

Santa Rosa Citywide Creek Master Plan Hydrologic/Hydraulic Assessment



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CITYWIDE CREEK MASTER PLAN HYDROLOGIC/HYDRAULIC ASSESSMENT

INTRODUCTION

Santa Rosa's creeks transport storm water runoff to the Laguna de Santa Rosa, providing flood protection for residents, businesses and property owners. The Citywide Creek Master Plan addresses the nearly 90 miles of creeks that flow through Santa Rosa. Generally, creeks begin in the eastern foothills, drop down to the urban area, and gradually make their way across the Santa Rosa Plain to join the Laguna de Santa Rosa, and ultimately the Russian River and Pacific Ocean. Watersheds draining to the Laguna de Santa Rosa include Santa Rosa Creek (tributary creeks: Arroyo Sierra, Austin, Brush, Coffey, College, Cooper Creek, Ducker, Forestview, Indian, Lornadell, Matanzas, Oakmont, Paulin, Peterson, Piner, Pomo, Poppy, Rincon, Russell, Skyhawk, Spring and Steele), Irwin Creek, Countryside Creek, Roseland Creek, Colgan Creek (tributary: Old Colgan Creek), Gravenstein Creek (tributary: Naval Creek), and Todd Creek (tributary creeks Hunter and Moorland). Many more unnamed tributaries exist.

One of the Master Plan's eleven goals is particularly relevant to the flood carrying function of local creeks:

Goal SW: Protect the ability of waterways to carry storm water runoff and surface drainage

To meet Goal SW of the Citywide Creek Master Plan, this Hydrologic/Hydraulic Assessment has the following objectives:

- In creek reaches where recommended actions have potential drainage impacts, assess the current flood carrying capacity through review of available information (including prior drainage analyses, drainage analyses in process, stream gauge data and observations/records from high water events) and field surveys to estimate current roughness characteristics.
- Analyze recommended actions to determine potential impacts on flood carrying capacity.
- Incorporate changes in recommended actions as needed to retain the current flood carrying capacity of creek reaches where the recommended actions have potential drainage impacts.

Many of the proposed improvements (such as trails on access roads and pedestrian bridges over creeks) will not impact the flood carrying capacity of the creeks. Proposed enhancements to the natural resources (such as removing concrete and adding trees and other vegetation to channels) have the potential to reduce the flood carrying capacity below existing levels. The creek reaches where recommended actions have the potential to impact flood carrying capacity are listed in Table 1.

The proposed enhancements were selected to be self-mitigating with respect to flood conveyance based on a master plan level of hydraulic analysis. When designs of these reaches are developed prior to implementation, a detailed hydraulic analysis must be completed for every project component affecting flood conveyance to identify allowable "roughness" values and to interpret those values in a Vegetation Planting and Monitoring

Plan. The detailed hydraulic analyses should be based on the results of any drainage studies currently in process (described below) that are completed at that time.

HISTORICAL CONTEXT

Precipitation in the Santa Rosa area is seasonal, with approximately 82 percent of the annual rainfall occurring during the winter months of November through March. Mean annual precipitation varies from about 29 inches in the lower portion of the watershed to about 45 inches along the ridgeline at the eastern edge of the Santa Rosa Creek watershed (US Army Corps of Engineers, 2002).

Santa Rosa Creek provided dependable water and annual runs of steelhead and salmon to the Pomo Indians. On the flat valley floor the creek was braided into many channels. The first wave of settlers built beyond the floodplain but further growth resulted in buildings along the borders of Santa Rosa Creek. It became a steep-sided creek channel missing much vegetation and prone to erosion. The first recorded flood occurred in 1861. Additional development and the winters of 1937 and 1940 resulted in severe flooding (Smith, 1990). After the very severe flood in 1955, local agencies requested assistance from the federal government through the U.S. Department of Agriculture Soil Conservation Service (now the Natural Resources Conservation Service). This resulted in preparation of the Central Sonoma Watershed Work Plan. By 1958, when the Watershed Work Plan was prepared, flooding in the Santa Rosa Creek watershed occurred in most years and sometimes three or four times in a single winter.

