Salmon Creek
Water Conservation Plan

Coastal Conservancy

This page is intentionally left blank.

Salmon Creek Water Conservation Plan

Prepared by:

Prunuske Chatham, Inc.
Virginia Porter Consulting
Occidental Arts and Ecology Center's WATER Institute

For the Occidental Arts and Ecology Center's WATER Institute

With funding from the California State Coastal Conservancy

Current Salmon Creek Water Conservation Program Partners:

Virginia Porter Consulting *Kathleen Kraft Consulting*

The Salmon Creek Water Conservation Program (SCWCP) is a multi-year, multi-stakeholder effort focused on developing alternative water supply solutions that support human needs while protecting and restoring instream flows for fish and wildlife.

TABLE OF CONTENTS

Page

Page

Appendices

EXECUTIVE SUMMARY

Salmon Creek is a rural, coastal watershed (Figure 1) with strong local support for protecting the environment, sustaining local communities, and restoring salmonid populations. The Salmon Creek Watershed drains a 35-square-mile area to the Pacific Ocean. Land use within the watershed is a mix of family-owned ranches, rural residential development, and small vineyards. The watershed's four communities (Occidental, Freestone, Bodega, and Salmon Creek) uniquely reflect the character and interests of their residents.

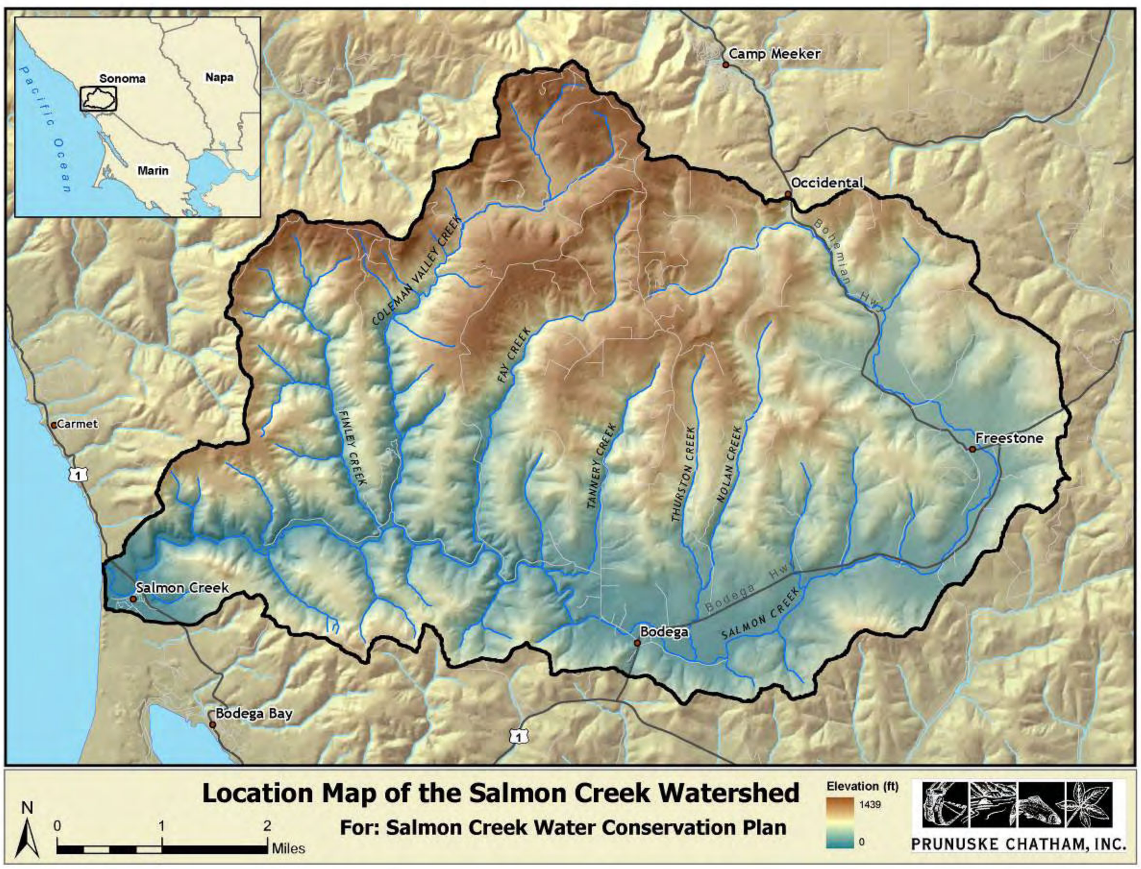


Figure 1. Salmon Creek Watershed, located in western Sonoma County, California

Examination of **water extractions and their impact on instream habitat** for imperiled salmonids in the watershed was initiated in 2003 through a study of the Salmon Creek estuary funded by the State Coastal Conservancy (SCC). *Salmon Creek Estuary: Study Results and Enhancement Recommendations*, completed in 2006 by Prunuske Chatham, Inc. (PCI) for the Occidental Arts and Ecology Center (OAEC), identified **lack of sufficient streamflow in late spring and summer as a primary factor limiting successful rearing of juvenile steelhead**.

Insufficient summer streamflow in both the upper watershed and the estuary creates disconnected rearing habitat with debilitating water quality conditions. This, coupled with inadequate cover for predator protection in pools and the estuary, leads to high rates of juvenile salmonid mortality.

Seasonal water scarcity is also an ongoing issue for the human residents of the watershed, often requiring that water be trucked in during summer months. In addition, streamflow conditions and water supply availability are likely to see climate change-related shifts due to projected changes in temperature and precipitation.

Many opportunities exist to reduce demand on extractive water sources that, through direct or cumulative effects, reduce streamflow and degrade instream habitat. Measurably increasing streamflows to improve salmonid rearing conditions and water supply sustainability requires that the following methods be integrated and applied in a concentrated manner in critical rearing reaches:

- Water conservation and wise-use practices;
- Groundwater recharge through practices to slow and infiltrate stormwater runoff;
- Development and wide implementation of alternative, non-extractive water supplies, including rainwater storage; and
- Reduction in riparian water diversions.

The Salmon Creek Water Conservation Program (SCWCP) was developed in response to the need to increase dry season instream flows for improved aquatic habitat while simultaneously supporting the freshwater demands of residents. Current SCWCP's efforts are focused on:

- Describing extractive water usage in the watershed and identifying opportunities to reduce its impacts on streamflow;
- Developing tools to promote water use efficiency and conservation; and
- Supporting residents in implementing measures to shift their reliance on extractive water supplies to alternative, storage-based sources.

Initial SCC funding was secured in 2008 to build the SCWCP framework through completing essential research, planning, and community outreach. The Grantee, OAEC's WATER Institute, partnered with consultants PCI, Virginia Porter Consulting, and Kathleen Kraft to complete this work.

The **objectives** of the 2008 SCC grant were to:

- **Analyze water supplies and demands** within the Salmon Creek Watershed, including local utilities, rural residences, and agricultural operations to characterize water use and focus water conservation efforts;
- **Develop Conservation Strategies** that both support the effective, long-term implementation of the SCWCP and are transferrable to other water-scarce communities along California's coast;
- **Design and implement public outreach materials and workshops**, including development of stakeholder meetings, to promote the SCWCP and use of the Conservation Strategies; and
- **Build a pilot demonstration program (the Bodega Pilot Program)** to show how small coastal communities can effectively combine water conservation with sustainable water supply planning.

This Salmon Creek Water Conservation Plan (Plan) summarizes SCWCP progress thus far and provides recommendations for ongoing work. This Plan introduces the background and science supporting the SCWCP, outlines the results of the water consumption analysis, describes the Bodega Pilot Program and the wider outreach effort, summarizes and presents the Conservation Strategies, and recommends future SCWCP research, projects, and outreach efforts.

THE ISSUES

Coastal Water Scarcity: A Scarcity of Storage

Author: L. Hammack

Due to its Mediterranean climate, steep topography, and geology, the Salmon Creek Watershed's dry-season water supplies often cannot meet the demands of existing human habitation needs. Irregular winter-season precipitation and unfailingly dry summers create a conflict between seasonal water availability and periods of high demand (Figure 2). The metamorphic rocks underlying much of the watershed and region are a poor aquifer; plus the steep terrain and relatively thin soils constrain rainfall infiltration and groundwater recharge. Thus, Salmon Creek, along with much of the coastal range in Marin, Sonoma, and Mendocino Counties, can be considered a water-scarce area (Kleinfelder 2003; Grantham et al. 2010).

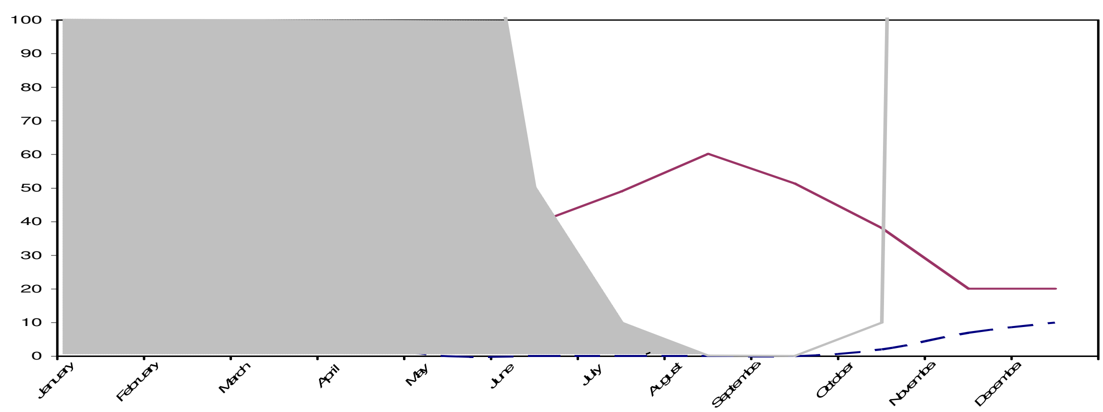


Figure 2. Diagram showing relative relationship of monthly consumptive water demand in acre-feet (solid line) to monthly rainfall in inches (dashed line) and surface water availability in acre-feet (fill area), as depicted by streamflow. Based on actual Salmon Creek Watershed data. Note that in the summer months demand far exceeds the amount of water in Salmon Creek. It is postulated that redirection of a portion of the current demands from direct extractions to winter-derived storage supply would increase streamflows proportionally. Monthly winter runoff and streamflow volumes often exceed demands by more than two orders of magnitude (i.e., 2000-6000 acre-feet).

Native species reliant on riparian habitat and instreamflows to survive are particularly vulnerable to water shortages and periods of drought. Naturally low streamflow conditions inherent to the Mediterranean climate are exacerbated by direct water extractions and groundwater depletions. Direct streamflow diversions in the summer have caused reaches of Salmon Creek to dry (during drought years) and pools to become disconnected (PCI 2006).

Ultimately, seasonal coastal water scarcity is a result of inadequate water storage. As shown on Figure 2, rural coastal watersheds such as Salmon Creek receive more than enough rainfall to meet the annual water demands of the residents; more information on this is in available in the Water Consumption Analysis in Chapter 2 of this Plan. However, with a Mediterranean climate, rainfall is concentrated mainly between the months of November and March.

This seasonal cycle of water abundance and scarcity can be balanced out—for the benefit of humans and fish—through the **strategic storage** of rainwater in off-channel ponds and roofwater harvesting systems for non-potable irrigation and livestock watering needs. With proper filtration and treatment, rainwater can also be used as a potable water source in accordance with applicable regulations.

However, water storage is not a panacea for all water supply concerns, and cannot substitute for efficient and conservative water use. The impacts of reservoirs on hydrologic flow regimes necessary to maintain ecosystem health have been widely documented (Graff 1999; Richter and Thomas 2007; Grantham et al. 2010). Instreamflow regulations for the State of California (AB 2121) are in final draft form and attempt to address these impacts. It is unlikely that small storage ponds or rainwater catchment systems used to fulfill existing water demands in rural coastal areas such as Salmon Creek would significantly decrease peak runoff during winter storm events. However, multiple, on-channel storage ponds within a small catchment may reduce early winter base flows and affect salmonid migratory flows. Grantham et al. (2010) suggest that there is an optimal storage capacity for a given watershed that can be calculated to meet water demands, while ensuring critical habitat needs and ecosystem function.

Water Use and Extractions

Many coastal communities and residents struggle to maintain adequate, stable water supplies. Water sources associated with surface water and adjacent to streams—wells, direct in-stream diversions, and on-channel storage ponds—tend to provide a more consistent and higher production supply and, thus, are preferentially developed and used. Residents in upland areas along the ridgelines are dependent upon groundwater wells and springs.

All water extractions likely affect streamflow, either directly or indirectly through cumulative impacts. Groundwater sources in the uplands are connected through aquifers, bedrock fractures, and geologic-formation contacts to springs. Springs feed directly into first and second order tributaries, or they locally maintain the water table that sustains summer streamflows. Groundwater wells in the alluvial valleys, thought to be disconnected from the water table by an impervious clay layer, are likely impacting shallow groundwater sources feeding the creeks (PCI 2006).

As shown below, there are 43 active documented water diversions (Figure 3) in the Salmon Creek Watershed (WRIMS database 2010). The combined diversion volume for the appropriative and registered water rights is 424 acre-feet (including both storage and direct diversions). The claimed riparian rights are not required to list a diversion amount, and most riparian water users do not file Statements of Diversion. The use of riparian supplies is common throughout the watershed for year-round domestic and agricultural water supply, as well as summer irrigation. See the Water Consumption Analysis in Chapter 2 for more information on water sources and supplies in the Salmon Creek Watershed.

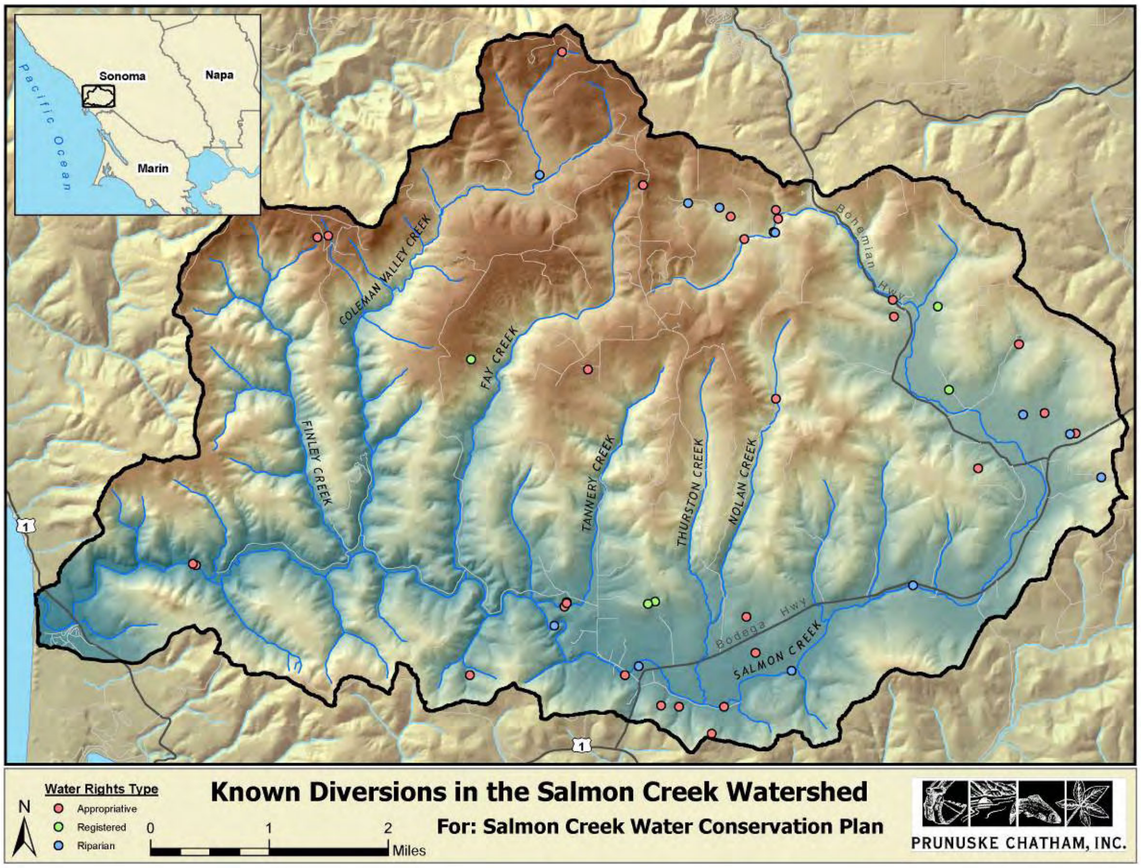


Figure 3. Locations of documented active diversion and storage rights in the Salmon Creek Watershed by type: appropriative, riparian, and registered stockponds/small domestic use.

Regulatory Framework

Water is recognized as a public trust resource and must be managed reasonably and for "beneficial uses," which historically included municipal and industrial uses, irrigation, hydroelectric generation, and livestock watering. The concept of beneficial use has recently been expanded to include recreational use, fish and wildlife protection, and enhancement and aesthetic enjoyment (State Water Resources Control Board 2010). The following description summarizes the current view of water and water rights held by the State Water Resources Control Board:

> "As increasing emphasis is placed on protecting instream uses—fish, wildlife, recreation and scenic enjoyment—surface water allocations are administered under ever-tightening restrictions, posing new challenges and giving new direction to the State Board's water right activities.
>
> "Under the public trust doctrine, certain resources are held to be the property of all citizens and subject to continuing supervision by the State. Originally, the public trust was limited to commerce, navigation and fisheries, but over the years the courts have broadened the definition to include recreational and ecological values.
>
> "In a landmark case, the California Supreme Court held that California water law is an integration of both public trust and appropriative right systems, and that all appropriations may be subject to review if 'changing circumstances' warrant their reconsideration and reallocation. The courts also have concurrent jurisdiction in this area. At the same time, it held that like other uses, public trust values are subject to the reasonable and beneficial use provisions of the California Constitution." (http://www.waterboards.ca.gov/waterrights/board_info/ accessed 04/05/10)

Use of surface water for water supply may be subject to water rights regulation and permit process. There are two types of surface water rights in California—appropriative and riparian. **Riparian rights** come with parcels adjacent to water bodies and are non-permitted or licensed, though they should be formally claimed through a Statement of Diversion and Use to be considered vested and ensure superiority over any appropriative rights. Riparian water users have rights only to the water naturally flowing by the parcel and are not allowed diversion to storage or use on parcels not adjacent to the stream.

Appropriative water rights are required for water diversions to storage and uses on non-riparian parcels. Appropriative rights permits commonly restrict the period of diversion to outside of the dry season (e.g., December through March). Permits are not required for use of springs or standing pools lacking natural outlets. Prior to 1969, all existing stockponds less than 10 acre-feet and small domestic uses were registered and granted a certificate of use. Today, it is necessary to secure permits on a case-by-case basis.

Groundwater is not regulated at this time in California except in basins with court-adjudicated decrees.

Decline of Salmonids and Other Sensitive Aquatic Species

Author: J. Michaud

Historic and ongoing land-use practices, combined with changes in ocean conditions, have had a dramatic effect on salmonid populations within the Salmon Creek Watershed. Steelhead (*Oncorhynchus mykiss)* and coho salmon (*O. kisutch*), collectively known as salmonids, were once abundant in Salmon Creek and its tributaries. Tales of their numbers, sizes, and favorite pools are still a vital part of the local history. Now only a small population of steelhead continues to return each year, and native runs of coho salmon are believed to be extirpated from the watershed. The last naturally propagated coho salmon was seen in 1996 (Cox 2005), and the watershed is now part of a reintroduction program.

Steelhead and coho salmon populations have declined from historic levels as a result of widespread, cumulative impacts, including those associated with ocean cycles and conditions, fishing, logging, land clearing and development, channel clearing and modification, stream diversions, water extractions, and water pollution.

Juvenile coho salmon.
Photo courtesy of Joe Pecharich (NOAA Restoration Center)

As a result, these species are now protected under the federal and State Endangered Species Acts. Salmon Creek steelhead are part of the central California coast Distinct Population Segment (DPS), which is federally listed as threatened by NOAA's National Marine Fisheries Service (NMFS). Coho salmon, central California coast DPS, are both federally and state-listed as endangered. Despite their decline, efforts are being made to reverse this trend. Many residents, community groups, and agencies have come together to understand reasons for the decline and attempt to restore the fisheries. **These efforts include the development of recovery plans and restoration projects to improve the key habitat features that support each life stage of these migratory species.**

Salmonids in the Watershed

There is a long history documenting steelhead and coho salmon populations within the watershed; see *Historical Timeline of Salmon Creek Watershed* in PCI 2006). Throughout the 1950s, fish were relatively abundant in the watershed. A record from 1953 noted 20 anglers caught 13 silver salmon (coho) in a period of 39 hours, all ranging in size from 2.5 to 10 pounds.

In 1961, the first stream survey of Salmon Creek was conducted by California Department of Fish and Game (CDFG) and noted the presence of both adult steelhead and coho salmon. Stream surveys were also conducted in 1964 and 1965. In the 1964 survey, the majority of fish observed were silver salmon, 50 to 100 fish per 100 feet with similar findings in 1965. During a survey in 1970, 25 to 40 fish per 100 feet were noted. In 1974, there was a record salmon catch at sea off Salmon Creek. Up to the 1970s, fishermen annually broke through the sandbar at the estuary noting coho salmon just "rushed in" and always made it to the plate in time for Thanksgiving.

By the early 1980s, coho salmon yearlings were reportedly stocked in Salmon Creek. At about that time, local CDFG biologist Bill Cox began regular surveys for fish. While he didn't have access throughout the watershed, he did observe coho salmon on a regular basis, especially in Tannery Creek in the late 1980s through early to mid-1990s. However, by 1996, he noted the last wild coho salmon ever to be seen in the watershed. Ongoing survey work since that time has documented steelhead throughout the watershed; however, no sightings of wild coho salmon have been recorded (CDFG 2003a-b; CDFG 2004a-e; PCI 2006; Hines 2010).

Other Sensitive Aquatic Species in the Watershed

In addition to listed salmonids, the Salmon Creek Watershed also provides critical habitat for a number of special-status aquatic species. Particularly noteworthy are the presence of California red-legged frog, California freshwater shrimp, northwestern pond turtle, and one estuarine fish—tidewater goby. These

species have similar aquatic habitat requirements to salmonids in that they also require adequate water supplies, especially freshwater shrimp and tidewater goby, which are entirely aquatic, and complex instream habitats, intact riparian canopies, and high-flow refuge habitat.

The **tidewater goby** (*Eucyclogobius newberryi*) is federally listed as endangered and a California Species of Special Concern. It is a small, elongate, grey-brown fish endemic to coastal lagoons, estuaries, and marshes of California. Its annual lifecycle is closely tied to the dynamics of lagoons and estuaries with breeding commencing after their habitat closes to the ocean. Small vertical nesting burrows are dug in the substrate in areas of coarse sand with peak breeding activity occurring in late April through early May. Threats to tidewater goby include development, water diversion and manipulation of habitat, channelization, nonpoint and point source pollution, discharge of agricultural and sewage effluents, and impacts from cattle grazing. The Salmon Creek estuary supports a robust population of gobies (PCI 2006).

California red-legged frog *(Rana draytonii)* is federally listed as threatened and a California Species of Special Concern. In general, they are most common in marshes, streams, lakes, reservoirs, ponds, and other water sources with plant cover. Breeding occurs in deep, slow-moving waters with dense shrubby or emergent vegetation from late November through April. Egg masses are attached to emergent vegetation (e.g., *Typha* sp. or *Scirpus* sp.) near the water's surface. Tadpoles require 3.5 to 7 months to attain metamorphosis. Adults take invertebrates and small vertebrates. Larvae are thought to be algal grazers. Within the watershed, California red-legged frogs are known to occur within stream channel habitats from the estuary and further upstream near the town of Bodega (CDFG 2010). Reservoirs, wetlands, and other large perennial water sources also support this species; however, reported observations in these areas are spotty.

Photo courtesy of Bill Cox

California freshwater shrimp *(Syncaris pacifica)* is federally and State-listed as endangered. It is a small, 10-legged crustacean occurring in low-elevation and gradient (less than 1%) perennial streams in Marin, Sonoma, and Napa counties. They occur in shallow pools away from the main current where they feed primarily on detritus and, to a lesser extent, on decomposing vegetation, dead fish, and invertebrates. Most shrimp appear opaque to nearly transparent with colored flecks across their bodies. Females can appear dark brown to purple under certain conditions. Breeding occurs in the autumn, but young do not hatch until the following May or early June. After breeding, female shrimp carry the fertilized eggs attached to their abdominal swimming legs throughout the winter. The freshwater shrimp has been extirpated from many streams and continues to be threatened by introduced predators, pollution, and habitat loss. Within the watershed, there have been freshwater shrimp sightings reported from approximately 2.25 miles upstream of the estuary to just north of Freestone along the mainstem. Population numbers within the watershed have tended to fluctuate from year to year due to pollution and drought (CDFG 2010).

The **northwestern pond turtle** *(Actinemys marmorata marmorata)* is a California Species of Special Concern and is one of two distinct subspecies of the western pond turtle. They are most commonly found in or near permanent or semi-permanent water sources in a variety of suitable habitats throughout much of western California. This omnivorous species requires basking sites, such as emergent logs, rocks, mud banks, or mats of aquatic vegetation, for thermoregulation. Underwater retreats are also required for predator avoidance. Nesting sites of this species have been found some distance, up to 1,300 feet or more, from aquatic habitat. They have also been found using upland sites for aestivation and overwintering. Within the watershed, pond turtles occur along stream channel habitats and also utilize reservoirs and other permanent water sources extensively (CDFG 2010).

Impaired Instream Habitat Conditions

Author: J. Michaud

Extensive assessments of watershed and stream conditions have been completed in Salmon Creek and its tributaries (CDFG 2003a-b; CDFG 2004a-e; PCI 2006; GRRCD 2009; GRRCD and PCI 2007; GRRCD and PCI in press; UCCE 2007; and PWA 2007). Evaluation of the habitat-related data and results from these assessments provides some indication of the limiting factors with the greatest potential to inhibit recovery of coho salmon and the continued existence of steelhead. Key findings of the assessment and ongoing monitoring efforts, with specific attention to summer base flows and water quality, are discussed below.

Summer flows are critical for the survival of rearing juvenile fish and maintaining high-quality habitat. Flows provide rearing space, allow for movement between habitats, maintain water quality and temperature, and facilitate delivery of food for juvenile fish. Near-channel shallow wells located in the alluvial valley have been found to be drawing from subsurface flows and affecting stream depths, especially during the summer rearing periods (PCI 2006). Flow monitoring in Salmon Creek shows that riffles become disconnected by early July, stranding juvenile salmonids, decreasing water quality in pools, and resulting in above-optimal instream temperatures (PCI unpublished data). Adequate streamflow in the lower watershed, immediately upstream of the estuary, has been shown to be a primary factor in determining habitat quality and dynamics of lagoon formation and breaching (PCI 2006). Anecdotal information about the system in the 1950s, 60s, and 70s suggests that summer freshwater flows were much higher than typically occur today. This is likely a result of population growth in the watershed and associated increases in water consumption.

Low flow conditions in lower Salmon Creek.

Long-term water quality monitoring data has been collected in freshwater habitats in Salmon Creek and the downstream estuary. Suitable water quality conditions are critical for the development, growth, and survival of salmonids at all life stages, as well as for other fish and the macroinvertebrates that comprise the base of the aquatic food chain. Steelhead and salmon need cool water temperatures, high dissolved oxygen (DO), and low quantities of fine sediment for successful juvenile rearing and adult migration and spawning. Overall, water quality is rated as fair to good at the monitoring locations, with tributaries exhibiting better conditions than the mainstem (UCCE 2007). The monitoring program shows that turbidity, temperature, and DO seasonally test outside optimal levels for salmonids and other aquatic organisms. Lethal concentrations of DO (<3 mg/L) have been measured in pools and the estuary during the summer months where salmonids are rearing (PCI 2006; GRRCD and PCI 2010 in press).

Maintaining streamflows in Salmon Creek and its tributaries throughout the summer to keep pools connected and aerate the water as it flows over the riffles and bedrock ledges is a principal way to ensure beneficial water quality. High pool DO concentrations are observed to be primarily associated with freshwater surface flows upstream, while pools with very low DO are disconnected and stagnant. Where groundwater continues to feed surface water during the dry months, the water will generally be cool and continuous.

Other keys to maintaining high summer water quality include:

- Dense, continuous forest canopy along the riparian corridor;
- Limited or no livestock access to the streams; and
- Well-managed uplands.

Implications of Climate Change

Author: L. Hammack

Streamflow conditions and water supply availability are likely to be subject to climate change-related shifts due to projected changes in temperature and precipitation. Average temperature in California has risen 1.5° F over the past 50 years and is projected to rise another 2-4° F by the end of the century (Karl et al. 2009). In California, precipitation is likely to decline slightly overall but with more intense storms during a shorter rainy period and longer, hotter dry seasons, resulting in both more droughts and more floods (Karl 2009). **While regional climate change models vary in their predictions, it is expected that there will be additional impacts water supply in coastal areas already experiencing summer water shortages.**

More intense winter storms over a shorter rainy season will affect the amount of precipitation available to recharge the groundwater aquifers. **The importance of slowing stormwater runoff in the uplands and promoting groundwater recharge throughout the watershed will increase**. Streams will rely on the seasonal water table to sustain flow for longer, hotter dry seasons, further increasing the need to reduce direct diversions and reliance on riparian water for agriculture and non-potable demands.

The **longer dry season** is likely to reduce summer and early fall minimum flows, exacerbating higher temperature conditions and resulting in insufficient water quantity for juvenile summer rearing and fall spawning. In addition, extreme summer heat events may temporarily push streams above thermal maximums while warmer summer evenings are likely to increase water temperature overall during the warmest months (Luers et al 2006).

In addition to direct thermal stress, higher water temperature may indirectly affect salmonid habitat through promoting algal growth and lowering dissolved oxygen. Both high water temperatures and low dissolved oxygen have direct physiologic impacts on juvenile salmonids. Temperature changes may also result in increased competition from warm water species (Bisson 2008).

THE RESPONSE

Community Action

Author: A. Crawford

As a Salmon Creek Watershed resident recently stated, "Water has always been an issue here, and people have always been careful about their supply." (pers. comm. A. Bleifus 4/26/10). **This water awareness has resulted in a range of community actions.**

Several years ago, some residents, seeing reduced flows in the creek, filed formal complaints with the State Water Resources Control Board about these withdrawals. Other residents began educating themselves about creek health and water sustainability. As word spread that no coho had been seen in Salmon Creek since 1996, a few landowners focused on implementing creek restoration projects in their own backyards, including riparian plantings; partnerships with Gold Ridge Resource Conservation District (GRRCD) funded some of these early efforts. Agricultural landowners protected riparian areas through installing fencing to exclude cattle from certain areas.

In the late 1990s, a group of residents began meeting in Freestone to discuss their increasing interest in fostering a healthier watershed. These early meetings resulted in the formation of the Salmon Creek Watershed Council (Council), which hosted the first Watershed Day at Harmony School in 1998 (pers. comm. A. Bleifus, 4/26/10).

The momentum from this first Watershed Day inspired the formation of watershed groups in adjacent watersheds. As the Council matured and built partnerships with local agencies and non-profits, the focus of the Council shifted to developing the scientific information necessary to demonstrate how land and water uses in the watershed impact streamflows.

The concept of the SCWCP, including the Bodega Pilot Program was also developed at this time as stakeholders recognized the need to increase dry season instream flows for improved aquatic habitat while simultaneously supporting the freshwater demands of residents. Detailed information on the SCWCP planning approach is below in Chapter 2.

As discussed above, the *Salmon Creek Estuary: Study Results and Enhancement Recommendations* (PCI 2006) provided the scientific foundation for the recommendations that guided the development of the SCWCP.

Several other watershed studies and reports have also been completed by resource agencies and non-profits active in the watershed, including habitat assessments by CDFG (2003, 2004) and the *Salmon Creek Watershed Assessment and Restoration Report* (GRRCD and PCI 2007). Currently, GRRCD and PCI are preparing the *Salmon Creek Integrated Coastal Watershed Management Plan*: http://www.goldridgercd.org/watersheds/salmoncreekplan.html.

Continuing restoration work has been undertaken by many watershed stakeholders, including local, state, and federal resource agencies, GRRCD, private landowners, and community organizations. Although the primary focus has been to improve instream fish habitat, many of the projects also improve water quality and promote infiltration. Highlights include:

- Cross fencing and water development to improve grassland vitality;
- Riparian fencing and off-channel livestock watering systems,
- Native plant revegetation to restore wide riparian buffers for shade;
- Sediment filtration, and streambank stability;
- Biotechnical streambank repair projects to reduce fine sediment delivery and improve riparian cover; and
- Instream habitat structures, designed to deepen pools, enhance riffles, create gravel bars, and/or provide cover for juvenile and adult salmonids.

Salmonid Habitat Enhancement and Recovery

Author: J. Michaud

State and federal agencies are charged with protecting and recovering native salmonid populations along the central California coast. Small coastal streams, such as Salmon Creek, that have fairly intact habitat and limited development pressure, are considered key systems for the protection of these threatened and endangered species. Watersheds with strong community support to protect and restore the natural resources will be supported by agencies to recover historic populations. The following sections describe some of these recovery efforts and how this Plan and the SCWCP integrate with these efforts.

Recovery Planning

NMFS recently completed a draft Recovery Plan for the central California coast evolutionarily significant unit (ESU) coho salmon to provide a scientific framework for the preservation, enhancement, and restoration of this species and their habitat (NMFS 2010). The Salmon Creek Watershed is grouped in a subset of watersheds with geographically linked populations and similar environmental conditions labeled the coastal "diversity strata," one of five in the central California coast ESU. Recovery of the species depends on the combined abundance within each of the five diversity strata, rather than individual watershed populations. Thus, each subwatershed's population goals are linked with and support the other watersheds to produce a regionally viable population with low extinction potential.

The Recovery Plan identifies drought and flooding as the greatest threats to recovery of coho salmon within the Salmon Creek Watershed, followed by channel modification, climate change, livestock farming and ranching, and water diversions and impoundments (NMFS 2010). Aside from supporting funding, outreach, and reintroduction as part the of broodstock program, the high priority recovery actions for streamflow include:

- "Avoid and/or minimize the adverse effects of water diversions on coho salmon by establishing a more natural hydrograph, by-pass flows, season of diversion, and off-stream storage; and
- Minimize water use and seek alternatives during droughts."

Captive Broodstock Reintroductions

In an effort to **reestablish coho salmon** within the Russian River basin, the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP) was initiated through a collaborative partnership with the Sonoma County Water Agency, U.S. Army Corps of Engineers, NMFS, CDFG, and others. In 2001, the first wild coho salmon juveniles were collected and reared at Warm Springs Hatchery (NMFS 2010). To improve genetic diversity and the distribution and abundance of coho salmon, captive-reared fish were released into streams within their historic range starting in 2004 (Conrad et al. 2005). Since that time, coho salmon have been released into Russian River tributaries in the fall and spring at select locations.

In 2008, Salmon Creek was selected as an additional release site for captive-reared coho salmon. In December 2008, adults and advanced fingerlings were released into the watershed, and adults were released into the watershed again in December 2009. Releases included captive-reared fish from the Russian River Watershed and Olema Creek, a tributary to Lagunitas Creek in Marin County. The fish were selected from these two strains in an attempt to recreate the likely genetic composition of the historic Salmon Creek fishery.

CHAPTER 2: SALMON CREEK WATER CONSERVATION PROGRAM PLANNING APPROACH

The SCWCP is directed toward identifying water usage in the watershed and developing tools to promote water conservation by all users, including residents and public utilities.

WATER CONSUMPTION ANALYSIS

Author: L. Hammack

Water security for both humans and the ecosystem is a concern for residents, water utilities, and agencies tasked with managing and recovering salmonid populations. Securing sufficient freshwater supply for homes and livelihoods is an ongoing challenge in this coastal watershed, and in some cases, historically stable wells and springs are becoming unreliable. As noted previously, streamflow volume and connectivity in the summer appear to be primary factors limiting salmonid survival and population viability. Anecdotal evidence indicates that summer streamflows have been decreasing, and climate change scenarios indicate that drought conditions may occur more frequently.

To support development of long-term strategies for water security in the watershed, an inventory of water supplies and water demands by types of water use was performed to characterize and quantify water consumption patterns. **This section describes how the residents of Salmon Creek use water and how that demand is distributed and supplied throughout the watershed.** The different freshwater supplies are characterized, and impacts of their use on ecosystem function are discussed.

Water Demand

Consumptive water demand in the Salmon Creek Watershed was assessed through a multi-pronged, land use based approach, as described in **Appendces B1 and B2**. Through this process, 14 land use based water use types were defined and mapped (Figure 4). Because the amount of water and seasonal usage patterns vary among types of agricultural use, the commercial agriculture properties were broken out into 4 categories:

- Pasture land for livestock—cattle and sheep are currently the primary grazing animals in the watershed;
- Dairies;
- Vineyards; and
- Non-irrigated orchards.

Residential units are associated with most, but not all, agricultural properties, and this distinction was made for demand accounting purposes. Developed rural residential parcels were determined through the County Assessor's Parcel database.

Four communities have water utilities that serve customers treated and metered Salmon Creek water—Freestone, Bodega, Salmon Creek, and Bodega Bay. Part of the town of Occidental is in the Salmon Creek Watershed, but Occidental is served by Russian River water. The parcels served by metered water are distinguished from the other residential properties, and their consumptive demand was calculated separately; **see Appendix B1 for a summary memo of the metered communities demand inventory.** Several other miscellaneous water use types were defined, including schools and church camps, and data on water demand for these uses was collected where possible.

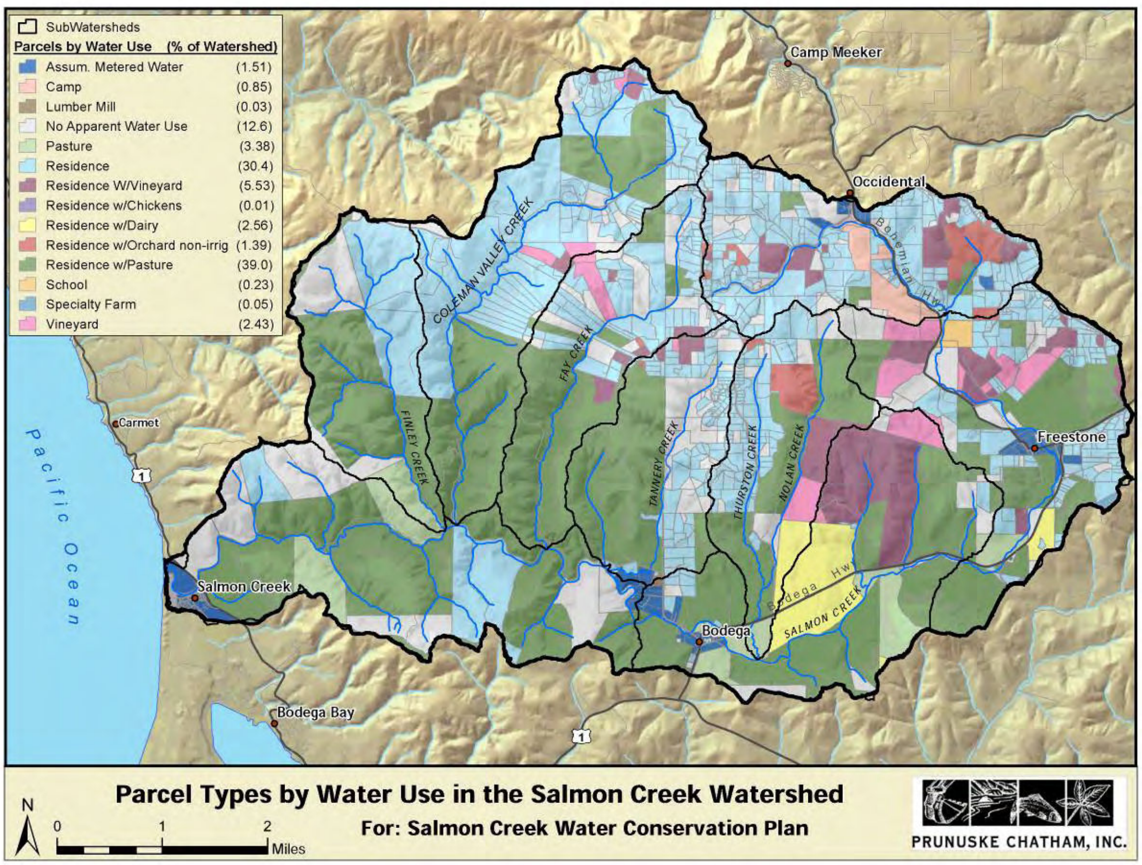


Figure 4. Water use types as defined by land use within the Salmon Creek watershed. Note the distribution pattern of rural residential in the upper watershed and along the ridgelines, with large livestock ranches in the lower watersheds and valley bottoms. This distribution is linked to vegetation, slope, and water supply availability. Vineyards are located primarily on ridge tops, out of the frost zone.

As expected, **freshwater demands** in the Salmon Creek Watershed are **primarily for residential and agricultural uses** (Figure 5). Residential water use accounts for 73% of the total consumptive demand and is comprised of potable indoor uses and outdoor irrigation with some non-commercial livestock, which can be served with non-potable supply. Vineyards and livestock-based ranches are the two primary commercial agricultural land uses in the watershed, accounting for 8% and 12% of total water demand, respectively. Community water systems for Freestone, Bodega, and Salmon Creek make up 5% of the total demand, while Bodega Bay—through an inter-basin transfer—utilizes approximately 1%. The three communities supplied wholly by local wells and springs have a small number of commercial properties that are constrained by water supply availability.

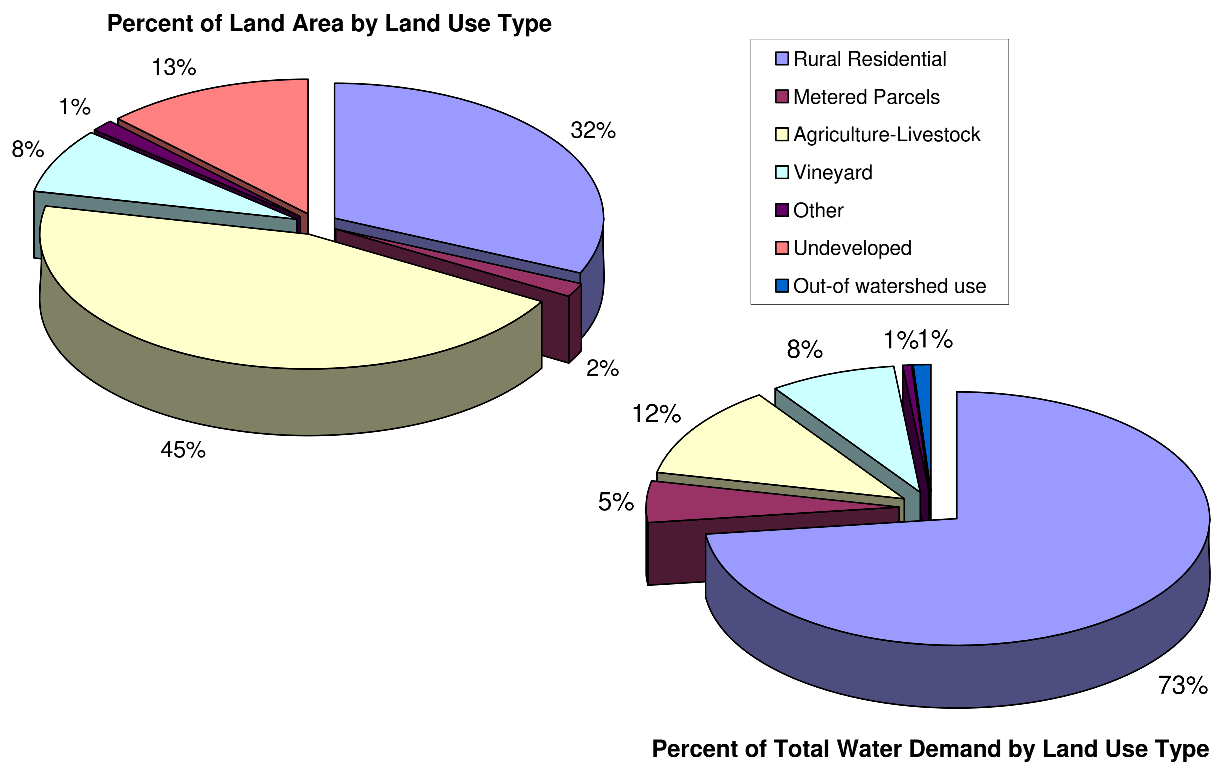


Figure 5. Distribution of land uses and their comparative percent usage of overall annual water demand within the Salmon Creek Watershed. Note that residential water demand is disproportionately higher than agricultural demand, especially given the proportion of the watershed acreage each utilizes.

