, and other foreign countries. The following types of additional conservation opportunities are presented.

- Educational and Outreach Opportunities
- Land Use Planning and Design for Conservation
- Additional Rebate Opportunities
- Retrofits and Equipment Upgrade Opportunities

2.7.1 Educational and Outreach Opportunities

Establish Numeric Goals or Targets

Existing educational and community awareness programs can be expanded to include numeric targets or dates to reach conservation goals. Slogans with numbers are effective at gaining public interest in a program. For example, in the late 1990's government health departments promoted the slogan "5-a-day" to promote consumption of five fruits and vegetables per day for better health. In 2007, the "I drive 55 mph" conservation project was initiated to promote fuel economy, safe driving, and pollution reduction. Incorporation of a numeric goal that is tangible to the general public can increase water conservation results.

Sonoma County Water Agency's 20-Gallon Challenge Logo

In Ventura County in southern California, the "20-gallon challenge" campaign encourages residents to voluntarily conserve at least 20 gallons of water per day. To positively reinforce water conservation activities, a special appreciation certificate is awarded to customers who successfully achieve the goal. Other water wholesalers and retailers that have promoted the "20-gallon challenge" include the Metropolitan Water District of Southern California including all of its retailers and subsidiary districts, the City of San Diego, the Calleguas Municipal Water District, and the Santa Clara Valley Water District. In 2008, the City of San Diego reduced its water demand by 6.3%, with the help of the 20-Gallon Challenge (Musaraca 2008). The Sonoma County Water Agency promoted the 20-Gallon Challenge from May through November 2013.

Saving 20 Gallons a Day
To save 20 gallons one may repair leaks and broken sprinkler heads or fix leaky faucets, either of which could save 20 gallons of water per day. Or combine several smaller tasks, such as only running the dishwasher when full (2 4.5 gallons per load), turning the water off while brushing (2 gallons per minute), turning off the water while rinsing dishes (2.5 gallons per load), and shortening showers by five minutes (2.5 gallons per minute), all of which can add up to 20 gallons of water per day (Calleguas Municipal Water District 2009).

Additional Public Involvement

Many of the existing public involvement programs sponsored by retailers throughout Sonoma County successfully reduce water consumption. These programs should continue to reach out to residential water users, especially children, and increase their focus on commercial water users. The existing standards implemented by most retailers in the county require installation of efficient water fixtures for new construction projects only. Upgrades to water fixtures in existing businesses have not been as popular as in the residential sector. When commercial construction declined in 2008-2009 many businesses closed or downsized. As there are no requirements (i.e., city policies or mandates) to replace water fixtures when tenants change, there are missed opportunities to implement water conserving measures. Overall, there are fewer incentives for building owners and commercial tenants to conserve water under such economic conditions.

To encourage increased public participation in water conservation efforts for both the residential and commercial sectors, unique programs should be considered. Below are a few examples of public involvement programs that could be a good model.

Water Smart Software

Water Smart Software provides a home water report that compares residents to their neighbors in hopes to solicit change in behavior. The software has been piloted by the City of Cotati and has seen a 5% decrease in demand. This social profiling has been an effective means to reduce demand and quantify water savings from residential use notifications, which is unique.

Tucson Community Conservation Task Force

The Tucson Community Conservation Task Force was initiated by the City of Tucson's Water Department and is a committee of various community stakeholders who provide input on new water conservation strategies proposed by the City. The task force reviews and comments on the new strategies, and makes community-supported conservation recommendations to the City. In this way, the City can be assured that the conservation strategies selected are appropriate and will be supported by the public. Community input also allows the city to tailor the programs to best suit behaviors of the variety of water users in the city. Through the Community Conservation Task Force, the city ensures the success of conservation programs before they are implemented (City of Tucson Water Department 2006). This program has been highly successful.

City of Rohnert Park Water Conservation Sub-Committee

The Water Conservation Sub-Committee of Rohnert Park was initiated by City elected officials to establish a relationship with City staff, the Water Agency, and various community stakeholders. The Sub-Committee meets monthly to discuss current issues, program proposals, and other water related issues. The meetings have helped to facilitate open communication between the City and the Water Agency while providing a forum for customer input.

Community Based Organization Partnerships (CBO)

CBO's have been used in the past to distribute fixtures, but new opportunities have arrived to showcase the skills of master gardeners, nonprofit garden groups and other local initiatives to promote sustainable water management practices. The City of Petaluma partnered with *Daily Acts* (a local non-profit) and held a widely attended sheet mulching workshop. The demonstration mulch area was on City property and was planted with low water use plants. The edible plants are harvested and distributed by *Petaluma Bounty*, a local nonprofit food bank. Many community gardens would appreciate the opportunity to partner with local cities or other utilities in this way. The Sonoma County iGROW campaign can provide outreach and other tools to facilitate these partnerships.

2.7.2 Land Use Planning and Design for Conservation

Land use planning can be conducted with more specific focus toward saving water. Good land use planning and development design should consider water conservation approaches throughout all phases of the design process. As summarized in **Figure 2-2**, water conservation can be integrated and emphasized during the siting process and the on-site design of the development and its buildings, through complying with local ordinances, and in selecting appropriate interior/exterior fixtures and appliances.

Development siting should consider the availability of recycled water and how water reuse and alternative source opportunities may reduce the overall water demand for a development. These approaches are reviewed in more detail in Chapter 3. The on-site building design should consider site characteristics that affect water use such as sun aspect, the sizing and shape of surfaces and structures for their water use efficiency.

Site and building design should consider the development's (or building's) overall water uses and demand, and landscaping and irrigation needs. The building layout should consider efficient room locations including locating kitchens and bathrooms near water heaters to reduce "down the drain" waste that occurs while waiting for hot water to travel through the pipes. Installing on-demand hot water systems may be an even better solution to this problem. For landscaping, good site planning and design involves selecting suitable plant species and locations for the site's specific climate, soil, and drainage conditions and to maximize irrigation efficiency.

Complying with local water conservation regulations and ordinances ensures conservation measures are implemented and water savings occur. Cities are passing ordinances that include minimum water conservation requirements for landscaping, appliances, and water fixtures in new development and redevelopment projects, including Sonoma County's Water Efficient Landscape Ordinance. Additionally, local developers and landowners have a responsibility to meet state-level conservation requirements such as the CALGREEN code (see previous discussions in Section 2.2). As a means to document compliance with water conservation goals, Appendix 3 includes a planning checklist intended for completion by the developer and for review by the local planning department.

Figure 2-2: Summary of Land Use Planning Considerations for Conservation

a. Development Site Planning

- Should consider areas where potable water supplies are feasibly available
- Should consider locations where recycled water is available

b. Site and Building Layout Design

- Should consider sun aspect and other local climate factors and how they affect water use
- Should consider the interior layout and positioning of rooms to attain water efficiencies
- Should consider exterior design landscaping to maximize water conservation
- Needs to comply with local Water Efficient Landscape Ordinances

c. Building Fixtures and Appliances

- Designer should select the most efficient interior water fixtures and appliances
- Designer needs to comply with local Building Codes

The following sections describe programs where water conservation approaches are integrated directly into the land use planning process. These programs offer examples to Sonoma County on how such approaches can be integrated into the land use planning process.

Build It Green

Build It Green (BIG) offers Green Building Guidelines for new home construction, home remodeling, and multifamily construction. The Guidelines were developed to address specific climate and market conditions in California. The Guidelines are based on sound building practice and engineering. In their development, the Guidelines were reviewed and refined by a diverse set of residential building stakeholders including production builders, contractors, architects and designers, multifamily home developers, state and local government leaders, regional and national building-science experts, product manufacturers and suppliers, and green building advocates.

Cities in Sonoma County that have a green building program typically use LEED® guidelines for new commercial construction and Build It Green guidelines for new residential construction.

The Green Building Program approved by the County Board of Supervisors in 2009 also uses LEED® and BIG guidelines and sets compliance thresholds at 40 points under the 2009 LEED® Version 3 commercial Green Building Rating System and 50 points under the BIG 2008-2011 Green Point Rating System for residential construction. Developing a countywide green building ordinance on these existing guidelines provided consistency among local jurisdictions and met objectives set in the Sonoma County General Plan 2020, Open Space and Resource Conservation Element, Policy ORSC-14f. Both plan check and inspection verification is conducted by a third party green rater who is certified under the applicable green building rating system. Standards include points for water-efficient landscape irrigation systems and practices, hot water heating and delivery systems, high-efficiency toilets, dishwashers and clothes-washers.

Conservation Offset Programs

The Department of Water Resources, in its 2005 California Water Plan Update (see Section 2.2 for a discussion of the Water Plan), identified an offset program as an under-utilized technique that can greatly aid in conservation efforts. A Conservation Offset Program requires residential or commercial developers to save at least the same amount of water as the water demand for the project (1:1 ratio). Some water districts require new developments to implement actions to save two or more times the projected water demand for the project, resulting in a 2:1 offset ratio. In such a case the development requires half the water to operate compared to past conventional development designs. A development can achieve such water savings through cutting-edge urban designs and reliable water-saving indoor and outdoor technologies, such as those discussed previously in this chapter.

Offset programs have already achieved results in some California communities, including the City of San Luis Obispo (2:1 offset), Soquel Creek Water District, Santa Cruz County (1.2:1 offset), and Cambria, in San Luis Obispo County (offset 7-8% of water use per year). Through these programs, discussed in detail below, water-short communities are able to develop and grow while conserving water at the same time.

The City of San Luis Obispo began its 2:1 water demand offset program in 1998 with the goal of expanding the number of homes or businesses in the area without negatively impacting local water supplies. San Luis Obispo requires developers to reduce the water impact of a project by half. The amount of water "normally required" for a project is referred to by the City as the "water use factor." This factor is based on water use data and is established by the City. Projects are assigned "water use factors" depending on the average lifetime water use of similar projects. New development projects must use half as much water as similar development projects under existing conditions. This program is mandatory and does not allow developers to opt out of the program by purchasing credits or paying fees. Common retrofits include upgrading inefficient showerheads or toilets. Landscaping changes are not used for calculating the savings ratio, as these changes can easily be reversed (Anderson 2006).

Soquel Creek Water District in Santa Cruz County has an offset program similar to that of San Luis Obispo. The program utilizes a list of "water use factors" (based on the water uses of similar projects) to determine the amount of water offset needed for each project. However, the program differs in that the offset ratio is 1.2:1, less than San Luis Obispo's 2:1 ratio. This program is unique in that it encourages developers to not only install water conservation elements for the proposed development, but it also provides credit for installation of water conservation measures at other locations to achieve the 1.2:1 water use offset at the proposed development (Anderson 2006). In other words, if the proposed project cannot meet the 1.2:1 water use offset, the project proponent can fund water use upgrades at an adjacent property, such as replacing turf or installing water-efficient fixtures, to achieve the mandatory offset for the proposed project. Thus, the program allows development flexibility while attaining water conservation goals. The program is intended to "neutralize" the impact new developments have on the region's water supply and maximize water conservation. As a result of this program, more water service connections are approved, yet water consumption in the region has decreased overall (Soquel Creek Water District 2009).

The City of Cambria refers to its over-20-year-old offset program as "Retrofit-to-Build." In order to build a new project (residential, commercial, or agricultural), developers are required to attain water conservation "points" by implementing retrofits to plumbing fixtures. Point requirements vary from 80 to 325 points per unit of development (such as a building or home). A typical home requires offsets equivalent to 166-216 points. Farm irrigation retrofits are also accepted. One point is equivalent to 1.47 gallons of water per day. Alternatively, developers can purchase points for $50 each. The number of points that developers are required to pay for or earn through retrofits are based on the number of bathrooms and lot size. This program has successfully resulted in a 7-8% reduction in total water use for the city (Anderson 2006).

Online Design Tool - BASIX Program from Australia

> ***Water Conservation Fact:***
> *Australia's BASIX program requires residents to build water and energy efficient homes, yet allows them a large degree of creativity (NSW 2006a)*

The Australia New South Wales (NSW) Government has implemented a program called BASIX (the Building Sustainability Index) that, if used in Sonoma County, could substantially increase local water savings from new development and redevelopment projects. BASIX is an online design tool that evaluates the water and energy efficiency of proposed new homes and their landscaping (2006a). The NSW government requires all new single and multiple family home designs (as well as kitchen remodels and room additions) to be BASIX-Certified. This means that each new home design must meet or exceed water and energy targets (set by the NSW government) before the project is approved for construction (see **Figure 2-3** for an example of a BASIX certificate).

Figure 2-3: BASIX Certificate

BASIX Certificate

Building Sustainability Index www.basix.nsw.gov.au

Certificate number: 126S

This certificate confirms that the proposed development will meet the NSW government's requirements for sustainability, if it is built in accordance with the commitments set out below. Terms used in this certificate, or in the commitments, have the meaning given by the document entitled "BASIX Definitions" dated 30/09/05, published by Department of Planning. This document is available at www.basix.nsw.gov.au

Director-General
Date of issue: Wednesday, 29 June 2005

NSW GOVERNMENT
Department of Planning

Score

- ✓ Water: 64 (Target 40)
- ✓ Thermal comfort: pass (Target pass)
- ✓ Energy: 33 (Target 25)

Description of project

Project address	
Project name	Hastings House
Street address	Lot 26, St. Vincents Way
Suburb	Bonny Hills
Postcode	2445
Local Government Area	Hastings Council
Project type	
Project type	separate dwelling house
No. of bedrooms	4
Site details	
Site area (m)	714
Roof area (m)	298
Conditioned floor area (m2)	182
Unconditioned floor area (m2)	18
Total are of garden and lawn (m2)	197
Assessor details and thermal loads	
Assessor number	20374
Certificate number	86889999
Cooling load (MJ/m year)	40
Heating load (MJ/m year)	71
Other	
Groundwater Licence/Water Supply Works Approval number	n/a

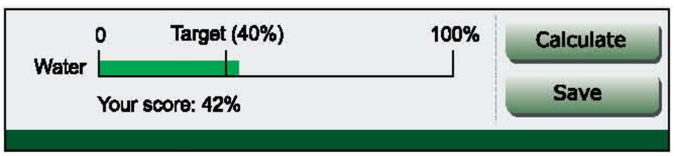
NSW 2008

The BASIX system uses an on-line assessment tool to evaluate a home design in terms of its water conservation potential. Using the entered home design information, BASIX will assess whether or not the home design complies with the energy and water efficiency targets. If the design does not achieve BASIX standards, the program will offer alternative adjustments to the design to achieve efficiency targets. Prospective home builders must choose among these alternatives and alter their home design in order to meet government building standards and gain construction approval. The BASIX program is easy to use, and does not require that custom designs be replaced with cookie-cutter homes. The tool also considers the location, size, and type of housing unit, thus a BASIX home can be custom designed to a specific environment or situation.

While BASIX offers many alternatives to meet home design standards, there are a few technologies that BASIX especially promotes. These include: high efficiency shower-heads, dual-flush toilets, water-saving aerators, and flow-regulators. BASIX will also suggest water reuse technologies and techniques such as connecting a rainwater tank to toilets, laundry, and garden use; increasing the amount of roof area that goes into the water tank (i.e. designing a roof so that more rainwater can be collected); and increasing the size of the home's water storage tank. These topics, as well as their constraints, are further discussed in Chapter 3 *Alternative Water Sources*. For outdoor water use, BASIX promotes the use of native and/or low-water use plants in a home's landscaping (NSW 2006b). Including such features into the development design increases the amount of water savings, and allows new homes to achieve the BASIX water target.

The water and energy targets in the BASIX program are unique in that they are based upon current NSW statewide average water and energy use values. The targets could potentially be modified to reflect California averages. The developer is required to design the home to meet 0-40% water savings compared to the NSW statewide averages. Target calculations are dependent on the location of the development (NSW 2006b). **Figure 2-4** shows an example of a BASIX "progress bar," which helps developers assess the water efficiency of their overall home design. The 0% savings mark represents the NSW statewide average water use. The majority (90%) of new developments are required to meet the 40% target. Under the BASIX program, a new home is not allowed to use more water than the current NSW statewide average. Thus, most new homes automatically save up to 40% more water compared to existing, non-BASIX-Certified homes (NSW 2006b).

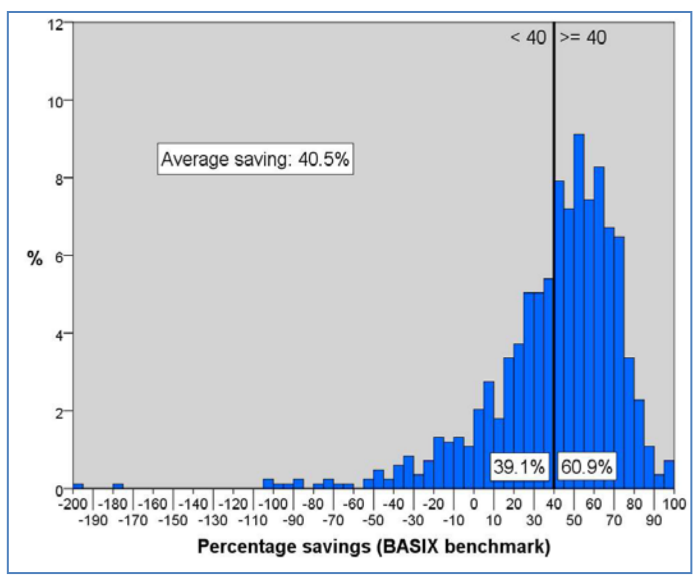
Figure 2-4: BASIX Water Target Progress Bar



In this figure, a green bar indicates a "passing score," while a red bar indicates that a user must add more water-efficient technologies to the design. (NSW 2009)

The NSW Government set the 40% potable water reduction goal (compared to the NSW statewide average) for new homes in 2004. By 2008, most new homes met this target, and the average water savings of new homes was 40.5%, according to the 2007-2008 BASIX Monitoring Study (see **Figure 2-5**) (NSW 2008; 2009a).

Figure 2-5: 2007-2008 BASIX Monitoring Study



Water savings of BASIX homes from the 2007-2008 BASIX Monitoring Study. The bold black line represents the 40% Water Target. The blue area to the right represents those who saved more than the 40% target, while the blue area to the left represents those who did not (NSW 2008).

Of the BASIX-Certified homes monitored in the study, over 60% actually saved *more* water than the 40% water savings target; 39% met or fell below the water savings target; and about 10% fell below the 0% target, meaning that those homes used more water than the NSW statewide average (NSW 2009).

The BASIX program is proven to successfully reduce water use through application of smart design, efficient technologies, and achievable goals. The online entry form, another innovative tool, generates a database of information to track the program's success. This program can and should be expanded to include the commercial sector. More information about BASIX can be found at this website: http://www.basix.nsw.gov.au/information/index.jsp.

2.7.3 Additional Rebate Opportunities

Section 2.7.3: Additional Rebate Opportunities
- Residential Water Submeter Rebate Program
- Water Softener Replacement Rebate

As discussed previously in this chapter, most water retailers in Sonoma County offer rebates for replacement of fixtures or equipment with more water-efficient ones. Water purveyors throughout the state and nation generally offer the same rebates as those offered in Sonoma County. Below, a few noteworthy rebate programs that offer potential additional water savings are described.

Pay as You Save (PAYS)

PAYS is a retrofit program developed by the Energy Efficiency Institute to provide a model to obtain and install money-saving resource efficiency products with no up-front payment and no debt obligation. The high efficiency products are paid off over time through a charge on utility bills. The monthly charge is always lower than the product's estimated savings and it remains on the bill for that location until all costs are recovered (unless the occupants move, whereby the charge is stopped). PAYS America, Inc. is a nonprofit organization that assists local utilities in setting appropriate monthly charges that are less than the estimated savings.

Windsor Efficiency PAYS Program launched in August 2012 after over a year of development. This type of program allows for self-funding of water and energy efficiency improvements with little or no rebate funds needed by the retailer. To ensure success, program participation is limited to the highest water users that are guaranteed to see a reduction in their bill.

Residential Water Submeter Rebate Program

Typically, single water meters are used for multiple-family living spaces such as apartments, condominiums, and mobile parks. The owner of such complexes usually pays the water bill as a singular payment for the entire complex. The result is that individuals and families in such multiple living spaces are not accountable for their water use or their conservation efforts. Because renters cannot monitor their water usage, they cannot determine if they are using too much water. Similarly, because they are not rewarded for their conservation efforts, they have less incentive to conserve.

Water submeters allow individual renters to track and be responsible for their own water use. The California Urban Water Conservation Council (2007) considers "Multi-Family Submetering" to be a good step toward increasing water conservation.

Water Submeter (Santa Clara Vallev Water District 2002b)

The Santa Clara Valley Water District offers a rebate for apartment and condominium complexes or mobile home parks that switch from one water meter per building or mobile home park to individual water submeters. Rebates of up to $100 are offered for each water submeter installed. The Santa Clara Valley Water District found that complexes that added individual water submeters resulted in an average of 25% water reduction (Santa Clara Valley Water District 2002a).

Water Softener Replacement Rebate

Many residents using ground water supplies do not like the high mineral content of ground water, often referred to as "hard water." Though safe to drink, such "hard" minerals have a detectable taste and odor, hinder soap lather, and accumulate as white or gray deposits on pipes and faucets, which results in frequent clogging. To address these problems, residents may install a water softener. This appliance utilizes calcium carbonate and a special resin to treat water before it is distributed throughout the home. The salt and resin remove the minerals from the water and the remaining brine is disposed to the sewer or soil. A traditional water softener treats an entire tank of water at a time. Any treated water that is not used within a set amount of time is flushed to the sewer.

Demand Initiated Regeneration Water Softener (Santa Clara Valley Water District 2002c)

To save water, demand initiated regeneration (DIR) water softening systems generate soft water "on demand," or based on how much water the household uses, rather than at a set time and quantity. This technology saves both water and energy. If the softener runs only when water is needed, it eliminates the amount of water that would be flushed to the sewer had the system continually run (City of Palo Alto 2009). Efficient water softeners use 5 gallons (or less) of water to remove 1,000 grains of hardness. At its most efficient, a DIR system can use 1.8 gallons per 1,000 grains of hardness, or 57 gallons of water used per cycle, with a total use of 3,340 gallons of water per year (Pentair Water 2008). It is estimated that DIR systems can save between 5,000 and 15,000 gallons of water per year in comparison to inefficient water softeners (Shaparenko 2009).

The Santa Clara Valley Water District (SCVWD) offers a $150 rebate for the replacement of a residential timer-based water softener with a DIR water softener, and a $400 rebate for commercial water softener replacements. The new commercial water softener must be a DIR type, and only one can be rebated per site (SCVWD 2002a). Water softeners are more often utilized for hard water conditions encountered with groundwater. In Sonoma County however - where a significant portion of the water supply is derived from the Russian River - this rebate may not be applicable in all areas.

Water Conservation Opportunities for the Industrial Sector
The Israel Ministry of Environmental Protection (2005) has shown that techniques such as process metering, pipe mapping, and pressure reductions in the industrial sector can significantly conserve water. Process metering is when an industrial process that uses water is sub metered, or measured and evaluated, either through long term or spot metering. Through this technique, water consumption can be monitored and measured for various processes (Distrigas 2008). Mapping of pipes can assist in determining locations of leaks or other maintenance needs in order to ensure the most efficiency in plant processes. Water pressure reducing valves can reduce the amount of water running through pipes by 50%; because much of the excess water is wasted, this technology can produce up to 50% water savings (Watts 2009). The Israel Ministry of Environmental Protection (2005) also claims that steam and pressure reduction significantly conserves water. Implementation of these techniques and technologies has enabled Israel to develop its industrial sector with little increase in water

2.7.4 Retrofit and Equipment Upgrade Opportunities

Section 2.7.4: Retrofit and Equipment Upgrade Opportunities
- Retrofit of Existing Car Washes
- Automatic Shut off Faucets
- Alternative No water Toilets
- Commercial Dishware Sensors
- Medical and Laboratory Equipment Upgrades
- Vacuum assisted Dry Street Sweepers

Some new water-efficient technologies are available to the public, but are not yet widely promoted or available through rebate programs. Opportunities for water savings through additional rebate programs include car wash retrofits, residential faucets upgrades, no or low-water toilets, commercial dishwasher upgrades, medical equipment upgrades, and upgraded street sweepers. These technologies are not currently widely-used in commercial and/or residential settings (or are still in the research stage) in the U.S., but have a high potential for water savings and often have other positive effects on the environment such as reducing demand for wastewater treatment and reducing energy demand). The products described below could be candidates for future rebate programs in Sonoma County, or included in future water conservation outreach and education efforts.

Retrofit of Existing Car Washes

California has approximately 1,500 commercial car washes. There are about 20-30 commercial car washes in Sonoma County. Efficient car washes can wash up to 1,000 cars a day, meaning that up to 1.5 million cars can be washed in California per day (usw.org 2009). Car washes without a water reclamation system (to recycle and reuse the wash water) use between 15-85 gallons per vehicle (gpv). Car washes with a full reclamation system use between 8-32 gpv. Installing a reclaim system on all the state's car washes could save up to 80 million gallons of water per day in California. While retrofitting car washes may provide good conservation opportunities, the costs of such retrofits are high and such upgrades may not be possible due to space and plumbing needs. Conveyor car washes and in-bay automated washes usually have enough space to house or install a reclamation system. However, older self-service facilities would likely require a complete remodel. In such cases, a retrofit may be too costly. Currently, Sonoma County does not have any car wash retrofit programs. Development of such a program could provide additional water savings (Brown 2009).

Automatic Faucet Upgrades

A standard faucet must be hand-operated to turn it on and off. A standard faucet has a flow rate of 1.3 gallons per minute, or 0.02 gallons per second. When conducting common kitchen or bathroom activities such as washing dishes or lathering hand soap, water is often wasted during the moments when one steps away from the sink or when the water is not directly in use, yet the faucet still runs. Automatic faucets that shut off and prevent constant running water can save up to 70% of faucet water use (The Energy Observer 2003). Some systems are mechanical and use a bar or foot pedal to press against to enable water flow. Other systems use a non-timed electronic sensor that shuts off the water immediately. Such faucets are already commonly used in public restrooms and hospital facilities, but have yet to become popular in the residential sector. Automatic faucets have the potential to save a half a gallon or more of water per day that is wasted through careless faucet uses (The Pacific Institute 2003). Establishment of a rebate program for automatic faucets would promote water savings.

Alternative No or Low-Water Toilets

As described in Section 2.4.3 above, new toilet replacements are an easy and popular approach to conserving water, and there are many attractive rebate programs. However, recommended toilets often still use a significant amount of water. Alternatively, composting and incinerating toilets use no or very little water. These toilets are not just for public parks and construction sites. Though not currently permitted in Sonoma County, new alternative toilet models have been developed for home and commercial use.

A Water-less Composting Toilet and a removable composting chamber (green container to the left of the toilet) (Envirolet 2005)

Composting toilets are generally not connected to septic or municipal sewer systems; some composting toilets require connections to drain excess liquids. Composting toilets resemble standard water-based toilets in general shape and comfort. The composting process occurs in the toilet's composting and drying chambers. Bacteria inside the composting chamber breaks down solids, and the drying chamber promotes liquid evaporation and reduces the volume of remaining solids. Composting toilets are vented to the outside, so no foul odors associated with the compost are detected inside the home. These toilets come in various types, including part-time models (those only used on a limited basis), electric versions (which include heaters that speed up the composting and dehydration process), and automatic composting toilets (which mix the compost every time the seat is lowered) (InspectAPedia 2009a). Others require large underground compost chambers constructed beneath the toilet. Electricity is required by some models to power venting fans or to aerate the compost. Composted waste is emptied from the toilet at intervals ranging from one or two months to 12 months, depending on level of usage and toilet design (InspectAPedia 2009a). While composting toilet manufacturers may indicate that compost processed in toilets could potentially be used for gardening applications or soil amendments, The Water Agency is implementing a pilot study to evaluate the feasibility of composting toilets in the Occidental area. Consumer preferences, as well as current regulatory requirements, may prevent the widespread use of such composting toilets in the near term.

An Electric Incinerating Toilet (The Spinalis Foundation 2008)

Incinerating toilets can be used in places that are not compatible with septic systems, such as remote cabins, guest rooms, or pool houses. These toilets use energy (electricity or gas) to destroy waste by incineration (i.e., burning); no water source is needed for this type of toilet. When properly installed and maintained, a venilation system removes residual odors and only a small amount of ash requires disposal (InspectAPedia 2009b). While incinerating toilets can greatly reduce interior water use they do require significantly more energy to operate compared with a standard toilet.

Commercial Dishware Sensors

In conveyor type dishwashers, hot water flows continuously while the unit is turned on. This results in wasted water and energy to produce heated water. Dishwashers are considered one of the most water-intensive appliances in a commercial kitchen. To reduce water use in commercial kitchens, dishwashers can be upgraded with a sensing arm or dishware gate that will detect the presence of dishes and automatically shut off when there are no dishes on the conveyor. Installation of commercial restaurant dishware sensing throughout California has the potential to save an average of 6,500 AF (acre feet) of water per year, according to the Pacific Institute (2003).

The Massachusetts Water Resources Authority studied one restaurant that saved 225,000 gallons of water annually by installing a dishware sensing gate. The device costs about $1,200 to install, but provides an annual water cost savings of about $2,700, paying for itself in about five months (MWRA 2008). There are many restaurants throughout Sonoma County that could save additional water through installing dishwasher sensor systems.

Medical and Laboratory Equipment Upgrades

Hospitals and medical facilities require water for equipment processing, cleaning, or cooling. X-ray equipment, vacuum pumps, sterilizers, hood exhaust systems, medical water filters and other equipment all use significant water amounts. Additional water saving opportunities include the following:

- <u>Water-efficient X-ray Equipment.</u> Standard and large-frame x-ray machines require water for development of x-ray films. Digital x-ray equipment eliminates the need for water because there are no x-ray films to develop. Digital x-ray equipment can reduce water use for film developing by 95%. Water-saving kits installed onto the film developers of large-frame x-ray equipment eliminate the need for continuous water cooling, thus eliminating the need for water altogether (ADWR 2009). Additionally, x-ray machines with recirculation systems can be used during an emergency where water supplies are cut off, as they only need 15 gallons of (bottled) water and a power source in order to operate (CUWCC 2008).

- Water-efficient Vacuum Pumps. Standard vacuum pumps, such as those used in hospitals and dentist offices used to perform medical procedures, are wet or use water to create the vacuum. A standard venturi aspirator system utilizes 1 million gallons of water per year in order to function (ADWR 2009). Replacement of wet vacuum pumps with dry vacuum pumps completely eliminates water use in this type of equipment.

The City of Bakersfield offers a $2,000 rebate for x ray film processor recirculation systems that can reduce the water usage by up to 98%. (CUWCC 2008).

- Sterilizers. Sterilizers can represent a large amount of water use in a medical facility. Table top steam sterilizing units use 30 to 100% less water than free standing models (ADWR 2009). Free- standing sterilizing units with a recirculation system will reduce water use significantly. Older models can be retrofitted with water saving kits (ADWR 2009a).

- Exhaust Hood Systems. Medical facilities and laboratories use hood exhaust systems (see above) to control chemical fumes. Standard hood exhaust systems use water to create suction to remove vapors. Replacement of exhaust hoods with dry systems can result in 100% water savings. If replacement of the unit is not feasible, the water flow rate can be reduced and recirculation systems or alternative water sources can be connected. These upgrades can save between 10 and 75% of the water normally used by a standard exhaust hood (ADWR 2009).

Laboratory Exhaust Hood (ADWR 2009a)

- Medical Water Filters. Filtered water is required for many medical uses, such as for kidney dialysis and intravenous fluids, or for patients with compromised immune systems. Thus, many hospitals and medical offices have on-site water filters to treat water to the degree needed to administer to patients (Biologically Pure Water 2009). Use of the most water-efficient water filters, such as resin deionization and reverse osmosis with minimal steam generation, and filters that treat water on-demand as opposed to continual filtration, can save between 30-100% of the water compared to standard medical filtration practices (ADWR 2009).

Vacuum-Assisted Dry Street Sweepers and Recycled Water for Sweepers

Standard street sweepers are used in nearly every city throughout the state, and use water to reduce the dust particles in the air that result from sweeping. The abundance of these street sweepers and their high water use encouraged the California Urban Water Conservation Council to include street sweepers in a four-year research project to study potential best management practices (CUWCC 2007). The Santa Clara Valley Urban Runoff Pollution Prevention Program promotes vacuum-assisted dry sweeping, which uses no water but retains the ability to efficiently sweep roads. Vacuum-assisted dry sweeping technology uses tandem sweeping equipment, which combines mechanical and vacuum-assisted sweepers to remove dirt from streets. A continuous filtration system stops fine particulates from escaping into the air (SCVURPPP 2007).

The City of Long Beach recently began using recycled water in their street sweepers. The city estimates 13 million gallons of potable water per year, or 28 gallons of water per year per person, will be saved as a result (Long Beach Post 2009). Use of recycled water offsets the need for potable supplies. However, no matter the source of water, standard street sweepers still utilize water to function. Dry sweepers do not require water to function, and are thus preferred over recycled water sweepers. If all standard street sweepers in California were replaced with dry sweepers, the state could save 1 billion gallons per year (SCVURPPP 2007).

2.8 Estimating Potential Water Savings

As described throughout this chapter there are many types of water conservation measures and programs. In many cases, effective conservation approaches have now been successfully implemented for many years since the onset of more formal water conservation efforts in California in the 1970s and 1980s.

Though significant progress has been made there are still opportunities for additional conservation and water savings in Sonoma County. **Table 2-4** is provided to compare past, present, and future water uses as a way to summarize where conservation has been effective, but also what more can be done. Table 2-4 compares water uses for interior and exterior fixtures, appliances, and other uses. In Table 2-4, year 1980 is used as a relative baseline to gauge past water consumption from an earlier period. Year 2009 is used to characterize more current water uses. The third column of Table 2-4 presents additional projected water uses and savings in the future. Future water savings in Table 2-4 are based on published standards provided by federal and state conservation programs, such as EPA's WaterSense and the CUWCC.

As shown in Table 2-4, the most apparent water savings are achieved through continued upgrades to toilets, urinals, and landscaping. While significant water savings have been achieved in the past 20 to 30 years, the continued use and application of more efficient technology, together with more stringent standards and regulations will provide additional savings.

However, it is important to consider that achieving higher conservation goals may be difficult due to lag times in regulating new technology, as well as consumer tastes. For example, consumer and regulatory uncertainties regarding composting toilets have prevented local application of this technology and its water-saving potential.

The degree of attainable water savings varies by region, population, community type, water uses, feasibility of implementation, and other factors. Quantifying water savings realized from water conservation measures has been conducted by many agencies, including the Water Agency. In 2008, the Water Agency undertook a water demand analysis and developed a decision support model to estimate potential water savings through implementing conservation measures (Brown and Caldwell 2008). The objective of the study was to assist individual retailers in customizing their conservation programs and thereby reduce their water demands. The investigation calculated the amount of water savings that would be realized after implementing a suite of conservation measures for specific retailers from 2004 through 2030. Incorporated into the demand analysis were projected growth rates, water usage rates, water demands, and standard conservation water savings (current at the time). Calculated potential water savings were developed for each individual water retailer based on a specific suite of measures tailored to each retailer's service area.

While the 2008 water demand analysis provides projected water savings for each water retailer, the results are not additive to generate a net countywide savings amount. Also, soon after the report was completed, the federal and state standard conservation savings percentages were updated. The water demand analysis and report soon became outdated due to changing population and water use projections that were affected by changed economic conditions. Though this study achieved its objectives, it illustrates how difficult it is to quantify water savings over a large area with varied water demands. In the future, continued monitoring and reporting on the results and effectiveness of past conservation approaches and programs will help target more effective conservation efforts.

Table 2-4: Water Use in California – Past, Present, and Future

Water Use Type	Fixture/Appliance/ Application	1980 Water Use	2009 Water Use	Future Water Use and Savings: Water Use	Future Water Use and Savings: Additional Water Savings[1]
Residential Interior Use	Toilets	6 gallons per flush	1.6 gpf (national average)	1.1 gpf	45-55%
	Dishwashers	10 gallons per load	9 gallons per load (national average)	4.25 gallons per cycle	34%
	Leaks	22 gallons per household per day	9.5 gallons per person per day (national average)	4.7 gallons[2] (routine leak detection and repair)	50%
	Clothes Washers	44 gallons per load	41 gallons per load (national average)	20 gallons per load (HECWs)	50%
	Showers	5 gallons per minute	2 gpm (national average)	1.5 gpm	15%
	Faucets		1 gpm (national average)	0.8-1.5 gpm	15%
Commercial Interior Use	Pre-rinse spray valves		2.5 gpm	1 gpm	10%
	Urinals			0-0.125 gpf	65-75%
	Faucets			0.5-2.0 gpm	10%
	Dishwashers		2.4 gallons per rack per load	0.5-1.0 gallons per rack per load	10%
Residential Exterior Use	Lawn Watering/Irrigation		73 gallons per square foot[3]	17 gallons per square foot (with low-water landscaping)[3]	9% - Rain Sensor Retrofit 20-40% - Cash for Grass Rebates 15% - Irrigation Meter Rebates 15% - Smart Irrigation Controller Rebates 15% - Financial Incentives/Rebates for Irrigation Upgrades 90% - Synthetic Turf Rebate
	Pools				Homes without pools save 58%
	Car Washing		15-85 gallons per vehicle	8-32 gallons per vehicle	

[1] Additional Water Savings percentages reflect potential savings compared to 2004 standard water use rates. These savings percentages provide a general estimate of additional potential water savings achievable toward the Year 2030 planning horizon (From Brown and Caldwell 2008).

[2] University of Kentucky 1999

[3] Public Policy Institute of California 2006

Chapter 3
Alternative Water Sources

3.1 Introduction

The Sonoma County Water Agency (Water Agency) strives to efficiently use the limited fresh water resources available to the region. To this end, the Water Agency encourages the use of alternative sources of water where appropriate and feasible to increase and extend potable water supplies throughout the county, as well as support other local efforts such as the Geysers Recharge Project. Alternative water source opportunities have the potential to significantly (or completely) replace exterior water use demands with non-potable water supplies. As discussed in Chapter 1, 30-60% of residential water use is for exterior purposes such as landscape irrigation. Exterior potable water use can, in most cases, be replaced by harvested rainwater, graywater, or recycled wastewater supply. Thus, alternative water sources are perhaps the most important component of the Water Smart Development approach in terms of its influence to protect water resources.

In this guidebook alternative water sources refers to the following three types of activities:

- Rainwater Harvesting (Section 3.2)
- Graywater Use (Section 3.3)
- Water Recycling (Section 3.4)

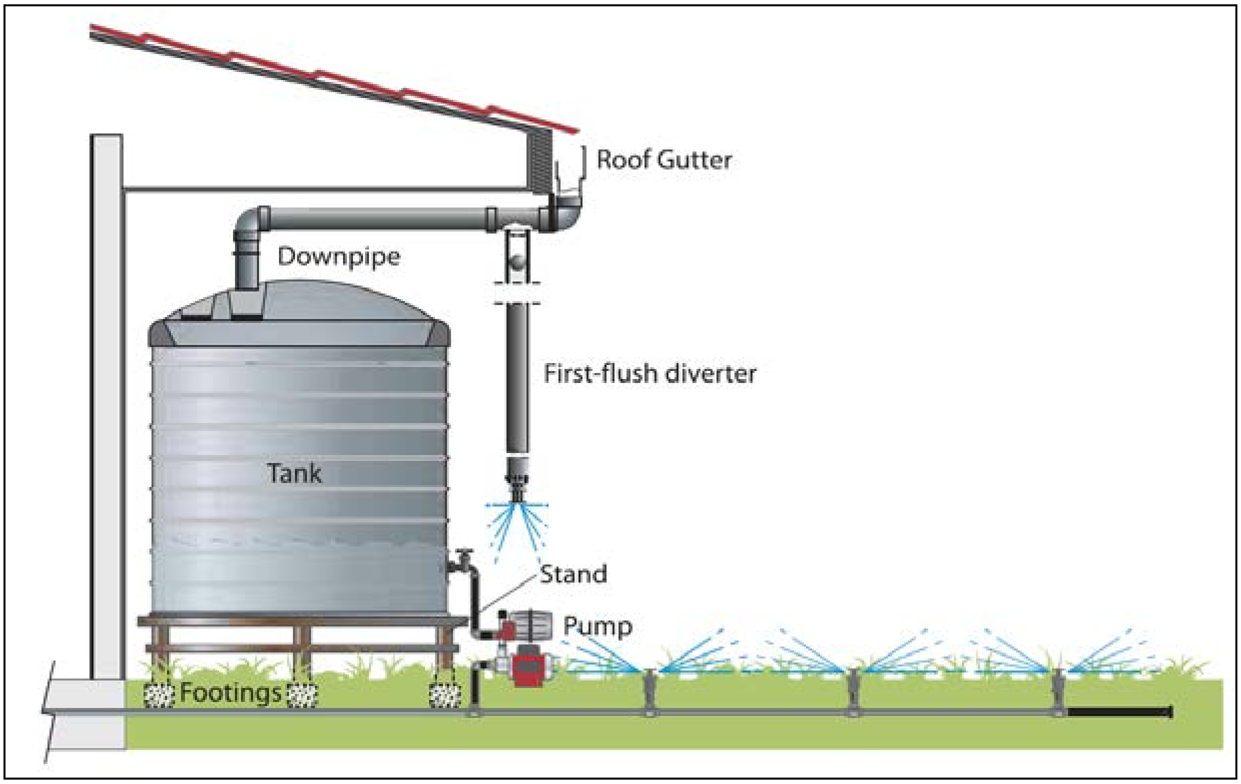
The following sections of this chapter describe these activities. For each activity an overview description is provided, followed by a brief discussion of the benefits, limitations, and risks of implementation. Current state and local regulations affecting these activities are described, as well as how these activities are currently implemented. This chapter also includes recommendations for additional water source opportunities to be considered for future planning.

3.2 Rainwater Harvesting

Rainwater harvesting is the practice of collecting and storing rainwater for later use. While gaining increasing popularity and awareness, this is actually an ancient practice that was used by the Romans, Native Americans in the American southwest, and by other cultures to direct surface runoff into cisterns and reservoirs. Today, rainwater harvesting most commonly uses a roof as the collection surface and a tank for storage (see **Figure 3-1**). Harvested rainwater can generally be used without prior treatment for irrigation. Other uses of harvested rainwater are possible with proper treatment and management practices. Many rainwater harvesting systems are simple and involve little more than a roof, a barrel and some piping; others are complicated systems involving sophisticated treatment processes and distribution mechanisms.

This section reviews the benefits, risks, and regulations surrounding rainwater harvesting while also describing local implementation of rainwater harvesting and potential future opportunities for increased rainwater harvesting. Additional details regarding the applications of and design for rainwater harvesting systems are presented in the "Rainwater Harvesting – Fact Sheet" in Chapter 4. Additionally, the City of Santa Rosa has developed guidance for rainwater harvesting systems. See their website on storm water management at: http://www.srcity.org/stormwaterLID.

Figure 3-1: Typical Residential Rainwater Harvesting System



3.2.1 Benefits, Limitations, and Risks of Rainwater Harvesting

Rainwater harvesting can offset potable water demands while improving on-site storm water management. Harvested rainwater can easily be used for outdoor irrigation and can potentially be used for indoor non-potable uses such as toilet flushing. In addition to providing water for non-potable uses, rainwater harvesting systems prevent runoff from their catchment areas as long as there is capacity in the storage tank. As discussed in Chapter 4, maximizing on-site detention of storm water can improve water quality of local receiving waters.

The extent to which rainwater harvesting can realize these benefits is generally limited by the size of the storage tank and local rainfall patterns. An inch of rain falling on a 1,000 square foot roof (a fairly small house) generates enough roof runoff to fill a 600 gallon rainwater tank (a fairly large tank for most residences). Wintertime irrigation needs may not be enough to use even the initial 600 gallons let alone the thousands of additional gallons that will run off the roof over the course of the winter. Due to of this seasonality issue in California – where runoff occurs in the winter and irrigation is needed in the summer - it is worthwhile to consider toilet flushing and other ways to use harvested rainwater throughout the wet season when irrigation demands are low.

Risks surrounding rainwater harvesting are generally considered to be minimal. In contrast to graywater use, there is little concern about pathogens or contaminants in rainwater, especially if the rainwater is to be used for outdoor irrigation. To ensure that rainwater storage tanks do not become breeding grounds for vectors such as mosquitoes, rainwater harvesting systems should be sealed and/or screened.

3.2.2 Regulation and Implementation of Rainwater Harvesting in California

In California, use of rainwater is not currently regulated at the State level, leaving local authorities to regulate rainwater use. There is no regulatory definition of rainwater use within California that would categorize it as either recycled water, graywater, or any other regulated water source. The 2010 California Plumbing Code has no approved standards for rainwater harvesting systems. The Rainwater Capture Act of 2012 (AB 1750), authorizes residential, commercial, and governmental landowners to install, maintain and operate rain barrel systems and rainwater capture systems (California Legislative Information 2012). Most cities, counties, and other local authorities in California have no specific regulations regarding rainwater use but many do require a permit (generally a building permit) for rainwater harvesting systems. Generally, most local authorities seem to be comfortable with using harvested rainwater for landscape irrigation. Systems using rainwater for toilet flushing have, however, been installed with regulatory approval in several California communities (see San Francisco example in adjacent text box). As an example of how

Rainwater Harvesting in San Francisco

Prior to 2005, San Francisco s residents were required to direct their roof runoff to the City s combined sewer system. The City code was changed in 2005 to allow San Franciscans to direct rainwater to alternative locations such as rain gardens, rain barrels, and cisterns.