Implementation of the Central Sonoma Watershed Work Plan during the 1960's included construction of 25 miles of flood control channels, four flood-retarding structures and two diversion structures. The facilities were generally designed to provide protection against a flood that would have 1% chance of recurring in a given year, commonly referred to as a 100-year flood. Creeks affected by this project included Santa Rosa Creek, Matanzas Creek, Piner Creek, Paulin Creek (tributary to Piner Creek), Brush Creek and Spring Creek. Project funding dictated that project designs be selected that minimized cost and right-of-way needs. As a result, channels were constructed for the single purpose of flood prevention.

Although flood control improvements on Spring Creek alleviated most of its flooding problems, the lower reach of Spring Creek continued to consistently overflow, causing ponding and sheet flow problems every few years (Federal Emergency Management Agency, 1981). As a result, the Spring Creek Bypass project was constructed in 1988 and 1989. This project diverted a portion of the flows from Spring Creek into a pipeline from Summerfield Road to Farmers Lane. Ponding and sheet flow problems still occur in the Spring Creek watershed during large storms.

The Sonoma County Flood Control and Water Conservation District (now the Sonoma County Water Agency) was created by special act of the State legislature in 1949. Flood control zones were established as the most favorable means of securing funds necessary for a construction and maintenance program. The Laguna - Mark West Creek Zone 1A includes the area tributary to Mark West Creek and the Laguna de Santa Rosa. The area of the Citywide Creek Master Plan is in Zone 1A. Zone 1A provided a local source of funds that supplemented the federal funds provided through the Central Sonoma Watershed Project to address local flooding problems.

The Roseland Creek flood control channel downstream of Hearn Avenue was constructed by the Sonoma County Water Agency in the 1970s. The channel was designed to convey a 25-year storm with no overflows. The 100-year storm causes overflow into the Naval Creek watershed (EIP Associates, 1984).

Colgan Creek was channelized as a series of Zone 1A projects generally from Petaluma Hill Road downstream to Todd Road. The channel was designed to convey a 25-year storm from Petaluma Hill Road to Bellevue Avenue and a 100-year storm downstream from Bellevue Avenue.

Zone 1A also funded construction of the Todd Creek Channel, Moorland Creek Channel and the Hunter Lane Channel.

PRIOR DRAINAGE ANALYSES

Drainage analyses of watersheds in the Santa Rosa area has been conducted over the years as needed to meet particular needs at the time the analyses were conducted. A single comprehensive analysis of all of the watersheds in the Santa Rosa area does not exist. The analyses that do exist are described below.

Central Sonoma Watershed Project

The Central Sonoma Watershed Work Plan, dated 1958, provided the first comprehensive drainage analyses of the streams in the Santa Rosa Creek watershed. Synthetic unit hydrographs were developed at points of concentration using the Soil Conservation Service unit hydrograph approach. Hydrographs were routed downstream and combined at junctions by addition. Results were compared to values from a regional stream study as a check. Peak flow rates were developed for the 1%, 2%, 4%, 10% and 50% frequencies (commonly referred to as the 100 year, 50 year, 25 year, 10 year and 2 year return period flood events). Hydrographs were developed synthetically for a typical 72-hour storm for designing the flood-retarding structures. The flows reflected estimates of future development. The flow rates developed under the Central Sonoma Watershed Work Plan continue to be used pending completion of the Santa Rosa Creek Ecosystem Restoration and Flood Damage Reduction Feasibility Study by the U.S. Army Corps of Engineers (described below under Drainage Analyses in Process).

The flood control channels under the Central Sonoma Watershed Work Plan were designed by Manning's formula using a roughness coefficient "n" of 0.035 for vegetated and riprapped channels and 0.015 for concrete lined channels. Bank slopes for the vegetated and riprapped channels were set at 2 ½:1 on Santa Rosa Creek and 2:1 on the other creeks, based largely on the condition of the existing banks. A slope of 1 ½:1 was used for the trapezoidal concrete lined channels. In reaches having design flows greater than 1,000 cubic feet per second or having water depths greater than 5 feet combined with velocities of more than 7 feet per second at design flow, rock riprap was placed to a minimum of one third the design flow depth. At bends and other points where high velocity flows were expected, riprap was extended to the full channel depth including freeboard.