Total annual water demand for each subwatershed area and the whole Salmon Creek Watershed is summarized in Table 1. **Consumption criteria methodologies developed for different water use categories are described in Appendix B and applied to parcel counts, livestock counts, and vineyard**

acreages. Residential demands are based on one household per parcel. This is likely an underestimation of the number of households, as many larger parcels in the watershed have multiple houses.

Livestock numbers for the entire watershed were roughly estimated by GRRCD staff and a daily water consumption by species applied; see Appendices B1 and B2[1]. The family livestock ranching and dairy operations are increasingly difficult to sustain as economically viable livelihoods due to loss of local support services and competition from large corporate farms. These agricultural operations, with their large parcel sizes and multiple generations of families, are crucial to maintaining the cultural and ecological integrity of the Salmon Creek Watershed.

Table 1. Estimated consumptive annual water demands by water use category for the Salmon Creek Watershed, listed by subwatersheds for water conservation planning purposes (data presented from demand inventories in Appendix B). One acre-foot is equal to approximately 326,000 gallons.

	Annual Water Demand (acre-feet)									
	Upper Salmon Creek	**Freestone Valley**	**Bodega Valley**	**Thurston and Nolan Creek**	**Tannery Creek**	**Fay Creek**	**Coleman Valley Creek**	**Finley Creek**	**Lower Salmon Creek**	**Total**
Residential	77.6	59.1	13.3	27.9	36.2	33.1	30.7	3.6	5.0	**286.4**
Metered		6.0	7.7						12.0	**25.7**
Vineyard	3.5	12.1	7.6	0.9	1.2	2.9	2.8	0.0	0.0	**31.0**
School	0	2.4	0	0	0	0	0	0	0	**2.4**
Sub-Total	**81.1**	**79.6**	**28.5**	**28.8**	**37.4**	**36.0**	**33.5**	**3.6**	**17.0**	**345.5**
Livestock	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**47.2**
Total										**392.7**

Vineyard calculations were based on actual acreages mapped from 2009 aerial photographs (Figure 6) and application of a 2 acre-inch per year irrigation rate.

---

[1] A more accurate accounting of the livestock type and distribution densities within subwatershed reaches would further refine the demand estimates and provide better data for water conservation planning. See Recommendations in Chapter 5.

The Salmon Creek Watershed has supported vineyards since the early 1800s when the Russians farmed the Freestone Valley. The recent interest in low-production, single-vineyard, high-end wines has renewed vineyard development in the watershed. For example, in the Joy Road area, which covers the upper Salmon Creek, Fay Creek, Tannery Creek, and Thurston Creek subwatersheds and is considered a Sonoma County water-scarce area, there has been an approximately 70% increase in the number of acres in vineyard since 1974 and a 22% increase since 2000. A number of vineyards that currently being developed in the upper Salmon Creek and Bodega Valley subwatersheds are not included in this analysis.

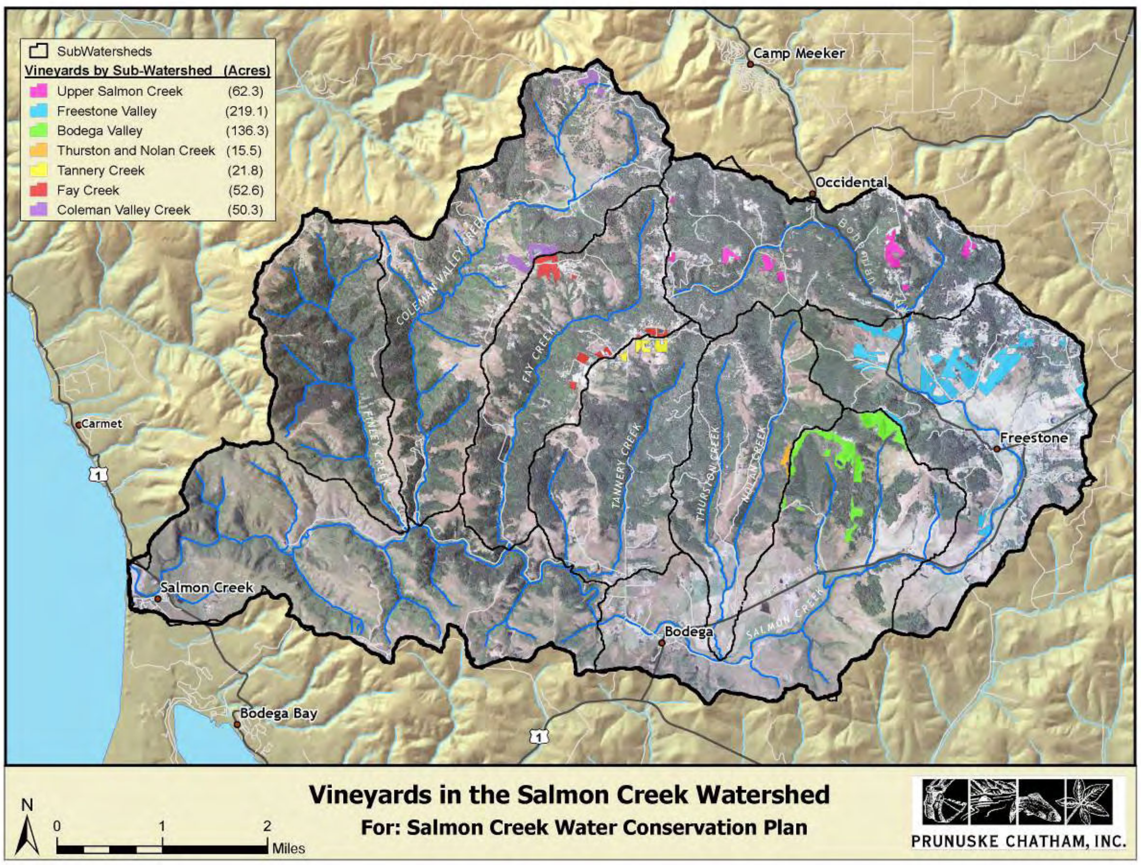


Figure 6. Acreage and location of vineyards in the Salmon Creek Watershed as of 2009. The vineyards are concentrated in the eastern portions of the watershed and on ridgetops–areas less affected by summer fog. Frost protection measures are not currently employed at vineyards within the watershed due to the milder coastal climate, although a few vineyards in the valley bottoms do experience frost losses.

The total annual consumptive water demand for water uses in the Salmon Creek Watershed is estimated to be approximate 393 acre-feet (128 million gallons). As discussed above, this estimate is likely low, although reasonable given the assumptions and high quality data utilized.

Note that permitted surface water diversion and storage rights in the watershed exceed the estimated demand (424 acre-feet versus 393 acre-feet), and the permitted diversions only account for a small portion of the supplies used to satisfy the existing demands. A possible explanation for this discrepancy is that the permitted water diversions and storage volumes are not currently being utilized fully for consumptive uses. See below for a description of water sources and the distribution and/or utilization of freshwater supplies by water use type.

Water Supply

All consumptive water uses, as well as the needs of the wildlife and plant communities, must be met by water supplies within the Salmon Creek Watershed. **Consumptive water demands are met by storage of rainfall runoff (ponds and roofwater catchment tanks), the annually recharged shallow groundwater table, bedrock aquifer storage, and direct streamflow withdrawals.**

The geology (Figure 7) and hydrogeology of a watershed largely determine the type of water supply available and utilized for a given parcel. In the uplands, along the ridgetops and steep canyons where the rural residential parcels are predominantly clustered, water sources are primarily groundwater wells and springs. However, the dominant geologic formation, Franciscan mélange, is a poor aquifer with typical yields averaging less than 3 gallons per minute (Kleinfelder 2003). The Franciscan mélange's metamorphic and sheared rocks are impermeable, carrying and storing water only along fracture zones. The Wilson Grove sandstone formation, locally capping the mélange, is a better, more consistent aquifer, but it is limited in extent and storage capacity. Riparian parcels typically extract water supplies directly from their watercourses through shallow wells or in-channel cisterns, as these sources are consistent and easily developed. Many parcels in Freestone Valley, Bodega Valley, and lower Salmon Creek have deep (over 80 feet) wells tapping the alluvial fill aquifer. The location, production, and quality of water in the valley alluvial aquifer are inconsistent.

Groundwater supplies in the upper watersheds are unpredictable. Residents in the area report that wells on neighboring parcels range from 25 gallons per minute to nominal amounts. Many residents report that their groundwater wells experience dramatic seasonal changes in production rates, with many requiring holding tanks to compensate for reduced pressure in the summer (pers. communications 2010). Other residents are forced to truck water in during the dry months. Studies of the Joy Road area document that groundwater wells and springs commonly experience diminished or intermittent production with perpetual use and adjacent extraction pressures (Kleinfelder 2003; Sonoma County 1974). Kleinfelder (2003) also documented that between the 1970s and 2000 the depths of new wells increased to follow a lowering water table and that this trend correlates to development rates, indicating an overdraft condition in the aquifer.

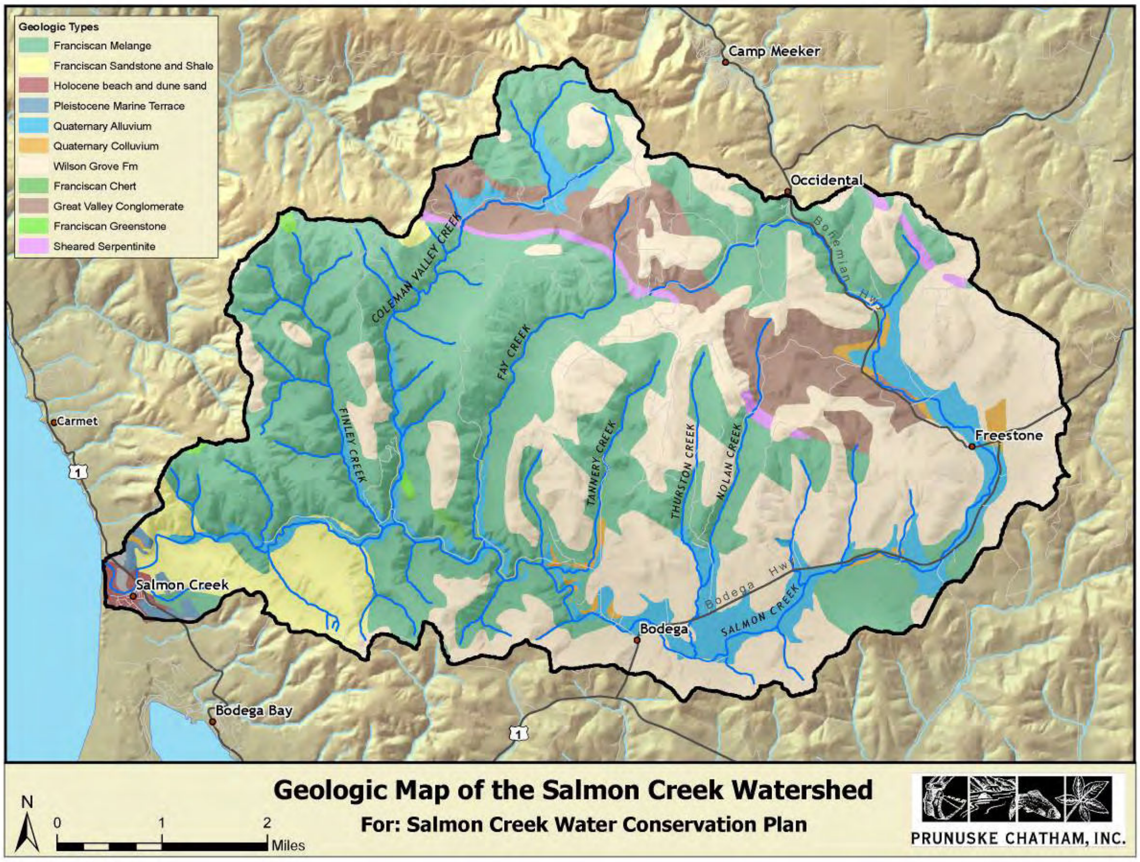


Figure 7. Geology of the Salmon Creek Watershed. Groundwater supplies from all of these formations are unpredictable and inconsistent. The Wilson Grove formation has high permeability but limited capacity as an aquifer. Springs typically occur along the interface between the impermeable Franciscan mélange and the Wilson Grove above it. The Quaternary alluvium filling the valleys along mainstem Salmon Creek and the lower portions of the tributaries provides seasonal groundwater storage for summer streamflows.

Springs are another common water source in the uplands. Anecdotal evidence indicates that springs in the uplands of Coleman Valley and Finley Creek are consistent and have not seen depletions in production associated with surrounding development pressures (pers. communications 2010). However, springs found lower in the watershed, down-gradient from rural residential concentrations, have decreased production since the 1960s and 1970s when development of the uplands took place.

The vast majority of **vineyards** (Figure 6) are using pond water captured during the rainy season. Thus, most are not pumping from groundwater during the irrigation season (pers. communication K. Beitler 2010). The ponds fill within the first few storms; the water is sand-filtered and used for irrigation. Some vineyards truck in water, especially during initial establishment of the vines. Vineyards in the Freestone Valley use a combination of pond storage, direct riparian diversions, and spring sources for their water supplies.

Water sources along the **riparian corridors** include direct diversions, pond storage, and riparian wells (both deep and shallow infiltration-gallery wells). Riparian and upland spring sources tend to be preferentially developed compared to groundwater when possible, as they are more consistent and often have better water quality. Direct diversions for consumptive water supplies can have localized impacts to habitat conditions and cumulatively can reduce streamflow volumes within a reach during the dry season.

Observations of community supply wells in the riparian corridor indicate that there is immediate water table response to pumping in the summer dry season and chronic effects to streamflow and instream habitat in drought conditions (PCI 2006; PCI 2010, Appendix A1). Storage ponds, which collect winter rainfall runoff for use in the summer, negate the need to directly extract riparian water during the dry season.

Bringing It All Together: Sustainable Supplies and Healthy Streamflow

Author: L. Hammack

As discussed in Chapter 1 of this Plan, inadequate summer dry-season water supplies are a result of the Mediterranean climate conditions and water demand pressures. One solution is to offset water shortages through storage of excess winter precipitation.

Watershed-wide water consumption data developed for the Water Consumption Analysis was divided into monthly demands for different water use types. The water demand for each water use type was further broken out by potable and non-potable use volumes. Riparian direct diversions were estimated based on known water use type supplies (metered parcel use in Bodega and Bodega Bay, a proportion of rural residential use, and livestock demand) and the State Board's water right dataset. Figure 8 illustrates the results of this **monthly demand analysis** and compares it to average monthly streamflow volumes.

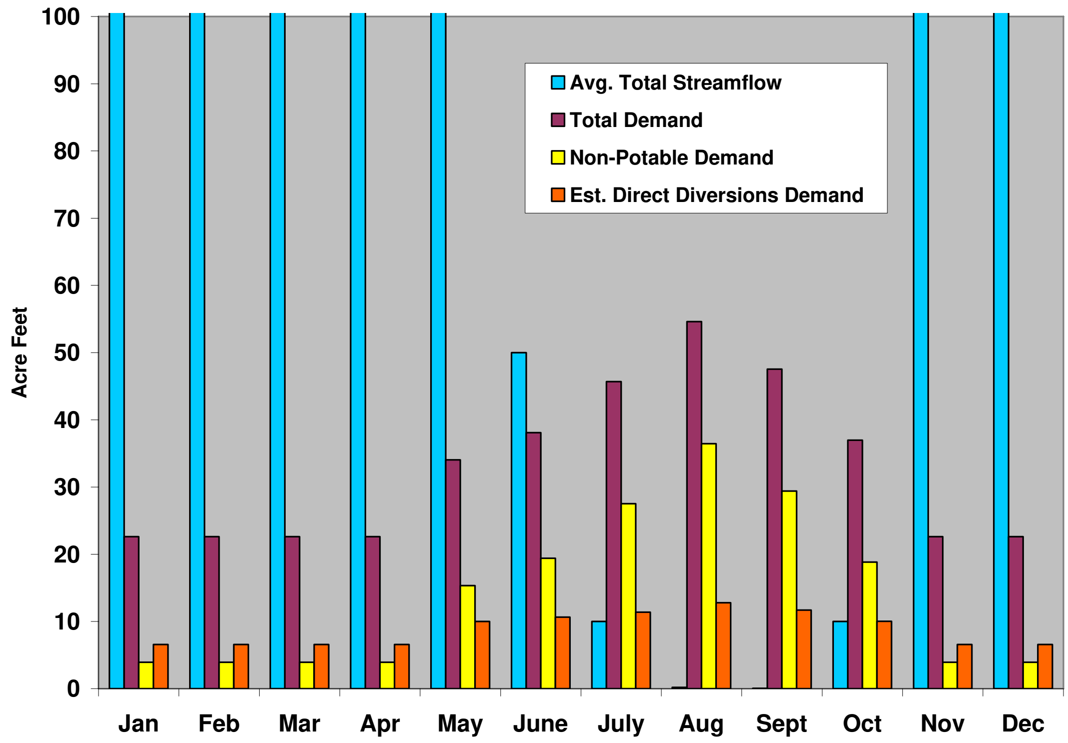


Figure 8. Monthly water demands versus streamflow volumes in Salmon Creek. This illustrates conceptually the contrast between extractive demands and available water supplies. It also illustrates the potential volume of water that could be available for instreamflows if current direct riparian diversions were converted to winter storage supplies.

Streamflows in mainstem Salmon Creek and its tributaries decline dramatically from July through October, with August and September flows often becoming intermittent or stopping altogether. This summer period is also the period of highest demand—vegetable gardens, landscaping, and higher livestock water needs occur during the warm, dry season. Along the stream courses these non-potable water demands are often met with direct riparian diversions or upland springs that directly feed first order tributaries.

Replacing these direct diversion extractions with stored winter precipitation or runoff could correspondingly increase water available for instream flows by the levels shown in Figure 8.

Withdrawals from groundwater and springs that are not directly connected to the stream system do not have an immediate and localized impact on streamflows during the summer but do reduce the amount of water available for summer base flows in the watershed overall and within individual subbasins.

Practices to increase groundwater infiltration will help maintain and improve groundwater supplies, while using stored winter rainfall and runoff will reduce the need to use extractive supplies to support non-potable water uses. Installation of winter storage projects for non-potable water uses could increase the water directly and indirectly available for instream flows by the levels shown in Figure 8.

Practices to reduce direct diversions, as well as increase groundwater supplies, are likely to have the most impact on dry-season streamflows within localized reaches of their subwatershed. Figure 9 shows the subwatersheds within the Salmon Creek Watershed and indicates areas that are currently considered high priority salmonid rearing reaches. **Water conservation and water storage projects concentrated in these reaches will have the most immediate impact on summer flows and salmonid survival.**

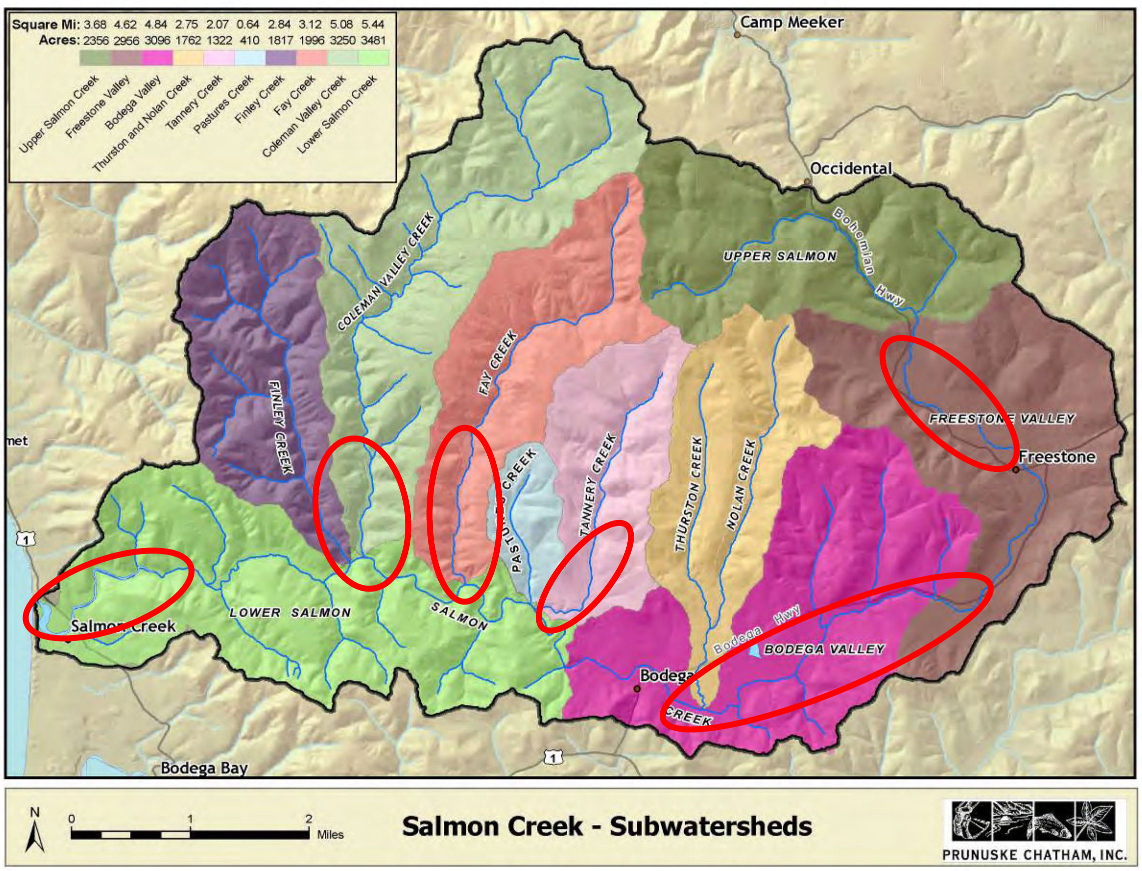


Figure 9. Subwatersheds in Salmon Creek Watershed with known salmonid-rearing reaches circled. Implementation of water conservation practices and winter rainfall storage projects that will protect and increase summer streamflows in these reaches are high priority.

Many opportunities exist to reduce demand on extractive water sources that, through direct or cumulative effects, reduce streamflow and degrade instream habitat. Measurably increasing streamflows to improve salmonid rearing conditions and water supply sustainability requires that the following methods be integrated and applied in a concentrated manner in critical rearing reaches:

- Water conservation and wise-use practices;
- Groundwater recharge through practices to slow and infiltrate stormwater runoff;
- Development and wide implementation of alternative, non-extractive water supplies, including rainwater storage; and
- Reduction in riparian water diversions.

The following section describes the pilot program integrating these methods that has been initiated in the town of Bodega.

BODEGA PILOT PROGRAM

History and Purpose

Authors: A. Crawford and L. Hammack

In 2004, the Bodega Pilot Program (BPP) was envisioned by a group of Salmon Creek residents who, having seen the creek's flows dip precariously in the summer months, understood that an effective rehabilitation strategy for the creek was possible because the Salmon Creek Watershed is home to landowners who wanted to improve the health of their watershed, threatened species, and a local water utility in need of infrastructure improvements. These residents also understood that the relatively small size of the watershed made it a manageable area in which innovative water conservation measures could be implemented and the effectiveness of those measures in improving instream flows could be monitored (pers. comm. B. Cluer 3/19/10).

Over the last five years, the original BPP vision has guided many planning efforts in the watershed and almost 2 million dollars have been secured for projects that demonstrate the effectiveness of rainwater harvesting, water conservation, and enhanced storage capacity to reduce extractive demands on streamflow during dry season months and improve fish habitat conditions. **By demonstrating the link between conservation and instream flows, the BPP provides a model to other communities and landowners along salmonid rearing streams; more detailed in formation is in Appendix A1.**

The ongoing success of the BPP depends upon multiple factors, including:

- **BPP participants receive benefits** in the form of greater water security and cost-effectiveness;
- **The BPP** is developed and implemented in a manner that **replaces, rather than augments, extractive water supply**. Water supply savings must be retained in the stream or groundwater table during the dry season;
- The **volume of water supplied by rainwater harvesting and increased storage are maximized** for a given location (well or pump) to either replace an extractive source or measurably reduce withdrawals from the extractive source;
- **Streamflow and groundwater extractions at a location (well or pump) are reduced** from existing pre-BPP conditions, the reductions are documented annually, and the amounts are commensurate with volumes generated by alternative sources and storage improvements;
- **The benefits and requirements of the BPP are clearly articulated** so that participation occurs with full "buy-in" for a long-term commitment;
- **Details of BPP participation** are understood and supported by the larger community;
- **Participants receive ongoing technical support** to maintain and utilize alternative water sources;
- **Partnership agreements** for BPP activities are made between funding agencies, resource management agencies, water suppliers and/or landowners that are pragmatic, comprehensive, and enforceable; and
- **An implementation monitoring program** is developed to track actual reductions in extractions over time and compliance with agreements.

A technical memo detailing BPP Water Supply Security and Streamflow Augmentation Criteria is Appendix A1 to this Plan.

Bodega Water Company Planning Process

Authors: A. Crawford and L. Hammack

The town of Bodega is considered a disadvantaged community, with some of the highest water rates in the state. Early Bodega residents utilized springs and wells and drew water from the creek. In 1981, the town's first centralized water system, the Bodega Water Company (BWC), was created to supply water to a golf course that, ultimately, was never constructed (pers. comm. A. Bleifus

3/26/10; BWC Articles of Incorporation). In the course of planning for this development, local residents were invited to join the nascent company. Today, BWC is a member-owned, mutual benefit corporation that supplies potable water to 39 hookups within the Bodega Valley. **BWC is one of the larger single users of Salmon Creek water in Bodega Valley, as the majority of their water supply comes from a shallow "gallery" well adjacent to Salmon Creek.** The depth of this well is only slightly lower than the streambed and is considered by the Department of Water Resources (DWR) to be drawing from shallow groundwater feeding Salmon Creek. BWC has two other deep groundwater wells that are limited in their production and have water quality issues.

BWC has applied for an appropriative water right for their well; however, the terms of this water right preclude the use of the well during the dry season. BWC has been seeking alternate water sources and storage options to reduce the use of the well in order to comply with DWR's terms for their appropriative water right.

BWC's proximity to Salmon Creek and need to explore alternate water supply options offer a unique and powerful opportunity to demonstrate the important role local water utilities can play in fisheries restoration. Because BWC is an all-volunteer, member-based organization, their ongoing involvement in the SCWCP depends on the professional technical support the SCC has funded through this SCWCP.

SCWCP partners Virginia Porter Consulting and PCI have worked closely with BWC to assess the company's infrastructure, analyze supply and demand data, and develop long-term strategies for water conservation measures and alternative supply options that will produce a reliable, sustainable water supply. Based on this assessment, recommendations have been made to the BWC Board for upgrading and repairing elements of the BWC water system, as well as conservation and other measures BWC members can take that will contribute to supply sustainability.

Rainwater Catchment System Design and Implementation

Authors: A. Crawford and L. Hammack

One recommendation in the *Salmon Creek Estuary Study and Recommendations* (PCI 2006) was to support local domestic water providers in securing offstream water storage and/or new water sources to reduce summer withdrawals from Salmon Creek.

In 2008, during the course of the SCWCP planning, the project team developed a framework for installing rainwater catchment systems throughout the watershed, in both upland areas and critical reaches of Salmon Creek. The information gathered during this planning process provided an important demonstration of the instream improvement potential if rainwater catchment systems were strategically installed in critical reaches.

In early 2009, the opportunity arose to apply, through the NOAA Restoration Center, for implementation funding from the American Recovery and Reinvestment Act (ARRA). Utilizing water use information from BWC and ideas generated as part of the BPP, SCWCP partners PCI and GRRCD developed a proposal for the "Save Our Salmon" (SOS) Program. GRRCD was awarded the grant for the SOS Program in mid-2009. **The SOS Program is now underway, with installation the following rainwater catchment systems planned for summer 2010:**

- **One tank at the new Bodega Volunteer Fire Department (BVFD) firehouse**
    - BVFD has often relied on treated BWC water from a shallow riparian well for emergency uses. This 38,000-gallon tank will provide an alternative source of water for department training, fire suppression, and community emergency uses. **Appendix A2 provides a summary of the planning and implementation for this tank.**
- **Residential property roofwater catchment systems**
    - These tanks will replace approximately 200,000 gallons of treated water from a shallow riparian well and be used for summer non-potable irrigation and livestock watering. The actual number of tanks installed will depend on the individual needs of residential properties.
- **Underground storage tank on an agricultural property**
    - This 230,000-gallon capacity tank will collect and store roofwater for summer cattle watering, replacing the use of a shallow riparian well and direct stream withdrawls.

The SOS Program is an important step forward in demonstrating the link between winter water storage and improved spring and summer instream flows in Salmon Creek. The NOAA ARRA funding is also supporting a 2-year ecological effectiveness monitoring program for the grant activities; the results of this monitoring will inform local and regional future projects.

In addition to the tanks funded by the NOAA ARRA grant, the BPP would benefit from additional installation of catchment systems on residential and agricultural properties in the town of Bodega and in Bodega Valley. Additional recommendations can be found below in Chapter 5.

CHAPTER 3: CONSERVATION STRATEGIES

Author: V. Porter

The SCWCP Water Conservation Strategies support efforts in California's coastal communities in their efforts to developing water conservation measures and alternative water supply solutions that support human needs while protecting and restoring instream flows for fish and wildlife. **The complete Strategies are Appendix D to this Plan.**

Table 2 below lists the 8 Water Conservation Strategies developed for the SCWCP, along with the target community for the specific strategy.

Table 2. SCWCP Water Conservation Strategies

Conservation Strategy	Target Community
1. Streamflow Restoration for Salmonids	All residents, businesses, visitors
2. Residential Self-Survey for Efficient Water Use	Residents on metered systems or private supply, single-family and multi-family
3. Low Water Gardening	Residents and businesses with gardens or landscapes
4. Stormwater Management	All landowners and land managers
5. Roofwater Harvesting	All property owners
6. Conservation in the Hospitality Industry	Hotels, restaurants, spas, golf courses, recreational facilities
7. Water Rates	Water purveyors – public and private
8. Managing Water Systems	Water purveyors – public and private

Each Strategy includes a brief summary of the topic, discussion of the target community, an assessment of the effect of implementation and numerous tools and resources to facilitate implementation. **The complete Strategies are Appendix D to this Plan.** Below is a brief discussion of each Strategy explaining how each one advances the goals of the SCWCP.

STREAMFLOW RESTORATION FOR SALMONIDS

The Streamflow Restoration establishes the rationale for all the rest of the Strategies by describing critical habitat requirements for the watershed's listed salmonid species.

Populations of steelhead trout and coho salmon have declined for many reasons, including past and current water diversions, development, removal of large wood from creeks, and degradation of riparian areas. As a result, the species are now protected under the federal and State Endangered Species Acts in most of coastal California.

Businesses, residents, water purveyors, and visitors to coastal California communities can make decisions that improve aquatic habitat if they understand the lifecycle of the native salmonid populations in their watersheds. As communities make decisions with the fish in mind, their water supply security will improve because a more diverse set of supply strategies may provide a buffer against mandatory use reduction if fish populations do not improve.

The next 7 SCWCP Water Conservation Modules provide specific guidance for implementing decisions that support fish habitat.

RESIDENTIAL SELF- SURVEY

The residential self survey is a tool for residents on community water systems or on private water supply (well, spring, pond) to identify opportunities to conserve water through improved efficiency. It is **a "do-it-yourself" water-saving approach that can result in tremendous savings in household water use.**

Residents complete the self-survey on their own. Water suppliers, community groups, and Resource Conservation Districts can promote use of the survey throughout by sponsoring educational self-survey workshops and neighborhood gatherings.

The survey consists of two steps:

1) Water audit, and

2) Calculation of efficient water use.

The water audit targets all household water uses, both indoor and outdoor. It identifies opportunities for detecting and then replacing or repairing inefficient fixtures and systems. In particular, the audit provides how-to steps for determining flow rates of faucets and showerheads, as well as toilet flush volumes; techniques for detecting leaks in the home and garden and information on leak repair; and data on irrigation needs based on climate conditions of four distinct coastal regions. **The self-survey also includes a Residential Water Use Calculator for determining the amount of water used at the residence, both indoors and outdoors. The Calculator is tailored to coastal California climates by geographic region.**

The 2003 study by the Pacific Institute *Waste Not Want Not: the Potential for Urban Water Conservation in California* reports the potential to save up to 40% of indoor water use in residences in California by installing efficient plumbing hardware and adopting practices to maximize water use efficiency. Pacific Institute further reports 25% - 40% savings of outdoor water use through garden design and maintenance practices. Performing the survey gives a resident the information needed to estimate the savings potential at their home.

By using the self-survey to reduce water use, residents can improve the likelihood that more water will be available instream during critical summer months. **Water security may also improve because residents will more clearly understand their water use patterns and will know how to curtail use as needed.**

LOW WATER GARDENING

Low Water Gardening minimizes the need for summer irrigation by recommending specific garden practices that, coupled with developing alternate water supplies, such as rainwater or graywater, will provide the maximum benefit to aquatic habitat.

In coastal California approximately 35% of all residential water use is outdoors. Implementing the principles of Low Water Gardening will result in a 25-50% reduction in outdoor water use, especially if high-water-using plants are replaced with less thirsty varieties.

Additional benefits accrue as a result of these practices, including reduced use of chemical pesticides and fertilizers, increased groundwater recharge, reduced run-off from irrigation and stormwater, and increased soil health. **Low Water Gardening principles may also result in a greater diversity of plant species, beneficial insects, and bird and mammal species.**

STORMWATER MANAGEMENT

This Strategy describes how to develop robust, scalable, decentralized stormwater management strategies, which are critical for improving watershed health and water security.

Implementing effective stormwater management measures address both human needs, and total watershed health.

Benefits to the watershed include:

- Increasing uplands water infiltration and retention capacity will improve water security by recharging groundwater aquifers, while increasing base flows in streams and reducing mortality in listed fish populations;
- Slowing down stormwater runoff will decrease topsoil loss, erosion, flooding and streamflow variance by reducing the volume and rate of peak flow events;
- Removing pollutants in runoff will improve water quality in streams and aquifers; and
- Reducing the delivery of erosion products to streams will increase flows by keeping pools and riffles free of excess sedimentation.

Benefits to landowners include:

- Recharging groundwater supplies will increase water security by improving the function of groundwater wells and alleviating the economic and resource costs of trucking in water;
- Well-designed roads will retain better drivability, with reduced maintenance needs;
- Reducing flooding will protect property values and lower expenses for stopgap measures like pumping, levees and raising houses;
- Increasing the quantity of infiltrated and stored water onsite will help increase fire suppression capacity and defensible space; and
- Retaining soil will keep land productivity high, lowering fertilizer costs.

ROOFWATER HARVESTING

Throughout California, **during summer months when rainfall, streamflows and groundwater supplies are lowest, human demand for water is highest and listed fish populations are under extreme stress.** Additionally, due to climate change, greater seasonal variation in rainfall is predicted, with the potential for diminishing California's overall water security. Given that most of California's coastal regions have adequate rainfall during the year to support our communities, incorporating this storage component increases the options for using the supply during the times of the year when we need it the most.

Roofwater harvesting systems are a viable method for capturing winter rains for water use during the dry season. A well-designed roofwater harvesting system can reduce or eliminate demand for surface and groundwater supplies.

Most often roofwater is used to supply non-potable needs such as garden irrigation. Roofwater supply can also be a source for potable uses with proper filtration and disinfection, and roofwater harvesting can diversify a landowner's water supply sources and decrease reliance on traditional sources. On a community scale, it can improve water supply security and improve fire protection supplies while supporting better streamflows for fish and other aquatic life during the dry season.

Conservation in the Hospitality Industry

The hospitality industry consists of food services, accommodations, recreation, and entertainment businesses and they have a **unique opportunity to create a "water resource stewardship" identity because of their contact with visitors.** Creating this message and enlisting the support of customers can positively influence the community's involvement in water conservation.

Depending on the community, a significant portion of the overall water may lie in supplying hospitality industry businesses. Many coastal communities in California depend on tourism and have relatively high water use in this sector. There are numerous cost-effective water efficiency measures that can be implemented by hospitality businesses to achieve water savings without reducing the quality of service provided by the business. Many of these actions will also reduce wastewater flow to a sanitary sewer or septic system.

Studies have shown that 25%-40% of savings can be achieved in most hospitality businesses by implementing the measures outlined in this Strategy. All the measures can result in reduced reliance on local water supply. Savings in landscapes and golf courses has the added effect of reducing demand during the peak irrigation season, which is also the peak time when increased streamflow is needed for aquatic habitat.

Water Rates

The amount of water used by customers on metered water systems tends to respond to the water rate and rate structure. Rate structure design can be used effectively to send a "price signal" to customers to reduce use, and can guide overall water use toward a more sustainable level.

Where local water supplies utilize streams that are breeding habitat for listed salmonid species, water rate structures can be used to target customers' discretionary uses during the critical periods of the year for aquatic habitat.

Using approaches such as seasonal rates, increasing block rates, or individual "goal" rates, utilities can result in reduced water use during the summer dry season. Rate structures to implement these approaches are discussed in detail in this Strategy.

Water purveyors have many options for rate structure design. Most rates are made up of two components: 1) a "fixed" charge that is assessed regardless of the amount of water used, and 2) a commodity fee for the actual amount of water used. **Examples of two very different structures are:**

- **"Flat fee":** A fixed amount is charged each month regardless of the amount of water that is used, and provides no financial incentive to use water efficiently; or
- **"Increasing block rate":** Has a fixed monthly fee, and a commodity charged for all water used, with higher rates per unit for successive blocks, or fixed quantities of water. This structures provides a measurable pay-back when efficient fixtures are installed or waste is reduced.

The Strategy describes a variety of structures with a focus on those that incentivize conservation.

MANAGING WATER SYSTEMS

Most rural coastal communities have small water systems with few connections. These systems face financing and staffing challenges. Because the financial burden of system operation and regulatory compliance is spread across relatively few customers, rates are often high in comparison to larger communities. Staffing can be a challenge, in part, due to the licensing requirements for water treatment operators and water distribution operators in California. Under these conditions, systems often suffer from deferred maintenance and high unaccounted-for-water (UAW). Coastal systems may also experience accelerated deterioration of components such as valves, pumps and pipelines because of the corrosive nature of salt in the air and soil.

A well-managed water system provides community stability, viability, and a sense of water stewardship. A physically well-managed system will have very little UAW, ideally less than 10%, so the water that is produced has the potential to be put to maximum beneficial use. Long-term planning can assure that demand is not allowed to grow past the sustainable supply capacity of the source water. Environmental water needs such as instream flow for fish can be maintained and managed for the beneficial use.

This Strategy presents system management techniques to increase water security and minimize water loss, thereby improving instream flow conditions. These techniques include:

- **Preventative maintenance** such as exercising valves and monitoring for leaks;
- **Timely reactive maintenance** such as leak repair;
- **Redundancy in physical systems** such as pumps and power sources;
- **Redundancy in human resources** such as operators;
- **Long-range planning for the physical system** replacement and upgrade; and
- **Long-range planning for water supply sustainability.**

Chapter 4: Outreach and Education

Authors: A. Crawford, B. Dolman, K. Lundquist

Watershed Signage

One of the objectives of the SCC SCWCP grant was to **design and install signage alerting residents and visitors to low-flow conditions as a means to encourage water conservation during these periods**. OAEC's WATER Institute led the SCWCP team in designing the look and content of these signs. Working with sign designer Ron Blair Signs, OAEC developed a mobile system that will allow signs to be rotated throughout the watershed on a seasonal basis.

This mobility will increase the visibility of the SCWCP, educating local residents and seasonal visitors about water conservation efforts in the watershed. The signs also provide the address of the updated Salmon Creek Watershed Council's website (www.salmoncreekwater.org; see below) which has many resources posted, including the Conservation Strategies and this Water Conservation Plan.

See Appendix E for the sign designs.

Public Workshops

OAEC's WATER Institute developed and hosted two successful workshops with two associated tours that focused on alternative water supply and conservation practices. The first workshop, held in late 2009, focused on rainwater catchment systems and included the option of touring a nearby residential rainwater catchment system. Thirty-one people attended. The second workshop and tour, held in April, 2010, provided the dozen attendees with an overview of water conservation measures and technical information summarized in the Conservation Strategies. The tour focused on the water conservation methods (including stormwater management and roofwater catchment) currently in use at the OAEC.

Updated Salmon Creek Watershed Council Website

An important part of our outreach strategy was to make our **educational materials easily available to the coastal communities they serve**. SCWCP partners at OAEC's WATER Institute and PCI worked with the Salmon Creek Watershed Council to update their website (www.salmoncreekwater.org) and post resources produced as part of the initial SCWCP planning work.

This updated site will provide a place for community members to learn about all conservation activities happening in the watershed, with links to the partner organizations that are carrying them out. An email announcement will be sent to watershed groups, public resource agencies and elected officials in targeted coastal counties inviting them to use this new resource.

STAKEHOLDER INTERVIEWS

A key component of this SCWCP planning process was to "convene a group of local residents and organizations to implement the water conservation plan and develop future programs to assist with design and installation of conservation and catchment projects". The intended outcome was to **encourage and empower local residents to develop and implement a range of projects that would advance the SCWCP goal.**

Due to the state budget freeze in late 2008, progress on convening the group was delayed for almost a year. Once funding was again available, the SCWCP team re-assessed what was feasible for this community outreach effort in the time remaining for the grant. **Because the time for a series of community meetings was limited by the time funding was re-released, the team discussed other approaches to soliciting community input.**

After receiving positive feedback from stakeholders in Sonoma Valley who had been part of a groundwater planning community process facilitated by the Center for Collaborative Policy (Center), **OAEC's WATER Institute retained the Center to conduct interviews with a range of stakeholders and make recommendations** for how to best move forward developing robust community collaboration that will support the SCWCP. In addition, all the interviewees were invited to a professionally facilitated meeting in early May where water consumption analysis information was presented and recommendations for future work was solicited from all present.