San Francisco has taken further steps to promote rainwater harvesting. San Francisco officially encourages the use of harvested rainwater for toilet flushing and is working to create a streamlined permitting system for small rain barrel rainwater harvesting systems. (www.sfwater.org)

Cisterns installed in a small courtyard area of a San Francisco home collect sufficient rainwater for 6 months supply of toilet water (without using pumps or electricity). The homeowner can easily switch back to potable water when the cisterns run dry.

one city has interpreted the applications of various statewide regulations to rainwater harvesting systems, see Section 3.2.3 for discussion of the permit requirements for rainwater harvesting systems in the City of Sonoma.

Across the U.S., some questions have been raised about whether capturing of rainwater represents some type of infringement or taking of a downstream user's water right. This issue was recently deliberated in Colorado in a court case. The state of Colorado claims the right to all moisture in the atmosphere that falls within its borders and that "said moisture is declared to be the property of the people of this state, dedicated to their use pursuant" to the Colorado constitution. The "first in time, first in right" appropriation priority system applies in Colorado. Thus, in most of the state it is illegal to divert rainwater falling on property expressly for a certain use unless the property-owner has a very old water right or during occasional periods when there is a surplus of water in the river system. The state, however, is beginning to relax its position on rainwater harvesting as evidenced by the July 2009 Senate Bill that was passed to allow residential rainwater harvesting on properties with permitted groundwater wells (Senate Bill 09-080; Colorado Division of Water Resources http://water.state.co.us/pubs/pdf/RainWaterBills.pdf).

Similarly, in Utah, rainwater diversion and beneficial use are subject to appropriation through the water right system. A water right issued from the State Engineer is required in order to divert and beneficially use rainwater. However, no water right is required to control and direct waters within a property; the water right laws only apply when water from a natural source (including rainfall) is actually diverted and beneficially used. For example, rainwater harvesting is a water right issue only to the extent rainwater is actually stored and then later used for some purpose rather than being released back to a natural drainage system (Utah Division of Water Rights http://www.waterrights.utah.gov/wrinfo/faq.asp).

In California, water rights are typically interpreted differently, in that the capture of surface water runoff is considered the right of the owner or authority who controls the source area for that surface runoff before it enters a stream or other type of channelized flow situation. In California, prior to the runoff entering a stream channel, the right to the runoff water belongs to the owner/authority of the runoff source areas. Prior to entering a stream channel, runoff water in California is not considered the right of the downstream receiving body. However, once the surface water runoff enters a stream or channel system the connection to the downstream user becomes more direct. Once runoff enters a stream channel, then the subsequent diversion or capture of that streamflow may negatively affect downstream water rights. This would be similar to an upstream user diverting creek flow to the detriment of the downstream water right. Also of note, if captured rainwater or runoff (not yet channelized or acting as streamflow) were to be transferred out of the watershed as an export, once it is captured, that might also require additional water rights consideration. However, for most typical rainwater harvesting practices, capturing of rainwater for local use does not imply the taking or effecting of a downstream water right (Willis 2009). The Rainwater Capture Act of

2012 confirmed that the use of rainwater collected from rooftops does not require a water right permit from the State Water Resources Control Board.

3.2.3 Regulation and Implementation of Rainwater Harvesting in Sonoma County

Within Sonoma County, several agencies have taken steps to encourage residential rainwater harvesting and to outline the regulatory issues and design guidance for rainwater harvesting systems. Homeowners may finance rainwater harvesting systems through the Sonoma County Energy Independence Program (see Chapter 2 for further discussion of this program).

County of Sonoma

The Sonoma County General Plan 2020 Water Resources Element, adopted by the county in 2008), includes goals, objectives, and policies to support water conservation and reuse, including rainwater harvesting, to meet future water needs of the County. Specifically, the General Plan includes the following policy:

> *Policy WR-4k: Where consistent with water quality regulations, encourage graywater systems, roof catchment of rainwater and other methods of re-using water and minimizing the need to use potable surface water or groundwater.*

City of Sonoma

The City of Sonoma has produced a handout containing requirements and guidelines for rainwater harvesting systems (handout included in **Appendix 2**). As noted in the handout, a City of Sonoma building permit is required for rainwater harvesting and storage systems under any of the following circumstances:

- If the property is connected to the City's water system and the total combined stored water capacity for the rainwater system exceeds 500 gallons. *[Installation and inspection of a cross-connection control device near the City water meter is required in accordance with Sonoma Municipal Code Section 13.20.030. and City Standard Plan #213]*

- If the storage tank is not supported directly by the ground or concrete slab or is supported by a raised platform or other structure. *[1997 Uniform Administrative Code – 301.2.1]*

- If the size of a water storage tank exceeds 5,000 gallons or the ratio of height to width of the tank exceeds 2:1. *[1997 Uniform Administrative Code – 301.2.1]*

- If electrical pumps, electrical valves or electrical controllers are installed, unless they are cord and plug connected or operate at less than 25 volts and not capable of supplying more than 50 watts. *[1997 Uniform Administrative Code – 301.2.3]*

- If the rainwater storage tank will be installed below or partially below grade. *[2007 California Building Code Appendix J103.1.]* (City of Sonoma 2009)

Simple small-scale rainwater harvesting systems that do not exceed these conditions do not need a permit.

The City of Sonoma handout also provides useful clarification as to the circumstances under which rainwater can be used for toilet flushing:

> *Section 601.1 of the California Plumbing Code requires that plumbing fixtures including toilets, urinals, washing machines and floor drains, be connected to an "adequate supply of potable running water" unless the City determines that it is not necessary for safety or sanitation reasons. Given that there are cities within the United States and other countries that have safely allowed the use of rainwater for fixtures such as toilets, urinals, washing machines and trap primers in floor drains, the City of Sonoma Building Department will review and determine the acceptability of such requests on a case-by-case basis when designed by a licensed California Mechanical Engineer that specializes in plumbing or rainwater systems* (City of Sonoma 2009).

City of Santa Rosa

In 2009, the City of Santa Rosa initiated an incentive program for residential and commercial customers to install rainwater harvesting systems. The City will provide water customers a rebate of $0.25 per gallon of rainwater storage installed provided that:

- A backflow device is installed;
- A minimum of 100 gallons of storage is installed;
- The site has City of Santa Rosa water service and applicant is property owner or has written consent from the property owner to install a rainwater harvesting system;
- The applicant allows brief pre and post-installation inspection by the Santa Rosa Water Conservation Program;
- The applicant obtains proper permits from the Santa Rosa Community Development.

As described in a September 2009 article in the Santa Rosa Press Democrat newspaper, the first Santa Rosa resident to take advantage of the program received a $1,400 rebate after she installed a 3,000 gallon rainwater tank and a 2,600 gallon rainwater tank in her backyard (the total estimated cost of the system was $4,000). A two-inch rainstorm in May of 2008 was enough to fill the 3,000 gallon tank and hand irrigate three fruit trees and a vegetable garden for six weeks (McConahey 2008).

Education and Training

In Sonoma County, workshops on rainwater harvesting are being conducted by groups such as the Occidental Arts and Ecology Center Water Institute (www.oaecwater.org), and Daily Acts (www.dailyacts.org).

3.2.4 Local Opportunities for Water Conservation through Expanded Rainwater Harvesting

Residential rainwater harvesting can be a simple and effective way to offset potable demands. If large enough, rainwater tanks can provide significant water supplies for outdoor irrigation. Smaller tanks can also be useful, especially if the collected rainwater is used for applications such as toilet flushing. Expansion of rainwater harvesting in Sonoma County can be encouraged by:

- Providing education and training
- Ensuring that local policies and permitting requirements are well understood by local officials (Building Departments, etc.)
- Creating a regulatory/permitting environment that allows the use of rainwater for toilet flushing (as has been done in San Francisco)
- Expanding rebate programs

The Bank of America Tower in New York City is an office building which includes a series rainwater collection tanks on the tower's roofs and at strategic points amid its 52 floors. In addition to the rooftop rainwater tanks, the building's thick concrete core walls are waterproofed to form the outer walls of a basement storage system with a total volume approximately 300,000 gallons. Collected water is used for toilets and landscape irrigation, saving over 10 million gallons of potable water annually.

Photo: Bank of America

3.3 Graywater Use

Graywater, greywater, gray water, or grey water?

All four permutations are grammatically correct but graywater is the version used in the California Code of Regulations.

Gray is the spelling in common usage in the United States while grey is the spelling used in the United Kingdom and most other English speaking countries.

Graywater refers to the water that flows out of bathroom sinks, showers, and laundry equipment. Wastewater from toilets (and kitchen sinks and dishwashers depending on local regulations) is referred to as "blackwater." Graywater, along with rainwater harvesting (Section 3.2), is a type of on-site water source that can be used to supplement water supplies and thereby offset potable water demands. Typically, graywater is used for outdoor irrigation but in some instances it has been used for indoor applications such as toilet flushing. In addition to offsetting potable water demands, graywater systems also reduce the load on sewer or septic systems.

Graywater systems range from basic systems wherein water from a residential washing machine (clothes washer) is directed into prepared areas of the yard - to sophisticated commercial systems with multiple fixture connections and treatment processes.

3.3.1 Benefits, Limitations, and Risks of Graywater Use

The water conservation benefits of graywater use are potentially very significant. Some experts estimate that extensive graywater use could save more than 16% of California's residential potable water use (Haefele 2009). Some studies indicate even greater potential water savings. In the early 1990s, the Los Angeles Department of Water and Power (LADWP) conducted a pilot project in which they installed graywater systems in eight homes. The installations reduced potable water consumption by about 50% per household (Haefele 2009).

In addition to conserving water through offsetting potable water demands, graywater use also provides benefits by reducing the amount of wastewater generated by residences and other buildings in which graywater systems are installed. For properties connected to sewer systems, decreased wastewater flows may translate to incrementally lower municipal treatment costs. Perhaps more significantly, graywater use also extends the useful life and capacity of septic systems. Indeed, reducing wastewater flows to septic systems is likely the primary motivation for many property owners that are currently operating graywater systems.

Although water conservation benefits of graywater use are easy to appreciate, some feel that the risks associated with untreated graywater are significant and that residential graywater systems should be discouraged. Potential human exposure to pathogens is generally the primary concern associated with graywater. Although it is suspected that most pathogens (viruses, bacteria, protozoans) in graywater are gradually overcome by soil microorganism populations, eggs of helminthes (such as tapeworms) could survive in soil for a long time (CAWSI 2009). The Water Environment Research Foundation (WERF) completed a long-term study on the effects of landscape irrigation using household graywater in 2012 and found that most landscape plants benefit from watering with household graywater. The study evaluated existing and new household graywater irrigation systems in, and found that only 3 of 22 plant species investigated showed negative responses to long-term graywater irrigation (WERF 2012).

Beyond the potential risk from pathogens, some graywater skeptics further argue that traces of household and personal care products found in graywater constitute potential environmental pollutants. There are also concerns about proper installation and maintenance of graywater systems, including adequate cross connection control to ensure separation between potable and non-potable water supplies. Additionally, if allowed to pool, whether in a storage tank or on the ground, graywater will become septic, create odors, and serve as a potential breeding ground for vectors such as mosquitoes. Between 2000 and 2010, Sonoma County received 340 complaints about graywater, mostly from persons concerned about odors from their neighbor's graywater system and graywater irrigation areas (personal communication with James Johnson, Sonoma County Permit and Resource Management Division).

There are eight million greywater systems in the US with 22 million users. In 60 years, there has been one billion system user years of exposure, yet there has not been one documented case of greywater transmitted illness.

Art Ludwig, Oasis Design, www.oasisdesign.net

Graywater advocates counter these concerns by pointing to empirical evidence provided by the many unpermitted graywater systems that are in current operation, and/or have operated for many years without creating public health issues. Because graywater is generally discharged onto the same property at which it is generated, any of the associated risks also remain onsite, incentivizing the property owner to properly construct and maintain the graywater system. In the LADWP pilot project described above, no human disease pathogens were found in the graywater drainage areas outside the homes (Haefele 2009).

With the adoption of the 2010 Graywater Standards (see discussion below), California regulators have indicated that, in their best judgment, the benefits of expanding graywater use in the state outweigh the risks. The Building Standards Commission approved the 2010 Graywater Standards after testimony both for and against the code changes. Most resistance came from local building departments and plumber industry representatives. It is noted that the State Department of Public Health supported the changes to the code (EBMUD 2009).

3.3.2 Regulation and Implementation of Graywater Use in California

Californians have likely used graywater systems in and around their homes for as long as there has been indoor plumbing. Only in the last few decades, however, has the State attempted to regulate the design and use of graywater systems. Statewide regulations guiding graywater use have developed slowly as regulators weigh water conservation benefits against concerns about health and safety issues.

California's drought of the late 1980's and early 1990s created interest in encouraging graywater use and formalizing guidelines and regulations for graywater system use and maintenance. As a result of the "Graywater Systems for Single Family Residences Act of 1992" (Assembly Bill 3518), the California Graywater Standards were adopted into the California Plumbing Code. In 1997, the Plumbing Code was revised to allow multi-family, commercial, and institutional graywater irrigation systems. Prior to the adoption of the Graywater Standards, graywater use was technically illegal in California.

Significant elements of the California Graywater Standards as adopted in 1997 include:

- Graywater shall not reach any storm sewer system or any water of the United States.
- Graywater irrigation shall be conducted at least nine (9) inches below the ground surface to ensure against pathogens and contaminants potentially contained in the graywater from coming into contact with people.
- Graywater systems must be permitted and inspected by appropriate local agencies.

The 1997 Graywater Standards did not provide specific guidance on indoor uses of graywater.

The 1997 Graywater Standards did little to encourage the growth of permitted graywater systems in California. The requirement for nine inches of cover over irrigation lines made permitted graywater systems prohibitively expensive and impractical for watering many types of plants. Additionally, permitting a graywater system could also be very expensive and time-consuming as local building departments were generally unfamiliar with graywater regulations and graywater system design. Art Ludwig, a leading graywater advocate and designer/installer of graywater systems, has estimated that as of 2008, approximately 200 permitted graywater systems and as many as 1.7 million unpermitted graywater systems have been built in California (Oasis Design, www.oasisdesign.net).

In the midst of yet another dry cycle, California regulators in 2008 began reexamining the 1997 Graywater Standards with an interest in making them more comprehensive and permissive. On July 2, 2008, the California Legislature passed Senate Bill 1258 which directed the Department of Housing and Community Development (HCD) to develop new graywater regulations for residential properties by January 1, 2011 for approval by the California Building Standards Commission. After the passage of Senate Bill 1258, HCD began to revise the Graywater Standards via a process that involved stakeholder involvement. Responding to the Governor's State of Emergency declaration regarding the 2007-2009 drought, the Building Standards Commission approved the revised Graywater Standards proposed by HCD in July 2009, a year-and-a-half ahead of the adoption schedule outlined in Senate Bill

Arguments for and against requiring permits for residential graywater systems:

For:

- *The permitting process allows local authorities to ensure that graywater systems are properly installed.*
- *Permitted graywater systems may be more likely to be eligible for special financing/rebates.*
- *Permitted graywater systems may be looked upon more favorably by homeowners insurance companies in the event that graywater system failure resulted in property damage.*

Against:

- *Required permits will dissuade some property owners from implementing graywater systems and realizing potable water offsets and/or reducing groundwater use.*
- *Others will simply ignore permit requirements continue to build unpermitted systems without proper guidance from design professionals who are wary of working on "illegal projects.*

1258. Although the revised standards became effective on August 4, 2009, HCD had up to 180 days to complete the rulemaking process and make the emergency regulations permanent (EBMUD 2009). During that time, several changes were made to the August 4, 2009 version of the Graywater Standards. These further revised Graywater Standards were permanently adopted in January 2010.

The Graywater Standards adopted in January 2010 (hereafter referred to as the "2010 Graywater Standards") regulate outdoor and indoor graywater reuse at residential buildings only. Other building types such as commercial and industrial buildings are still governed by existing (unchanged) standards. For residential buildings, the 2010 Graywater Standards include less stringent criteria for graywater reuse for outdoor irrigation than previous regulations. Subsurface irrigation with graywater is now allowed with a minimum of two inches of cover, significantly less than the previously required nine inches. The 2010 Graywater Standards have also relaxed permitting requirements. As shown in **Table 3-1** below, the 2010 Graywater Standards introduced several categories for graywater systems with varying permit requirements.

Table 3-1: Graywater System Types and Permitting Requirements per 2010 Graywater Standards*

System Type**	System Description	Permitting Requirements
Clothes Washer System	Graywater system utilizing only a single domestic clothes washing machine in one- or two-family dwellings.	No construction permit required if conditions in Graywater Standards are met (but local authorities can require permits).
Simple System	Graywater system serving a one- or two-family dwelling with a discharge of 250 gallons per day or less. Simple systems exceed a clothes washer system.	Plans and permits required unless exempted by local authority.
Complex System	Graywater system that discharges over 250 gallons per day.	Plans and permits required unless exempted by local authority.

**California Code of Regulations, Title 24, Part 5, Chapter 16*

** *All system types described in this table are intended to supply graywater for outdoor irrigation. A system type called "Single-Fixture Systems" (graywater system collecting graywater from one plumbing fixture or a single drain which collects graywater from more than one fixture on a one or two family dwelling) was included in the version of the Graywater Standards that was adopted as an emergency measure in July 2009. Discussions of the single fixture systems were removed from the final Graywater Standards as adopted in January 2010 based on based on public comments.*

Local authorities (cities, counties, etc.) can adopt more restrictive permitting requirements than those in the 2010 Graywater Standards. For example, a city may choose to require permits for clothes washers or may ban graywater systems altogether. Additionally, local authorities may also adopt stricter graywater system design requirements (such as greater depths of cover over graywater irrigation systems or requiring some treatment of graywater prior to irrigation use).

With regard to indoor graywater use, the 2010 Graywater Standards stipulate that "graywater shall not be allowed for indoor use, such as flushing toilets and urinals, unless treated by an on-site water treatment system approved by the Enforcing Agency." The 2010 Graywater Standards do not specify the type or level of treatment.

The National Sanitation Foundation International (NSF) and the American National Standards Institute (ANSI) recently developed Standard 350 and 350-1 to establish material, design, construction and performance requirements for residential and commercial graywater treatment systems. The standards also set water quality requirements for wastewater treatment to remove chemical and microbiological contaminants for non-potable water use, including restricted indoor water use, such as toilet and urinal flushing, and outdoor unrestricted water use, such as lawn irrigation. NSF 350 has been incorporated into the 2013 California Plumbing Code which becomes effective on January 1, 2014. (California Building Standards Commission 2013)

3.3.3 Regulation and Implementation of Graywater Systems in Sonoma County

As noted above, cities, counties, or other local authorities may adopt building standards that are more restrictive than the statewide 2010 Graywater Standards. The Sonoma County General Plan 2020 Water Resources Element includes Policy WR-4k, which states: "Where consistent with water quality regulations, encourage graywater systems, roof catchment of rainwater and other methods of re-using water and minimizing the need to use potable surface water or groundwater." For several years, various stakeholders have worked together to develop local regulations and guidelines for graywater use in Sonoma County. The Sonoma County Graywater Working Group (SCGWG) has been meeting since the summer of 2008. The SCGWG is facilitated by the Sonoma County Permit and Resource Management Division (PRMD) and is attended by staff from Sonoma County Environmental Health Department, the Water Agency, the City of Santa Rosa, as well as a number of private contractors, engineering firms, and some non-profit groups including Daily Acts and the Occidental Arts and Ecology Center. SCGWG has produced educational materials to facilitate the installation of safe and compliant systems in Sonoma County (see http://www.sonoma-county.org/prmd/docs/misc/graywater.pdf).

PRMD has been delegated the authority to regulate graywater systems in the unincorporated area of Sonoma County by the California Regional Water Quality Control Board (RWQCB). PRMD does not regulate graywater systems in the incorporated cities in Sonoma County. The County currently adheres to the regulations set forth by the 2010 Graywater Standards and the current California Plumbing Code. Additional County guidance on greywater systems is available at http://www.sonoma-county.org/prmd/divpages/wellsepdiv.htm.

PRMD regulations exempt graywater systems that collect graywater from a clothes washer only and where no modifications to the plumbing system are required or pumps are used in the graywater system from construction permits but the system must still meet the design and construction standards found in the regulations. All other graywater systems require a construction permit. Plans for graywater systems must be submitted to PRMD or the authorized permitting agency for review and approval of the graywater design. Once the design is approved, a construction permit must be obtained to install the graywater system and allow for inspection by the permitting agency.

PRMD requires that a person or entity must contact their local building department to discuss plumbing, venting and electrical requirements as needed for either new construction or the retrofit of an existing structure where a graywater system is proposed. In addition, the local water purveyor must be contacted in order to discuss the need for the installation of a backflow protection device at the water meter.

It is unknown how many unpermitted graywater systems currently exist within Sonoma County. In collaboration with the non-profit organization Daily Acts, the cities of Santa Rosa, Petaluma, Cotati, Sonoma, and the Town of Windsor are conducting a voluntary registration process for Sonoma County residents who install graywater systems on their property. As of August 2013, there have been 140 voluntary registrations of graywater systems in Sonoma County (Daily Acts 2013). Additionally, in 2012, the non-profit organization Graywater Action collaborated with the City of Santa Rosa and Ecology Action of Santa Cruz to compile the report "Residential Greywater Irrigation Systems in California: An Evaluation of Soil and Water Quality, User Satisfaction, and Installation Costs" (Allen et al. 2013). A few residences in Cotati, Petaluma and Santa Rosa were included in the study.

Studies conducted in other portions of the U.S. indicate that around 7% to 13% of households in the United States have some kind of graywater system (WERF 2006). In general, unpermitted graywater systems are more common at properties using septic systems as diverting graywater flows can improve the performance and extend the life of a septic system. Most (69%) of Sonoma County's population of nearly half-a-million people live within the city limits of the nine Sonoma County cities (County of Sonoma, Citizens Guide to County Government, www.sonoma-county.org/cao/citizens_guide/sonoma_county_population.htm, accessed October 2009). All city-dwellers and some residents of the unincorporated areas are connected to sewer systems but the County still has a significant number of septic systems. The statewide and regional emphasis on water conservation has likely prompted more and more households in both urban and rural areas to implement graywater reuse for landscape irrigation.

A handful of complex graywater projects were permitted prior to the adoption of the 2010 Graywater Standards:

- **Trathen Heckman's house, Petaluma:** Trathen Heckman, founder of Daily Acts and member of the City of Petaluma Green Team, coordinated the first permitted residential graywater system in Sonoma County at his Petaluma home in 2008. The system features a constructed wetland that treats water from the home's bathroom sinks, showers, and clothes washer. Approximately 36,000 gallons per year are expected to be generated by the system for use in the home's backyard (Young 2009).

- **Osmosis Day Spa, Freestone:** Osmosis Day Spa installed a graywater system including constructed wetlands in 2009 that is estimated to offset 1,000 gallons per day in potable water demands for outdoor irrigation. The graywater system allowed Osmosis to decommission an existing septic leach field that was within a creek floodplain. As such, Osmosis has recently completed constructed wetlands that treat nearly 1,000 gallons of graywater per day for landscape irrigation (Osmosis Day Spa 2009).

- **Florence Lofts, Sebastopol:** Florence Lofts is a 12-unit live/work complex that was developed by IBIS. Designers expect to capture and re-circulate about 150,000 gallons of gray water a year, enough to meet all of the project's irrigation needs (McConahey 2008).
- **Lyding Commons, Sebastopol:** Another development by IBIS, Lyding Commons consists of four mixed-use buildings. The complex has a similar graywater system to Florence Lofts.

No permitted graywater systems for indoor uses (such as toilet flushing) are known to exist in Sonoma County.

3.3.4 Local Opportunities for Water Conservation through Expanded Graywater Use

The extent to which graywater use can offset potable demands depends on how much graywater can practically be collected and how the graywater is used. Graywater constitutes approximately 50% of the total wastewater generated within a household (WERF 2006) but capturing all of this graywater would require a substantial system that collects water from all showers and bathroom sinks, as well as the clothes washer. Most existing graywater systems, however, route the wastewater from a single fixture (clothes washer, sink, or shower/tub) to an outdoor landscaped area.

Estimating the quantity of potable water demand offsets from graywater systems for residential landscape irrigation is complex. Using a daily potable water usage rate of 69 gallons per person/day, an average household population of 2.6 persons and assuming that fully 50% of household wastewater can be captured as graywater, approximately 90 gallons of graywater per day per household would be available for use. This is a sufficient amount to irrigate drought-tolerant plants on a 5,500 square foot residential lot (WERF 2006).

Household graywater generation does not, however, exactly align with the schedule of landscape irrigation needs. For a given period of time, the irrigation demand rate may exceed the generated rate of graywater; or conversely, the irrigation demands may be less than the graywater generation rate. While storage could in theory be used to balance these differences, storing graywater is problematic as organic matter in graywater quickly breaks down and creates odors. Twenty-four (24) hours is generally considered the maximum time for storage of graywater (Oasis Design, www.oasisdesign.net). Some residences simply may not have sufficient irrigation needs to justify graywater systems while other property owners would perhaps use the "extra" water afforded by a graywater system to expand their gardens.

Graywater uses beyond landscape irrigation (such as toilet flushing) offer the potential for significant potable water demand offsets but are not well supported by existing regulations and can be technically challenging as well.

Sonoma County s Energy Independence Program provides an opportunity for property owners to finance energy efficiency, water efficiency and renewable energy improvements through a voluntary assessment. These assessments will be attached to the property, not the owner, and will be paid back through the property tax system over time, making the program not only energy efficient but also affordable. See Chapter 2 for more information.

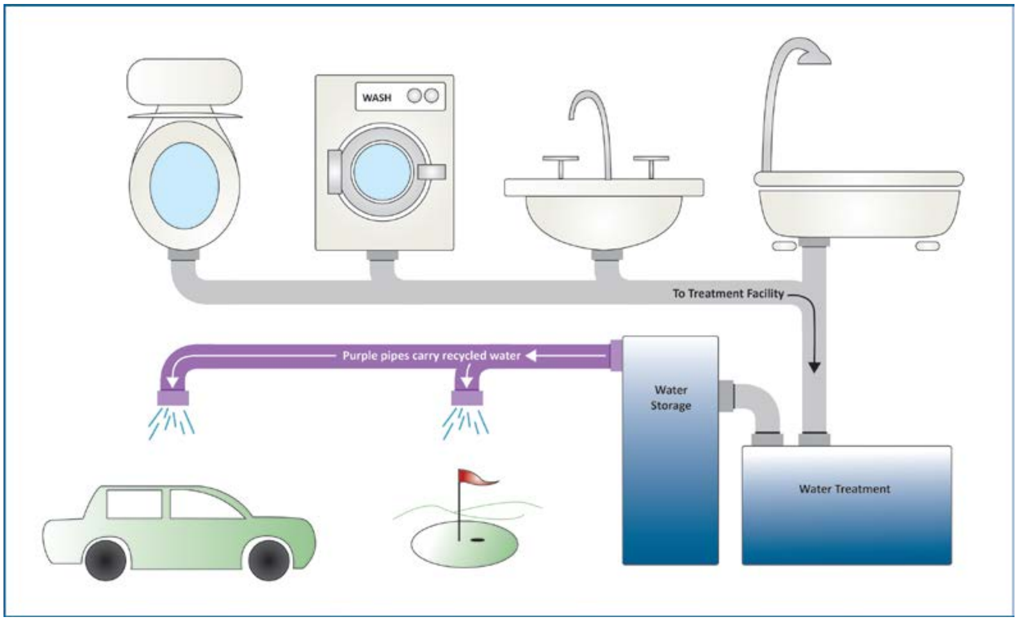
Like other forms of on-site water management such as rainwater harvesting (see Section 3.2) and LID storm water techniques (see Chapter 4), residential graywater systems work best when property owners are actively involved in and well-informed about their operation and maintenance. As such, expanded graywater use can best be encouraged by local authorities by providing financial incentives such as rebates or low-interest financing and by offering technical support and educational material that can help ensure that homeowners properly install and maintain graywater systems. The Water Agency is participating with other local agencies in the development of policies regarding graywater permitting and public education efforts. Additionally, graywater systems are eligible for financing under the Sonoma County Energy Independence Program (see Chapter 2 for additional information about this program).

In 2010, the City of Santa Rosa developed a Graywater Rebate Program to encourage the installation of graywater systems. The City provides two options for the Graywater Rebate Program: a $75 rebate for single-fixture graywater systems and a sustained reduction rebate of $200 for every 1,000 gallons per month of sustained water savings. The sustained reduction option would typically be used for multi-fixture and engineered systems. In 2011, to further encourage installation of graywater systems, the City launched the Graywater Installation Workshop. Customers who were willing to install a Laundry-to-Landscape graywater system were offered a hands-on course to learn how to install, operate and maintain a graywater irrigation system. The workshop takes place over two days. The first day provides information and helped participants create a graywater design. At the end of the day, participants are taken to a local irrigation supply house where they are provided a $75 voucher for purchasing the parts. The second day, participants install the graywater systems at their homes. A total of 30 graywater systems were installed through the initial workshops, and due to their success, additional workshops have continued to beoffered. The Cities of Petaluma and Cotati have partnered with Daily Acts to conduct greywater workshops.

3.4 Water Recycling

Recycled water is highly treated wastewater that can be beneficially reused in a variety of non-potable applications thus providing environmental and water supply benefits. Recycled water is typically conveyed to end users through purple-colored pipe distribution lines that are not directly connected to potable water supplies (see **Figure 3-2**).

Figure 3-2: Recycled Water Schematic



3.4.1 Benefits, Limitations, and Risks of Water Recycling

Like rainwater and graywater, recycled water can be used in applications where potable water is often used (such as the irrigation of public parks and golf courses). In addition to allowing for potable water offsets, recycled water use can facilitate "in lieu groundwater recharge." For example, if a farm that has historically used well water for crop irrigation begins using recycled water instead, the groundwater aquifer beneath will "recover" through reduced pumping and natural recharge.

Other benefits of recycled water include a local, reliable water supply that is less vulnerable to drought events. Recycled water is a sustainable water source, and allows potable supplies to be reserved for the best and highest use. Additionally, utilizing recycled water for irrigation also means a decrease in discharge of treated wastewater to local waterbodies such as the Russian River.

The use of recycled water is often limited by the ability to cost-effectively deliver recycled water to the end users. For example, many cities could in theory meet the irrigation demands of all their public parks with recycled water but building the pipelines to connect several parks to the treatment plant might be prohibitively expensive.

As recycled water is wastewater before it undergoes a high level of treatment, some raise concerns about the potential for contaminants to be present within it. Recycled water is, however, strictly regulated by Federal, State and local agencies; it must meet stringent standards prior to use. Recycled water is being safely and successfully used throughout California and around the world in multiple applications including irrigation of parks, playgrounds, school yards, and crops.

3.4.2 Regulation and Implementation of Water Recycling in California

California regulatory agencies actively encourage water recycling. In May 2009, the State Water Resources Control Board (SWRCB) approved the Statewide Recycled Water Policy. The purpose of the Recycled Water Policy is to increase the use of and improve the permitting process for recycled water from municipal wastewater sources. The Recycled Water Policy includes a stated goal to "increase the use of recycled water over 2002 levels by at least one million acre-feet per year (afy) by 2020 and by at least two million afy by 2030." In 2002, statewide recycled water use was approximately 525,000 afy (DWR 2004).

Approved uses of recycled water are based on the level of treatment of recycled water and are dictated by the State of California in Title 22 of the California Code of Regulations (Title 22 standards), as shown in **Table 3-2**. The most common uses of recycled water are irrigation of outdoor landscaped areas (such as parks and golf courses) and agricultural irrigation. As shown in the table below, other allowed but less common uses of recycled water include toilet flushing, industrial processing, commercial laundries, industrial and commercial air-conditioning, and fire suppression.

Recycled water may also be used for groundwater recharge with a permit from the local Regional Water Quality Control Board (RWQCB).

Table 3-2: Allowed Uses for Recycled Water: California Code of Regulations – Title 22

Wastewater Treatment Step	Treatment Type	Sampling of Approved Reuse Applications (per Title 22)
Primary	Screening/Settling	No approved reuse applications
Secondary [1]	Biological treatment	Food crops where edible portion not contacted by recycled water, cemeteries, freeway landscaping, restricted-access golf courses, pasture, dust control, cleaning roads/sidewalks, non-structural fire-fighting, industrial processes where no human contact of the water occurs, industrial/commercial air conditioning (no mist).
Tertiary/ Advanced Treatment[2]	Filtration	All applications of secondary recycled water, all food crops, parks and playgrounds, school yards, residential landscaping, unrestricted access golf courses, decorative fountains, flushing toilets and urinals, structural firefighting, commercial laundries, industrial/commercial air conditioning (mist ok).

1. Disinfected secondary. Title 22 specifies a more limited set of allowed uses for undisinfected secondary recycled water.
2. Disinfected tertiary.

3.4.3 Regulation and Implementation of Water Recycling in Sonoma County

Water recycling is well established within Sonoma County. Current uses of recycled water within Sonoma County include irrigation of urban parks, vineyards, golf courses, and pasture lands. Existing water recycling projects within Sonoma County include:

- Water recycling at Water Agency operated county sanitation districts and sanitation zones
- Santa Rosa Subregional Water Reuse System
- Town of Windsor Water Recycling Program
- City of Petaluma Recycled Water Program
- Forestville – Graton Water Recycling
- Bodega Bay Water Recycling

These programs are further discussed below.

Water Recycling at Water Agency Sanitation Districts and Zones

The Water Agency manages and operates eight separate county sanitation districts (CSDs) and sanitation zones (SZs) within Sonoma County – most of which provide wastewater treatment, reclamation and disposal. The Water Agency assumed operation of these districts and zones in 1995. Each zone and district operates under an individual permit from one of the California Regional Water Quality Control Boards (either North Coast or San Francisco Bay region) that sets requirements for operation including discharge. The Water Agency's affiliated CSDs and SZs are listed in **Table 3-3** along with their design capacity, service area, service connections, treatment level and discharge information.

Table 3-3: Water Agency Affiliated County Sanitation Districts and Sanitation Zones

District/Zone	Permitted Capacity (gpd)[1]	Service Area (acres)	Connections[2]	Treatment Level	Annual Reuse/ Discharge[3]	Reuse/Discharge
Occidental CSD	50,000	55	275	Secondary	2.43 MG / 37.04 MG	May 15-Sept 30 irrigation; Oct 1-May 14 discharge to creek
Russian River CSD	710,000	2,700	3,199	Tertiary	42.51 MG / 101.83 MG	May 15-Sept 30 irrigation of a golf course and other lands; Oct 1-May 14 discharge to Russian River
Sonoma Valley CSD	3,000,000	4,500	17,321	Tertiary	336.45 MG / 721.83 MG	May 1-Oct 31 agricultural irrigation reuse; Nov 1-Apr 30 discharge to sloughs tributary to San Francisco Bay
South Park CSD	N/A	1,460	3,968	N/A		Collected influent routed to Santa Rosa's Laguna Subregional plant for treatment and disposal/reuse.
Airport/Larkfield /Wikiup SZ	900,000	2,100	3,777	Tertiary	329.85 MG / 0 MG*	All treated effluent reused for irrigation (or stored when irrigation cannot be conducted).
Geyserville SZ	92,000	177	353	Secondary		Discharge to evaporation ponds.
Penngrove SZ	N/A	475	522	N/A		Collected influent is routed to the City of Petaluma's system for treatment and disposal/reuse
Sea Ranch SZ[4]	27,000 (Central SZ) 160,000 (North SZ)	4,600	582	Secondary	1.15 MG / 0 MG* (Central SZ) 11.5 MG / 0 MG* (North SZ)	Central SZ: irrigation reuse of secondary treated water North SZ: treated to tertiary level at the Gualala CSD treatment plant and used for irrigation of golf course.

1. Average dry weather flow

2. Equivalent single family dwellings as of May 2013

3. Data based on water year 2012 (10/1/2011 through 9/30/2012)

4. the Sea Ranch Sanitation Zone is comprised of two separate sanitation zones, Central and North.

** = zero discharge plants*

As shown in the table above, treated wastewater from several of the CSDs/SZs is utilized in a range of reuse applications including agricultural irrigation, irrigation of forested land and irrigation of golf courses. During the non-irrigation season, treated wastewater is discharged to surface water bodies including creeks and the Russian River except at Airport/Larkfield/Wikiup SZ where all effluent is used for irrigation (or stored when irrigation cannot be conducted) and the Geyserville SZ where evaporation ponds are used year-round for the disposal of treated wastewater.

Subregional Water Reclamation System

Finley Community Park in Santa Rosa is irrigated with recycled water from the Subregional Water Reclamation System

The City of Santa Rosa is the managing partner of the Subregional Water Reclamation System - a wastewater collection and treatment system which collects wastewater from the cities of Santa Rosa, Rohnert Park, Cotati and Sebastopol, and the South Park CSD for treatment at the Laguna Treatment Plant. The participating agencies do not operate their own wastewater treatment plants, but pay the City of Santa Rosa to collect and treat their wastewater and conduct a subregional pretreatment program. Of the wastewater collected at the Laguna Treatment Plant, approximately 98% is reused after treatment. Discharge to surface water (the Russian River or tributaries to the Russian River) is conducted only in winter months when irrigation demands are at a minimum and river flows are high. During the relatively dry winter of 2008-2009, the Subregional System was able to reuse all treated effluent and avoid any discharges to surface water.

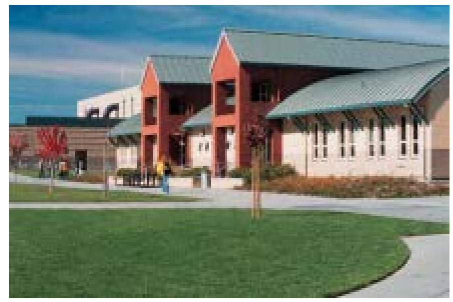
Uses of the recycled water from the Subregional System include agricultural irrigation, landscape irrigation, and recharge of the underground steamfield for the purpose of geothermal energy generation at the Geysers Recharge Project. Currently, nearly a third of the Subregional Systems annual 8.1 billion gallons of recycled water is used to irrigate more than 5,800 acres of agricultural land including pasture/hay and silage crops (4,120 acres), vineyards (1,436) and vegetable and specialty crops (187 acres). Recycled water from the Subregional System irrigates urban landscaped areas such as Finely Park and a Place to Play sports complex, along with irrigation of several schools, parks and businesses in Rohnert Park including Sonoma State University.

The Geysers Recharge Project conveys treated wastewater from the Laguna Treatment Plant to the Geysers steamfield in Lake County (approximately 40 miles north of Santa Rosa). The recycled water is injected into the ground to produce steam which is then captured by steam production wells and converted into energy. The project began operation in 2003, and as of 2010 was converting 12.62 mgd of recycled water to “green” energy on an annual basis – enough energy to power 100,000 households.

Town of Windsor Water Recycling Program

The Town of Windsor owns and operates a recycled water facility as part of its wastewater treatment plant. Windsor uses recycled water to irrigate large areas such as the Town Green, Wilson Ranch Soccer Park, Windsor Golf Course, Windsor High School, agricultural areas including Santa Rosa Junior College's Shone Farm and residential front and back yards in the Vintage Greens subdivision.

Windsor High School is one of the first schools in Sonoma County to utilize recycled water. Recycled water irrigates approximately 40 acres of outdoor landscaping and playfield areas, along with toilet flushing at the school. The Windsor High School water recycling effort saves approximate 1.4 million gallons of drinking water annually. The school district and Windsor's government were awarded the state's highest environmental honor in 2006.



Recycled water is used to irrigate outdoor areas at Windsor High School.

-Photo: Town of Windsor

Windsor's Vintage Greens subdivision was one of the first residential applications of recycled water in Northern California. The front yards of all 473 homes are irrigated with recycled water and as of 2008, 52% of Vintage Greens homeowners elected to irrigate their back yards with recycled water as well. By using a dual-piped recycled system for landscape irrigation, the Vintage Greens subdivision is saving approximately 25 million gallons of drinking water per year.

Residential landscape irrigation in the Vintage Greens subdivision.

-Photo: Town of Windsor

Santa Rosa Junior College's Shone Farm, a 365 acre educational farm on the eastern edge of Windsor, irrigates approximately 60 acres of wine grapes, 100 acres of pasture for beef cattle and sheep and 35 acres of diverse crops and gardens with recycled water from the Windsor treatment plant. Shone Farm is involved in a joint storage project between the SRJC and the Town of Windsor storing approximately 40 mg of recycled water.

City of Petaluma Recycled Water Program

The City of Petaluma has been providing recycled water for agricultural use since 1984. More recently, golf courses and a vineyard have begun using Petaluma's recycled water. Petaluma's current recycled water production is 700 million gallons per year and they are undertaking a significant expansion project to provide more recycled water to irrigate additional City parks, schools and fields, and agricultural areas. Existing Petaluma recycling operations save approximately 143 million gallons of drinking water per year. The Water Recycling Expansion Program would increase recycled water usage from approximately 700 to 1,070 million gallons per year by 2025.

Forestville – Graton Water Recycling

The wastewater treatment plants in the towns of Forestville and Graton were operated by the Water Agency until 2004 when their operation was turned over to the Forestville Water District and the Graton Community Services District respectively. Both treatment plants have been upgraded to tertiary treatment. The wastewater treatment facilities at Graton Community Services District are designed treat up to 140,000 gpd (average daily dry weather flow), and 130,000 gpd at Forestville. Recycled effluent from the two treatment plants is used to irrigate approximately 350 acres of agricultural and urban areas including vineyards, parks and schools (irrigation capacity of 177 acre-feet). The amount of irrigation is variable dependent on weather conditions and land available. The Forestville to Graton pipeline allows for the delivery of recycled water to property owners along the pipeline route.

Bodega Bay Water Recycling

Bodega Bay Public Utilities District operates a wastewater treatment plant that serves portions of the town of Bodega Bay. The highly-treated effluent from the plant is used to irrigate a golf course (The Links at Bodega Bay).

3.4.4 Local Opportunities for Expanded Water Recycling

There are many opportunities for new water recycling programs or significant expansions to existing water recycling programs in Sonoma County. Several projects are at various stages in the planning process. These projects include:

- Russian River Irrigation Reliability and Beneficial Reuse Project
- North Sonoma County Agricultural Reuse Project
- North Bay Water Recycling Program (North San Pablo Bay Restoration and Reuse Project)
- Santa Rosa Urban Reuse Program
- Additional Recycled Water Delivery to the Geysers
- City of Healdsburg Water Recycling
- City of Cloverdale Water Recycling
- Recycled Water Projects in the North Coast Integrated Regional Water Management Plan

These planned programs are further described below.

Russian River Irrigation Reliability and Beneficial Reuse Project

The Russian River Irrigation Reliability and Beneficial Reuse Project, if constructed, would expand the use of treated wastewater for irrigation within the vicinity of the Russian River CSD. The proposed project would deliver treated wastewater for irrigation needs to agricultural, municipal and other permitted operations in the surrounding area - thus expanding beyond the current irrigation reuse applications at the Northwood Golf Course and the forested lands adjacent to the treatment plant. By expanding the Russian River CSD's disposal options through additional irrigation customers, this project improves disposal reliability for the treatment plant and reduces the hydraulic loading on the existing irrigated lands. A Final EIR was certified for the project in November 2007 and design alternatives are under consideration while interested users of the recycled water are identified. Most of the potential users are, however, located a significant distance from the treatment facility. The project will proceed when an alternative is selected and funding is secured.

North Sonoma County Agricultural Reuse Project

The purpose of the North Sonoma County Agricultural Reuse Project (NSCARP) is to provide a reliable alternative source of water for agricultural water users in the Russian River, Dry Creek, and Alexander Valley areas (north Sonoma County area) to reduce reliance on natural regional water supplies and address regional water supply and regulatory issues. NSCARP proposed the design and construction of storage reservoirs, conveyance and distribution pipelines, and pump stations in the North Sonoma County area. The water for NSCARP would be tertiary treated municipal wastewater from as many as three wastewater treatment plants located in the project area including Airport Larkfield/Wikiup SZ, the Subregional Water Reclamation System, and the wastewater treatment plant operated by the Town of Windsor. A Final EIR was prepared by the Water Agency in March 2009; however, the Water Agency’s Board of Directors did not certify the EIR, concluding the project lacked funding and sufficient customer support. At this point NSCARP needs supporters and funding, without which the project will not move forward.

North Bay Water Recycling Program

The North Bay Water Recycling Program (NBWRP), also known as the North San Pablo Bay Restoration and Reuse Project, is an integrated partnership between existing and planned water recycling projects in the North San Pablo Bay region. NBWRP is being administered by a coalition of five public agencies - Napa Sanitation District, Sonoma Valley CSD, Las Gallinas Valley Sanitary District, Novato Sanitary District and the Water Agency. The North Marin Water District and the County of Napa also provide funding for NBWRP. The agencies have banded together to meet local, state and federal water resource management objectives and regulatory requirements, and the partnership allows for cost-savings on a project level and the ability to take advantage of state and federal funding opportunities. In March 2009, President Obama signed a bill authorizing $25 million to fund $100 million of “Phase I” NBWRP projects which include expanding use of recycled water for urban and agricultural irrigation as well as using recycled water to accelerate salinity reduction in the groundwater basin. A Final EIR/EIS was prepared for the NBWRP and certified December 8, 2009. Sonoma County projects included in the NBWRP are the Sonoma Valley Recycled Water Project, and the Napa Salt Marsh Restoration Project. Combined, these two projects will utilize approximately 3,000 acre-feet of recycled water from Sonoma Valley CSD (North Bay Water Reuse Authority 2009).

As part of the Sonoma Valley Recycled Water Project, recycled water would be delivered to the City of Sonoma and unincorporated areas of Sonoma County for landscaping and agricultural reuse. The project includes new pipelines, storage and additional pumping capacity. The

Sonoma Valley Groundwater Management Advisory panel recommends implementation of the project to help improve groundwater conditions, including reduction of saline groundwater intrusion.