The channels were designed such that the water surface at design flow would be below the natural ground except in the lower reaches of Piner Creek and Santa Rosa Creek. Levees were designed to withstand a maximum depth of about 2 feet and freeboard of 3 feet through most of the area. Downstream of Willowside Road the levees would be inundated by backwater from the Laguna de Santa Rosa.

The Watershed Work Plan acknowledged that the proposed flood control improvements would have an adverse impact on the fishery resource.

Matanzas Creek Alternatives for Stabilization

The only component of the Central Sonoma Watershed Work Plan that has not been fully implemented is the stabilization of Matanzas Creek. The lower, flatter sections of Matanzas Creek were rapidly developed after World War II. Homes were built right up to the creek banks with no setback. In some areas the creek channel was narrowed to create land for development. During the 1950's it became apparent that the concentrated flow in the channel was causing undercutting, erosion and collapse of the streambank at many locations. The Central Sonoma Watershed Work Plan called for construction of a sediment and flood control reservoir in the upper part of the watershed and streambank protection measures above and below the dam.

In 1963 and 1964, Matanzas Reservoir was constructed upstream of Bennett Valley Road and has since been successful at controlling flooding and sedimentation in the creek downstream. Erosion problems, however, still persist. One of the root causes of erosion on Matanzas Creek is gradual lowering of the stream bed, which is known as downgrading. A report prepared in November 1977 by the Soil Conservation Service in cooperation with the Sonoma County Water Agency identified a wide range of design alternatives to solve the downgrading problem on Matanzas Creek. These alternatives included concrete bank lining, low concrete and rock grade stabilizers, loose rock lining of the creek bank and channel, and "spot" repair of bank erosion when necessary. These alternatives were brought to the public at meetings held before the Santa Rosa Planning Commission and City Council in 1980. Public acceptance of the project was mixed. Opposition to the project came from those who feared that a project would destroy the riparian and aesthetic qualities of the creek. Support came from property owners who had lost structures and sections of their property due to continuing erosion and streambank instability. The compromise alternative that was selected was construction of grade control structures. Due to funding, environmental, and property ownership issues this alternative has not been implemented. Flooding is not a problem along Matanzas Creek. Matanzas Creek is primarily in private ownership with a healthy riparian corridor. This Citywide Creek Master Plan does not propose significant changes to Matanzas Creek.

Flood Insurance Study for City of Santa Rosa

In 1981, a Federal Emergency Management Agency (FEMA) flood insurance study was published for the area included in the City of Santa Rosa at that time. The purpose of the study was to "investigate the existence and severity of flood hazards in the City of Santa Rosa, Sonoma County, California, and to aid in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973." The hydrologic and hydraulic analyses for the flood insurance study were performed by the U.S. Army Corps of Engineers. Since many of the streams in Santa Rosa had been analyzed and reconstructed as flood control channels, it was agreed that reconstructed streams would not be investigated in the flood insurance study. Approximate analyses

were used to study Santa Rosa Creek, Matanzas Creek and the lower reach of Spring Creek. This resulted in a determination that the 100-year flood would be contained within the creek banks. Detailed analyses and flood plain mapping were developed for Spring Creek between Summerfield Road and the confluence with Matanzas Creek. Roughness values for the Spring Creek main channel ranged from 0.050 to 0.080; roughness for the overbank areas ranged from 0.100 to 0.140. The Flood Insurance Rate Map (FIRM) published with the Flood Insurance Study report showed flooding outside of the banks of Spring Creek between Summerfield Road and Church Street, just downstream of Farmers Lane. 100-year base flood elevations for Spring Creek were also shown on the FIRM. The 100-year flood for Matanzas Creek was shown as contained within the channel; base flood elevations were not determined. No other streams were shown on the FIRM or addressed by the Flood Insurance Study.

Spring Creek Bypass

The most recently constructed component of the Central Sonoma Watershed Work Plan is the Spring Creek Bypass pipeline between Summerfield Road and Farmers Lane, which was completed in 1989. The plan approved for Spring Creek in the original Central Sonoma Watershed Work Plan was a concrete channel from Summerfield Road to a point about 1,000 feet downstream of Farmers Lane. As time passed, Spring Creek continued to flood but residents became more interested in the natural values of the creek. Additional studies and a related EIR resulted in selection of a bypass pipeline as the preferred alternative to alleviate flooding along Spring Creek. Based on the hydraulic analysis conducted for the Spring Creek Bypass project, the FEMA flood plain maps were revised (upon request from the City of Santa Rosa) through a Letter of Map Revision. Although the bypass pipeline has been constructed, flooding continues to be a problem along Spring Creek between Summerfield Road and Farmers Lane.