The facilitator's summary and recommendations, along with a list of the interviewees, is in Appendix C.

CHAPTER 5: RECOMMENDED WATER CONSERVATION AND STREAMFLOW RESTORATION EFFORTS

These recommendations have been synthesized from numerous meetings and discussions with SCWCP partners, watershed residents, local utilities, and many others during this initial planning process.

1. *CONTINUE COLLABORATIVE SCWCP EFFORTS*

A. **Partnerships:** Hold professionally-facilitated quarterly planning meetings with existing and potential SCWCP partners. Objectives for these meetings include:

- Adopting an updated SCWCP name that is agreeable to all SCWCP partners and reflects more accurately the SCWCP goals of developing alternative water supply solutions that support human needs while protecting and restoring instream flows for fish and wildlife.
- Developing products, including educational materials, that makes the SCWCP partners and projects easily recognizable to watershed residents and funding organizations.
- Identifying additional partners, including local utilities, state and federal agencies, and non-profits;
- Building agreement about optimal communication methods between partners;
- Cooperative scheduling of community education and outreach through development of a web-based "watershed calendar";
- Increasing understanding of the unique role each partner plays in restoring streamflows in the watershed; and
- Identifying collaborative funding opportunities, as well as methods for supporting each organization's individual fundraising efforts.

B. **Incentives:** With SCWCP existing and potential partners, develop watershed-wide incentive programs for implementing water conservation measures, including:

- Limiting the amount of landscaping and irrigation installed around residential buildings;

- Installing water wise landscaping where appropriate and using low flow gardening methods; and
- Installing water-conserving household plumbing fixtures, including toilets, showerheads, aerators, and washing machines.

2. *IMPLEMENT PRIORITY REACH-BASED PROJECTS*

A. **Riparian Sources:** With SCWCP partners, identify, develop, and implement reach-concentrated water diversion reductions and streamflow restoration projects and practices in the watershed. Proposed project types include:

- Design and installation of residential roofwater harvesting systems to replace extractive water sources for non-potable water uses;
- Design and installation of agricultural water supply storage such as off-channel ponds and roofwater harvesting systems, including water distribution systems for livestock use and riparian corridor fencing; and
- Continuation of the Bodega Pilot Program through implementation of roofwater harvesting and off-channel water storage projects that measurably reduce direct diversions from Salmon Creek, as well as associated SCWCP effectiveness monitoring.

B. **Uplands:** With SCWCP partners, identify and implement regionally-concentrated groundwater recharge and spring enhancement projects and practices in the watershed. Proposed project types include::

- Grading and planting stormwater infiltration swales on residential and agricultural roads;
- Design and installation of rain gardens to capture and infiltrate excess stormwater;
- Replacement of impervious surfaces (such as parking areas and patios) with pervious materials (such as grass pavers and porous concrete) to increase groundwater recharge; and
- Design and installation of residential roofwater harvesting systems to replace groundwater sources for non-potable water uses.

3. Research and Practice Development

A. **Research:** Conduct scientific research and planning tools to support SCWCP efforts, including:

- Researching, mapping, and designating high-priority groundwater recharge areas within the watershed based on known characteristics of geology, soils, slope stability, and land uses;
- Developing an accurate accounting of livestock types and distribution densities within the subwatersheds;
- Exploring linkages between upland springs and creeks and flows in Salmon Creek and its tributaries;
- Researching and incorporating climate change predictions into developing projects that improve the watershed's resiliency to predicted alterations in weather patterns and events;
- Researching the viability of beaver (*Castor canadensis*) re-introduction into appropriate locales within the watershed to provide instreamflow and fish habitat improvement;
- Researching and reporting on the relationship between riparian vegetation and instreamflow;
- Refining hydrologic models of the watershed, including water supply, demand, and diversion datasets, to identify priority sites for rainwater catchment and runoff storage systems; and
- Researching options for tracking reductions in water extractions and monitoring streamflow and/or streamflow related habitat responses.

B. **Practices:** Bring SCWCP scientific research, data, and methodologies to a wide audience, including:

- Refined practices to increase groundwater recharge, spring enhancement, and direct diversion reductions.
- Research and options for protecting existing streamflows and voluntary discontinuations of diversions for instreamflow restoration;
- Protocols for transferring SCWCP scientific findings to appropriate Sonoma County agencies (such as the Sonoma County Water Agency

and the Sonoma County Permit and Resource Management Department) for use in their planning efforts.

4. *Continue Outreach and Education to Watershed Residents*

A. **Community Sustainability:** Communicate via meetings, website content, and other materials, that the SCWCP objective is to improve the watershed resident's quality of life and local agriculture while improving instream flows and habitat for fish and other aquatic organisms.

B. **Ecological Awareness:** Develop materials and strategies for educating residents about:

- Ecological impacts of pumping water directly from creeks;
- Importance of maintaining healthy and fire resilient forests and woodlands to ensure optimal stream health;
- Options for abstaining from using riparian water rights for the purpose of improving salmonid habitat; and
- Practices and implementation materials that support landowners in increasing upland spring production and groundwater recharge.

C. **Water Supply, Use and Policy:** Develop and host workshops that provide substantive water supply, use and policy information to residents, including:

- Types and levels of water use in the watershed (including rural residential, dairies, ranching, schools and recreational properties, and vineyards);
- Impacts that varying types of vegetation have on streamflows (for example, willows or redwoods);
- Interconnection of groundwater, surface water, and springs;
- Documented changes in streamflow levels over the past decades;
- Impacts of upstream diversions on downstream users; and
- Potential impacts of emerging legislation (such as AB 2121, AB 811, and AB 2304) on landowners' existing and future water supply and use rights.

D. **Agricultural Water Conservation:** Develop and host workshops and individual consultations for agricultural landowners on targeted water conservation methods for agricultural operations.

E. **Existing Programs:** Inform residents about existing water conservation incentive Programs, including Sonoma County Energy Independence Program.

F. **Community Monitoring:** Explore opportunities for involving volunteers in monitoring water supply, including:

- Promoting volunteer monitoring of creek conditions and refining the methods for collecting data about creek conditions;
- Seasonal spring flow monitoring;
- Promoting installation of residential rain gauges and refining methods for collecting and analyzing data from the gauges; and
- Developing a well monitoring program and methods for collecting and analyzing data on spatial and temporal variations in groundwater supplies.

5. *SUPPORT MANAGEMENT OF WATER SYSTEMS IN THE WATERSHED*

A. **Infrastructure**: To reduce unaccounted-for water losses in water systems throughout the watershed, identify opportunities to upgrade each system's infrastructure, including:

- Developing and maintaining accurate records of system infrastructure;
- Sub-metering to troubleshoot leaks;
- Repair and/or replacement of leaking water lines;
- Repair and/or replacement of leaking storage tanks; and
- Regular replacement of water meters.

B. **Water Supply Sustainability:** Research and develop a suite of options for ensuring ecologically-sound water supply sustainability in the watershed, including:

- Working with local water systems to develop water balance strategies for each system so that water demands do not exceed supply;

- Long-term planning and implementation for adequate storage for each system, including options that support the reduction or elimination of extractive diversions during the dry season;

- Developing and hosting a series of workshops with SCWCP partners and regulators to align on mutually-agreeable alternative sources for potable and non-potable water; and

- Developing recommendations for appropriate water conservation rate structures for each small water system.

C. **Customer/Member Engagement:** Support engagement of local water system customers/members in water conservation efforts by:

- Providing SCWCP materials to water system staff for distribution to customers/members and

- Developing targeted SCWCP workshops to present information about each system's infrastructure and operations. Depending on the preference of the water system management, these workshops could be co-hosted with water system staff.

6. *COASTAL COMMUNITY INFORMATION TRANSFER*

- Utilize SCWCP partner expertise and products to conduct trainings for organizations in other coastal communities seeking to develop water conservation programs that support improved aquatic habitat while simultaneously supporting the freshwater demands of residents.

ACKNOWLEDGMENTS

Project Team for this State Coastal Conservancy-funded SCWCP planning process

State Coastal Conservancy
Deborah Hirst, Project Manager

Occidental Arts and Ecology Center's WATER Institute
Brock Dolman, Director
Kate Lundquist, Assistant Director

Salmon Creek Watershed Council
Kathleen Kraft
David Shatkin

Prunuske Chatham, Inc.
Aimee Crawford, Senior Project Manager
Lauren Hammack, Geomorphologist
Jennifer Michaud, Senior Biologist
Liza Prunuske, Principal

Virginia Porter Consulting

The Project Team thanks the following for their participation in and support of this planning process:

SCWCP planning process assistance
Mary Selkirk, Center for Collaborative Planning: meeting facilitation
Kevin Swift, Swift Writing: Conservation Strategy writing
Ginny Laughlin, Athena Web Design: Strategy design
Lenaya Pongan: Salmon Creek Watershed Council website assistance
Dave Jordan: Salmon Creek Watershed Council website design
Ron Blair Signs: Watershed signage design and production
Kathie Lowrey, PCI: Editing and style guidance
Dylan Loudon and Lucas Walton, PCI: GIS and mapping

Agency Staff
Joe Pecharich and Pat Rutten, NOAA Restoration Center
Gail Seymour, California Department of Fish and Game
Janice Oakley, California Department of Public Health
Lisa Hulette and John Green, Gold Ridge RCD
Brian Cluer, NOAA's National Marine Fisheries Service

Community Participants and Supporters
Noelle Bouck, Margaret Gerner, and Victoria Johnston, Salmon Creek Watershed Council
Hal Wood and Stephanie Voet, Russian River Utilities
Rod Huls and Janet Mantua, Bodega Bay Public Utilities District
Steve Perucchi, Rancher
Kurt Beitler, Boheme Vineyard
Bodega Water Company Board and Luana Presser
Bodega Volunteer Fire Department
Craig Williams, Architects without Borders
Doug Richmond, Harmony School
Bodega Post Office

REFERENCES

Bisson, P. 2008. Salmon and Trout in the Pacific Northwest and Climate Change, June 16, 2008. U.S. Department of Agriculture, Forest Service, Climate Change Resource Center. http://www.fs.fed.us/ccrc/topics/salmon-trout.shtml

California Department of Fish and Game (CDFG). 2003a. Stream Inventory Report Fay Creek, Salmon Creek Watershed Sonoma County, Survey: Summer 2002, Report: October 2003.

California Department of Fish and Game (CDFG). 2003b. Stream Inventory Report Tannery Creek, Salmon Creek Watershed Sonoma County, Survey: Summer 2002, Report: October 2003.

California Department of Fish and Game (CDFG). 2004a. Stream Inventory Report Coleman Valley Creek, Salmon Creek Watershed Sonoma County, Survey: Summer 2002, Report: March 2004.

California Department of Fish and Game (CDFG). 2004b. Stream Inventory Report Finley Creek, Salmon Creek Watershed Sonoma County, Survey: Summer 2002, Report: March 2004.

California Department of Fish and Game (CDFG). 2004c. Stream Inventory Report Nolan Creek, Salmon Creek Watershed Sonoma County, Survey: Summer 2003, Report: March 2004.

California Department of Fish and Game (CDFG). 2004d. Stream Inventory Report Salmon Creek, Salmon Creek Watershed Sonoma County, Survey: Summer 2003, Report: March 2004.

California Department of Fish and Game (CDFG). 2004e. Stream Inventory Report Thurston Creek, Salmon Creek Watershed Sonoma County, Survey: Summer 2003, Report: March 2004.

California Department of Fish and Game (CDFG). 2010. California Natural Diversity Database, RareFind Version 3.1.1 and GIS Shapefiles. California Department of Fish and Game, Sacramento, CA.

California State Water Resources Control Board (State Board). 2010. Electronic Water Rights Information Management System. http://www.waterboards.ca.gov/water_issues/programs/ewrims/

California State Water Resources Control Board (State Board). 2010. Water Rights Division, Useful water rights information web page. http://www.waterboards.ca.gov/waterrights/board_info/

Conrad, L. M. Obedzinski, D. Lewis, and P. Olin. 2005. Annual Report for the Russian River Coho Salmon Captive Broodstock Program: Hatchery Operations and Monitoring Activities. July 2004 – June 2005.

Cox, Bill. 2005. California Department of Fish and Game. Personal communication.

Gold Ridge Resource Conservation District (GRRCD). 2009. Assessment of Coho Salmon Habitat in Salmon Creek, Draft February 19, 2009, Revised April 27, 2009.

Gold Ridge Resource Conservation District (GRRCD) and Prunuske Chatham, Inc. (PCI). 2007. The Salmon Creek Watershed Assessment and Restoration Plan, Version 1, March 31, 2007, Revised April 16, 2007.

Gold Ridge Resource Conservation District (GRRCD) and Prunuske Chatham, Inc. (PCI). 2010. Salmon Creek Integrated Coastal Watershed Management Plan, Draft Version 1, April 20, 2010.

Graff, W. L. 1999. Dam nation: a geographic census of American dams and their large-scale hydrologic impacts. *Water Resources Research*, 35, 1305-1311.

Grantham, T., A. Merenlender, and V. Resh. 2010. Climatic influences and anthropogenic stressors: and integrated framework for streamflow management in Mediterranean-climate California, USA. *Freshwater Biology*, 55 (Supp. 1), 188-204

Hines, Diana. 2010. Gold Ridge Resource Conservation District. Personal communication.

Karl, T.R., J.M. Mellilo, and T.C. Peterson (eds). 2009. Global Climate Change Impacts in the United States. A State of Knowledge Report from the U.S. Global Change Research Program. Cambridge University Press. Accessed at www.globalchange.gov/usimpacts.

Kleinfelder, Inc. 2003. Pilot Study of Groundwater Conditions in the Joy Road, Mark West Springs, and Bennett Valley Areas of Sonoma County, California. Report prepared for Sonoma County Permit Resource Management Department, Santa Rosa, California.

Luers, A.L., et al. 2006. Our Changing Climate: Assessing the Risks to California. Prepared by the California Climate Change Center with funding from the California Energy Commission and the California Environmental Protection Agency. CEC-500-2006-077.National Marine Fisheries Service. 2010. Public Draft Recovery Plan for Central California Coast Coho Salmon (*Oncorhynchus kisutch*) Evolutionary Significant Unit. National Marin Fisheries Service, Southwest Region, Santa Rosa, California.

Prunuske Chatham, Inc. (PCI). 2006. Salmon Creek Estuary Study Results and Enhancement Recommendations, May 2006.

Richter, B. D. and G. A. Thomas. 2007. Restoring environmental flows by modifying dam operations. Ecology and Society, 12, online URL: http://www.ecologyandsociety.org/vol12/iss1/art12/

Sonoma County Planning Department. 1974. Joy Road Study: An opportunity to preserve a special life style. 36 pps.

University of California Cooperative Extension (UCCE). 2007. Characterizing freshwater inflows and sediment reservoirs of fecal coliforms and *E. coli* at five estuaries in northern California. Prepared for Gold Ridge Resource Conservation District by University of California School of Veterinary Medicine and Cooperative Extension in Sonoma and Marin Counties.

White, Ben. 2010. Pacific States Marine Fisheries Commission Warm Springs Hatchery. Personal communication.

APPENDICES

A. Bodega Pilot Program Planning Process Memos

1. Water Supply Security and Streamflow Augmentation Criteria
2. Bodega Volunteer Fire Department Landscaping and Roofwater Catchment System

B. Water Supply and Demand Memos

1. Salmon Creek Watershed—Metered Water Systems Supply and Demand Inventory Summary
2. Salmon Creek Watershed Rural Water Demand

C. SCWCP Interviews: Overall Observations & Recommendations

D. Conservation Strategies

1. Streamflow Restoration for Salmonids
2. Residential Self-Survey
3. Low Water Gardening
4. Stormwater Management
5. Roofwater Harvesting
6. Conservation in the Hospitality Industry
7. Water Rates
8. Managing Water Systems

E. Watershed Signage

PRUNUSKE CHATHAM, INC.

Technical Memorandum

To: Salmon Creek Water Conservation Program partners and participants

By: Lauren Hammack, Geomorphologist/Watershed Planner, Prunuske Chatham, Inc.

Date: January 18, 2010

Re: Bodega Pilot Program: Water Supply Security and Streamflow Augmentation Criteria

---

This memo outlines a suite of planning level criteria and background information that can be, and have been, used to guide the development of implementation projects for the Bodega Pilot Program[i]. They are derived from concepts developed during the initial Salmon Creek Water Conservation Program team meetings, conversations with agency staff tasked with protecting and restoring salmonid populations, discussions with local Bodega residents and the Bodega Water Company Board, and my professional assessment of the hydrologic conditions affecting summer streamflows in the Bodega Valley. I acknowledge that these planning criteria are likely incomplete and that the prioritization suggested here may change over time and with additional information.

Program Success Factors

The Bodega Pilot Program, while part of the larger Salmon Creek Water Conservation and Streamflow Augmentation Program, is the keystone project for showing the effectiveness of rainwater harvesting, water conservation, and enhanced storage capacity to reduce extractive demands on streamflow during dry season months and improve fish habitat conditions. The success of the Bodega Pilot Program is critical for future implementation of streamflow augmentation projects with communities and landowners along salmonid rearing streams. Program success is dependent upon multiple factors, including:

- Program participants receive benefits in the form of greater water security and/or a cost effective water supply.
- The Program is developed and implemented in such a way that extractive water supplies are replaced, not augmented; and that the water supply savings are left in the stream or groundwater table during the dry season.
- The volume of water supplied by rainwater harvesting and increased storage are maximized for a given location (well or pump) to either replace an extractive source or measurably reduce withdrawals from the extractive source.

400 MORRIS STREET, SUITE G · SEBASTOPOL CA 95472 · 707 824-4600 · FAX 707 824-6854

- Streamflow and groundwater extractions at a location (well or pump) are reduced from existing pre-Program conditions, the reductions are documented annually, and the amounts are commensurate with volumes generated by alternative sources and storage improvements.
- The benefits and requirements of the Program are clearly articulated so that participation occurs with full "buy-in" for a long term commitment.
- Details of Program participation are understood and supported by the larger community.
- Participants receive ongoing support to maintain and utilize their alternative water sources.
- Agreements are made between funding agencies, resource management agencies, water suppliers and/or landowners that are comprehensive, lasting, trackable, and enforceable.
- An implementation monitoring program is developed to track actual reductions in extractions over time and compliance with agreements.

Background

Salmon Creek in the Bodega Valley is currently utilized by steelhead (*Oncorhyncus mykiss*) for summer rearing, and it is a potential rearing reach for coho salmon (*Oncorhynchus kisutch)*. This reach also hosts California freshwater shrimp (*Syncaris pacifica*) and California red-legged frog (*Rana aurora draytonii*). Pools are relatively deep (2 to 4.5 feet). During wet and average hydrologic years the pools retain their water depth through the dry season even though they become disconnected. During drought years, such as 2009, pools become shallow and stagnant. In stretches adjacent to water supply wells, the pools may dry completely.

Pool water quality appears to be less than ideal for salmonids during the summer rearing period, with dissolved oxygen levels measured repeatedly in Bodega Valley at less than 5 ppm to as low as 0.06 ppm (M. Fawcett, personal communication, November 2009). Pools with low dissolved oxygen occur where there is no surface flow over the riffles (i.e. the pools are disconnected). High nutrient levels may also be affecting dissolved oxygen levels in the Bodega Valley, though this hypothesis has not been tested. Cattle have access to large stretches of the creek during the spring and summer in the upper Bodega Valley, and algal blooms are common in pools exposed to direct sunlight.

Multiple, direct extractive demands on dry-season streamflows exist in the Bodega Valley. Streamflow extractions include private and community shallow groundwater wells adjacent to Salmon Creek, in-stream pumps for irrigation and off-channel livestock watering, and direct livestock watering. Other standard water sources include deep groundwater and springs, though both are very limited and highly variable in production. Several of the agricultural operators have off-channel ponds that supplement other water sources. This is a water scarce region, and residents consider water security for themselves, the community, and their livestock to be a high priority concern.

Bodega is considered a disadvantaged community, their water supply is tenuous, and the cost of the water is one of the highest in the State. Bodega Water Company (BWC) is a member-owned, mutual benefit corporation that supplies potable water to 39 hookups within the Bodega Valley. They are one of the larger single users of Salmon Creek water in the Bodega Valley, as the majority of their water supply comes from a shallow "gallery" well adjacent to Salmon Creek. The depth of Well #5 is approximately 20 feet (i.e. slightly lower than the stream bed) and is considered by the Department of Water Resources to be drawing from the shallow groundwater feeding Salmon Creek. Confirmation of this occurred in the summer of 2009 when Salmon Creek went completely dry adjacent to Well #5 – the dry reach extended approximately 100 feet upstream and 500 feet downstream. Pools upstream and downstream of the dry reach had water and juvenile steelhead in them. BWC has two other deep groundwater wells that are limited in their production and have water quality issues.

BWC has applied for an appropriative water right for Well #5. The terms of this water right preclude the use of the well during the dry season. Thus, BWC is seeking alternate water sources and storage options to reduce the use of Well #5 in order to comply with the Department of Water Resource's terms for the appropriative water right. Potential alternate water sources are limited. They include a large off-channel reservoir and/or a combination of rainwater catchment and increased storage. An alternatives analysis will be completed.

Program Effectiveness

The following are proposed actions to maximize the effectiveness of the Bodega Pilot Program to reduce extraction pressures on dry season streamflows and allow tracking of ecological effectiveness in the Bodega Valley reach. The actions are prioritized based on community need, understood volume of given location extractions, and ability to track implementation. Opportunities to implement any and all of the proposed actions should be pursued concurrently. All are important, required components for augmenting summer instream flows and improving water quality conditions for salmonids and other aquatic species in the Bodega Valley.

1. Replace all non-potable water uses (e.g. livestock and outdoor irrigation) currently using BWC potable water with harvested rainwater systems.
2. Replace and significantly increase water storage capacity for BWC to reduce their weekly dry season pumping requirements at Well #5.
3. Fix documented leaks in BWC storage and line system to reduce their monthly unaccounted-for-water volumes and associated pumping requirements at Well #5.
4. Replace the use of shallow "gallery" wells in the Bodega Valley with alternative water supplies such as roofwater harvesting systems or off-channel ponds.

5. Replace instream riparian pumps with roofwater harvesting and storage systems.
6. Exclude livestock from stream access during the dry season and develop alternative water sources, such as either roofwater harvesting and storage systems or off-channel ponds.

Effectiveness of these actions to reduce extractions and subsequently increase water available for streamflow will require strong agreements with individual landowners and/or the responsible water supply organizations (i.e. BWC) and a comprehensive implementation monitoring program.

Prioritization for Roofwater Harvesting Locations (non-potable)

To support the effectiveness and monitoring of the Bodega Pilot Program the following is a suggested prioritization for roofwater harvesting locations for residential, urban commercial, and small ag participants (i.e. not large, commercial agriculture properties). It is recognized that annual water demand is variable and that tracking reductions in demand and individual property usage is subject to these annual variations. Thus, it is suggested that initial installation sites focus on water users with the highest, consistent non-potable water demands.

1. BWC members who use significant amounts of BWC potable water for non-potable water uses (e.g. livestock and irrigation).
    a. BWC members who purchase 10,000 or more gallons of potable water for non-potable, outdoor water uses during the dry season.
    b. BWC members who purchase 5,000 or more gallons of potable water for non-potable, outdoor water uses during the dry season.
2. Riparian landowners who supplement their non-potable water supply with instream pumps (priority to larger or consistent usage).

---

[i] Current Program funders include:
California State Coastal Conservancy (Grant # 07-173)
NOAA Fisheries, ARRA (Agreement # NA09NMF4630326)
California State Water Resources Control Board, NCIRWMP (Agreement #)

400 MORRIS STREET, SUITE G · SEBASTOPOL CA 95472 · 707 824-4600 · FAX 707 824-6854

PRUNUSKE CHATHAM, INC.

MEMO

Date: May 27, 2010

To: Salmon Creek Water Conservation Program (SCWCP)

From: Aimee Crawford

Subject: Summary of SCWCP's Planning for Bodega Volunteer Fire Department Landscaping and Rainwater Catchment System

---

Introduction

Several years ago, SCWCP partners, including Occidental Arts and Ecology Center WATER Institute (OAEC), the Salmon Creek Watershed Council, and Prunuske Chatham, Inc. (PCI), began conversations with the Bodega Volunteer Fire Department (BVFD) about developing a roofwater harvesting and storage system for a new firehouse BVFD planned to build. At present, BVFD uses an on-site well and Bodega Water Company (BWC) supplies for both daily use and for fire suppression. The BVFD well is close to Salmon Creek, as are the BWC wells.

Developing an alternative water supply for BVFD is intended to support SCWCP efforts to improve summer flows in Salmon Creek, as well as to provide a greatly increased level of stored water for emergency uses. The objective of installing this system was to reduce BVFD's dependency on groundwater withdrawals and BWC water. In addition, installing a roofwater harvesting system at the BVFD firehouse, which is located on Bodega Highway in the town of Bodega, creates a demonstration site for water conservation efforts in the Salmon Creek Watershed that is highly visible to the public.

The roofwater catchment system will be installed in late 2010, thanks to the efforts of numerous SCWCP partners and a successful leveraging of State Coastal Conservancy (SCC) planning funds that facilitated securing construction monies for the system through the 2009 American Reinvestment and Recovery Act (ARRA).

400 MORRIS STREET, SUITE G · SEBASTOPOL CA 95472 · 707 824-4600 · FAX 707 824-6854

State Coastal Conservancy Planning Support

As a result of discussions with BVFD, one of the recommendations included in the State Coastal Conservancy-funded 2006 *Salmon Creek Estuary: Study Results and Enhancement Recommendations* was to assist the BVFD with designing and securing funding for a roofwater catchment system, as well as providing advice to BVFD on installation of native landscaping at the new fire department site.

In 2008, SCC awarded a grant to OAEC that has supported a number of SCWCP efforts, including planning for the BVFD roofwater catchment system. SCC funding supported SCWCP partners in working with BVFD's architect to review the fire station design and provide technical analysis and support necessary for integration of the roofwater system and native landscaping into the site design.

2010 Implementation

In 2009, Gold Ridge Resource Conservation District (GRRCD), another SCWCP partner, was awarded ARRA funding through the NOAA Restoration Center to plan, design, and construct numerous rainwater catchment systems in key rearing reaches of Salmon Creek. This ARRA grant included funding for the BVFD tank.

With support from the SCC's 2008 grant, PCI worked with BVFD to finalize the specifics for the roofwater harvesting system and developed a Request for Bid (RFB) for a 35,000-gallon, American-made water storage tank and approximately 200 linear feet of waterline. GRRCD distributed the bid and awarded the work to a local contractor. Construction on the new BVFD fire station, including the roofwater harvesting system, is anticipated to be completed in fall 2010.

Salmon Creek Watershed - Water Conservation Project
Bodega Bay/Bodega Bay Public Utility District
Water System Supply and Demand Inventory

A. Overview

This Supply and Demand Inventory is based on water production and metered water use provided by the Bodega Bay Public Utilities District for the years 2007 and 2008.

A.1 SERVICE AREA DESCRIPTION

Bodega Bay is an unincorporated town in coastal Sonoma County located on California State Highway 1 approximately eight miles north of the Sonoma/Marin County line, and ten miles south of the mouth of the Russian River at Jenner. The town itself has a population of approximately 1,500 and the Bodega Bay Public Utility District (BBPUD) water system serves the town and surrounding areas with a service area population of 2,625. Bodega Bay has a year round resident population, with about 60% of the homes in the community occupied full time. Bodega Bay is also a destination vacation spot with a vital hospitality industry including hotels, vacation rentals, restaurants, boating and golf. Bodega Bay is not within the Salmon Creek watershed, and only one connection to the BBPUD system is within the watershed, which north of Bodega Bay but south of Salmon Creek. Bodega Bay is part of this supply and demand evaluation because a portion of the water served by BBPUD is from wells in the Salmon Creek watershed.

A.2 DESCRIPTION OF WATER SOURCE

The State recognizes seven groundwater wells in the BBPUD system: three in the Roppollo well field, two at Salmon Creek and two in the Bodega Dunes. For the inventory years of 2007 and 2008, 18% and 10% respectively of the total water supply for BBPUD came from the Salmon Creek wells, and this was supply was used only during the months of December plus January – June in 2007; and December plus January – March in 2008. In 2009, 10% of the water supply for the BBPUD came from Salmon Creek wells and this supply was used only in the winter months.

A.3 WATER RATES AND RATE STRUCTURE

Water is billed every two months by BBPUD to all customers. Water is measured in cubic foot units and billed in hundred cubic foot units (1 HCF = 748 gallons). The rate structure for all customers (residential and commercial) as of January 2010 is:

Base rate (includes first 8 HCF per 2 mos):	$30.73 each 2 mos.
First tier (9-25 HCF):	$ 3.24 /HCF
Second tier (over 25 HCF):	$ 3.70/HCF

Table 1 compares BBPUD's water rates with those of other local communities. These systems vary in size and source of water supply. Most of the communities in Table 1 have water rates that increase as use goes up, or increasing block rates or tiers. For the 4,500 gallon month example in Table 1, all water use is billed at the first tier.

Table 1 - Comparison of Monthly Residential Water Bill (based on 4,500 gal. use)

	Fixed Charge	Billing Unit	First Tier Use Charge	Use Charge/ gal	Billable Use (1)	Total Use Charge	Bill
Bodega Bay PUD (3)	$15.37	Hundred Cubic Ft.	$3.24	$0.004	1,500	$6.50	$21.86
Salmon Creek (2)	$37.50	Hundred Cubic Ft.	$8.00	$0.011	4,500	$48.13	$85.63
Bodega (4)	$50.00	1,000 Gallons	$25.00	$0.025	4,500	$112.50	$162.50
Freestone (5)	$40.00	1,000 Gallons	$9.22	$0.009	4,500	$41.49	$81.49
Sereno del Mar (6)	$64.95	Hundred Cubic Ft.	$4.00	$0.005	4,500	$24.06	$89.01
City of Sebastopol (7)	$11.87	Hundred Cubic Ft.	$1.46	$0.002	4,125	$8.05	$19.92

(1) Some water systems include an increment of water in the monthly fixed charge
(2) Second tier > 20 hcf - $10.06; third tier > 27 hcf - $17.91
(3) Second tier > 25 hcf - $3.70
(4) Second tier > 8 tg - $40.00
(5) Second tier > 15 tg - $13,41; third tier > 20 tg - $20.11
(6) Second tier > 67 hcf - $4.50; third tier > 107 hcf - $5.50
(7) Second tier > 30 hcf - $1.54

B. Supply Characteristics and Inventory

B.1 TOTAL WATER PRODUCED - 2007 AND 2008.

Table 2 shows total water produced by month for the two years of this inventory. All water is from the groundwater supply wells discussed in the previous section.

Table 2 – Water Production by Month – Million Gallons

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2007	9.7	8.5	9.8	11.1	11.7	13.3	16.5	15.1	13.2	12.8	11.0	8.6	141.4
2008	8.1	9.0	11.0	13.3	13.3	13.7	14.7	13.6	11.9	11.9	8.9	8.1	137.4

B.2 UNACCOUNTED FOR WATER

Unaccounted for water (UAW) is percentage of water that is produced that is not sold or accounted for in other ways (such as fire flow or water system maintenance). UAW is based on the difference between water production (Table 2) and water sold (Table 4). For BBPUD, UAW for the years 2007-2009 follows. The drop in UAW from 2008 to 2009 was due to two large leaks being repaired which apparently had been leaking for years.

2007 UAW: 23.3%
2008 UAW: 22.3%
2009 UAW: 10.5%

C. Demand Characteristics and Inventory

C.1 NUMBER OF CONNECTIONS AND WATER USE BY CUSTOMER CLASS

Table 3 shows the number of connections for each of the customer classes, Residential and Commercial, as well as the percentage of the total connections for each customer class for each year.

Table 3 – Connections by Customer Class – Number and Percent of Total

	Res # Con	Res % Con	Com # Con	Com % Con	Total # Con
2007	973	92.5%	79	7.5%	1,052
2008	975	92.5	79	7.5	1,054

Table key: Res – Residential
Com – Commercial
Con – Connections

Table 4 shows water use by customer classes and the percent of total use for each class for each year.

Table 4 – Annual Metered Water Use by Customer Class – Use and Percent of Total

	Res Use -MG	Res % Use	Com Use - MG	Com % Use	Total Use- MG
2007	59.53	54.8	48.93	45.1	108.46
2008	62.92	58.9	43.82	41.1	106.74

Table key: MG – million gallons
Res – Residential
Com – Commercial

Of interest in this data on connections and water use is the trend that the residential class make up approximately 92% of the connections, but this customer class uses only 55-60% of the overall water consumed. Commercial customers make up only 7.5% of the connections but account for 40-45% of the water use. This data suggests that targeting commercial customers with conservation initiatives may be a good strategy in terms of maximizing the effect per contact.

Table 5 below expands the information presented in Table 4 by showing the variation in water use *per connection* by each customer class for each year of this analysis.

Table 5 – Annual Water Use per Connection by Customer Class

	Res Use (gal/con)	Com Use (gal/con)
2007	61,185	619,335
2008	64,529	554,741

Table key: Res - Residential
Com – Commercial
Con – Connection

C.2 PER CAPITA DEMAND

Per capita water use or per capita demand is a standard measurement for public water systems – it is a measure of the water use per person. Most typically per capita demand is expressed in the unit "gallons per person per day" or GPCD. In California the recognized standard for per capita demand is total water produced divided by total population served. This "gross per capita" figure includes all water uses in a community including residential and commercial use, fire flow, system maintenance use, as well as UAW. For purposes of tracking water use trends on a metered water system, it is useful to also look at the per capita demand of the residential sector only. Additionally, to track seasonal trends, it is valuable to compare seasonal GPCD, so both gross GPCD and residential GPCD are shown below for the four summer months (June-Sept.) and the four winter months (Dec.-March).

Table 6 presents these various GPCD measurements for BBPUD for the years of this analysis. Note that only those GPCD figures designated as "gross" include UAW; all other GPCD figures are based on metered water use. The first column, Gross GPCD, is technically the per capita demand according to California standards.

Table 6 – Per Capita Water Use – Gallons/Person/Day (GPCD)

	Annual Gross	Gross Summer	Gross Winter	Annual Residential	Residential Summer	Residential Winter
2007	147	182	115	62	77	46
2008	143	168	114	66	81	49

C.3 AVERAGE DAY METERED DEMAND

Average day demand factors are used in water systems to make operational decisions and planning projections. Average day factors are often used to derive peak day and peak hour flow, both important factors in determining system component size and rating. These figures represent an average of metered water data, therefore UAW is not included in Table 7 figures which shows average day demand factors for the BBPUD for the years of this analysis.

Table 7 – Average Day Metered Demand System-wide - Gallons

	Annual	Peak Month	Minimum Month
2007	297,153	409,904	210,679
2008	292,439	368,739	209,158

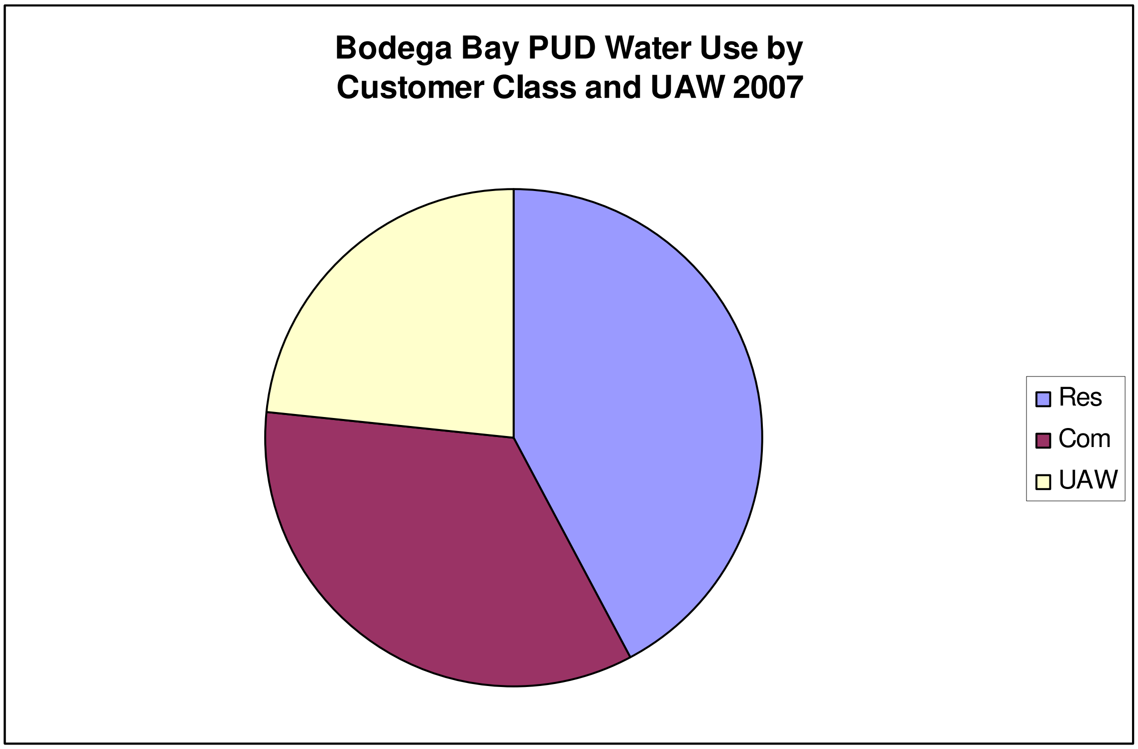
D. Graphics that Illustrate BBPUD Inventory Trends

The following graphs illustrate trends on the BBPUD system:

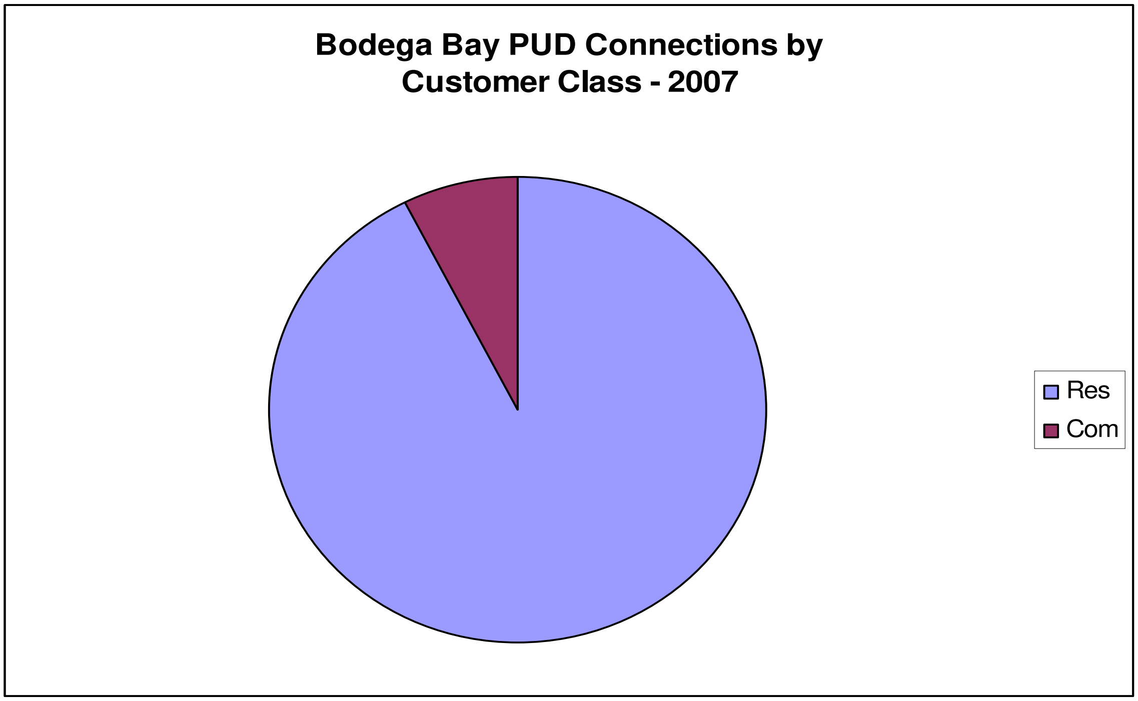
- Graphs 1 & 2: Annual water use and number of connections by user class for 2007

- Graphs 3 & 4: Annual water use and number of connections by user class for 2008
- Graphs 5 & 6: Bi-monthly water use by user class for 2007 and 2008