As part of the Napa Salt Marsh Restoration Project, new pipelines and pumping facilities would be installed to deliver recycled water for environmental restoration of the former salt ponds. This project is sponsored through the cooperative efforts of multiple local agencies, the California Coastal Conservancy, U.S. Army Corps of Engineers and California Department of Fish and Game to restore tidal habitats and managed ponds.

Santa Rosa Urban Reuse Program

The City of Santa Rosa is in the process of evaluating ways to further develop the use of recycled water from the Subregional System. In April 2005, the City began work on the Santa Rosa Urban Reuse Project Expansion Conceptual Plan, which analyzed several alternatives for expanded urban reuse within the City's service area. In September 2006, the City's Board of Public Utilities approved contracts for pre-design of a phased urban reuse project with ultimate service to the majority of the south and west portions of the city, and a total delivery of 3,000 acre-feet per year (AFY) to sites which would otherwise be served by potable water. In December 2007, the City approved the Santa Rosa Urban Reuse Project, which could supply up to 3,000 AFY of recycled water to current and future approved water uses, primarily landscape irrigation. The cost of implementing the Project is estimated to total $119 million, in 2006 dollars. This project will be implemented in phases, as needed for water supply offset and wastewater disposal capacity. The phased nature of this urban reuse alternative allows City policymakers to develop this water supply source incrementally as more supply is needed, while continuing to evaluate other potentially more cost-effective water supply sources for future supply needs.

The City selected Phase 1 West as the first phase to be implemented. Phase 1 West is designed to provide up to 750 AFY of recycled water and was initiated in 2009. Based on the projected water supply and wastewater disposal capacity needs, it is anticipated that the City will only need to build Phase 1 West through 2035.

Additional Recycled Water Delivery to the Geysers

In addition to the urban reuse program, the City of Santa Rosa will increase deliveries of recycled water to the Geysers steam field in the future. In 2008, the City of Santa Rosa and Calpine, the operator of the Geysers, signed a contract under which the current 12.62 mgd of recycled water deliveries will be increased to 19.8 mgd. The contract has a term of 30 years and expires in 2038. The Town of Windsor has an agreement with the City of Santa Rosa to deliver 0.75 mgd to the Geysers as of 2011. The recycled water supplied by Windsor will form part of the total 19.8 mgd of recycled water deliveries that are specified in the City of Santa Rosa's contract with Calpine.

City of Healdsburg Water Recycling

In 2008, the City of Healdsburg upgraded their wastewater treatment plant to a high-level of tertiary treatment. In October 2010, Healdsburg received a permit from the Regional Water Quality Control Board to operate their Recycled Water Project. The city envisions producing 30 mgd of recycled water initially. The ultimate reuse of 135 mg or more annually is projected to irrigate the Tayman golf course, recreation parks, and other play fields within the city limits.

City of Cloverdale Water Recycling

The City of Cloverdale operates a wastewater treatment plant which discharges treated effluent to percolation ponds. Similar to Healdsburg, the City of Cloverdale may consider in the future implementing a water recycling program in order to comply with NPDES seasonal discharge restrictions while also providing a sustainable water source for the irrigation of local parks, agricultural lands, or other areas.

Recycled Water Projects in the North Coast Integrated Regional Water Management Plan

The North Coast Integrated Regional Water Management Plan (IRWMP) has identified various water management projects throughout the North Coast Region. Multiple projects identified as part of the Planning Process are located within Sonoma County and are in various stages of funding and implementation. The Sonoma County projects involving recycled water are:

- Sonoma County Water Recycling and Habitat Preservation Project
- Graton Wastewater Treatment Upgrade and Reclamation Project
- Monte Rio Community Wastewater Project
- Rohnert Park/Cotati Urban Recycled Water System Expansion
- Sonoma County Airport Area Recycled Water Irrigation

More information on the projects can be accessed through the North Coast IRWMP website at: www.northcoastirwmp.net.

Additional Water Recycling Opportunities at the Municipal and Regional Levels

> *As water demands and environmental needs grow, water recycling will play a greater role in our overall water supply. By working together to overcome obstacles, water recycling, along with water conservation can help us to conserve and sustainably manage our vital water resources.*
>
> *US EPA, Region 9*

Although water recycling is well established within Sonoma County, opportunities exist to expand water recycling within the region. The Water Agency and its water contractors currently have policies and programs in place to further the development of water recycling. The Water Agency and its contractors encourage recycled water use by collecting, as part of Agency water rates, funds to be held in a special reserve for recycled water projects carried out by its water contractors and other Agency customers. Between this program's inception on July 1, 2000 and June 30, 2010 a total of $4,144,272 had been disbursed for new recycling programs (Sonoma County Water Agency 2011). As discussed above, the Water Agency and other agencies in the region are currently planning new recycled water projects and the expansion of existing recycled water projects.

In addition to these existing programs and projects that seek to expand recycled water use, further opportunities for increased water recycling can be identified in a general sense by a broad examination of recycled water generation and potential recycled water uses. Within Sonoma County, the majority of municipal wastewater generated and treated during the summer months is beneficially reused. In the winter months, most treatment plants discharge some treated wastewater to surface waters, although the Airport/Larkfield/Wikiup SZ is a zero discharge facility and the Subregional System also achieved zero discharge in the relatively dry winter of 2008-2009. **Table 3-4** presents information on the extent of recycled water generation and use in Sonoma County at the larger wastewater treatment facilities that conduct water recycling. For any region, maximizing beneficial reuse of recycled water depends on:

- Providing appropriate levels of treatment;
- Identifying and prioritizing end users;
- Connecting recycled end users to recycled water supplies via distribution systems;
- Overcoming seasonal differences between recycled water supply and demand;
- Conducting outreach/education to ensure public acceptance of recycled water; and
- Project financing.

Each of the above criteria is examined below with respect to expanding recycled water use within Sonoma County.

Table 3-4: Recycled Water Generation and Use from Larger Sonoma County Wastewater Treatment Plants

Wastewater System	Wastewater Treated	Recycled Water Generation[1]		Discharge to Surface Waters		Amount of Urban Reuse		Amount of Non-Urban Reuse[2]	
	ac-ft/year	ac-ft/year	% of Total WW	ac-ft/year	% of Total WW	ac-ft/year	% of Total WW	ac-ft/year	% of Total WW
Airport/ Larkfield/ Wikiup SZ[3]	750	750	100%	0	0%	0	0%	750	100%
Sonoma Valley CSD[3]	3,616	3,616	100%	2,500	69%	0	0%	1,116	31%
Forestville Water District[4]	144	144	100%	74	51%	20	14%	50	35%
Subregional System[5]	23,047	23,047	100%	288	1%	856	4%	20,015	87%
Town of Windsor[6]	2,866	1,546	54%	1,320	46%	1,136	73%	410	27%
City of Petaluma[7]	8,200	3,319	40%	4,881	60%	487	15%	1,190	36%

1. *Amount of treated effluent meeting Title 22 standards for reuse of secondary or tertiary treated wastewater.*
2. *Non-urban reuse includes agricultural irrigation as well as recycled water sent to the Geysers from the Subregional System and recycled water used for maintenance of wildlife habitat.*
3. *Unpublished Sonoma County Water Agency operational data from 2012.*
4. *Adapted from Tables 5-3, 5-4, 5-5, and 5-6 of SCWA's 2005 Urban Water Management Plan (Sonoma County Water Agency 2006)*
5. *Data from Tables 4-10, 4-11, and 4-13 in City of Santa Rosa's 2010 UWMP (City of Santa Rosa 2010).*
6. *Data from 2010 Town of Windsor UWMP (Town of Windsor 2011).*
7. *Treatment upgrades at the City of Petaluma treatment plants allow for all wastewater to be treated to Title 22 standards. Data from 2010 City of Petaluma UWMP (City of Petaluma 2011).*

Level of Treatment: Tertiary treated water can be reused in many more applications than secondary treated water can, including those applications that have the greatest potential to offset potable water use such as urban landscape irrigation. Within Sonoma County, most wastewater treatment plants are providing tertiary treatment or are upgrading to tertiary treatment in the near future. As such, the level of treatment provided by wastewater treatment plants in Sonoma County is not a significant barrier to expanded water reuse, at least from a regulatory point of view.

Identifying and Prioritizing End Users: As shown in the **Table 3-5** below, a variety of end uses of recycled water are already established within Sonoma County. The projects representing these end uses have generally been successful and can thus act as models for future applications of recycled water.

Table 3-5: Recycled Water Ends Uses in Sonoma County

Recycled Water End Use	Currently Conducted in Sonoma County	Examples/Comments
Urban Uses		
Irrigation of public parks	Yes	Finley Community Park (Santa Rosa), Windsor Town Green and numerous others
Irrigation of school yards	Yes	Windsor High School, Sonoma State University
Toilet flushing	Yes	Windsor High School
Residential landscape irrigation	Yes	Vintage Greens subdivision (Windsor)
Industrial/commercial uses (non-landscape irrigation)	No	Industrial/commercial users of recycled water may be included in the City of Santa Rosa's urban reuse program
Agricultural Uses		
Irrigation of agricultural areas including vineyards and pasture land	Yes	SRJC Shone Farm; various pasture, hay and silage crops, vineyards, vegetable and specialty crops
Other Uses		
Habitat enhancement	No	Habitat enhancement using recycled water is ongoing or planned in areas near Sonoma County. NBWRP recycled water is planned to be used for salinity reduction at Napa Salt Marsh Restoration Project
Geothermal recharge	No	The Geysers Recharge Project is an unusual groundwater recharge project in that the recharge is being conducted for geothermal energy generation. Groundwater recharge for the purpose of replenishing aquifers for potable supply is conducted in parts of Southern California but is not currently conducted within Sonoma County.

Distribution Systems: Providing cost-effective distribution systems for recycled water use is often the most significant barrier to increased recycled water use. There are numerous potential users of recycled water in Sonoma County that are not near existing recycled water distribution lines. In limited instances, recycled water piping can be installed in advance of available connections to recycled water supplies. Cities and counties can install recycled water mains in conjunction with street works if future recycled water demands/supplies can be adequately estimated to determine reasonable pipe sizes and routes. Additionally, developers can be encouraged to dual-plumb new buildings even if recycled water is not yet distributed to the area.

Seasonal differences between recycled water supply and demand: Due to the inflow and infiltration that occurs in all sewer systems, wastewater treatment plants treat greater volumes of water during the winter wet season than in the summer dry season. Because a significant portion of recycled water produced in Sonoma County is used for irrigation, much of the wintertime treated wastewater cannot be reused and is discharged to surface waters. Construction of additional water storage facilities can partially bridge the gap between wintertime supplies and the summertime irrigation demands.

Public Outreach/Education: Public outreach and education is an essential component of any recycled water program. As recycled water use is expanded in Sonoma County, existing public outreach efforts will also need to be further developed. Recent changes in regional regulation of recycled water use have generated significant comment from local environmental groups which are concerned about potential growth inducement and perceived environmental risks associated with recycled water use.

Opportunities for On-Site Wastewater Treatment and Reuse

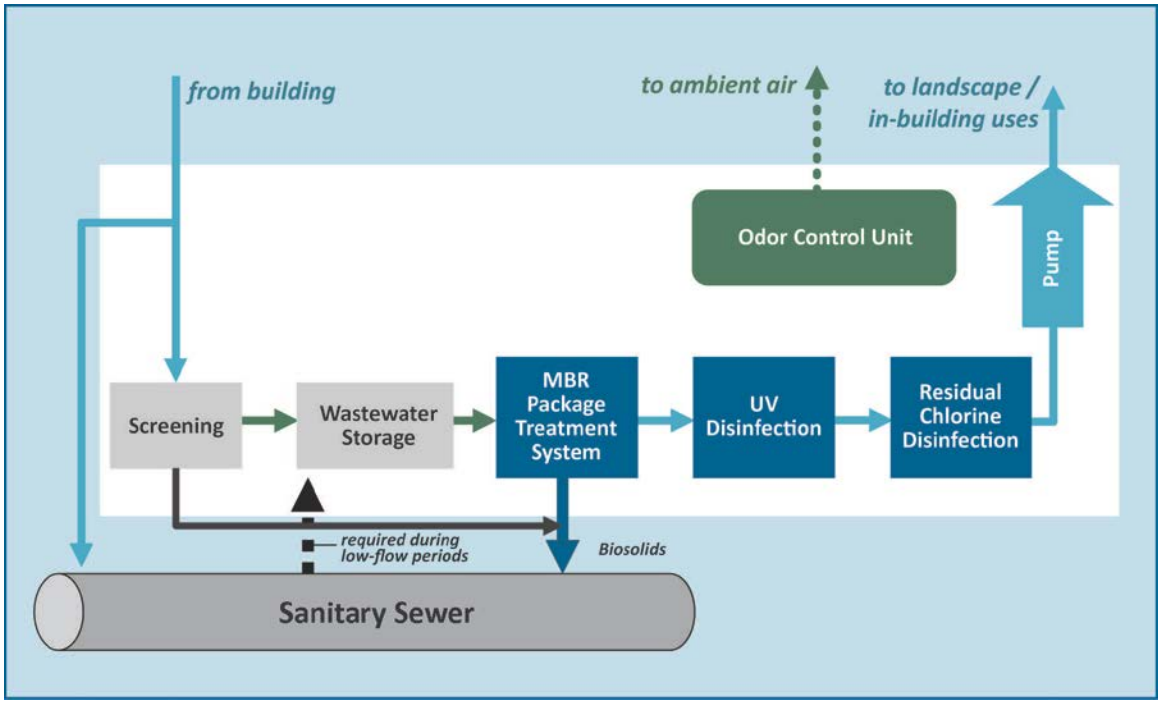
Larger buildings (especially new buildings) may be able to incorporate on-site wastewater treatment and reuse. At larger buildings, onsite wastewater treatment is most commonly accomplished via Membrane Bioreactors (MBRs). MBRs are small-scale wastewater treatment plants that can be installed within larger buildings or at institutional settings such as a college campus. MBR systems are capable of treating wastewater to Title 22 standards. The resulting recycled water can be used within the same building for non-potable uses such as toilet flushing, landscape irrigation, and building cooling. Although MBR systems are not common, there may be future opportunities for facilities in Sonoma County to use MBR systems for wastewater treatment and water reuse.

In a typical MBR system, wastewater from a building's toilets, showers, washing machines, and sinks is piped to the basement of the building where it is held in storage and settling takes place. Biosolids are directed to the municipal sanitary sewer system. The wastewater then passes through an MBR package unit that uses aerobic and anaerobic biological treatment in conjunction with microfiltration to purify and filter the wastewater. From the MBR, the water is disinfected using a UV disinfection process. Chlorine is added before distribution to ensure residual disinfection throughout the distribution system. At this point, the treated water meets

Title 22 standards for water reuse and is pumped back into the building or pumped to adjacent buildings for use as irrigation or cooling tower process water. Any water that is produced beyond demand is routed to the sanitary sewer for disposal. An odor control unit is necessary to eliminate treatment-related odors before releasing air to the atmosphere. This treatment process is illustrated in **Figure 3-3**.

In most cases of in-building water recycling, the amount of wastewater supplied to the system will exceed the demand for recycled water in the same building. Excess waters can be distributed to adjacent areas or discharged to the sanitary sewer.

Figure 3-3: **Membrane Bioreactor Treatment Process**



While an MBR recycled water system would benefit the water supply and water treatment systems within Sonoma County, there are also drawbacks associated with implementing such a system. **Table 3-6** outlines the advantages and disadvantages inherent in an in-building recycled water project.

Table 3-6: Advantages and Disadvantages of In-building Recycled Water Treatment Systems

Advantages	Disadvantages
▪ Decreases potable water demand for non-potable uses such as toilet flushing, HVAC, and irrigation ▪ Decreases wastewater flow to sewer system	▪ Requires maintenance of decentralized treatment system ▪ Relatively new application of technology ▪ Health and public perception issues related to storing wastewater

Chapter 4
Reducing Storm Water Impacts

4.1 Introduction and Purpose

The mission of Sonoma County Water Agency (Water Agency) is to effectively manage the resources in its care for the benefit of people and the environment in its service area. As a part of this pursuit, the Water Agency encourages the use of Low Impact Development (LID) techniques to the greatest extent practical to reduce the adverse impacts of storm water runoff on water quality, stream and riparian conditions, and flooding while also promoting beneficial uses of storm water. This section of the Water Smart Development guidebook describes LID planning approaches and techniques.

The purpose of this chapter is to (1) provide general guidance on how to incorporate LID storm water approaches into the site planning and design process, and (2) provide an introduction to LID BMPs and treatments that can be applied to development sites. The combination of using LID planning approaches and BMP treatments helps reduce and avoid deleterious effects of storm water resulting from urban development and encourages beneficial uses of storm water. This chapter is intended for several audiences, including land-use planners, engineers, landscape architects, and developers in Sonoma County who may be working with staff at Sonoma County and cities in the county for project approvals.

The contents of this chapter are not intended to establish specific or mandatory LID requirements to comply with storm water permits administered through the Regional Water Quality Control Boards (RWQCBs). As introduced in Section 1.1, and described further in the section below, the City of Santa Rosa has taken the lead on behalf of the Phase 1 CoPermittees in establishing LID guidance for development projects in compliance with the Phase 1 NPDES permit in the 2009 NPDES permit area. The Water Smart Development Guidebook is, however, intended to include support for development of LID approaches throughout Sonoma County, and may serve as a reference guide to complement existing LID guidelines and implementation criteria required for NPDES storm water permit compliance. Other communities in Sonoma County, such as those regulated under the Phase 2 NPDES program within RWQCB Region 2, may utilize this guidebook to assist in establishing their own LID guidelines and implementation criteria to comply with requirements in their NPDES storm water permit, or simply enhance their practices and policies to achieve specific storm water management objectives.

Regulatory Background: Sonoma County NPDES Permitting and LID

The Federal Clean Water Act of 1972 regulates discharges to surface waters (other than dredge or fill material) through the National Pollutant Discharge Elimination System (NPDES). Under the NPDES, municipalities, including public entities like the County of Sonoma, are required to maintain compliance with the conditions of NPDES permits for their storm water discharges. The municipalities, in turn, require that individual projects within their jurisdiction comply with the requirements of these permits.

Municipal storm water NPDES permits have been issued by the State in two phases, referred to as Phase 1 and Phase 2 permits. Phase 1 of the NPDES storm water program provides coverage for large or medium sized municipalities with populations of 100,000 or more. Smaller (<100,000 population) municipal separate storm sewer systems (MS4s) are covered under Phase 2 of the NPDES program. Phase 1 permits are individual NPDES permits, while Phase 2 permits are covered by a statewide general NPDES permit; the requirements associated with Phase 1 are generally more stringent than those associated with Phase 2. However, the State Water Resources Control Board's (State Water Board) 2013 statewide general Phase 2 Small MS4 NPDES permit includes similar requirements to those included in 2009 Phase 1 permit issued to the Sonoma County Phase 1 communities by the North Coast Regional Water Quality Control Board. Information on the NPDES permits issued by the State Water Board is available at the following website: http://www.waterboards.ca.gov/water_issues/programs/stormwater/.

The Water Agency, Sonoma County, and the City of Santa Rosa are Phase 1 communities that are joined together as Phase 1 CoPermittees under the Phase 1 *Waste Discharge Requirements for Storm Water and Non-Storm Water Discharges from Municipal Separate Storm Sewer System (MS4) discharges from Sonoma County* (2009 NPDES Permit), issued by the North Coast Regional Water Quality Control Board (Order No. R1-2009-0050, NPDES No. CA0025054). The permit boundary or permit area for the 2009 NPDES Permit includes the Santa Rosa city limits, areas tributary to the City, Sonoma County islands within the city limits and the City's future urban growth boundary. The permit area also includes those areas of the MS4s within the Mark West Creek and Laguna de Santa Rosa watersheds that are controlled by the City of Santa Rosa and Sonoma County, in addition to County-controlled MS4s located in Graton and urban clusters outside of Healdsburg[1].

After October 2014, there will be no NPDES Phase 2 designees in the Sonoma County portion of RWQCB Region 1. However, NPDES coverage for small MS4s within RWQCB Region 2 will

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[1] Upon the renewal of the Phase 2 permit that became effective July 1, 2013, select Phase 2 communities took the opportunity to align their MS4 programs with the Phase 1 NPDES permit. These Phase 2 communities are referred to as Phase 1 Program Participants. The Phase 1 Program Participants include Cloverdale, Cotati, Healdsburg, Rohnert Park, Sebastopol, Ukiah (Mendocino County), and Windsor. Upon the renewal of the Phase 1 permit, which is scheduled to take place in October 2014, the Phase 2 Program Participants will become Phase 1 CoPermittees and the Phase 1 NPDES permit boundary will be expanded to include the boundaries of the Phase 1 Program Participants.

continue to be covered under the Phase 2 permit. This includes the following communities: City of Petaluma, City of Sonoma, and portions of the County of Sonoma and Sonoma County Water Agency within RWQCB Region 2. These designees are not be able to join the RWQCB Region 1 NPDES Phase 1 program. In accordance with coverage under the Small MS4 General Permit, each of these communities have developed its own storm water management program, some have adopted the Standard Urban Storm Water Mitigation Plan (SUSMP) prepared by the City of Santa Rosa for compliance with their Phase 1 NPDES permit. The remainder of this section focuses on requirements of the Phase 1 NPDES permit. However, similar requirements are included in the Phase 2 permit, and thus apply to Phase 2 permittees as well.

The Phase 1 2009 NPDES Permit (Special Provisions Part 5) identifies the development of an Integrated Water Quality and Water Resource Plan for new development and redevelopment. This plan is to include an LID manual, post-construction treatment BMP criteria, and a hydromodification control and mitigation plan. It is envisioned that these three components of the overall water quality plan will be developed in phases and that, once complete, will serve as a comprehensive manual that replaces the SUSMP manual.

The Phase 1 CoPermittees developed a Storm Water Management Plan (SWMP 2005) and a Standard Urban Storm Water Mitigation Plan (SUSMP 2005) to guide construction, post-construction, industrial, commercial, and storm system operation and management operations within the permit area. These plans were updated to incorporate the requirements of the 2009 Phase 1 permit. The revised manual was renamed as the "Storm Water LID Technical Design Manual" and was finalized in August of 2011 (City of Santa Rosa and County of Sonoma 2011).

This guidebook supports a portion of the LID manual requirement of Special Provisions Part 5 of the Phase 1 NPDES permit. As specified in the permit, the LID manual should include guidance on the following LID objectives and strategies:

A. Site assessment;
B. Site planning and layout;
C. Vegetative protection, revegetation, and maintenance;
D. On-site soil protection with the goals of reducing soil compaction, retaining topsoil and facilitating runoff capture;
E. Retention of natural runoff infiltration, storage and evapotranspiration rates;
F. Techniques to minimize land disturbance;
G. Techniques to implement LID measures;
H. LID BMP design guidance;
I. LID BMP maintenance guidance;
J. Integrated water resources management practices;
K. LID design and flow modeling guidance;

L. Hydrologic analysis; and

M. LID offset credits.

Hydromodification refers to changes in runoff volume, frequency, and duration due to urban development. Increased runoff and streamflow from urban areas discharged to natural watercourses can adversely impact aquatic ecosystems and stream habitats and cause stream bank erosion and physical modifications.

Hydromodification management is a process that preserves natural hydrograph attributes for a development site and its watershed. Hydromodification Management Plans (HMPs) have been developed by cities and counties in California to comply with NPDES permitting requirements. In Sonoma County, these criteria and requirements are specified in the 2009 Phase 1 NPDES permit and hydromodification management requirements are prescribed in the Phase 2 Small MS4 Permit .

This guidebook is intended to complement the Phase 1 CoPermittee's Storm Water LID Technical Design Manual by emphasizing on-site and broader regional approaches to storm water management. This guidebook provides the reader with background information on LID concepts in general, while the CoPermittee's manual provides specific design requirements for compliance with NPDES permit requirements.

The 2009 NPDES Permit also describes the need for hydromodification control criteria. These criteria would limit the extent to which new development and redevelopment projects may alter post-development storm water runoff discharge rates, velocities, and durations to receiving creeks. Hydromodification approaches are implemented to prevent post-project downstream erosion and associated impacts to stream habitat in receiving waters. The 2009 NPDES Permit requires that LID strategies be the preferred method to meet these requirements. However, other methods are likely needed when LID approaches alone cannot reduce post-development related discharges. The 2009 NPDES Permit requires that more specific hydromodification control criteria be developed in a Hydromodification Control Plan as the third component of the overall integrated water quality plan. The Hydromodification Control Plan is being developed by the City of Santa Rosa, on behalf of the CoPermittees, and will include approaches to analyze and evaluate potential hydromodification effects, as well as, design criteria to use to mitigate for potential hydromodification effects on receiving streams. For the latest information on the Hydromodification Plan, see the City's storm water permit compliance website: http://srcity.org/departments/utilities/stormwatercreeks/swpermit/Pages/SWPERMITCOMPLIANCE.aspx.

Chapter 4 Organization

The remainder of this chapter is organized into the following sections:

- Section 4.2 – *LID Approach to Storm Water Management*. This section describes LID principles and general approaches to on-site storm water management.
- Section 4.3 – *The LID Storm Water Planning Process*. This section presents a step-by-step process to incorporate LID into the project design and implementation process.

Planning steps include site assessment, site planning, design and selection of LID measures, and project construction, operations and maintenance.

- Section 4.4 – *LID Feature Summaries*. This section presents informative summary sheets for several LID on-site storm water management techniques.
- Section 4.5 – *Off-site, Retrofit, and Regional Approaches*. This section describes off-site mitigation, retrofit, and other regional approaches that can be used to manage storm water in addition to the on-site LID approaches.
- Appendix 3 – Project Review Checklists
- Appendix 4 – Reference Maps

4.2 LID Approach to Storm Water Management

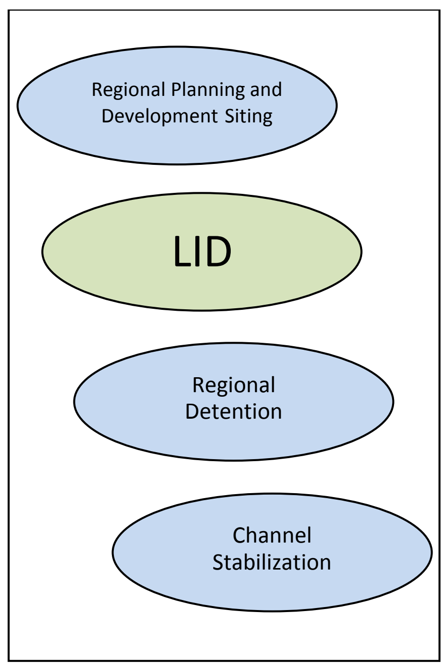
LID storm water management is a site design strategy with the goal of avoiding and minimizing hydrologic and water quality impacts associated with development. The LID strategy emphasizes design practices and techniques that effectively capture, filter, store, evaporate, detain, and infiltrate runoff close to its source. LID also seeks to conserve natural resources and preserve ecological functions. The LID concept is based on the premise that storm water management involves more than just preventing flooding, and that runoff is a valuable resource if used wisely. LID recognizes the value of pre-existing hydrologic functions and their influence on the surrounding environment.

The LID storm water management approach recognizes that urban design, landscape architecture, and engineered infrastructure are intrinsically linked.

While LID is recognized as a valuable approach to storm water management at the site scale, it is not the only approach to storm water reduction and mitigation. As depicted in **Figure 4-1**, effective storm water management occurs at several scales. Regional planning and watershed management approaches (including "smart growth" techniques) can minimize storm water impacts through careful siting considerations. Regional storm water management facilities (such as detention basins) also provide an effective means to capture or manage storm water. Regional approaches to storm water management

***"Smart growth** refers to community development that is designed to preserve natural resources, protect air and water quality, and reuse developed land. Principles include mixing land uses, providing opportunities for alternative transportation, and utilizing compact building designs (USEPA 2009).*

Figure 4-1: Storm Water Planning Approaches



are discussed later in this chapter (Section 4.5). In addition to LID, regional planning, and regional facilities; stream restoration and channel stabilization measures may be needed to address downstream erosion.

Additionally, it should be stated that LID is generally used in conjunction with conventional storm water infrastructure, such as municipal storm drains and drainage channels. LID techniques are best suited for minimizing the impacts of small-to-moderate-sized storms on water quality and runoff volume. For most sites, conventional storm water infrastructure is also needed to prevent flooding during large rainfall events.

Section 4.2 continues with a summary of how the hydrologic cycle is affected by development and storm water, a review of four guiding principles of LID storm water management, an overview of LID design features, and a discussion of challenges to LID implementation.

Storm Water LID and the Hydrologic Cycle

As described in Chapter 1, the hydrologic cycle describes the movement and storage of water across the atmosphere, the land surface, the subsurface, and the ocean basins. Runoff and streamflow are a relatively small, but very important, component of the overall cycle. Storm water LID approaches focus on preventing runoff generation.

Preserving and promoting infiltration, the process by which rainfall enters the soil, is perhaps the most important aspect of LID storm water management. Healthy soils (with moderate to high infiltration capacities) provide a critical role in receiving, storing, and infiltrating rainfall. Soils are not solely mineral composites. Healthy soils maintain biota and organic matter that chemically and physically bind mineral particles into stable aggregates; these build soil structure and provide pore spaces.

> ***Infiltration*** *is the process by which rainfall enters the soil. Infiltration is determined by the available soil pore space (porosity) and the interconnectivity of these cavities (permeability). After a storm, water that has infiltrated into surface soils may evaporate, be used by plants, or flow by gravity deeper into the soil.*
>
> *Once water has infiltrated beneath the root zone, there is no longer any opportunity for evaporation or transpiration. The water then* ***percolates*** *downward through the soil to the shallow subsurface zone. Although the terms infiltration and percolation are often used interchangeably, infiltration generally refers to the process by which water enters and moves through soil, whereas percolation is infiltration that occurs beneath the root zone.*
>
> *In Sonoma County there is a great variety of infiltration conditions, ranging from very high infiltration rates in places like the plains and hills east of Windsor to very low infiltration in areas of Rohnert Park and Petaluma.*

Porosity and permeability are the keys to good infiltration. Soil porosity is the available pore space (or voids) that a soil has for water or air. Permeability is the way in which such pore spaces are arranged or structured such that water is able to move down through the linked pores or cavities by gravity. The ability for water to move down through the soil is called hydraulic connectivity. Clays and microbes in soils also play an important role in potential pollutant filtering and degradation, and enable moisture retention for use by vegetation. As soil conditions vary across the landscape (or within a development site) the influence of these soil functions on the hydrologic system also varies.

Evaporation releases water back to the atmosphere. This can happen directly from water vaporizing from the land, vegetation, or soil surface or being released from open water bodies. Evaporation also occurs from near surface soil pores when the vaporizing force is greater than the capillary or suction forces acting to keep moisture in the soil. Transpiration is the process where plants release water back to the atmosphere through their stomata and lenticels. Evapotranspiration (ET) refers to the collective processes of evaporation and transpiration. ET is a fundamental consideration for the effective operation of LID storm water features. As described later in this chapter, many LID features rely on detaining and holding collected runoff. If such collected runoff can be effectively evaporated or transpired following a rainfall event, then the LID feature will have more available volume to store runoff during the next rainfall event.

In California's two-season Mediterranean climate, the rainy season is also our winter season, when evaporation and transpiration rates are at their lowest. That said, breaks between winter storms with sunshine and/or strong winds do provide opportunities for evaporation and transpiration. During the later winter and early spring weeks, particularly after March when annual vegetation growth is strong and daylight hours are longer, the role of evapotranspiration improves greatly.

Surface water that is not infiltrated, evaporated, or transpired is available as runoff to streams and downstream waters. The amount and timing of runoff and streamflow over a given time period (storm event, season, or year) reflect the region and watershed's climate, topography, geology, and soils. As described in Chapter 1 and illustrated in **Figure 1-6**, development alters the quantity, quality, and timing of storm water runoff in ways that can be detrimental to the land surface and to streams. Land development generally increases impervious surfaces, reduces tree and vegetation cover, and compacts or removes healthy soils. These changes typically reduce and disrupt infiltration and water storage processes provided by shallow surface depressions, upper soil layers, shallow subsurface flows, and vegetation uptake and evapo-transpiration. These changes result in increased surface runoff and increased pollutant loadings to receiving waters.

LID Principles

LID storm water management relies on four fundamental principles:

1. **Avoid** hydrologic impacts by integrating site topography, soil, and hydrology assets into the site plan and design features
2. **Conserve** existing soils, vegetation, and hydrologic features
3. **Minimize** impervious areas and maximize permeability
4. **Manage** storm water on-site through LID features

The first two principles emphasize protecting and using existing resources, while the last two principles shift focus to impact management and controls.

Principle 1: Avoid impacts by integrating existing topography, soil, and hydrology assets into the site plan and design features

Historically, site drainage approaches often sought to direct runoff as rapidly and efficiently as possible away from the site. In contrast, LID seeks to mimic pre-development hydrologic functions, most notably by favoring on-site retention and infiltration. LID uses existing topography and open space opportunities to slow, capture, and infiltrate storm water. Implementing this principle first requires a thorough assessment of pre-development site conditions to understand how to incorporate the existing drainage features and hydrologic functions into the post-project site design. The site assessment process is discussed further in Step 1 of Section 4.3.

Principle 2: Conserve existing soils, vegetation, and natural features

Conserving soils, vegetation, and natural hydrologic features such as creeks, ponds, and wetlands helps reduce runoff and maintain hydrologic functioning of the site. Such natural features provide opportunities to capture, filter, store, evaporate, detain, and infiltrate runoff while providing habitat for wildlife species and aesthetic benefits. As discussed above, evaporation and transpiration processes often supplement LID features. Plants that are part of LID features allow for some storm water volume control via transpiration while also providing some storm water treatment by taking in pollutants (phytoremediation). The conservation of wetlands and other natural features also helps avoid project impacts to habitats and species[2]. The identification of site areas to be conserved and protected occurs through the LID site assessment and planning processes described in Section 4.3.

Principle 3: Minimize impervious areas and maximize permeability

During the planning phase of the LID process, impervious areas are minimized in order to eliminate impervious surfaces that cause off-site runoff. Methods to reduce impervious area include clustering development, limiting the building footprint, maximizing permeable surfaces, directing drainage from impervious areas toward more pervious areas, and creating a site design with less pavement and roof area. Using these measures can reduce storm water runoff volumes, flow rates, and the need for additional storm water management facilities. Smart growth approaches that cluster development may also protect open spaces and thereby maintain the hydrologic functions and benefits of those open spaces. Methods to minimize impervious areas and maximize permeability are further discussed in Section 4.3 (Step 2) below as part of the LID planning processes.

Impervious surfaces that drain to pervious ground generate less runoff than impervious surfaces that are directly connected to downstream drainage systems.

[2] Compliance with Clean Water Act (CWA) and Endangered Species Act (ESA) regulations focused on wetlands and threatened and endangered species often requires significant project planning and mitigation efforts to meet applicable federal, state, and local regulations. Use of LID to avoid and minimize potential CWA and ESA related impacts is an added benefit beyond the storm water management advantages.

Principle 4: Manage storm water on-site using LID features

Detention involves the short term storage of storm water to slow and detain runoff. Retention involves the long term capture of runoff on site.

This principle builds on the previous three principles by incorporating LID features into the actual project site design. When natural features have been avoided and conserved and impervious surfaces have been minimized, storm water runoff generated by the development is then managed on-site using LID features (or treatments). The LID site design approach integrates natural features with engineered small-scale hydrologic controls to maintain or closely mimic the pre-development hydrologic conditions. LID features can be designed for **detention** or **retention**. Detention is the temporary storage or slowing of storm water, while retention refers to permanent capture of storm water. Depending on the design of the LID feature, detention can provide storm water treatment via settling, filtration, or biologic uptake of pollutants. Detention is a general strategy to slow down and capture runoff, depending upon the specific treatment and site conditions, detention may not be the most appropriate strategy. In many LID features involving retention, retained water is designed to be lost via infiltration and evaporation/transpiration. Retained water may also be reused on-site for landscape irrigation. LID features are summarized below in *Overview of LID Features,* and described more fully in the summary sheets of Section 4.4. Note that all project proponents should confer with the appropriate local municipality or governing entity for guidance and approval of LID features. For example, the Phase 1 and Phase 2 NPDES Permit does not accept detention strategies as LID compliant.

In other documents, LID Features" may be called:

- *Integrated Management Practices (IMPs)*
- *LID Best Management Practices (BMPs)*
- *LID Treatments*

Overview of LID Features

LID features are constructed structures or landscapes that provide a variety of storm water management functions. Classic examples of LID features are vegetated swales, green roofs, rain barrels, permeable paving and infiltration trenches. Within this document, LID features have been grouped into the following five categories:

- **Biofilters:** A biofilter is any vegetated area to which storm water is intentionally directed. Biofilters come in many shapes and sizes, and often use multiple hydrologic processes (infiltration, evaporation/transpiration and detention/retention) to manage storm water flows and quality. Common biofilter treatments include vegetated swales, rain gardens, and flow-through planters. Constructed wetlands are another type of biofilter. These are discussed in Section 4.5.

- **Permeable Paving:** Permeable paving provides important infiltration opportunities for storm water management. Permeable surfaces include permeable concrete, permeable asphalt, and permeable paver blocks. These can be installed on non-vehicle traffic areas such as footpaths and courtyards, and roads and parking lots where vehicles are present. Due to the infiltrating properties of permeable paving, pollutant removal in vehicle traffic areas is an added functional benefit, if the pavers are properly maintained.

- **Green Roofs:** A green roof is a vegetation and soil roof system used in place of a conventional roof. Green roofs are designed to infiltrate rain falling on the roof within an engineered rooftop soil matrix. Infiltrated rain is used by the rooftop vegetation and eventually discharged to the atmosphere via evaporation and transpiration.

- **Rainwater Harvesting Systems:** A rainwater harvesting system typically collects the run-off from a building's roof and stores the water in a tank for later reuse. Harvested rainwater is often used for outdoor purposes, such as landscape irrigation and may also provide opportunities for indoor purposes such as toilet flushing. However, in Sonoma County, use of rainwater for indoor purposes is currently not permitted. See Chapter 3 for further discussion of harvested rainwater as an alternative water source.

- **Subsurface Detention/Infiltration Strategies:** For smaller sites with space constraints, subsurface structures can be used to manage storm water on-site. Subsurface detention and infiltration structures range from simple gravel infiltration trenches to highly engineered underground storage structures. A variety of pre-fabricated products are available to facilitate subsurface detention and infiltration. Additionally, storm water management benefits can be realized by amended site soils so as to promote detention and infiltration. However, in land uses that may generate higher pollutant loading, some type of pre-treatment may be necessary prior to infiltrating storm water.

- **Soil Amendments:** Amending site soils can improve a soils ability to retain rain water, promote detention and infiltration, and thereby reduce runoff. Soil amending might involve soil additives to improve physical structure or chemical balance. Beside these properties, a very important element of a soil that supports its overall health is the soils biologic content, including its surface organic content, as well as microbial organisms deeper below. A healthy soil with rich biologic activity will generally provide good soil structure and thereby favor good infiltration conditions.

Table 4-1 compares how LID features use infiltration, evaporation/transpiration, detention, or retention processes to manage storm water.

LID Feature Categories	Infiltration*	Evaporation/ Transpiration	Detention	Retention
Biofilters	✓	✓	✓	✓
Permeable Surfaces	✓		✓	
Green Roofs		✓	✓	
Rainwater Harvesting Systems		✓		✓
Subsurface Detention/Infiltration Strategies	✓	✓	✓	
Soil Amendments	✓	✓	✓	✓

** Appropriate use of LID features for infiltration functioning is highly dependent on on-site soil type and infiltration rates.*

Challenges to LID Implementation

There are many potential limits and challenges to implementing storm water LID measures. Some challenges are merely problems of perception, whereas other issues represent substantive constraints. LID is not a panacea for all storm water issues, but it does provide a flexible design approach that can improve storm water quality, provide beneficial uses of storm water, and prevent deleterious runoff impacts. Below is a discussion of some of the commonly noted challenges to LID implementation.

Cost: Despite common misperceptions, LID is often the most economical way to manage a site's storm water. Studies and surveys conducted by the U.S. Environmental Protection Agency (EPA) have found LID practices save money for developers, property owners, and communities. LID can provide savings compared to conventional storm water management techniques even if benefits such as enhanced property values and aesthetic amenities are not considered to have a monetary value.

As part of the ***Brooklyn Creek Basin Program****, the City of Portland is implementing hundreds of LID features including bioretention areas and rain barrels throughout a 2.3 square mile neighborhood. In combination with sewer improvements, these LID features will alleviate basement flooding problems. The alternative solution upgrading an undersized combined sewer trunk line would have been more expensive.*

Maintenance: All storm water management strategies (including LID features and conventional techniques) require maintenance. LID features such as bioretention areas have an advantage over conventional storm water management structures because, being above ground, they are not "out of sight, out of mind." Because LID features like bioretention areas and green roofs provide aesthetic benefits, property owners have additional incentives to keep them looking good and functioning properly.

Vector Control: LID features may create standing water sources and can therefore be a potential breeding ground for mosquitoes. Mosquitoes are vectors of disease and have the potential to seriously affect public health. LID features can create standing water and conditions that are excellent mosquito breeding habitat. With proper design and maintenance, however, mosquito breeding in LID features can be prevented. LID features like bioretention areas must be designed to drain fully within 72 hours. For larger storm water control features that require longer detention times (such as detention ponds or constructed wetlands), using mosquito-eating fish may be warranted. Vegetation growing in and around the feature should be properly managed to reduce mosquito breeding habitat. LID features that maintain standing water can also attract rodents such as rats, raccoons, opossums, and skunks. LID features should be monitored frequently to reduce and control mosquito populations, particularly for rainwater harvesting, surface detention systems, and storm water filters. In addition to ensuring that standing water drains in a timely fashion, rodents may be discouraged through other means such as fencing. Potential LID designers should consult the Marin/Sonoma Mosquito & Vector Control District for further information on requirements for mosquito and rodent issues. The Marin/Sonoma Mosquito & Vector Control District must be notified of the locations where conventional and LID storm water systems are to be constructed and used in Sonoma County. These sites are entered into a database and periodically surveyed for presence of mosquito and other vectors.

Infiltration Limitations: As stated previously, infiltration is one of the key strategies of LID features. However, in many locations in California soils exhibit low porosity and permeability potential, particularly in lowland basins and clay rich plains and alluvial fans as found in Sonoma County. As shown in the soil maps of Figures 4-9 and 4-10 (described further in Section 4.3.1), the majority of Sonoma County exhibits soils in Classes C and D of the USDA classification system for hydrologic soil groups. For example, implementation of LID features which incorporate a significant amount of infiltration to function may not be appropriate for areas within Rohnert Park and Petaluma that have limited infiltration capacity.

Groundwater Protection: As discussed throughout this guidebook, one of the most prominent LID strategies is to infiltrate as much storm water as possible. Because storm water can contain pollutants, there may be some concern that infiltrated storm water might negatively affect groundwater quality. Studies have shown, however, that infiltration through soil is generally effective at removing common storm water pollutants and that infiltrating LID features rarely pose any significant threat to groundwater quality. Infiltrating LID features may not, however, be appropriate for certain industrial sites that have the potential to generate elevated levels of pollutants in storm water.

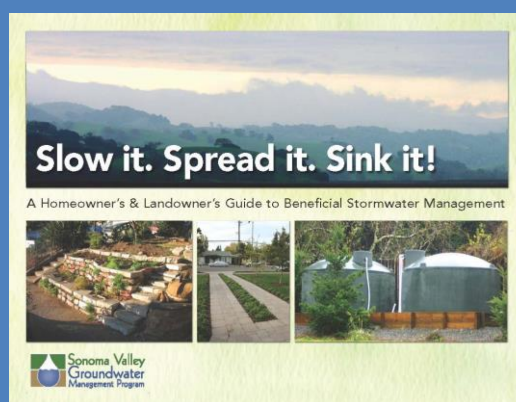
*Results from the long term **Los Angeles Basin Water Augmentation Study** (2005) by the Los Angeles & San Gabriel Rivers Watershed Council indicate that storm water infiltration has not negatively impacted groundwater quality at six monitoring sites.*

California Climate: California's seasonal rainfall pattern poses particular challenges for LID implementation. In California, rainfall primarily occurs during the wet winter months and is followed by a long dry-season that extends from mid-Spring to mid-Fall. During the winter rain season, frontal storms arriving from the Pacific may come in successive waves with little break between storm events. During the winter season, LID features that rely on lengthy dry periods between storm events may be overwhelmed by successive storms. During the dry summer season, vegetated LID features (such as biorentention areas), may struggle to maintain plants without some supplemental irrigation (most often from a potable water source). Careful plant selection can, however, provide vegetated LID features that remain effective and attractive throughout the year with minimal supplemental irrigation. The most common use for water collected by rainwater harvesting systems is landscape irrigation. With rainfall occurring in the winter and irrigation needs occurring in the summer, significant storage capacity is required if the collected rainwater is to be used when it is most needed.

Regulatory, Institutional and Legal Barriers: LID is still a relatively new strategy for managing storm water. In some instances the regulatory, institutional and legal framework has not kept pace with recently-developed techniques and applications for LID approaches. One example of this is the reuse of rainwater. Currently, rainwater use in California lies in a legal/regulatory "gray area." Use of untreated rainwater is generally considered acceptable only for landscape irrigation. This regulatory context is, however, slowly changing to support other uses of rainwater such as toilet flushing. The City of San Francisco recently adopted codes and policies that make rainwater use for toilet flushing legal with a permit. In Sonoma County, LID is supported and advocated by many local agencies. However, the use of rainwater for indoor purposes such as toilet flushing is currently not permitted within Sonoma County. It is anticipated that the regulatory, institutional, and legal context in Sonoma County will increasingly facilitate the use of LID.

Sonoma Valley Groundwater Management Program Southern Sonoma County Resource Conservation District

Slow it. Spread it. Sink it!