Santa Rosa Creek Master Plan

Hydrologic and hydraulic impacts from implementation of the Santa Rosa Creek Master Plan were analyzed in 1992 as part of the plan development and described in the EIR for the master plan. The proposed project was determined to produce two significant adverse impacts: 1) Non-compliance with a "no net fill" ordinance due to proposed fill along the outside of the north levee of Delta Pond; and 2) reduction of storage capacity of Delta Pond due to filling along the inside levee, and potential reduction in the structural integrity due to root penetration into the levee from proposed tree planting. The project's hydraulic impacts were substantially reduced by design. While proposed changes in the Santa Rosa Creek channel could radically alter the performance of the channel during peak flow events, detailed design of altered channel sections, phasing, revegetation, and monitoring efforts would be specifically carried out to prevent any increases in water surface elevation at the design discharge. Bank protection and land acquisition elements were included in the plan so as to mitigate erosion and flood damage impacts which might otherwise occur under the proposed plan. Geomorphic impacts were expected to be positive. Water quality impacts were also expected to be positive.

Lower Colgan Creek Concept Plan

A hydraulic analysis was conducted in 2001 for the Lower Colgan Creek restoration concept plan between a drop structure downstream of Victoria Drive and Bellevue Avenue. Flow rates were based on a hydrologic analysis conducted by the Sonoma County Water Agency in 1992. The analysis concluded:

- 1) In the reach downstream of the 90 degree bend upstream of Dutton Meadow to Bellevue Avenue, the Colgan Creek channel is not capable of conveying even the 10 year peak flow with ultimate development in the upper watershed based on applying the 1.5 feet of freeboard required by the Sonoma County Water Agency; and
- 2) In the reach from the drop structure downstream of Victoria Drive to the 90 degree bend upstream of Dutton Meadow, the conveyance capacity increases to a 25-year peak flow level and even a 100-year peak level near Victoria Drive.

Under the proposed conceptual enhancement plan with reasonable management of vegetation in the enlarged channel and recommended bridge modifications, channel conveyance in the concept plan reach would increase to carry the 100-year ultimate development condition peak flow.

Hydraulic Assessment of Sonoma County Water Agency Flood Control Channels

A hydraulic assessment of Zone 1A constructed flood control channels was performed in 2002 in order to determine the effects of various vegetation maintenance practices on flood capacity. These constructed flood control channels had been widened and straightened for flood control purposes. Vegetation maintenance was historically and routinely provided by the Sonoma County Water Agency to ensure that the design flow could be safely passed. Most of the Zone 1A channels were designed with the expectation that vegetation growth would be limited by maintenance activities. Historic maintenance practices typically involved the wide-spread removal of vegetation. In recent years the Sonoma County Water Agency has modified these maintenance practices to retain some vegetation to provide cover, shade and cooler water temperatures for federally listed fish species (Coho and Chinook salmon and Steelhead trout). The hydraulic assessment considered four maintenance scenarios: 1) Original Design (low grass on banks, no trees); 2) No Maintenance (full development of mature vegetation); 3) Post-Maintenance (described below); and 4) Pre-Maintenance (5 years of vegetative growth since last maintenance activity).

The Post-Maintenance scenario reflected the current fish-friendly maintenance activities currently practiced by the Sonoma County Water Agency, as follows:

- a) Top 2/3 of channel bank is subject to only very limited thinning to prevent dense under-story of willows, blackberries and other shrubs. Existing trees are not removed, and the banks may become well vegetated.
- b) Bottom 1/3 of bank has no more than a couple of years of growth, allowing only scattered small shrubs and young willow (less than 5 feet height)
- c) Channel bed is near original design condition, however some encroachment of vegetation from banks and aquatic vegetation, primarily tules and grasses, is initially establishing (up to 2 years growth).

Creeks within Santa Rosa analyzed in detail in the hydraulic assessment include Santa Rosa Creek and Piner Creek. Also mentioned were the following Santa Rosa area creeks: Austin, Brush, Colgan, College, Forestview, Paulin, Peterson/Forestview, Rinconada, Roseland and Todd.