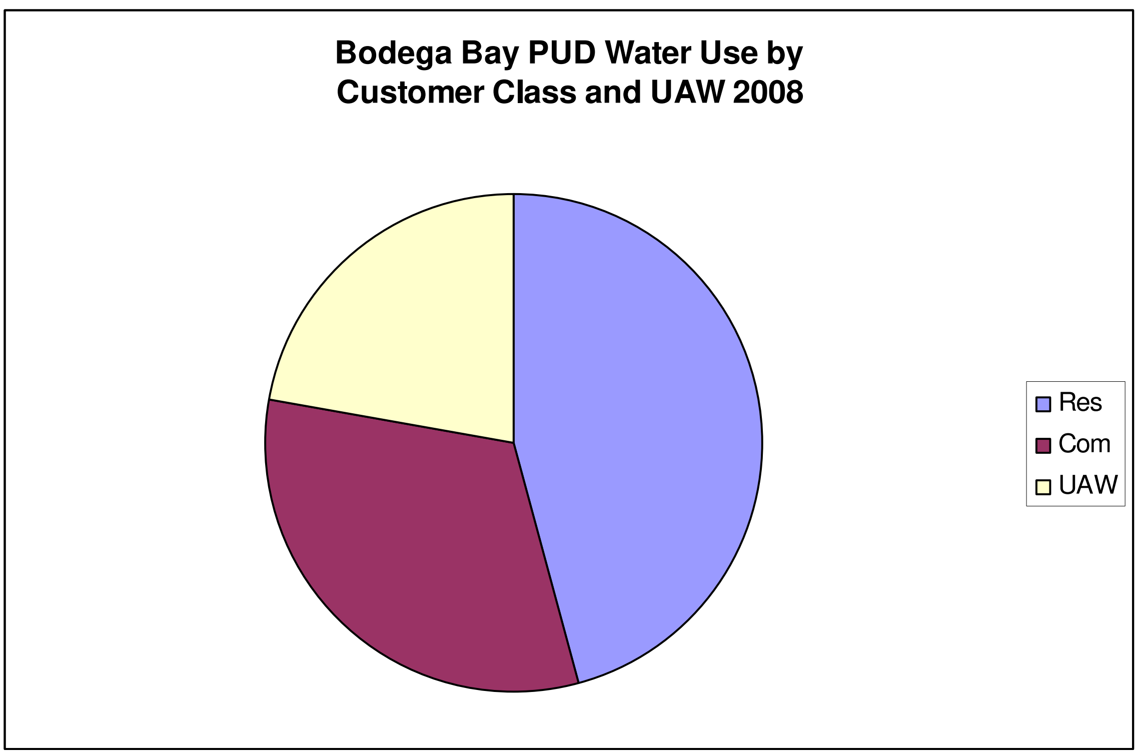
Graph 1



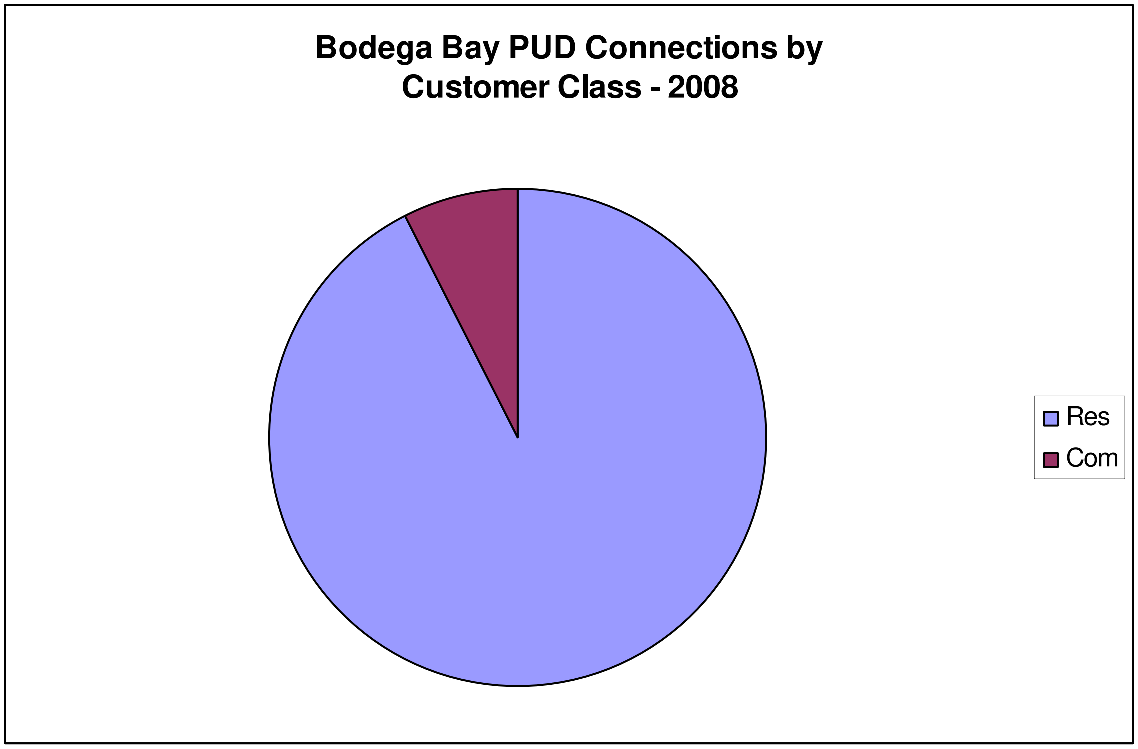
Graph 2



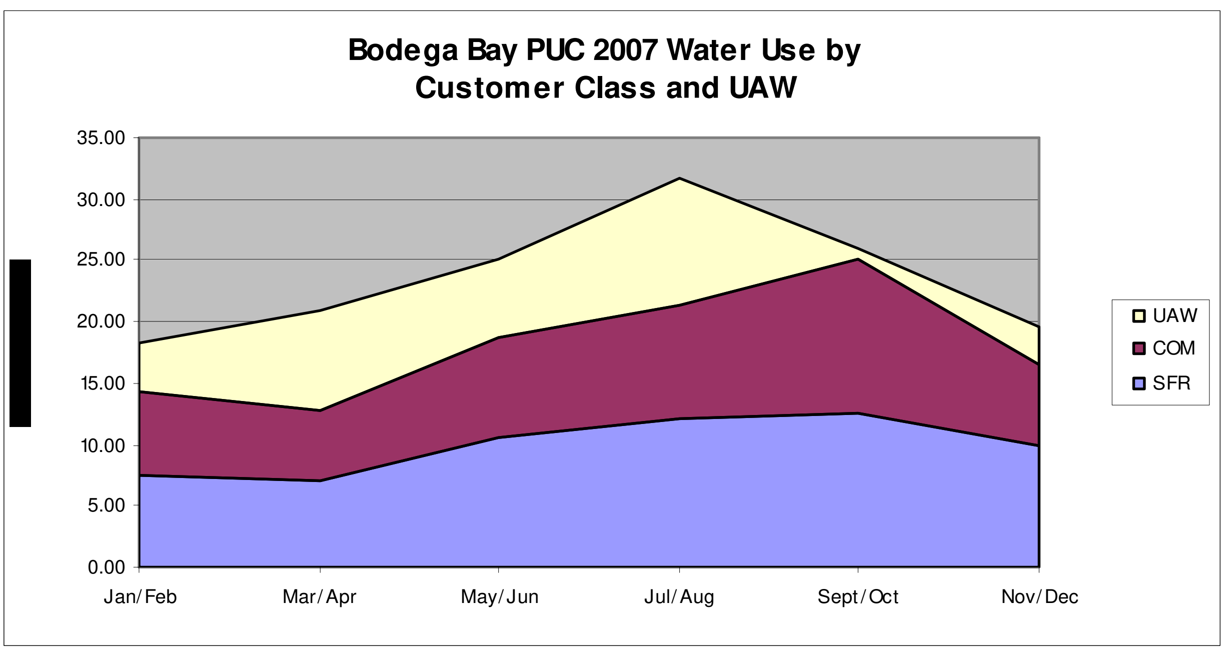
Graph 3



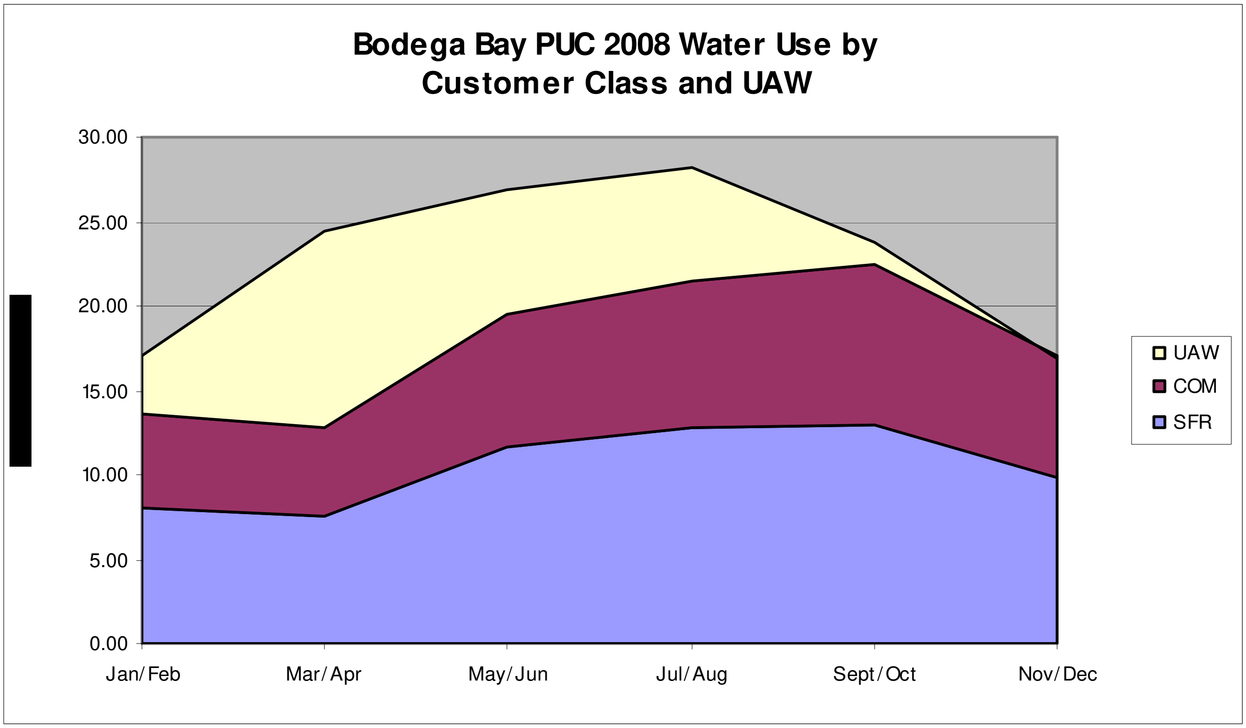
Graph 4



Graph 5



Graph 6


Bodega Bay PUC 2008 Water Use by
Customer Class and UAW
[redacted]
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Jan/Feb
Mar/Apr
May/Jun
Jul/Aug
Sept/Oct
Nov/Dec
UAW
COM
SFR

Salmon Creek Watershed - Water Conservation Project
Town of Bodega/Bodega Water Company
Community Water System Supply and Demand Inventory

A. Overview

This Supply and Demand Inventory is based on water production and metered water demand for the years 2007 and 2008. Bodega Water Company (BWC) provided monthly treatment plant production and metered water sales data which was used in this analysis. BWC water is primarily supplied by one well (well #5) which is approximately one and a half miles from their treatment facilities. There is no meter at the well. During summer months, well #5 is often supplemented by water from two smaller production wells, # 2 and # 3. Occasionally water is trucked into Bodega by local water hauling services for unforeseen needs, such as to supply a customer that has been temporarily disconnected from the main BWC distribution system, or to meet demand during a power outage.

BWC is a private non-profit mutual benefit company that serves the Town of Bodega. It was formed in 1981.

A.1 SERVICE AREA DESCRIPTION

Bodega is an unincorporated town in Sonoma County located on Bodega Highway, approximately 5 miles west of Freestone, and one mile east of California State Highway 1. A population of approximately 500 is within the area that could be served by BWC, of which a population of approximately 100 is served. The greater Bodega area has a population of over 1,000.

Bodega is primarily a residential community, with 31 of the 36 water connections serving single-family and multi-family residences. The five non-residential water connections serve commercial establishments in the business core of Bodega on the highway. These businesses include a store, a restaurant/bar, and retail shops; they serve both Bodega residents and tourists.

Salmon Creek flows through the Town of Bodega, and numerous parcels border the Creek.

A.2 DESCRIPTION/CONFIGURATION OF THE WATER SYSTEM

The State recognizes three wells in the Bodega Water Company system. Currently, well #5 is the primary source of water supply, with wells # 2 and #3 and trucked water supplementing well #5 as needed. Well # 5 is an infiltration gallery well located on private property. It is approximately 20’ deep, and is located about 40’ from the bank of Salmon Creek. Well # 5 is diverting water from the alluvium of a subterranean stream which is tributary to Salmon Creek. It has an approximate flow rate of 12 gallons per minute. Wells #2 and #3 are 275’-300’ deep, and have a combined flow rate of 2.75 gallons per minute. Wells #2 and #3 have had high incidents of fluoride, iron and manganese in the raw water, but with treatment the finished water has meet all regulatory requirements.

Raw water is pumped from the wells to a sand filtration system located south of the town. The filtration system has a capacity of 7 gallons per minute. Filtered water feeds into a chlorination system, and is then pumped to holding tanks which collectively store approximately 40,000 gallons. The finished water storage tanks are located near the treatment system. Water feeds the Town of Bodega through gravity from the storage facilities.

The distribution system from the tanks to the 36 water connections is not mapped. Every active water connection is metered, and a meter replacement program is in place.

California Department of Public Health (DPH) monitors all public water systems for compliance with state and federal water quality regulations. Janice Oakley, Senior Sanitary Engineer with DPH reports the following conditions of concern regarding the BWC system:

1. BWC is under a connection moratorium due to lack of water supply.
2. On August 13, 2009 BWC received notice that they exceeded the lead action level and are required to do public education.
3. BWC storage tanks have been leaky or out of service.
4. Two BWC wells have high fluoride, which is reduced after treatment.
5. BWC is required to do increased monitoring for manganese, due to high manganese in the sources.

DPH recognizes that the BWC Board is working diligently to improve their water system.

In a 2009 application for Federal Economic Recovery funds, Kerri Kor, then president of the BWC Board of Directors, specified the following conditions on the BWC system that are in need of upgrade:

1. Electrical system: Upgrade electrical service and panels to supply wells.
2. Chlorination system: Need to replace with new flow-generated chemical injector pump and upgrade chlorine analyzer.
3. Storage tanks: Current multi-tank storage system is leaking and storage volume is inadequate. Need to upgrade to a single steel storage tank for finished water in proximity to the current storage tanks and treatment system.
4. Distribution system mapping: Need to map the system including location size and specification of all system components: valves, meters, pipelines, hydrants, tanks, treatment system, and wells.
5. Distribution system upgrade/repair: Replace substandard lines.
6. Meter replacement and backflow prevention: Currently less than 20% of the meters include backflow prevention devices. All meters should have backflow devices.

A.3 WATER RATES AND RATE STRUCTURE

Water is billed monthly by BWC to all customers. Water is billed in 1000 gallon units. The rate structure for all customers (residential and commercial) since March 2006 has been:

Base Rate: $50.00 (billed to all hookups even if not using water)
First 8,000 gallons: $25.00 per 1,000 gallons
Over 8,000 gallons: $40.00 per 1,000 gallons

The cost of water to the end user in Bodega is very high in comparison with other water systems in Sonoma County and in the Salmon Creek Watershed. This is due in part to the small size of the water system. Table 1 compares water bills and rates for 5 communities in or near the Salmon Creek Watershed and a mutual water system in Santa Rosa (Holland Heights) based on a monthly use of 4,500 gallons. These systems vary in size and source of water supply. Most of the communities in Table 1 have water rates that increase as use goes up, known as "increasing block rates" or "increasing tiers". For the 4,500 gallon month example in Table 1, all water use is billed at the first tier.

Table 1 - Comparison of Monthly Residential Water Bill (based on 4,500 gal. use)

Water Company/ *Number of Connections*	**Fixed Charge**	**Billing Unit**	**First Tier Use Charge**	**Use Charge/ gal**	**Billable Use (1)**	**Total Use Chg**	**Bill**
Bodega Water Co (4) *35 connections*	$50.00	Thousand Gallons	$25.00	$0.025	4,500	$112.50	$162.50
Salmon Creek (2) *99 connections*	$37.50	Hundred Cubic Feet	$8.00	$0.011	4,500	$48.13	$85.63
Bodega Bay PUD (3) *1,052 connections*	$15.37	Hundred Cubic Feet	$3.24	$0.004	1,500	$6.50	$21.86
Freestone (5) *31 connections*	$40.00	Thousand Gallons	$9.22	$0.009	4,500	$41.49	$81.49
Sereno del Mar (6) *180 connections*	$64.95	Hundred Cubic Feet	$4.00	$0.005	4,500	$24.06	$89.01
Holland Heights Mutual Water Co. *115 connections*	$30.00	Thousand Gallons	$2.75	$0.003	1,500	$4.13	$34.13

(1) Some water systems include an increment of water in the monthly fixed charge
(2) Second tier > 20 hcf - $10.06; third tier > 27 hcf - $17.91
(3) Second tier > 25 hcf - $3.70
(4) Second tier > 8 tg - $40.00
(5) Second tier > 15 tg - $13,41; third tier > 20 tg - $20.11
(6) Second tier > 67 hcf - $4.50; third tier > 107 hcf - $5.50

B. Supply Characteristics and Inventory

B.1 SOURCES OF WATER

Table 2 shows water sources and portion of total supply for the two years of this inventory. Water is trucked into Bodega for one of a number of reasons: supply augmentation, in preparation for a power outage, or to supply connections that have temporarily lost continuity with the BWC distribution system for some reason.

Table 2 – Water Source by Year – Gallons and Percent of Total

	Groundwater		Trucked Water		Total
2007	2,496,700 gal	99%	17,500 gal	1%	2,514,200 gal
2008	2,409,900 gal	97%	70,000 gal	3%	2,479,900 gal

B.2 TOTAL WATER PRODUCED - 2007 AND 2008.

Table 3 shows total water produced by month for the two years of this inventory.

Table 3 – Water Production by Month – Million Gallons

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2007	0.22	0.15	0.18	0.19	0.19	0.22	0.21	0.22	0.19	0.18	0.31	0.25	2.51
2008	0.22	0.21	0.23	0.20	0.22	0.21	0.22	0.24	0.20	0.19	0.15	0.20	2.48

B.3 UNACCOUNTED FOR WATER

Unaccounted for water (UAW) is the percentage of water that is produced that is not sold or accounted for in other ways (such as fire flow or water system maintenance). UAW is based on the difference between water produced (Table 3) and water sold (Table 5). For BWC, UAW for the inventory years was:

2007 UAW: 25.9%
2008 UAW: 28.3%

UAW fluctuates significantly from month to month on the BWC system. Field survey of the treatment and storage system revealed significant leakage at the site of the finished water storage tanks. Some tanks leak when the storage elevation is high, which may explain why UAW changes from month to month so dramatically. This level of UAW can be reduced in the long run by upgrading the storage system, and in the short run to some extent through operational management of water elevation in the tanks and visual monitoring for leaks.

C. Demand Characteristics and Inventory

C.1 NUMBER OF CONNECTIONS AND WATER USE BY CUSTOMER CLASS

Table 4 shows the number of connections for each of the three customer classes – Single Family Residential, Multi-Family Residential and Commercial, as well as the percentage of the total connections for each customer class for each year.

Table 4 – Connections by Customer Class – Number and Percent of Total

	SFR # Con	SFR % Con	MFR # Con	MFR % Con	Com # Con	Com % Con	Total # Con
2007	24	67%	7	19%	5	14%	36
2008	24	69%	6	17%	5	14%	35

Table key: SFR – Single Family Residential
MFR – Multi-Family Residential
Com – Commercial
Con – Connections

Table 5 shows water use by the three customer classes and the percent of total use for each class for each year.

Table 5 – Annual Metered Water Use by Customer Class – Use and Percent of Total

	SFR Use (gal)	SFR % Use	MFR Use (gal)	MFR % Use	Com Use (gal)	Com % Use	Total Use (gal)
2007	983,210	53%	659,420	35%	220,160	12%	1,862,790
2008	947,014	53%	489,431	28%	342,100	19%	1,778,545

Table key: SFR – Single Family Residential
MFR – Multi-Family Residential
Com – Commercial

Of interest in this data on connections and water use is the trend that single family residences make up approximately two-thirds of the connections, but this customer class uses only about half of the water. Multi-family residences make up less than 20% of the connections but account for 30-35% of water use. Commercial connections account for approximately 15% of both the connections and water use. This data suggests that targeting multi-family residential connections may be a good strategy in terms of maximizing the effect per contact because each contact has the potential to lower a greater base water use.

Table 6 below expands the information presented in Table 5 by showing the variation in water use *per connection* by each customer class for each year of this analysis.

Table 6 – Annual Water Use per Connection by Customer Class

	SFR Use (gal/con)	MFR Use (gal/con)	Com Use (gal/con)
2007	40,967	94,203	44,032
2008	39,459	81,572	68,420

Table key: SFR – Single Family Residential
MFR – Multi-Family Residential
Com – Commercial
Con – Connection

Table 7 below shows water use for each customer class by month. This data is coupled with monthly UAW data in Graphs 5 and 6 in Section D of this report.

Table 7 – Water Use by Customer Class by Month - Gallons

2007	SFR	MFR	Com	Total
January	76,990	51,620	25,960	154,570
February	67,760	44,470	15,890	128,120
March	73,726	76,420	17,520	167,666
April	75,784	56,040	17,050	148,874
May	88,930	59,330	19,380	167,640
June	98,360	67,490	17,430	183,280
July	95,400	56,280	17,540	169,220
August	101,870	51,790	19,910	173,570
September	89,300	53,140	17,810	160,250
October	81,270	47,770	19,350	148,390
November	69,370	48,090	17,970	135,430
December	64,450	46,980	14,350	125,780
TOTAL	**983,210**	**659,420**	**220,160**	**1,862,790**
2008	**SFR**	**MFR**	**Com**	**Total**
January	86,010	42,520	27,840	156,370
February	70,970	38,850	20,820	130,640
March	77,800	41,260	31,130	150,190
April	70,080	40,690	30,730	141,500
May	81,260	47,950	33,860	163,070
June	90,560	40,710	30,190	161,460
July	89,210	41,276	31,440	161,926
August	103,654	46,575	34,300	184,529
September	92,000	45,460	28,300	165,760
October	64,000	41,480	32,840	138,320
November	60,260	33,680	21,740	115,680
December	61,210	28,980	18,910	109,100
TOTAL	**947,014**	**489,431**	**342,100**	**1,778,545**

Table key: SFR – Single Family Residential
MFR – Multi-Family Residential
Com – Commercial

C.2 PER CAPITA DEMAND

Per capita water use or per capita demand is a standard measurement for public water systems – it is a measure of the water use per person. Most typically per capita demand is expressed in the unit “gallons per person per day” or GPCD. In California the recognized standard for per capita demand is total water produced divided by total population served. This “gross per capita” figure includes all water uses in a community including residential and commercial use, fire flow, system maintenance use, as well as UAW.

For purposes of tracking water use trends on a metered water system, it is useful to also look at the per capita demand of the residential sector only. Additionally, to track seasonal trends, it is valuable to compare seasonal GPCD. Therefore, both gross GPCD and residential GPCD are shown below for the three summer months (June-Aug.) and the three winter months (Dec.-Feb).

Table 8 presents these various GPCD measurements for BWC for the years of this analysis. Note that only those GPCD figures designated as "gross" include UAW; all other GPCD figures are based on metered water use. The first column, Gross GPCD, is technically the per capita demand according to California standards. In both years of this analysis there was very high UAW in the winter months which contributes to the high gross winter use. Winter and summer gross GPCD are higher than the annual gross GPCD both years because of this high UAW during the summer and winter months and the relatively low UAW during the spring and fall months of the inventory years.

Table 8 – Per Capita Water Use – Gallons/Person/Day (GPCD)

	Annual Gross	Summer Gross	Winter Gross	*Annual Residential*	*Summer Residential*	*Winter Residential*
2007	69	70	69	*45*	*51*	*39*
2008	68	74	69	*39*	*45*	*35*

C.3 AVERAGE DAY METERED DEMAND

Average day demand factors are used in water systems to make operational decisions and planning projections. Average day factors are often used to derive peak day and peak hour flow, both important factors in determining system component size and rating. These figures represent an average of *metered water data,* therefore UAW is not included in Table 9 figures.

Table 9 shows average day demand factors for the BWC for the years of this analysis.

Table 9 – Average Day Metered Demand System-wide - Gallons

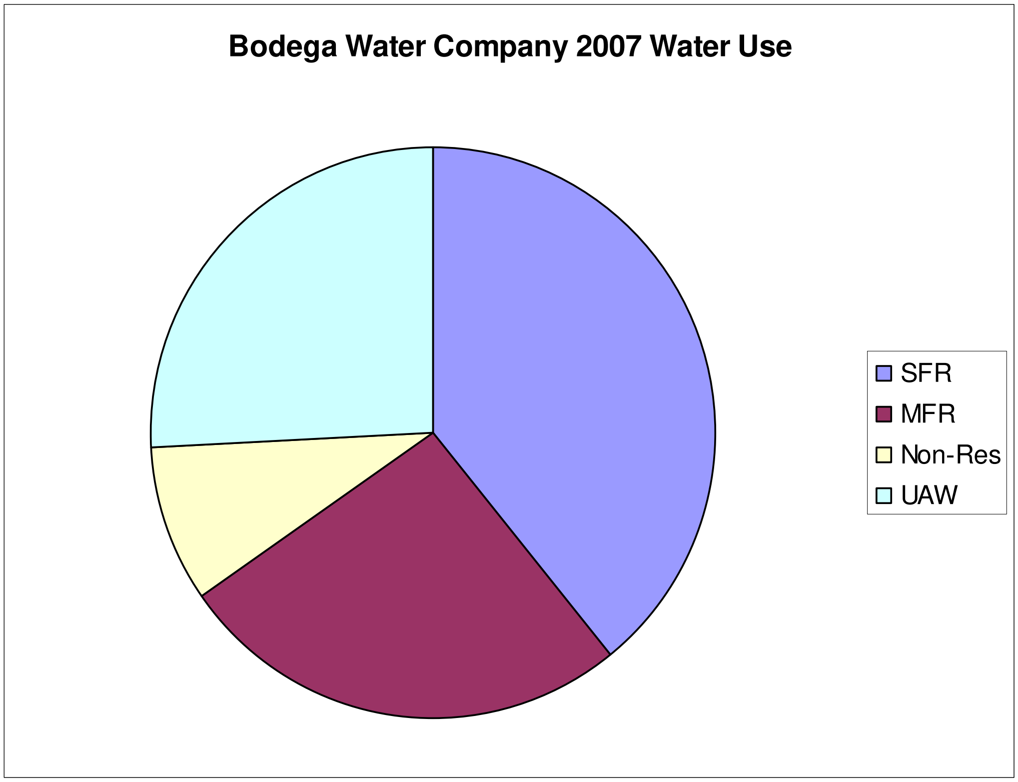
	Annual	Peak Month	Minimum Month
2007	5,103	6,109	4,057
2008	4,873	5,953	3,519

D. Graphics Illustrating BWC Inventory Trends

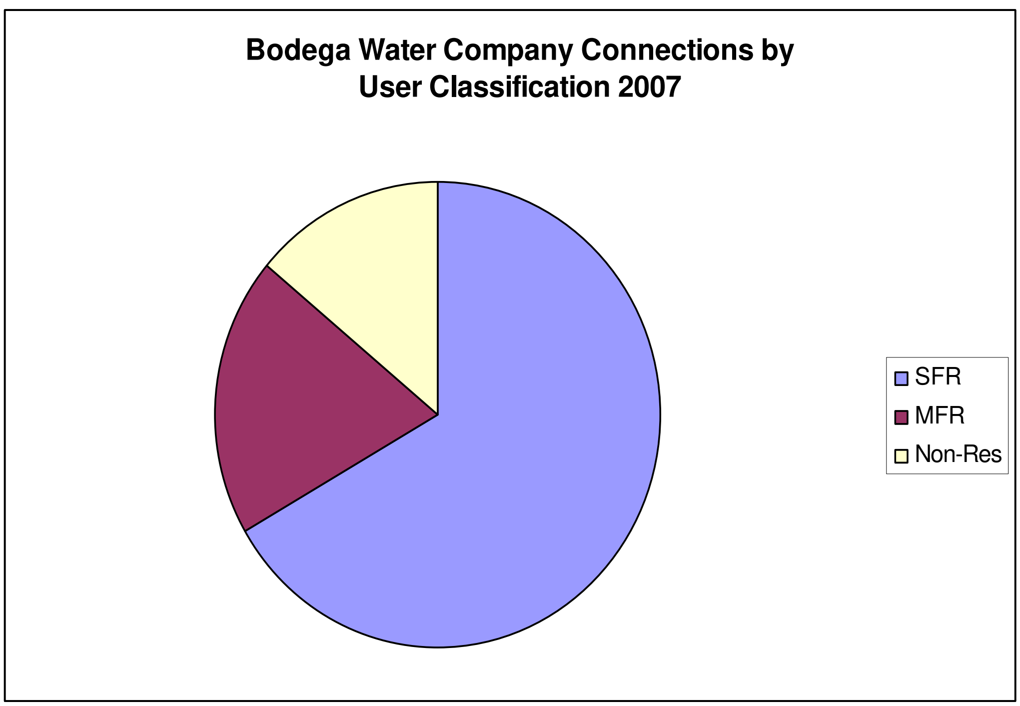
The following graphs illustrate trends on the BWC system:

- Graphs 1 & 2: Annual water use and number of connections by user class for 2007
- Graphs 3 & 4: Annual water use and number of connections by user class for 2008
- Graphs 5 & 6: Monthly water use by user class for 2007 and 2008
- Graphs 7 & 8: Monthly unaccounted for water (UAW) in gallons and in percent of total production for 2007 and 2008

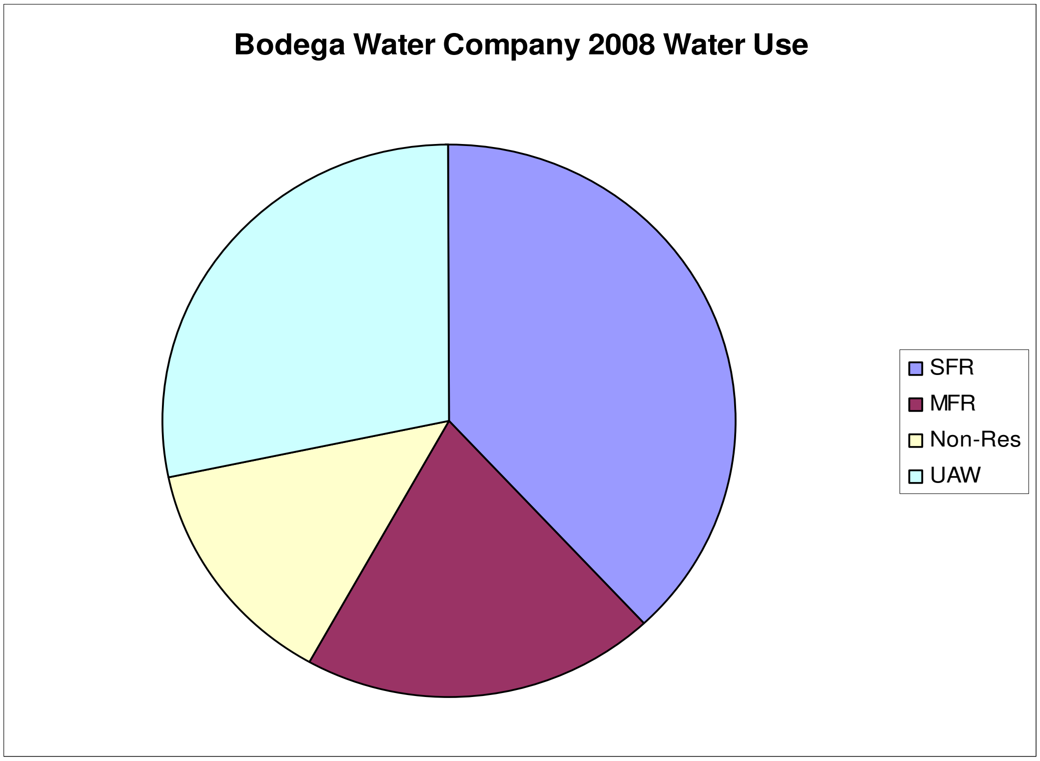
Graph 1



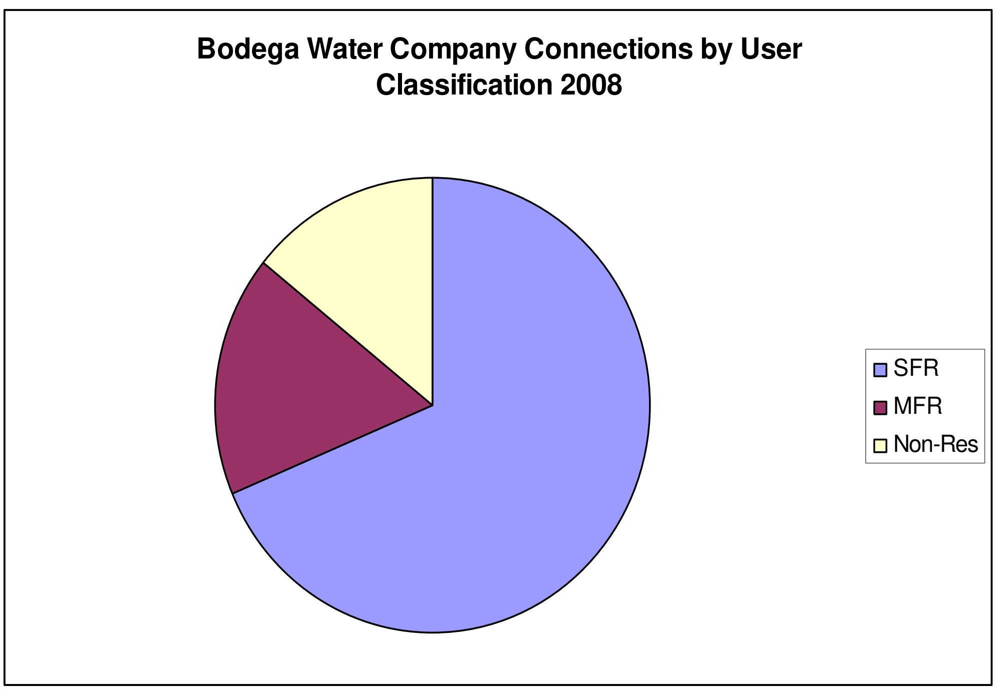
Graph 2



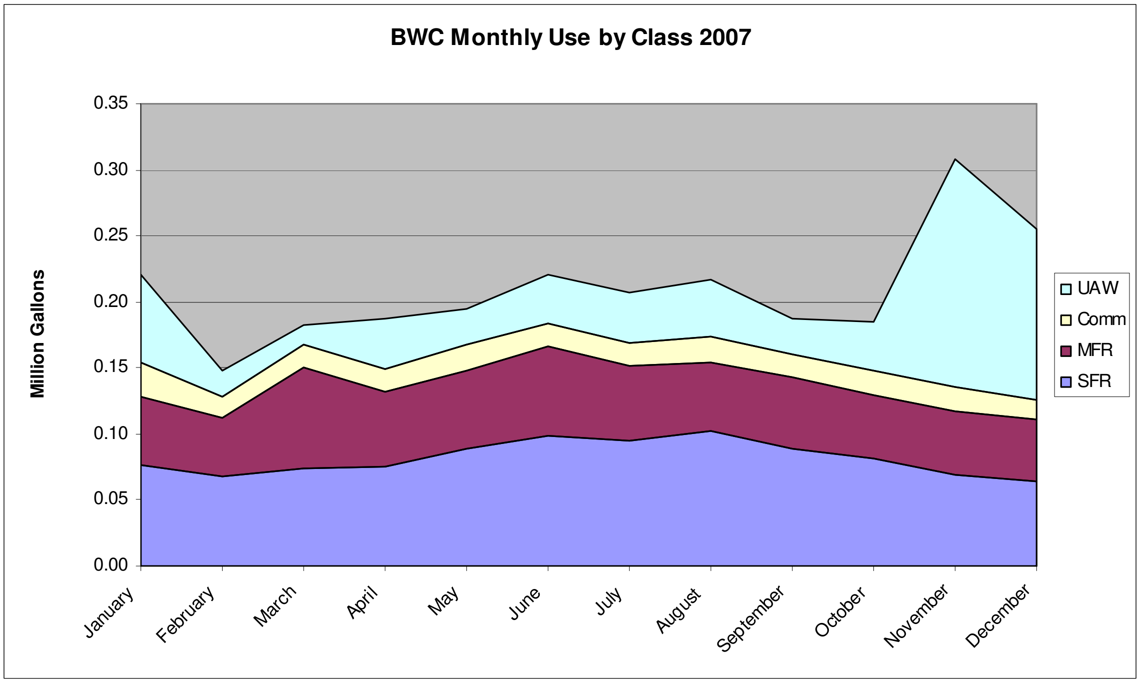
Graph 3



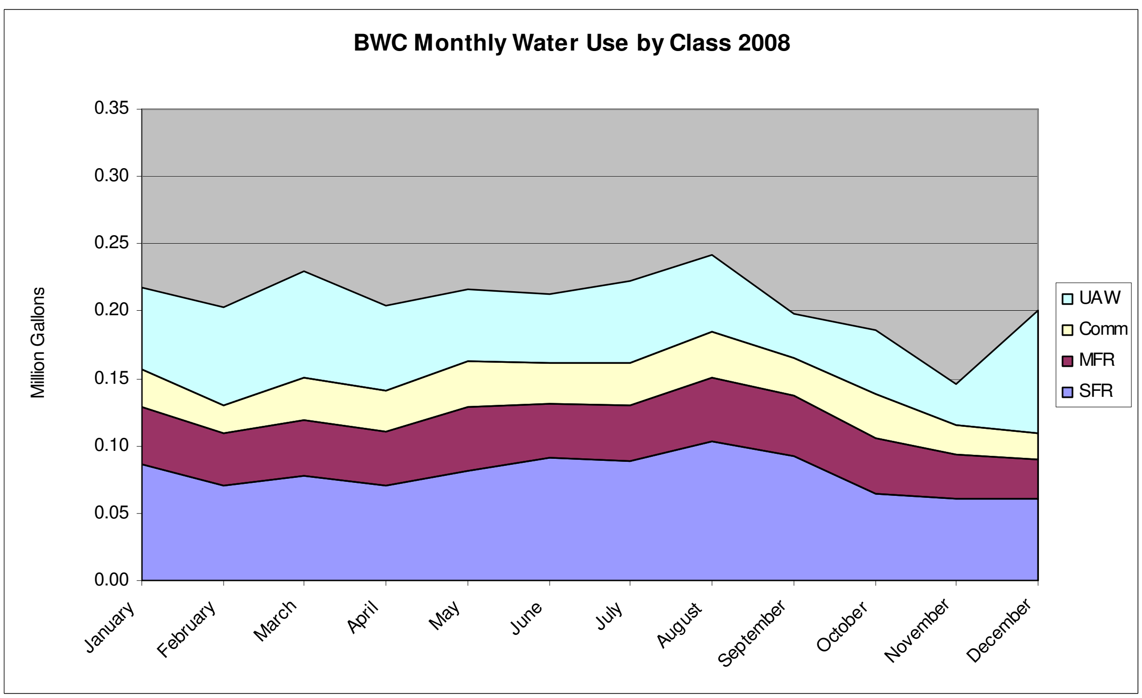
Graph 4



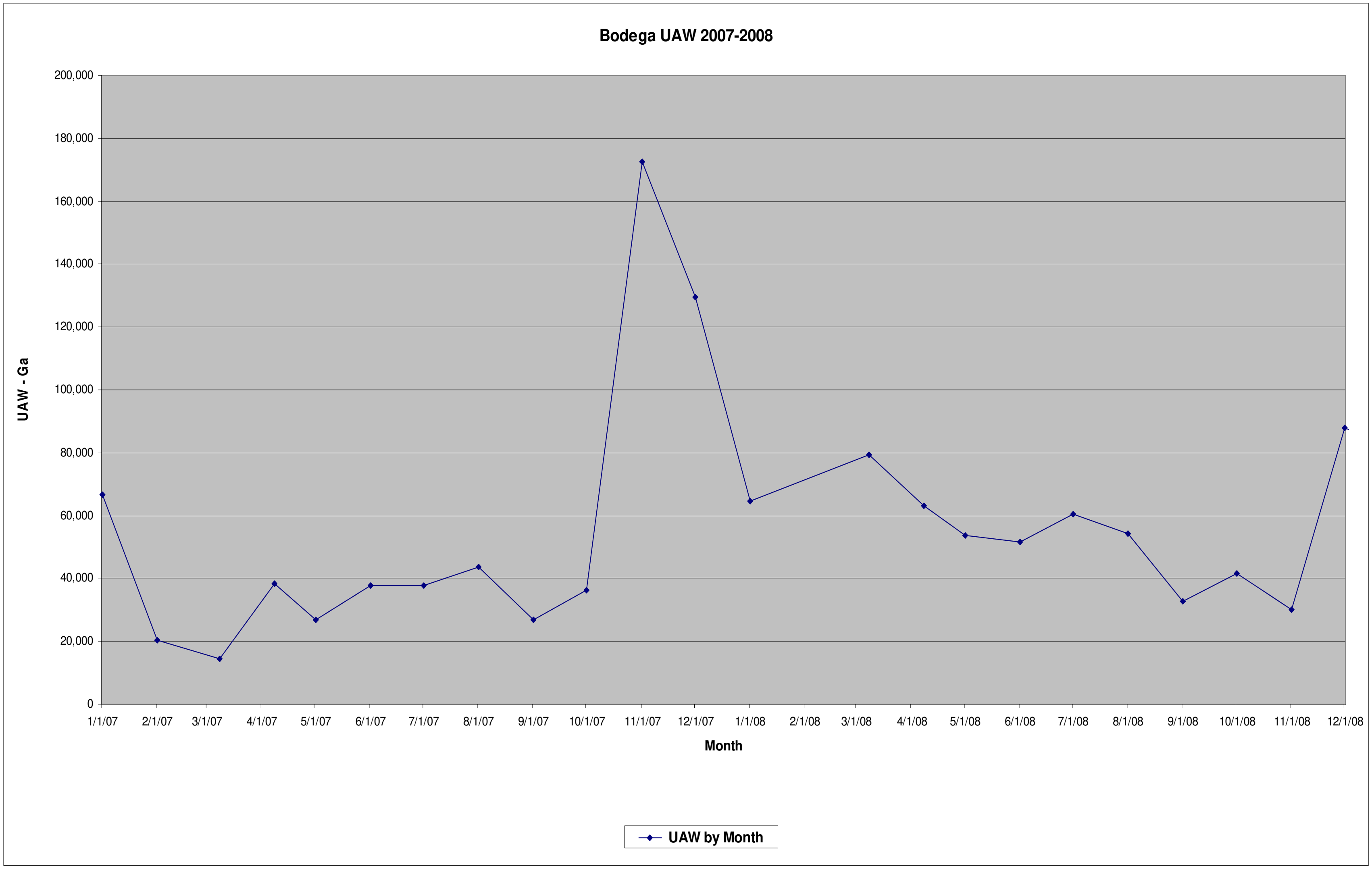
Graph 5



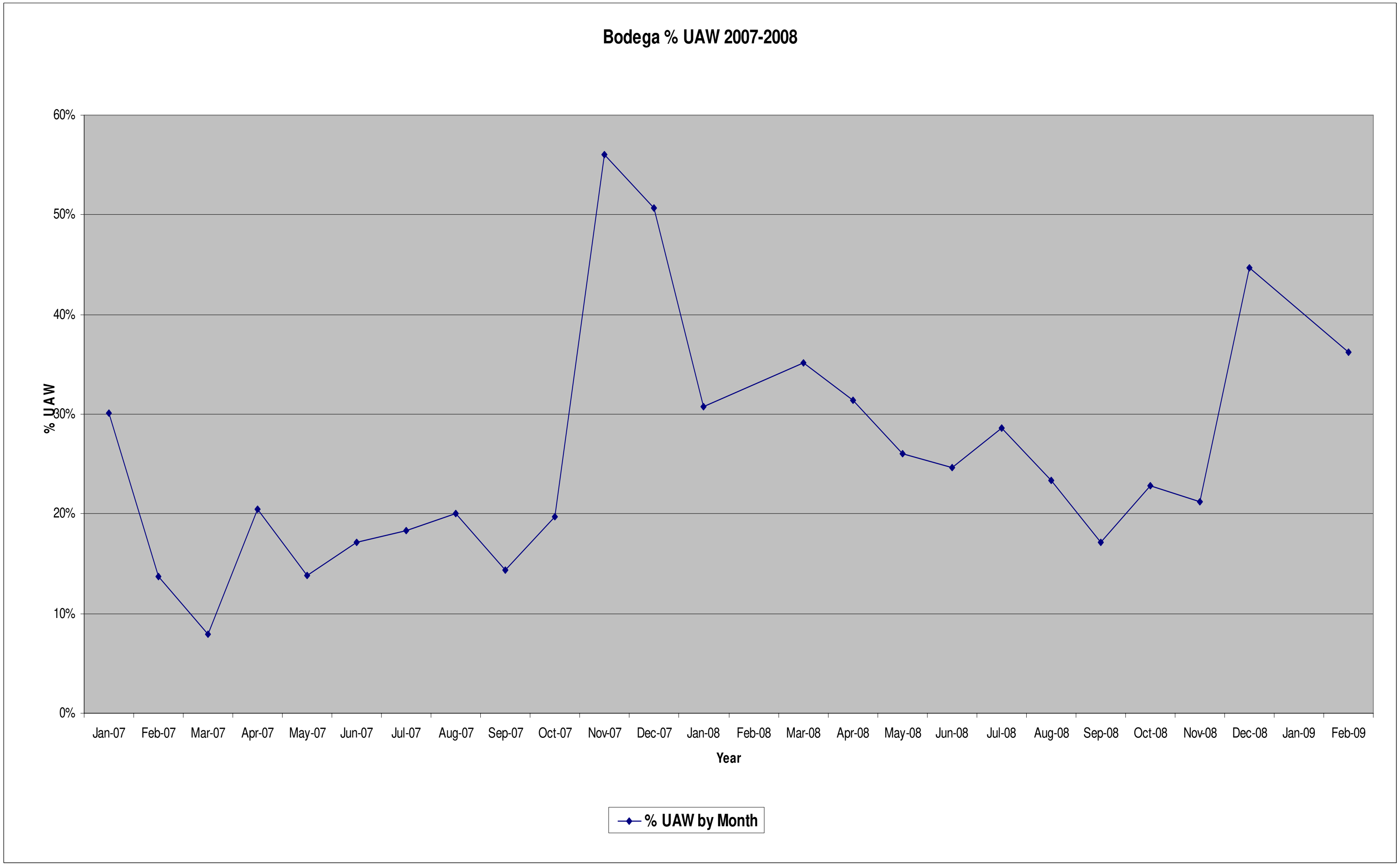
Graph 6



Graph 7


Bodega UAW 2007-2008
UAW - Ga
200,000
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1/1/07
2/1/07
3/1/07
4/1/07
5/1/07
6/1/07
7/1/07
8/1/07
9/1/07
10/1/07
11/1/07
12/1/07
1/1/08
2/1/08
3/1/08
4/1/08
5/1/08
6/1/08
7/1/08
8/1/08
9/1/08
10/1/08
11/1/08
12/1/08
Month
UAW by Month

Graph 8


Bodega % UAW 2007-2008
60%
50%
40%
30%
20%
10%
0%
% UAW
Jan-07 Feb-07 Mar-07 Apr-07 May-07 Jun-07 Jul-07 Aug-07 Sep-07 Oct-07 Nov-07 Dec-07 Jan-08 Feb-08 Mar-08 Apr-08 May-08 Jun-08 Jul-08 Aug-08 Sep-08 Oct-08 Nov-08 Dec-08 Jan-09 Feb-09
Year
% UAW by Month

Salmon Creek Watershed - Water Conservation Project
Freestone Water System
Supply and Demand Inventory

A. Overview

This Supply and Demand Inventory is based on water production and metered water use data for the Freestone Water System (FWS) provided by the Russian River Utility (RRU) and the County of Sonoma (County) for the years 2007 and 2008. The FWS is a County Service Area water system governed by the County Board of Supervisors, and supervised by the County Department of Transportation and Public Works. Water billing and collection is provided by the County Auditor. Operation, maintenance, management, engineering, meter reading and repairs are carried out by RRU under contract with the County.