The "Slow it. Spread it. Sink it!" manual includes storm water runoff improvement practices which can be implemented by homeowners and landowners in Sonoma County. The manual covers general methods to understand and evaluate storm water runoff around a home and solutions to reduce impacts of storm water runoff. The manual presents LID type solutions that are similar to those presented in this Guidebook; the two guides complement each other in the information provided to local homeowners in Sonoma County. Also included in the "Slow it. Spread it. Sink it!" manual are examples of local storm water treatment projects implemented in Sonoma County. This manual is an excellent reference for local application of LID features and is available for review online at: http://sscrcd.org/.

4.3 The LID Storm Water Planning Process

The LID Planning Process:
Step 1 Site Assessment
Step 2 Site Planning Process
Step 3 LID Design Objectives and Feature Selection
Step 4 LID During Construction Phase
Step 5 LID Operations and

Developing and implementing LID for storm water management follows a process of site planning, construction, and post-construction activities for development and redevelopment projects. The LID planning process is summarized in **Figure 4-2**. This figure may not specifically illustrate the exact process for every site plan developed in Sonoma County, but this illustration is offered as a general representation of an adaptable process that could be followed. In this guidebook, LID principles and approaches are applied at each stage of the planning process. The LID planning process may be applied to residential, commercial, industrial, and municipal projects, regardless of size. This section describes each step in the planning process of **Figure 4-2**. Where possible, the discussion is tailored to conditions encountered in Sonoma County. **Figure 4-3** depicts an area of Sonoma County on the Santa Rosa Plain that is currently on the fringe of urban development. This area and the site shown in the highlighted box of **Figure 4-3** will be used throughout this section as a hypothetical development site to illustrate the LID planning process.

Successful LID planning requires early collaboration and close communications amongst property owners, planners, architects, engineers, builders, and the project developers. It is important that the LID concept for storm water management plan does not conflict with (and is integrated with) the site, grading, and landscaping plans for the project.

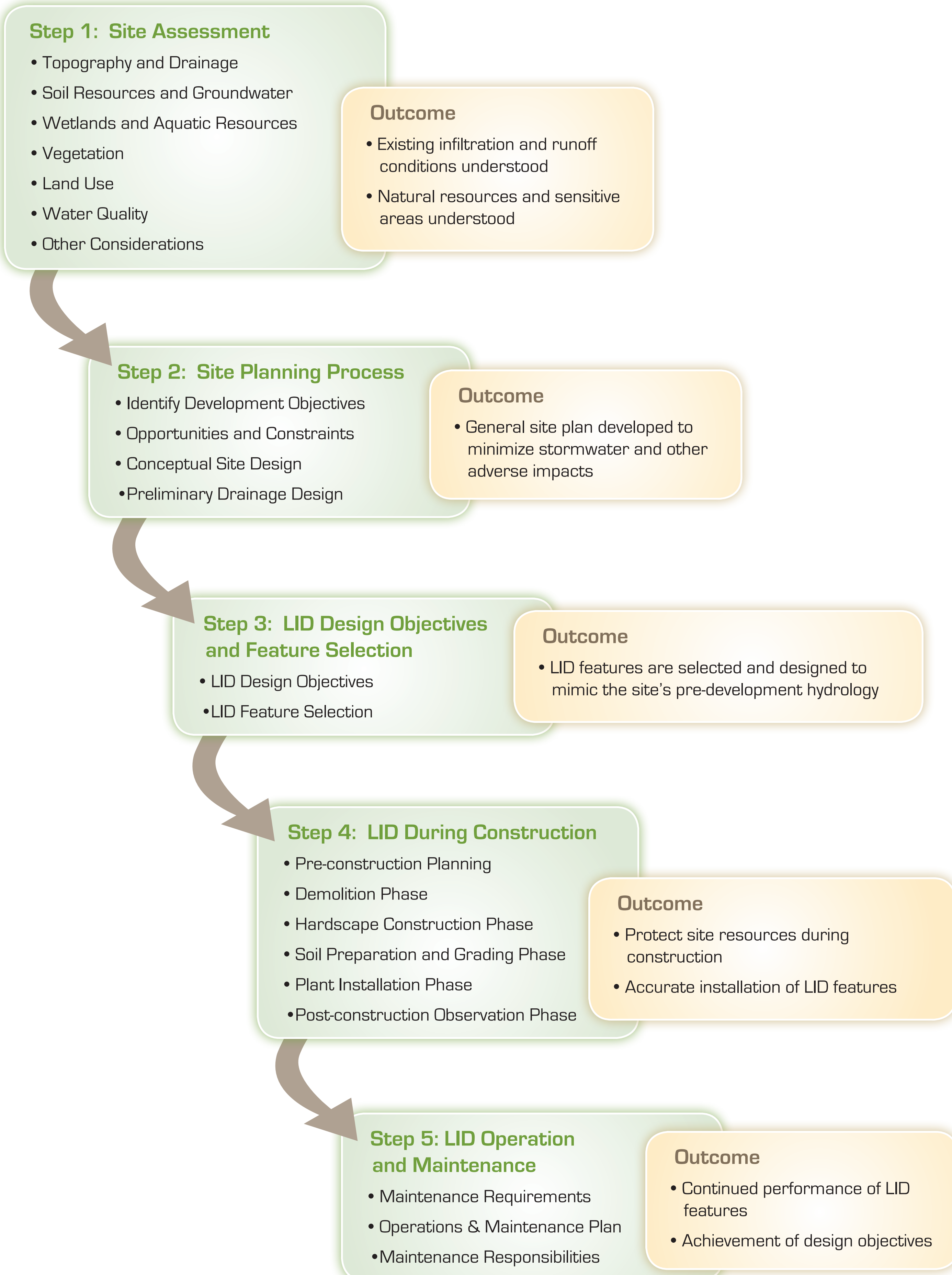
Typical LID Stakeholders include:
- *Land developers*
- *Land use planning agencies*
- *Storm water managers*
- *Water quality regulators*
- *Local community*
- *Consulting engineers*

Step 1: Site Assessment

The Site Assessment represents the first step of the LID planning process and is fundamental to all subsequent steps. The objective of the Site Assessment is to understand the site well enough to inform and guide the site planning and LID feature design steps. The Site Assessment should be conducted with overall project goals in mind while identifying and evaluating specific pre-project site conditions. This guidebook discusses the Site Assessment process in depth. This is important for understanding and recognizing on-site resources to improve LID planning and effectiveness.

Site Assessment:
a) Topography and Drainage
b) Surface Hydrology
c) Soil and Infiltration
d) Groundwater
e) Wetlands, Ponds, and Floodplains
f) Vegetation, Riparian Resources, and Upland Habitats
g) Land Use
h) Water Quality
i) Other Site Considerations

Figure 4-2 LID Planning Process



(a) Topography and Drainage

Existing site topography determines general flow patterns on-site prior to any grading activities. For LID planning, key topographic considerations include recognizing steeper areas that have potential to generate more runoff and identifying depressions or low lying areas that may provide opportunities for retention and infiltration. Hillslope gradients and lengths should be assessed, as several LID approaches are limited above certain slope thresholds. Conversely, exceedingly flat sites should be mapped carefully so that natural drainage directions may be understood. Understanding the site's base elevation in relation to any existing adjacent storm water delivery system (to which the site may eventually route runoff) is also important.

Figure 4-3: Site Assessment

hypothetical site located on the fringe of developed area

Surface topography should also be studied to identify locations of sediment erosion, transport, and deposition. Because surface topography reflects underlying geology and soils, understanding site topography within the larger watershed will help with the later planning steps of identifying potential opportunities or constraints to LID features. Some useful framing questions to assess the site's setting within its watershed include:

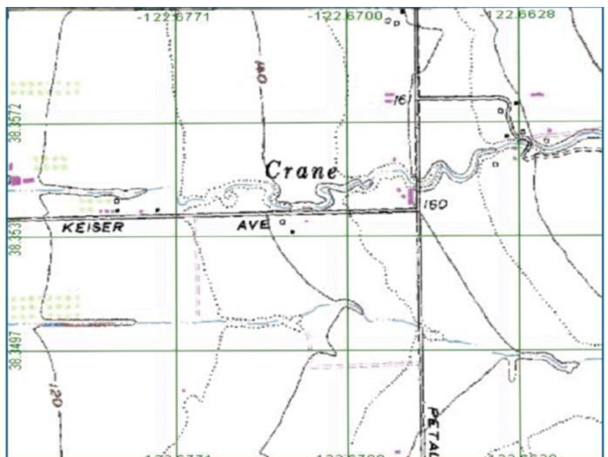
- Upper Watershed and Headwaters Areas: Is the site located in steeper upper watershed or headwater areas? Under existing conditions are surface erosion rates high? Are there any signs of mass movement or slope failure? Are there any channels on site and are they incised? Are there springs or seeps on site, and if so where is the water coming from and where is it flowing to? Is on-site vegetation playing an important role in providing surface cover, reducing erosion, or stabilizing slopes?

- Mid Watershed Areas: Is the site located in the transition zone between upper headwaters and lower watershed areas? Is the site located on an alluvial fan? Are there any significant breaks in slope on the site which would encourage sediment deposition? If the site has historically been a depositional area, do the deposits appear to have high infiltration capacities (to be assessed below in soil section)? Geologic faults are also often found in transitional slope areas in Sonoma County. Are faults present and do they influence surface water or groundwater movement (also addressed below)? These transitional slope zones are commonly important areas that support wildlife habitat and vegetation while recharging groundwater and streamflow.

- Lower Watershed Areas: Is the site located in the gentler sloping lower watershed? Are there indications of less permeable soils or a high water table on-site that may encourage ponding or reduced infiltration rates? In Sonoma County most historic development has occurred within these lower watershed zones, thus the site may be influenced by surrounding existing land uses or storm drainage systems.

Figure A-1 in **Appendix 4** provides a topographic map of Sonoma County. **Figure A-2** shows the topography of southern Sonoma County, including the Laguna de Santa Rosa watershed (Water Agency Zone 1A) and portions of the Petaluma River watershed (Water Agency Zone 2A) and Sonoma Creek watershed (Water Agency Zone 3A). **Figure 4-4** shows a portion of a USGS topographic quadrangle from southern Sonoma County. The area shown in **Figure 4-4** is an alluvial fan setting, where historically abundant sediment delivered from the upper watershed was deposited and stored along the fan. The map includes 10-ft elevation contours and depicts a few creeks and swales. Development in such areas should consider infiltration possibilities and sediment delivery patterns, as these issues directly affect storm water runoff. The topographic assessment should also consider potential wetlands and vernal pools, as they provide sensitive upland or aquatic habitats and may be relevant to storm water management.

Figure 4-4: Site Topography



example of existing topography and hydrology

(b) Surface Hydrology

Understanding existing hydrologic conditions is essential to assess potential post-project runoff conditions. The assessment of site surface hydrology begins with understanding rainfall conditions, including average annual precipitation and more specific storm event rainfalls observed at local gages. Average annual rainfall as isoheyets (lines or contours of equal rainfall) for Sonoma County are available from NOAA’s Atlas 14 Cartographic Maps of Precipitation Frequency http://hdsc.nws.noaa.gov/hdsc/pfds/pfds_maps.html. Specific LID features will have different design capacities based on rainfall rates, so understanding an expected range for daily 24-hr rainfall amounts, as well as shorter duration intensities (1-hr, 30-min) is also useful in order to best understand the effectiveness of a given LID feature. Note, however, that criteria for NPDES storm water permit compliance may not require an evaluation of multiple rainfall events. Refer to the storm water permit requirements of the applicable jurisdiction.

LID features can function for a range of storm events, but are typically designed for events smaller than the flood control design storm”

Existing runoff patterns on site should be identified based on the topography assessment described above. Additional details should be included to precisely map out the existing drainage pattern from where channelized flows are first observed (smaller rills or gullies) to any larger primary drainage courses or streams. Existing drainage features should be studied for evidence of maximum water elevations and whether the features are perennial, intermittent, or ephemeral. Is the site affected by any surrounding runoff delivered from other urbanized areas? Understanding the site's existing drainage pattern is important in planning for post-project runoff management. Subsequent planning steps will integrate these hydrology considerations into the site design, aiming to preserve areas and features that provide infiltration functions.

(c) Soil and Infiltration

As described above in the introductory sections, infiltration is one of the fundamental LID strategies. LID site planning favors preserving areas with higher infiltrating soils, locating development over less permeable areas, and routing runoff toward higher infiltration areas where possible. Because soil and infiltration are so critical to the entire LID approach, the site assessment for soils and infiltration is very important.

Infiltration rates are affected by soil texture and structure, vegetation types and cover, antecedent water content in the soil, soil temperature, and rainfall intensity. For example, coarse-grained sandy soils with large pore spaces between grains typically drain quickly and sustain relatively high infiltration rates. In contrast, soils with a higher proportion of smaller grained clay minerals will have reduced porosity and permeability. **Figures 4-5 (a) and (b)** compare infiltration and runoff outcomes for generally sandy or clay soil conditions. Infiltration capacity is greatest at the beginning of a rain event and decreases over time as soil pore spaces fill with water during the event.

Figure 4-6 illustrates how the difference in runoff generated from sandy and clay terrains lessens when moving from moderate sized events to large or extreme rainfall events. At higher magnitude events, infiltration capacities may be exceeded by rainfall intensities. Following a series of storm events, higher antecedent soil moisture conditions may saturate available pore spaces. The difference between sandy and clay soils lessens as soils reach and maintain saturation during the extreme event. **Figure 4-6** also compares developed and non-developed conditions for generally sandy or clay soils. Under moderate rainfall events, the developed site on sandy soils may have runoff that approaches or surpasses the non-developed clay soil. However, under the larger magnitude, or extreme runoff conditions, these relative differences diminish.

Figure 4-5(a): Soil Infiltration

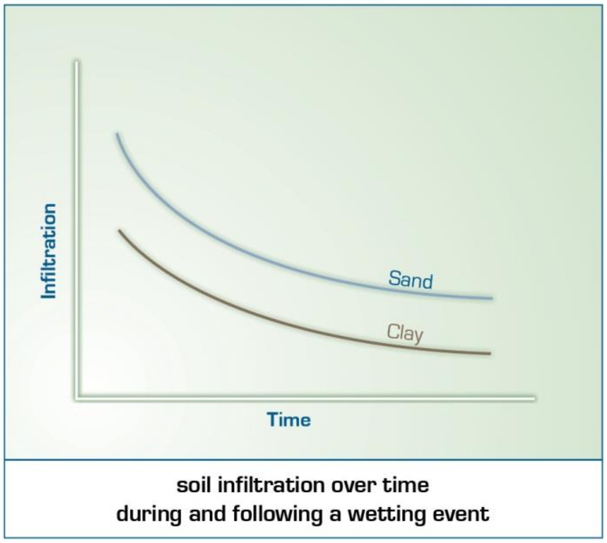


Figure 4-5(b): Soil Runoff

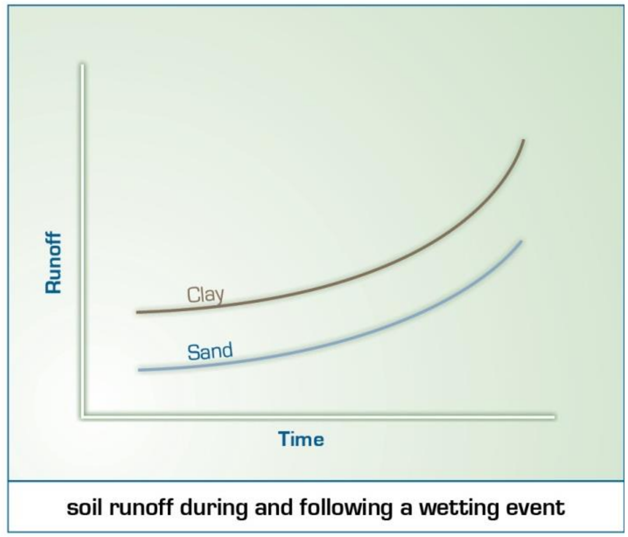
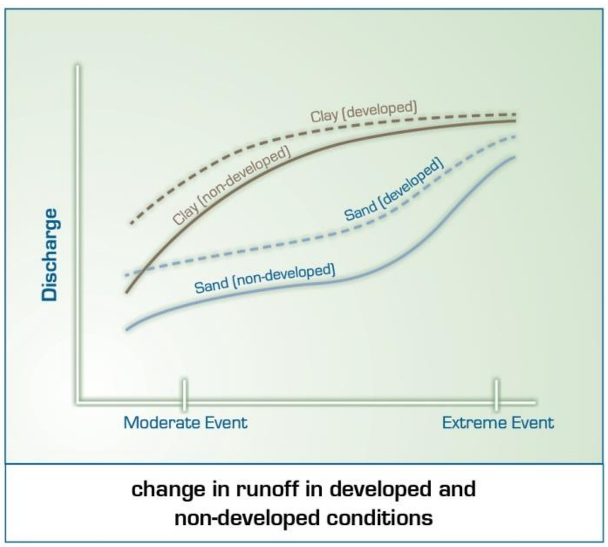
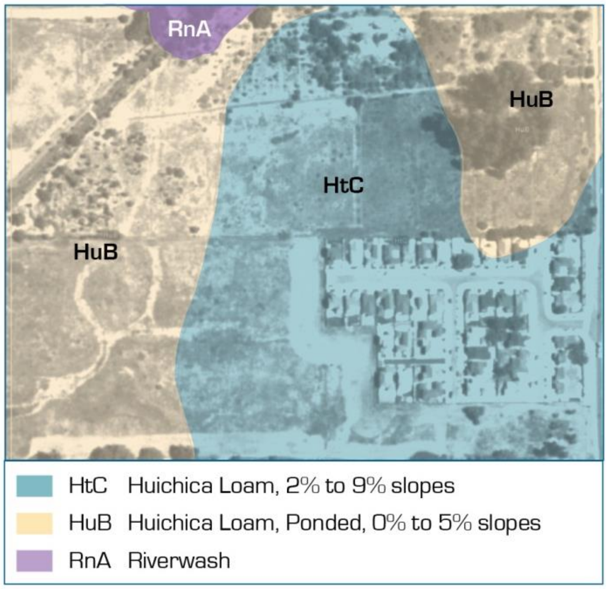


Figure 4-6: Change in Runoff



Vegetation has several important interactions with soil that influence infiltration. Root action, organic material, and biota from vegetation improve soil structure through increased particle aggregation and enlarged root pore spaces. Forests with complete canopy coverage protect soil surfaces from erosion and surface sealing which can reduce infiltration. The thick litter and duff on the surface beneath forests also supports infiltration. As a result, coniferous forests typically have the highest infiltration rates of any vegetative types (not accounting for site specific soils or geology). The removal of tree cover through development can thus have an adverse affect on infiltration. Similarly, the removal of top soil associated with mass grading typically results in a heavily compacted soil with lower infiltration rates. As described below in Step 4 of the LID planning process, LID approaches during construction aim to preserve and protect valuable top soil.

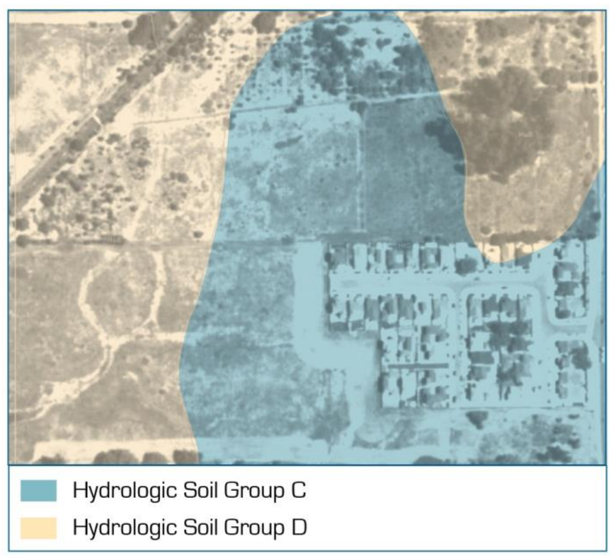
Figure 4-7: Site Soil Types



The soil assessment involves understanding the properties and conditions of surface soils and underlying horizons. The USDA Natural Resource Conservation District (NRCS) collects soil data and information for nearly the entire United States, including Sonoma County. In addition to delineating soil types and names, soil surveys include valuable information about soil hydrologic and engineering properties, as well as suitability for various land uses. **Figure 4-7** illustrates soil types for the hypothetical development site referenced earlier in this section. NRCS soil surveys provide data regarding infiltration conditions, including presence of low permeability layers, highly permeable sand/gravel layers, depth to groundwater, and other soil properties useful to assess the site's ability to infiltrate and percolate. This information can be found at their interactive Web Soil Survey website: http://websoilsurvey.nrcs.usda.gov.

Soils are varied in Sonoma County, being derived from diverse landform, geologic, climatic, and biologic conditions. The Soil Survey for Sonoma County includes 15 soil associations (USDA NRCS 2009). At the association level, soils are generally distinguished according to their geomorphic and topographic setting; whether they are located in basins, tidal flats, floodplains, terraces, alluvial fans, high terraces, foothills, uplands, or mountains. In general, the soils in the lowland basins, floodplains, and alluvial fans range from gravelly sandy loams to clays - most often composed of clays and clay loams that formed in alluvium from sedimentary and volcanic material. These soils vary in drainage capacity from poor to excessive, with the more clay-textured soils draining more poorly. Soils on the high terraces, foothills, uplands, and mountains consist of gravelly to stony sandy loams to clay loams and range in drainage capacity from moderate to excessive, with the coarser textured soils draining better.

Figure 4-8: Site Hydrologic Groups



Soils in the USDA soils classification system are divided into four Hydrologic Soil Groups, all of which are very relevant to LID planning. Soils in Hydrologic Soil Group A have high infiltration rates and low runoff potential, B soils have moderate infiltration, C soils have slow infiltration, and D soils have very slow infiltration rates and high runoff potential. Soils in the C and D category tend to have higher clay content and encourage ponding. Soils in the A and B groups tend to have a higher sand proportion and are typically preferable for LID features that use infiltration. **Figure 4-8** shows the hypothetical development site on the Santa Rosa Plain with a mix of Hydrologic Soil Group C soils and D soils. Relatively better C-class infiltration conditions occur in the central portion of the site and poorer infiltrating D-class soils occur in the western and northeastern portions of the site. **Figure 4-9** shows Hydrologic Soil Groups for Sonoma County. **Figure 4-10** shows Hydrologic Soils in the southern Sonoma County area, including the Laguna de Santa Rosa watershed and portions of the Petaluma River and Sonoma Creek watersheds.

Hydrologic Soil Group maps provide only a general indication of the infiltration capacity at a site. In some cases, field testing of infiltration rates may be warranted. Simple field infiltration test methods include excavating “test pits,” filling the pits with water, and recording the time required for water levels in the pit to drop. This type of field evaluation of infiltration is similar to tests conducted for septic system design. More sophisticated field infiltration tests, such as single-ring or double-ring infiltrometer tests provide more precise estimates of a soil’s longer-term infiltration capacity. Field infiltration tests should be supervised by a qualified hydrogeologist or geotechnical engineer.

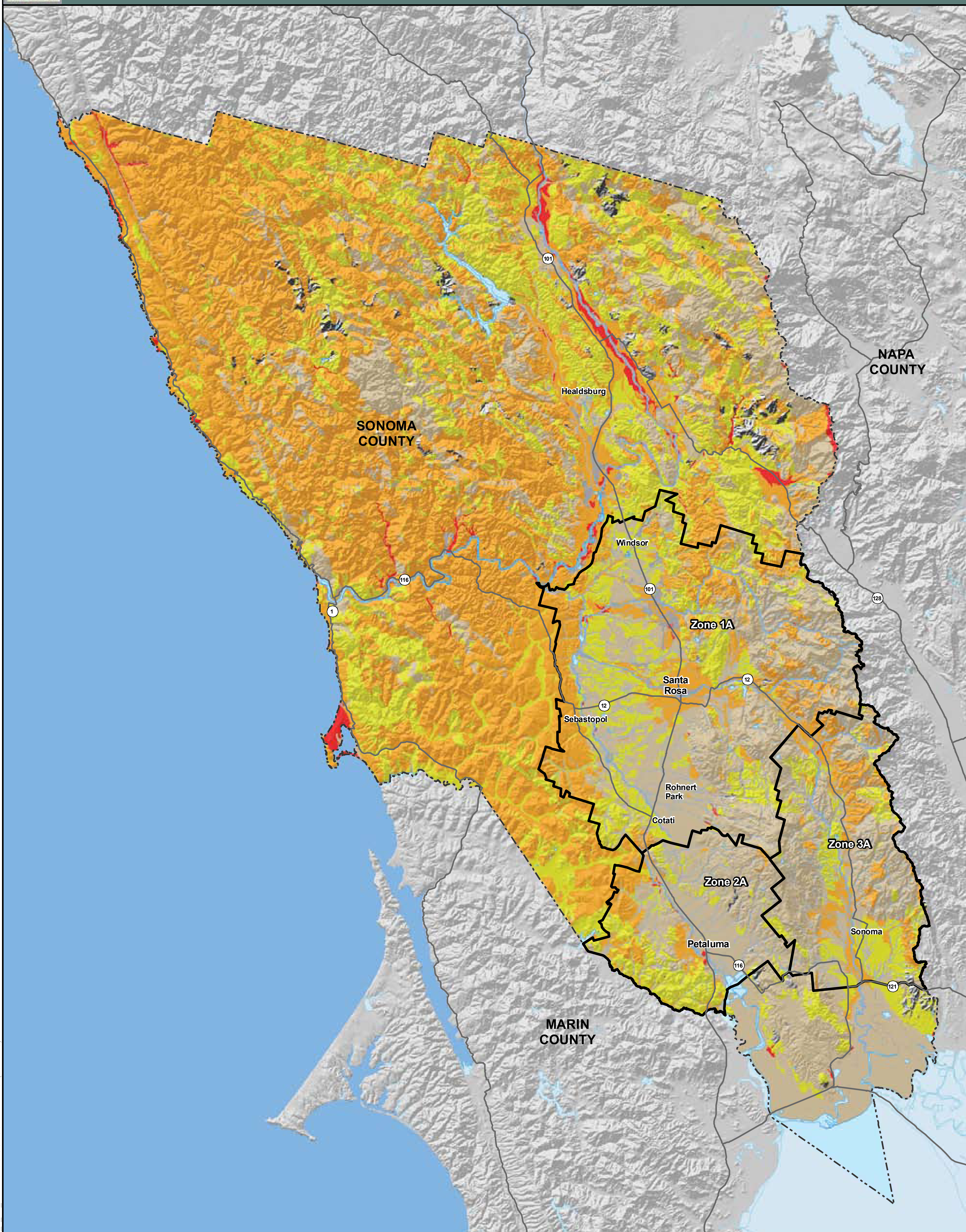
(d) Groundwater

As described above in reference to the hydrologic cycle, groundwater collects from infiltrated rainfall and streamflow that percolates by gravity through surficial soils and shallow subsurface zones to saturated strata (aquifers) below that act as groundwater reservoirs. As simplified in **Figure 1-6**, groundwater aquifers may occur at several levels, including near surface zones known as shallow-subsurface flow, where the process of interflow (or throughflow) moves subsurface water down slope toward streams or seeps. At deeper levels larger and more regional aquifers (or groundwater basins) are found. Aquifers tend to be associated with porous and permeable sedimentary rocks or alluvium that has higher water-bearing capacities, but groundwater can also be held in less porous igneous or metamorphic rocks that have permeability through large joints or fractures. Faults, such as the Rodgers Creek Fault Zone (**Figure A-4** in **Appendix 4**), can provide another avenue for groundwater to collect and migrate.

In terms of storm water management, preservation of naturally functioning interactions between the processes of surface infiltration, soil pore filling, shallow subsurface throughflow, and groundwater is a key aspect of the LID approach. As part of the site assessment, it is important to understand how the site contributes to groundwater; and conversely, to recognize if and how site features are supported by subsurface water. For example, a site may have a swale which provides a good conduit for infiltration and deeper percolation to groundwater, or it might have a vernal pool or wetland that is supported by shallow subsurface flows.

Sonoma County Water Agency

Water Smart Development Guidebook



Hydrologic Soil Group

A B C D

SCWA Flood Control Zone Boundary
Highway
Streams and Channels
Water Bodies

0 1 2 3 4
Miles

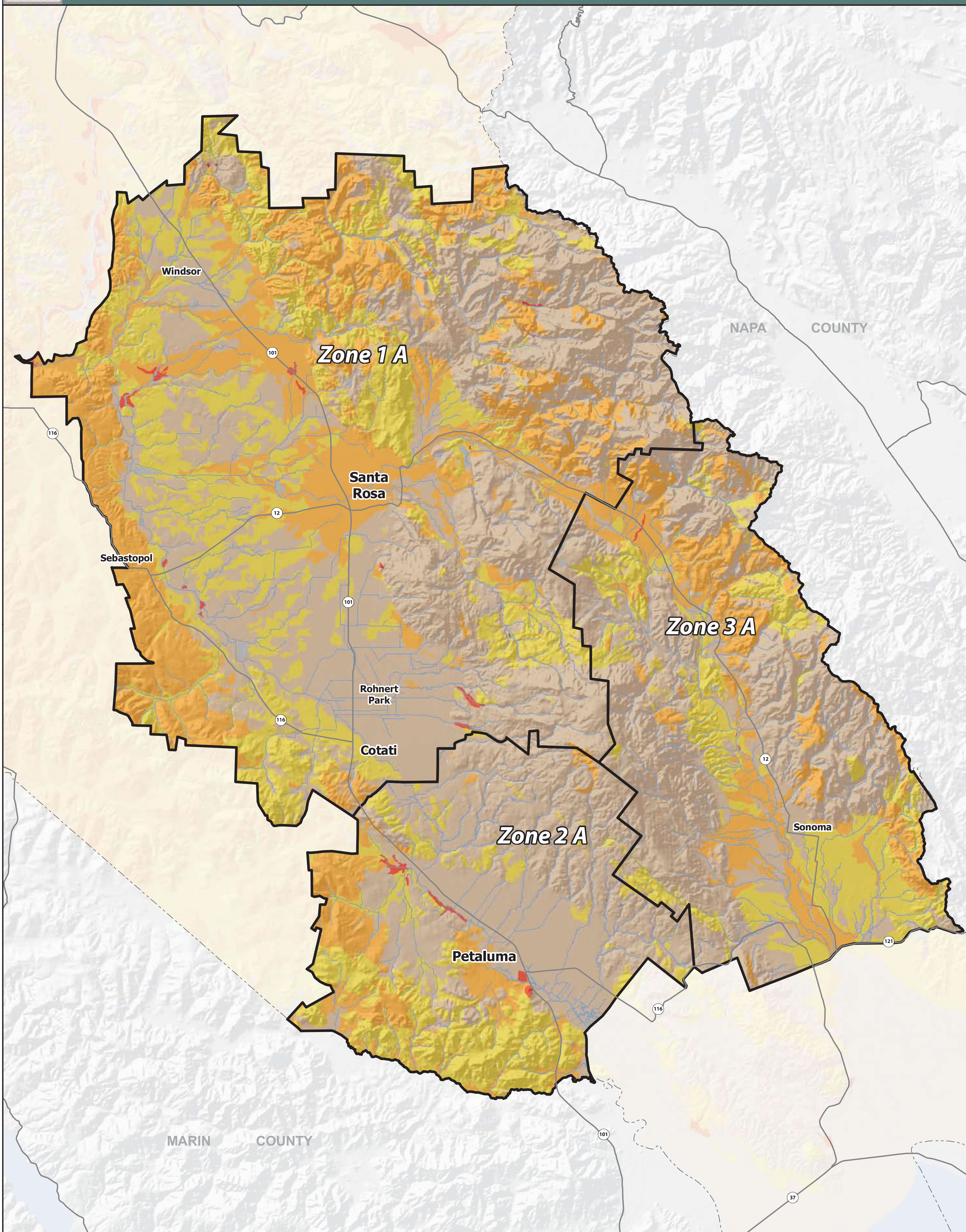
Horizon WATER and ENVIRONMENT

Figure 4-9

Hydrologic Soils of Sonoma County

Sonoma County Water Agency

Water Smart Development Guidebook



Hydrologic Soils Group

A B C D

SCWA Flood Control Zone Boundary
Streams and Channels
Highway
Water Bodies

Erosion factor Kf indicates the erodibility of the fine-earth fraction, or the material less than 2 millimeters in size. (NRCS, SSURGO 2004)

Figure 4-10

Hydrologic Soils Group

0 1 2 3 4
Miles

Horizon WATER and ENVIRONMENT

Figure A-5 and A-6 in **Appendix 4** shows the groundwater basins of southern Sonoma County. Groundwater basins in Sonoma County are generally associated with surface topography and watershed patterns. However, surface watersheds and groundwater basins are not always aligned or coterminous. For example, a portion of the northern Laguna de Santa Rosa watershed that surficially drains Mark West Creek overlies the Alexander Valley groundwater basin that continues north outside of the Mark West and Laguna de Santa Rosa watersheds.

In terms of site planning, impervious surfaces can sever pathways for groundwater recharge. Additionally, subsurface elements of development including foundations, subsurface pipes or cable vaults, or other infrastructure can disrupt or block the horizontal movement of shallow subsurface flows. In subsequent site planning steps, identifying buildable areas over portions of the site that provide the least contributions to groundwater recharge may reduce such impacts.

It should be noted that for a particular site or area, the LID strategy to maximize on-site infiltration should also be weighed against any potential contamination issues. If increased infiltration of runoff with impaired, contaminated, or poor water quality would potentially pollute groundwater resources, then other approaches should be sought. Information on existing on-site water or soil contamination is available from the RWQCBs, California Department of Toxic Substances Control, and the U.S. Environmental Protection Agency. The project proponent is encouraged to contact these agencies to determine current project site conditions.

In Sonoma County, stream channels are often important recharge corridors that provide water directly to aquifers below. Earthen stream channel beds prevalent throughout the county are often comprised of coarse-grained sands, gravels, and cobble which provide excellent recharge capacity. Lower Mark West Creek, lower Santa Rosa Creek, the Laguna, and Petaluma River alluvial plains are identified as key recharge streams (Sonoma County 2008), but many additional earthen bed creeks across the alluvial plains and fans in the county provide similar functions. LID features that are designed to reduce site erosion (particularly in areas of fine sediments and clay soils) provide an indirect benefit of maintaining groundwater recharge capacities in downstream creeks by preventing pore reduction (clogging) in the channels. Note that concrete engineered channel beds and banks effectively eliminate groundwater recharge.

(e) Wetlands, Ponds, and Floodplains

Wetlands

Wetlands are valuable aquatic features that provide and support habitat, water quality treatment, groundwater recharge, and flood control benefits. Wetlands typically occur in low lying areas along the margins of creeks and drainages or in depressions away from drainages that are fed by springs, seeps, or other seasonal water sources. In northern California, water levels in typical wetlands gradually rise in the beginning of the wet season and subside slowly as the wet season ends.

Due to presence of abundant vegetation, wetland soils are rich in organic nutrients and provide excellent water quality filtration functions. For these reasons, mimicking wetland functions has become a popular and effective method for storm water treatment. In the LID storm water management approach, these features are referred to as biofilters or bioretention areas and are described and illustrated in Section 4.4.

Wetlands are extremely sensitive and highly valuable hydrologic and biological features. The majority of vegetation and wildlife species that inhabit these aquatic features (especially amphibians) are specifically adapted to a seasonally moist environment.

In terms of LID planning, wetlands should be identified and emphasized for protection during site design, as their native vegetation, soils, and hydrologic functioning can provide many storm water and water quality benefits. During the site assessment wetlands should be mapped, water sources identified, and if possible hydroperiod conditions (including the seasonal range, depth, and duration of inundation) that support the wetland should be measured. Reduced infiltration and shallow subsurface flows associated with post-development conditions can drastically affect wetland functioning (Azous and Horner 2001). Development projects with impacts to wetlands often require a time-consuming permitting and environmental compliance process as well as costly mitigation. The use of LID approaches that protect and maintain wetland features through the site planning process is strongly encouraged.

Hydroperiod is the seasonal occurrence of flooding and/or soil saturation that represents the depth, frequency, duration, and seasonal pattern of inundation.

Ponds

Natural ponds are similar features to wetlands in their functioning, though they are typically larger, deeper, and retain more water. Ponds can be seasonal or perennial, depending upon precipitation, infiltration rates, and underlying soils and geology. Ponds provide breeding and juvenile rearing habitat for amphibian species, such as turtles, frogs, and salamanders, and support wetland plant species, birds, and other wildlife. Ponds function to capture, retain, and cleanse storm runoff as well. Sediment and contaminants transported within storm runoff are allowed to settle out of the water column within a pond. If the bottom of the pond is permeable, infiltration below the pond can recharge groundwater. Because natural ponds provide many hydrologic and biologic benefits, storm water management approaches often include construction of engineered retention and detention basins that mimic these aspects of natural ponds (see Section 4.5). Similar to wetlands, if ponds are present on a project site, their location should be mapped, their volume and hydroperiod measured, and they should be prioritized for protection and preservation through the LID site design.

Floodplains

Floodplains are low-lying areas adjacent to rivers and creeks that (without constructed flood protection features such as levees) are occasionally inundated by high stream flows that move overbank and spread on the adjacent lands. Floodplains provide natural hydrologic storage during

A development project located within the natural floodplain or channel migration zone is not considered a low impact development high magnitude flow events. As seasonal or periodic aquatic environments, floodplains support a wide variety of plant and wildlife species and are sensitive to hydrologic changes. Regional planning and project siting steps should avoid locating development in floodplains, even prior to LID considerations for a project. Section 4.5 describes use of floodplains as regional approaches to storm water management.

(f) Vegetation, Riparian Resources, and Other Habitats

Site vegetation and hydrology are intrinsically connected through the many components of the hydrologic cycle described above. For storm water management, site vegetation provides water and nutrient uptake, evapo-transpiration, interception of precipitation (which reduces soil erosion), soil pore spaces, and root tunnels promoting infiltration, shading, as well as other habitat and aesthetic benefits. Common vegetation communities in Sonoma County include Douglas fir and redwood forest, oak and bay woodlands, grassland, and chaparral.

For the LID site assessment, support from a biological resource specialist is recommended to evaluate primary vegetation types present on-site and their condition. Any special-status vegetation should be identified, as well as the presence of undesirable invasive and/or exotic species. On-site trees should be evaluated for their use into the site plan. Vegetation characteristics to consider include:

Special status species are defined as plants and animals that are legally protected under the Endangered Species Act (ESA), California Endangered Species Act (CESA), or other regulations, and species that are considered sufficiently rare by the scientific community to qualify for such listing. These species are typically the focus of avoidance, minimization, and mitigation requirements under the California Environmental Quality Act (CEQA).

- species;
- plant age/development (seral) stage;
- extent of canopy;
- major pest or pathological problems;
- extensive crown damage;
- weakly attached co-dominant trunks that could cause damage or safety hazards if dislodged;
- stability of the trunk and any extensive decay or damage; and
- ability to withstand influences of post development conditions.

Riparian vegetation is found along stream courses and is dependent upon streamflow hydrology and moisture. In Sonoma County the riparian tree community typically includes willows, alders, box elders, laurel, ash, and oaks, with riparian scrub and understory shrubs beneath. Riparian vegetation provides several important functions including stabilizing streambanks, providing soil structure, filtering sediment and nutrients, shading streams and moderating temperatures, and providing woody debris to adjacent streams. Riparian corridors provide several important migration, breeding, refugia, and foraging habitats for special-status wildlife species including amphibians and birds.

Site assessments of riparian areas should carefully consider the hydrologic connectivity between the site and adjacent streams and how existing riparian plants, particularly mature trees, are dependent upon moisture sources. Post-development changes to surface or ground hydrology could result in decline of riparian trees.

Figure 4-11: Site Vegetation & Habitat

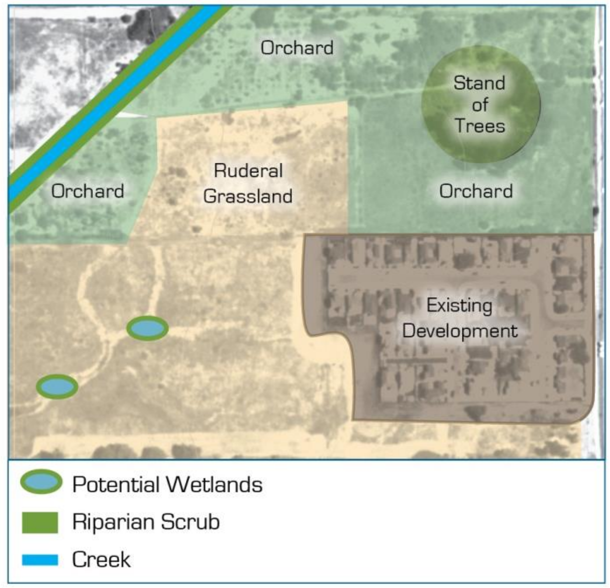


Figure 4-11 illustrates the mapping of vegetation types for the hypothetical development site. In addition to the stand of existing mature trees, potential wetlands and the on-site creek are also mapped in relation to the vegetation cover.

Other Habitats

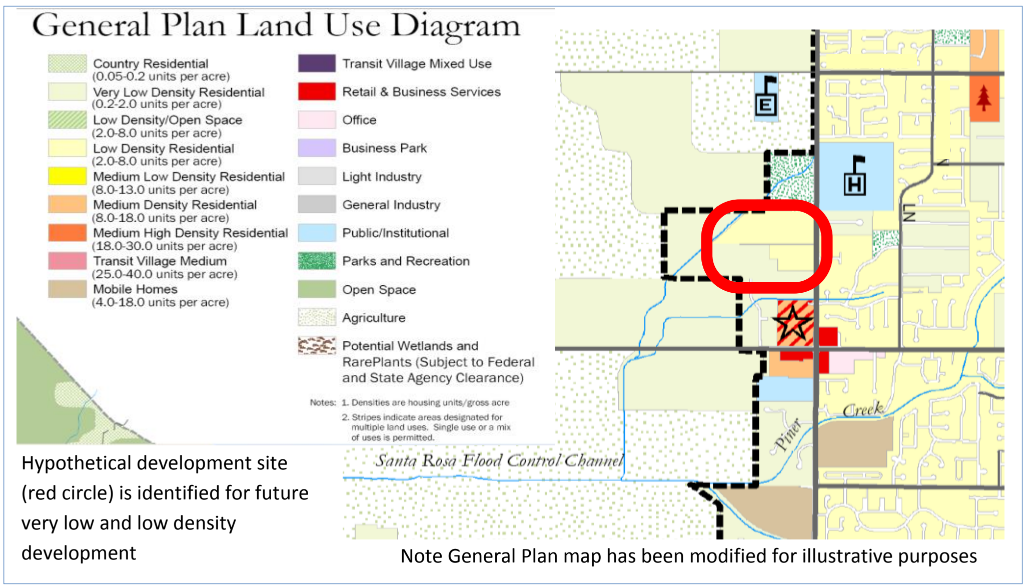
Protecting and enhancing wildlife habitat contributes to the hydrologic functioning by increasing transpiration, promoting soil infiltration, supporting nutrient cycling, and reducing sediment erosion and transport. Fish and amphibians are highly sensitive to changes in aquatic environments, especially those resulting from storm water runoff. The presence and quality of the site's aquatic habitats are assessed in the above step for wetlands and riparian areas. In addition to these aquatic habitats, there are many other wildlife species and habitats which can occur on-site that should be evaluated during the site assessment. For example, habitats for burrowing mammals, migrating and nesting birds, roosting areas for bats, and insects, including species listed as threatened or endangered under the state or federal Endangered Species Acts or otherwise protected by law, should be assessed (as reasonable) to understand the diversity and health of the site. In many locations for proposed development, surrounding urban settings may heavily influence the quality and diversity of habitat at a site. Often there is a high potential to improve or restore habitat as part of the project plan.

(g) Land Use

The past land use of the site and adjacent sites can strongly influence current site conditions and potential future development in relation to storm water management. The LID site assessment process considers the current, past, and proposed land uses of the site. Adjacent sites are also considered for how their topography, surface drainage, and subsurface flows may drain onto, or away from, the project development site. The location and characteristics of adjacent structures and buildings are assessed to ensure that proper drainage pathways are designed to prevent conflicts with adjacent land uses and aesthetics. Similarly, adjacent open spaces including federal, state, or local preserves should be identified.

A county's general plan describes land use categories, permitted uses, and allowable densities. New development projects are reviewed and approved for consistency with the terms of the general plan. For example, **Figure 4-12** shows the designated land use for the hypothetical development site according to the applicable General Plan for the area. In this case the site is planned for very low density (0.2-2.0 units/acre) and low density (2.0 – 8.0 units/acre) residential development. Land use designations establish maximum densities and can be developed for lower densities. In some cases, the application of LID features may use a significant portion of the site's developable area. If allowed by zoning, this would require more intense development of the remaining area. The project scope may have to be reduced in cases where zoning does not allow sufficient density to develop the project within the remaining area.

Figure 4-12: **Planned Land Use**



The land use assessment also evaluates zoning plans, conservation plans such as Habitat Conservation Plans (HCPs) or Natural Community Conservation Plans (NCCPs), building restrictions, public access requirements, availability of utilities, and setbacks, such as easement, parking lot, and landscaping requirements. In southern Sonoma County, the 2005 Santa Rosa Plain Conservation Strategy (SRPCS) provides conservation and protection strategies for four federally listed wildlife and plant species that may be impacted by development on the Santa Rosa Plain. For sites within the SRPCS boundary, the site assessment should review findings of the SRPCS for the individual project site.