The post-maintenance scenario provided 100-year flood capacity in almost all segments of Santa Rosa Creek and Piner Creek. However, there were short segments along Santa Rosa Creek and Piner Creek where the flows would be just over top of bank in a 100-year event. On average, flows would exceed top of bank by 0.1 feet in the Santa Rosa Creek reach below the Piner Creek confluence. The median freeboard on Santa Rosa Creek is an average of 0.3 feet in the reach below Piner Creek and an average of 0.8 feet of freeboard in the reach above Piner Creek. The average freeboard on Piner Creek is 1.7 feet. Both channels could pass the 25-year flood with virtually no locations where flow would exceed top of bank under the post-maintenance scenario. Sonoma County Water Agency Flood Control Design Criteria calls for a minimum freeboard of 1.5 feet between the design water surface and the top of bank or 0.2 of the specific energy, whichever is greater. The assessment concluded that it is prudent and necessary to have a greater margin of safety associated with protecting properties and infrastructure from over-bank flows than can be provided in some sections of Santa Rosa Creek and Piner Creek. The assessment was based on the assumption that sediment has not deposited and diminished the cross-sectional area of the channels analyzed.

DRAINAGE ANALYSES FOR CONCEPT PLANS INCLUDED IN MASTER PLAN

Two creek concept plans were developed concurrent with this Citywide Creek Master Plan and are included in the plan and appendices. Detailed hydraulic analyses were conducted to support these concept plans as described below.

Upper Colgan Creek Concept Plan

A hydraulic analysis was conducted in 2004 by Philip Williams and Associates (PWA) for the Upper Colgan Creek restoration concept plan between Petaluma Hill Road and a culvert behind the Costco store at the Santa Rosa Marketplace shopping center. The analysis was conducted on the Upper Colgan Creek Concept Plan that was developed by Quadriga, a landscape architecture and planning firm. Flow rates were based on a preliminary hydrologic analysis conducted by Winzler and Kelly for the Southern Santa Rosa Drainage Study. These flow rates were approximately 9-17% lower for the 10-, 25- and 100-year events than the flow rates previously assumed by the Sonoma County Water Agency. PWA developed a hydraulic model of proposed channel conditions using HEC RAS, an open channel analysis software package developed by the US Army Corps of Engineers. The proposed channel geometry and planting plan were refined to be consistent with a roughness value of 0.05, which is higher than the existing conditions roughness value of 0.035. The proposed channel cross section included pulling back one of the banks at the toe of bank to enlarge the area available for flow. The additional flow area was necessary to compensate for the reduced velocity of flow that would be expected with a higher roughness value. The analysis concluded that the proposed conceptual plan for Upper Colgan Creek maintains the conditions that have previously been assumed to exist in the project reach, and that the conceptual plan is consistent with the hydrologic and hydraulic design requirements of the Sonoma County Water Agency. It also concluded that the predicted 100-year water surface elevation falls below the identified top of bank elevations within the project reach, indicating that even significant storms are expected to be contained within the channel under proposed conditions.

Roseland Creek Concept Plan

A hydraulic analysis was conducted in 2006 by City staff for the restoration reach of the Roseland Creek conceptual plan from downstream of Burbank Avenue to Stony Point Road. Flow rates were based on those used by the Sonoma County Water Agency in the 1970's for design of the Roseland Creek flood control channel. Per the Sonoma County Water Agency Flood Control Design Criteria, this reach of Roseland Creek was designed to convey a 25-year flood event. However, the City is interested in conveying the 100-year flood event in the Roseland Creek channel. A proposed channel configuration and planting plan was developed with the intent of both improving habitat and providing additional flood protection. City staff developed a hydraulic model of the proposed channel conditions using HEC RAS, an open channel analysis software package developed by the US Army Corps of Engineers. The proposed channel geometry and planting plan were refined to be consistent with roughness values of 0.045 on the banks and 0.040 in the bed, which are higher than the existing conditions roughness value of 0.035. The proposed channel cross section included enlarging the area available for flow to compensate for the reduced velocity of flow that would be expected with a higher roughness value and to provide additional flood protection up to a 100-year event. The analysis concluded that the proposed conceptual plan for the restoration reach of Roseland Creek would not increase the hydraulic grade lines above existing conditions. It also concluded that the predicted 100-year water surface elevation falls below the identified top of bank elevations within the project reach, indicating that even significant storms are expected to be contained within the channel under proposed conditions.