A.1 SERVICE AREA DESCRIPTION

Freestone is a small unincorporated community of single family homes and several businesses in the Sonoma County's Salmon Creek watershed. Freestone is located at the intersection of Bodega Highway and Bohemian Highway, approximately 6 miles west of Sebastopol and 5 miles east of California State Highway 1. Most of the homes and businesses in the town are served by the FWS. The specialty shops which occupy the center of Freestone draw many Sonoma County residents and tourists to this small community.

A.2 DESCRIPTION OF WATER SOURCE

The water supply for FWS is from one spring and two wells. A third well which may be drawing from underflow to Salmon Creek is not approved by the California Department of Public Health.

A.3 WATER RATES AND RATE STRUCTURE

Water is billed every month to all customers of FWS. Meters are read by RRU and the County Auditor bills and collects payment. Water is measured and billed in thousand gallon units. The rate structure for all customers as of January 2010 is:

Base rate (charged regardless of water use):	$ 40.00/mo.
First tier (0-15,000 gallons):	$ 9.22 /1000 gal.
Second tier (16-20,000 gallons):	$ 13.41/1000 gal.
Third tier (over 20,000 gallons):	$ 20.11/1000 gal.

Table 1 compares FWS's water rates with those of other local communities. These systems vary in size and source of water supply. All of the communities in Table 1 have water rates that increase as use goes up, with increasing blocks or tiers. For the 4,500 gallon month example in Table 1, all water use is billed at the first tier.

Table 1 - Comparison of Monthly Residential Water Bill (based on 4,500 gal. use)

	Fixed Charge	Billing Unit	First Tier Use Charge	Use Charge/ gal	Billable Use (1)	Total Use Charge	Bill
Freestone (2)	$40.00	1,000 Gallons	$9.22	$0.009	4,500	$41.49	$81.49
Salmon Creek (3)	$37.50	Hundred Cubic Ft.	$8.00	$0.011	4,500	$48.13	$85.63
Bodega (4)	$50.00	1,000 Gallons	$25.00	$0.025	4,500	$112.50	$162.50
Bodega Bay (5)	$15.37	Hundred Cubic Ft.	$3.24	$0.004	1,500	$6.50	$21.86
Sereno del Mar (6)	$64.95	Hundred Cubic Ft.	$4.00	$0.005	4,500	$24.06	$89.01
City of Sebastopol (7)	$11.87	Hundred Cubic Ft.	$1.46	$0.002	4,125	$8.05	$19.92

(1) Some water systems include an increment of water in the monthly fixed charge
(2) Second tier > 15 tg - $13,41; third tier > 20 tg - $20.11
(3) Second tier > 20 hcf - $10.06; third tier > 27 hcf - $17.91
(4) Second tier > 8 tg - $40.00
(5) Second tier > 25 hcf - $3.70
(6) Second tier > 67 hcf - $4.50; third tier > 107 hcf - $5.50
(7) Second tier > 30 hcf - $1.54

B. Supply Characteristics and Inventory

B.1 TOTAL WATER PRODUCED - 2007 AND 2008.

Table 2 shows total water produced by month for the two years of this inventory. RRU provided production numbers for 2009 to include in this portion of the inventory. All water is from the groundwater supply wells and spring discussed in the previous section. In most years over half of the supply comes from the groundwater wells.

Table 2 – FWS Water Production by Month – Million Gallons

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2007	0.13	0.15	0.15	0.11	0.15	0.15	0.20	0.30	0.19	0.23	0.14	0.14	2.04
2008	0.13	0.10	0.17	0.22	0.17	0.25	0.25	0.19	0.19	0.15	0.09	0.10	2.01
2009	0.12	0.12	0.12	0.15	0.15	0.23	0.19	0.22	0.21	0.12	0.09	0.09	1.81

B.2 UNACCOUNTED FOR WATER

Unaccounted for water (UAW) is percentage of water that is produced that is not sold or accounted for in other ways (such as fire flow or water system maintenance). UAW is based on the difference between water production (Table 2) and water sold (Table 4). For FWS, UAW for the years of this inventory is:

2007 UAW: 36.6%
2008 UAW: 33.3%

UAW is high on the FWS. RRU reports that this is due to an inefficient backwash system which was upgraded in September 2009. RRU expects to reduce UAW in future years.

C. Demand Characteristics and Inventory

C.1 NUMBER OF CONNECTIONS AND WATER USE BY CUSTOMER CLASS

Table 3 shows the number of connections for each of the customer classes, Residential and Commercial, as well as the percentage of the total connections for each customer class. This data has been unchanged for a number of years.

Table 3 – FWS Connections by Customer Class – Number and Percent of Total

Res # Con	Res % Con	Com # Con	Com % Con	Total # Con
26	84%	5	16%	31

Table key: Res – Residential
Com – Commercial
Con – Connections

Table 4 shows water use by customer classes and the percent of total use for each class for each year. Water use distribution between classes was very stable for these two years.

Table 4 – FWS Annual Metered Water Use and Percent of Use by Customer Class; and Annual Metered Use

	Res Use- MG	Res % Use	Com Use- MG	Com % Use	Total Use- MG
2007	0.813	62.98%	0.478	37.02%	1.291
2008	0.849	63.28%	0.493	36.72%	1.342

Table key: MG – million gallons
Res – Residential
Com – Commercial

The data from Tables 3 and 4 is illustrated in Graphs 1 and 2 at the end of this report. Of interest in this data on connections and water use is the trend that the residential class makes up 84% of the connections, but uses only 63% of the overall water consumed. Commercial customers make up 16% of the connections but account for 37% of the water use. This information suggests that targeting commercial customers with conservation initiatives may be a good strategy in terms of maximizing the effect per contact.

Table 5 below expands the information presented in Table 4 by showing the variation in water use *per connection* by each customer class for each year of this analysis. This further demonstrates the value in targeting conservation to the Commercial users in Freestone.

Table 5 – FWS Annual Water Use per Connection by Customer Class

	Residential Use (gal/connection)	Commercial Use (gal/connection)
2007	31,272	95,594
2008	32,650	98,528

C.2 PER CAPITA DEMAND

Per capita water use or per capita demand is a standard measurement for public water systems – it is a measure of the water use per person. Most typically per capita demand is expressed in the unit "gallons per person per day" or GPCD. In California the recognized standard for per capita demand is total water produced divided by total population served. This "gross per capita" figure includes all water uses in a community including residential and commercial use, fire flow, system maintenance use, as well as UAW.

To evaluate seasonal trends, it is valuable to compare seasonal GPCD, so the GPCD for the three summer months (June-Aug.) and the three winter months (Dec.-Feb.) are also shown below.

Table 6 presents these various GPCD measurements for FWS for the years of this analysis. Note that only those GPCD figures designated as "gross" include UAW; all other GPCD figures are based on metered water use. The first column, Gross GPCD, is technically the per capita demand according to California standards.

Table 6 – FWS Gross per Capita Water Use – Gallons/Person/Day (GPCD)

	Annual	Summer	Winter
2007	107	135	88
2008	106	144	71

C.3 AVERAGE DAY METERED DEMAND

Average day demand factors are used in water systems to make operational decisions and planning projections. Average day factors are often used to derive peak day and peak hour flow, both important factors in determining system component size and rating. These figures represent an average of metered water data, therefore UAW is not included in Table 7 figures which shows average day demand factors for the FWS for the years of this analysis.

Table 7 – Average Day Metered Demand System-wide - Gallons

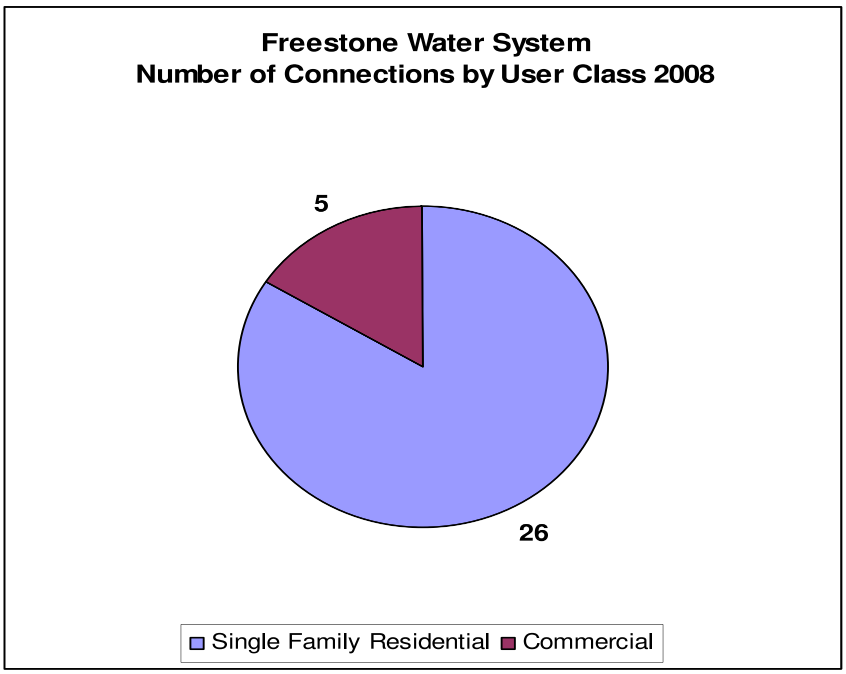
	Annual	Peak Month	Minimum Month
2007	3,537	4,995	2,389
2008	3,675	5,221	2,437

D. Graphics that Illustrate FWS Inventory Trends

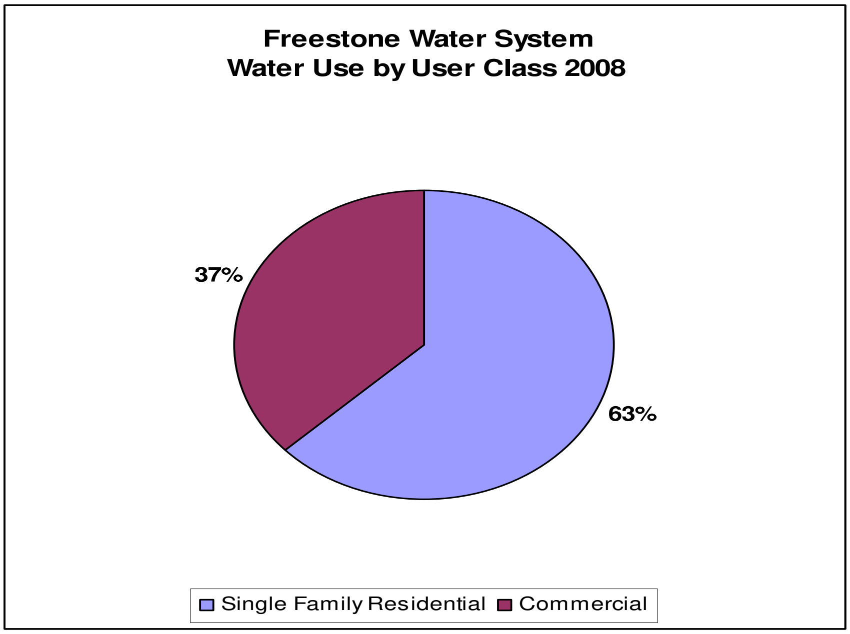
The following graphs illustrate trends on the FWS system:

- Graphs 1: Number of connections by user class
- Graphs 2: Annual water use by user class for 2007 and 2008 average
- Graphs 3 & 4: Monthly water use by user class and UAW for 2007 and 2008

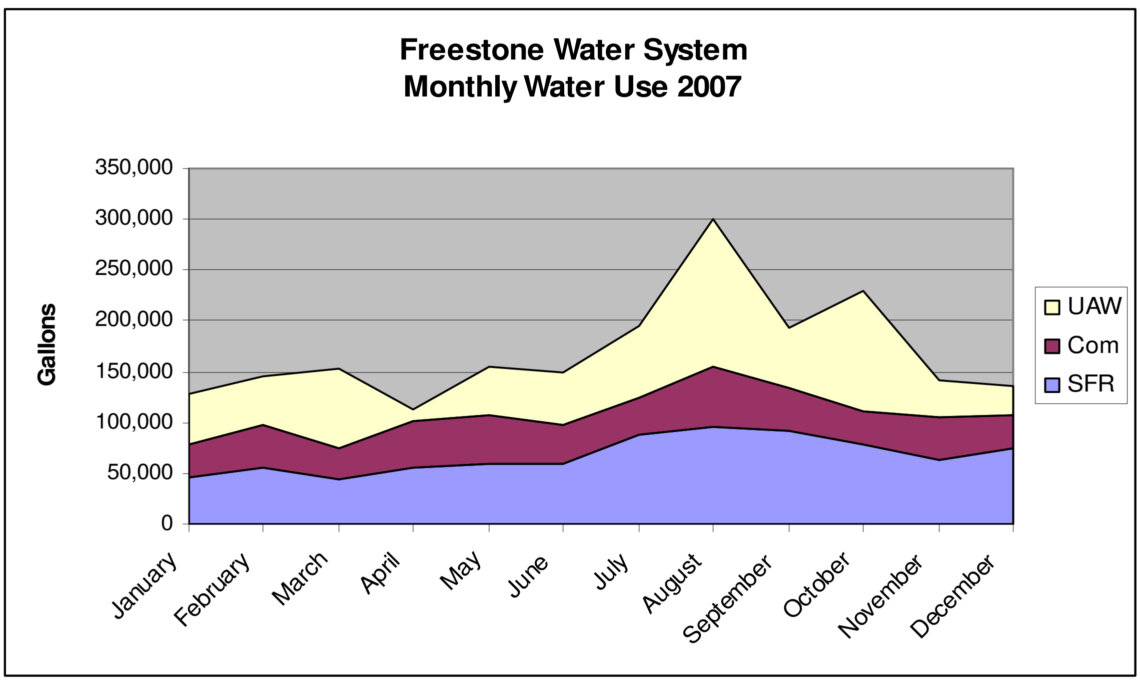
Graph 1



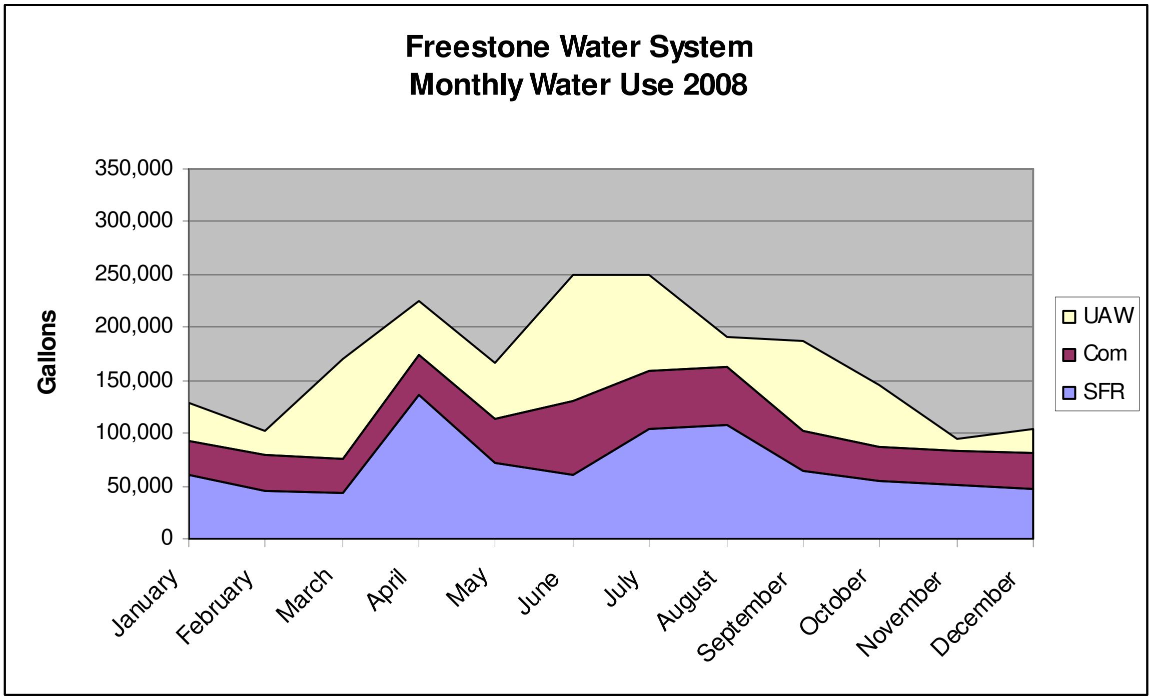
Graph 2



Graph 3



Graph 4


Freestone Water System
Monthly Water Use 2008
Gallons
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
January
February
March
April
May
June
July
August
September
October
November
December
UAW
Com
SFR

Salmon Creek Watershed - Water Conservation Project
Salmon Creek Water System
Supply and Demand Inventory

A. Overview

This Supply and Demand Inventory is based on water production and metered water use data for the Salmon Creek Water System (SCWS) provided by the Russian River Utility (RRU) and the County of Sonoma (County) for the years 2007 and 2008. The SCWS is a County Service Area water system governed by the County Board of Supervisors, and supervised by the County Department of Transportation and Public Works. Water billing and collection is provided by the County Auditor. Operation, maintenance, management, engineering, meter reading and repairs are carried out by RRU under contract with the County.

A.1 SERVICE AREA DESCRIPTION

Salmon Creek is a small unincorporated community of about 100 homes in coastal Sonoma County located on California State Highway 1 approximately ten miles north of the Sonoma/Marin County line, and eight miles south of the mouth of the Russian River at Jenner. The community is just south of the stream named Salmon Creek in the far west section of the Salmon Creek watershed. The area that is served by the SCWS has an estimated population of 106 based on an average of 1.07 persons per household in the Lower Salmon Creek census track in the 2000 US census. Salmon Creek is a residential community that has year-round residents, partial-year residents and homes that are primarily vacation rentals. RRU estimates that 20% of the homes are occupied only part of the year.

A.2 DESCRIPTION OF WATER SOURCE

The water supply for SCWS is from two separate sources: one well, the Maryana well, and one spring. Disinfection is with liquid chlorine. Currently, the County is evaluating the installation of a micro-filtration system to treat all water served by SCWS.

A.3 WATER RATES AND RATE STRUCTURE

Water is billed every month to all customers of SCWS. Meters are read by RRU and the County Auditor bills and collects payment. Water is measured and billed in hundred cubic foot units (1 HCF = 748 gallons). The rate structure for all customers as of January 2010 is:

Base rate (charged regardless of water use):	$ 37.50/mo.
First tier (0-20 HCF):	$ 8.00 /HCF
Second tier (21-27 HCF):	$ 10.06/HCF
Third tier (over 27 HCF):	$ 17.91/HCF

Table 1 compares SCWS's water rates with those of other local communities. These systems vary in size and source of water supply. All of the communities in Table 1 have water rates that increase as use goes up, with increasing blocks or tiers. For the 4,500 gallon month example in Table 1, all water use is billed at the first tier.

Table 1 - Comparison of Monthly Residential Water Bill (based on 4,500 gal. use)

	Fixed Charge/ Month	Billing Unit	First Tier Use Charge	Use Charge/ gal	Billable Use (1)	Total Use Charge	Bill
Salmon Creek (2)	$37.50	Hundred Cubic Ft.	$8.00	$0.011	4,500	$48.13	$85.63
Bodega Bay (3)	$15.37	Hundred Cubic Ft.	$3.24	$0.004	1,500	$6.50	$21.86
Bodega (4)	$50.00	1,000 Gallons	$25.00	$0.025	4,500	$112.50	$162.50
Freestone (5)	$40.00	1,000 Gallons	$9.22	$0.009	4,500	$41.49	$81.49
Sereno del Mar (6)	$64.95	Hundred Cubic Ft.	$4.00	$0.005	4,500	$24.06	$89.01

(1) Some water systems include an increment of water in the monthly fixed charge
(2) Second tier > 20 hcf - $10.06; third tier > 27 hcf - $17.91
(3) Second tier > 25 hcf - $3.70
(4) Second tier > 8 tg - $40.00
(5) Second tier > 15 tg - $13,41; third tier > 20 tg - $20.11
(6) Second tier > 67 hcf - $4.50; third tier > 107 hcf - $5.50

B. Supply Characteristics and Inventory

B.1 TOTAL WATER PRODUCED - 2007 AND 2008.

Table 2 shows total water produced by month for the two years of this inventory. RRU has provided additional data for 2009 production for this section of the inventory only. All water is from the well and spring discussed in the previous section.

Table 2 – SCWS Water Production by Month – Million Gallons

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
2007	0.17	0.15	0.13	0.23	0.21	0.23	0.29	0.28	0.21	0.20	0.19	0.13	2.41
2008	0.24	0.16	0.20	0.22	0.23	0.25	0.28	0.26	0.23	0.21	0.15	0.19	2.61
2009	0.25	0.13	0.13	0.19	0.19	0.26	0.24	0.27	0.18	0.16	0.17	0.14	2.30

B.2 UNACCOUNTED FOR WATER

Unaccounted for water (UAW) is percentage of water that is produced that is not sold or accounted for in other ways (such as fire flow or water system maintenance). UAW is based on the difference between water production (Table 2) and water metered to customers (Table 3). For SCWS, the UAW for 2006-2009 is as follows:

2007 UAW: -2.5%
2008 UAW: 9.5%
2009 UAW: 7.0%

The negative UAW number in 2007 is of concern because it is not physically possible for the water system to sell more water than it produces. Every effort was made to confirm the accuracy of all meter reading data which was used in this analysis. Based on review of the data and meter reading and recording techniques, the conclusion is that the negative UAW in 2007 is most likely is due to one or more of the following conditions: production meters could be under registering; an error or errors could have taken place in recording production data; or there could be inconsistency in the dates the production meters and customer meters were read in 2007 (production meter readings could cover fewer days than customer meter readings).

C. Demand Characteristics and Inventory

C.1 NUMBER OF CONNECTIONS, ANNUAL USE, AND ANNUAL USE PER CONNECTION

Table 3 shows the number of connection, annual metered water use, and annual metered water use per connection for the SCWS. Metered water use is the water sold to customers, and does not include UAW. All connections on this system serve single family residences.

Table 3 – SCWS Number of Connections, Annual Metered Water Use, and Annual Metered Water Use per Connection

	Connections	Annual Use (Gallons)	Annual Use per Connection (Gallons)
2007	99	2,475,100	25,000
2008	99	2,357,700	23,815

C.2 PER CAPITA DEMAND

Per capita water use or per capita demand is a standard measurement for public water systems – it is a measure of the water use per person. Most typically per capita demand is expressed in the unit "gallons per person per day" or GPCD. In California the recognized standard for per capita demand is total water produced divided by total population served. This "gross per capita" figure includes all water uses in a community including customer use, fire flow, system maintenance use, as well as UAW.

To evaluate seasonal trends, it is valuable to compare seasonal GPCD, so the GPCD for the three summer months (June-Aug.) and the three winter months (Dec.-Feb.) are also shown below.

Table 4 presents these GPCD measurements for SCWS for the years of this analysis. Note that these figures include UAW.

Table 4 –SCWS Gross per Capita Water Use – Gallons/Person/Day (GPCD)

	Annual	Summer	Winter
2007	62	82	48
2008	67	82	62

C.3 AVERAGE DAY METERED DEMAND

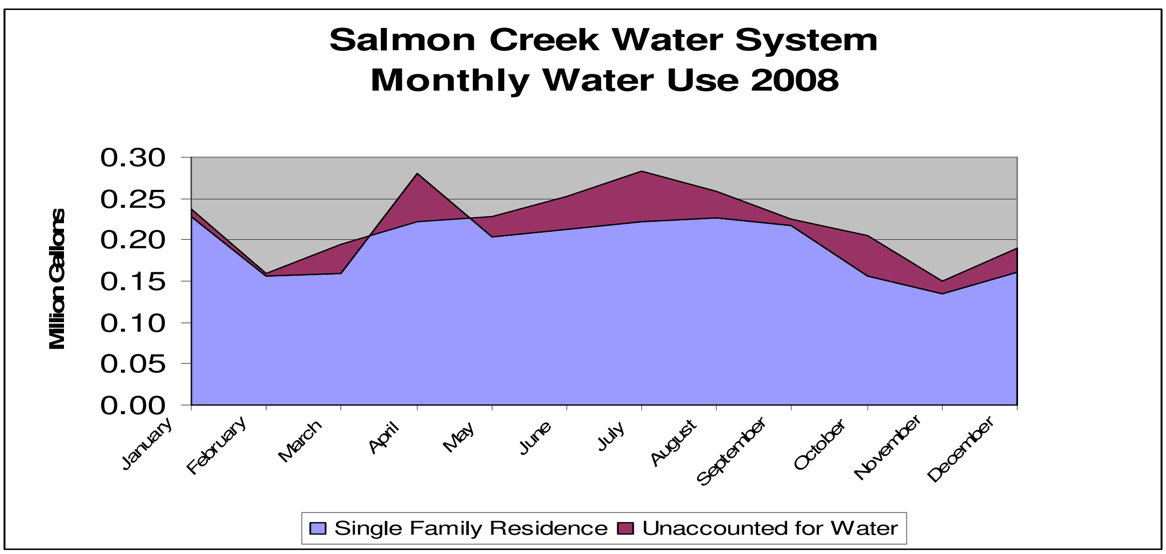
Average day demand factors are used in water systems to make operational decisions and planning projections. Average day factors are often used to derive peak day and peak hour flow, both important factors in determining system component size and rating. The figures presented in Table 5 represent an average of metered water use, therefore UAW is not included.

Table 5 – SCWS Average Day Metered Demand System-wide - Gallons

	Annual	Peak Month	Minimum Month
2007	6,780	9,210	4,200
2008	6,460	9,140	4,990

D. Graphic Illustration of Inventory Trends

The following graph illustrates monthly water use and UAW for 2008. Only one year is illustrated because of uncertainty about the quality of the 2007 data.



Virginia Porter
CONSULTING SERVICES

TECHNICAL MEMORANDUM

To: Brock Dolman, OAEC WATERInstitute
Kate Lundquist, OAEC WATERInstitute
From: Virginia Porter, Virginia Porter Consulting
Subject: Salmon Creek Watershed – Metered Water Systems Supply and Demand Inventory Summary
Date: May 21, 2010

INTRODUCTION AND PURPOSE

One component of the Salmon Creek Water Conservation Program (SCWCP) is analyzing the total water supply and water demand within the Salmon Creek Watershed. The analysis described in this Technical Memorandum is a companion to the Rural Water Demand analysis that was also performed as a part of the SCWCP. Together these analyses provide the foundational data on which to build planning strategies for increasing stream flow in Salmon Creek during the critical spawning period salmonids. In particular, by quantifying summer demands throughout the watershed, strategies can be developed to both reduce summer demands through conservation and efficiency, and increase and diversify alternate supplies to offset summer withdrawal from Salmon Creek.

For purposes of discussion of metered water systems in this memorandum, the term "supply" refers to the water produced for each metered water system. This is not to be confused with the greater discussion of overall watershed sources of supply based on the hydrogeology of the Salmon Creek Watershed which is found in the Salmon Creek Water Conservation and Streamflow Restoration Plan. The supply of the metered water systems analyzed in this memorandum is categorized as "consumptive demand" when analyzing the overall supply and demand balance of the Salmon Creek Watershed.

There are four communities with water utilities that serve customers treated and metered water from Salmon Creek or its tributaries:

- Freestone,
- Bodega,
- Salmon Creek, and
- Bodega Bay.

Bodega Bay's service area is outside the Salmon Creek Watershed, but approximately 10% of its supply currently comes from Salmon Creek. Though much of the town of Occidental is in the Salmon Creek Watershed, its water is supplied by Russian River sources therefore it is not included in this Salmon Creek analysis.

The discussion of water use or water demand in this analysis is based on evaluation of metered water use records from each water system for 2007 and 2008, the most recent two years with full records available at the onset of this study.

For each water system analyzed, unaccounted for water (UAW) is determined. UAW is the percentage of water that is produced that is not sold or accounted for in other ways (such as fire flow or water system maintenance). A well maintained water system should have UAW less than 10%.

SUMMARY OF PROCEDURES

For purposes of developing the inventory of metered water use supplied by sources from Salmon Creek, metered water production records and metered customer water use records were obtained from each of the four community water systems analyzed:

- Bodega (Bodega Water Company is the water purveyor).
- Freestone (Russian River Utility operates and the County of Sonoma governs).
- Salmon Creek (Russian River Utility operates and the County of Sonoma governs).
- Bodega Bay (Bodega Bay Public Utilities District is the water purveyor).

Data was reported on a monthly basis for the years 2007 and 2008. Metered water use data from customers was segregated into the following user classes: single-family residential, multi-family residential, and commercial. Water use within each user class was aggregated, and the number of accounts represented by the aggregated water use was provided. The California Department of Water Resources Public Water Systems Statistics Report form (attached) was used to gather the data from each water purveyor.

Data from each system was compiled and analyzed for the following reasons:

- to determine water use trends throughout the year and from year-to-year;
- to determine UAW;
- to evaluate customer classes and use patterns within each customer class; and
- to develop strategies to improve water use efficiency where possible.

The full inventories for each community are attached to this memorandum. This summary captures only the total supply and demand detail from the full inventories.

WATER SUPPLY AND DEMAND BY COMMUNITY

Bodega

Bodega Water Company (BWC) supplies treated water to most of the population of the Town of Bodega, and most of the commercial businesses in the town. BWC has 36 water connections, of which 5 serve businesses, 7 serve multi-family residences and 24 serve single family residences. Water is supplied from three local wells. Table 1 summarizes BWC's average water production (supply), water use (demand), and UAW during the years of this analysis. Monthly data on water production and water use is in the complete inventory report for Bodega attached to this memorandum.

Table 1 – Bodega Water Company Supply and Demand – Average of 2007-2008

Annual Water Production (Supply)	Annual Water Use (Demand)	Unaccounted For Water (UAW)
2,497,050 gal	1,820,700 gal	701,350 gal (28%)

Freestone

Russian River Utility (RRU) supplies treated water to most of the population and businesses of Freestone. RRU has 31 water connections in Freestone, of which 5 serve businesses and 26 serve single family residences. Water is supplied from two local wells and one spring. Table 2 summarizes BWC's average water production (supply), water use (demand), and UAW during the years of this analysis. Monthly data on water production is in the complete inventory report for Freestone attached to this memorandum.

Table 2 – Freestone Water System Supply and Demand – Average of 2007-2008

Annual Water Production (Supply)	Annual Water Use (Demand)	Unaccounted For Water (UAW)
1,952,750 gal	1,316,300 gal	636,450 gal (32.6%)

Salmon Creek

RRU supplies treated water to the 99 single family residences that make up the community of Salmon Creek. Water is supplied from one local well and one spring. Table 3 summarizes BWC's average water production (supply), water use (demand), and UAW during the years of this analysis. Monthly data on water production is in the complete inventory report for Salmon Creek attached to this memorandum.

Table 3 – Salmon Creek Water System Supply and Demand – Average of 2007-2008

Annual Water Production (Supply)	Annual Water Use (Demand)	Unaccounted For Water (UAW)
2,519,850 gal	2,330,550 gal	189,300 gal (7.5%)

Bodega Bay

Bodega Bay Public Utilities District (BBPUD) supplies treated water to the Town of Bodega Bay which is outside the Salmon Creek Watershed. Approximately 10% of the total water supply to Bodega Bay, or an average of 1.4 million gallons per year, comes from Salmon Creek. BBPUD UAW averages 14.3% from 2007-2009. Detailed data on BBPUD water use and production is in the complete inventory report attached to this memorandum.

TOTAL METERED WATER SYSTEM PRODUCTION

Table 4 summarizes the total water production from the metered water systems served by water supply from Salmon Creek. For purposes of the greater Salmon Creek Watershed supply and demand analysis, this total production number should be considered a known "water demand" within the watershed.

Table 4 - Total Metered Water System Production from Salmon Creek Watershed – Based on 2007 & 2008 Data

Water System	Gallons/Year	Acre-Feet/Year	Sources
Salmon Creek Water System	2,519,850	7.73	well and spring
Freestone Water System	1,952,750	5.99	well and spring
Bodega Water Company	2,497,050	7.66	Well
Bodega Bay Public Utilities District*	1,393,913	4.28	Well
TOTAL	**8,363,563**	**25.66**	

* BBPUD supply from Salmon Creek Watershed is currently 10% of total BBPUD Production

Attachments:

1. DWR Public Water Systems Statistics form

2. Water System Supply and Demand Inventories for: Bodega, Freestone, Salmon Creek and Bodega Bay

TECHNICAL MEMORANDUM

To: Brock Dohlman, OAEC
Kate Lundquist, OAEC
From: Virginia Porter, Virginia Porter Consulting
Subject: Salmon Creek Watershed Rural Water Demand
Date: May 21, 2010

1. Assumptions and Data Sources

For this inventory, the approach to determining rural water demand is to quantify the non-metered water uses within the Salmon Creek Watershed. The rural demand assessment is based on a land use analysis approach which is one standard approach to demand projection for both the non-metered and metered water use (Johnson and Loux, 2004). This method links water use to individual parcel land use. Water use factors were developed for parcel land use types using the following data and conditions: metered household water use data from watershed communities and adjacent Sonoma County communities; regional climate conditions; and demographics of the watershed. Livestock population estimates are included in the analysis.

This analysis does not attempt to tie specific demands to specific source waters, whether they are streamflow, spring water, or groundwater. The general assumption is that the majority of the demand is served by water originating in the watershed, and that reducing these demands may have a positive impact on salmonid spawning habitat in Salmon Creek and its tributaries.

The rural demand analysis uses the land use data and classification system from County of Sonoma assessors parcel records coupled with aerial photo analysis and ground-truthing to verify and refine the geographic information systems (GIS) parcel dataset. The GIS data and mapping analysis was performed by Prunuske Chatham, Inc. (PCI). Climate data is derived from the California Irrigation Management Information Systems (CIMIS) network of weather stations and interpretative analyses carried out by CIMIS scientists to correlated CIMIS station data with coastal climates that might not have stations. Information about local vineyard irrigation practices was provided by the California Cooperative Extension and local vineyard managers. Demographic data was derived from the 2000 federal census. Livestock populations were provided by Gold Ridge Resource Conservation District staff. Published standard use factors, such as the volume of water consumed by dairy cattle, were utilized to develop livestock water use data.

2. Summary of procedure

For purposes of developing the rural inventory of water uses within the Salmon Creek Watershed, the land area was divided into nine sub-watersheds so that impacts to the tributaries and reaches of Salmon Creek could be evaluated separately and collectively. The sub-watersheds are:

- Upper Salmon Creek
- Freestone Valley

- Bodega Valley
- Thurston and Nolan Creek
- Tannery Creek
- Fay Creek
- Coleman Valley Creek
- Finley Creek
- Lower Salmon Creek

Within each sub-watershed, land use was categorized based on County of Sonoma assessors parcel data and land use classifications, aerial photographs, and some ground verification of land use.

Given the range of land use classifications, the methodology used to derive water use was to identify and group together all parcels within the same land use within each sub-watershed. The result was an inventory of land uses, and number of parcels within each land use classification by sub-watershed. This inventory is summarized in Table 1 below.

Table 1 – Salmon Creek Watershed Rural Inventory by Land Use Classification – Number of Parcels by Sub-watershed

→ SUB-WATERSHED ↓ LAND USE	Upper Salmon Creek	Free-stone Valley	Bodega Valley	Thurston and Nolan Creek	Tannery Creek	Fay Creek	Coleman Valley Creek	Finley Creek	Lower Salmon Creek
Residence	254	178	24	90	117	91	100	3	5
Residence w/Vineyard	11	13	4	2	7	11	3	0	0
Residence w/Pasture	5	20	17	5	5	13	8	10	13
Residence w/Dairy	0	1	3	2	0	0	0	0	0
Residence w/non-irrig Orchard	11	1	0	2	2	5	0	0	0
Residence w/Chickens	0	1	0	0	0	0	0	0	0
School	0	2	0	0	0	0	0	0	0
Vineyard	2	9	2	1	1	1	3	0	0

The **residential classification** includes both simple residential properties, and residential properties coupled with the following additional land uses: vineyard, pasture, non-irrigated orchard, dairy, and chickens. For purposes of developing demand projections for each residential category, the water demands of the actual residence were segregated from the additional land use. For example, the classification "residence with vineyard" was evaluated as a residence plus a vineyard of a certain acreage, whereas "residence with dairy" was evaluated as a residence and the dairy demand was included in the watershed-wide water demand for dairy cattle. Residential water demand is discussed in Section 3 of this report. It is possible that more than one residence exists on some large parcels within the watershed. If this is the case, the field verification performed as part of this analysis suggests it is the exception rather than the norm, and that most parcels with the residential land use classification have one residence.

Non-residential land use classifications include all land uses without a residence, such as a school or vineyard. The non-residential water demand is a combination of the water demand from these land use classifications, plus the water demand from uses that are linked to the residential classifications described in the previous paragraph. Non-residential water demand for this inventory falls into three categories: vineyards, schools and livestock. Each of these categories is discussed in Section 4 of this report.

Other land uses within the Salmon Creek Watershed were identified but found to have no apparent water use impact on the watershed. These include non-irrigated pasture and orchards, two lumber mills that no longer operate, and camps that receive water from the Town of Occidental which receives water from the Russian River.

The demand factors used to develop water use data from the land use classifications as described above are described in the sections that follow.

3. Residential Water Demand

For purposes of calculating residential water demand, each parcel designated as residential is calculated as one residence. For land use classifications with a residence linked with other uses such as "residence with dairy," each parcel is assumed to have one residence, and the demand from the linked use is covered in Section 4 – Non-residential Water Demand. The total number of residences within the rural inventory is 1,037. Residences are separated into sub-watersheds as summarized in Table 2 at the end of this Section.

The residential demand factor for this inventory is 90,000 gallons per residence per year, or approximately 0.28 acre-feet. The number of residences is multiplied by the demand factor to derive the residential demand that is summarized in Table 2 below. The residential demand factor is based on professional knowledge of water use trends and, for this inventory, was informed by data from a number of sources and studies specific to the Salmon Creek Watershed and surrounding region. These sources are summarized as follows:

- Residential water demand as measured through water meters for community water systems within the Salmon Creek Watershed ranges from about 35,000 – 65,000 gallons per residence per year. Adding a factor of 15% - 20% for water system maintenance (like flushing lines and filters) and distribution system leaks, brings annual water demand to about 40,000 – 75,000 gallons per account per year.

Because water costs are relatively high on these metered water systems, it is a reasonable assumption that many residents have installed water efficient water fixtures and are careful about how they use water. Additionally, some communities such as Salmon Creek do not have year-round residents so the per account water use is representative of only a partial year of consumption. For these reasons, these factors were assumed to be too low for the rural residential demand factor for this inventory. In addition, it is reasonable to assume residents without meters would use more water than residents with water meters and relatively high water rates.

- In 2003, Kleinfelder, Inc. conducted a study of three water scarce areas of Sonoma County, including the Joy Road area located in the Salmon Creek Watershed. This report used a residential demand factor of one-half to one acre-foot per year (1 acre-foot = 325,851 gallons). The Kleinfelder report cited an average of Northern California households as the basis for this demand factor. This demand factor is 2-8 times higher than the actual demand metered at households within the Salmon Creek Watershed, and seems like a high estimate given the documented scarcity of water within the watershed. Additionally, coastal climatic conditions typically result in less overall water use outdoors, so using the average of a large area with the majority of the population inland did not seem appropriate for this inventory.
- In 2003, John O. Nelson conducted an analysis of metered water use for customers of the Sonoma County Water Agency, including Santa Rosa, Cotati, Windsor and other Sonoma County communities. The average use in this survey was about 110,000 gallons per residence per year, with a range from 103,000 – 147,000 gallons per residence per year. Given that these communities are inland and have typical residential landscaped lots, the use was assumed to be somewhat higher than would be expected in the Salmon Creek Watershed due both to climate conditions and the relative water scarcity of the region.

The demand factor of 90,000 gallons per residence per year is a reasonable factor given that metered water use within the watershed is significantly lower than this factor, but metered water use in adjacent inland communities is higher. A rural water use factor higher than the metered use in the watershed is reasonable given the absence of water meters and high water rates. A rural factor lower than metered water use in adjacent communities is reasonable given the Salmon Creek Watershed's climate, the relative water scarcity, and the approach to landscaping compared to the more turf-dominated landscapes found in urban areas.

Table 2 shows the residential demand by sub-watershed and total, calculated with this demand factor.