As part of the land use assessment, potential occurrences of legacy contamination both at the site and at all adjacent sites should be investigated. Legacy contamination can result from past land use activities, such as gas stations or dry cleaners, where chemicals may have leached into soil or groundwater. Legacy contamination can also occur from naturally-occurring mineral deposits like arsenic, which are toxic to humans and wildlife. In the case of chemicals, the contaminant plume can migrate to adjacent soils or groundwater aquifers. Disturbance and improper handling of contaminated areas during construction or post-development can increase the potential for harm to the public and wildlife. It is likely that this portion of the site assessment was previously investigated by the developer as part of the purchase of the property. However, this information should be reviewed and considered as part of the overall LID site assessment. Additionally, future planned land uses which could influence the quality of storm water runoff should be considered in the site assessment. For example, additional treatment measures may be needed in the LID storm water management design for future gas stations, commercial parking lots, or industrial operations.

Land use information is available at the city or county office applicable to the project site. Locations of documented sites with contaminated soil or groundwater are available online through the GeoTracker database maintained by the State Water Resources Control Board. Information on existing on-site water or soil contamination is also available from the RWQCBs, California Department of Toxic Substances Control, and the U.S. Environmental Protection Agency. The project proponent is encouraged to contact these agencies to determine current project site conditions.

(h) Water Quality

Urban development generates pollution sources through vehicle emissions and maintenance waste, municipal sewage, pesticides, household hazardous waste, pet waste, trash, and other sources. Under conventional storm water management systems, these pollutants are either washed (or directly deposited) into storm drains and transported to local streams, rivers, lakes, estuaries like the San Francisco Bay, and eventually to the ocean.

The effect of pollutant contributions from a single residential home or small business may be small, but, when considered collectively at the watershed scale, significant environmental impacts to local water resources can be observed (USEPA 2005). LID site planning and implementation of LID features can provide water quality treatment control for both small and large storm events and reduce pollutant loading and transport. As described above, LID achieves water quality protection by using native soils and vegetation, or bioengineered solutions, to naturally filter storm water. The LID approach also reduces the introduction of urban pollutants, such as trash and gasoline byproducts, into the environment by encouraging pollution prevention practices by residents and business owners (Prince George’s County 1999).

Existing conditions at the proposed development site may be particularly influential to the quality of surface or ground waters at or surrounding the site, especially if a watercourse is located within the property. For instance, storm water infiltration areas can convey contaminants to underlying groundwater, and improperly installed drainage outlets can encourage erosion and sedimentation. To better understand potential post-development impacts, the site assessment evaluates on-site conditions that influence surface water and groundwater quality.

Water quality data gathered from the site or from locations upstream or downstream to the site can inform the site plan and design. Water quality data may be available from federal, state, or local monitoring efforts, including the U.S. Geological Survey, Regional Water Quality Control Boards, Sonoma County Water Agency, and local residents and volunteer creek monitors. Combined with information about the soil and vegetation characteristics of the site, water quality characteristics can be used to adjust the effectiveness of on-site LID features.

Water quality is protected and managed by the State Water Resources Control Board and its Regional Water Quality Control Boards (North Coast and San Francisco Bay Regions for Sonoma County), as described in Section 4.1. The Regional Water Quality Control Boards establish "beneficial uses" of water bodies within their region. If any beneficial uses become impaired, the water body can be added to the Clean Water Act Section 303(d) list of Impaired Water Bodies. The pollutant responsible for the impairment is listed, and all additional contributions of that pollutant to the listed water body are subject to restriction. For example, if the proposed development would potentially contribute additional sediment to a water body whose quality is already impaired by sediment, the development must be designed to ensure that no additional sediment is discharged to that water body. Therefore, the site assessment should include review of the current 303(d) List and any water quality restrictions, such as Total Maximum Daily Load (TMDL) conditions, applicable to the property. This information may influence the site plan and selection of LID features.

Beneficial Uses define the resources, services, and qualities of aquatic ecosystems and underground aquifers for which the RWQCBs are responsible to protect with the goal of achieving the highest water quality consistent with maximum benefit to the people of the state.

(i) Other Site Specific Considerations

The following site consideration topics are briefly discussed as they are important within the overall LID planning process. Though these topics may only be indirectly related to storm water issues, they are important in assessing the suitability for LID use on-site.

Easements

The site assessment includes mapping of existing or potentially required easements on or adjacent to the project site. Easements are unbuildable areas set by local utility or city agencies to provide access to underground utility lines, such as sewer pipelines and communication lines, or to overhead power lines. Easements can also consist of natural areas that are prohibited from development (e.g., conservation easements), subject to the conditions in the easement. Easement information is available at the city or county planning department or at local municipal authorities. The presence of easements on-site may influence the selecting and locating of LID features.

Stream Setbacks

As part of the project approval process, developments must also comply with city and county stream setback ordinances. The following communities currently have ordinances for stream or creek setbacks: Cotati, Cloverdale, Healdsburg, Rohnert Park, Santa Rosa, Sebastopol, and Windsor, and the County of Sonoma. Stream setback restrictions are contained in city or county development codes. The specific restrictions on development adjacent to streams are defined differently in each ordinance. In general, the ordinances direct that no structure, road, parking access, parking spaces, paved areas, or swimming pools be constructed within a creek or creekside setback area. In general, setback distances vary from 30 to 50 feet from the top of a stream bank throughout Sonoma County. In unincorporated areas of the County, setbacks for flatland waterways are 100 feet, with the exception of the Russian River, which has a 200 foot setback along its entire length. Some setback ordinances also restrict vegetation removal or planting and development adjacent to a wetland. For example, in the Coastal Zone, development is prohibited within 100 feet of a wetland unless a reduced buffer is found to have no impact on the wetland resource. It is recommended that residents and developers check with their local city or county planning department for specific setback requirements.

Existing utilities, streets, fire safety requirements

The locations of existing municipal structures such as utilities and streets may constrain the project plan and opportunities for LID use. Streets or underground utility lines may be located closest to one side of the parcel; thus layout designs may be restricted by existing structures or standards. Existing or proposed on-site septic systems could require additional planning to ensure proper functioning and coordinated use with LID features, especially for septic leach fields. Additionally, city or county standards may require setbacks from fire fighting facilities or for public safety. For example, city standards may require setbacks around fire hydrants and tree clearance under overhead lines. This information is available from the city or county planning department or from local municipal authorities.

Aesthetics

Aesthetic values of the current site and its relationship with the surrounding landscape are evaluated in the site assessment. The county, city, or neighborhood may have specific requirements for the visual character of the area, such as placement of trees or other landscaping features, restricted use of certain materials or paint colors, or road and sidewalk designs. Aesthetic resources are commonly documented by photos and observational accounts recorded during site surveys.

Step 2: Site Planning

The LID Planning Process:
Step 1 Site Assessment
Step 2 - Site Planning Process
Step 3 LID Design Objectives and Feature Selection
Step 4 LID During Construction Phase
Step 5 LID Operation and Maintenance

This section describes the process of integrating the baseline resource information from the Site Assessment of Step 1 into the development's site plan. The Site Planning process is essentially an iterative mapping exercise conducted by stakeholders and the designer team to achieve development objectives while avoiding and minimizing storm water and other impacts. Stakeholders include the land developer, local planning agencies, storm water managers, water quality regulators, and the local residential and business community. The design team may include agency or consultant urban planners, landscape architects, hydrologists, geologists, and biologists. In Step 2, the Site Planning process proceeds according to the 4 sub-steps, labeled (a) through (d) as shown in the highlight box. Each of these stages builds on the previous tasks while incorporating LID principles.

Step 2 The Site Planning Process:
a) Identify Development Objectives
b) Opportunities and Constraints
– Conservation Areas
– Buildable Areas
c) Conceptual Site Design
d) Preliminary Drainage Design

(a) Identification of Development Objectives

It is important to establish the specific objectives of the development project to guide the rest of the planning process. The development objectives should include a broad and flexible planning approach on which the LID principles can apply. The development objectives can include a general description of the targeted on-site land uses, such as residential housing or parking for an adjacent office building, etc. Yet the development objectives should also frame more specific goals for on-site land use, such as residential housing for 20 families or parking for a minimum of 50 cars. These framing objectives should include the minimum utility or density requirements for the building footprint for which the developer can feasibly pursue the project. Other thematic objectives such as aesthetic or recreational aspects can be incorporated into the development objective as well: "residential housing for 20 families that includes an open space recreational area" or "parking for a minimum of 50 cars that blends into the surrounding vegetated landscape."

(b) Opportunities and Constraints Based on Site Assessment

Building on the resource information gathered during the site assessment, and following the LID principles described above, an opportunities and constraints analysis carefully reviews the site's existing resources, assets, and limiting factors or constraints, and attempts to balance these pros and cons in light of the development objectives.

In terms of storm water management, the opportunities analysis seeks to preserve existing natural resources and minimize impacts from potential development runoff. The following opportunities (framed as questions) can potentially be integrated into the site plan:

- How does site topography influence drainage and where does water naturally flow to or collect?
- Where are the site's higher infiltrating areas and how well do they drain?
- How do the site's poorer draining areas relate to site topography and a potential building area?
- How do existing vegetation and soil resources support any existing hydrologic features?
- Are there site drainage opportunities or unique site features?

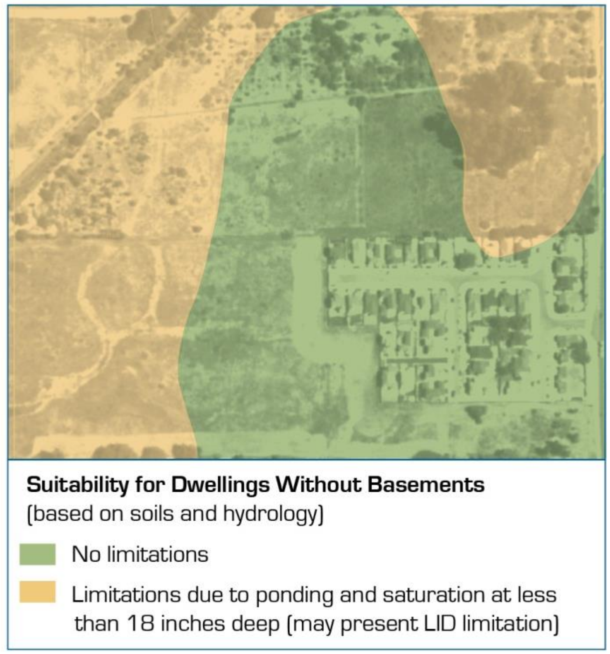
The question relating to the site's poorer infiltrating soils is framed as an "opportunity" because areas of poorer infiltration may provide suitable building areas, whereby the relative impact (in terms of storm water generation) of developing impervious surfaces above the poorer infiltrating soils will be less than developing impervious soils above well draining soils.

In terms of the constraints analysis, each specific development site will have its own particular constraints, but the following questions help identify initial limiting factors to incorporating LID principles into the site plan:

- Does the site's physical location and setting in the watershed present constraints due to being on an active floodplain, in an area of slope instability, or in a seismic or liquefaction hazard zone?
- Does the site's topography contain steep or excessive slopes (>25%) that may challenge or prevent certain LID feature approaches?
- Is the site dominated by, or have significant portions underlain by bedrock or a very thin soil mantle that prevents infiltration?
- If the site has a soil cover, what are the infiltration properties? Is the site dominated by poorly infiltrating soils?
- Is depth to groundwater very shallow such that ponding and poor percolation characterize the site?
- In terms of land use planning – is the site constrained by particular zoning uses or required set-backs that would limit how an LID site plan could be developed?
- Do existing or planned utilities, easements, or roadways constrain how storm water could be routed, infiltrated, or managed through LID approaches on-site?
- Do existing or planned utilities, roadways, or other infrastructure interfere with shallow subsurface flows (interflow) that help drain the site laterally off-site?
- Are there known or potential soil contamination or water quality conditions on-site or adjacent the site that would prevent the use of infiltration as a storm water strategy?
- Are there local aesthetic or community requirements which constrain the site plan and possible storm water solutions?

Figure 4-13 illustrates the constraints analysis approach for one parameter of infiltration and shows soil ponding and saturation properties at the hypothetical development site. The western and northeastern portions of the site are constrained by ponding and potential soil saturation at depths less than 18 inches from the surface. The central portion of the site is not constrained by ponding and saturation.

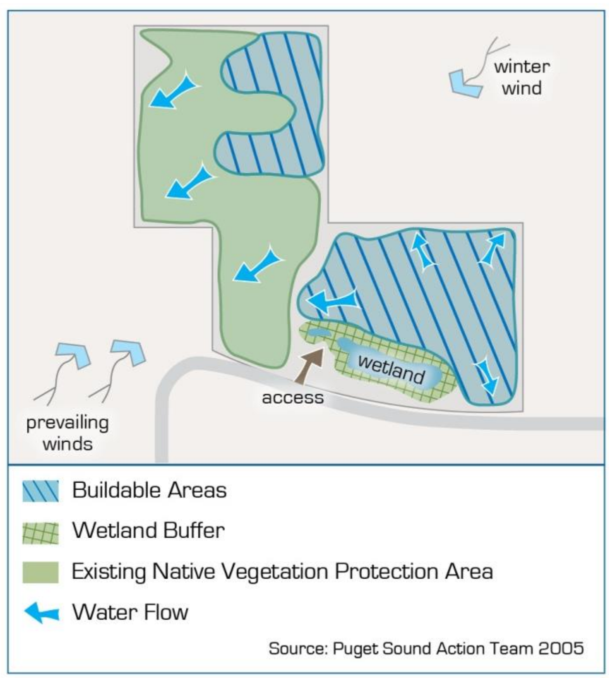
Figure 4-13: Site Planning



(c) Conceptual Site Design

With information from the Site Assessment, Development Objectives, and Opportunities and Constraints planning steps in hand, the site design process moves ahead. The first step to develop the site plan is to generally delineate conservation areas to be preserved and/or enhanced, and buildable areas to be developed. **Figure 4-14** demonstrates this delineation of conservation versus buildable areas for a site. Figure 4-14 also illustrates several other elements that can be included in the initial concept site plan, including references to flow directions, the presence of wetlands, buffers, and even prevailing wind directions.

Figure 4-14: Site Opportunities and Constraints



Conservation Areas

Reducing the development footprint and increasing vegetation and soil conservation areas can provide the single largest reduction of storm flows. In addition to reducing potential runoff, conservation areas can provide erosion and sediment control, water quality treatment, and other storm water functions. Beyond storm water, conservation areas provide habitat protection, open space corridors, visual buffers, and other benefits.

According to the Puget Sound Action Plan (2005), a LID guidance manual for the Puget Sound region of the Pacific Northwest, conservation areas supporting native vegetation and soil should be prioritized as follows:

1. Riparian areas that connect and create contiguous riparian conservation areas.
2. Critical and wildlife habitat areas that connect and create contiguous conservation areas.
3. Areas that create common open space among and/or within developed sites.
4. Conservation areas on individual lots that connect to areas on adjacent lots or common conservation areas.
5. Conservation areas on individual lots.

Buildable Areas

Buildable areas are identified as the locations within the site plan that would have the least effect on existing hydrology or habitat while taking advantage of a site's natural storm water processing capabilities. Construction of structures, roads, and storm water infrastructure should be configured within the buildable areas. Keeping consistent with the LID principles, the area of disturbance is limited to the minimum area required for roads, utilities, building pads, landscape areas, and other developed areas.

Figure 4-15: Site Planning – Conservation and Buildable Areas

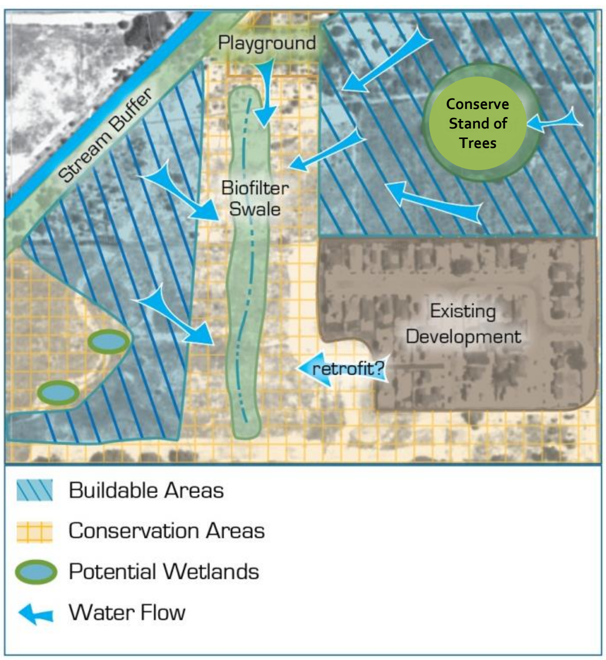


Figure 4-15 illustrates the delineation of conservation and buildable areas for the hypothetical development site. The hypothetical LID site plan includes two primary buildable areas based on understanding of the site's existing topography, soils, flow paths, wetlands, creeks, vegetation, as well as practical considerations of existing development and roadway access. The buildable areas are located on the poorer infiltrating soils, making use of the central portion of the site as a conservation area with a biofilter swale that will collect and infiltrate runoff from the adjacent development. There may be an opportunity to "retrofit" the existing development in the southeast quadrant of the site by routing its runoff to the central biofilter swale. Retrofitting existing sites with LID measures is further described in Section 4.5 below. Areas around the existing stream course in the northwest site and the wetlands of the southwest site are protected in conservation areas and have buffers. The open space around the biofilter provides a good communal area for a recreational path with a tot play yard at its north end.

LID methods to reduce total impervious areas, concentrate surface flows, and increase infiltration include increasing residential density by clustering houses together, minimizing road widths, and maximizing open space throughout the parcels. The following bullets include design guidance for the site planning and layout of building lots, roads, parking lots, subdivision lots, building drainage design, stream crossings, and planted trees. These LID design approaches are illustrated in the 3 concept site plans in **Figure 4-16** taken from the Low Impact Development Technical Guidance Manual for Puget Sound (Puget Sound Action Team 2005) and other storm water management publications (Center for Watershed Protection 2008). Note that the projects listed below must comply with local, state, and federal requirements, and approval from those agencies is required for implementation of these LID approaches.

Roads, Driveways, and Parking Areas

- Design the road network to minimize site disturbance, avoid sensitive areas, and reduce fragmentation of landscape.
- Reduce total impervious area by reducing the overall road network coverage, road widths, driveway lengths, and sidewalk widths.
- Minimize or eliminate impervious area and concentrated surface flows on impervious surfaces by reducing or eliminating hardened conveyance structures, such as pipes or curbs and gutters.
- Infiltrate and slowly convey storm flows in roadside bioretention cells and swales, and through permeable paving and aggregate storage systems under the pavement.
- Create connected street patterns and utilize open space areas to promote walking, biking, and access to public transit and services.
- Provide efficient fire and safety vehicle access.

Subdivision and Lot Layout

This primarily applies to lots for residential housing, but the concepts are similar for other land uses where impervious structures would be constructed.

- Minimize site disturbance.
- Strategically locate lots to disperse storm water to open space areas.
- Orient lots and buildings to maximize opportunities for on-lot infiltration or open conveyance through bioretention swales to downstream LID features.
- Cluster homes to reduce development area and road lengths
- Design subdivision with shared driveways
- Lengthen street blocks to reduce the number of cross streets and overall road network per home
- Provide mid-block pedestrian and bike paths to reduce distances to transit, and open space pathways or common areas between homes

Building Drainage Design

The objective for building design is to disconnect roof storm water from storm water conveyance and pond systems, and reduce site disturbance from the building footprint. Strategies to achieve this objective include:

- Reduce the building footprint. Designing multiple-story structures is one method to reduce the building footprint.
- Orient the long axis of the building along topographic contours to reduce the need to level the land.
- Control roof runoff water on-site.
- Use low impact foundations (with reduced footprint and reduced excavation needs) to minimize soil compaction.
- Limit clearing and grading activities to the minimum amount necessary to maneuver machinery.

Stream Crossings

- Eliminate, or reduce to an absolute minimum, all stream crossings.
- Where stream crossings are unavoidable, bridges are preferable to culverts.
- Locate bridge piers or abutments outside of the active channel or channel migration zone.
- If culverts are utilized, install slab, arch, or box type culverts, preferably using bottomless designs that more closely mimic stream bottom habitat.
- Utilize the widest possible culvert design to reduce channel confinement.
- Minimize stream bank armoring and establish native riparian vegetation and large woody debris to enhance bank stability and diffuse increased forces created by road crossings structures.
- Do not discharge storm flows directly from impervious surfaces associated with roads directly to the stream—disperse and infiltrate storm water or detain and treat flows.

Tree Planting

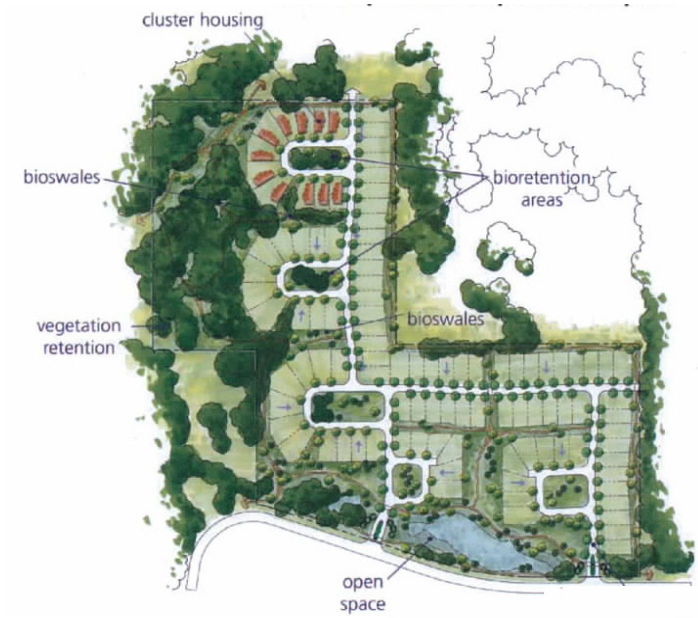
Appropriate selection and placement of tree species will increase energy conservation, air quality improvement, and aesthetic enhancement for the site, as well as reduce potential problems with pavement damage from roots and poor growth performance. When selecting trees for the site design, consider:

- The available growing space.
- Type of soil and availability of water.
- Longevity or life-span (a 100 year life span is ideal).
- Evapotranspiration productivity
- Tolerance for urban pollutants.
- Growth rate.
- Tolerance to drought, seasonally saturated soils, and poor soils.
- Canopy spread and density.
- Foliage texture and persistence.

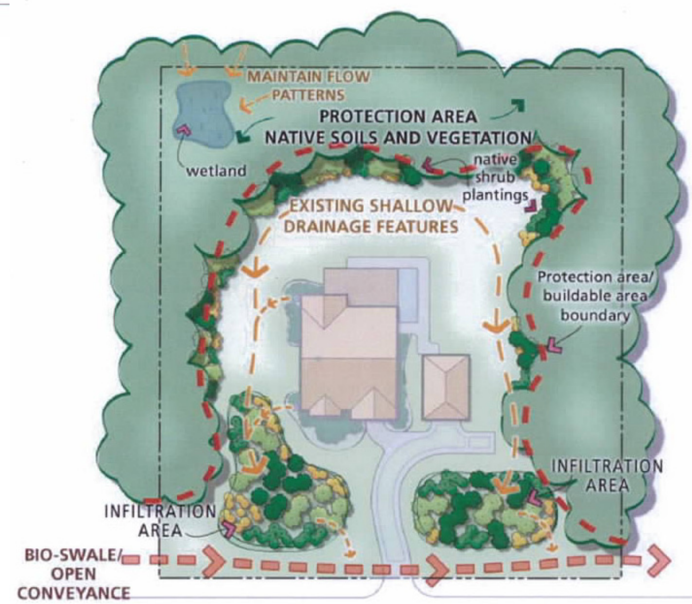
- Overhead wires.
- Vehicle and pedestrian lines of sight.
- Proximity to paved areas and underground structures.
- Proximity to neighbors, buildings, and other vegetation.
- Prevailing wind direction and sun exposure.

Additional desired functions, such as shade, aesthetics, windbreak, privacy screening, etc.

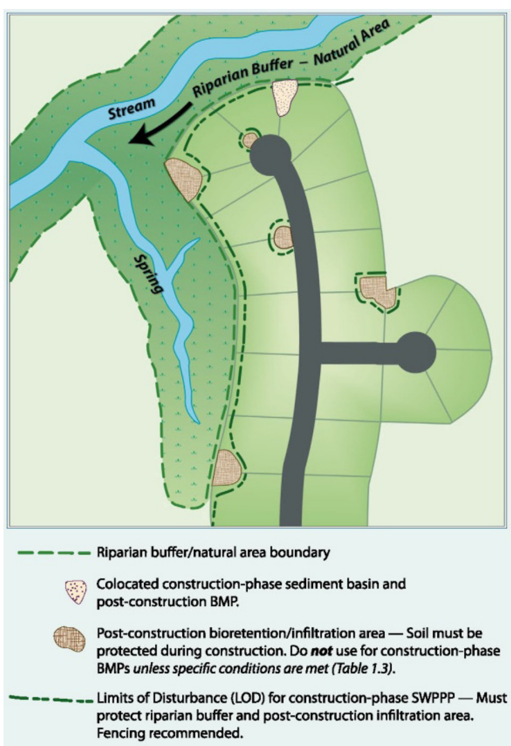
Figure 4-16: Conceptual Site Designs



Source: Puget Sound Action Team 2005



Source: Puget Sound Action Team 2005



Source: Hirschman, D. and Kosco, J. 2008

(d) Preliminary Drainage Design

Following the development of the conceptual site plan, a preliminary drainage design is prepared to generally identify runoff source areas and routing directions. This step is preliminary because the final drainage design will be developed iteratively with the design of specific LID features (Section 4.4) selected for the site.

The Drainage Design Process

Step 1 Delineate drainage management areas (DMAs)

Step 2 Classify DMAs and determine runoff factors

Step 3 Tabulate DMAs

Step 4 Select and lay out Integrated Management Practices (IMPs)

Step 5 Make size and rain adjustment factors for IMPs

Step 6 Calculate areas and volumes for IMPs

Step 7 Determine if IMP areas and volumes are adequate

Step 8 Compute maximum orifice flow rates

Step 9 Write summary report

From the Contra Costa Clean Water Program Stormwater Guidebook 2008

The preliminary drainage design process typically begins with delineating drainage management areas (DMAs). DMAs are essentially subwatersheds of the project site. DMAs follow grade breaks and roof ridge lines as well as boundaries between pervious and impervious surfaces. Next, DMAs are categorized in terms of how their runoff is handled or routed, and then runoff conditions are tabulated for the individual DMAs. Since specific LID features and treatments are not yet determined in the process, these steps that involve calculating runoff from the DMAs will need to occur iteratively following the selection and design of specific LID features.

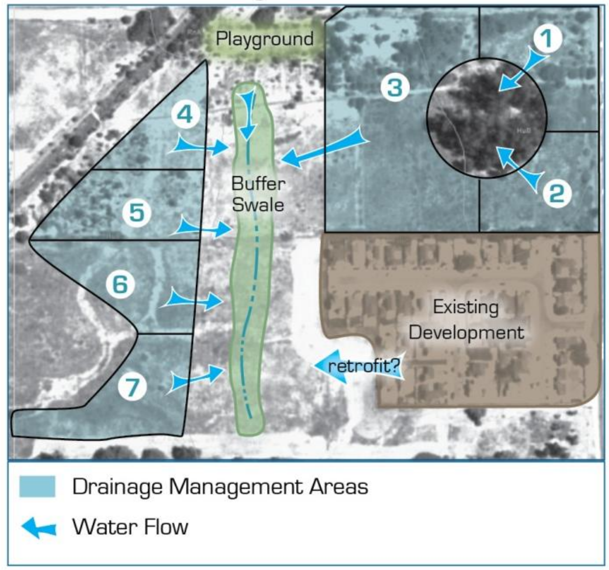
In terms of runoff generation and routing, there are four general types of DMAs:

1. Self-treating areas: non-developed areas that do not route runoff to LID features.
1. Self-retaining areas: designed to infiltrate or treat runoff and not generate runoff. In the Santa Rosa area the 85^{th} percentile 24-hour storm (0.92 inches) is used as the design rainfall amount to retain or infiltrate without generating runoff. .
2. Areas draining to self-retaining areas: drain impervious areas (or partially impervious areas) to more permeable areas.
3. Areas that drain to LID features.

Monitoring data from past LID features suggests that in general, an impervious area can be routed to a pervious area (of about half its size) if only water quality treatment is required, and flow-control requirements aren't necessary. If flow-control requirements apply, then more likely, a larger pervious area that is as large as the impervious area will be necessary. Sizing factors have been developed to relate how much treatment area is needed for impervious DMA areas. Water quality treatment and flow-control treatment approaches are discussed more in Step 3 below.

Figure 4-17 illustrates a preliminary drainage design for the hypothetical development site. Drainage management areas (DMAs) are delineated according to their topography and flow routing. In Figure 4-17, runoff from the DMAs in the buildable areas is routed to pervious areas. This is the case of *areas draining to self-retaining areas*, as described above. Additionally, the central portion of the hypothetical site plan in Figure 4-17 involves a biofilter swale that receives runoff. This is the case of *areas draining to LID features.* Figure 4-17 is general in nature and is used to illustrate the concepts introduced in this section while showing the site at a similar scale to the previous site development figures in this guidebook. Also to consider, the routing of storm water to riparian areas should consider inclusion of a buffer area surrounding the riparian area to dissipate, infiltrate, and remove pollutants from overland flow. In this way, such a riparian area can provide a self-treating approach for the parcel.

Figure 4-17: Site Planning – Drainage Management Areas



Step 3: LID Design Objectives and Feature Selection

The LID Planning Process:
Step 1 Site Assessment
Step 2 Site Planning Process
Step 3 - LID Design Objectives and Feature Selection
Step 4 LID During Construction Phase
Step 5 LID Operation and Maintenance

After the site planning process has been initiated and a conceptual site design and preliminary drainage design is developed (with general drainage management areas delineated), specific LID features can be selected and designed to effectively manage storm water on-site. In most cases, LID features are combined with pollution source controls and conventional storm water controls to form an overall site storm water management strategy.

LID Design Objectives

In addition to protecting on-site amenities from damage from ponded and flowing water, the overall site storm water management strategy should provide protection to the off-site environment by:

1. Minimizing the volume and rate of storm water leaving the site, and
2. Minimizing the concentrations of pollutants in storm water leaving the site.

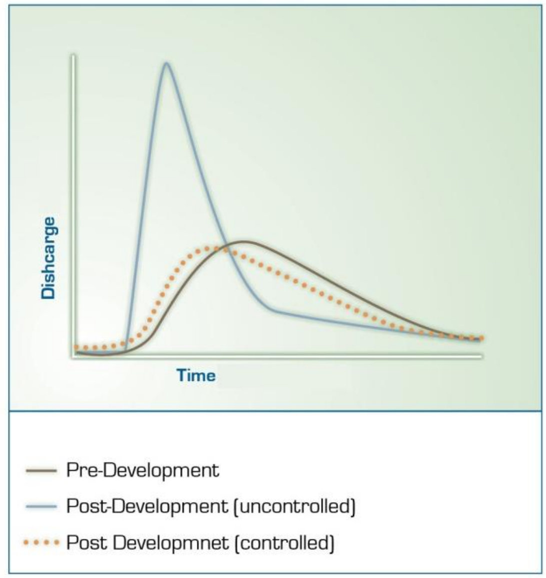
In general, the site storm water strategy should aim to fulfill these two objectives to the greatest degree practical. Further discussion of these two design objectives and how LID techniques can help achieve them is provided below.

Minimizing Storm Water Leaving the Site

As discussed earlier in this document, high volumes and high velocities of storm water discharged from developed areas into natural watercourses can adversely impact aquatic ecosystems and stream habitat and cause stream bank erosion and physical modifications. These changes can also result in increased flooding to downstream areas.

Figure 4-18 compares hydrograph results under pre-development, post-development (without runoff volume controls), and post-development (with runoff volume controls) scenarios.

Figure 4-18: Hydrograph Comparisons: Pre- and Post-Development



In attempting to maintain a site's general pre-development runoff conditions, there are four aspects to the hydrograph that should be considered:

1. **Time of concentration:** what is the time needed for rainfall runoff to flow from the drainage area's most distant location to be discharged off-site, and how is this time affected by the development?
2. **Peak flow rate**[3]: can the maximum rate at which runoff leaves the site during a storm be kept similar to the pre-developed condition?
3. **Duration:** how does the total time (when runoff is leaving the site during and after a storm event) change following development?
4. **Volume:** can the total amount of runoff that leaves the site be kept similar to the pre-developed condition?

At most sites, maintaining pre-development runoff conditions can be achieved by taking a LID approach to site planning and by using LID features to control runoff. Similar to designing conventional storm water management systems, designing LID features begins with understanding the size of inflows to the feature during the design storm[4]. Knowing the rate and volume of inflows, the feature can then be sized appropriately to manage storm water via detention, retention, and/or infiltration.

Demonstrating that a site's planned storm water management strategy (including LID features) will effectively mimic pre-development runoff conditions is often evaluated using hydrologic models that simulate runoff conditions. Some communities have developed a set of

[3] Note that "peak flow control" is not a requirement of the Phase 1 2009 NPDES Permit. The required "interim hydromodification" requirement is met by the change in volume capture and 100% treatment. See the CoPermittee's LID Technical Design Manual for future guidance on projects within the 2009 NPDES permit area: www.srcity.org/stormwaterLID.

[4] See the CoPermittee's LID Technical Design Manual for future guidance on calculating the "design storm" for projects within the Phase 1 2009 NPDES permit area: www.srcity.org/stormwaterLID.

standardized LID features and corresponding sizing criteria that have been designed to control runoff volumes that are appropriate to that region. Witin the Phase 1 2009 NPDES Permit area, the sizing criteria requires capture and treatment of 100% of the flow generated by the 85th percentile 24 hour storm event, as calculated using the Rational Method and a known intensity of 0.20 inches per hour[5].

Water Quality Treatment Objectives

Land development often increases concentrations of pollutants in storm water runoff. Types and sources of pollutants vary but can include heavy metals (such as copper from vehicle brake pads or mercury from atmospheric deposition), petroleum hydrocarbons (such as gasoline and motor oil), trash (from on-site users or blowing debris), nutrients and pesticides (from landscaping features), or increased sediment (from disturbed areas). Concentration of pollutants can be reduced by implementing both pollution source controls and storm water treatment measures.

Existing storm water regulations require that pollution source controls and storm water treatment be implemented to the "Maximum Extent Practicable" (MEP). MEP refers to the technology-based performance standard established by Congress in the Clean Water Act. To achieve the MEP standard, all practices that prevent storm water pollution must be employed to the extent that these practices are technically feasible and are not cost prohibitive.

MEP generally emphasizes pollution prevention and source control best management practices (BMPs) as the first line of defense to be used in combination with treatment methods as a backup (or additional line of defense). The MEP is a moving target and will continue to evolve based on national, statewide and local experience. The Phase 1 NPDES Permit requires a "*New and Redevelopment Integrated Water Quality/Water Resource Plan*" where volumetric and/or flow-based criteria for water quality protection be established. The Phase 2 NPDES Permit includes volumetric and flow-based criteria for runoff capture and treatment and a detailed water quality monitoring protocol. Other than the water quality targets established in TMDLs, numerical limits for specific storm water pollutants are not currently prescribed or implemented in Sonoma County.

Source Control BMPs are relatively low technology and in many cases low cost practices that help keep pollutants out of storm water. Source controls are not intended to remove pollutants after they have entered storm water. Source control BMPs must be selected to address specific activities or features that will be included in the project. (USEPA 2013)

Source controls can include site operational procedures (such as restricting the use of herbicides, pesticides and fertilizers) and infrastructure controls (such as storing dumpsters under rain awnings). This document does not provide detailed discussions of source control

[5] See the CoPermittee's LID Technical Design Manual for future guidance on calculating the "design storm" for projects within the Phase 1 2009 NPDES permit area: www.srcity.org/stormwaterLID.

measures. The CoPermittee's Storm Water LID Technical Design Manual outlines what source controls are appropriate to specific types of projects.

Treatment methods are employed to address pollutants that cannot be avoided via source controls. A variety of treatment methods exist, including conventional storm water treatment devices (such as oil/water separators, vortex separators, or filtration units) and LID features (such as biofiltration areas). LID features are generally preferred over conventional storm water treatment devices because of the additional benefits afforded by LID (such as groundwater recharge and site greening). Conventional storm water treatment devices may sometimes be an effective supplement to LID features, especially when a site is likely to generate particular pollutants of concern that can effectively be targeted by particular conventional storm water treatment devices.

The same LID site planning techniques and LID features that are implemented to achieve a runoff volume control objectives are also generally useful in achieving the MEP water quality protection. LID site planning techniques, such as minimizing impervious area, act as source controls and many LID features provide water quality treatment via various mechanisms such as filtration, settling, and phytoremediation.

LID Feature Selection

As described throughout this document, the general LID approach is to reduce post-project runoff increases and water quality impacts from development through site design and source control measures that avoid and minimize runoff. While these LID site planning techniques may reduce the amount of runoff requiring treatment, it is generally also necessary to retain, manage, or treat storm water runoff actively through LID design features in order to ensure that post-development hydrograph matches the pre-development hydrograph, and that storm water pollution is controlled to the MEP.

General LID Feature Types:
- *Biofilters*
- *Permeable Surfaces*
- *Green Roofs*
- *Rainwater Harvesting Systems*
- *Subsurface Detention/Infiltration Strategies*

The actual selection of specific LID features will depend upon site specific conditions, including the site concept plan, the general development objectives, as well as the anticipated runoff conditions associated with the post-project scenario.

In Section 4.2 above, in the sub-section *Overview of LID Features*, general families of LID features were introduced, as shown in the highlight box. Once the conceptual site design and preliminary drainage design are developed and provide an estimate of on-site runoff quantities, the most appropriate LID feature types can be considered for selection.

The information described above relating to design objectives for post-project runoff control and water quality effects will also be considered in evaluating LID feature types. In addition to hydrologic requirements, additional factors to be considered in the selection of the most suitable LID features include surrounding land use activity, potential pollutants of concern, LID feature effectiveness, site constraints (area, slope, soils, topography, etc.), cost, and maintenance requirements (Santa Clara Valley Urban Runoff Pollution Prevention Program 2004).

Section 4.4 of this guidebook provides more detailed snapshots of various LID features through a series of summary sheets. In the summary sheets the following topics are addressed:

- LID feature description
- Function and benefits
- Selection criteria and limitations/site constraints
- Applications
- Example schematics and photographs
- Key design and installation considerations
- Estimated costs
- Maintenance information
- References and additional resources

Step 4: Construction Phase

The LID Planning Process:
Step 1 Site Assessment
Step 2 Site Planning Process
Step 3 LID Design Objectives and Feature Selection
Step 4 - LID During Construction Phase
Step 5 LID Operation and Maintenance

For LID features to operate effectively post-development they must be properly constructed and installed. Because so many LID features rely on gravity fed drainage, the grades and elevations of soil and hardscape elements (i.e., curb cuts, trench drains, curb heights, etc.) are critical and must be carefully constructed and checked throughout the installation process. Even minor discrepancies in elevation can prevent an LID feature, such as a curb cut, from functioning as designed.

Construction Management for LID:
a) Pre construction Planning
b) Demolition Phase
c) Hardscape Construction Phase
d) Soil Preparation and Grading Phase
e) Plant Installation Phase
f) Post construction Observation

The San Mateo Countywide Water Pollution Prevention Program (SMCWPPP) developed a *Sustainable Green Streets and Parking Lots Design Guidebook* (2009) to provide designers, builders, and municipal staff a state-of-the-art reference manual for LID street and parking lot design. The following measures were identified to protect conservation areas and ensure proper installation of LID features during construction (SMCWPPP 2009). These elements are recommended measures, and are not necessarily required for compliance with NPDES permits.

(a) Pre-Construction Planning

- In the construction bid, separate the work to be conducted by the general contractors and landscape contractors.
- Establish specific qualifications for each discipline's tasks, to ensure quality assurance in the contractor selection process.

- Add sufficient time and funding for the design team to regularly inspect the site to ensure accuracy of installation of LID features during construction.
- Phase the project to complete operations in one section of the site before clearing and grading the next. This will reduce equipment activity and potential damage to conservation areas.
- Begin clearing, grading, and heavy construction activity during the driest months and conclude by late fall.
- Establish and maintain erosion and sediment controls before or immediately after clearing and grading activity begins.
- Map native soil and vegetation protection areas on all plans and delineate these areas on-site with appropriate fencing from clearing, grading, and construction damage.

(b) Demolition Phase

- For retrofit projects, inspect native soil conditions under existing concrete or asphalt areas to determine if soil mix adjustments are necessary.
- Check for undetected utility lines or vaults.

(c) Hardscape Construction Phase

- Inspect forms prior to pouring concrete or asphalt elements to ensure accurate grades and elevations for conveying runoff into storm water facilities.

(d) Soil Preparation and Grading Phase

- Soil preparation and grading activities should be conducted in dry conditions without standing water on the soil surface.
- Excavate native soil to design depth, rototill any compacted soil surrounding the excavated area.
- Till in imported topsoil mix with native soil conditions in 6-inch lifts. Finish topsoil grade below the final grade of the storm water facility to account for a mulch layer.
- Check final grades to assure that elevations and side slopes are built accurately. Make adjustments in the field as necessary.
- Within the Conservation Areas and where LID features are being installed, do not compact soil with heavy equipment during construction. Use only foot-compaction or a landscape-roller to finish the grade of the LID feature.
- Temporarily block off storm water entrances, if possible, to protect the newly graded soil conditions from receiving storm water flow.

(e) Planting Phase

- Make sure that plant installation activities are done in dry conditions without standing water on the soil surface.
- If plants are installed in dry summer months, provide irrigation during the predetermined establishment period for the plants.
- Prior to the plants being delivered to the project site, verify with the contractor that the correct plant species and quantities were ordered.

- Apply specified mulch material to establish final grade of the storm water facility.

(f) Post-Construction Observation Phase

- Visit the project site often (particularly during or soon after rainfall events) to determine if it is performing successfully. Look for any signs of erosion, poor plant health, lack of maintenance, prolonged periods of ponding of water, and inlet, overflow, checkdam or other storm water facility malfunctions.
- Survey the general public to determine if the project is successful from a community perspective.

Step 5: Operations and Maintenance

The LID Planning Process:
Step 1 Site Assessment
Step 2 Site Planning Process
Step 3 LID Design Objectives and Feature Selection
Step 4 LID During Construction Phase
Step 5 - LID Operations and Maintenance

This section describes the responsibilities for long-term care of LID features, the contents of an Operations and Maintenance (O&M) Plan, and long-term guidance on what items to address in order to prevent deterioration and failure of LID features.

(a) Identifying Maintenance Responsibilities

During the project development process, the party responsible for maintenance of the LID features will be identified and designated. Maintenance responsibilities may belong to a city, the County, a homeowners' association (HOA), or the site owner/developer, depending on the project site, its location, its scale, adjacent land ownership, and existing maintenance responsibilities. For example, most LID features installed within a single parcel residence (see Figure 4-17b) or a small group of homes (Figure 4-17c) can be maintained by the landowners through educational training and a modest commitment to maintenance activities. In this way, most single family residence and small scale LID features are maintained similar to landscaping or other home-ownership commitments. Landowners are more likely to value the benefits of LID features and thus maintain them properly. LID features installed for a larger grouping of homes (as shown in Figure 4-17a) or a complex of townhomes or apartments is best maintained by the developer, the city, or a homeowners' association to ensure effective upkeep of the LID features. This is especially important for rental properties, as residential turnover is high. For LID features to consistently perform according to design, it is important that O&M responsibilities at all scales are supported in perpetuity.

(b) Operations & Maintenance Plan

The project designer should prepare an operations and maintenance (O&M) plan, also called a maintenance and inspection report, for the site that will identify the procedures, schedule, and persons responsible for implementing and documenting O&M activities. Additionally, to minimize mosquito habitat and allow access for mosquito surveillance and control, vegetation maintenance, such as cattail removal, should be included in the O&M plan. The following is an example outline for an O&M plan specific for LID features based on a successful storm water program for the City of Portland, Oregon (2008). For CoPermittee and Program Participant communities under the Phase 1 NPDES permit, permit compliance requirements for the

Maintenance and Inspection Report are provided in the Phase 1 CoPermittee's Storm Water LID Technical Design Manual.

Example Outline for LID Operations & Maintenance Plan or Maintenance and Inspection Report

1. Introduction
    a. Summary of overall Storm Water Management Plan
    b. Table identifying each storm water facility, including storm water source, square footage treated, and discharge point
    c. Map of specific location of storm water facilities
    d. Identification of who will assume responsibility for ongoing operations
2. Maintenance Schedule
    a. When and how often facilities will be inspected
    b. Specific intervals between maintenance duties
    c. Definition of what size storms require additional inspections
    d. Irrigation schedule (if applicable)
3. Operations and Maintenance Procedures
    a. Specific procedures for each facility type
    b. Likely deficiencies and corrective actions
    c. Course of action for unexpected deficiencies
4. Financial Responsibility
    a. The party(s) fiscally responsible for operating and maintaining the storm water facility must be designated.
    b. The costs associated with inspection and maintenance efforts must be identified.
5. Inspection and Maintenance Logs
    a. Examples and instructions for maintaining inspection and maintenance logs are required as part of NPDES permit conditions.

The date, description, and contractor (if applicable) for all repairs, landscape maintenance, and facility cleanout activities will be recorded with records kept for a minimum of 5 years and made available upon request to City, County, and/or Regional Water Quality Control Board as appropriate.

Additionally, maintenance of LID features for public health and safety is essential. Vegetation must be maintained in compliance with fire codes, particularly adjacent to buildings and fire lanes. Any source of standing water, including natural and constructed wetlands, detention basins, and other storm water conveyance systems (even those below ground) can be breeding grounds for mosquitoes and other vectors which could result in adverse public health effects.