DRAINAGE ANALYSES IN PROCESS

Two drainage analyses currently in process will provide the City and the community with a much greater understanding of the level of flood protection afforded by the existing drainage system. One addresses the Santa Rosa Creek watershed which drains the central and northern areas of Santa Rosa. The other addresses the largest watersheds in southern Santa Rosa. When completed, these analyses will show where flooding would likely occur in a 100-year storm event and what alternatives should be considered by the community to address flooding problems. The drainage analyses conducted for the Citywide Creek Master Plan should be updated based on information from these drainage analyses when each is completed.

Santa Rosa Creek Ecosystem Restoration and Flood Damage Reduction Feasibility Study

In 1999, the City of Santa Rosa entered into a cooperative agreement with the U.S. Army Corps of Engineers for the Santa Rosa Creek Ecosystem Restoration Feasibility Study. The Sonoma County Water Agency is a partner on the project and funds the local share of the project costs. After completion of the original hydrologic analysis, the scope of the feasibility study was expanded to also include flood damage reduction. The current scope includes an in-depth examination and refinement of alternatives for ecosystem restoration and flood damage reduction in the Santa Rosa Creek watershed. These alternatives will be assessed and screened based on current resource use/value, anticipated restoration outputs, costs, damages, benefits, local support/opposition, and overall ecosystem and flood damage reduction needs. Following this process, an alternative will be identified that will be used to develop a detailed preliminary design for the restoration and flood damage reduction of Santa Rosa Creek.

A draft hydrologic analysis completed by the Corps in August 2002 concluded that channels within the watershed might experience flows during a 100-year storm event greater than previously estimated, and that existing flood control projects therefore might be inadequate for a 100-year flood event. The feasibility study is estimated to be a nine-year study. Tasks currently under way by the Sonoma County Water Agency and the Corps include surveying and topographic mapping, hydraulic analyses and flood plain mapping.

Southern Santa Rosa Drainage Study

A study of waterways in Southern Santa Rosa was initiated in 2000. The study tasks included researching existing information, developing existing and future hydrology and hydraulics based on City and County general plans, and providing recommended alternatives to alleviate predicted flooding. However, no stream gauge data or high water mark information was available at that time to calibrate the hydrologic and hydraulic computations. The severe winter storms of 2005/06 increased the City's concerns about drainage facilities in southern Santa Rosa. An expanded scope of work and more detailed hydrologic and hydraulic analyses are needed to address these concerns.

After the severe storm of December 30 and 31, 2006, City staff surveyed high water marks along Colgan Creek and Roseland Creek in southern Santa Rosa. Data for this storm from several rain gauges in the surrounding area are available. The Sonoma County Water Agency is preparing to install a stream gauge on Colgan Creek that will begin collecting data during the winter of 2006/07. This increased amount of data will allow calibration of drainage analyses for the southern Santa Rosa area. In addition to calibration to actual storm events, the expanded scope of work for the Southern Santa Rosa Drainage Study includes flood plain mapping for Roseland and Colgan Creeks. Zone 1A funding has recently been authorized for the expanded Southern Santa Rosa Drainage Study. The City is in the process of initiating this work.

CREEK DREAMS PUBLIC PARTICIPATION PROCESS

Over 250 people participated in five workshops and several creek walks conducted during the summer of 2003. Comments from many others added to the list of ideas for protecting and enhancing creeks in Santa Rosa. In October 2003, a citywide meeting was held to celebrate the success of the summer's public involvement efforts and to share highlights of the nearly 700 comments received over three months.

A summary of drainage-related comments is presented here.

General comments heard during most workshops

- Flooding is a concern in some areas.
- Maintain channel capacity for flood protection.

Watershed-specific comments

Roseland and Colgan Creeks

- One location on Roseland Creek was observed topping its bank in 1993.