Table 2 – Rural Residential Water Demand in the Salmon Creek Watershed – Million Gallons per Year (MGY) and Acre Feet per Year (AFY)

	Upper Salmon Creek	Freestone Valley	Bodega Valley	Thurston and Nolan Creek	Tannery Creek	Fay Creek	Coleman Valley Creek	Finley Creek	Lower Salmon Creek	Total
Residences	281	214	48	101	131	120	111	13	18	**1,037**
Water Use MGY	25.29	19.26	4.32	9.09	11.79	10.80	9.99	1.17	1.62	**93.33**
Water Use AFY	77.61	59.11	13.26	27.90	36.18	33.14	30.66	3.59	4.97	**286.42**

4. Non-residential Water Demand

Vineyard water demand GIS software was used in conjunction with land use parcel maps and aerial photographs to determine the acreage of vineyards by sub-watershed. An annual water use factor of 2 acre-inches per acre of applied irrigation was used throughout the watershed. This demand factor was based on personal communication with local vineyard managers and with Rhonda J. Smith, Viticulture Farm Advisor for the Sonoma County Cooperative Extension. Vineyard water demand by sub-watershed and total is summarized in Table 3.

Table 3 – Vineyard Water Demand in the Salmon Creek Watershed – Million Gallons per Year (MGY) and Acre Feet per Year (AFY)

	Upper Salmon Creek	Freestone Valley	Bodega Valley	Thurston and Nolan Creek	Tannery Creek	Fay Creek	Coleman Valley Creek	Finley Creek	Lower Salmon Creek	Total
Acreage	62.3	219.1	136.3	15.5	21.8	52.6	50.3	0	0	**557.9**
Water Use - MGY	1.13	3.97	2.47	0.28	0.39	0.95	0.91	0.00	0.00	**10.10**
Water Use - AFY	3.46	12.17	7.57	0.86	1.21	2.92	2.79	0.00	0.00	**30.99**

School water demand

The only schools in the watershed are in the Upper Salmon Creek sub-watershed. Metered water use records were obtained from the Harmony School District. Average annual water use for 2007 and 2008 was 770,000 gallons, or 2.36 acre-feet (Doug Richmond, personal communication, Nov. 2009).

Livestock water demand

Livestock population numbers were provided for the entire watershed by the Gold Ridge Resource Conservation District staff (Brittany Heck, personal communication with Lauren Hammack, August 2009). Water use factors are from Cooperative Extension System published data on water needs of livestock.

Table 4 summarized the livestock water demand in the full Salmon Creek Watershed. Data does not exist for livestock populations by sub-watershed.

Table 4 – Livestock Water Demand in the Salmon Creek Watershed – Million Gallons per Year (MGY) and Acre Feet per Year (AFY)

	Number in Watershed	Water Use Gallons/Day	Water Use - MGY	Water Use – AFY
Dairy cattle – lactating	600	50	10.95	33.60
Dairy cattle – non-lactating	300	9	0.99	3.02
Beef cattle	600	10	2.19	6.72
Horses	80	20	0.58	1.79
Sheep	1,500	1.25	0.68	2.10
TOTAL			**15.39**	**47.24**

5. Total Rural Water Demand

Table 5 summarizes the total rural water demand by sub-watershed within the Salmon Creek Watershed. By adding in the livestock demand, a total rural demand within the Salmon Creek Watershed is established.

Table 5 – Total Rural Demand in the Salmon Creek Watershed – Acre Feet per Year (AFY)

	Upper Salmon Creek	Freestone Valley	Bodega Valley	Thurston and Nolan Creek	Tannery Creek	Fay Creek	Coleman Valley Creek	Finley Creek	Lower Salmon Creek	Total
Residential Demand	77.61	59.11	13.26	27.90	36.18	33.14	30.66	3.59	4.97	**286.42**
Vineyard Demand	3.46	12.17	7.57	0.86	1.21	2.92	2.79	0.00	0.00	**30.99**
School Demand	0	2.36	0	0	0	0	0	0	0	**2.36**
Sub-Total	**81.07**	**73.64**	**20.83**	**28.76**	**37.39**	**36.07**	**33.45**	**3.59**	**4.97**	**319.78**
Livestock Demand	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**47.24**
Total Demand	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**367.02**

6. Trend Evaluation

Two studies of land use and water use have been completed on the section of the Salmon Creek Watershed knows as the Joy Road area:

- In September 1974 the Sonoma County Planning Department completed and published the *Joy Road Study*
- In September 2003 Kleinfelder, Inc. completed and published the *Pilot Study of Groundwater Conditions in the Joy Road, Mark West Springs, and Bennett Valley Areas of Sonoma County, California* for the Sonoma County Permit Resource Management Department (PRMD)

The 2010 Salmon Creek Water Conservation Program (SCWCP) evaluated land use and water use for the entire watershed. In conjunction with the watershed evaluation, GIS professionals with PCI separately analyzed the geographic area studied in the 2003 Kleinfelder study to allow an analysis of treads within the Joy Road area.

Data from the three studies is presented in Table 6 below. Data from 1967 and 1974 is from the 1974 Sonoma County Planning Department Study.

Table 6 - Joy Road Land Use Studies of 1974, 2003, 2010 and Trend Evaluation

	1967 (from 1974 Study)	1974	2003 (2000 data)	2009	Comments on Trends
Study Area Size	6,984 acres		5,752 acres		
Parcels	192	434 (359 in 2003 study area boundary)	466	482	1967 to 1974 – 126% increase in number of parcels; 1974 to 2009 – 34% increase in number of parcels
Parcel Size (acres)	36.4	16.1	NA	14.6	1967 to 2009 – 60% reduction in parcel size
Property Owners	NA	340	323	430	2000 to 2009 – 33% more property owners
Housing Units	NA	256 (210 in 2003 study area boundary	323	355	1974 to 2009 – 69% more housing units
Parcels with Structures	NA	356	NA	381	No data in same size study area
Vacant Parcels	NA	178	NA	101	No data in same size study area
Vineyard Acres	NA	30 in 1980	80	97.7	2000 to 2009 – 22% increase in vineyard acres

7. Rural and Metered Water Demand

Table 7 summarizes total water use from metered water systems for communities using water that originates within the Salmon Creek Watershed. The town of Occidental lies partially within the watershed, but its water supply is from the Russian River. Bodega Bay lies outside the watershed but approximately 10% of their water supply originates within the Salmon Creek Watershed.

Table7 – Total Metered Water Supply from Salmon Creek Watershed – Based on 2007 & 2008 Production Data

Water System	Gallons/Year	AFY	Sources
Salmon Creek Water System	2,519,850	7.73	well and spring
Freestone Water System	1,952,750	5.99	well and spring
Bodega Water Company	2,497,050	7.66	well
Bodega Bay Public Utilities District*	1,393,913	4.28	well
TOTAL	**8,363,563**	**26**	

* BBPUD supply from Salmon Creek Watershed is 10% of total BBPUD Production

Combining water demand from the metered inventory (Table 7) with water demand from the rural inventory (Table 5), total water demand for the Salmon Creek Watershed is 393 acre feet annually.

REFERENCES

Cooperative Extension System. "Farm Resource Area." http://www.extension.org/. (accessed March, 2010).

Johnson, Karen E. and Jeff Loux. Water and Land Use – Planning Wisely for California's *Future.* Solano Press Books. Point Arena, CA. September, 2004.

Kleinfelder, Inc.2003. *Pilot Study of Groundwater Conditions in the Joy Road, Mark West Springs, and Bennett Valley Areas of Sonoma County, California*. Prepared for the Sonoma County Permit Resource Management Department. September, 2003.

Nelson, John 0. 2003. *Comparison of Annual Cost of Retail Water Service to Typical Single Family Detached Home Customer*. Prepared for the Sonoma County Water Agency. October, 2003.

Porter, Virginia. *Salmon Creek Water Conservation Program Metered Water System Inventory: Salmon Creek, Freestone, Bodega and Bodega Bay*. Prepared for Occidental Arts and Ecology Center. May, 2010.

Sonoma County Planning Department. 1974. *Joy Road Study*. September, 1974.

Salmon Creek Water Conservation Program Interviews: Overall Observations & Recommendations

Mary Selkirk
Center for Collaborative Policy
April 28, 2010

Background

As part of laying the groundwork for the OAEC-sponsored Water Conservation Program in the Salmon Creek watershed, Mary Selkirk, Senior Mediator for the Center for Collaborative Policy, conducted interviews of twenty stakeholders in the Salmon Creek watershed. The purpose of these interviews was to elicit the interviewees' diverse perspectives and concerns about water resources and water conservation in the watershed, as well as their feedback on knowledge gaps and effective outreach. Interviewees included agricultural water users, rural residential water users, water providers, resource agencies and non-profit organizations who are actively working on improving the health of the watershed.

The interviews took place over the course of three days in March, 2010.

The following is a brief summary of the highlights of the interviews, and a list of those who were interviewed.

Overall observations

- All of those interviewed expressed a deep sense of place, and a deep commitment to be good stewards of the land and the Creek.

- All of those interviewed are advocates for a healthy watershed in various ways. Many both live and work in the watershed, some of them for generations.

- Many observed positive progress in collaboration among groups in the watershed.

- Most expressed a high awareness about water scarcity in the Creek and watershed,and a desire to know more, and in more depth, about the causes.

- Some expressed concerns about effects of water scarcity on the viability of the human communities in the watershed, as well as overall health of the Creek itself.

- Several expressed optimism about making real improvements to the watershed as a whole, but also concern that the link between water and the watershed is not yet deeply understood.

- Some expressed concerns about any new agricultural or rural residential development in the watershed, due to the scarcity of water, and a couple of interviewees advocated for more active involvement of the County Permit Department in the Water Conservation Program.

- A number of interviewees expressed an awareness of the need for better communication and dialogue among different water users and communities: to raise general community awareness about water use in the watershed, to dispel myths about the causes of lower flows in the Creek, and/or to reduce any miscommunications that can occur in the absence of ongoing communication or shared information.

- Many expressed a desire to understand the relationship between actions or water diversions in the upper watershed with those in the lower watershed.

- Finally, a number of those interviewed expressed a desire for improved general education and outreach on water conservation. Several offered creative ideas for outreach into the various communities in the watershed.

Areas for improved education and collaboration

Building on the dedication and teamwork already in evidence in the watershed, CCP recommends the following two areas for further development for the Water Conservation Program:

1. Develop a joint educational program among the various user groups in the watershed to address some of the specific data gaps regarding protection and restoration
Many interviewees expressed the desire to deepen the understanding in the Salmon Creek community about the interaction of the overall conditions in the watershed, types of water extraction taking place, and the reliability of Creek flows throughout the year.

Examples of data gaps mentioned:

- Levels of use of different users (e.g. rural residents, dairies, ranching, Salmon Creek School, vineyards, communities of Bodega and Bodega Bay—some of which is already under study in the Water Conservation Program).
- Impact on Creek flows from vegetation (e.g. willows versus redwoods)
- How groundwater, surface water and springs are all interconnected and interacting
- How upstream diversion can affect downstream users
- How many rural residents or other users are having to haul water in the summer
- Trends in Creek flows over the past decade(s)
- Feasibility of floodplain restoration to improve recharging into the soil.
- What's water diversion impact on the Creek from various uses: water utility diversions, rural residential, grapes, sheep, cattle; how does it change throughout the year?
- Map out watershed's retention capacity

- Map the aquifers.
- What is optimal habitat for a salmon in Salmon Creek?
- Historic flow patterns in the Creek so we can consider what we want to strive for now
- What are the best ways to capture water in the winter: tanks versus offstream ponds/reservoirs

2. Focus on improving communications and joint project development to leverage more funding of water conservation and streamflow augmentation projects in the watershed.

- Develop a clearer understanding and agreement on optimal communication and mutual coordination among those currently working under the NOAA and other grants, and for future projects that may evolve.

- Improve active involvement, coordination and communication with water purveyors.

- Explore how the Salmon Creek Water Conservation Program and the pending Integrated Coastal Watershed Management Plan can provide synergies in outreach and education in the watershed.

- Explore developing shared objectives for broader community education, how each ongoing project adds value, and how different projects can build on one another.

3. Focus on broad public education and outreach. Some proposed themes and methods included:

- Focus on natural beauty of the watershed (that's what most people care about) Circulate pictures of a restored Creek, appeal to residents' aesthetic interest
- Bill inserts
- Education workshops that are accompanied by possible funding (incentive)
- Fact sheets in everybody's mailboxes: do you know how you affect the Creek?
- Regular meetings of the water utilities with the NOAA and SCC grantees
- Public meetings about the whole watershed
- Different organizations sharing their meeting summaries.
- Develop Salmon Creek website with links to all participating organizations.
- Outreach at Farmers Market.
- Outreach about niche agriculture potential and healthy watershed
- Annual watershed days
- Use Ecology Center resources at the Salmon Creek School

Salmon Creek Water Conservation Interviews

Center for Collaborative Policy, March 2010

1. Gold Ridge Resource Conservation District
Lisa Hulette
Joe Pozzi

2. Occidental Arts and Ecology Center
Brock Dolman
Kate Lundquist

3. Bodega Water Company
Rick Williams

4. Salmon Creek Watershed Council
Kathleen Kraft
David Shatkin
Noelle Bouck, Joy Ridge
Margaret Gerner, Occidental Service District
Michael Johnston, LandPaths

5. BBPUD (Bodega Bay Public Utilities Department)
Rod Huls
Janice Mantua

6. Russian River Utilities
Hal Wood

7. NOAA/NMFS
Brian Cluer
Joe Pecarich

8. DFG
Gail Seymour

9. Steve Perucchi, dairy farmer

10. Boheme Wines & Vineyard
Kurt Beitler

11. Prunuske Chatham, Inc.
Lauren Hammack
Aimee Crawford

Salmon Creek Water Conservation Program

Conservation Strategy No.1: Streamflow Restoration for Salmonids

Coastal Conservancy

Overview

Streams, both large and small, touch the lives of every resident in a watershed. They provide water supply, flood capacity, aesthetic and recreation values, and fish and wildlife habitat. Within small coastal communities, streams provide critical habitat for populations of steelhead (*Oncorhynchus mykiss*) and coho salmon (*Oncorhynchus kisutch*).

Target community

Water purveyors, community groups and the resident and visitors to the watershed are the targets of this Strategy. Water purveyors, Chambers of Commerce, schools and community groups can play an important role in supporting native salmonid populations within their watershed by understanding the salmonid life cycle and making decisions about the how they do business with the fish in mind.

Young coho salmon.

Photo by Joe Pecharich.

Status within the Watershed

As in many California coastal communities, steelhead and coho salmon, collectively known as salmonids, were once abundant in Salmon Creek and its tributaries. Tales of their numbers, sizes, and favorite pools are still a vital part of local history. Now only a small population of steelhead continues to return each year, and the last naturally propagated coho was seen in 1996. Coho salmon were reintroduced into the watershed as part of the California Department of Fish and Game's annual coho broodstock program starting in 2008. Populations of steelhead and coho salmon have declined from historic levels for many reasons, including past and current water diversions, development, removal of large wood from creeks, and degradation of riparian areas. As a result, the species are now protected under the federal and state Endangered Species Acts.

Life History

Steelhead and coho salmon are anadromous fish; they are born and rear in freshwater streams, migrate to the ocean to grow and mature, and return to freshwater to reproduce. The life history of salmonids is relatively complex with some slight variation between species. Steelhead and coho salmon need a variety of habitats to support each stage of their development during the journey from egg to spawning adult. The diagram and text below outline the key stages and habitat requirements; a specific timeline for each species follows.

Spawning, Incubation, and Emergence

Each winter after the rains have returned, adult salmon begin to congregate at the mouth of the stream where they were born, guided by their keen sense of smell detecting small particles in the water. As they navigate upstream to select a suitable nesting site, they struggle against high winter flows and both man-made and natural obstacles. Once they reach their destination, the female selects a mate and begins **spawning. Redds** (salmon nests) are typically constructed at the head of riffles, where oxygenation of the developing eggs is key to development, in pea- to apple-sized gravels. Each salmon nest contains 300 to 1,200 eggs. Coho salmon die after spawning, whereas steelhead may spawn several times. The decaying fish provide nutrients to the stream and nourishment for a variety of species including their developing young.

Salmon eggs incubate in the gravels for several weeks - ideally in cool, well-oxygenated water free of excessive suspended particles. After hatching, small fish called **alevin** continue their development in the gravel, nourished by their attached yolk sac. Once the yolk sac is depleted, the young fish emerge from the gravels, typically in spring. These young fish that emerge from the gravel and begin rearing in freshwater are called **fry**.

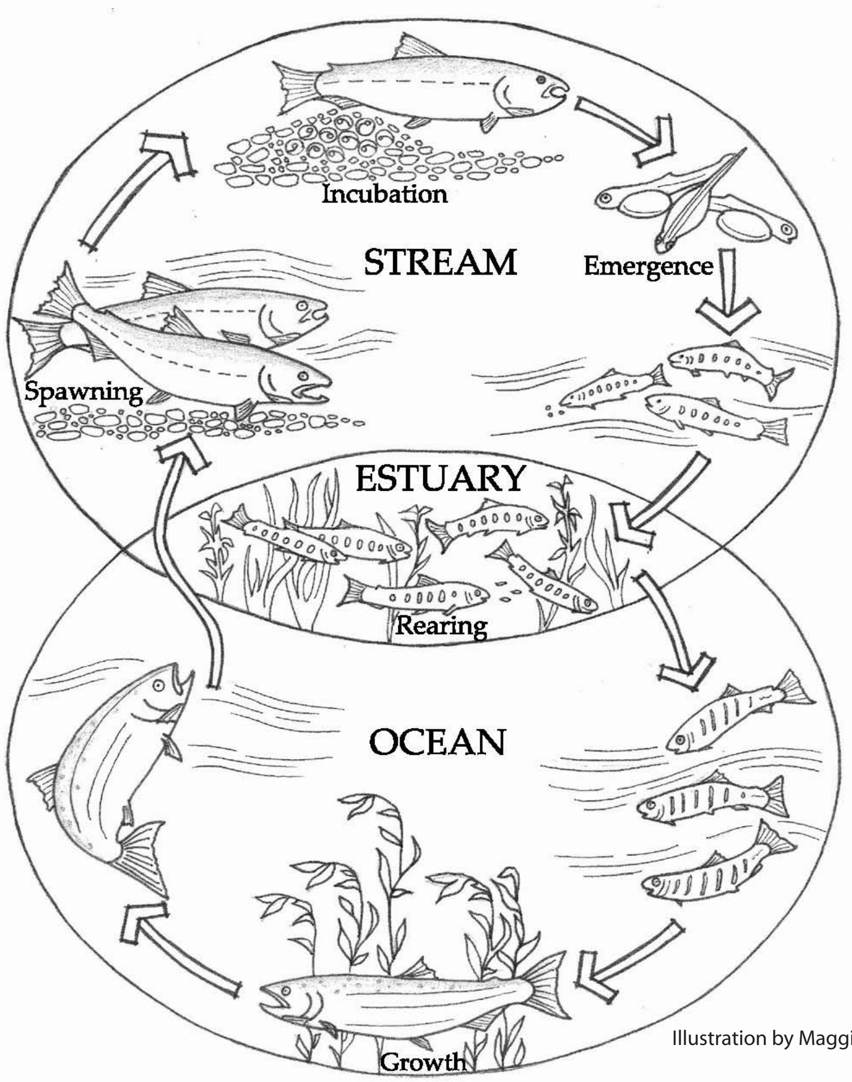


Illustration by Maggie Young

Habitat Elements Needed for Successful Spawning, Incubation, and Emergence

- High-quality, permeable gravels
- Sufficient riffles
- Passage to habitat
- Cool water temperatures
- High dissolved oxygen
- Minimal suspended sediment

Freshwater Rearing

Coho salmon typically spend a full year in freshwater, emerging from the gravels in spring and rearing there until the follow year. Steelhead may spend one to four years, typically two.

In **winter,** young, small fish are particularly vulnerable to high stream flows during storm events. They use the spaces between gravel particles and vegetation along stream banks for safety from winter storms and predators. As they gain strength and mobility, fry begin to seek out deeper, swifter water, yet they continue to need complex, low-velocity habitats throughout their rearing period.

During the **summer** rearing period, sufficient stream flows and optimal water quality conditions (cool water temperatures, well-oxygenated water, and clear conditions) continue to be critical for development. Low summer flows can reduce the availability of rearing habitat by creating isolated pools and increasing vulnerability to predators. Riparian cover is also important because it shades the stream channel, keeping water temperatures low.

Helpful Definitions

Redd – a salmon nest dug in the streambed where eggs are deposited.

Spawning – process of building a nest (redd) in gravel, mating, and laying eggs.

Alevin – salmonid larvae still in the gravel with their yolk sacs attached.

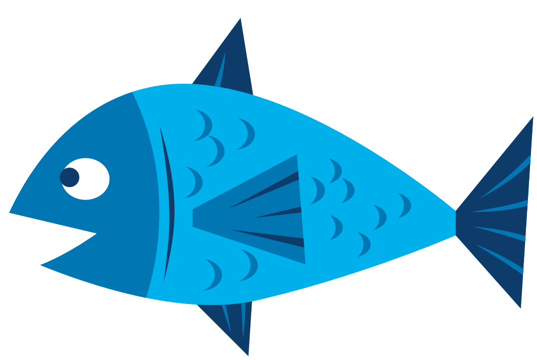
Fry – young salmon rearing in freshwater.

Smolt – a juvenile seaward-bound salmonid in the process of transition from fresh to saltwater.

Throughout the rearing period, salmonids need plenty of insects for food. Drifting terrestrial insects produced in the riparian canopy, aquatic invertebrates produced on the substrate, and leaf litter provide the bulk of their diet.

Habitat Elements Needed for Successful Rearing

- Low-velocity backwater areas (winter) and deep pools
- Shelter in the form of roots, large wood, vegetation, cobbles/boulders
- Vegetated stream margins
- Overhead shade and well-vegetated canopy
- Food supply
- Cool water temperatures
- High dissolved oxygen
- Minimal suspended sediment
- Sufficient flow (summer)



Estuary Rearing and Beyond

In the spring after completion of freshwater rearing, young salmonids begin to transition to life in the ocean. As they migrate downstream to the estuary, where fresh and saltwater mix, juvenile fish undergo a physiological process called **smoltification**, where their body makes adjustments to be able to survive in saltwater. Young fish may remain in the estuary for days or months as they adjust to the saltwater and grow. Salmon mature in the ocean in 1 to 4 years, depending on the species, before returning to their natal stream to begin the cycle all over again.

Habitat Elements Needed for Transition from Freshwater to Ocean

- Sufficient flow to allow safe passage
- Shelter in the form of roots, large wood, vegetation, cobbles/boulders
- Estuarine conditions that allow for adequate mixing of fresh and saltwater for gradual adjustment

Timeline of Salmonid Life History Stages within California Coastal Streams

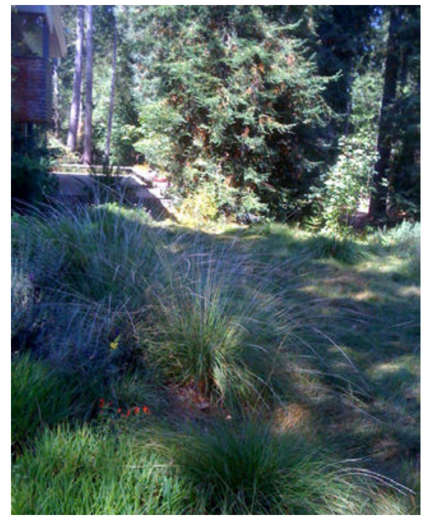
(darker shading represents periods of peak activity; lighter shading represents less active periods)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept
Steelhead												
Upstream migration and spawning												
Egg incubation												
Fry emergence												
Rearing												
Smolt outmigration (1 to 4 years)												
Coho Salmon												
Upstream migration and spawning												
Egg incubation												
Fry emergence												
Rearing												
Smolt outmigration (typically 1+)												

Implementation

By implementing the following key conservation measures communities can help preserve riparian and aquatic habitat and ensure an adequate water supply for salmonids and other species:

- Protect and enhance riparian forests to provide shade, bank stability, and sources of large wood.
- Protect grasses and small shrubs along the riparian corridor to provide bank stability and pollutant filtration.
- Reduce the delivery of fine sediment from upland sources.
- Maintain and increase summer base flows to supply instream pools and the estuary with cool, oxygenated water.



Reduce overall water usage by practicing water conservation in homes, businesses and on community water systems

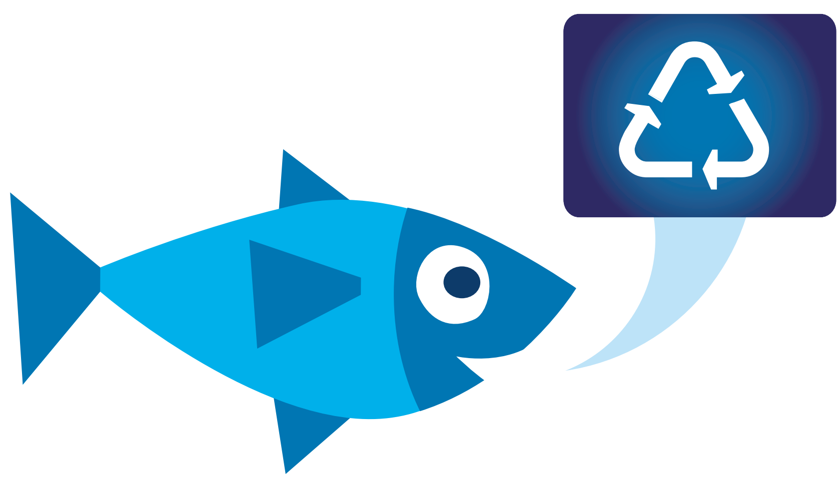
- Install water smart appliances and fixtures: washing machines, dishwashers, tankless or on-demand water heater, toilets, showerheads, and faucets.
- Check for water leaks and fix immediately.
- Use the Salmon Creek Water Conservation Program "Residential Self Survey Conservation Strategy" as a tool for identifying fixture efficiency and prioritizing which changes will make the biggest impact.
- Use the Salmon Creek Water Conservation Program "Conservation in the Hospitality Industry Conservation Strategy" to identify water saving opportunities in the food services, accommodations, recreation, and entertainment sectors.
- Install water efficient landscaping. Plant drought tolerant/low water use plants. Replace lawns with locally-adapted plants and mulch.
- Install efficient irrigation systems and program for effective watering.
- Use the Salmon Creek Water Conservation Program "Low Water Gardening Conservation Strategy" for a comprehensive approach to gardening and landscape management designed to preserve stream flow during the most critical times of the year.
- Install roofwater harvesting systems to capture winter runoff and reduce demand on the community water supply during critical periods.
- Use the Salmon Creek Water Conservation Program "Roofwater Harvesting Conservation Strategy" for a guide to using roofwater to offset summer dependence on local supply sources.
- Water purveyors, use the Salmon Creek Water Conservation Program "Managing Water Systems Conservation Strategy" for water system management practices designed to maintain stream flows and support water supply sustainability.

Reduce instream water diversions during critical low-flow summer rearing period

- Install roofwater harvesting and catchment tanks and agricultural storage ponds for alternative water supplies.
- Use the Salmon Creek Water Conservation Program "Roofwater Harvesting Conservation Strategy" for a guide to using roofwater to reduce diversions during critical periods.
- Implement water conservation practices (see above).

Protect the riparian corridor and improve stormwater retention and infiltration

- Fence riparian corridors from livestock during critical periods to protect water quality and plants.
- Improve and protect riparian cover by planting with native species and allow for adequate buffers.
- If you live on a creek, leave some fallen trees and small debris accumulations.
- Minimize impervious surfaces, such as paved driveways and patios.
- Refer to the Salmon Creek Water Conservation Program "Stormwater Management Conservation Strategy" for practices designed to decrease stormwater runoff and maximize on-site infiltration.



Tools

Salmonid Information

NOAA's National Marine Fisheries Service (NOAA Fisheries) Office of Protected Resources Federal regulatory overview and life history information for listed salmonids. http://www.nmfs.noaa.gov/pr/species/fish/

NOAA's National Marine Fisheries Service (NOAA Fisheries) Northwest and Southwest Regional Offices Local federal regulatory overview, life history information, and range maps for listed salmonids. http://swr.nmfs.noaa.gov/ and http://www.nwr.noaa.gov/

Russian River Coho Salmon Captive Broodstock Program Information on the coho salmon reintroductions in the Salmon Creek watershed and local fish identification guide and links. http://groups.ucanr.org/RRCSCBP/

The Russian River Interactive Information System Informative website with salmonid life history information and local references. http://www.russianriverwatershed.net/

Salmonid Restoration Federation Non-profit organization dedicated to the protection and restoration of California's salmonid populations and their habitat. Offers education services and useful resources on their website. http://www.calsalmon.org/

Water Conservation Tools

California's Water Conservation Resource - Save Our Water Offers water conservation background and tools.

http://www.saveourh2o.org/

Habitat Protection

Groundwork: A Handbook for Small-Scale Erosion Control in Coastal California - New 2nd Edition from the Marin Resource Conservation District and MCSTOPP. Got to resource for erosion control practices with an excellent references section for riparian protection and agricultural issues. http://www.mcstoppp.org/acrobat/Groundwork.pdf

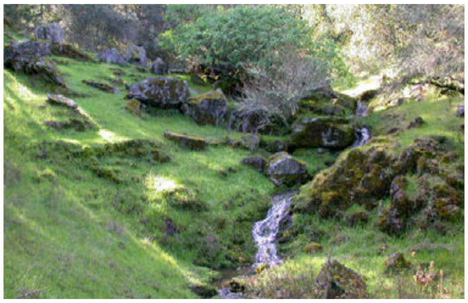
Coastal Conservancy

This conservation strategy was produced by Jennifer Michaud, Prunuske Chatham, Inc., for the Salmon Creek Water Conservation Program (SCWCP). The SCWCP is a multi-year, multi-stakeholder effort focused on developing alternative water supply solutions that support human needs while protecting and restoring instream flows for fish and wildlife.

Salmon Creek Water Conservation Program

Conservation Strategy No.2: Residential Self-Survey for Efficient Water Use in Coastal California Communities

Coastal Conservancy



Overview

The residential self-survey is a tool for residents on community water systems or on their own water supply (well, spring, pond) that helps identify opportunities to conserve water through improving efficiency and understanding how water is used within the home and garden. It is a "do-it-yourself" saving water challenge that can result in tremendous savings in household water use.

Residents can complete the self-survey on their own. Water suppliers and community groups can promote use of the survey throughout the towns and rural areas by sponsoring educational self-survey workshops and neighborhood gatherings.

The survey includes a water-audit of all household water uses, indoors and outdoors. The audit identifies opportunities for assessing and then replacing or repairing inefficient fixtures and systems. In particular, the audit provides how-to steps for determining flow rates of faucets and showerheads, as well as the flush volumes of toilets; techniques for detecting leaks in the home and garden and information on leak repair; and data on irrigation needs based on climate conditions of the coastal region you live in. The survey also includes a Residential Water Use Calculator for determining the amount of water used at the residence, both indoors and outdoors. The Calculator is tailored to coastal California climates by geographic region.

Target community

This self-survey is designed for single-family residences with any water supply source. Metered water users can apply the specific information about using the water meter to help understand water use and detect leaks. The survey can also be used for multi-family residences by using the indoor portion for each unit of an apartment complex or condominium development, and using the outdoor portion of the survey for the common landscaped areas.

Potential effect

The 2003 study by the Pacific Institute *Waste Not Want Not: the Potential for Urban Water Conservation in California* reports the potential to save up to 40% of indoor water use in residences in California by installing efficient plumbing hardware and adopting practices to maximize water use efficiency. Pacific Institute further reports savings of 25% - 40% in outdoor water use through garden design and maintenance practices. Performing the self-survey will give a resident the information needed to estimate the savings potential at their home.

Implementation

There are two action steps for a household to take to complete this self-survey:

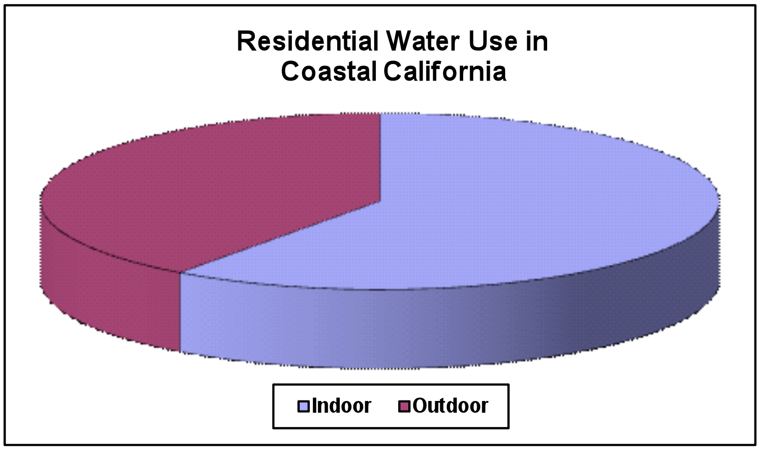
1) complete a water-audit of your home and garden water use, and

2) calculate your household water use according to your family size, the results of the audit and the region of the California coast where you live.

Before taking on these action steps, let's take a big-picture look at where water is used in homes in coastal California.

About residential water use in coastal California

The Pacific Institute estimates that 55-65% of all residential water use serves indoor needs in coastal California communities. Outdoor uses make up 35-45% of overall residential use. The graph below illustrates the breakdown of residential water use.

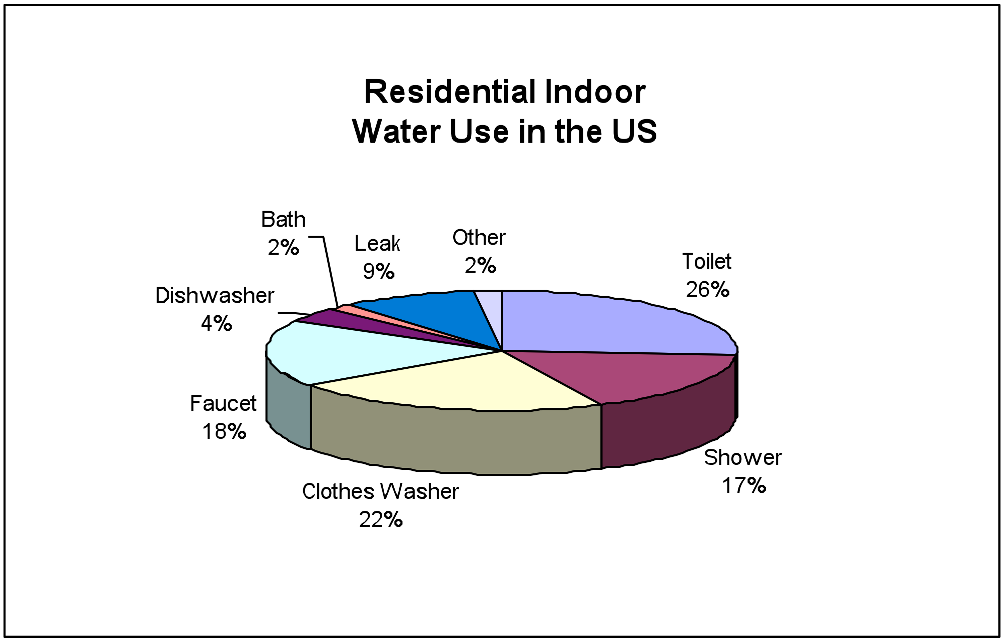


Actual residential use per person (called per capita use) varies according a number of factors:

- the age and efficiency of the plumbing fixtures in the home
- the size of the garden, types of plants, climate and efficiency of irrigation
- the presence of water meters (people use less when water is metered)
- the price of water (people use less when water is costly)

Average per capita residential indoor water use was measured in a 1999 study by the American Water Works Association (AWWA), *The Residential End Uses of Water Study*. Researchers physically measured water use at 100 single-family homes in each of 12 cities in the US (1,188 homes in all) using data-loggers installed on each home. Homes in the study had a mixture of efficient and non-efficient fixtures. The average per capita indoor use was 73 gallons per person per day. Assuming this represents only 60% of the residential per capita water use as illustrated above, adding outdoor water use brings the total estimated per capita residential water use to about 120 gallons per person per day.

A closer look at indoor water use based on the work of AWWA and Amy Vickers, author of the *Handbook of Water Use and Conservation: Home, Landscapes, Businesses, Industries, Farms*, is presented in the chart that follows. Clearly toilets, showers, faucets and clothes washers account for the majority of indoor water use. These fixtures are targeted for efficiency in the "water-audit" section of this self-survey.



Residential Water-Audit

The residential water-audit is a tool to determine the efficiency of the current water using fixtures in the home and garden, and to check for the leaks that most households have. You can save 25% or more on your water use (and your water bill if you are served by a community system) by going through the audit steps and taking the recommended simple actions. The audit tool includes numerous links to other web resources with helpful illustrations, guidance and even films illustrating how to become more water efficient today!

The water-audit consists of three sections:

1) checking for leaks,

2) auditing indoor water uses, and

3) auditing outdoor water uses.

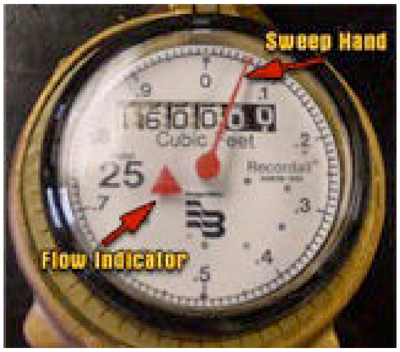
Homes with water meters take different steps in Section 1 of the water-audit than homes without water meters.

1) Checking for Leaks

Checking for leaks with a water meter

- Turn off all water using fixtures in the home and garden (including the ice maker).
- Locate the water meter – usually in the ground in a concrete box in the public right-of-way in front of the house.
- Check the meter to see if the "low flow indicator" (a small red or blue triangle or dial on the face of the meter) is moving, or if the sweep-hand going around the dial is moving. Meters vary in how the dials are configured. The picture on the left below is a fairly common type of water meter that reads in cubic feet (one cubic foot = 7.48 gallons). The picture on the right is a meter that reads in gallons.

Cubic Feet Meter



Gallon Meter

- Read the meter and record the meter reading similar to reading the odometer on a car. Most meters have a six- or seven-digit number on the face that shows the total number of gallons used since the meter was installed. On most meters the last digit of this number does not move. The large sweep hand registers for this last digit, revolving one time for every ten gallons or for every cubic foot (depending on the type of meter) of water use.
- Wait for one hour and read the meter again.
- If no water flowed through the meter during the hour, there are no leaks in the garden or house. You can go on to Section 2 of the audit – evaluating indoor water use.
- If the low-flow indicator is moving or if the meter reading shows that water flowed through the meter during the hour, there are one or more leaks. You now need to figure out whether the leaks are in the house, in the garden, or both.
- Locate and turn off the master house valve and master irrigation valve if you have them. The master house valve is usually located on a mainline serving the house, in line with a hose bib. The irrigation master valve is probably located on the irrigation system. With both valves off, check the meter again. If there is no longer any use through the meter, the leak is either in the house or on the irrigation system. If there is still use on the meter, there is a leak on the mainline and you will likely need a plumber to locate and fix the leak. After the mainline leak is fixed, go on to the next step to test if there are also leaks in the house or garden.
- To determine if there is a leak in the house, open the master house valve and check the meter again. If water is moving through the meter, there is a leak in the house. Testing for leaks in the house is covered in Section 2 of this audit.
- To determine if the leak is on the irrigation system, close the house valve and open the irrigation valve. If water is moving through the meter there is a leak on the irrigation system. Evaluating the irrigation system for leaks is covered in Section 3 of this audit.

Checking for leaks without a water meter

- Locate the point of connection of your house plumbing and the source water (well, spring, tank, etc).
- Visually inspect the piping from the point of connection to the point of entry to the house and to the connection to the garden watering system. Look for excessive plant growth, soggy soil, the presence of moss and water-loving weed plants along the entire path of the pipelines outdoors. If you find leaks, repair them immediately.
- In the house, check around all water using fixtures for signs of leakage – around toilet seals, under sinks, around the dish washer and at the inlet for the clothes washer. If you find leaks, repair them immediately. Checking for toilet leaks is covered in Section 2 of this audit.
- In the garden, inspect all piping from the point of connection to the main water system to the valves – the section of the irrigation system that is under constant pressure. If you find leaks, repair them immediately. Evaluating the irrigation system for leaks while in operation is covered in Section 3 of this audit.

2) Indoor Water Use

Toilets – To make sure your toilets are as efficient as possible, there are two important areas to test for each toilet in the home: 1) whether the toilet is leaking, and 2) the toilet flush volume. Check for toilet leaks even if your meter leak check in Section 1 resulted in no leaks.

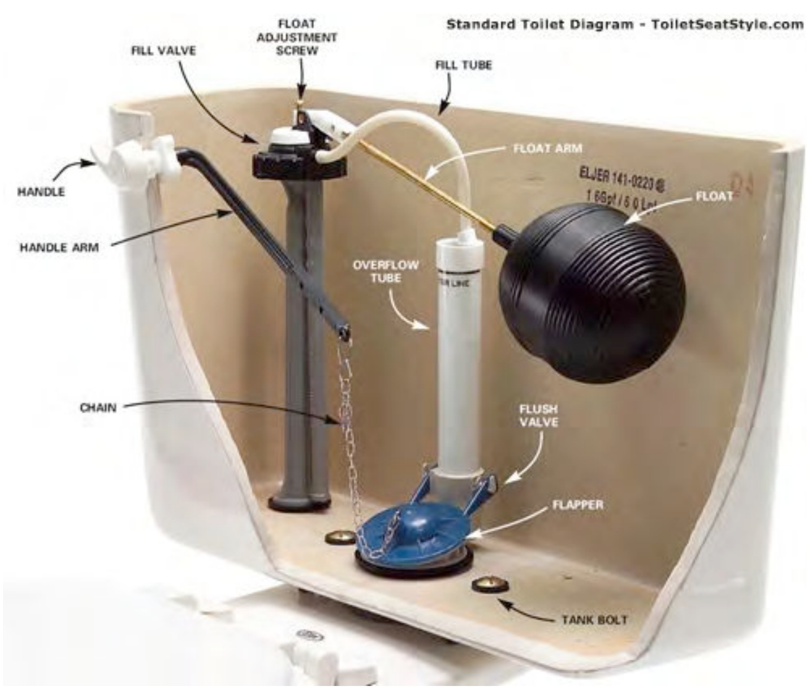
Toilet leaks

In addition to the instructions that follow, you can find illustrated information on testing for toilet leaks, and repairing leaks at: http://www.h2ouse.org/action/index.cfm and at the "Toiletology" web site at: http://www.toiletology.com/intro.shtml.

- Put several drops of food coloring in the tank of the toilet (if you have a coloring toilet sanitizer, remove it and flush the color away before this step).
- Wait 15 minutes and do not flush the toilet during this time.
- If colored water appears in the bowl you have a toilet leak from the tank to the bowl. Most often this is the flapper or an overflow leak. Use the illustration that follows to help problem solve a toilet leak with the steps that follow.
- Check the flapper to see if it is worn, if it fits into the flush valve snugly and if it is catching on anything. Replace the flapper if needed. When you shop for a replacement flapper, take the make and model of the toilet with you - make sure that the replacement flapper is the correct replacement for your toilet.
- To test for an overflow leak, sprinkle a small amount of talcum powder on top of the water in the tank. If the water moves toward the overflow tube, there is an overflow leak. Adjust the float arm to shut off the valve before water spills into the overflow tube.