The most effective methods to minimize the mosquito production potential within LID features are: (1) ensure that standing water does not remain within the LID feature for more 72 hours, (2) deny mosquitos' access to standing water, or (3) make the habitat less suitable for mosquito breeding. LID features with standing water can also attract rodents, such as rats, raccoons, opossums, and skunks, which can be vectors of human diseases. In addition to ensuring that standing water is eliminated in a timely fashion, rodents may be discouraged through other means such as fencing. The O&M Manual should include a method to monitor and eliminate rodents from LID features.

4.4 LID Feature Summaries

The following pages contain summary descriptions for these classes of LID features:

- Biofilters
- Permeable Pavement
- Green Roofs
- Rainwater Harvesting Systems
- Subsurface Detention/Infiltration Strategies

Each summary sheet includes a description of the basic functions and benefits of the LID feature, selection criteria, applications, design and installation considerations, costs, and maintenance activities. Examples of each LID feature are included in each sheet.

As mentioned previously, the CoPermittees have developed specific guidance for implementation of acceptable LID features that comply with NPDES permit requirements within the 2009 NPDES permit area. The summary sheets presented in this guidebook are intended to provide a broad overview of LID features, whereas the CoPermittee's fact sheets are intended to be implicitly followed in order to obtain NPDES permit coverage. The CoPermittee's LID fact sheets can be reviewed at the following City of Santa Rosa website: www.srcity.org/stormwaterLID.

Introduction: A biofiltration area is any vegetated area to which storm water is intentionally directed. Common biofiltration treatments include:

- rain gardens/biorentention areas,
- flow-through planters,
- vegetated swales,
- vegetated filter strips.

Curb cuts allow any runoff from the permeable pavement to flow into a biofilter (Chicago, IL) *Photo: Abby Hall, US EPA*

Function & Benefits: Biofilters come in many shapes and sizes, and often use multiple hydrologic processes (infiltration, evaporation/transpiration, and detention/retention) to manage storm water flows and quality. Biofilters treat storm water via filtration (through soil and through plant material), settling, and phytoremediation (uptake of pollutants by plants).

In addition to their storm water management benefits, biofilters are visually interesting landscape features and provide habitat for wildlife.

Biofilter in a Portland, Oregon sidewalk. Street runoff is directed into the biofilter via small check dams in the gutter.
Photo: RMC Water & Environment

Selection Criteria: Biofilters can be used in a wide variety of applications and can be designed to suit particular site needs. Selection considerations for using biofilters include:

- Biofilters work best in infiltrating soils. Many biofilters have traditionally been designed with piped underdrains in areas with low infiltration rates. However, storm water permit compliance in Sonoma County may require that only overflow-type subdrains located above the required capture volume be utilized. The requirements of the applicable governing agency (city/county) should be consulted before incorporating subdrains into the biofilter design.
- Biofilters are generally installed on flat ground (rain gardens) or gentle slopes (vegetated swales). For steep sites, terraced rain garden or vegetated swales with check dams may be an option.
- Care should be taken when installing biofilters on sites with shallow depths to groundwater. There should be at least two feet of separation between the bottom of the biofilter and the water table to prevent the swale bottom from being saturated, which impacts plant growth and can foster mosquito breeding.

Sonoma County Example: Lowe's Home Improvement Store, Cotati, CA

The Lowe's Home Improvement store in Cotati features a large vegetated swale that treats runoff from the store's parking area. The parking lot also features areas of permeable asphalt.

Vegetated swale/biorentention area at the Lowe's Home Improvement Store in Cotati, CA
Photo: David Woltering

Applications: Biofilters have wide applicability and can be used in residential, commercial, and industrial settings.

RESIDENTIAL

Rain gardens at the Jordan Cove Urban Watershed Project in Connecticut collect and treat runoff from the adjacent houses.

Photo: University of Connecticut

Vegetated swales along Seattle's residential "Street Edge Alternatives" project.

Photo: Seattle Public Utilities

COMMERCIAL

Flow-through planters receive roof run-off at the Emery Station East office building in Emeryville, CA

Photo: Abby Hall, US EPA

Runoff from the parking lot of Portland's New Seasons Market is directed to a vegetated swale.

Photo: RMC Water & Environment

MUNICIPAL/INSTITUTIONAL

Rain garden at the Glencoe Elementary School in Portland, OR captures water from nearby paved areas.

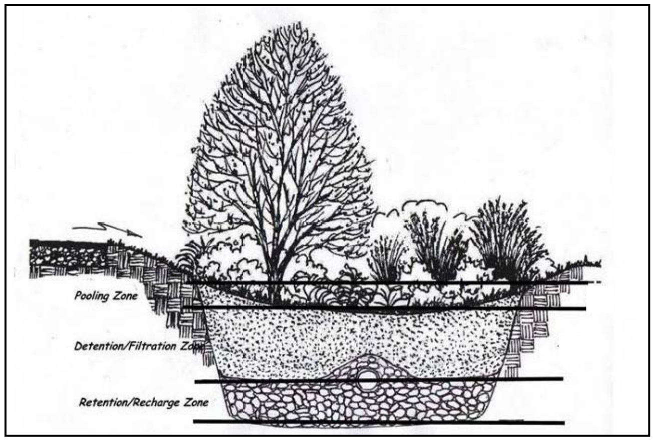
Photo: RMC Water & Environment

Biofiltration curb extension in Portland, OR. Storm water flows into the curb extension from the gutter.

Photo: RMC Water and Environment

Design: As biofilters vary widely in their applications, so does the complexity of the biofilter design process. In general, when designing a biofilter the following design aspects are considered. **See the CoPermittee's LID Technical Design Manual for more detailed design requirements for biofilters (City of Santa Rosa 2011).**

- **Sizing:** Biofilters are generally sized based on hydromodification control objectives for runoff volume. Flow rate, and duration control are also sometimes considered in sizing biofilters. With proper design, water quality treatment objectives can be met along with hydromodification control objectives.
- **Ponding/Drainage Time:** Design ponding depths of biofilters vary. Some vegetated swales are designed to have no ponding, whereas biorentention areas in well-infiltrating soils are sometimes designed with varying ponding depths. Biofilters must be designed to drain within 72 hours. Longer ponding times may provide breeding opportunities for mosquitoes. Biofilters require soils with high infiltration characteristics. On-site percolation/infiltration studies may be necessary.
- **Soil amendments:** Depending on local soil conditions, imported soils are commonly used in biofilters in order to achieve appropriate detention/retention capacity (in soil interstitial spaces) and treatment (via filtration through the soil).



Schematic of a biorentetion area showing ponding, amended soils, and a drain pipe (above the designed capture volume). Note that use of underdrains is not currently allowed under NPDES permits in Sonoma County.
Graphic: Adapted from Prince George's County, 2007

- **Conveyance:** If the biofilter is designed to convey water from one point to another (vegetated swales), appropriate slopes should be designed (generally between 1% and 2%). Biofilters may be constructed on steeper slopes by using check dams or terracing.
- **Plant Selection:** Plants for biofilters must be carefully selected in order to tolerate brief periods of inundation (up to 3 days) while also being drought-tolerant. Plants within biofilters should require minimal irrigation during the dry season. Native plants are recommended because they are adapted to the local climate. Low to medium height native vegetation is preferred to minimize mosquito habitat. Cattails and bull rushes are not recommended due to their fast growing capacity and attraction for mosquito populations.

Installation: Because biofilters rely on gravity-fed drainage, the grades and elevations of soil and hardscape elements (i.e., curb cuts, trench drains, curb heights, etc.) are critical and must be carefully constructed and checked throughout the installation process. A minor discrepancy in elevation can prevent drainage from occurring as designed. Care should also be taken to avoid compacting native and imported soils to the greatest extent possible.

Cost: The costs for constructing biofiltration areas varies widely depending on site conditions, design objectives and plant selection. Biofilter areas are, however, often the least expensive means of achieving storm water management objectives for runoff control and water quality (i.e. less expensive than conventional storm water conveyance/treatment and less expensive than other LID features). Studies indicate that integrating bioretention across a site can achieve a net reduction of between 15 and 50 percent of the site development costs compared with conventional BMPs (Prince George's County 2007).

Maintenance: Maintenance activities for biofilters include:

- Irrigate as needed. Irrigation may be necessary in the first 1-3 dry seasons following construction to establish newly-planted vegetation.
- Manually remove weeds and debris and prune plant overgrowth.
- Cut back grass and prune overgrowth 1-2 times a year.
- Do not apply fertilizers, herbicides, or pesticides.
- Remove litter and debris.
- Rake, till, or amend to restore infiltration rate.
- Inspect occasionally after storm events to ensure that the biofilter is draining appropriately and water is not ponding for more than 72 hours.

Forebay structure allows for easy trash removal. Drought-tolerant sedges are low-maintenance plants (Portland, OR)
Photo: RMC Water & Environment

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December 2013

Introduction: A variety of permeable surfaces can be used as alternatives to conventional impermeable paving surfaces such as asphalt and concrete. In general, permeable pavement systems are intended to manage only the rainwater that falls on them, but with proper design they can also manage limited amounts of runoff from other site areas.

Permeable paving surfaces include:

- Permeable (porous) concrete
- Permeable (porous) asphalt
- Permeable pavers (impervious blocks separated by pervious/porous areas)
- Grass and gravel "pavers"

Permeable Concrete
Photo: HydroSTON®

Concrete pavers in a pedestrian area at a Philadelphia school allow for storm water infiltration and plant growth.
Photo: Abby Hall, US EPA

Function & Benefits: Permeable paving systems consist of a durable, load bearing, pervious surface that overlies a crushed stone base. The base rock detains rainwater that percolates through the pervious surface above. In soils with low infiltration capacity, many permeable pavement systems have traditionally been installed with piped underdrains. However, storm water permit compliance requirements in Sonoma County may require that only overflow-type subdrains located above the required capture volume be utilized. **The requirements of the local governing agency (city/county) should be consulted before incorporating subdrains into the permeable pavement design.**

In addition to providing storm water management benefits, permeable pavement systems can also add a visual interest to the site. Permeable pavers can be arranged in interesting patterns and grass pavers allow for green spaces in unexpected areas.

Selection Criteria: As a general rule, permeable pavement is suitable for low speed/low traffic areas such as parking lots and pedestrian walkways. Note that permeable pavement may not meet Americans with Disabilities Act (ADA) standards. Selection considerations for using permeable pavement include:

- Permeable pavement has a lower load-bearing capacity than conventional pavement and should not be used in areas that receive regular traffic from large vehicles (such as loading docks).
- Permeable paving should only be used in flat areas and on gentle slopes (<5%).
- Soil pores in permeable pavement can become clogged with fine sediment, which reduces infiltration capacity. As such, permeable paving should not be used in areas that may receive significant quantities of dust or sand via wind transport or storm water flows.

Permeable paving in courtyard of Sebastopol's Florence Lofts
Photo: David Abbott; Sonoma West Times

Sonoma County Example: Florence Lofts, Sebastopol, CA

Florence Lofts is a 12-unit townhouse development site on 1.1 acres at the north end of downtown Sebastopol. In addition to many other impact avoidance measures, the property makes extensive use of permeable paving. The parking areas and the courtyard utilize a 6-inch layer of permeable concrete over a 10 inch layer of drain rock.

Applications: Permeable paving is often a viable alternative to conventional asphalt and concrete.

RESIDENTIAL

Simple gravel parking area at a house in Alameda County, CA.

Photo: www.bluegreenbldg.org

Ecostone® paver driveway at the Jordan Cove Urban Watershed Project in Connecticut (www.jordancove.uconn.edu)

Photo: University of Connecticut

COMMERCIAL

Grass pavers form the parking stalls at the Little House Café in Alameda, CA.

Photo: RMC Water & Environment

Permeable paver parking lot at a West Berkeley office building.

Photo: www.bluegreenbldg.org

MUNICIPAL/INSTITUTIONAL

A parking lot on the University of California, Merced campus uses gravel pavers in the parking stalls and conventional asphalt in the driving lanes.

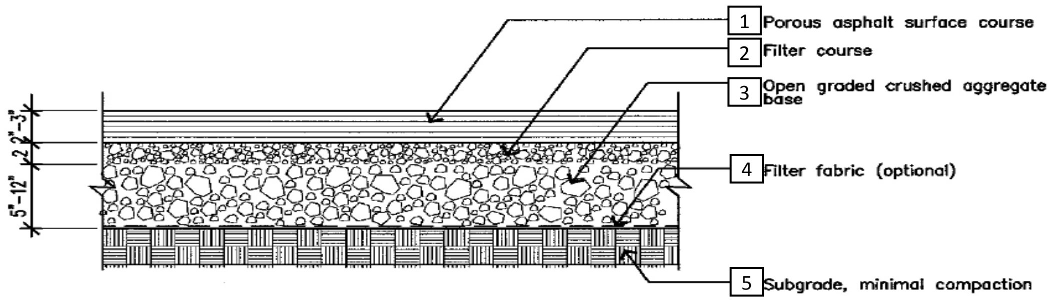
Photo: Horizon Water and Environment

Sand-set pavers (permeable sand fills the spaces between tiles) are used in the parking lanes on Naito Parkway, Portland, Oregon.

Photo: RMC Water & Environment

Design: Permeable paving systems consists of several layers:

1. Permeable surface: The decision of what type of surface to use is based on cost/maintenance considerations as well as aesthetic preferences.
2. Filter course: A narrow layer (~2") of small (~0.5") crushed rock or sand should underlie the pervious surface.
3. Aggregate base: To allow for subsurface water storage, the aggregate base must be open graded (limited size range), crushed stone (angular stones, not rounded stones such as pea gravel). The depth of the base rock layer can vary based on loading requirements and desired storm water detention capacity.
4. Optional geotextile liner: A geotextile liner is sometimes placed between the aggregate base and the soil to prevent fines from migrating upward into the aggregate base and filling the void spaces. Geotextile liners can, however, clog with fines that have infiltrated though the pavement and aggregate, thereby inhibiting infiltration. **The decision whether or not to use a liner at a particular site should be made by a qualified engineer and in consultation with the local governing agency (city/county).**



Graphic: BASMAA, 1999

Unless a site's underlying soils are known to be capable of rapid infiltration rates, it is generally recommended that permeable paving systems be designed with an underdrain system. Depending on the storm water management needs at the site, the underdrain may discharge into the municipal storm sewer or to another on-site storm water management feature (such as a biofiltration area). **For storm water permit compliance, the requirements of the governing agency (city/county) should be consulted prior to incorporating underdrains (subdrains) into the permeable pavement design. Also refer to the CoPermittee's LID Technical Design Manual for more detailed design requirements for permeable paving (City of Santa Rosa 2011).**

Installation: Handling and installation procedures for permeable paving systems are different from conventional pavement. As such, contractors experienced with permeable paving systems should be used whenever possible. Consistent with other LID techniques, the soils underlying the aggregate base should be compacted as minimally as possible during the site grading and construction phase. During installation, care should be taken not to introduce fine sediments into the permeable surface or aggregate base.

Costs: In general, permeable paving initially costs more than conventional asphalt or cement paving techniques. Construction costs for permeable asphalt and concrete may be 50% more than conventional asphalt and concrete. Construction costs for permeable pavers and grass/gravel pavers vary considerably. Some sources estimate that permeable pavement can be up to 25 percent cheaper than traditional pavement when all construction and drainage costs are included. Permeable paving reduces the need for storm water conveyances and treatment structures, resulting in cost savings elsewhere. Permeable paving also reduces the amount of land needed for storm water management, possibly allowing more development on a site.

Maintenance: Maintenance activities for permeable pavements include:

- Keep adjacent landscaped areas well-maintained and prevent soil from being transported onto the pavement.
- Permeable concrete and asphalt surfaces should be cleaned once or twice a year using vacuum sweeping machines. Vacuuming is most effective during dry conditions.
- For paving stones, periodically add joint material (sand) to replace material that has been transported.
- Grass pavers may require periodic reseeding to fill in bare spots.
- Prevent large root systems from damaging subsurface components.
- Monitor regularly to ensure that the paving surface drains properly after storms. The infiltration rates can also be tested.
- Do not reseal or repave with impermeable materials.
- Inspect the surface annually for deterioration and repair as needed.

Demonstrating infiltration rates at a Villanova University. Permeable concrete (upper) permeable asphalt (lower)

Photo: Abby Hall, US EPA

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December 2013

Introduction: A green roof is a vegetated roof system used in place of a conventional roof. Green roofs are also referred to as “living roofs,” and are relatively common in Europe and becoming increasingly popular in the United States. American cities such as Chicago and Portland have well-established programs that support the use of green roofs.

There are generally two green roof categories: intensive or extensive. Intensive roofs (sometimes called rooftop gardens) have a thicker layer of soil and are thus able to support larger vegetation and foot traffic. Extensive vegetated roofs use a thin layer of soil and smaller plants and cannot be walked upon.

Green Roof of h2hotel in Healdsburg, CA
Photo: City of Healdsburg

Function & Benefits: Green roofs manage storm water by capturing some or all of the rain that falls on the roof and then slowly release the water to the atmosphere by allowing for evaporation and transpiration through the rooftop plants. Typical green roofs have been found to reduce annual roof runoff volumes by 50 to 65 percent and to reduce peak flows for large rain events (those exceeding 1.5 inches) by approximately 50 percent.

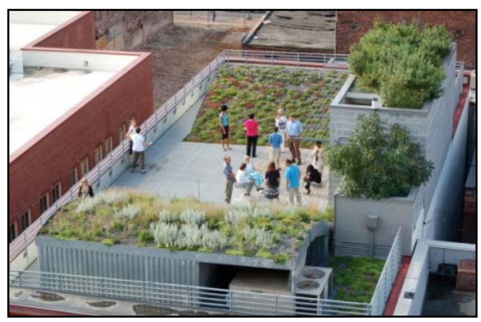
In addition to providing storm water management benefits, green roofs also:

- Provide insulation (possibly lowering cooling and heating costs for the building)
- Reduce the urban heat island effect
- Create habitat for wildlife including birds and beneficial insects
- Provide aesthetic and recreational amenities

Selection Criteria: Green roofs may be especially appropriate for projects where:

- ground-level space is constrained and opportunities for storm water management using other LID features are limited;
- the green roof can be seen from the ground or other adjacent structures;
- building occupants can access (but not necessarily walk upon) the green roof;
- the urban or building setting is lacking in vegetation.

Note that green roofs may not meet volume capture requirements for storm water management permits. **The local governing agency (city/county) should be contacted if volume capture is a consideration for a proposed project.**



American Society of Landscape Architects (ALSA) building in Washington DC
Photo: ALSA

Sonoma County Example: Salmon Creek Falls Environmental Center, Occidental, CA

The construction of the Salmon Creek Falls Environmental Center was completed in the Spring 2009. A portion of the Center’s 10,500 square foot roof will be planted with cuttings started by the Center’s students. The Center has many other green features and has applied for LEED Certification.

Salmon Creek Falls Environmental Center
Photo: Kevin Falkerson, Symbios Holistic Development (May 2009)

Applications: Green roofs can be used on a wide variety of structures.

RESIDENTIAL

Small structures like this backyard shed in Portland, Oregon are a good place to experiment with green roofs (see www.sustainablestormwater.com/blog).

Photo: Dave Elkin, Portland Sustainable Stormwater

Green roofs have been in use for centuries. Sod roofs provide insulation in the cold climate of Norðragøta on Eysturoy, Faroe Islands.

Photo: Erik Christensen

COMMERCIAL

The West Elm store in Emeryville, CA boasts a green roof (left) and solar array (right) that are highly visible from the adjacent freeways.

Photo: RMC Water & Environment

Ford's River Rouge truck plant in Dearborn, Mich., has a 10-acre "living" roof — the largest in the world

Photo: William McDonough + Partners

MUNICIPAL

A 1,200 square foot green roof was constructed atop the Summit Pump Station in central San Francisco

Photo: San Francisco Public Utilities Commission

The green roof at Portland's Metro Regional Center building was retrofitted onto an existing roof terrace. Hardy succulents are used on this extensive green roof.

Photo: RMC Water & Environment

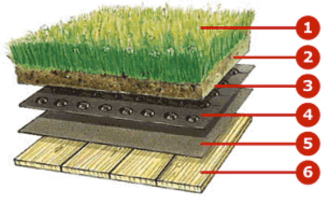
Design: Green roofs vary in design, but most modern green roofs are composed of several layers which (from top to bottom) generally include:

1. Vegetation - Drought-tolerant plants should be selected so as to minimize irrigation requirements.
2. Growing medium - Specialized lightweight soils are often used.
3. Root barrier - A layer of filter fabric is often used to prevent roots and soil particles from entering the drainage/storage layer below.
4. Drainage/storage layer - Gravel or specialized plastic products may be used to facilitate drainage and create water storage capacity. Note that excess water should drain within 72 hours.
5. Waterproofing layer - A variety of products may be used.
6. Structural support - The roof structure must be designed so as to accommodate the weight of the green roof layers plus the weight of the rainwater that will be retained.

Green roofs are generally installed on roof slopes less than 20 degrees (40 percent or a 5 in 12 pitch) but specialized designs allow for green roofs in almost unlimited shapes and sizes. Designs should also consider overflow drainage.

Green roofs may be designed for a particular application or modular green roof systems may be used. Modular systems are essentially trays of vegetation in a growing medium that are grown off-site and placed on the roof to achieve complete coverage. Typically, the manufacturers of modular green roof systems work with the building architect and structural engineer to ensure that the building can accommodate the modular green roof.

Because a poorly designed green roof may lead to leakage and/or structural damage, it is generally recommended that the services of experienced professionals be employed when considering the use of a green roof.



Green Roof Layers
Graphic : Triton Chemicals

The steep "hills" of the Academy of Sciences green roof (San Francisco, CA)
Photo: Tim Griffith

Modular green roof being assembled
Photo: GreenGrid Systems

Cost: Installation costs for green roofs are often more than double the installation costs for a conventional roof. Green roofs, however, typically last twice as long (about 40 years) as conventional roofs. Additionally, green roofs have lower heating/cooling costs and lower maintenance costs that conventional roofs. Current estimates place the overall life cycle cost of a green roof at approximately 10% more than that of a conventional roof. Costs for green roofs are likely to decrease in the future as green roofs become more common and green roof technologies are further developed.

Maintenance: Maintenance activities for a green roof include:

- Inspecting the roof regularly to check drainage and vegetation. Inadequate or obstructed drainage can result in water ponding which can damage the structure and encourage mosquito breeding. Eroded areas should be repaired, as needed.
- Occasionally removing dry vegetation to ensure that combustible material does not accumulate. Some plant types, such as grasses, may need more frequent trimming while others, such as succulents, will rarely need maintenance. Do not use pesticides.
- Irrigating as necessary. Most green roofs are designed to need minimal watering but irrigation may be necessary to maintain plants during extended dry periods and to establish plants after they are initially installed.

Low maintenance succulents (*Sedum*)
Portland's Metro Regional Center
Photo: RMC Water & Environment

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Introduction: A rainwater harvesting system typically collects the run-off from a building's roof and stores the water for later reuse. Storage tanks (or cisterns) are an important component of rainwater harvesting systems and can range from small wooden barrels (such as wine barrels) to large custom-designed cisterns. Harvested rainwater is often used outdoors for landscape irrigation. **Currently, indoor use of rainwater, such as toilet flushing, is not permitted in Sonoma County.**

Although roofs are the most common "watershed" in rainwater harvesting, other collection surfaces are possible. At the Cambria Elementary School in Cambria, CA (photo at right) the entire campus, including the fields, was designed to collect all available storm water and hardscape runoff. Under the soccer field, large pipes store up to 2,000,000 gallons of water. Harvested water is used for irrigating the athletic fields.

Cambria Elementary School, Cambria CA
Photo: Rehbein Environmental Solutions

Wine barrel cistern
Photo: Adrienne Aiona

Function & Benefits: Rainwater harvesting systems can collect up to 100% of the runoff from their catchment areas as long as there is capacity in their storage tanks. When the storage tank is full, additional storm water can be directed to a biofiltration area or directed to a storm drain system. Reductions in peak flows and runoff volumes using rainwater harvesting systems depend on storage tank (cistern) sizes and water use between storms. Rainwater harvesting provides additional benefits when it is reused onsite to reduce potable water demands. Even when collected water is not reused, improved capture and storage provides several storm water benefits.

Selection Criteria: Rainwater harvesting can be applied on a wide range of scales from a single home's rain barrel to a commercial or municipal site with a large underground storage tank. Rainwater harvesting requires a few key elements:

- A drainage area from which to collect water
- An approved application for captured water
- An appropriate overflow point for excess water

Rainwater harvesting is most beneficial at:

- Sites with irrigation needs
- Sites with limited space for landscaped facilities
- Sites that can install underground storage

Contrary to common misconceptions, rainwater harvesting is not illegal in California. Use of harvested rainwater outdoors is allowed, though permits from local jurisdictions may be required. Storm water benefits are maximized when rainwater is used for non-potable indoor uses such as toilet flushing. **However, these systems require additional infrastructure including pipes, pumps and signage, and are not currently allowed in Sonoma County.**

Two 500 gallon pillow tanks installed under the deck of a San Leandro home store enough water to supply toilet and laundry water through the rainy season
Photo: www.watersprout.com

Rainwater tank at the Occidental Arts and Ecology Center
Photo: Jim Coleman/Brock Dolman

Sonoma County Example: Occidental Arts and Ecology Center, Occidental, CA

The Occidental Arts and Ecology Center harvests rainwater for various uses at the Center. OAEC's education programs include information about rooftop rainwater harvesting and techniques to encourage "harvesting water in the soil" such as creating rain gardens, berm and swale configurations, and other landscape features that allow draining rainwater to safely infiltrate through the soil.
The "*Slow it. Spread it. Sink it!*" guide prepared by the Southern Sonoma County Resource Conservation District includes more examples of rainwater harvesting in the county.

Applications: Rainwater harvesting can be applied at many different scales.

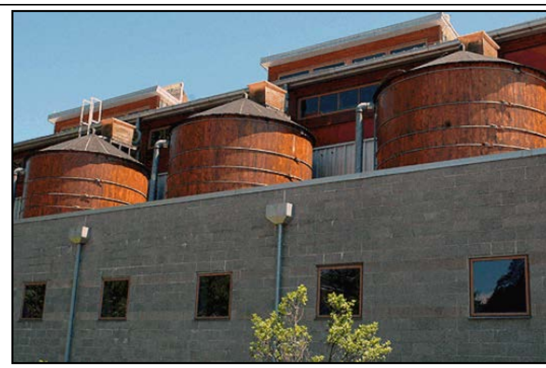
RESIDENTIAL

Two 1,800 gallon cisterns capture rainwater for irrigation use at TreePeople's Hall House demonstration project in Los Angeles, CA.
Photo: David O'Donnell

Plastic rain barrel at a home in Santa Monica, CA. Plastic rain barrels are available commercially.
Photo: Abby Hall, US EPA

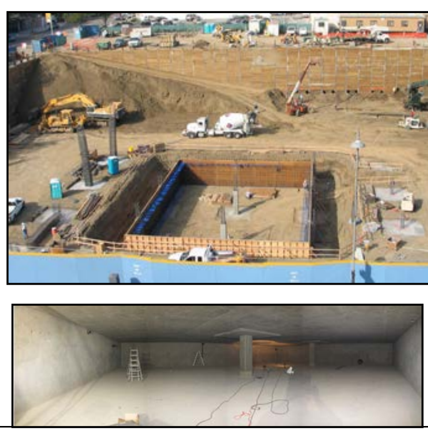
COMMERCIAL

A 5,300 gallon tank made of Atlantis D-Raintank units stores roof runoff from a Sydney, Australia big-box hardware store. Harvested water is used in the store's nursery department.
Photo: Atlantis - www.atlantis-america.com



Cisterns at the Chesapeake Bay Foundation's headquarters in Annapolis, MD collect rainwater for use in bathroom and mop sinks, gear washing, irrigation, fire suppression, and laundry.
Photo: Chesapeake Bay Foundation

MUNICIPAL/INSTITUTIONAL



A 200,000 gallon cistern at the Santa Monica Public Library under construction and completed. The water is collected from the library roof and used for landscape irrigation.
Photo: www.smpl.org

Cisterns at the Chicago Center for Green Technology are screened with trellised vines. The 12,000 gallon cisterns store water for irrigation.
Photo: Abby Hall, US EPA

Design: There are several aspects to the design of rainwater harvesting systems **(also refer to the CoPermittee's LID Technical Design Manual for more detailed design requirements for rainwater harvesting (City of Santa Rosa 2011)**:

- **Collection surface:** Rainwater harvesting is easiest when the collection surface is relatively clean (requiring little treatment before storage and reuse) and is elevated (such that gravity flow may be used to drain and reuse the water). Roofs fill these two criteria very well.
- **Pre-treatment:** Prior to storing the rainwater, it is often advisable to implement simple treatment measures to prevent the storage recepticle from collecting excessive sediment and debris. Pre-treatment mechanisms can be as basic as a metal mesh covering to prevent leaves from entering the roof downspout. "First flush diverters" or "roof washers" can also be purchased to divert or treat the initial (more polluted) volume of any storm.
- **Conveyance (from surface to tank):** If rainwater is being harvested from a roof, conveyance from the collection surface to the storage tank is generally already available in the form of the roof gutters and downspouts.
- **Storage tank:** Storage tanks should be completely sealed, and if any vents exist they should be covered with fine mesh screening (less than 1/16") to prevent mosquitos and other pests from entering. Tank sizing, tank type and tank location are important aspects of designing rainwater harvesting systems:
  - Tank sizing: The storage tank should be sized in accordance with the design objectives. For example, if the rainwater harvesting system is intended mostly as a storm water management tool, the tank will be sized relative to the amount of runoff from the roof during the design storm and the ability to drain the tank after the storm has passed. If water conservation is the priority, a larger tank may be desired so as to capture the runoff from multiple storms.
  - Tank type: For small residential rainwater harvesting systems, simple off-the-shelf containers are often used. Larger rainwater harvesting system may wish to use custom designed tanks (such as poured-in-place concrete tanks). Transparent or translucent tanks are not recommended as sunlight contributes to the growth of algae within the tank.
  - Tank location: Rainwater storage tanks are most often placed on level ground adjacent to the building directly beneath a downspout. Tanks can be placed more or less anywhere on a site with the use of conveyance systems and pumps. Tanks can be located below ground (saving space but requiring pumping for water reuse), on elevated platforms below roof level (allows gravity flow into and out of the tank but requires that a platform be constructed), or even on top of the roof (requires pumping into the tank and possibly structural reinforcing of the building). If possible, tanks should be placed in a cool or shaded area to limit algal growth.

Roof runoff from portable classrooms is stored in two 2,500 gallon cisterns to water the Da Vinci Middle School in Portland, OR. Overflow runs through the raingarden into a storm water wetland.
Photo: Adrienne Aiona

- **Treatment:** For use in landscape irrigation, no treatment of collected rainwater is required. Treatment may be required if the collected rainwater is to be reused for other purposes. Note that use of harvested rainwater indoors is currently not allowed in Sonoma County.
- **Overflow:** When the storage tank is full, additional storm water should be directed to an overflow system. The overflow should be equal in size to the total volume of all inlets and should lead to an approved discharge location, such as a biofiltration area or storm drain system. The appropriate local governing agency (city/county) should be consulted early in the project design to ensure approval of the overflow system.

Cost: Costs for rainwater harvesting systems vary widely, depending mostly on the volume and type of the storage tank and the pumping requirements. Rainwater harvesting systems provide cost savings by off-setting needs for potable water and by collecting rainwater that would otherwise require management through conventional or LID techniques.

Maintenance: Maintenance activities for rainwater harvesting systems include:

- As-needed cleaning of the collection surface. Cleaning of roofs may be warranted at the end of the dry season to remove excess dust. Leaves should be removed from gutters to prevent clogging.
- Storage tank should be inspected twice annually to ensure that they are not leaking, do not contain excessive algal growth, do not have openings greater than 1/16”, and are not hosting mosquito larvae or other insects.
- Drain/clean first flush diverters/roof washers as needed.
- Vents or inlets to or from the system should be screened and checked regularly.

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Introduction: For smaller sites with space constraints, subsurface infiltration and detention strategies can be used to manage storm water on-site. Types of subsurface detention/infiltration strategies include:

- Infiltration trenches
- Underground infiltration galleries
- Soil amendments

A perforated pipe delivers rooftop runoff to the full length of this infiltration trench. After completion the area will be covered with sod and the trench will be invisible.
Photo: Cahill Associates, Inc.

Function & Benefits: Subsurface detention/infiltration structures allow on-site storm water management with minimal surface space requirements.

- Infiltration trenches store water in the void space between crushed stone or gravel; the water slowly percolates downward into the subsoil.
- Underground infiltration galleries create void spaces for storm water detention and provide a broad underground surface though which infiltration can occur.
- Amending site soils is a strategy that improves the soils ability to retain rain water and thereby prevents some degree of runoff from occurring. The intent of soil amendments is to mimic the infiltration functions of healthy naturally occurring topsoils that may have been removed or compacted by development.

Parking lot runoff directed to this infiltration basin is pretreated by a vegetated filter strip.
Photo: California Stormwater Quality Association, 2004

Selection Criteria: Infiltration trenches and underground infiltration galleries are best used on sites that, due to space constraints, cannot use other LID storm water management techniques such as biofiltration areas. Infiltration capacity testing is advisable prior to the consideration of these types of LID features to ensure that proper drainage can be achieved.

Soil amendments are useful particularly on sites where the natural topsoil has already been degraded or where significant regrading/surface disturbance is a necessary part of the site development plan.

For storm water permit compliance, the requirements of the governing agency (city/county) should be consulted prior to incorporating these types of features into the project design. Also refer to the CoPermittee's LID Technical Design Manual for more detailed Storm water design requirements (City of Santa Rosa 2011).

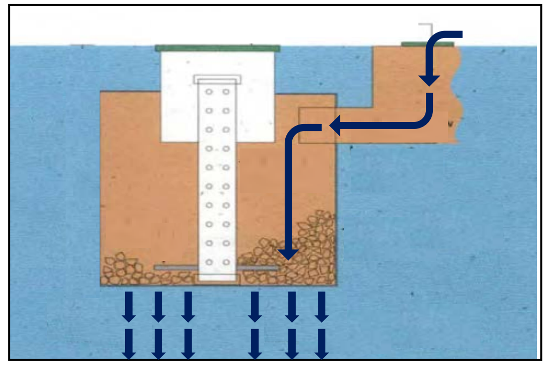
Sonoma County Example: Simple steps like adding mulch cover to exposed soils can significantly improve the ability of the ground surface to detain storm water and reduce storm water runoff. At the Sonoma County Administration Center, the use of mulch cover in the landscaping has been designed so as to need little irrigation water while also reducing storm water runoff.

Mulch under drought tolerant plants at the Sonoma County Administration Center
Photo: Sonoma County Permit and Resource Management Department

Applications: Subsurface strategies can be applied at many different scales and locations.

RESIDENTIAL

A grate in the driveway at TreePeople's Hall House demonstration project in Los Angeles, CA directs storm water into a "infiltration well." Infiltration wells function like small infiltration trenches.
Photo: David O'Donnell



Cross-section schematic of the driveway infiltration well at the TreePeople Hall House (see left). Water flows through the grate and into the gravel filled infiltration well. A perforated pipe topped by a valve box allows for checking to see if proper drainage is occurring.
Graphic: modified from TreePeople graphic

COMMERCIAL

Subsurface structure beneath parking lot: runoff passes through depressed landscape medians (pictured) and a vegetated swale before entering the subsurface detention/infiltration structure.
Photo: Gerry Greene; City of Downey

Underground infiltration gallery using StormTech arched plastic chambers being constructed beneath a commercial parking lot in Downey, CA (near Los Angeles).
Photo: Gerry Greene; City of Downey

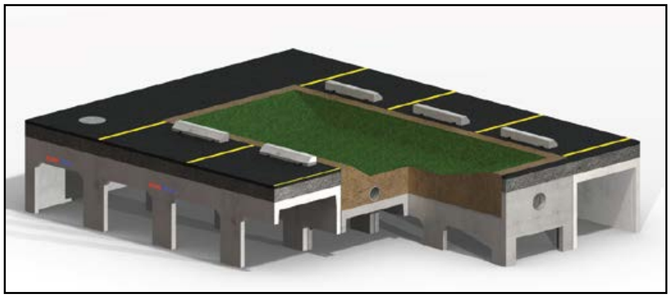
MUNICIPAL/INSTITUTIONAL

An 8 acre-foot storm water vault lies beneath sports fields at the Discovery Sports Complex in Downey, CA. Runoff from over 60 acres is treated by various LID and conventional storm water devices before entering the facility vault.
Photo: City of Downey, May 2008

The storm water vault at the Discovery Sports Center allows for infiltration through large holes in the concrete structure. 20 ft. deep rock-filled wick drains enhance infiltration
Photo: RMC Water and Environment

Design:

- Infiltration trenches and underground infiltration galleries: Infiltration trenches, and underground infiltration galleries should be sized to accommodate the full volume of the runoff from the design storm and to drain after the conclusion of the storm, preferably within 72 hours. As these structures are vulnerable to clogging, pre-treatment mechanisms should be included in the design to prevent debris and sediment from flowing into the structure with the runoff. Pre-treatment also helps protect groundwater from pollutants such as petroleum hydrocarbons. Filter fabric (non-woven geotextiles) is sometimes used to line the sides and bottoms of these structures in order to prevent in-situ soils from migrating into the void spaces. Infiltration trenches and underground infiltration galleries should be designed with some mechanism for overflow drainage. An observation well (a perforated PVC leading to the bottom of the structure) can be included in the design to allow monitoring of the drawdown rate. Infiltration trenches and underground infiltration galleries should not be located near septic systems/leach fields as each will interfere with the proper operation of the other. Any vents or holes in access lid should be screened with fine mesh (less than 1/16") to prevent adult mosquito access into the system.



Biofilters can be used to treat runoff before it enters a detention/infiltration structure.
Graphic: StormTrap

- Soil Amendments: Soil amendments consist of compost, mulch, and top soil. Supplements such as lime (for pH adjustment) , gypsum (in order to increase calcium and sulfur) and nutrients (particularly insoluable nitrogen) can also be useful in the soil amendment mix. These additional components help offset nutritional deficiencies and control acidity. In order to determine the appropriate mix for soil ammendments, a thorough soil analysis of the native soil is advisable. Developing a healthy soil with good structure and infiltration capacity also involves ensuring that the soil contains micro biota, bacteria, and other organisms which are essential at recycling nutrients, creating pore space, oxygenating the soil, and improving stability and infiltration.

Cost: Costs for detention/infiltration structures vary widely depending on the depth, materials used, and individual site conditions. Costs for soil amendments can be obtained from local nurseries/soil suppliers.

Maintenance:

- Infiltration trenches: The most important aspect of maintaining infiltration trenches is ensuring that pre-treatment mechanisms are functioning properly and excess sediment is not accumulating.
- Underground infiltration galleries: Maintenance of pre-treatment mechanisms is also very important for underground infiltration galleries. Underground infiltration galleries can also be designed to facilitate access for maintenance activities such as pressure washing of gravel base and for mosquito surveillance and control.
- Soil amendments: Care should be taken to not compact amended soils (for example, amended soils should not be driven upon). Maintaining vegetation cover and periodic mulching protects amended soils from erosion.

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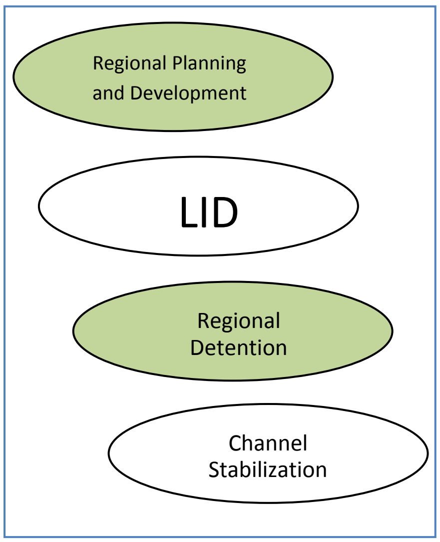
4.5 Off-site, Retrofit, and Regional Approaches

This section discusses off-site[6], retrofit, and regional runoff management approaches to use beyond the immediate project site approaches presented earlier in this chapter. The approaches discussed in this chapter span a range of options and scales.

At the simplest level, local off-site solutions may be pursued to mitigate individual projects that do not meet storm water or flood control requirements. This might involve implementing the LID techniques described previously in this chapter at another local project site. Off-site mitigation can also occur through applying in-lieu fees that support more regional storm water and flood control solutions. Retrofit options are also discussed in this chapter for situations where it is feasible and effective to modify an existing land use or site design to reduce storm water discharges.

Figure 4-19: Storm water planning and management approaches occur on-site and off-site and occur at



As shown in **Figure 4-19** (and Figure 4-1), storm water planning and management approaches can occur through different types and scales of activities. Regional land use planning and watershed management approaches are used at the broadest scale to locate developments in appropriate settings that would avoid or minimize storm water and other impacts. At the site scale, LID measures are selected and designed to address the specific needs of the individual project. Regional detention facilities provide another avenue to manage storm water at individual creek or watershed scales, and may be located either upstream or downstream of developed areas. Lastly, channel stabilization may be necessary if storm water effects aren't adequately managed through the other approaches and protective measures are needed to prevent stream erosion downstream of development. Effective storm water management may use and integrate all of these approaches.

The previous sections of Chapter 4 focused on site-specific planning and design for LID features at the site scale. In contrast to these earlier on-site topics, this section also reviews regional scale approaches that are typically implemented by city, County, and agency partnerships.

[6] The intent for this Guidebook is to include discussion of opportunities for off-site, retrofit, and watershed scale, regional projects that support the broad water resource objectives of Water Smart Development. These broader objectives may or may not address or fully align with NPDES Permit requirements for offsetting impacts of on-site development. Agencies with project approval authority should be contacted directly to obtain guidance for specific NPDES permitting requirements.

Regional approaches can be pursued for large-scale development projects where regional runoff management opportunities are available. Regional approaches can be developed through cooperative planning initiatives that integrate storm water from multiple developments or existing land uses. In other cases, regional approaches are more focused toward land use planning, seeking "smart growth" or regional LID approaches to avoid and minimize storm water and other development impacts.

Purpose and Need for Off-site Storm Water Management

When to Pursue Off-Site Approaches

Off-site approaches to storm water management may be appropriate in the following cases:

- Where on-site LID cannot meet storm water design objectives because of site constraints such as small size, extreme slopes, impermeable soils, etc. Or, where the development plans cannot be designed or modified to effectively integrate LID techniques while still meeting development objectives.
- Where off-site approaches are more cost-effective and efficient. This may be the case where on-site LID is possible, but due to the site constraints identified above, it would only provide limited benefits. Alternatively, off-site approaches may be more advantageous than on-site plans where multiple developments could more effectively pool resources to develop regional solutions.
- Where a combination of on-site and off-site storm water management can yield the greatest benefits.

Municipal NPDES Waiver Program

The municipal Phase 1 NPDES Permit (2009) provides a means for off-site or regional approaches to storm water management. A waiver from permit requirements is allowed where it is infeasible for a specific project to implement appropriate storm water reducing BMPs. A project developer can pay an in-lieu fee, toward a mitigation fund that supports regional or sub-regional storm water mitigation projects. Such projects would:

- Result in equivalent or improved storm water quality,
- Protect stream habitat,
- Be fiscally sustainable and have secure funding,
- Promote cooperative problem solving by diverse interests, and
- Be completed in four years or less including the construction and start-up of treatment facilities.

The NPDES Permit also requires creating a management framework to fund regional mitigation solutions. If an approved watershed management plan, integrated water resources management plan, regional storm water mitigation plan, or wetlands recovery plan exists that can provide storm water management and treatment benefits, then mitigation credit can be applied to an individual project. It is anticipated that developers will be able to mitigate and retrofit for potential storm water impacts on their own properties. A successful off-site mitigation program will require some flexibility in determining appropriate and allowable sites. As such, regional storm water solutions are an important consideration in addition to the on-site treatments emphasized by LID. The off-site, retrofit, and regional approaches presented in this section are consistent with the NPDES waiver program.

Strategies and Considerations for Off-Site Solutions

For an off-site solution to be effective, the solution must align with, and mitigate for, the project impacts. In other words, off-site approaches should address the extent and scale of the on-site project impacts. Ideally, the off-site treatment should also be located within the same general geographic region (or primary watershed) as the impacted site.

In designing off-site solutions, the scale of the impact must be considered. Are project impacts occurring at the parcel, neighborhood, specific plan, or sub-watershed scale? Smaller-scale impacts will be matched with smaller-scale solutions (or may be most practically addressed by an in-lieu fee which is used to fund a larger project). Where multiple parcels or an entire area share impacts, they may be better served by larger sub-regional or regional solutions.

As an example of a parcel-specific solution, consider a site where post-project discharge peaks (for a certain recurrence interval and duration) exceed pre-project conditions and cannot be reduced on-site due to steep slopes surrounding the site’s buildable area which make infiltration, detention, or retention infeasible within the site’s conservation areas. Such a project may seek to find an area lower in the watershed with a gentler gradient that could be used to effectively infiltrate, store, or detain runoff and therefore mitigate for the on-site increases in peak discharge.

At regional scales, larger storm water management facilities become more practical, such as detention basins, larger floodplain conservation areas, or flood control reservoirs that are capable of effectively addressing runoff from larger watershed source areas or multiple developments. Examples of regional storm water approaches are described below in Section 4.5.3.

Multi-Benefit Projects

Off-site solutions also provide opportunities to address multiple objectives beyond storm water. The trend in storm water management in California has moved towards projects which support the concept of integrated regional water management (IRWM). In this framework, projects are designed to not only solve immediate issues related to storm water quantity or quality, but also effectively address other concerns such as water supply, water reuse and recycling, flood control, watershed management, and habitat protection and restoration.