Toilet flush volume

- Most toilets have the flush volume on the bowl rim between the seat and the tank, or the date of manufacture stamped on the inside of the tank. To determine flush volume based on manufacture date use the chart below. Note that since 1992, all toilets sold in the US must be 1.6 gallons per flush (gpf) or less. High Efficiency Toilets (HET) with an average flush volume of 1.28 gpf or less are now considered the wisest choice if purchasing a new toilet.



Toilet Flush Volume by Manufacture Date

Manufacture Date	Gallons per Flush
1980 and earlier	5-7 gpf
1980 – 1992	3.5 gpf
After 1992	1.6 gpf or 1.28 gpf (HET)

- If there is no flush volume or date on the toilet, you can calculate the volume of the flush by measuring the inside of the tank and level to which the water falls during a flush as follows:
  - Using a tape measurer, measure and record the length and width of the toilet tank.
  - Place the tape measurer straight down into the tank and make a note of the water level in inches.
  - Leave the tape in place and flush the toilet, making a note of the lowest water level before the tank begins to refill.
  - Subtract the second water level reading from the first to get the height reading.
  - Multiply height x length x width to get the flush volume in cubic inches.
  - Divide the cubic inches by 231 to convert to gallons.
  - Plan to replace older, high water using toilets with new water efficient models. The latest and most efficient HET toilets use an average of 20% less than the current standard of 1.6gpf. Some HETs use as little as 1.0 gpf.

Showerheads

Determine the flow rate of the showerheads in the home by going through the steps below for each showerhead. If the flow rate is greater than 2 gallons per minute (gpm), plan to replace with new showerheads. Check with your water utility to see if they provide water efficient showerheads to their customers. If they don't, ask that they start a showerhead and aerator distribution program!

- To calculate the flow of a showerhead, turn it on to the normal flow rate that you use.
- Using a large water pitcher, a bucket, or jar with a handle, hold the container under the showerhead and capture all flow for 10 seconds.
- Measure the quantity of water collected (using a measuring cup or known volume container) and multiply the volume by 6 to calculate the gpm. One gallon holds 4 quarts, or 16 cups.

Faucets

Check all faucets for leaks and to determine flow rate.

- Check for leaks by turning the faucets off and visually inspecting for leaks. Even a slow leak is a big water waster – a drip a second wastes almost 200 gallons a month. For information on repairing faucet leaks visit: http://www.h2ouse.org/action/index.cfm
- Determine the flow rate of all faucets in the home by going through the steps outlined above in the showerhead section. If the flow rate of the bathroom faucet is greater than 1.5 gpm or the kitchen faucets is greater than 2.2 gallons per minute, plan to change the faucet aerators (the small fitting that threads into most faucets) to lower flow. Utility sink faucets and bathtub spouts typically have higher flow rates because they are designed to fill a volume fast. Check with your water utility to see if they supply low flow faucet aerators to their customers. If they don't, ask that they start a showerhead and aerator program.

Bathtub

Turn on the water to the bathtub and divert water to the showerhead to check for leaks. When the water is diverted to the showerhead, the water flow should stop from the tub faucet. If flow continues, the shower diverter needs replacement or repair.

Clothes washer

Check the supply lines when the machine is in operation for leaks. If you have a front-loading clothes washer, consider replacing with a water and energy efficient EPA rated EnergyStar rated model which may reduce water use by 50%. Find out more at: http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CW

Dishwasher

The supply line is not visible in most dishwasher installations, so check the flooring around the dishwasher periodically for signs of water leaks or seepage. Consider replacing any pre-1994 machines with a water and energy efficient EPA rated EnergyStar rated model. Find out more at: http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=DW

Pressure regulation

Some homes may have too much water pressure, which can cause household appliances to malfunction and wear out. Most household appliances are designed to operate best with no more than 50 psi (pounds per square inch) of water pressure. If water flows from faucets and showers with excessive force, or pipes vibrate or make noise when water is flowing, or fixtures such as your dishwasher make excessive noise in operation, your water pressure may be high. Have a plumber check the pressure inside the home and outside the home. If pressure exceeds 60 psi, install a pressure regulator at the main supply source (after the water meter if you have one). This will save the life of appliances and reduce water use. A pressure regulator also provides protection to your house from unexpected water pressure surges.

Other

If you have other water uses in the home such as an ice maker, check the supply lines to those uses for proper operation.

3) Outdoor Water Use

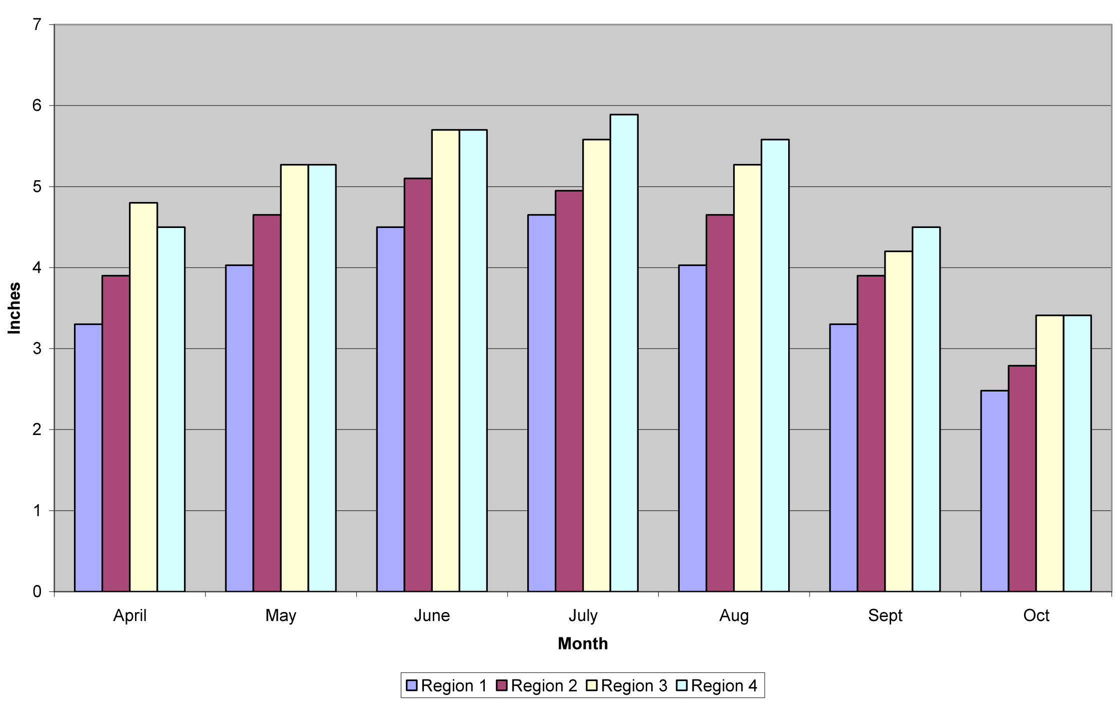
This section of the water-audit is designed to check the repair and efficiency of your current gardening watering system. Outdoor watering is often the most inefficient water use in the household, and most studies show savings potential of 25 - 50% through good garden watering practices. For more information on a comprehensive approach to designing and caring for your garden in rural coastal California communities, visit the Low Water Gardening Conservation Strategy at salmoncreekwater.org

- Checking the mainline of the irrigation system for leaks was covered in Section 1 of this water audit.
- If you have an in-ground watering system (automated or not), run each valve on the system and observe the system in operation. This is something you should do every spring and at least once during the summer. Look for the following and adjust or repair as recommended below:
  - Visually inspect the valves, pipelines, irrigation heads and drip emitters for leaks or malfunction. Look for excessively wet areas, soil mounding, or water seeping from planted area/sidewalk edges. Drip irrigation lines are low-pressure so leaks are not as evident as they are on high-pressure overhead sprinkler lines. Walk each drip line and observe whether the line is intact, the emitters are working (not clogged) and if the fittings are intact. Fix any leaks or broken equipment.

- For overhead sprinklers, observe each head in operation to make sure that the full spray pattern is operating (if not, unclog the nozzle), the heads are upright (if tilted, straighten), rotors are rotating (if not, clean the gears in the head or replace), coverage is even (if not, adjust nozzles), the spray is not obstructed by plants (if so, trim plants or adjust spray), and if the spray is hitting the target plants (if not, adjust the spray).
- For drip irrigation, make sure the emitters are placed at the appropriate distance from the plants and that all emitters are dripping at approximately the same rate (if all emitters on the line are the same flow rate emitter).

- If you have an automatic irrigation controller check the schedule for each valve. The schedule includes the days of the week or month the valve runs (which is scheduled in the "program"), the length of time it runs each time it turns on (the "run-time") and the time or times of day that it waters ("start-time/s"). Irrigation controllers have the capability to water with "multiple start times" which is especially valuable with heavy soils (clay-type soils) or on slopes. Using repeat start times allows you to apply the water slowly – at a rate the soil can absorb. For example – watering for 15 minutes by applying three 5-minute applications separated by an hour each will allow more water to soak in than watering 15 minutes at one time. This is called "cycle irrigation" and it is a no-cost way to save water today!
- If you hand water, check all hose fixtures for leaks and install new washers as needed. If you use a hose-end sprinkler to water the garden, install a mechanical water timer between the hose bib and the hose that can be set for a certain amount of time or flow, and will shut off automatically when the watering is done.
- Inspect all planted areas to make sure that mulch covers all non-planted areas and the soil under all plantings.
- Know your climate and water according to the plants' water needs. The California Irrigation Management Information Systems (CIMIS) network of weather stations provides historical and current data about plant water needs throughout our state. Coastal California has four regions, each with different irrigation needs. A map illustrating these regions is at: http://www.cimis.water.ca.gov/cimis/pdf/eto-map1.pdf. The four regions are described in the table below.

Reference ET of Four Coastal Califonial Regions–Inches/Month



- Identify your region by the description or the map. The graph that follows shows the reference evapotranspiration (ET) by region during the typical months when irrigation might be needed. Reference ET is an estimate of water needed by very high water use plants like turf-grass. Most garden plants need only 1/3 to 1/2 of reference ET, and most drought resistant plants will need no supplemental irrigation once established. More information on plant water use is in the next part of the survey – the Water Use Calculator.

Residential Water Use Calculator

Calculate your individual household water use by answering the questions in the Residential Water Use Calculator, using the results from the water-audit wherever they can be applied. If you are not sure about the answer, fill in your most reasonable estimate for an answer. This tool can be used to test out some "what if's" about your water use, such as:

- What if we change the lawn to drought-resistant shrubs?
- What if we get a front-loading EnergyStar clothes washer?
- What if our young adult son/daughter moves out?
- What if there is a drought and we have to cut our water use in half – how will we do it?

Residential Water Use Calculator

To download the interactive spreadsheet version of this calculator, go to: http://www.salmoncreekwater.org/water-use-calculator

Coastal Regions of California – from CIMIS (Calif. Irrigation Management Information Systems)

Region 1	Coastal plains and heavy fog belt - Most of the immediate coast North of Santa Barbara, except the Monterey Bay and San Francisco Bay
Region 2	Coastal mixed fog areas - Monterey Bay, East side of San Francisco Bay and portions of the immediate coast south of Santa Barbara
Region 3	Coastal valleys and plains and North coast mountains - just East of Region 1 in Del Norte, Humboldt, San Mateo, Santa Cruz and Santa Barbara Counties
Region 4	South coast inland plains and mountains North of San Francisco - just East of Region 1 in Mendocino, Sonoma, Marin, Ventura, Los Angeles, Orange and San Diego Counties

RESIDENTIAL WATER USE CALCULATOR – for Coastal California

Instructions: Fill in the lightly shaded areas with input and calculated water use in the darker shaded areas

Calculating Residential Water Use in Coastal California				
A - Household Information		**Input**	**Units**	**Calculated Water Use**
1-HI	How many people are in your household?		People	
2-HI	In which Region of the coast is your residence? (see Coastal Regions Table on previous page)		Region	
B - Indoor Water Use				
	SHOWERS/BATHS			
1-S	How many showers are taken each day in your household?		Showers	
2-S	What is the average length of each shower?		Minutes	
	Enter 6.3 if unsure			
3-S	What is the flow rate of your showerhead (from the audit- average if more than one shower)?		Gallons/ minute	
	Shower water use – Calculate: Number of showers X length of shower X showerhead flow rate			Gallons per day
4-S	How many baths are taken each week in your household?		Baths	
4-S	What is the volume of your bathtub?		Gallons	
	Enter 35 if unsure			
	Bath water use – Calculate: Number of baths X volume of bath / 7days per week			Gallons per day
	TOILETS			
1-T	How many times a day on average does each person flush the toilet in your house?		Flushes	
	Enter 5.1 if unsure			
2-T	How many gallons does your toilet flush (from the audit - average if more than one toilet)?		Gallons/ flush	
	Toilet water use – Calculate: Number of flushes X number of people X volume of toilet flush			Gallons per day
	FAUCETS			
1-F	How many times a day on average does each person use the faucet to brush teeth, wash hands, etc.?		Times	
2-F	What is the average flow rate of your faucets (from audit – kitchen and bath faucets only)?		Gallons/ minute	
3-F	How many minutes on average does the water run with each use?		Minutes	
	Faucet water use – Calculate: Number of uses X number of people X number of minutes X faucet flow rate			Gallons per day

	WASHING DISHES			
1-DW	How many times a day are dishes washed by hand?		Times	
2-DW	How many minutes does the water run during each washing?		Minutes	
	Hand washing use – Calculate: Number of times X minutes X faucet flow rate X faucet flow rate (from 4-F)			Gallons per day
3-DW	How many times a week is the dish washer run?		Times/ week	
4-DW	How many gallons per load is your dish washer?		Gallons/ load	
	Average for pre-1994 machines is 10 gallons; average for EnergyStar is 6 gallons			
	Dish washer use – Calculate: Number of times X gallons per load / 7 days per week			Gallons per day
	LAUNDRY			
1-L	How many loads of laundry are done each week in your household?		Loads/ week	
2-L	How many gallons per load are used by our washing machine?		Gallon/ load	
	Average machine uses 42 gallons; average for EnergyStar is 24 gallons			
	Laundry water use – Calculate: Number of loads X gallons per load / 7 days per week			Gallons per day
Total Indoor Daily Water Use – Add all uses				Gallons per day
Per person indoor water use – divide Total Indoor Daily Water Use by number of people in the home				Gallons per person per day
Annual indoor water use – multiply Total Indoor Daily Water Use by 365				Gallons per year

Annual Irrigation Demand by Coastal Region

Irrigation Demand - Gallons per Square Foot Total for Irrigation Season (Apr – Oct)				
Plant Types	**Region 1**	**Region 2**	**Region 3**	**Region 4**
High water use (e.g., turf, annuals, planters, some vegetables)	16.38	18.65	21.33	21.71
Moderate water use (e.g., many ornamentals, citrus, some vegetables, cut flowers)	10.81	12.31	14.07	14.33
Low water use (e.g., most CA native and Mediterranean ornamental trees and shrubs, grapes, pears, figs, many perennials)	5.40	6.16	7.04	7.16
Drought resistant (e.g., some CA native and Mediterranean ornamentals, many conifers and endemic species)	0	0	0	0

C - Outdoor Water Use				
	GARDEN - Refer to your Coastal Region	Input	Units	Calculated Water Use
	Region ____ high water use factor (from Irrigation Demand by Region Table)		Gallons per SF per year	
	Region ____ moderate water use factor (from Irrigation Demand by Region Table)		Gallons per SF per year	
	Region ____ low water use factor (from Irrigation Demand by Region Table)		Gallons per SF per year	
1-G	If you have a lawn, what is the area covered?		Square feet	
	Lawn water use – Calculate: Square feet X gallons per SF for high water use (from above) / 365			Gallons per day
2-G	If you have a vegetable garden, what is the area covered?		Square feet	
	Vegetable garden water use – Calculate: Square feet X gallons per SF for moderate water use / 365			Gallons per day
3-G	If you have containers, what is the surface area of all containers?		Square feet	
	Container water use – Calculate: Square feet X gallons per SF for high water use / 365			Gallons per day
4-G	If you have flower beds, what is the area covered?		Square feet	
	Flower beds water use – Calculate: Square feet X gallons per SF for moderate water use / 365			Gallons per day
5-G	If you have ornamental plantings, what is the area covered?		Square feet	
	Ornamental plantings water use – Calculate: Square feet X gallons per SF for high water use (from Table) / 365			Gallons per day
6-G	If you have drought resistant plantings, what is area covered?		Square feet	
	Drought resistant water use – ZERO water use once established			ZERO
	OTHER			
1-O	How long do you use the hose for other than garden watering each week?		Minutes	
	Other water uses – Calculate: Minutes X 7 gallons per minute / 7 days per week			Gallons per day
Total Outdoor Daily Water Use – Add all outdoor uses				Gallons per day
Per person outdoor water use – divide Total Outdoor Water Use by number of people in the home				Gallons per person per day

Annual outdoor water use – multiply Total Outdoor Water Use by 365				Gallons per year
D - Total Household Water Use				
	Gallons per household per day - Add Total Indoor Daily Water Use and Total Outdoor Daily Water Use			Gallons per household per day
	Gallons per person per day – Add Per person indoor water use and Per person outdoor water use			Gallons per person per day
	Gallons per household per year - Add Annual Indoor Water Use and Annual Outdoor Water Use			Gallons per household per year
	Acre feet per year – Divide Gallons per household per year by 325,851 (gallons in an acre-foot)			Acre Feet per household per year

Tools

Web resources:

H2Ouse at http://www.h2ouse.org/action/index.cfm

US Environmental Protection Agency web page Indoor Water Use in the United States:
http://www.epa.gov/WaterSense/pubs/indoor.html

Information about fixing toilets and more is at the Toiletology web site:
http://www.toiletology.com/intro.shtml

The EnergyStar Program lists water efficient appliances for the home at:
http://www.energystar.gov/index.cfm?c=products.pr_find_es_products

The coastal area map from CIMIS (California Irrigation Management Information Systems) that is used on the water use calculator is at: http://www.cimis.water.ca.gov/cimis/pdf/etomap1.pdf

Additional References Used:

American Water Works Association. 1999. *The Residential End Uses of Water Study*. AWWA. Denver, CO.

Gleick, Peter, et al. 2003. *Waste Not Want Not: The Potential for Urban Water Conservation in California*. Pacific Institute Berkeley, CA. Can be downloaded at no cost at: http://www.pacinst.org/reports/urban_usage/

Vickers, Amy. 2001. *Handbook of Water Use and Conservation: Home, Landscapes, Businesses, Industries, Farms*. Waterplow Press. Amherst, MA.

Coastal Conservancy

This conservation strategy was produced by Virginia Porter Consulting, for the Salmon Creek Water Conservation Program (SCWCP). The SCWCP is a multi-year, multi-stakeholder effort focused on developing alternative water supply solutions that support human needs while protecting and restoring instream flows for fish and wildlife.

Salmon Creek Water Conservation Program

Conservation Strategy No.3: Low Water Gardening for Rural Coastal California Communities

Coastal Conservancy



Overview

Many residents and businesses in California's rural coastal communities depend upon water from local sources such as streams, springs and shallow wells. These local sources usually feed into streams that are important habitat for aquatic species, some of which are threatened or endangered, such as the salmonids of Sonoma County's Salmon Creek Watershed.

During the summer months, many of these supply sources suffer from low water flows due to lack of rain and the use of water pumped from streams. Low water flows can jeopardize habitat for listed species. Low Water Gardening, which minimizes the need for summer irrigation, will help improve the local aquatic habitats that these species depend upon to survive. Low Water Gardening coupled with the development of alternate water supplies such as roofwater or graywater, provides maximum benefit to aquatic habitat.

Target community

Low Water Gardening is ideal for residential and commercial water users with gardens and landscapes in rural coastal communities, either on community water systems or a private supply.

Potential effect

These gardening practices can result in an enhanced supply of water during the critical months in the life-cycle of many aquatic species. The 2003 study by the Pacific Institute, *Waste Not Want Not: the Potential for Urban Water Conservation in California*, reports that in coastal California approximately 30% of all residential water use is outdoors. The Pacific Institute study finds that implementing the principles of Low Water Gardening will result in a 25-40% reduction in outdoor water use. If turf-dominated landscapes are converted to Low Water Gardening landscapes, there will be even greater savings.

Additional benefits from these practices include reduced use of chemical pesticides and fertilizers, increased groundwater recharge, reduced run-off from irrigation, and increased soil health. Low Water Gardening principles may also support greater diversity of plant species, beneficial insects, birds and mammals, as well as producing vegetation that requires less pruning, generating less garden waste.

Implementation

Low Water Gardening principles begin with the first decisions made in designing a garden or landscape. All decisions about planting, watering, feeding and changing a garden are influenced by the principles of Low Water Gardening.

Here are some guidelines for praciticing Low Water Gardening in coastal California, including design and installation practices, maintenance practices, and methods for bringing these principles to existing landscapes or gardens.

Low Water Gardening: Design and Installation

- Wherever possible, preserve existing native vegetation during garden design and installation.
- Preserve topsoil on the site even if it means stockpiling the h before grading and reintroducing after grading. Once lost, nutrient-rich topsoil can take decades to rebuild.
- For ornamental plantings, choose drought-resistant natives or Mediterranean species, with an emphasis on California natives that thrive naturally in the region. The University of California Cooperative Extension has compiled a list of the native landscaping plants by region, with their water use requirements: the Water Use Classification of Landscape Species (WUCOLS) at: http://www.water.ca.gov/wateruseefficiency/docs/wucols00.pdf

- Do not plant invasive species. Check the California Invasive Plant Council's web site for a comprehensive list of these pests: http://www.cal-ipc.org/
- Plan to install new plants or landscapes in the fall after the first rains. This maximizes root growth and increases long-term plant viability.
- Choose small size (4") plants for perennials or groundcovers. Select no larger than 5 gallon plants for trees. Starting small maximizes root development into parent soil, and usually produces a more vigorous mature plant.
- Space plants far enough apart so there is an adequate soil reservoir for each plant. Base the distance between plants on the mature size of the species. This allows mature plants to use more of the water stored in the soil and require less irrigation.
- Choose plant varieties that will mature to a size that does not require severe pruning, allowing each plant to have its natural form without a lot of pruning. This will result in healthier and more beautiful plants.
- Use organic compost as a top-dressing to all new plants. Mulch all bare soil areas with at least 4" of organic top-dressing. This organic layer feeds the soil and soil organisms as it breaks down.
- Consider using the "sheet mulching" method when planting. Place a layer of cardboard, newspaper or other organic porous product over soil and then top dress with a mulch such as wood chips or straw. See how sheet mulching is done at: http://www.agroforestry.net/pubs/Sheet_Mulching.html
- Group plants with like water needs together so they can be watered (or not watered) according to their thirst.
- Do not install turf lawns which need mowing and fertilizing to maintain their appearance. Instead consider a natural meadow that requires less water and can go dormant in the summer, or a porous hardscape, such as decomposed granite, for paths or a patio.
- If all or part of the garden will require summer irrigation, use drip irrigation for these areas. Install a separate irrigation valve for each degree of sun exposure or water requirement so plants can be watered according to their needs.
- If an automatic irrigation controller is used, consider installing a "smart controller" that changes the irrigation schedule as the weather changes. For a list of these controllers visit the Irrigation Association page at: http://www.irrigation.org/swat/industry/ia-tested.asp

Low Water Gardening: Maintenance Practices

- Cover all bare soil areas at all times with a minimum of a 4" layer of compost, leaves, woodchips or any other organic matter. This will reduce the need to water, increase infiltration, feed the soil, improve soil structure and discourage weeds. To avoid root rot and other problems, don't pile mulch around tree trunks or the crowns of shrubs and perennials.
- Use organic compost liberally as top-dressing to supply nutrients and improve soil structure.
- Keep any organic matter that is generated in the garden right where it was generated: in the garden. Fallen leaves can be used as mulch under trees. Weeds and trimmings from herbaceous plants can be composted for top-dressing.
- Remove weeds to reduce competition for the water stored in the soil, leaving it for the desired plants.
- Know the natural shape and size of each plant and allow it to grow into its natural form. Use selective pruning techniques to remove damaged or diseased limbs and branches. Minimize other pruning.
- If there is a turf lawn, leave grass clippings on the lawn after mowing. This practice known as "grass-cycling" adds nutrients and organic matter to the soil and reduces thatch build-up. Find out more about this practice at: http://www.calrecycle.ca.gov/Organics/GrassCycling/
- Avoid synthetic fertilizers, herbicides and other pesticides. For natural alternatives to pesticides visit: http://www.pesticide.org/factsheets.html#alternatives and http://www.ipm.ucdavis.edu/
- If summer watering is used, water only when needed. Observe the plants and soil to determine the garden's water needs.
- If an automatic irrigation controller is used, adjust it at least every two weeks as the weather and seasons change. If a "smart controller" is used, check the watering schedule to confirm that the schedule adjustments are following the weather pattern.
- Find out more about irrigation water use and weather conditions throughout our state by visiting the California Irrigation Management Information Systems (CIMIS) information site to locate the CIMIS station closest to your community: http://wwwcimis.water.ca.gov/cimis/info.jsp
- If an irrigation system is used, run the system at least monthly and observe each valve circuit in operation. Drip irrigation is low-pressure so leaks are not always evident. It is important to walk each drip line to make sure emitters are in place, lines are not cut or damaged, and that fittings have not come apart.

Low Water Gardening Practices for Existing or Mature Landscapes

- When working with an existing garden, identify the plants and evaluate whether their placement in the landscape is appropriate. Make sure each plant has the space to mature and an adequate soil reservoir to maintain vigor. Removing some plants can often "free up" air, light, and soil resources for other plants, resulting in a healthier landscape.
- As the garden matures, evaluate whether the planting density is correct for the form of the species and the region in which it is growing. Groundcover shrubs may become shaded by mature trees, and tree canopies may be competing for space.
- In understory areas, strive for a mixture of planted and unplanted space to allow trees adequate water from rainfall or irrigation. Always use a generous layer of mulch in both unplanted and planted areas.

Tools

Web sites:

The *Water Use Classification of Landscape Species* (WUCOLS) published by the University of California Cooperative Extension is at: http://www.water.ca.gov/wateruseefficiency/docs/wucols00.pdf

For natural solutions to pest problems visit these two sites: http://www.ipm.ucdavis.edu/ and http://www.pesticide.org/factsheets.html#alternatives

For weather station location and information about irrigation water use and weather conditions throughout our state visit the California Irrigation Management Information Systems (CIMIS) information site: http://wwwcimis.water.ca.gov/cimis/info.jsp

For information on "grasscycling" visit: http://www.calrecycle.ca.gov/Organics/GrassCycling/

For information on sheet mulching visit: http://www.agroforestry.net/pubs/Sheet_Mulching.html

The California Invasive Plant Council's web site has a comprehensive list of these pests: http://www.cal-ipc.org/

Books:

Bornstein, Carol, David Fross and Bart O'Brien, *California Native Plants for the Garden*, Cachuma Press, 2005.

Bossard, Carla, John Randall and Marc Hoshovsky, *Invasive Plants of California Wildlands*, University of California Press, 2000.

Francis, Mark and Reimann, Andreas, *The California Landscape Garden: Ecology, Culture, and Design*, University of California Press, 1999

Keator, Glenn and Middlebrook, Alrie, *Designing California Native Gardens: the Plant Community Approach to Artful, Ecological Gardens*, University of California Press, 2007

Harlow, Nora and Jakob Kristin (editors), *Wild Lilies, Irises, and Grasses: Gardening with California Monocots*, University of California Press, 2003

Lowry, Judith Larner, *Gardening with a Wild Heart: Restoring California's Native Landscapes at Home*, University of California Press, 1999.

Schmidt, Marjorie G., *Growing California Native Plants,* University of California Press, 1980.

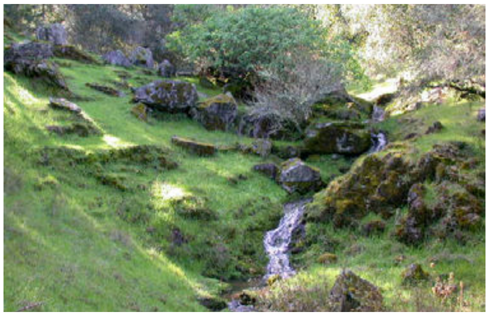
Coastal Conservancy

This conservation strategy was produced by Virginia Porter Consulting and Kathleen Kraft for the Salmon Creek Water Conservation Program (SCWCP). The SCWCP is a multi-year, multi-stakeholder effort focused on developing alternative water supply solutions that support human needs while protecting and restoring instream flows for fish and wildlife.

Salmon Creek Water Conservation Program

Conservation Strategy No.4: Stormwater Management for Coastal California Communities

Coastal Conservancy



Overview

In many California coastal communities, reliable access to fresh water is limited and watershed health and instream flows are growing concerns. Current trends toward longer droughts and more severe storms render traditional methods of stormwater management ineffective. Development of a robust, scalable, decentralized stormwater management strategy is critical for addressing watershed health and water security.

Target community

All landowners, residents, businesses, and land managers in all coastal California communities whose stormwater runoff is impacting natural waterways, especially those supporting endangered and threatened species.

Potential effect

Implementation of effective stormwater management measures will result in the following benefits, addressing both human needs and total watershed health.

Watershed:

- Increasing uplands water infiltration and retention capacity will improve water security by recharging groundwater aquifers, while increasing base flows in streams and reducing mortality in endangered fish populations
- Slowing down stormwater runoff will decrease topsoil loss, erosion, flooding and stream flow variance by reducing the volume and rate of peak flow events
- Removing pollutants in runoff will improve water quality in streams and aquifers
- Reducing the delivery of erosion products to streams will increase flows by keeping pools and riffles free of excessive sedimentation

Landowner:

- Recharged groundwater supplies will increase water security by improving the function of groundwater wells and alleviate the economic and resource costs of trucking in water
- Well-designed roads retain better drivability, with reduced maintenance needs
- Reduced flooding protects property values and lowers expenses for stopgap measures like pumping, levees and raising houses
- More infiltrated and stored water onsite helps increase fire suppression capacity and defensible space
- Retaining soil keeps land productivity high, lowering fertilizer costs

Implementation

This Conservation Strategy provides an overview of major elements in stormwater management common to all land uses, followed by land uses of special concern. Tools and resources are provided for further research.

What is stormwater?

Stormwater is water flowing on land surfaces during or within 24 hours of a precipitation event that is not infiltrated into the soil. Historically it has been viewed as a problem primarily of urban areas to be solved by the outmoded engineering practice of "pave it and pipe it". This method fails to properly manage stormwater in the uplands, with disastrous consequences—large, powerful volumes of water, moving too fast, resulting in severe erosion and flooding in low-lying areas. This excessive runoff requires expensive engineered systems that simply move the problem downstream until the runoff enters a stream and ultimately the ocean, leaving the ecosystem to absorb the excess volume and pollution. This paradigm creates a cascade of negative effects.

According to a comprehensive study done in 1997, "Streams with increasing imperviousness exhibit many of the following conditions: increased flood peaks, lower stream flow during dry conditions, degradation in stream habitat structure, increased stream bank and channel erosion, fragmentation of riparian forest cover, and decline in fish habitat quality." (Kauffman, Brant)

Instead of a problem, water can more accurately be viewed as an enormously valuable resource to be sequestered and re-used whenever possible, and from this perspective, it makes good sense to keep it around. Slowing, spreading and sinking stormwater as high in the uplands as possible will ensure that any water discharged from hardscapes will be clean and moving slowly enough to avoid erosion and sedimentation problems.

The trouble with impervious surfaces

It is important to note that,h in the context of stormwater management, the phrase "impervious surfaces" refers to a gradient of impermeability. This is expressed as a percentage of impermeability relative to the original, pre-human-use condition.

Virtually all surfaces modified for human use lose permeability, and the current perception of impervious surfaces as exclusively concrete, asphalt and roofing (100%) fails to address the total impact of reduced permeability. Many rural land uses such as poorly designed and maintained roads, subsurface drained hillside vineyards, overgrazing and excessive discing, while only partially impervious, tend to encompass a much larger total surface area resulting in stream flow variance, flooding and erosion that can be more severe even than urban areas.

Even small increases in impervious surfaces have a disproportionately large impact on watershed health. A study in Washington found that fish habitat quality and channel stability both deteriorate rapidly after watershed cover increases to 10% imperviousness (Booth, 1991), while Maryland found that brown trout abundance declined sharply at 10-15% (Galli, 1993).

Lost permeability prevents rain infiltration and creates higher volumes of runoff and greater water velocity, which:

- Cause topsoil loss, sedimentation and downcutting of watercourses
- Exacerbate flooding
- Reduce groundwater recharging rates
- Decrease stream base flow during dry months

Increased wet season flow rates also worsen pollution. Water moving faster in larger volumes will be carrying a higher sediment load as well as more of the pollutants accumulated from roads, lawns, vehicles, farms, vineyards, ranches and all other human uses. When these contaminants become waterborne they seriously impair watershed health. Decreased stream base flow during dry months concentrates pollutants and disconnects pools, dramatically increasing mortality for all aquatic life.

Performing a site assessment

To find out if your current stormwater management practices are successful, begin by performing a site assessment. Make it as comprehensive as possible, and remember that a walk in the rain is the best way to get good information.

1. Walk the perimeter of all impervious surfaces—a road, parking area, roof, patio, stable, pasture, or other modified surface. The surfaces themselves are not necessarily problems either—often the dangerous part is the drainpipe, culvert, ditch or other drainage structure where the water concentrated by the impervious surface gains volume and speed.
2. Find out whether the water that comes off these surfaces leaves your property.
3. If it leaves the property, find all the locations where stormwater exiting your property enters a natural waterway—a stream, river, wetlands, lake, or the ocean.

Having followed all the water leaving your property, answer the following questions:

- Where this runoff daylights (leaves a drainpipe or other subsurface drainage structure), do you see recent erosion scars or obvious fresh soil being removed?
- If causing erosion, is this runoff also carrying sediment to a natural body of water?
- Has this stormwater been running through manures, soils that have been exposed to or treated with chemicals, or other contaminated sites on your property?
- Have you seen or do you have reason to believe that the water has been exposed to any kind of contaminant upstream of your property?

If you answered yes to any of these questions, you will benefit from implementing updated stormwater management practices.

Strategies for stormwater management

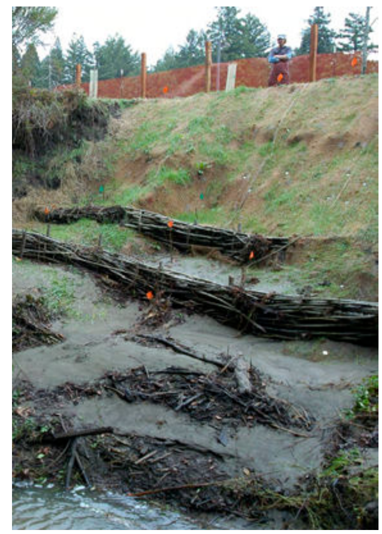
With acute sediment delivery, all that can be done initially is to keep the water clean. Sediment controls are the first step, and will at least keep the erosion products from reaching a natural waterway, but they do nothing about the actual erosion problem.

- Sediment fences are sturdy, permeable fabric barriers that can be rapidly staked out in the path of an uncontained flow to catch soil.
- Straw bales packed tightly end to end will act as a sediment fence and keep erosion product from reaching a stream, but degrade over time.

- Straw wattles act like straw bales, but are lighter and more suitable for small-scale control.

Erosion controls will help retain valuable topsoil and buy time to trace the source of the problem upstream. While stabilizing the headcut (the actively eroding upper edge of the gully) at the erosion site may alleviate some erosion problems, it will not address the fact that the system is receiving too much water.

- For concentrated outflows, start by placing energy dissipators to break up the force of the water and protect the banks from further collapse. Depending on flow volume, you can use large rocks, brush check dams (a small dam constructed in a gully to stabilize the grade or control headcutting), or hand-place thick mats of brush at the headcut and bed of the gully downstream. These woody materials can be harvested through limbing and thinning forests as part of a fuel load reduction project.
- For large areas of bare soil showing rill erosion (small shallow channels no more than a few inches deep found in newly exposed soils), first select and plant an erosion control seed mix that uses native, non-invasive plants. Then mulch with straw to keep birds from eating the seeds, or use erosion control blankets—biodegradable woven textiles that keep soil in place and help plants get established. Do not use plastic netting products—they can trap and kill wildlife



There are many different strategies available for both sediment and erosion control—a testament to the ever growing need. For an excellent guide, read *Groundwork: A Handbook for Small Scale Erosion Control in Coastal California*, available online at http://www.mcstoppp.org/acrobat/groundwork.pdf

Contact your local supplier of erosion and sediment control products for information on current tools and reputable local contractors.

Permanent stormwater management solutions are by far the preferred method because they stop problems before they start. Using source control strategies means working as far upstream as possible to slow down stormwater, spread the water out on the landscape, and sink it into the soil to avoid excess runoff. These decentralized stormwater techniques are effective because:

- Dealing with the source of the problem means you only have small amounts of water to manage, and the scale and expense of the actions you need to take are proportionately smaller but have greater impact
- Increasing the frequency of energy/flow dispersion provides many small opportunities to infiltrate water that would otherwise become runoff

At the community level the ideal is to disconnect those land uses with decreased permeability from direct discharge/drainage to the stream network as completely as possible.

The following effective, long-term stormwater management or low impact development strategies have proven track records, and are detailed in the references available in the "Tools" section below:

- **Roofwater Harvesting** captures rain and retains it onsite to prevent runoff entirely. See our Roofwater Harvesting Strategy for more information.
- **Contour Infiltration Trenches** are shallow trenches dug on contour that catch, temporarily hold and infiltrate runoff and, when full, direct water to an appropriate catchment or overflow area.

- **Rain Gardens** are excavated and planted depressions designed to thrive on the high volumes of water and nutrients in stormwater runoff while slowing down the water and soaking it into the soil.
- **Bio-Swales** are gently draining, off-contour channels that are heavily planted to improve water quality prior to discharge.
- **Ground Covers** such as mulch, gravel, or vegetation keep soil in place and trap water, giving it time to infiltrate.
- **Mycofiltration** is a strategy that uses fungus to break down nutrients, chemicals and other pathogens such fecal coliform bacteria that harm waterways. Paul Stamet's book *Mycelium Running* is the definitive guide to all uses of fungus.
- **Pervious Hardscapes** (grass pavers, porous concrete, etc.) allow water to seep into the ground naturally, while retaining useful hard surfaces.
- **Enlist your upstream neighbor**—Sometimes a friendly chat can move your ideas upstream and make them more effective. Try giving them this guide and offering a helping hand, or offer them a tour after installing your own measures.

Specific site challenges

No one strategy is right for all locations, so consider the following before beginning any new stormwater management measures.

- Steep slopes and landslide areas are inherently unstable, so avoid directing or infiltrating runoff at them, and be sure all drainage systems end well away from them. Landslide zones are too dangerous to modify without professional consultation, and can put others at risk. Proceed with caution.
- In low-lying areas and floodplains where infiltration is not possible, increasing the available surface area of bio-filtration will at least clean up the water before it leaves your property and help as part of flood control management downstream.
- Coastal bluffs are highly sensitive to erosion, and require considerable planning for successful site drainage.

Land uses of special concern

For the purposes of this Conservation Strategy, commercial logging operations, dairies, construction sites and vineyards will not be discussed. Please refer to professionals and authorities for help with these land uses as needed.

Regulations and Permitting

Before starting any work, research existing plicies or ordinances that regulate land use and stormwater. Checking with your county resource management or planning department is a good place to start.

Roads

If you do only one thing, work with your roads. Nothing impairs the natural drainage and infiltration functions of a watershed more than roads. Without exception, more roads mean more degraded natural stream networks. By acting as a network of artificial streams, all flowing dramatically faster and carrying much higher sediment loads than natural streams, roads create excessive water volume that worsens erosion, sedimentation and downcutting of stream beds. For the complete manual on roads, see *Handbook for Forest And Ranch Roads*, by William E. Weaver & Danny K. Hagans.

Animal Husbandry

This includes small-scale animal operations from goats, chickens and a few horses to larger scale equestrian facilities, commercial dairies and livestock grazing operations. When improperly managed, concentration of manures results in increased nutrient flows in streams, leading to algal blooms, low oxygen conditions (eutrophication) and fish mortality. Good practices include:

- Keep roofwater and hardscape drainage from running through all areas where manures are concentrated, and prevent direct runoff to the creek
- Move manure to safe containment and composting areas that exclude stormwater
- Employ riparian fencing to reduce livestock "loafing time" in the creeks

Other strategies are available online at: www.mcstopp.org/acrobat/Horse%20Keeping%20Guide.pdf

Tillage Based Agriculture

"Agricultural activities account for the largest percentage of non-point source pollution in the United States. Soil erosion and runoff of pesticides are the major problems…" (General Accounting Office, 1990). Regardless of scale or regulatory conditions, all intensive agricultural operations need to pay special attention to erosion, sedimentation and chemical runoff. Some successful strategies include:

- Using contour plowing, cover crops and/or no-till techniques
- Maintaining vegetation in ditches to act as bioswales
- Incorporating sediment basins and tailwater ponds

For more information, see www.agwaterstewards.org/txp/Resource-Center

Rural Residential Wastewater Systems

Improperly maintained or aged and failing septic tanks and leach fields can become sources of significant nutrient and fecal coliform pollution during peak runoff events.

Owners of septic systems need to test and maintain their systems annually to ensure proper function. *Wells and Septic Systems* by Max and Charlotte Alth is a useful guide.

Urban Areas

Urban stormwater from various sources (golf courses, ball fields, median strips and industrial park landscaping) has been proven to significantly increase pollution in runoff. Low Impact Development (LID) is a well-developed collection of strategies for urban stormwater management. More information on LID design and maintenance practices is available from the *Bay-Friendly Landscaping Guidelines: Sustainable Practices for the Landscape Professional* by Alameda County Waste Management Authority. Visit www.stopwaste.org

Tools

Web

The Center for Watershed Protection is one of the most comprehensive sources of information on stormwater management. See: http://www.cwp.org/Resource_Library/Better_Site_Design/index.htm

The Low Impact Development (LID) Urban Design Tools Website offers excellent design ideas for the numerous techniques and examples of applied LID at http://www.lid-stormwater.net/

Most coastal counties now have stormwater management websites. For a list of bay area municipal websites, visit the Bay Area Stormwater Management Agencies Association: http://www.basmaa.org/About-BAstormwater managementAA/tabid/55/Default.aspx

Books

One of the best guides, written in a very accessible style with many homeowner-scale examples, is *Slow It Spread It Sink It: A Homeowners Guide to Greening Stormwater Runoff* by the Santa Cruz RCD.

http://www.rcdsantacruz.org/media/brochures/pdf/HomeDrainageGuide.v25.pdf

For the ultimate guide to managing water with earthen structures, see *Rainwater Harvesting for Drylands, Volume 2: Water Harvesting Earthworks* by Brad Lancaster. http://www.harvestingrainwater.com

For help with designing and installing a rain garden, read *Rain Gardens: Managing Water Sustainably in the Garden and Designed Landscape* by Nigel Dunnett and Andy Clayton, www.timberpress.org

Design for Water by Heather Kinkade-Levario offers a suite of creative approaches and applications of stormwater management, and includes many case studies.