These multiple benefits can be enjoyed regardless of the scale of the solution. For instance, a small-scale vegetated swale that is located off-site may not only slow water velocities and provide water treatment functions, but also provide wildlife habitat and habitat connectivity, and serve as a recreational or aesthetic amenity for the community. Larger-scale solutions often increase the scale of such benefits. For example, the preservation and management of open space in a highly erosive area not only reduces sediment loads to downstream areas, but also provides for habitat amenities, groundwater recharge, and a wide variety of other benefits.

Developers are encouraged to think about the ways in which a project can provide multiple benefits when approaching off-site solutions, and design such solutions accordingly.

Off-Site Retrofit Opportunities

Retrofitting refers to implementing LID techniques and treatments at previously developed sites to reduce storm water impacts. If conditions are right, retrofitting can be a cost-effective means to mitigate impacts that cannot be adequately addressed at the project site. Examples of the LID practices described in this guidebook that can be implemented at already developed sites include roof gardens and vegetated roofs, rain barrels, and replacement of impervious surfaces with pervious surfaces such as permeable pavement. Retrofit opportunities may offer fruitful ways to mitigate storm water impacts and provide benefits to both the on-site developer and the off-site receiver for such retrofits. Retrofitting also effectively integrates a longer-term view of storm water management in which all development—past, present and future—is designed to meet storm water management goals.

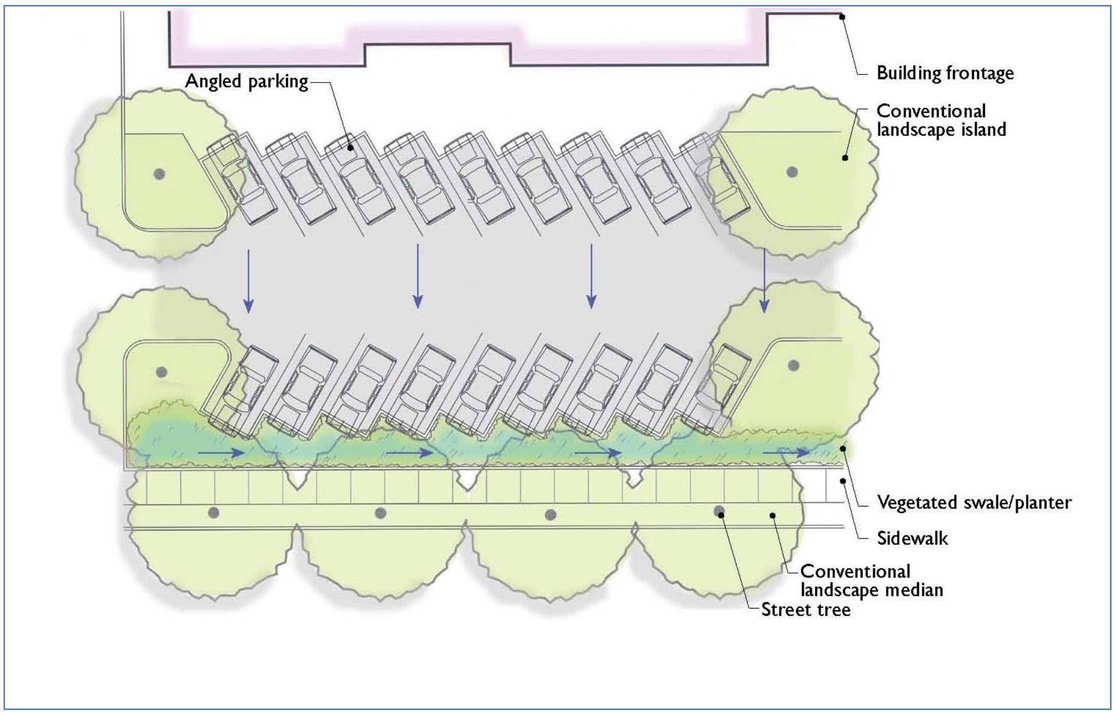
Parking Lots

One promising opportunity in Sonoma County, considering their size and effect on storm water, is the retrofitting of parking lots. Traditional parking lots contain large areas of impervious surface which greatly reduces the time of concentration, reduces runoff duration, increases net runoff volume, and reduces subsurface infiltration and recharge. Additionally, parking lots typically introduce contaminants from automobiles and other sources, such as oil, grease, heavy metals, nutrients, and particulates. Currently in Sonoma County there are a few parking lot retrofit demonstration projects, including at the County Fairgrounds, at the County Administrative Center parking lot, and a few other projects sponsored by Caltrans.

Retrofitting a parking lot can include installation of vegetated drainage swales which can slow and filter storm water, rain gardens, and use of infiltration galleries and basins to reduce the volume of storm water and increase subsurface recharge. For parking lots that drain internally to a drainage point within the parking lot itself, the retrofit opportunities may be more limited, depending upon the parking lot size and graded elevations. Extensive regrading to achieve suitable elevations that enable infiltration would likely make such a project cost prohibitive. In these cases, pervious paving may represent the best and most practical option to reduce runoff, if even limited to a portion of the parking area. Pervious paving can be targeted to particular areas of the parking lot, such as at selected parking stalls, around buildings, at lot boundary areas or margins, or near landscaped areas to achieve targeted results.

Depending on the configuration, gradient, and elevations of the existing parking lot, LID improvements may be relatively easy. For instance, angled parking creates a triangle of unused area at the head of each parking space that can be used for installation of vegetated swales or planters (**Figure 4-20**). Existing islands in parking lots or medians between rows of parking can provide similar opportunities. In some cases, parking spaces can be shortened by several feet to allow for installation of swales or other biofilter-type features. Other opportunities include routing of storm water to an off-site treatment feature such as a constructed wetland, or reconstructing a portion of the parking lot to provide such a feature. Key constraints to LID retrofitting for parking lots include having a suitable gradient and having elevations of potential runoff receiving areas (such as swales) that will enable capture and detention.

Figure 4-20: Vegetated Swale or Planter within Angled Parking Lot



San Mateo Countywide StormWater Pollution Prevention Program 2009

In considering LID retrofit options for parking lots, the lots need to be carefully evaluated for their existing space requirements, entrance and egress requirements, drainage flow lines and patterns, and lot overall design to determine what LID opportunities exist. The retrofit evaluation will consider not only storm water treatment but also the usability of the parking area. At many locations, parking lot capacity exceeds expected daily and even peak use, in which case there is available space for retrofit options. In other instances, the parking lot can simply be reconfigured (e.g., resizing of parking spaces) to allow space for LID features without compromising parking lot capacity. LID features in parking lots need to be carefully designed and sized to accommodate a particular storm event flow, and allow for overflow when an event exceeds the design capacity. Ongoing inspection and maintenance of the retrofits are also required.

Streets and Other Paved Areas

Other regional opportunities to reduce impervious areas and improve storm water quality include retrofitting paved areas throughout a city or large developed areas with permeable paving materials and applying biofilter features (similar to those discussed above) along streets and sidewalks. The site planning and design practices described above in Chapter 4 can be applied at the street-scale, as well as for large business parks or residential complexes. LID retrofit opportunities can be applied to more efficiently utilize street and public rights-of-way for storm water management. For example, underutilized portions of streets and sidewalk areas can be retrofitted with storm water curb extensions and various types of vegetated swales that capture, treat, and even prevent runoff from pervious areas from entering the existing underground storm drainage system. Public spaces such as courtyards between office or residential buildings and walkways can be retrofitted with permeable paving materials, as discussed in the above Fact Sheet on permeable paving. The San Mateo Countywide Storm water Pollution Program's *Sustainable Green Streets and Parking Lots Design Guidebook* (2009) includes many examples of these retrofit techniques.

Regional Approaches

This section provides a general description of the following regional storm water management approaches: dry ponds, multi-objective detention basins, floodplain and channel restoration, constructed wetlands, storm water percolation systems, and watershed source control protection. Taken together, these regional approaches not only provide storm water benefits, but also provide flow management benefits for larger magnitude "flood flows," especially when these approaches are integrated throughout a drainage system or watershed.

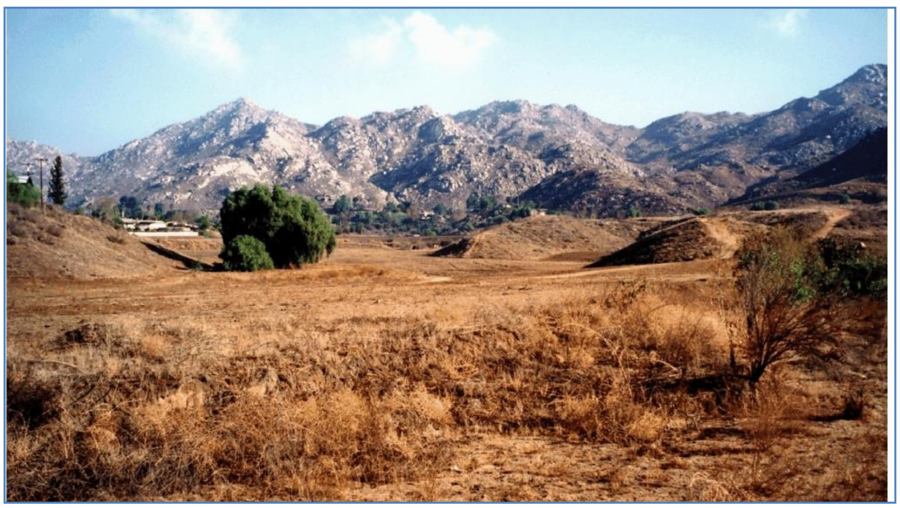
As described above, there may be situations where LID on-site strategies alone cannot fully meet storm water design objectives, including flood management objectives. In such cases it may be more effective to develop regional solutions that can provide flood management for the region in addition to local LID type efforts. These types of regional projects can also be designed to provide other resource benefits such as water supply and water quality benefits as well as open space, habitat protection, and recreational opportunities.

Dry Ponds

Dry ponds are a type of detention basin that are also commonly referred to as dry extended detention ponds, detention ponds, or extended detention ponds. Dry ponds are basins that detain storm water runoff for a minimum duration to moderate discharge peaks and allow sediment particles and associated pollutants to settle out. Dry ponds, in contrast to wet ponds, do not hold a permanent pool of water. Dry ponds can be sized and designed to address higher frequency (lower magnitude) storm water type events, lower frequency (higher magnitude) flood control events, or a range of events. Because of this flexibility, dry ponds are a very widely applied storm water treatment practice.

In general, dry ponds are best used on sites with a minimum drainage area of 10 acres (Center for Watershed Protection 2008). The basin or pond site needs enough elevation change (slope) between pond inlets and outlets to maintain flow through the system. Dry ponds can be constructed in almost all soil and geology types, but the base of the pond should not intersect the groundwater table. Dry ponds or basins that are specifically intended to detain and retain flows and encourage infiltration and groundwater recharge will need to be developed in higher infiltrating/percolating soil and subsurface conditions (**Figure 4-21**).

Figure 4-21: Dry pond detention basin in Riverside, CA receives runoff from steep bedrock watershed areas upstream. This dry pond site provides excellent infiltration capabilities into deep alluvium.



Depending upon land uses in the runoff source areas, the water quality of incoming flows, and/or any known pollutant or contamination issues, interaction between percolation from the pond and the groundwater table below may or may not be desired. In areas with high sediment loads, a sediment forebay is often used above (upstream) of the pond or basin to capture coarse sediments before they enter the main basin. If water quality from the runoff source area is of particular concern, design of the dry pond should seek to maximize retention and detention times as possible. In general, dry ponds and detention basins are effective at physical detention, but in some cases may not provide as effective water quality treatment as smaller scale LID features.

Depending on the pond size, local climate, past storm events, sediment trapping efficiency of the pond, etc., the pond may have variable effectiveness at pollutant removal. Such basins typically require annual maintenance to remove accumulated sediments and clear inlets and outlets of debris or vegetation. Stagnant water can lead to mosquito breeding, especially in ponds with overgrown vegetation and general lack of maintenance. However, dry ponds must be designed to drain within 72 hours of a rainfall event in order to prevent mosquito breeding, and the potential for mosquito-borne disease transmission and/or public health issues.

Multi-Objective Detention Basins

Multi-objective detention basins are similar to dry ponds in that they provide potential storm water, water quality, and flood control benefits. However, they also provide additional water resources, natural resources, recreational, and other land use and educational benefits. Multi-objective basins are specifically designed to address an array of topics and issues. Such basins may be on-line (within the direct flow course of the drainage system, with a more direct hydraulic connection to inflows and outflows), or located off-line (not directly within the flow course of the drainage system, whereby the connection to inflows and outflows is more moderated and managed).

Figure 4-22 shows the completed construction of an award winning multi-objective detention basin design in Placer County by the Placer County Flood Control and Water Conservation District (PCFCWCD). The Miner's Ravine Off-Channel Detention Basin was designed to mitigate increased stormflows in the Dry Creek watershed resulting from upstream development and increased watershed imperviousness over the last few decades. The gravity-draining basin was designed to detain a portion of peak flows for up to six hours without affecting surrounding surface water elevations on the floodplain. Beyond storm water and flood control management, the basin provides several other benefits, including wetlands restoration, floodplain and channel restoration through a levee setback, no fish-trapping effects, native vegetation restoration throughout, a multi-use recreational trail, and interpretive signage. Though the residence detention time is fairly short, the basin promotes and enhances groundwater infiltration and recharge.

Maintenance issues for multi-objective detention basins are similar to those described above for dry pond type basins. However, if the multi-objective basin provides habitat (through enhancement or restoration activities) then the maintenance approach to the basin will need to be sensitive to those habitat requirements.

Figure 4-22: Miner's Ravine Off-Channel Detention Basin, Placer County, CA

Hegedus 2008

In southern Sonoma County, there are a number of existing storm water and/or flood control basins or reservoirs. These include:

- Brush Creek Reservoir,
- Piner Reservoir,
- Matanzas Reservoir,
- Spring Lake Reservoir, and
- Cook Creek Sediment Basin.

The reservoirs listed above provide the benefits of flood control, storm water management, natural resource conservation, and recreation. **Figure 4-23** shows a portion of the Brush Creek Reservoir at its inlet facility and dam. The Cook Creek Sediment Basin is a smaller and more targeted facility, specifically designed to capture sediment delivered from a very erosive headwater source area (**Figure 4-23**). The Cook Creek Sediment Basin has been very effective at trapping sediment, which has reduced the need for sediment removal in downstream flood control channels. By providing a focused location to concentrate sediment removal activities, the Cook Creek Sediment Basin provides a cost-effective strategy to sediment management and reduces high impact maintenance activities in downstream channels. As it is located within the generally coarser sediment and soil conditions of the Rohnert Park area alluvial fan, the Cook Creek Basin is thought to also provide good groundwater recharge benefits.

Figure 4-23: Brush Creek Reservoir provides detention to foothill tributary streams in the Santa Rosa Creek watershed

Figure 4-24: Cook Creek Sediment Basin captures and traps sediment from high yielding headwaters areas

As shown in the topographic map and profiles of **Figures A-1 and A-6** in **Appendix 4**, the rapid break in gradient along the western slopes of Sonoma Mountain, Taylor Mountain, and the southern Mayacamas Range in southern Sonoma County creates a strong need for sediment and runoff management. Flows and sediment are transported from the steeper headwater areas and delivered (or deposited) on the alluvial fans and plains below. Similar to the Cook Creek Sediment Basin, other opportunities for multi-objective basins occur in southern Sonoma County. However, any new basin concepts would likely integrate additional natural resource and groundwater management into the design objectives along with sediment and runoff capture.

Floodplain and Channel Restoration

Channel and floodplain restoration projects can be very effective means to provide regional storm water and flood control management. For floodplains, the general approach is quite simple in theory: let "floodplains act as floodplains" and enable overbank flows to spread from stream channels onto their adjacent floodplains and thereby use the natural detention and storage capacity of the low lying floodplain areas to moderate downstream discharge and water surface elevations. But floodplain restoration is far more involved and difficult in practice due to the myriad of existing flood control facilities that may require alteration, the potential flood threat to other lands, structures, and infrastructure that also may require modification, land ownership issues, zoning, etc.

Agricultural and undeveloped rural lands offer some of the most significant opportunities for successful floodplain restoration projects. In agricultural lands, to maximize the arable growing land, levees or engineered banks were commonly developed to prevent streams from going overbank. The removal or phased setting-back of levees or engineered stream banks can allow localized or widespread floodplain inundation, depending upon local conditions. Floodplain restoration in rural lands also poses fewer flood risks to structures, people, and infrastructure compared to more urban areas. The process of floodplain inundation (if not destructive) is also generally restorative to soil resources, with both agricultural and ecological benefits. Ecologists and environmental regulators are enthusiastic supporters of floodplain restoration because it not only restores a natural area, but also restores the physical processes that can sustain the habitats in those areas and help to stabilize morphology of adjacent stream channels or rivers. A key limit to floodplain restoration in agricultural areas is the willingness of current landowners to sell their properties (to land conservancies) or to enter into easement agreements with a local partnering land use agency that would typically take management responsibility for the restored floodplain.

As described above, floodplain restoration in more urban environments is more difficult due to the presence of existing infrastructure. However, floodplain restoration in urban environments can be achieved. An example of a very successful floodplain restoration project in a semi-urban and agricultural environment is taken from the Napa River Flood Management Plan, a cooperative effort between multiple agencies and led by the Napa County Flood Control and Water Conservation District (NCFCWCD) and the US Army Corps of Engineers (USACE). This far reaching plan (**Figure 4-25**) was based on the "living river concept" to provide the Napa River with as much room as feasible and to re-occupy historic floodplains in the lower watershed. The project involved several engineering works, including the rebuilding of several bridges, roads, and a flood bypass channel. This successful project has won awards and acclaim for improving flood management, lowering the flood risk in the City of Napa, and providing several miles of restored floodplains.

Figure 4-25: Aerial Views of Lower Napa River and Floodplain and the Napa River Flood Project

Napa County Flood Control District 2006

Channel restoration activities can also provide regional storm water and flood management benefits. This typically occurs on a smaller scale than the larger floodplain restoration projects, and involves expanding stream and channel areas that were previously constricted or narrowed through engineered facilities or other channel incision processes. Expanded channel areas that allow flows to expand and spread onto adjacent channel bars and bench features can provide additional runoff storage detention within the channel easement (without involving overbanking onto adjacent floodplains).

In Sonoma County there may be several opportunities for additional stream channel and floodplain restoration projects that would provide the regional benefits of runoff detention and storage, groundwater recharge, and natural resource enhancement and restoration. In addition to floodplain restoration projects, land use planning policies that discourage or prohibit urban development in active floodplains are another means to protect the hydrologic functions of floodplains.

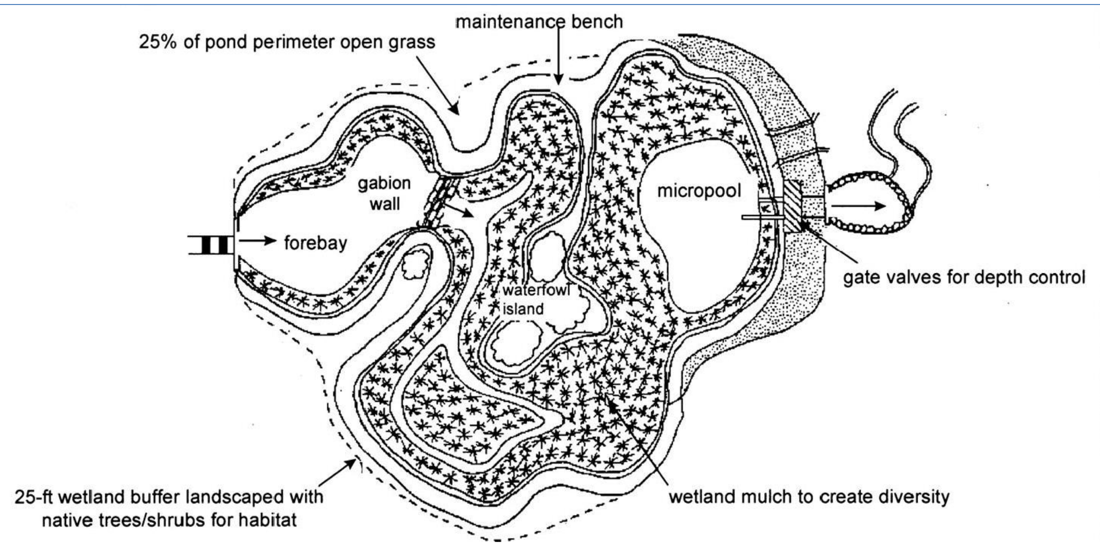
Constructed Wetlands

Constructed wetlands are also known as storm water wetlands or treatment wetlands. They are engineered and designed shallow pools and depressions that incorporate wetland vegetation and attributes to store and detain runoff and also provide water quality treatment (Center for Watershed Protection 2008). Constructed wetlands are especially effective at removing storm water pollutants, including nutrients (nitrogen and phosphorus) and bacteria. Constructed wetlands are fundamentally different from natural wetland systems in that they typically provide less plant and animal biodiversity, and do not typically have underlying soils that contain high levels of organic material. Constructed wetlands have wide application and can be used effectively as a retrofit approach to an existing development or land use.

As illustrated in **Figure 4-26**, a sediment forebay, similar to dry ponds, is an important design consideration to reduce sedimentation and the need for sediment removal maintenance activities. For best results, constructed wetlands need a sufficient drainage area to maintain a shallow permanent pool, and therefore may not work in particular climates or watersheds. For effective water quality filtration, it is recommended that the surface area of the constructed wetland be at least 1% of the source area draining to it (e.g. 100 acre drainage area would require a 1 acre wetland), and the wetland should be 3 times longer than it is wide, with different elevation zones within the wetland to provide different settling areas (Bay Area Storm Water Management Agencies Association 1999).

Constraints for the use of constructed wetlands include the requirement for adequate space, vector control (e.g., the creation of mosquito breeding areas), the potential release of nutrients back into the drainage system during the non-growing season, and very limited groundwater recharge capacity due to the sealing effect of sediment and organic matter (which can accumulate on the wetland substrate over time). Some of these concerns are illustrated in **Figure 4-27**, which shows a constructed wetland in Sonoma County.

Figure 4-26: Example Design Approach for Constructed Wetlands



MWCOG 1992

Figure 4-27: Constructed Wetland in Southern Sonoma County

Southern Sonoma County Resource Conservation District, date unknown

Storm Water Percolation Systems

Storm water percolation systems are designed to allow storm water to penetrate the subsurface zone and thereby recharge groundwater. Prior to the percolation process, collected storm water is typically treated through a settling process (using a swale or sediment basin) to remove finer sediments. Pre-treatment can also include oil separators or other specific water quality treatments, either conventional or bioengineered. The collected storm water is then routed to an infiltration area, usually developed in clean gravel or stone, where the water can infiltrate. Percolation systems can use a vertical infiltration process [including pipes, infiltration wells (or dry wells), and sumps] or a horizontal process (such as French drains and trenches) to accomplish the infiltration.

Use of storm water percolation systems must consider local groundwater use for drinking water supplies, and therefore must be located at a safe distance away from any water supply wells and areas susceptible to a high groundwater table. The effectiveness of storm water percolation systems will greatly depend upon soil, geologic, and topographic conditions. Percolation systems are generally best applied to small sites less than 5 acres that have relatively high impervious cover with excellent infiltration capacity beneath. The system should be constructed so that soil infiltration rates range between 0.5 and 3 inches per hour. In addition, the soils should have no greater than 20% clay content, and less than 40% silt/clay content (Center for Watershed Protection 2008). Storm water percolation systems are relatively expensive to maintain to prevent sedimentation and clogging of the infiltration well. Storm water percolation and injection is also highly regulated by federal and state agencies and requires higher levels of regulatory oversight and coordination than some of the other regional management approaches described in this section.

Figure 4-28 depicts a storm water infiltration well (dry well) installed on a property in Sonoma County. These types of features can provide valuable groundwater recharge benefits and are actively being pursued in Sonoma County, particularly in conjunction with agricultural operations, such as vineyards. The use of dry wells should carefully consider adjacent building's foundations and be located at sufficient distance to prevent any persistent foundation saturation and possible damage.

Watershed Source Control Protection

Another approach to regional storm water management involves land use and watershed management planning efforts to avoid, reduce, and mitigate storm water or flooding effects. Sonoma County and cities within the county have various policies that relate to 100-year flood zones as defined by the Federal Emergency Management Agency (FEMA). Several cities in the County have policies that restrict development in areas along FEMA 100-yr flood zones unless adequate protection for flood hazards is incorporated. This includes the cities of Petaluma, Rohnert Park, and Santa Rosa which require flood protection for new or remodeled habitable structures within such areas along local rivers and creeks (i.e. Petaluma River, Spring Creek, Matanzas Creek, Copeland Creeks, etc). Within unincorporated areas of Sonoma County located in FEMA-mapped 100-year flood zones, a "no net fill[7]" requirement is enforced. Additionally, Policy PS-2f of the Sonoma County General Plan 2020 seeks to reduce fill placement that would impact flood storage or retaining flood water (Sonoma County 2008).

The conservation of watershed lands through protective easements or restrictions on development can minimize runoff impacts or mitigate other watershed sources of storm water runoff. Additionally, restoration activities in watershed lands that reduce existing runoff or sediment yields also provide storm water benefits. This approach can be used for watershed lands in which the soil has historically been compacted, the vegetation removed or thinned, or for local creeks that have been incised and eroded. Restoration projects that return vegetation cover, stabilize incised or eroded creeks, and provide soil benefits that can increase infiltration conditions all help to provide the regional benefits of reducing runoff and stormflows.

[7] Throughout the county, there are different definitions and application of fill policies and requirements. For example, Section 11.16.020 (C)(9) of the Sonoma County Code states that "no fill shall be placed in any special flood hazard area, unless an engineering analysis demonstrates that no reduction in flood storage capacity within the special flood hazard area will result from the fill placement and related improvements." Whereas, the City of Petaluma General Plan, Policy 8-P-33 (A), established the "Zero Net Fill" requirement which includes the area between the 100-year flood elevation and the lowest finished floor elevation (City of Petaluma 2008). The reader is encouraged to confirm requirements of local jurisdictional land use authority (city or county) when working in a floodplain.

Figure 4-28: Infiltration Well Installed in Sonoma County

Southern Sonoma County Resource Conservation District, date unknown

Chapter 5
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Appendix 1

Adopted Conservation Policies

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Adopted Policies

General Plans are long-range comprehensive plans developed for cities and counties that govern growth and development. Typically, city and county general plans contain planning policies on water conservation and measures and ordinances are developed to implement the general plan policies.

Water Waste/ Non-Essential Use Policies

Water Waste ordinances promote water conservation and potable water use efficiency by prohibiting deliberate or unintentional waste when a reasonable alternative solution is available, and by prohibiting use of equipment that are wasteful. These ordinances typically identify and prohibit non-essential uses of water. Some examples include ordinances adopted by the City of Cotati (§13.30.060), City of Petaluma (§15.17.070), City of Rohnert Park (Ordinance 13.62), City of Santa Rosa (Ordinance 14-21), City of Sonoma (§ 13.10.060), and the Town of Windsor (§12.3.361 and 12.3.820).

In general, the water waste and non-essential use ordinances stipulate that water customers must comply with the following regulations and restrictions:

- prohibited actions:
  - direct hosing of sidewalks, walkways, driveways, parking lots and other hard-surfaced areas by direct hosing (except when preventing or eliminating materials dangerous to the public health and safety);
  - irrigating which results in excessive runoff of water or unreasonable over spray of irrigated areas;
  - washing vehicles and machinery directly with a hose not equipped with a shutoff nozzle;
  - using water for non-recycling decorative fountains (new or existing), or in new conveyor car wash systems or industrial clothes wash systems;
  - using water for single pass evaporative cooling systems for air conditioning in all new installations unless required for health or safety reasons;
- Leaks should reasonably be discovered and repaired - generally within a 72 hour period.

The City of Petaluma also prohibits dedicated irrigation accounts from exceeding their allocated water budgets by more than 20% in any billing period. Petaluma also requires the use of covers for all outdoor pools and spas, as well as a pressure-regulating valve where the meter exceeds eighty pounds per square inch.

Exemptions

There are some exemptions to these regulations, including water associated with fire suppression, water quality flushing and sanitation purposes, and water supplied by private wells or from reclaimed water, grey water or rainwater utilization systems.

Enforcement

Depending on the extent of the water waste the municipalities may implement several actions to enforce these ordinances and notify customers in violation. These actions range from written notices, direct contact, installation of a flow-restricting device, penalties, fees and charges, and finally, termination of water service.

Landscaping Standards

Water efficient landscaping ordinances have been adopted by several cities in Sonoma County, including the County itself (Chapter 7D3). Some examples include the City of Sonoma (Ordinance 14.32), City of Santa Rosa (Ordinance 14-30), City of Petaluma (§15.17.050), City of Cotati (Chapter 17.34), the Town of Windsor (Title XII, Article 9), and the City of Rohnert Park (§17.14).

The purpose of these ordinances is to achieve water conservation through proper plant selection, installation, and maintenance practices. The following landscaping principles are common to these ordinances and serve as the primary means of achieving this water conservation. (*Note that the following information is intended to be a summary only, greater detail regarding specific policies can be found by contacting the appropriate agency*)

A. Appropriate planning and design

Prior to installation of the proposed landscape and/or irrigation project water customers are generally required to submit a set of the following plans:

- A landscape or planting plan which indicates the location and square footages of turf, soil amendments, type and quantity of high water use and low water use plants; hardscaped areas; and swimming pools, spas and water features. Plants with similar water use needs should be grouped together in distinct hydrozones. The estimated water use from selected plants must not exceed the maximum applied water allowances.
- An irrigation plan which indicates the type and location of irrigation hardware that will be installed. The description should include the following: location, quantity and type of irrigation device(s) with manufacturer name and rated specifications of gallons per minute of each device; manufacturer's recommended operating pressure in pounds per square inch and precipitation rates for each device. This includes information for

irrigation emission devices, backflow prevention devices, pressure reducing valves, and automatic irrigation controllers.

- If applicable, a grading and drainage plan indicating site elevations may also be required.

B. Limiting turf to locations where it provides functional benefits

A major portion of water demand used for landscape purposes is required for the irrigation of lawn areas. Portions of landscaped areas that have been customarily designed as lawns are generally being discouraged in favor of less water consuming designs.

Municipalities generally prohibit the installation of turf and other high-water-use plantings in areas that cannot be irrigated efficiently. This includes median strips, parking islands, narrow strips, severe slopes (generally exceeding 10%), and beds with sharply curved perimeters. Additionally, some municipalities limit the percentage of turf area allowed within the total developed landscape area. For instance, the City of Petaluma limits the combined turf and high-water use plant area to less than 20%.

However, landscapes that are irrigated with recycled water, or sites requiring large turf areas for their primary functions (e.g., cemeteries, golf courses, parks, playgrounds, schools, and sports fields) are generally exempt or have increased allowances.

C. Efficient irrigation systems

In order to ensure efficient irrigation of landscaped areas, installed automatic irrigation systems must meet the following requirements:

- Electric controller with multiple functions including repeat start time and multiple program potential, set for night or early morning irrigation. Some areas specify the use of automatic irrigation controllers labeled as ET controllers or smart controllers or otherwise have the ability to automatically adjust irrigation start-times, run-times and/or run days based on local or site specific soil moisture levels, weather and/or reference evapotranspiration data;
- Automatic rain shutoff unit for each controller;
- Precipitation rate sprinklerheads where slopes exceed ten percent;
- Efficient sprinklerhead layout and system design for minimum runoff and over-spray;
- Backflow prevention devices installed where required;
- Check valves where elevation differential between heads may cause low-head drainage;
- Matched precipitation rates within each valve circuit;

- Separate valves for turf areas, plantings with similar water needs, exposure variations, and slope variants; and

- Drip irrigation, low-flow point applicator or subsurface irrigation systems, where appropriate (i.e. where slopes are greater than 15%, or where plant height maturity will affect uniformity of an overhead system).

Overhead irrigation must meet the following additional requirements:

- Distance between spray heads on turf shall be between 50% and 55% of the spray diameter; i.e., spray heads on turf are placed for spray radius to achieve head to head coverage;

- Distance between spray heads for non-turf areas shall not exceed 70% of the spray diameter;

- Spray heads must be adjusted so spray radius is within the range of 75% to 100% of the manufacturer's rating for that nozzle and the specified operating pressure shown in the irrigation plans;

- Nozzle precipitation rates for all heads within each valve circuit must be matched to within 20% of one another; and

- Minimum 24 inches set back of overhead irrigation is required where turf is directly adjacent to continuous hardscape that flows into the curb and gutter.

Many policies include provisions which specify that irrigation for decorative water features (e.g., fountains, ponds, pools) must include recirculating water systems.

Some municipalities require that a separate landscape water service meter must be installed for new or altered large-scale landscapes (those generally associated with commercial/industrial uses or multi-family landscapes). This dedicated irrigation meter shall separate all outdoor irrigation water use from all other water use. A water budget may be imposed on such non-residential water meters serving the landscape improvements.

D. The use of soil amendments and use of mulch to improve the structural characteristics of the soil

In order to encourage healthy growing conditions for low-water-use plant materials, site preparation may be needed such as:

- Scarifying of existing soil to a minimum depth of 8 inches;

- Amendment of existing soil with organic matter at a minimum rate of six cubic yards per one thousand square feet; and

- A minimum 8 inches depth of non-mechanically compacted soil shall be available for water absorption and root growth in planted areas.
- Exposed soil surfaces of non-turf areas within the developed landscape area must be mulched with a minimum 3 inch deep layer of organic material (mulch).

E. The use of drought-tolerant plants

Properly managed non-grass landscape developments will typically be able to survive on a reduced water requirement and survive drought conditions better than lawn areas. Planting of low-water-use plant materials and California native plants is highly encouraged. To achieve this, municipalities impose limits on the total area of high-water-use plants and decorative water features allowed.

F. Appropriate and timely maintenance

Landscaping should be maintained in a healthful and thriving condition at all times. This includes regular maintenance of irrigation systems and their components; aerating and dethatching turf areas; adding/replenishing mulch, fertilizer, and soil amendments; pruning; trimming; and weeding all landscaped areas.

Specific Policies

In addition to the above described policies that are common to many municipalities in Sonoma County, numerous additional policies exist that are specific to a particular community. Some examples are presented below.

Sonoma County

Chapter 7D1 – Green Building

This chapter of the County's code of ordinances establishes the adoption of the California Green Building Code provisions for any new residential or commercial buildings within the County which are not otherwise exempt (as defined in § 7D1-2). This chapter also defines the documentation and compliance requirements as well as enforcement.

Town of Windsor

Article 11 – California Green Building Code – Title 24, Part 11

This article established the adoption of the California Green Building Code and making mandatory the measures identified for achievement of Tier 1 (CALGREEN Code Appendix A4 and Appendix A5).

Ordinance 12-3-310: Low Flush Toilets Required

This ordinance requires that all new construction or remodeling of existing structures, requiring the issuance of a building permit, must install "ultra low flush" (1.6 gallon per flush or less) toilet fixtures.

Ordinance 12-7-105: Recycled Water Service Policy

This policy establishes the Town's policy on the use and application of recycled water services. In general, the policy states that the Town will require the use of recycled water in lieu of potable water for residential and non-residential irrigation within the Town's recycled water service area, whenever feasible and consistent with legal requirements, preservation of public health, safety and welfare, and the environment. The use of recycled water can be achieved through an application process and fulfillment of permit conditions.

Ordinance 12-3-825- Prohibition of Non-Essential Use of Water

No water furnished by the Town shall be used for any purpose declared to be non-essential. Further restrictions (both voluntary and mandatory) are defined in this section which apply during Stage 1, 2, and 3 Water Shortage Emergencies.

Ordinance 12-3-830 Signs on Lands Supplied with Private Sources or Supplied With Recycled Water

The owner or occupant of any land within the water service area of the Town that is supplied with recycled wastewater or water from a source not owned or operated by the Town (such as a well, spring or legal surface diversion) which is used to irrigate landscape which is visible to the general public, will be requested to post and maintain in a conspicuous place thereon a sign furnished by the Town fiving public notice of the private supply.

Ordinance 12-3-835 – Use of Sprinklers Conditional

a. Any customer of the Town may use sprinklers to apply water furnished by the Town to irrigate any turf grass, garden, landscaped area, trees or shrubs provided said application is properly controlled and performed in a non-wasteful and efficient manner confined to the nighttime hours of 7:00 p.m. and 9:00 a.m. of the next day. In the event low pressure micro-jet sprayers are present in a drip system, irrigation by the valve(s) controlling same shall also be confined to the nighttime hours noted above.

b. The amount of water normally applied for landscape irrigation shall not exceed eighty (80%) percent (or such percent as specified by resolution). This condition shall not apply to residential customers if Stage 3 allotments are implemented.

c. In determining the amount of water to apply to turf grass, customers are encouraged to use the following formula:

Applied water for turf grass (gallons)=	Area of turf grass (sq ft) x ETo (inches for given period of time – typically 3 to 7 days) x ETo adjustment factor of 0.64 x conversion factor of 0.62

The ETo Adjustment Factor is based on the assumption that overall irrigation efficiency is sixty-five (65%) percent and that the crop coefficient for turf grass is zero point eight (0.8). Use of this formula to determine applied water will yield the appropriate amount of water to apply while rationing is in effect.

Applied water for mixed trees and shrubs (gallons)=	Area of landscape (sq ft) x ETo (inches for given period of time – typically 3 to 7 days) x ETo adjustment factor of 0.48 x conversion factor of 0.62

The ETo Adjustment Factor is based on the assumption that overall irrigation efficiency is sixty-five (65%) percent and that the crop coefficient for mixed trees and shrubs is zero point six (0.6). Use of this formula to determine applied water will yield the appropriate amount of water to apply while rationing is in effect.

d. In determining the amount of water to apply to landscaped areas containing a mixture of trees and shrubs, customers are encouraged to use the following formula:

e. Water applied by sprinklers shall be applied in short enough cycles to avoid run-off to gutters and drains.

f. During the suspension period, use of water by sprinklers is a privilege and permission to use water in this way may be withdrawn if it comes to the attention of the Town Engineer that such use by a given customer is wasteful or in excess of the amount determined in subsection b of this section. A common result of wasteful application of water by sprinklers is evidence of runoff to a gutter.

City of Cotati

§ 13.64.030: Conservation Devices--Required for New Construction

Under this ordinance, all toilets in any and all new construction and any project involving remodel of a bathroom(s) shall use no more than 1.28 gallons per flush or less and conform to the U.S. EPA WaterSense specifications. Those who install these ultra low flush toilets are eligible for a rebate of $150 from the City following a post installation visit.

§ 13.64.040: Credit for installation of Water Sense toilets.

A $150 rebate will be given to the property owner for the replacement of each toilet using 1.6 gpf or more with one that uses 1.28 gpf or less and conforms to the U.S. EPA WaterSense specifications.

Chapters 13.72 and 13.73: Water Conservation Toilet Retrofit

All existing toilet fixtures in pre-1992 residential and non-residential structures receiving water from the City's water system must be retrofitted, exclusively with a WaterSense (1.28 gpf or less) toilet at the time of water service change. Once completed, a certificate of retrofit compliance will be placed on file with the City.

Generally, the property owner will have sixty days from the date of request for change of water service to certify compliance with this chapter..

City of Healdsburg

Chapter 15.16 Green Building Program

This Chapter of the municipal code formally adopts Part 11 of Title 24, California Code of Regulations “2010 California Green Building Standards Code” including Appendix A-4 Tier 1 and Appendix A-5 Tier 1.

Chapter 17.12.080 Water Shortage Emergency Plan

The city has developed a water shortage emergency plan that establishes different levels of water conservation during a water shortage emergency resulting from a reduced supply of water such as may result from drought, water supply shortages or limitations of water delivery conditions. The city council may enact different levels of conservation measures depending on the water shortage: Stage 1 - voluntary conservation; Stage 2 - mandatory compliance-water alert; or Stage 3 mandatory compliance-water emergency. Repercussions for non-compliance range from issuance of fines to termination of water service.

City of Sonoma

§14.10.050–2010 California Green Building Standards Code amendments

The City adopts the 2010 California Standards code with further amendments. The City amends the definition of “newly constructed” and also requires the measures necessary to achieve Tier 1 status to be mandatory (as opposed to voluntary).

§ 14.32.100 Requirement for Separate Water Meters

In all new commercial development subject to the provisions of this chapter, a separate water meter is required for the purpose of landscaping. A separate water meter is also required for common areas associated with new residential condominiums and planned unit developments.

City of Rohnert Park

§ 13.62.040 Recycled Water Service Required

Under this ordinance, all new applicants for water service whose properties may be served by recycled water, must connect their property to recycled water service for those uses for which the use of potable domestic water would be deemed a waste or unreasonable use of water Failure to do so may result in the termination of the customer's potable water service.

§15.26.010 – Adopted – California Green Building Standards Code, Title 24 Part 11

The 2010 Edition of the California Green Standards Code, Part 11 of Title 24, including Appendix Chapter A4, Residential Voluntary Measures at Tier 1 Level and Appendix Chapter A5, Nonresidential Voluntary Measures at Tier 1 level, are adopted by the City by reference.

City of Petaluma

Chapter 15.17 of the Petaluma Municipal Code contains the City’s Water Conservation Regulations Ordinance. This chapter promotes the efficient use and reuse of water by all City of Petaluma water service customers by requiring that all new construction projects and existing customers use water as efficiently as possible and comply with new development standards, landscape water use efficiency standards and water waste prohibition regulations. Below is a summary of these regulations.

§ 15.17.030 Development Standards

The development standards established in this section apply to all new commercial, industrial, institutional, agricultural, single-family and multifamily residential construction, including tenant improvements or a change in use requiring any city entitlement or permit for existing commercial, industrial and institutional accounts. The development standards are intended to ensure that all installed water using fixtures, appliances, irrigation systems, and any other water using devices apply water as efficiently as possible.

Indoor Water Use Development Standards—New Residential Construction. Any water using device installed in any new development shall meet the standards of the California Plumbing Code (Part 5, Title 24, California Code of Regulations), and the following.

- Single Family
  - Water closets must be an approved high efficiency toilet (HET) as designated on the City's list of qualifying HETs.
  - Showerheads must not use more than two gallons per minute. Where more than one showerhead exits in a shower unit, each showerhead must be plumbed so that each showerhead can be turned on and off independently from each other.
  - Any clothes washing machine provided with the residence must have a water factor of six or lower.
  - Lavatory and/or bar faucets must not exceed 1.5 gallons per minute.
  - Kitchen and/or utility sink faucets must not exceed 2.2 gallons per minute.
  - All dishwashers must have the EPA's Energy Star label.
- Multifamily Residential Dwellings
  - Water closets must be an approved high efficiency toilet (HET) as designated on the City's list of qualifying HETs.
  - Showerheads must not use more than two gallons per minute. Where more than one showerhead exits in a shower unit, each showerhead must be plumbed so that each showerhead can be turned on and off independently from each other.
  - Any clothes washing machine installed on the premises must have a water factor of six or lower.

- Lavatory and/or bar faucets must not exceed 1.5 gallons per minute.
- Kitchen and/or utility sink faucets must not exceed 2.2 gallons per minute.
- All dishwashers must have the EPA's Energy Star label.
- Each dwelling unit must be separately metered or sub-metered.

Standards for Commercial, Industrial, or Institutional (CII) Accounts that are new, undergoing renovations, improvements, or change in use must comply with the following:

- Toilets and/or urinals must be an approved high efficiency toilet (HET) as designated on the City's list of qualifying CII HETs.
- Showerheads must not use more than two gallons per minute. Where more than one showerhead exits in a shower unit, each showerhead must be plumbed so that each showerhead can be turned on and off independently from each other.
- Commercial clothes washing machines shall have a water factor of 4.5 or lower.
- Lavatory faucets must be self-closing and not exceed 1.5 gallons per minute. All faucets must be equipped with an aeration device.
- Kitchen and/or utility sink faucets must not exceed 2.2 gallons per minute. All faucets must be equipped with an aeration device.
- Dishwashers must have the EPA's Energy Star and/or Water Sense designation and must recycle the final rinse into the next wash cycle.
- Pre-rinse hand-held dish-rinsing wands must not exceed 1.6 gpm and must utilize positive shut-off valves.
- Ice makers must be air-cooled.
- Any other water-using apparatus not mentioned above must use or reuse water as efficiently as possible and must be approved by the city prior to installation.

§ 15.17.040 Standards for New or Renovated Vehicle Wash Facilities

- Vehicle wash facilities using conveyorized, touchless, and/or rollover in-bay technology shall reuse a minimum of 50% of water from previous vehicle rinses in subsequent washes.
- Vehicle wash facilities using reverse osmosis to produce water rinse with a lower mineral content shall incorporate the unused concentrate in subsequent vehicle washes.
- Self-service spray wands shall emit no more than three gallons of water per minute.

§ 15.17.060 Water budgets for new and existing dedicated irrigation accounts.

Dedicated irrigation meter(s) will be provided with a landscape water budget. The water budget will be calculated by the City or its agent by measuring the total irrigated landscaped area and the plant type(s) that exist per water meter. Any account assigned a water budget may not exceed the water budget for that billing period by more than 20% during that billing period. Violators will be notified and corrective actions will be taken by the City.

City of Santa Rosa

14-25 Recycled Water Regulations. This chapter specifies and defines the City's regulations on the development of and authority to enforce recycled water usage. The following is a summary of some of the included policies:

§ 14-25.040 Requirement to use recycled water.

The City reserves the right to require all customers who connect to the City's water system on or after October 19, 2007 to use recycled water in-lieu of potable water for all approved uses.

§14-25.050 Recycled Water User's Guide

Describes the Guide which details the requirements of rules and regulations for the City's recycled water system.

§14-25.050 *Recycled* Water User's Guide

The City will issue to each recycled customer a Recycled Water Use Permit for each site, which grants permission to use recycled water and requires the customer to use recycled water in accordance with the rules, regulations and standards of the Recycled Water User's Guide and all applicable state and local rules and regulations.

References

City of Cotati municipal code
http://www.codepublishing.com/CA/Cotati/

City of Healdsburg municipal code
http://www.codepublishing.com/CA/healdsburg/

City of Rohnert Park municipal code
http://library.municode.com/index.aspx?clientId=16586

City of Santa Rosa municipal code
http://qcode.us/codes/santarosa/view.php

City of Sonoma municipal code
http://codepublishing.com/ca/sonoma/

City of Petaluma municipal code
http://www.codepublishing.com/CA/Petaluma.html

Sonoma County Municipal Code
http://library.municode.com/index.aspx?clientId=16331

Appendix 2

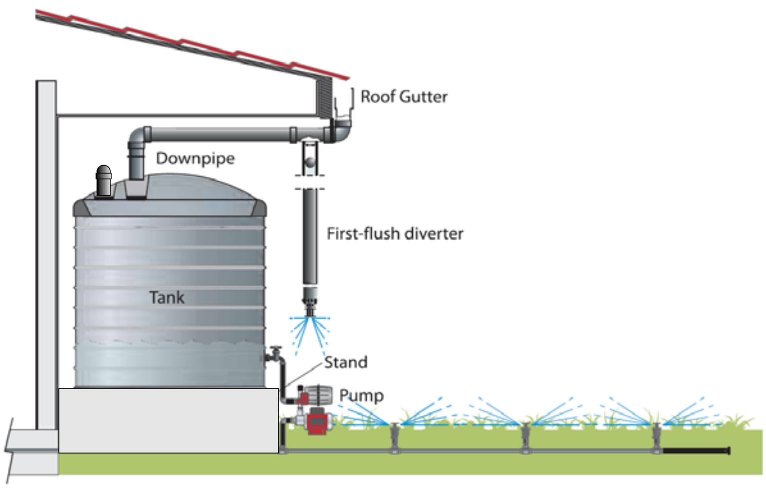
City of Sonoma Rainwater Harvesting & Storage Systems Handout

Rainwater Harvesting & Storage Systems

Handout No: 36
Revised: 9/22/09

Rainwater Harvesting

Rainwater harvesting is the capture, diversion and storage of rainwater for use in landscaping and other purposes. Collection of rainwater is usually from rooftops which is stored in catchment storage tanks. Stored water can be used for nonpotable purposes such as irrigating landscaping, washing cars or possibly even flushing toilets. Rainwater harvesting systems can range from a simple barrel at the bottom of a downspout to multiple large tanks with pumps and controls.



Rainwater Harvesting System Limitations

Most rainwater harvesting systems are used exclusively for landscaping irrigation purposes. A building permit is usually required for the installation of large storage tanks, distribution systems, pumps and backflow prevention devices associated with a rainwater harvesting system. A building permit is always required if the rainwater storage and distribution system is proposed for use inside of a building. Currently, the State of California has not adopted rainwater harvesting standards for use in buildings. Section 601.1 of the California Plumbing Code requires that plumbing fixtures including toilets, urinals washing machines and floor drains, be connected to an "adequate supply of potable running water" unless the City determines that it is not necessary for safety or sanitation reasons. Given that there are cities within the United States and other countries that have safely allowed the use of rainwater for fixtures such as toilets, urinals, washing machines and trap primers in floor drains, the City of Sonoma Building Department will review and determine the acceptability of such requests on a case-by-case basis when designed by a licensed California Mechanical Engineer that specializes in plumbing or rainwater systems. The installation of a rainwater system within a building requires separate and identifiable piping systems for both the nonpotable rainwater system and the potable City water system to prevent contamination between them.

Requirements for Rainwater Harvesting and Storage Systems

<u>Zoning.</u> Rainwater storage barrels are containers with a volume of 80 gallons or less. Larger storage tanks are considered structures for the purposes of determining City zoning and setback requirements. The following enumerates some of the City's zoning requirements:

<u>Setbacks for Residential Uses.</u>

- A rainwater storage barrel with a volume of 80 gallons or less may be placed below downspouts around a building without considering front, side or rear yard building setback requirements. *[Planning Department Interpretation]*
- Rainwater storage tanks that do not exceed 8 feet in height above finished grade and do not exceed 120 square feet in area may be placed immediately adjacent to a side or rear property line. *[Sonoma Municipal Code Section 19.50.080.C.2.b.]*
- Rainwater storage tanks not exceeding 9 feet in height above grade that are separated from other buildings on the property by a 6 foot wide or more open yard may be placed as close as 5 feet to a side or rear property line. *[Sonoma Municipal Code Section 19.50.080.C.5. and 19.50.080.C.2.a.]*
- Aboveground storage tanks are prohibited in required front and street-side setbacks, and in designated creek setback areas. *[Sonoma Municipal Code Section 19.50.080.C.3.]*
- Aboveground rainwater storage tanks not meeting the above requirements must comply with the building setback requirements set forth in the Article III of the City's Development Code for the zoning district in which it is located. *[Sonoma Municipal Code Section 19.40.110.A.1]*

<u>Setback and Design Review Requirements for Nonresidential Uses.</u>

- A rainwater storage barrel with a volume of 80 gallons or less may be placed below downspouts around a building without considering front, side or rear yard building setback requirements. *[Planning Department Interpretation]*

- Rainwater storage tanks not meeting the above requirements must comply with the building setback requirements set forth in the Article III of the City's Development Code for the zoning district in which it is located. *[Sonoma Municipal Code Section 19.40.110.A.1]*
- Aboveground rainwater storage tanks for nonresidential uses are prohibited in required front and street-side setbacks, and in designated creek setback areas. *[Sonoma Municipal Code Section 19.40.110.A.3, 19.40.110.E. and 19.40.020.D.2]*
- Design Review Approval is required for aboveground rainwater storage tanks for which a building permit is required. *[Sonoma Municipal Code Section 19.54.080.B.2]*
- Design Review Approval is required for rainwater storage tanks located in public view. *[Sonoma Municipal Code Section 19.54.080.B.2]* EXCEPTION: Design Review Approval will not be required for single rainwater storage barrels with a volume of 80 gallons or less and placed below downspouts around a building. *[Planning Department Interpretation]*

Permits. A City building permit is required for rainwater harvesting and storage systems under any of the following circumstances:

- If the property is connected to the City's water system and the total combined stored water capacity for the rainwater system exceeds 500 gallons. *[Installation and inspection of a cross-connection control device near the City water meter is required in accordance with Sonoma Municipal Code Section 13.20.030. and City Standard Plan #213]*
- If the storage tank is not supported directly by the ground or concrete slab or is supported by a raised platform or other structure. *[1997 Uniform Administrative Code – 301.2.1]*
- If the size of a water storage tank exceeds 5,000 gallons or the ratio of height to width of the tank exceeds 2:1. *[1997 Uniform Administrative Code – 301.2.1]*
- If electrical pumps, electrical valves or electrical controllers are installed, unless they are cord and plug connected or operate at less than 25 volts and not capable of supplying more than 50 watts. *[1997 Uniform Administrative Code – 301.2.3]*
- If any portion of the rainwater harvesting system is proposed to be used or located inside of a building or for supplying toilets, urinals, trap primers or washing machines. *[2007 California Plumbing Code 601.1]*
- If the rainwater storage tank will be installed below or partially below grade. *[2007 California Building Code Appendix J103.1.]*

Other Requirements and Considerations for Rainwater Harvesting Systems.

- Untreated rainwater may contain contaminants and is considered nonpotable water. Non potable water piping must be exposed to view and must be marked every 20 feet with a yellow identification band and labeled "CAUTION: NONPOTABLE WATER, DO NOT DRINK." Discharge outlets must be exposed to view and must be labeled with the international symbol for nonpotable water and the words "CAUTION: NONPOTABLE WATER, DO NOT DRINK." *[2007 California Plumbing Code 603.4.11 and 601.2.2]*

- Rainwater harvesting systems may not be directly connected to other potable water sources such as the City supplied domestic water system or a well serving the home or business. *[2007 California Plumbing Code 602.4]*

- For above-ground water storage tanks exceeding 5,000 gallons or if the ratio of height to width of a tank exceeds 2:1, an engineered pad base and adequate anchorage system must be provided. *[2007 California Building Code Chapter 16 and Section 1604.1]*
- Rainwater storage tanks installed below grade must be adequately tied down and anchored to prevent lifting caused by groundwater.
- Rainwater storage tanks must be provided with pressure relief mechanisms and tank overflows to prevent tank pressure build-up and to provide an overflow route should the tanks fill to capacity.
- The rainwater harvesting system should be designed as an integrated solution incorporating collection, contaminant removal, pumping, control and reticulation. Rainwater tanks should be well sealed, maintainable and be provided with first-flush devices and filters to keep out leaves and other contaminants. Inlet and overflow screens should be provided to prevent access of mosquitoes and other insects and vermin. Provisions should be made for periodically draining and cleaning the rainwater storage tanks of siltation and other contaminants.

- It is important that a rainwater harvesting system be designed to prevent growth of algae and other organisms in the system. Good aeration and circulation of water, no sunlight on water and keeping leaves and organic matter in the water to a minimum will help to reduce the growth of algae.
- The rainwater harvesting system should be properly sized. Variables such as available capture area, storage availability, spring-time average rainfall and usage requirements must be considered to properly design a system.
- For automated irrigation and distribution systems, consideration should be given to providing makeup water to the tank from sources other than rainwater (i.e. City or well water).

Rainwater Harvesting Resources

- San Francisco Public Utilities Commission Web Site: http://sfwater.org/mto_main.cfm/mc_id/14/msc_id/361/mto_id/559
- American Rainwater Catchment Systems Association: http://www.arcsa.org/

For further questions, please contact the City of Sonoma Building Department at 707-938-3681.

Appendix 3

Water Smart Project Review Checklists:

Checklist 1 – Water Conservation

Checklist 2 – Water Reuse Planning

Checklist 3 – Project Site Planning

Checklist 1 – Water Conservation Checklist

This water conservation checklist is intended to support the local (city/county) review and approval process for proposed development projects in Sonoma County. This is the first of three checklists developed to provide guidance on implementation and tracking of the recommended water conservation, water reuse, and stormwater management actions presented in the Water Smart Development Guidebook. Evaluation of the content in all three checklists is recommended to ensure comprehensive evaluation and application of the guidebook recommendations for individual projects.

However, local entities are encouraged to develop their own specific checklists to achieve local development objectives. These template checklists are provided as a reference for local communities to refine or further develop their own checklists.

The intended users of this checklist include developers, county and municipal planners, water agency staff, and regulatory personnel who may be engaged in project development or review capacities. Part A of the Checklist includes questions related to development site planning, while Part B is intended to document water conservation features incorporated into the project.

Part A. Development Site Planning

Check the applicable box for each item listed below. For each topic, a brief statement should describe how or why these issues were considered (or not considered).

	Yes	No	**Explanation** *(how, why or why not)*
Development Site Planning			
Is the proposed project consistent with the General Plan Land Use map?			
Is there available potable water supply available for this project?			
Is there available recycled water to supply this project?			
Site Layout and Building Design			
Site Layout			
Has the Stormwater Project Site Planning and Assessment checklist been completed (see Checklist 3)?			
Does the site layout consider sun aspect and other local climate factors and their effect on water use?			
Does site landscaping comply with the local Water Efficient Landscape Ordinance?			

Interior Design			
Is the plumbing designed to maximize water conservation (kitchens, bathrooms, laundry rooms located closest to the water heater)?			
What additional features are included in the site layout to conserve water beyond the minimum requirements?			
Building Fixtures and Appliances			
Does the project comply with state and local Building and Plumbing Codes standards related to water conservation?			
Are the most efficient water fixtures and appliances incorporated into the project?			
Monitoring and Maintenance			
What monitoring and maintenance features will be installed or implemented for the project to ensure proper function of water conserving devices?			
▪ Interior monitoring and maintenance			
▪ Exterior (landscaping) monitoring and maintenance			

This checklist is to be used in conjunction with Part A to document further details of water conserving components of the proposed project.

Part B. Project Water Conservation Checklist

This checklist presents water conserving fixtures and appliances for consideration in development projects. A more complete description of these features is provided in Chapter 2 of the Water Smart Development Guidebook. Check the applicable box for each item listed below. Provide a brief explanation of the fixtures and appliances incorporated in the project and how much water they might use. Incorporation of recycled water features should be documented on Checklist 2 *Water Reuse Checklist*.

	Considered for Project? (Y/N)	**Number of Units Installed**	**Water Use per Unit**	**Comments**
Interior				
Toilets 1.28 gpf or less				
Urinals 0.5 gpf or less				
Bathroom Sink Faucets 1.5 gpm or less				
Showers 1.5 gpm or less				
Clothes Washing Machine 4.5 gallons per cycle per foot or less				
Dishwashers 4.5 gallons per cycle or less				
Commercial or Medical Appliances				
Other Interior Fixtures				
Exterior				
Smart Controllers				
Rain Sensors				
Water Budget				
Other				

Checklist 2 - Water Reuse Planning

The following checklists support the water reuse planning concepts described in Chapter 3 of the Water Smart Development Guidebook. The intended users of this checklist includes developers, county and municipal planners, water agency staff, and regulatory personnel who may be engaged in project development or review capacities. There are two parts to this checklist: Part A *Consideration of Water Reuse in Project Planning* and Part B *Planned Water Sources for Demands Eligible for Water Reuse*.

A. Consideration of Water Reuse in Project Planning

Check the applicable box for each item listed below. For each topic, a brief statement should describe how or why these issues were considered (or not considered)

	Yes	No	Comments
Water Reuse (General)			
Most projects can incorporate some form of water reuse. The following questions regarding water reuse should be considered in project planning. These questions apply to all types of water reuse.			
(a) Demands for Non-Potable Water			
▪ **Landscape Irrigation:** Does the project include landscaping (plants) that need to be irrigated or decorative water features such as fountains or ponds? *(Landscape irrigation is the most common application of water reuse)*			
▪ **Toilet Flushing:** Does the project include installation of or upgrades to restrooms? *(Under the right conditions, toilet flushing is an excellent application for water reuse. However, indoor water reuse is currently not allowed in Sonoma County. These regulations may change in the near future, and so this option is included on this checklist.)*			
▪ **Industrial Processes, Cooling Towers and Other Water Demands:** Does the project include industrial processes, cooling towers, or other water demands that could be served by non-potable water? *(For example, a car washing facility could potentially use non-potable water)*			
If the answer to any of these questions is "yes", the project could potentially incorporate water reuse. The questions below will help to determine what types of water reuse might be suitable for a given project.			

	Yes	No	Comments
Rainwater Harvesting			
(a) Sources of Rainwater for Reuse			
▪ Are existing buildings present on the project site or are new buildings planned as part of the project or are other impermeable areas included in the project? *(Roofs are the most common "catchment areas" uses in rainwater harvesting but other impermeable areas such as non-vehicular paved areas may be used as catchment areas)*			
▪ Can a rainwater storage tank be accommodated on the project site? *(Rainwater storage tanks vary in size from less than 50 gallons to more than 5,000 gallons and can be installed above or below ground so most sites have sufficient space for rainwater storage tanks)*			
(b) Reuse Applications of Rainwater			
▪ **Landscape Irrigation:** Does the project include landscape irrigation? *(Landscape irrigation is the most common way to use harvested rainwater)*			
▪ **Toilet Flushing:** Does the project include installation of or upgrades to restrooms? *(Systems that use rainwater for toilet flushing have been installed in several California areas. Check with local authorities for permitting requirements in your area. Indoor water reuse is currently not allowed in Sonoma County. However, these regulations may change in the near future, and so this option is included on this checklist.)*			
▪ **Industrial Processes, Cooling Towers and Other Water Demands:** Does the project include industrial processes, cooling towers, or other water demands that could be served by rainwater?			

	Yes	No	Comments
Graywater Use			
(a) Sources of Graywater for Reuse			
▪ Does the project include laundry facilities? *(Some of the most straightforward graywater systems are residential "laundry-to-landscape" systems that direct water from clothes washers to suitable outdoor landscaped areas. Check with local authorities for permitting requirements in your area. Indoor water reuse is currently not allowed in Sonoma County. However, these regulations may change in the near future, and so this option is included on this checklist.)*			
▪ Does the project include bathroom sinks and/or showers? *(The plumbing for a graywater system that collects water from sink and shower drains is generally more extensive than the plumbing for a "clothes washer" system? Check with local authorities for permitting requirements in your area. Indoor water reuse is currently not allowed in Sonoma County. However, these regulations may change in the near future, and so this option is included on this checklist.)*			
▪ Does the project include the use of water in industrial processes? *(Depending on the water quality, it may be feasible to collect and reuse industrial process water on-site)*			
(b) Reuse Applications of Graywater			
▪ **Landscape Irrigation:** Does the project include landscaping that can be irrigated with subsurface irrigation? *(Per the 2010 Graywater Standards, untreated graywater can only be used for landscape irrigation. The irrigation lines must be under at least 2 inches of cover.)*			
▪ **Toilet Flushing:** Can the project's graywater be treated and used within the building to meet water demands such as toilet flushing? *(Check local guidelines for the requirements for treatment of graywater for indoor use. Indoor water reuse is currently not allowed in Sonoma County. However, these regulations may*			

change in the near future, and so this option is included on this checklist.)			
▪ **Industrial Processes, Cooling Towers and Other Water Demands:** Does the project include industrial processes, cooling towers, or other water demands that could be served by treated or untreated graywater?			

	Yes	No	Comments
Water Recycling (Municipal Recycled Water)			
(a) Sources of Municipal Recycled Water			
▪ Is the project located near an existing or planned recycled water distribution pipeline? *(Check with local authorities to find out the locations of existing and planned recycled water pipelines)*			
(b) Reuse Applications of Municipal Recycled Water			
▪ **Landscape Irrigation:** Does the project include landscape irrigation?			
▪ **Toilet Flushing:** Does the project include installation of or upgrades to restrooms? (Toilet flushing is an approved use of recycled under Title 22. However, check with local authorities for permitting requirements in your area. Indoor water reuse is currently not allowed in Sonoma County. However, these regulations may change in the near future, and so this option is included on this checklist.)			
▪ **Industrial Processes, Cooling Towers and Other Water Demands:** Does the project include industrial processes, cooling towers, or other water demands that could be served by recycled water?			

	Yes	No	Comments
On-Site Wastewater Treatment and Reuse			
(a) Sources of On-Site Recycled Water			
▪ Does the project include larger buildings that generate wastewater and have sufficient space for an on-site wastewater treatment plant?			
▪ Are project buildings frequently occupied? (On-site wastewater treatment plants need fairly consistent inflow in order to operate properly)			
(b) Reuse Applications of On-Site Recycled Water			
▪ **Landscape Irrigation:** Does the project include landscape irrigation?			
▪ **Toilet Flushing:** Does the project include installation of or upgrades to restrooms? (Toilet flushing is an approved use of recycled water under Title 22). However, check with local authorities for permitting requirements in your area. Indoor water reuse is currently not allowed in Sonoma County. However, these regulations may change in the near future, and so this option is included on this checklist.			
▪ **Industrial Processes, Cooling Towers and Other Water Demands:** Does the project include industrial processes, cooling towers, or other water demands that could be served by recycled water?			

B. Planned Water Sources for Demands Eligible for Water Reuse

This form records the planned water sources for typical water demands that can be met through water reuse. Write the estimated volume or rate (e.g., gallons per day) of water reuse in the applicable box or boxes for each item listed below. A brief explanation of why a particular water source was selected for a particular demand should also be included.

	Rainwater	**Graywater**	**Municipal Recycled Water**	**On-Site Recycled Water**	**Potable Water (Public system)**	**Groundwater (on-site well)**	**Explanation** *(why this water source was chosen)*
Landscape Irrigation							
Toilet Flushing							
Industrial Processes, Cooling Towers and Other Water Demands							

Checklist 3 – Project Site Planning

The Project Site Planning checklist below supports the site development planning process described in Chapter 4 of the Water Smart Development Guidebook. The intended users of this checklist include developers, county and municipal planners, water agency staff, resource managers, or regulatory personnel who may be developing or reviewing projects.

This *Project Site Planning and Assessment* checklist is intended to complement the discussion presented in Chapter 4 of the Guidebook. More specifically, the checklist below was developed to help project proponents or reviewers organize several of the key considerations for stormwater management during the site development process.

The checklist below is also offered as complementary reference to the CoPermittee's LID Technical Design Manual. The checklist below is not intended to replace any aspect of the CoPermittee's LID Technical Design Manual. For projects that require direct compliance with NPDES permit regulations for the Phase 1 MS4 area, the CoPermittee's LID Technical Design Manual is the primary regulatory guidance document and should be consulted to determine the appropriate level of information needed for project compliance and approval.

The LID Technical Design Manual is available at: www.srcity.org/stormwaterLID.

The LID Technical Design Manual website should be reviewed to obtain the latest information on LID regulatory compliance measures in the 2009 NPDES permit area. LID regulatory compliance measures in other parts of the county may differ and the local storm water management entity should be contacted to obtain the most current and detailed information on LID requirements.

Project Site Planning and Assessment Checklist

Check the applicable box for each item listed below. For each topic, a brief statement should describe how or why these issues were considered (or not considered).

	Yes	No	Explanation *(how, why or why not)*
Site Assessment and Preliminary Site Plan			
Did the site assessment and planning process assess the following baseline conditions in terms of opportunities or constraints for LID applicability?			
(a) Topography and Drainage:			
▪ Evaluation of slope and drainage as suitable for LID?			
▪ Evaluation of watershed setting: upper watershed, mid-watershed, or lower watershed and general depositional or erosional trends?			
▪ Areas of slope instability?			
▪ Areas in a seismic or liquefaction hazard zone?			
(b) Surface Hydrology:			
▪ Do you know the average annual precipitation at site and design precipitation amounts for a range of storm events, for example 30-min, 1-hr, and 24-hr rainfall amounts for 2-yr and 10-yr return intervals?			
▪ Mapping of existing on-site drainage features, site runoff patterns, areas of potential ponding, runoff delivered from elsewhere?			

	Yes	No	Explanation *(how, why or why not)*
(c) Soil and Infiltration			
▪ Soil types, structures, and texture?			
▪ Hydrologic soil groups on-site?			
▪ Known or measured infiltration capacity?			
▪ Quality of existing top-soil?			
(d) Groundwater			
▪ Depth to groundwater? (including consideration of seasonal variations)			
▪ Evidence of features that rely on shallow groundwater levels (wetlands, pools, etc.)?			
▪ Existing groundwater contamination or potential for proposed land use to influence groundwater quality?			
▪ Groundwater recharge area on-site?			
(e) Wetlands, Ponds, and Floodplains			
▪ Wetlands and/or ponds on-site?			
▪ Wetland and/or pond water sources?			
▪ Wetland and/or pond hydroperiod?			
▪ Site located within a floodplain or channel migration zone?			

	Yes	No	Explanation *(how, why or why not)*
(f) Vegetation, Riparian Resources, and Other Habitats			
▪ Types and condition of vegetation on-site?			
▪ Special-status, invasive, or exotic vegetation?			
▪ Riparian habitat on-site? If so, what are the hydrologic pathways that support this habitat?			
▪ Habitat for species protected under the federal or state Endangered Species Acts?			
(h) Water Quality			
▪ If present, what are the Beneficial Uses of on-site or directly connected water bodies? And are any of them impaired?			
▪ Water quality data from those water bodies?			

	Yes	**No**	**Explanation** *(how, why or why not)*
(g) Land Use			
As described in the LID Guidebook, was consideration given to:			
▪ Existing or Prior Land Uses?			
▪ Surrounding Land Uses?			
▪ Clustered Development?			
▪ Footprint Minimization?			
▪ Site Disturbance Minimization?			
▪ Pedestrian-oriented Infrastructure?			
▪ Utilities/ Infrastructure Safety Requirements?			
▪ Easements?			
▪ Setbacks?			
▪ Legacy soil or groundwater contamination?			
Were any of the following conservation areas included in the site plan, and if so please explain how they were identified/developed:			
▪ Common open space among or within developed sites?			
▪ Conservation areas on individual lots?			
▪ Conservation areas on individual lots that connect to adjacent lots or common conservation areas?			
▪ Riparian conservation or other habitat areas?			

Preliminary Planning Plan The following questions help to assess the suitability of selected species and vegetation placement for the development.			
	Yes	**No**	**Explanation** *(how, why or why not)*
Does the plan consider:			
Available growing space, growth rate, and life span of trees			
Type of soil and water availability for vegetation			
Evapotranspiration productivity during rainy season (Nov – April)			
Tolerance to drought, seasonally saturated soils, and poor soils			
Canopy spread and density			
Site-specific hazards (overhead wires; vehicle and pedestrian line of sight; proximity to paved areas, other plants, and buildings)			
Other considerations?			

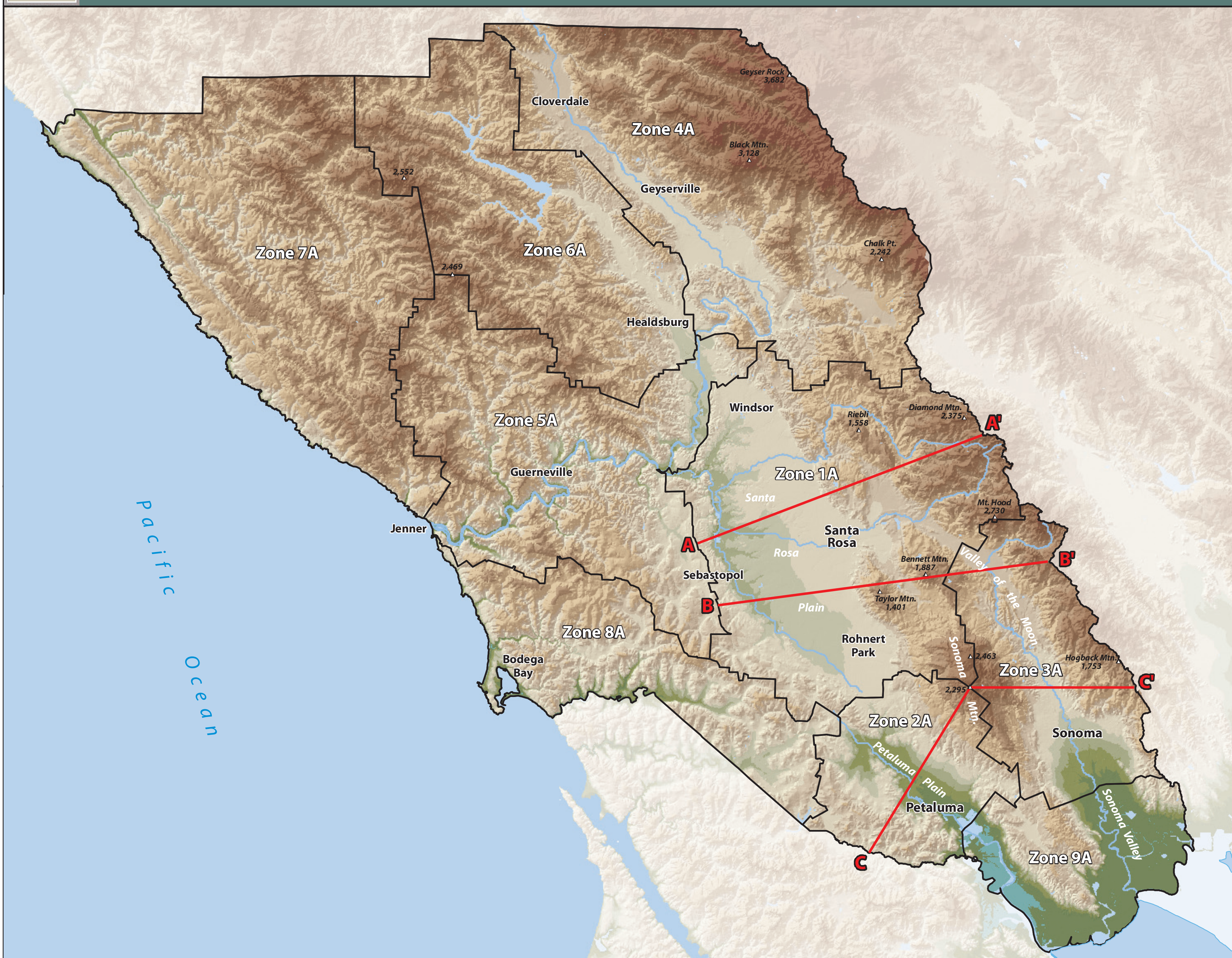
Appendix 4

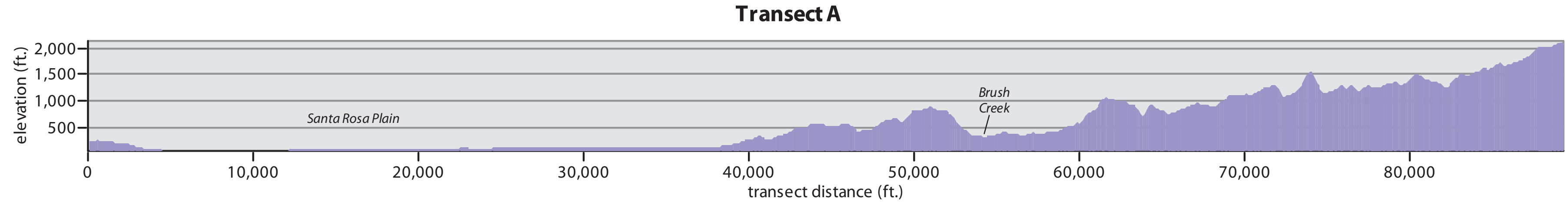
Reference Maps

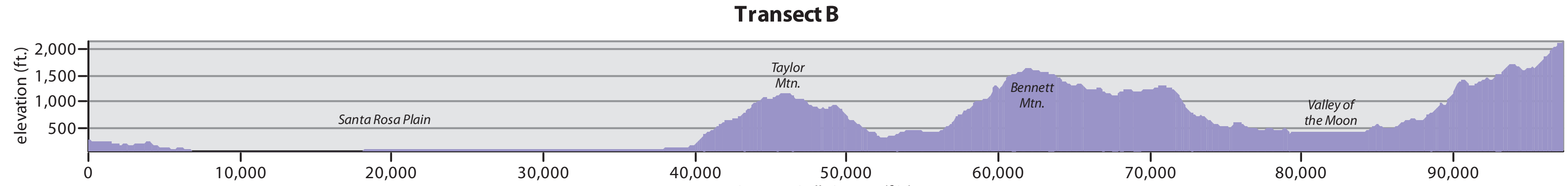
SONOMA COUNTY WATER AGENCY

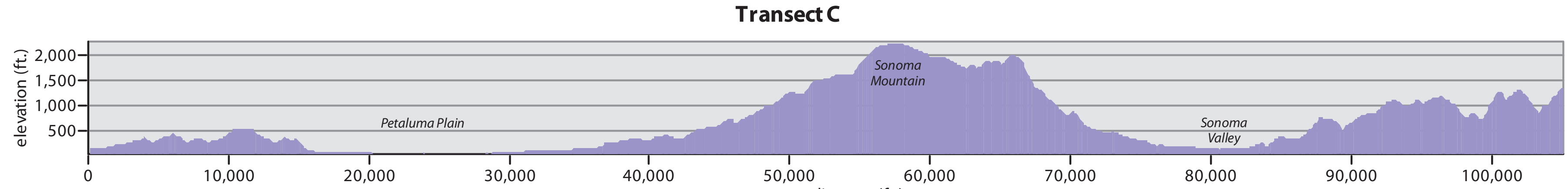
Sonoma County Water Agency

Water Smart Development Guidebook









Elevation (feet)

- Below Sea level
- 0 - 25
- 25 - 50
- 50 - 75
- 75 - 100
- 100 - 250
- 250 - 500
- 500 - 1,000
- 1,000 - 1,500
- 1,500 - 2,000
- 2,000 - 2,500
- Above 2,500

- Transect
- SCWA Flood Zone Boundary

Figure A-1

Sonoma County Topography

0 2.5 5 7.5 10
Miles

Sources:
Sonoma County Water Agency
County of Sonoma
California Spatial Information Library
U.S. Geological Survey

Horizon WATER and ENVIRONMENT

Sonoma County Water Agency

Water Smart Development Guidebook

Elevation (feet)

- Below Sea level
- 0 - 25
- 25 - 50
- 50 - 75
- 75 - 100
- 100 - 250
- 250 - 500
- 500 - 1,000
- 1,000 - 1,500
- 1,500 - 2,000
- 2,000 - 2,500

SCWA Flood Control Zone Boundary

Highway

Streams and Channels

Water Body

Figure A-2

Topography of the Santa Rosa Area, Petaluma Valley, and Sonoma Valley

0 1 2 3 4

Miles

Horizon WATER and ENVIRONMENT

Sonoma County Water Agency

Water Smart Development Guidebook

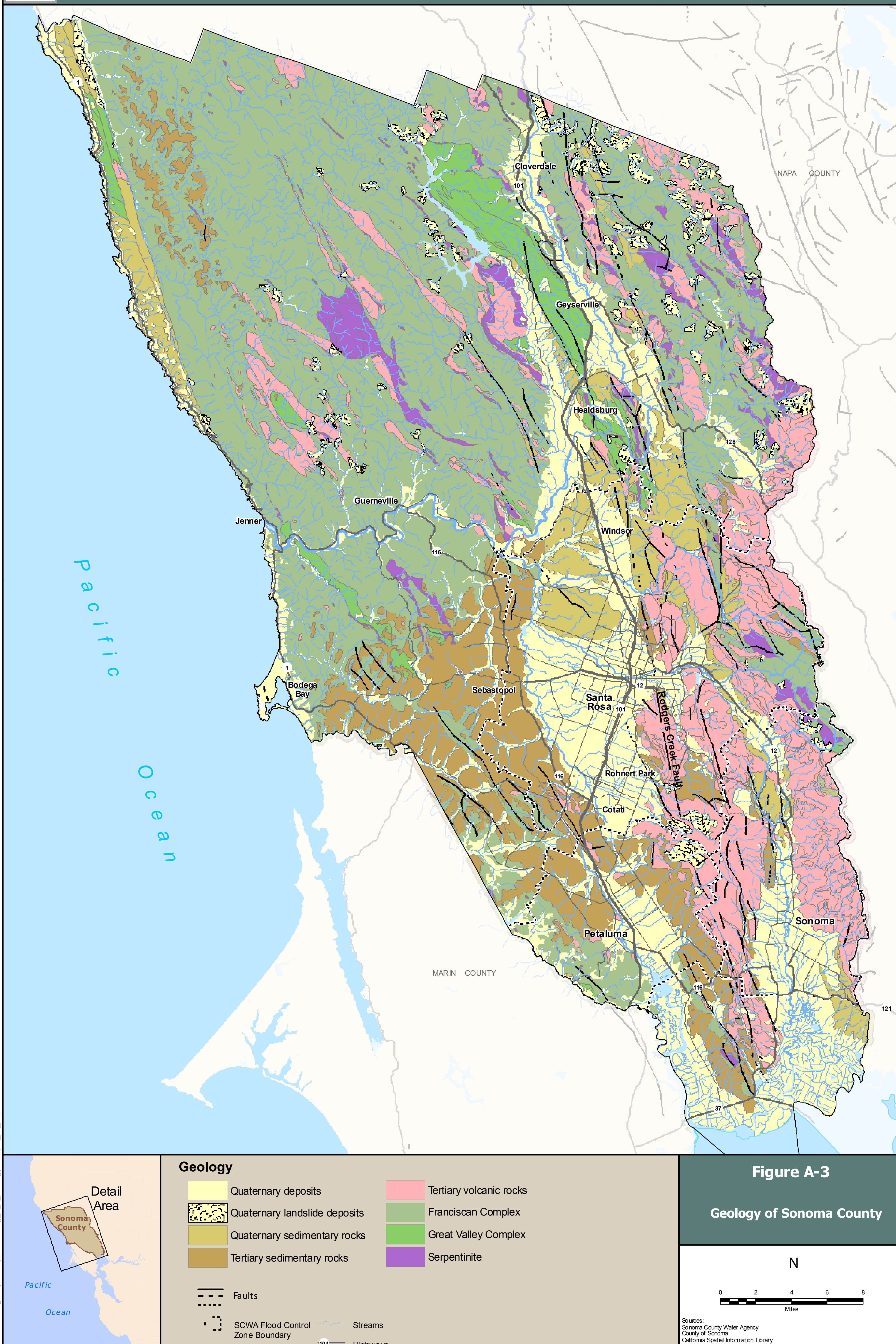


Figure A-3

Geology of Sonoma County

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Sonoma County Water Agency

Water Smart Development Guidebook

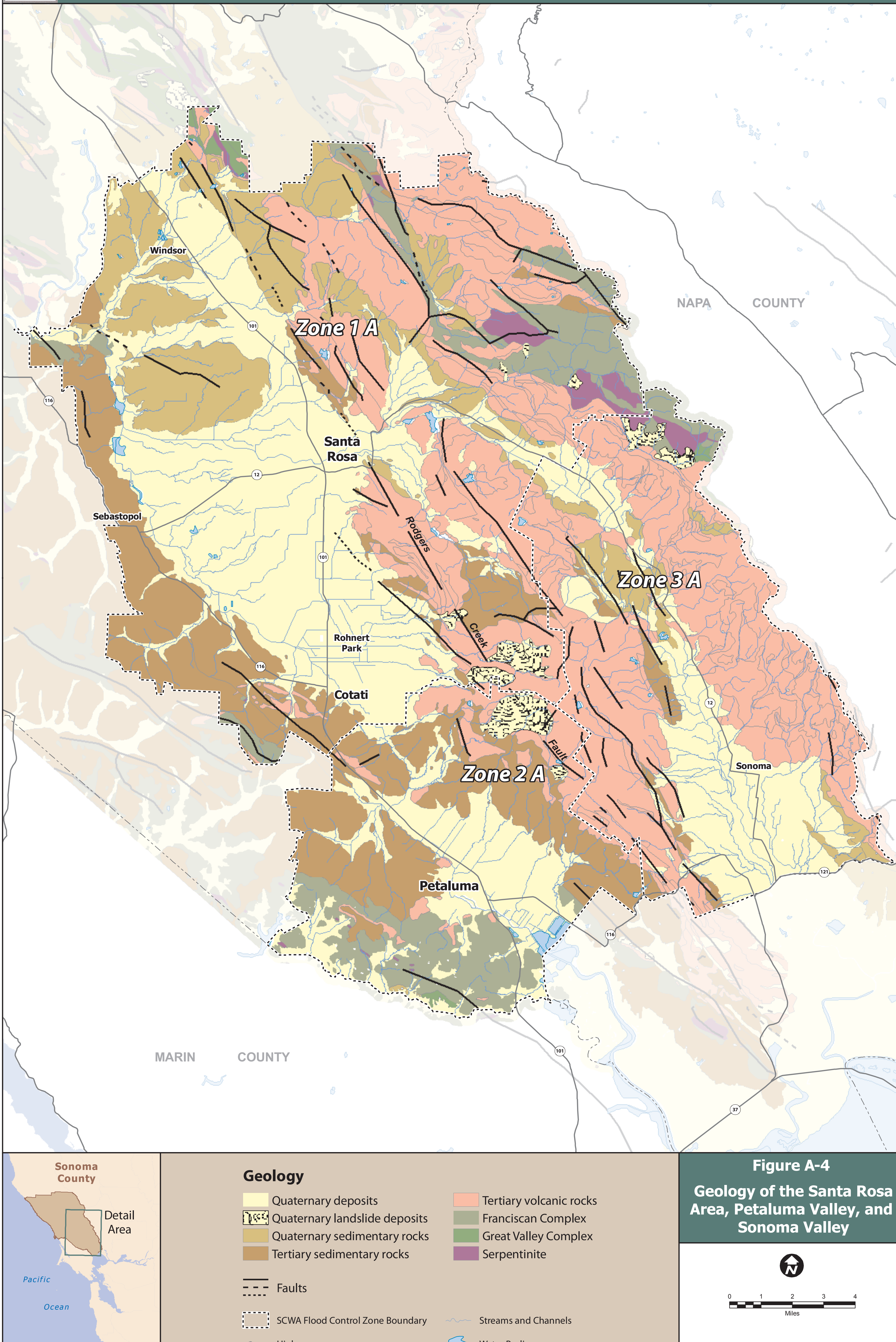


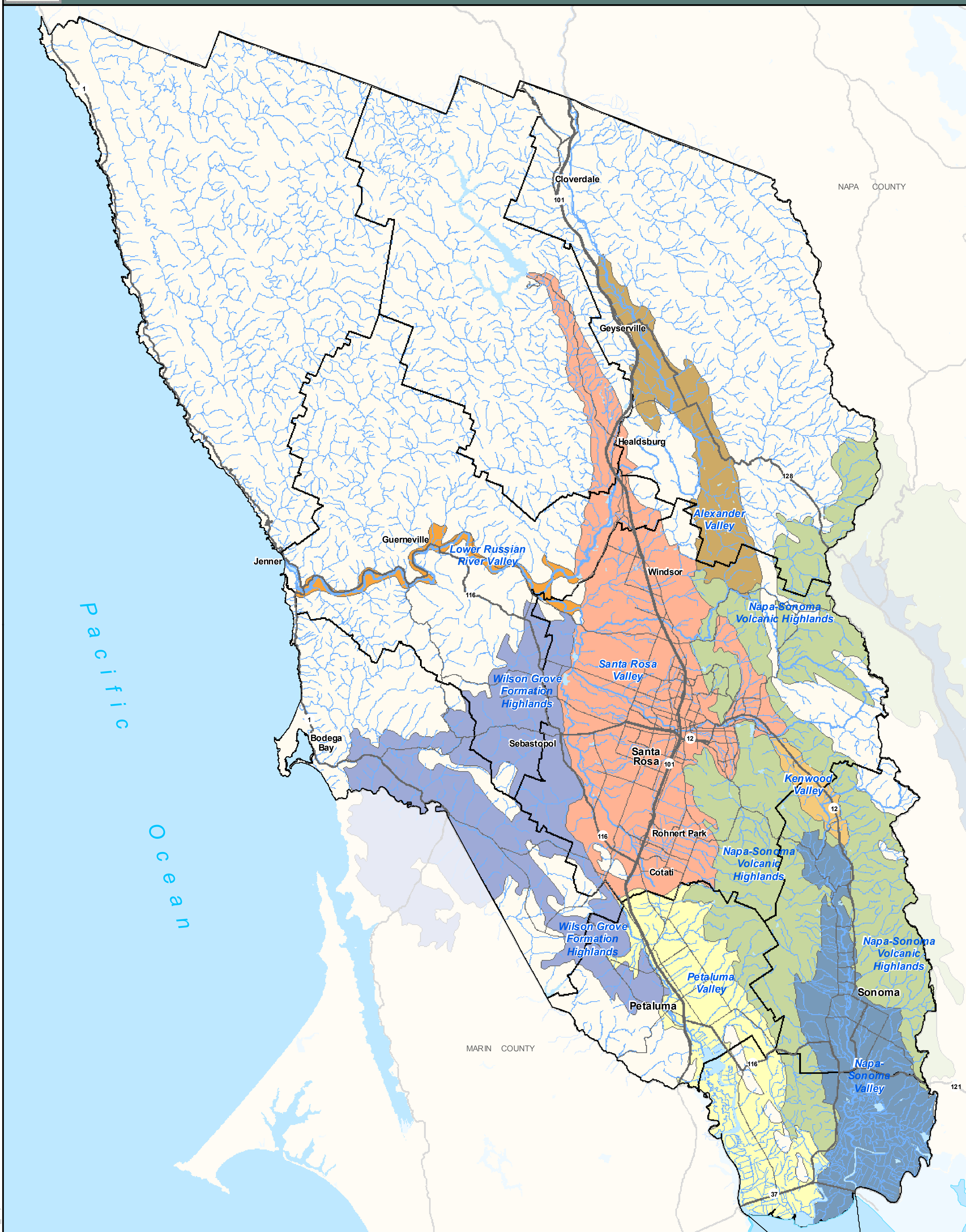
Figure A-4

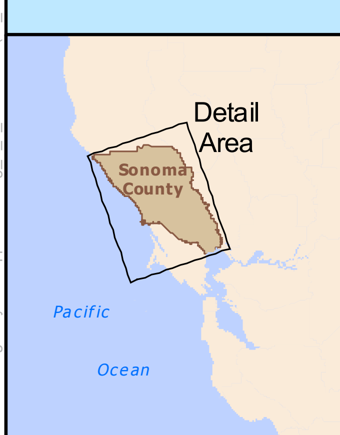
Geology of the Santa Rosa Area, Petaluma Valley, and Sonoma Valley

SONOMA COUNTY WATER AGENCY

Sonoma County Water Agency

Water Smart Development Guidebook





Groundwater Basins

- Alexander Valley
- Kenwood Valley
- Lower Russian River Valley
- Napa-Sonoma Valley
- Napa-Sonoma Volcanic Highlands
- Petaluma Valley
- Santa Rosa Valley
- Wilson Grove Formation Highlands

SCWA Flood Control Zone Boundary

Streams

Highways

Figure A-5

Groundwater Basins of Sonoma County

N

0 2 4 6 8
Miles

Sources:
Sonoma County Water Agency
County of Sonoma
California Spatial Information Library
U.S. Geological Survey
Geografika Consulting

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Sonoma County Water Agency

Water Smart Development Guidebook

Groundwater Basins

- Alexander Valley
- Kenwood Valley
- Lower Russian River Valley
- Napa-Sonoma Valley
- Napa-Sonoma Volcanic Highlands
- Petaluma Valley
- Santa Rosa Valley
- Wilson Grove Formation Highlands

SCWA Flood Control Zone Boundary
Highway
Streams and Channels
Water Body

Figure A-6

Groundwater Basins of the Santa Rosa Area, Petaluma Valley, and Sonoma Valley

0 1 2 3 4
Miles