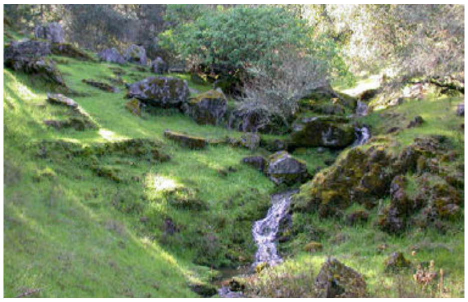
Coastal Conservancy

This conservation strategy was produced by Brock Dolman and Kate Lundquist, Occidental Arts and Ecology Center's WATER Institute and Kevin Swift, Swift Writing, for the Salmon Creek Water Conservation Program (SCWCP). The SCWCP is a multi-year, multi-stakeholder effort focused on developing alternative water supply solutions that support human needs while protecting and restoring instream flows for fish and wildlife.

Salmon Creek Water Conservation Program

Conservation Strategy No.5: Roofwater Harvesting for Coastal California Communities

Coastal Conservancy



Overview

In many coastal communities, reliable access to fresh water is limited and watershed health is a concern. During summer months, when stream flows and groundwater supplies are lowest, human demand is highest and endangered fish populations are under extreme stress. Additionally, climate change forecasts indicate that greater seasonal variations in rainfall could affect water security.

Roofwater harvesting systems are a "low-tech" way to capture winter rains for use during dry periods. The following is a brief overview of design and construction considerations for roofwater harvesting systems.

Target community

Residents and businesses within all coastal California communities, especially those with water supplies directly linked to waterways supporting threatened or endangered salmon and steelhead fisheries.

Potential effect

A well-designed roofwater harvesting system can reduce or eliminate demand for surface and groundwater supplies, increase water security, improve fire protection, and result in more reliable instream flows for fish and other aquatic life during the dry season. In addition, capturing and infiltrating storage tank overflows onsite can recharge groundwater supplies while reducing erosion, flooding, and pollution during rains.

Implementation

Design elements common to both potable and non-potable systems are listed below, followed by those specific to potable water systems. Special considerations for residential, non-residential, and agricultural uses are addressed next, with a final section of additional web and print resources that offer in-depth analysis of the information in this Conservation Strategy. For a recent rainwater harvesting case study, see: www.oaecwater.org/education/roofwater-harvesting-booklet

First Steps in System Design

Conservation – Efficiency First

A roofwater harvesting system is not intended as supply augmentation for inefficient use, waste, or increase in demand. Roofwater harvesting in coastal California is one approach to seasonally offset demand for instream flows and groundwater with stored rainwater. In any water system design, conservation, and efficiency are always the first steps.

The following websites offer strategies that can significantly reduce a site's water use. For residential conservation, see www.h20use.org or use the Salmon Creek Water Conservation Program's Residential Self Survey Conservation Strategy at www.salmoncreekwater.org. Many businesses can also use the Salmon Creek Water Conservation Program's Conservation in the Hospitality Industry Conservation Strategy also at www.salmoncreekwater.org Agricultural users visit www.pacinst.org

Regulations and Permitting

Before starting to design a system, research existing policies or ordinances in your area that regulate the use of rainwater, and be sure your intended system will be in compliance. In many counties, tanks over 5,000 gallons will need a building permit for their grading and installation. For more information visit your county's building department website.

Intended Use: Potable or Non-potable

Anyone who has their water supply impacted during the dry season or who uses water from a stream will benefit from installing a roofwater system. The type of system selected will depend on the intended use of the stored water.

Simple non-potable systems provide fire protection, irrigation, and livestock water supply independent of instream flows and groundwater. Potable systems need filtration, treatment, and possibly a backflow preventer. Consider these factors to determine which roofwater system is most appropriate:

- If irrigation or livestock water supplies are insufficient or unusable, or there are water needs in remote/inaccessible areas (even those currently served by stream diversion or pumping), consider a non-potable system.
- If the current potable water supply requires trucking in water, seasonal changes diminish well capacity or reliability, or there are concerns about water quality, then a potable water system may be worth developing.

RAINWATER CALCULATOR

A = (catchment area of building)
R = (inches of rain)
G = (total amount of collected rainwater)

(A) x (R) x (600 gallons) / 1000 = (G)

Site Survey and Water Audit

To determine how much water will be needed during the summer, perform a water audit on the structures and surrounding landscape. A Residential Self Survey Conservation Strategy is available at www.salmoncreekwater.org, and will help in estimating storage capacity needed for the rainless months of the year. For help performing a water audit and designing systems for larger scale agricultural needs, contact your local Resource Conservation District (RCD). The Gold Ridge RCD also has information on roofwater systems for dairy operations. Their website is: www.goldridgercd.org.

Factors Common to Both Potable and Non-potable Systems

Roofwater harvesting systems range in complexity from rain barrels under downspouts to municipal-scale systems. All share the following elements discussed below.

Collection Capacity

To calculate the collection area of a structure's roof, measure the horizontal length and width of your roof line (not the sloped roof) and multiply the two measurements. Next, gather data on average annual rainfall for the area. On-site rain gauge data is optimal, but contacting the local weather service, agricultural extension agent, or public water agency will suffice.

Then, estimate the water quantity the structure's roof could harvest per year using the following formula: (Collection area square footage) x (Average annual inches of rainfall) x (600 gallons) / 1000 = Total gallons of rainfall harvested per year.

While average annual rainfall numbers are a good starting point, it is a valuable exercise to do this calculation for 25- and 50-year drought figures in order to plan for the worst- case scenario. A capacity calculator is available at www.oaec.water.org/calculators

Gutters and downspouts

24-hour storm intensity in the area will determine gutter and downspout size. Ideally, gutters should capture all the rain that falls during a storm without overflowing. In most coastal communities, a 6" gutter system will work for all but the most severe storms.

First flush diverter/pre-filter

During the dry season, debris will accumulate on the roof and in gutters. First flush diverters and pre-filters ensure that the first few minutes of runoff are rejected, allowing time for rain to clean the roof. As a rough estimate of the necessary diverter capacity, plan for 1 to 2 gallons diverted per 100 square feet of roof area.

Storage capacity

In medium to large systems, storage will be the largest expense and occupy the most space, and so needs to be carefully selected and sized. Based on your water audit, include storage for at least a six-month supply (or whatever it takes to get through our lengthy dry season). Remember this is a minimum number—current climate change projections are for worsening droughts and increasingly unpredictable storms. Increasingly, municipalities are offering incentives to offset part of the installation cost for roofwater harvesting systems. For additional information on storage options, see *Water Storage: Tanks, Cisterns, Aquifers and Ponds*, by Art Ludwig.

Overflow

Once the storage structure is full, the overflow water needs to be piped to an appropriate storm water management location like a rain garden or bio-swale. For help with designing an overflow system, please read the Stormwater Conservation Strategy available at www.salmoncreekwater.org

Considerations Unique to Potable Water Systems

Potable water systems have more exacting design requirements than non-potable, and need careful consideration of the following elements:

Roofing

The more non-reactive the roof surface, the better. Many common materials add chemicals that are unsuitable for a potable water system, as do lead roof jacks. For some resources concerning roofing materials and water quality, visit: http://www.thecenterforrainwaterharvesting.org/2_roof_gutters2.htm

Gutters

Keeping your gutters clean of debris and leaves is critical for water quality. In fire-prone areas, gutters act as part of the "defensible space" strategy for your home. For best performance, gutters should be:

- Round-bottomed, smooth, durable, and supported every 30"
- Soldered with non-lead solder
- Protected from leaves and debris

Roof washer

For an additional level of filtration after the first-flush diverter, consider using a roof washer system—a device that mechanically removes finer levels of particulates and debris before it gets to the storage structure. Many different designs are available.

Storage

If a tank is employed, at a minimum it should be National Sanitation Foundation (NSF) certified. All storage vessels regardless of type need to be fully enclosed and screened at all inlets and outlets to prevent mosquito breeding. Also include a connection for Fire Department use and plumb for full drainage to allow cleaning. A complete guide to storage methods and materials can be found in *Water Storage: Tanks, Cisterns, Aquifers and Ponds*, by Art Ludwig.

Backflow prevention

In many cases, municipal water supply codes require a backflow prevention device to be installed. These devices require annual inspections by qualified inspectors. For more information regarding these regulations, call your municipal water supply agency.

Post-storage filtration

For potable water, a fine level of post-filtration for particulate matter is required prior to any disinfection treatment. Failure to filter particulates leaves microscopic sheltered sites where pathogenic bacteria and microbes can survive disinfection. Carbon filtration is the preferred technology. Sand filtration and other methods are sometimes used.

Post-storage treatment

Disinfection deals with bacteria, viruses or other pathogens that are small enough to pass through a particulate filter. The three most common options are:

- Chlorine: the primary biocide in many city water systems and has a long track record, but many people have health concerns with the by-products of chlorination.
- Ozone: can be used as a disinfectant. It is made on site by passing oxygen through ultraviolet light and adding it to the tank water by bubble contact. It requires electricity, has fewer potentially dangerous by-products and leaves no taste or odor.
- Ultra Violet (UV) light: a proven technology that kills unwanted microbes. Electricity is required to operate the UV bulb, which must be changed periodically, but it is effective and leaves no chemical residue in the water. Installing UV with carbon pre-filtration at points of use avoids the need for residual chemicals intended to disinfect storage and distribution systems.

Testing

Collect a sample of water at the tap and send it in to a local Environmental Laboratory Accreditation Program accredited laboratory for testing before drinking it. Consider sampling at the downspout, after the storage structure, and after treatment, for a complete system profile. For additional information, see: www.oasisdesign.net/water/quality/coliform.htm

Site Design

Storage structure placement design parameters are beyond the scope of this document and may require professional assistance. At a minimum, the location must be solid, seismically stable, and provide sufficient clearance below your lowest gutter to install the first-flush pre-filter and/or roof washer above the top of the installed tank. For underground installations, be sure to assess the water table before designing the site.

Deciding Who Will Build the System

As with any building project, it is important to ensure that your design is safe. Water is very heavy (over 8,000 pounds for a full thousand-gallon tank) and it is recommended to have professional review of your plans, even if you are building the system yourself. If you prefer to hire a contractor, a list of licensed regional contractors is available at: www.oaec.water.org/roofwater-suppliers

Special Considerations for Residential Applications

Residential lots tend to have limited space as well as setback requirements, making storage installed within the building envelope attractive. Consider a tank in the basement or under a deck. At a minimum, a rain barrel helps—they are cheap, simple, and have fewer design requirements.

Special Considerations for Non-residential Applications

Larger public and commercial buildings have significant collection capacity and opportunities for tank placement within the building envelope or under playing fields, golf courses and parking lots, yielding high storage capacity.

Special Considerations for Agricultural Applications

Large roof area and open spaces can make agricultural installations less prone to restrictions on tank size and siting, while offering much improved water security for crops and animals during drought years. In upland dry sites that are distant from existing plumbed infrastructure, consider placing a freestanding, self-filling tank. If additional capacity is needed, simple shed roofs built over roofwater storage structures can reduce demand for stream withdrawal and groundwater pumping. Collection and storage capacity of the structure must be sufficient to accommodate the stocking rate and duration of use.

Tools

Financial Incentives

For financial incentives and resources related to roofwater harvesting, Brad Lancaster's site is a good place to start: http://www.harvestingrainwater.com/rainwater-harvesting-inforesources/water-harvesting-tax-credits/

The Sonoma County Energy Independence Program offers financial incentives for "permanently installed rainwater cisterns". For more information, see: www.sonomacountyenergy.org

Some municipalities provide rebates on installation of rain barrels. For example, Santa Rosa rebates $0.25 per gallon of storage. Check with your local water agency.

Books/Periodicals

A highly accessible book for the beginning do-it-yourselfer is *Rainwater Collection for the Mechanically Challenged* by Suzy Banks with Richard Heinichen. www.rainwatercollection.com/rainwater_collection_how.html

The definitive introductory book to all things rainwater is *Rainwater Harvesting for Drylands, Volume 1: Guiding Principles to Welcome Rain Into Your Life and Landscape,* by Brad Lancaster. www.Harvestingrainwater.com

Websites

For a list of Environmental Laboratory Accreditation Program accredited laboratories in California that can test drinking water quality, download: www.cdph.ca.gov/certlic/labs/Documents/ELAPLABLIST.xls

For information on restoring and protecting watersheds by utilizing a framework of regenerative water-use practices known as Conservation Hydrology, visit the Occidental Arts and Ecology Center (OAEC) WATER Institute website at: www.oaecwater.org/education/bor-publication and purchase *"Basins of Relations."* Proceeds benefit the WATER Institute.

For educational opportunities, rainwater harvesting seminars, conferences and a business directory, visit The American Rainwater Catchment Systems Association website at: www.arcsa.org

Coastal Conservancy

This conservation strategy was produced by Brock Dolman and Kate Lundquist, Occidental Arts and Ecology Center's WATER Institute and Kevin Swift, Swift Writing, for the Salmon Creek Water Conservation Program (SCWCP). The SCWCP is a multi-year, multi-stakeholder effort focused on developing alternative water supply solutions that support human needs while protecting and restoring instream flows for fish and wildlife.

Salmon Creek Water Conservation Program

Conservation Strategy No.6: Conservation in the Hospitality Industry for Coastal California Communities

Coastal Conservancy



Overview

The hospitality industry consists of businesses within the food services, accommodations, recreation, and entertainment sectors. These businesses typically serve many non-residents as well as residents, and often provide a venue for leisure activity.

Depending on the make up of a community, a significant portion of the overall water use can support hospitality industry businesses. Many coastal communities in California have relatively high water use in the hospitality sector because the communities depend on the economic vitality provided by tourism. There are numerous cost-effective water efficiency measures that can be implemented by hospitality industry businesses to achieve sustainable water savings. Many of these actions will also reduce wastewater flow to a sanitary sewer or septic system. These measures include:

- installing efficient hardware such as low volume pre-rinse spray nozzles for dish washing, low flow toilets and showerheads in hotel rooms or at a spa, and "smart" irrigation controllers for landscaping.
- adopting water-efficient practices in operations and maintenance such as defrosting foods without using a water bath and sweeping rather than hosing hard surfaces.
- requesting the cooperation of customers to maximize water use efficiency by serving water only on request in restaurants, providing hotel users with the opportunity to request clean sheets and towels only as needed, and posting a contact for reporting leaks in all public restrooms.

Target community

The hospitality industry includes hotels, motels, and bed & breakfast inns; food service businesses such as restaurants, pubs and nightclubs; recreational businesses such as golf courses, recreational spas and boat tours. Conservation measures can target staff and customer behaviors as well as efficient fixture installation.

Potential effect

Implementing water use efficiency measures in the hospitality industry can achieve significant and sustainable water savings, often coupled with reduced wastewater flow and energy use. Some known water savings actions are discussed below.

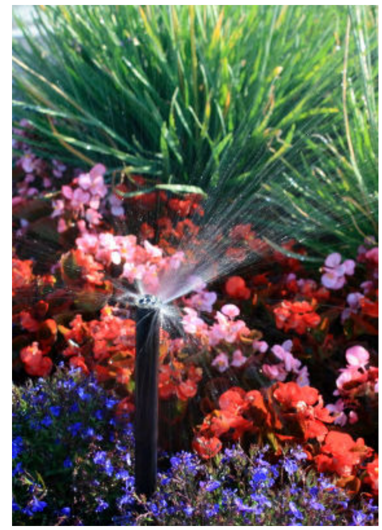
Hospitality businesses have a unique opportunity to create a community "water resource stewardship" brand identity because they interface with visitors more than other water users. Creating this message and enlisting the support of customers can positively influence the character of a community.

The 2003 study by the Pacific Institute *Waste Not Want Not: the Potential for Urban Water Conservation in California* reports the following savings potential for specific hospitality business by installing efficient plumbing hardware and adopting business practices to maximize water use efficiency. (It is likely that coastal communities would experience savings toward the lower end of the range because the Pacific Institute study looked at statewide averages and coastal climates require less water for landscapes than inland climates).

Restaurants – savings of 27% - 32%, with significant savings from landscape irrigation, cooling system and restroom efficiencies.

- **Hotels** – savings of 30% - 38%, with significant savings from laundry, landscape irrigation, cooling and restroom efficiencies.
- **Golf courses** – savings from 26% to 39% with all savings from improved irrigation hardware and practices. Irrigating golf courses with recycled water has the potential to realize a 100% savings of potable water through complete replacement of the supply source.

How to implement



Certain types of water use are common to all types of hospitality businesses. Conservation measures that target these common uses apply to all hospitality businesses. These common use measures are listed first below. Other water uses are specific to a particular type of hospitality business, and targeted conservation measures are listed next, according to a specific type of business covered, such as restaurants or golf courses.

Conservation actions for common uses in most hospitality businesses

- **Restrooms:** Install low volume toilets, urinals, showerheads and faucet aerators in all public and staff bathrooms. Specifications and lists of these efficient fixtures are found at the Federal EPA web site at: http://www.epa.gov/watersense/ The initial cost of installation is typically repaid through decreased water and sewer bills quickly.
- **Leaks:** Place "In Case of a Leak, Contact__________" notices (cards or mirror stickers) in all restrooms or other water using facilities used by the public.
- **Irrigation/Landscape Maintenance:**

  ✔ A thorough checklist of landscape practices for water efficiency for parks, golf courses and commercial landscapes is at: http://www.water.ca.gov/wateruseefficiency/docs/WUEIdeasParks.pdf

  ✔ Make sure there is a requirement for regular irrigation system checks in all landscape maintenance contracts, including the requirement to observe the system in operation at least monthly and to repair leaks and malfunctioning equipment.

  ✔ Consider installing a "smart irrigation controller" that adjusts for weather conditions; for a list of controllers and more information visit: http://www.irrigation.org/swat/industry/ia-tested.asp
- **Metering:** Install separate meters, whether through the water utility or sub-metering within the on-site system, to increase the information about where water is used and where leaks are on a site. If irrigation and indoor uses are served by one meter, consider installing a separate irrigation meter.
- **Monitoring:** Read the water meter(s) regularly (at least quarterly, preferably monthly) and keep a record of water use to become familiar with water use trends and to detect unexplained increases in use (most likely due to leaks). If all known water uses on site can be turned off, the meter can be used as a leak detector – if it is moving there is a leak.
- **Employees:** Train employees about all the conservation initiatives in place and how to use water efficiently themselves. Point out the importance of using water efficiently and how each employee

can make a difference. Post water-saving measures and results. Consider a program to reward water-saving efforts.

- **Hard Surface Cleaning:** Sweep sidewalks and parking lots clean rather than hosing them off with water.

- **Alternate Supply Sources:** Consider using rainwater harvested from roofs, graywater and/or recycled water as alternate sources of supply for landscape irrigation and other approved uses.

Conservation actions for hotels, motels and bed & breakfast inns

In addition to the "actions for common uses" listed previously, take these actions:

- Purchase or set up an efficient laundry system: A rinse-water recycling system or high-efficiency washers and dryers conserve both water and energy. See this EnergyStar link for information about efficient commercial washers: http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CCW . The initial cost of this investment may be significant but it is typically recovered in a few years through reduced water, energy and sewer bills.

- Start a linen reuse program in all guest rooms by placing pillow cards or door hangers indicating that linens will be laundered every three days unless the guest requests otherwise. This is now commonplace in many hotels and is a cost-saving, water-saving and time-saving measure that works well. Most customers will participate, and they appreciate the opportunity to hang up their towel instead of tossing it on the floor for changing.

Conservation actions for restaurants

In addition to the "actions for common uses" listed previously, take these actions:

- Install an efficient dishwashing system -- Many newer dishwashing systems use as little as a gallon of water or less per rack of dishes washed. See this EnergyStar link for a list of commercial dish washers: http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COH . The initial cost of this investment may be significant but it is typically recovered in a few years through reduced water, energy and sewer bills.

- Install water-efficient low volume (not more than 1.6 gallons per minute) spray nozzles with automatic shut-off trigger for pre-rinsing dishes.

- Install foot pedal or other manual controls so that garbage disposal water only runs when needed. Alternatively, sign up for food waste collection if it is available and eliminate the use of a garbage disposal.

- Convert water-cooled ice machines to air-cooled models.

- Replace boiler-based steam cookers with "connectionless food steamers" which require no plumbing to a water source and no drain. EPA tests show that certain energy-efficient connectionless steam cookers are as much as 90 percent more water efficient than traditional models.

- Thaw frozen foods in the refrigerator and melt ice naturally instead of running water over them in the sink.

- Wash vegetables in a water basin and not under running water.
- Soak pots and pans and scrape dishes and cookware before washing them.
- Serve water only on request to guests. Table cards can carry the message: "water gladly served on request" like the cards (in English and Spanish) available at this link which can be used by any restaurant: http://www.saveourh2o.org/index.cfm/conservation-tools/downloadable-conservation-materials/
- Provide children's coloring sheets, table materials and coasters showing a "saving water " theme.

Conservation actions for golf courses

In addition to the "actions for common uses" listed previously, take these actions:

- Consider installing a centralized control irrigation system, with "smart irrigation" technology to maximize the potential to control how irrigation water is applied.
- Locate your closest CIMIS (California Irrigation Management Information System) station and use the evapotranspiration data daily or weekly to determine irrigation run times and frequency. CIMIS station locations are available at this web page: http://wwwcimis.water.ca.gov/cimis/info.jsp
- Confined irrigation to crucial playing areas only. Identify water use priority areas, including high priority areas like tees and greens as well as those areas requiring little or no supplementary irrigation.
- Perform a comprehensive audit on the irrigation system at least once per year. This identifies leaks, irrigation head malfunction, and/or design limitations, as well as determining if the proper water distribution is being achieved in all irrigated areas. The form at this link can be used to record data in an irrigation site audit on a golf course or other large landscaped site : http://aggie-horticulture.tamu.edu/GREENHOUSE/hortgardens/conservation/agentdemo1.pdf
- Use "repeat cycling" in irrigation scheduling. It is more effective to apply only a portion of the total water needed at any one time. After the water has infiltrated and percolated into the soil, apply another portion of the water and repeat the cycle until all the water is applied.
- Mow to manage the turf with as high a cutting height as possible within the confines of the particular turfgrass used on greens, tees, or fairways.
- Manage soil compaction so water can penetrate to the rootzone of the turf. Leave grass clippings on the turf after mowing (grasscycling) whenever possible to maintain good infiltration, add nutrients and decrease thatch development. Use mechanical maintenance practices such as topdressing, vertical cutting, and turf cultivation only during periods when the turf is not under stress.
- Irrigate for turf durability and increased stress tolerance by irrigating thoroughly, but as infrequently as possible.
- Irrigate at the most efficient time of day when there is less evaporative water loss and less wind. This is typically from late evening through early morning (between 10 pm and 8 am). Irrigation frequency should also vary with environmental or climatic factors.
- When irrigating steep slopes, apply water slowly and with repeat cycles to avoid runoff, especially where turf thatch has accumulated or where soils are heavily compacted.

Tools

Web sites:

- Save Our Water has free down-loadable "water on request" restaurant cards and hotel linen cards in English and Spanish: http://www.saveourh2o.org/H2O/index.cfm/conservation-tools/

- The Federal Environmental Protection Agency WaterSense site has specific resources for non-residential water use: http://www.epa.gov/watersense/spaces/ci.html

- The California Department of Water Resources has technical recommendations for non- residential water use: http://www.water.ca.gov/wateruseefficiency/cii/

- Search for water efficient faucets and toilets at this WaterSense site: http://www.epa.gov/watersense/product_search.html

- Search for water efficient Energy Star commercial clothes washers: http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=CCW

- Search for water efficient Energy Star commercial dish washers: http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COH

- The Center for Irrigation Technology presents case studies related to efficient golf course irrigation: http://cati.csufresno.edu/cit/Golf%20Course%20Irrigation%20Nozzle%20Study.pdf

- California Irrigation Management Information Systems (CIMIS) web site has station locations and more information about the network of weather stations: http://wwwcimis.water.ca.gov/cimis/welcome.jsp

- The Pacific Institute report *Waste Not Want Not: the Potential for Urban Water Conservation in California*: http://www.pacinst.org/reports/urban_usage/waste_not_want_not_full_report.pdf

Coastal Conservancy

This conservation strategy was produced by Virginia Porter Consulting for the Salmon Creek Water Conservation Program (SCWCP). The SCWCP is a multi-year, multi-stakeholder effort focused on developing alternative water supply solutions that support human needs while protecting and restoring instream flows for fish and wildlife.

Salmon Creek Water Conservation Program

Conservation Strategy No.7: Water Rates for Rural Coastal California Communities

Coastal Conservancy



Overview

The amount of water used by customers on metered water systems is responsive to the water rate structure. In coastal California water is generally a scarce commodity, and rate structure design can be an effective tool to send a "price signal" to customers to reduce use. Rate structures can guide overall water use toward community goals for sustainable water supply.

Water rate structures can also be used to influence customers' discretionary uses during the critical periods of the year for aquatic habitat. Approaches such as seasonal rates, increasing block rates, or individual "goal" rates can achieve reduced water use during critical life stage periods for aquatic species such as the listed Salmonids in Sonoma County's Salmon Creek Watershed. Rate structures to implement these approaches are discussed in the implementation section of this Strategy.

Water purveyors have many options for rate structure design. Most rates are made up of two components:

1) a "fixed" charge that is assessed regardless of the amount of water used, and

2) a commodity fee for each unit of water used.

Not all rate structures have the commodity fee; for example, with a "flat fee" rate structure, a water customer pays a fixed charge each month regardless of the amount of water that is used. This means there is no financial incentive to use water efficiently. An "increasing block rate" structure usually has both a fixed and commodity charge: a fixed monthly fee regardless of use, and a commodity charged for all water used, with higher rates per unit for successive blocks (fixed quantities). The increasing block rate structure is conservation-oriented and results in a measurable pay-back when efficient fixtures are installed and use is reduced.

Target community

The community water system purveyor is the target for this Conservation Strategy. The water purveyor is responsible for setting water rates for customers of public, private or mutual water systems. Privately-owned water systems must have their rates approved by the California Public Utilities Commission.

Potential effect

Generally, customers respond to the price signal sent by water rates in making decisions about how they use water. Different rate structures send different price signals. In general, water use goes down as the price of water goes up, and rate structures that price the commodity high result in the greatest reduction in water use. The income level of the community may influence how effective a rate structure is in reducing water use; in affluent communities rates might have to be coupled with additional regulatory requirements, such as water flow restrictionfor customers that exceed their goal or allotment, to change water use levels.

Implementation

Setting water rates and deciding on the water rate structure is just one component of the financial decision-making process all water utilities face. Water utility managers must establish and design water rates that meet revenue requirements and are fair and equitable to all customer classes, including single-family residential, multi-family residential, commercial, industrial, and any special customer classes that are recognized by the utility. Rates must be set in such a way that no customer class subsidizes another customer class. Rate-setting involves the following procedures:

- Determining the water utility's total annual revenue requirements, including reserves, for the period for which the rates apply.
- Determining service costs by allocating the total annual revenue requirements to the water system components and distributing these costs to the various customer classes according to their service requirements.
- Designing water rates to recover the cost of service from each class of customer while maintaining rate equity between customer classes. This step is the focus of the discussion that follows.

This financial analysis and rate-setting process is covered in detail in the US Environmental Protection Agency's guide Setting Small Drinking Water System Rates for a Sustainable Future at: http://www.epa.gov/waterinfrastructure/pdfs/final_ratesetting_guide.pdf

The focus of this Conservation Strategy is on designing water rates that support water conservation and reduce dependence on water supply from sources critical for aquatic habitat. This is only one step of the process outlined above.

Water providers can expect to achieve any or all of the following goals when they adopt water conservation rate structures:

- reduce peak use
- reduce seasonal use
- reduce total system demand

The **community benefits** from water conservation rates because these rates:

- communicate an overall conservation consciousness
- reward efficient users
- surcharge nonessential and inefficient water users

Utilities can also achieve economic goals through water conservation rate structures, including:

- establishing price equity among customers
- maintaining revenue stability

There are two key elements to evaluate in the design of a conservation water rate structure:

1) the proportion of utility costs that is recovered through fixed versus commodity charges, and

2) the structural form of the commodity rate.

These elements are described in detail below. Water utilities need to evaluate all of these options before deciding which structure most effectively carries out the community goals for financial stability, water supply reliability, and environmental health.

Fixed versus commodity rate components

Water rates typically have a monthly fixed charge (based on meter size) that is assessed whether water is used or not. Historically, this charge has been designed to cover the "fixed costs" the utility faces regardless of the volume of water sold – the cost of running the distribution system, fixing leaks, reading meters, etc. As conservation rate structures have become the predominant approach to water rate setting in California, the percent of overall revenue from the fixed charges has been declining. As a result, some of the utilities' fixed costs are typically covered by the commodity-charge revenue.

The second part of a typical water rate is the commodity charge, which is a charge per unit for the quantity of water used. Water is typically billed in either the 1,000 gallon unit or the hundred-cubic-foot unit (1 HCF=748 gallons). The commodity charge sends a signal that the bill will increase as water use increases. The nature of the price signal depends on the amount of the commodity charge. This commodity component of water revenues tends to be more "volatile" than the fixed charge revenue; concerns about volatility can be alleviated by establishing a "rate stabilization reserve fund" to provide adequate revenue during years of low water usage.

A key element of conservation-based rates is having a high percentage of total revenue for water sales coming from the commodity charge rather than the fixed charge. In general, the higher the portion coming from the commodity charge, the greater the price signal is to the consumer. The California Urban Water Conservation Council considers a rate structure conservation-oriented if 70% or more of the revenue from water sales comes from the commodity charge.

The example that follows illustrates how the price signal changes when the rate structure changes. The table below compares a water bill for 5,000 gallons of water use with two different rate structures: a high fixed charge/low commodity charge scenario (in italics), and a low fixed charge/high commodity charge scenario. The same rate structure is then applied to a 3,000 gallon water bill to illustrate how a low fixed charge delivers a greater prices signal (a 32% reduction rather than an 8% reduction) when water use goes down. This example demonstrates how critical it is to have a high ratio of commodity to fixed charge for sending a price signal to the customer.

Comparison of Two Variations of Fixed and Commodity Charges

	Water Use (gal)	Fixed Monthly Charge	Commodity Charge per 1000 gal	Total Commodity Charge	Water Bill	Percent Change in Bill
	5,000 GALLON USE MONTH					
High Fixed/ Low Com.	5,000	$20.00	$1.00	$5.00	$25.00	
Low Fixed/ High Com	5,000	$5.00	$4.00	$20.00	$25.00	
	3,000 GALLON USE MONTH					
High Fixed/ Low Com.	3,000	$20.00	$1.00	$3.00	$23.00	-8.00%
Low Fixed/ High Com	3,000	$5.00	$4.00	$12.00	$17.00	-32.00%

Water rate structures

There are numerous ways to structure the commodity water rates. The following sections briefly define non-conservation-based rate structures and more fully define the most common conservation-based rate structures.

Non-Conservation -Based Rate Structures

Flat Fee Rates have no commodity charge and the customer received the same bill regardless of the level of water use. Most often systems with flat fee rates do not have water meters.

Decreasing Block Rates have a commodity charge that decreases as the quantity of water consumed increases.

Uniform Rates have a commodity charge that is constant for each unit of water sold regardless of the quantity of water consumed. Uniform rates can be considered conservation-based if a very large portion of overall revenue is from commodity charges and the unit rate is high. Regardless of the unit charge, a uniform rate does not send as strong a message as an increasing block rate.

A simple illustration of the difference in pricing structures between the decreasing block rate, uniform rate and increasing block rate is presented in the table below.

Comparison of Three Commodity Charge Structures

Block Size	Decreasing Block	Uniform	Increasing Block
Block 1	$5.00/1000 gal	$3.50/1000 gal	$1.50/1000gal
Block 2	$3.00/1000 gal	$3.50/1000 gal	$3.00/1000gal
Block 3	$1.50/1000 gal	$3.50/1000 gal	$5.00/1000gal

Conservation -Based Rate Structures

Increasing Block Rates separate consumption levels into two or more blocks, with rates per unit increasing as the level of consumption increases. Customers with higher levels of water use face higher rates and higher water bills. It is not uncommon for the highest block of an increasing block rate to be tied to the cost of new water sources.

One requirement of maintaining rate equity among customer classes with block rate structures is that rates and block break-points must be set so that the average rate paid within each customer class is equal across all classes. This assures that no customer class subsidizes another customer class.

Seasonal Rates have water prices varying by season. The design of the seasonal rate, the particular season used and the difference in price between seasons should be based on the community circumstances and unique characteristics. Seasonal rates can be blended with increasing block rates. For coastal California communities, seasonal rates have the greatest potential to achieve reduced water use during the critical habitat period for the aquatic species.

Simple Seasonal Rate Example

Season	Water Rate	
Winter (November - March)	$4.00	per 1,000 gal
Spring/Fall (April, May, October)	$7.00	per 1,000 gal
Summer (June - September)	$12.00	per 1,000 gal

Individualized "Goal" Rates are most often a special application of the increasing block rate structure, but with the block sizes and block break-points set for each customer designed to provide for a use "goal" which is based on efficient water use for the needs of that customer. The "goal" for customers should be linked to the water utility and community goals. Individualized "goal" rates are more administratively intensive than most other rate structures.

Here is an example of the individualized "goal" rate: the initial block may be set at efficient indoor use for the number of people in a given home; any use above the initial block may be charged at a higher unit cost. Goal rates can be coupled with both increasing block rates and seasonal rates for a more customized rate structure.

Excess Use Rates impose a higher rate on excessive water use. The customer pays more for water use that is considered higher-than-average. This structure requires the utility to establish a threshold level for excess consumption for each type of user. The residential threshold is often based on average per capita water use. The non-residential thresholds might be based on a standard for a certain kind of industry. Like the goal-based rate structure, excess use rates require special billing capability and account-specific information for each customer.

Tools

US Environmental Protection Agency's *Setting Small Drinking Water Rates for a Sustainable Future* guides water managers through the steps of assessing cost of service and setting rates:
http://www.epa.gov/waterinfrastructure/pdfs/final_ratesetting_guide.pdf

Boise State Environmental Finance Center has several easy to use computer programs (*CapFinance, Ratio8*, and *RateCheckup*) to help water systems with financial decisions and rate structures at:
http://efc.boisestate.edu/efc/Tools/tabid/58/Default.aspx

The California Urban Water Conservation Council (CUWCC) *Memorandum of Understanding for Urban Water Conservation in California* has a definition of a water conservation rate structure at:
http://www.cuwcc.org/mou/bmp1-utility-operations-programs.aspx

Coastal Conservancy

This conservation strategy was produced by Virginia Porter Consulting for the Salmon Creek Water Conservation Program (SCWCP). The SCWCP is a multi-year, multi-stakeholder effort focused on developing alternative water supply solutions that support human needs while protecting and restoring instream flows for fish and wildlife.

Salmon Creek Water Conservation Program

Conservation Strategy No.8: Managing Water Systems in Rural Coastal California Communities

Coastal Conservancy



Overview

A well-managed community water system serves both its customers and the environment, because water is used efficiently and managed in a sustainable manner. A well-managed system starts at the beginning with proper design, installation and inspection. Management continues through the life of the system with proper operation, maintenance, monitoring, repair and administrative management. Long-term plans are in place to assure water supply sustainability and reliability. A well-managed system can have cost control while maximizing system effectiveness.

Most rural coastal communities have small water systems with few connections. These systems face unique financing and staffing challenges. Financially, the burden of system operation and regulatory compliance is spread across relatively few customers, so rates may be high when compared with rates in larger communities. Licensing requirements for water treatment operators and water distribution operators in California can make staffing a challenge. In addition, small systems have few employees and each staff member needs to have the diverse skills needed to perform a variety of tasks. Coastal systems may also experience accelerated deterioration of components such as valves, pumps, and pipelines due to the corrosive nature of salt in the air and soil.

A well-managed water system includes preventative maintenance such as exercising valves and monitoring for leaks, as well as timely reactive maintenance such as leak repair. All reliable water systems need redundancy in physical systems such as pumps and power sources, and human resources such as operators. Long-range planning is critical for both the physical system replacement and to develop a sustainable water supply.

Target community

The water system purveyor is the target for this Conservation Strategy. The water purveyor may be a public or private entity.

Potential effect

A well-managed water system provides a community with a increased sense of stability, vitality, and viability. The system will have very little unaccounted-for- water (UAW), ideally less than 10%. With low UAW, the water that is produced is put to maximum beneficial use with minimal waste. Long-term planning can assure that demand is not allowed to grow past the sustainable supply capacity of the source water. Other water needs, such as instream flow for fish habitat, can be maintained and managed for beneficial use.

Implementation

Water System Management Elements

- A water system inventory needs to be developed and maintained. The United States Environmental Protection Agency (EPA) has a free asset management tool for compiling and maintaining the inventory called *Check Up Program for Small Systems* (CUPSS) at: http://www.epa.gov/safewater/cupss/index.html Information for your inventory includes:

- Characteristics of the system components (pipelines, meters, hydrants, valves, pumps, etc), such as size, age, and material
- Condition of the water mains, such as corrosion
- Soil conditions or type
- Failure and leak records
- Water quality
- High/low pressure conditions
- Operating records, such as pump and valve operations
- Customer records including complaints
- Meter reading data

- A water system map needs to be prepared, showing the service area, water sources, pipelines, meters, valves, treatment systems and other physical components.
- Records need to be kept in a central and accessible location. Key data needs to be kept current, including water production, water sampling and test results, water usage by each metered connection and collectively by class of user, backflow protection devices and testing, leak detection and repairs, and water rights. Washington State Department of Health has a valuable tool to aid in small water system record keeping at: http://www.doh.wa.gov/ehp/DW/Publications/331-134-4-30-08.pdf
- Redundancy needs to be developed for the elements of the system necessary for uninterrupted system operation. Redundancy includes piping configuration that allows more than one way for water to be introduced into the distribution system, a back up power source for pumping and treatment, diversity of water sources, and qualified back up staff who can perform key functions such as water quality monitoring, treatment plant operation and pipeline repair.
- Sub-metering the system at strategic locations is critical if unaccounted-for-water is to be kept low. Large water meters need to be installed at strategic points such well discharge points, treatment discharge points, and select points within the distribution system. These large meters allow water company staff to compare the quantities of water delivered to a specific metered area with the collective use of the customer water meters served in that area.
- Financial practices need to be set in place for evaluating cost of service, setting rates, and establishing and monitoring the budget. The EPA has published this guide to determine cost of service and set rates for small water systems: http://www.epa.gov/waterinfrastructure/pdfs/final_ratesetting_guide.pdf
- All meters need to be checked for accuracy on a scheduled basis. The measurement of water use with a meter provides essential data for charging fees based on actual customer use. Billing customers based on their actual water use has been found to contribute directly to water conservation. Meters also aid in detecting leaks.
- Water production and total metered use need to be monitored at least monthly to detect and resolve unexplained changes in water use. American Water Works Association has free software for determining water loss at: http://www.awwa.org/Resources/WaterLossControl.cfm?ItemNumber=48511&showLogin=N

- Planning for future replacement of water system components needs to be ongoing. Assume that new regulations may require purchase of new or updated equipment and might require implementation of new monitoring. A capital replacement fund needs to be set up and supported by water rates to sustain the water system components which support water system reliability.

- A long-term strategy to assure water supply security and reliability needs to be developed. Work to develop diverse supply sources such as supplementing existing surface water supplies with developed groundwater supplies. Small rural systems may need to rely on innovative supply solutions such as roof-water harvesting. Coastal communities often have adequate annual rainfall to meet supply, but limited storage or regulatory constraints on pumping year-round. Careful supply planning, together with diligent management of demand, produces a reliable supply.

Water System Operations, Maintenance and Monitoring Elements

The Environmental Protection Agency has a guide to best maintenance practices at: http://www.epa.gov/safewater/smallsystems/pdfs/guide_smallsystems_dist_system_08-25-06.pdf .

Here are some key recommendations:

- Annually exercise all valves and hydrants, and flush all pipelines. If water quality is poor this should be done twice annually.

- Inspect tanks and treatment system at least weekly for vandalism, and annually for defects, vent protection and tank condition.

- Monitor water quality through sampling routinely as required by system size and State Department of Public Health standards for routine or special conditions (such as pH, temperature, coliform bacteria, and other constituents).

- Monitor system pressure continuously to ensure no backflow condition has occurred and proper service pressure to customers is maintained.

- Perform leak detection (through visual inspection and with listening equipment) of entire system annually unless conditions such as seismic activity or unstable soils make more frequent detection necessary. Early detection of leaks reduces the chances that leaks will cause major property damage.

- Fix detected leaks as soon as possible to prevent leaks from becoming larger and to minimize water loss. Repairing leaks controls the loss of water that communities have paid to obtain, treat, and pressurize.

- Test large meters (3" and greater) for accuracy every year and test a sampling of small meters every few years to maintain accurate accounting of water use and minimize unaccounted-for-water due to low meter registration. Replace inaccurate meters.

- Check all valves, pumps, hydrants, and other system components annually for corrosion, damage and normal wear and tear.

Tools

US Environmental Protection Agency has a web site that is designed to help small water system owners and operators learn more about providing safe drinking water and protecting public health at: http://www.epa.gov/safewater/smallsystems/

US Environmental Protection Agency has a free downloadable asset management tool called *Check Up Program for Small Systems (CUPSS)* at: http://www.epa.gov/safewater/cupss/index.html

US Environmental Protection Agency's *Taking Stock of Your Water System: A Simple Asset inventory for Very Small Water Systems* focus on asset inventory for systems the size of most of those in our rural coastal California communities: http://www.epa.gov/safewater/smallsystems/pdfs/final_asset_inventory_for_small_systems.pdf

US Environmental Protection Agency's *Setting Small Drinking Water Rates for a Sustainable Future* guides water managers through the steps of assessing cost of service and setting rates: http://www.epa.gov/waterinfrastructure/pdfs/final_ratesetting_guide.pdf

American Water Works Association (AWWA) has an information page dedicated to small water systems at: http://www.awwa.org/Resources/SmallSystem.cfm?ItemNumber=3640&navItemNumber=1567&showLogin=N

AWWA has a free downloadable software for performing a water loss audit at: http://www.awwa.org/Resources/WaterLossControl.cfm?ItemNumber=48511&showLogin=N

California State University Sacramento offers a for-credit course and an excellent text book/resource on Small Water System Operation and Maintenance. For course and text book information and registration visit: http://www.owp.csus.edu/training/courses/drinking_water/sws1.php

National Rural Water Association publishes a quarterly magazine on line which is free at: http://www.nrwa.org/prMag.htm

Universities Council on Water Resources published the article *The Social Aspects of Small Water Systems* by Comelia Butler Flora which looks beyond the technical challenge of managing a water system to the community-wide impact: http://www.ucowr.siu.edu/updates/128/Flora.pdf

Washington State Department of Health has a published the *Small Water System Management Program Guide*. This tool can be valuable in California also for general system inventory and compliance with federal regulations. Find this guide at: http://www.doh.wa.gov/ehp/DW/Publications/331-134-4-30-08.pdf

California Rural Water Association is a membership organization that focuses on support and resources specifically for small rural systems in California: http://www.calruralwater.org/

Coastal Conservancy

This module prepared by Virgina Porter Consulting as part of the Salmon Creek Water Conservation Program (SCWCP). The SCWCP is a multi-year, multi-stakeholder effort focused on developing alternative water supply solutions that support human needs while protecting and restoring instream flows for fish and wildlife.

Salmon Creek Water Conservation Plan - Watershed Signage

Sandwich board style portable signs to alert watershed residents of flow conditions in creek.

Prunuske Chatham, Inc.