Brush Creek

- Flooding concerns at numerous street crossings due to excessive vegetation in creeks.
- Need to manage runoff from future development to reduce flooding.
- Water table is too high. Increased vegetation maintenance will improve drainage.
- Reduce Sonoma County Water Agency vegetation maintenance.
- Protect natural creeks and restore degraded creeks by increasing creek setbacks and moving homes within the flood plain.
- The primary function of creeks should be habitat and not drainage. This goal (habitat) should get the priority over all the other goals.

Piner Creek

- Increase infiltration of storm water to reduce runoff.
- Increase infiltration to reduce discharges of storm water and enhance water quality.

Paulin Creek

- Poppy Creek north of Silva Drive near Beaver Street is thick with weeds and needs thinning to reduce flooding.
- Streets flood near Gay Street and Danbeck Avenue every year when leaves block a storm drain inlet.

Matanzas Creek

- In some areas the creek only comes up to a third of its capacity in big rainstorms.
- On one occasion, storm water came up near the top of bank between Yulupa Avenue and Bethards Drive.
- Spring Creek used to flow year round until it was diverted to Spring Lake. Restore the year round flow.

HYDROLOGY

Hydrology of flood control channels in the Santa Rosa area was studied in the various drainage analyses described above. Consistent with the Sonoma County Water Agency Flood Control Design Criteria, these studies estimated peak flow rates under envisioned ultimate development conditions. This analysis relies on the peak flow estimates of the original studies. Updated estimates of peak flow rates and calibration to additional rainfall and stream flow data are in process through the U.S. Army Corps of Engineers study on Santa Rosa Creek and the Southern Santa Rosa Drainage Study. When each of these studies is completed the drainage analyses conducted for the Citywide Creek Master Plan should be reviewed based on updated estimates of peak flow rates and other relevant information that may become available through these studies.

Stream gauges were installed by the U.S. Geological Survey (USGS) in 2002 on Brush Creek at Highway 12, Matanzas Creek at Brookwood Avenue, and Santa Rosa Creek at Pierson Street. These gauges were requested by the City of Santa Rosa and funded through Zone 1A to develop a continuous record of flow and water levels at key points in each watershed. Between 2002 and 2006, one of the gauges was calibrated each year. Starting in the 2006-07 rainy season, all three gauges are scheduled to be calibrated every year. These gauges supplemented an existing USGS gauge on Santa Rosa Creek at Willowside Road which is substantially downstream of the Santa Rosa urban area and is impacted by backwater from the Laguna de Santa Rosa. Flow and water level data have been more or less continuously collected since installation. An additional USGS stream gauge for the Santa Rosa area is scheduled for installation on Colgan Creek prior to the 2006-07 rainy season. Water level is recorded in feet above National Geodetic Vertical Datum 1929 (datum is 223 feet). Stream gauge data are available online from the USGS at <http://waterdata.usgs.gov/ca/nwis>. Stream gauge data will be used to calibrate the drainage studies in process.

The most recent period of flooding in the Santa Rosa area occurred during winter storms, December 17, 2005 through January 3, 2006. The Federal Emergency Management Agency issued a Disaster Declaration for these winter storms. The most severe single storm during this period occurred on December 30-31, 2006 and is commonly referred to as the New Year's Eve flood. Santa Rosa Creek at Pierson Street peaked at 140.35 feet elevation per the USGS stream gauge, a flow depth of 17.75 feet. This correlates to a peak flow rate of approximately 10,500 cubic feet per second (cfs) which was greater than a 25-year flood event based on the U.S. Army Corps of Engineers draft Hydrologic Engineering Office Report for the Santa Rosa Creek Ecosystem Restoration Feasibility Study. Matanzas Creek at Pierson Street peaked at a flow rate of approximately 3,700 cfs, also between a 25-year and 50-year flood event based on the draft U.S. Army Corps report. Colgan Creek between Corby Avenue and the railroad tracks near Hearn Avenue showed high water marks at top of bank with flow on the Sonoma County Water Agency service road in some areas. Local street flooding occurred throughout Santa Rosa and flooding of some garages occurred in the Spring Creek watershed. A discussion convened by the Sonoma County Water Agency of flooding that occurred throughout the Zone 1A area showed that flood conditions were more severe in the southern communities of Rohnert Park and Cotati than they were in Santa Rosa. Based on that discussion and without stream gauge data for streams in southern Santa Rosa, the rainfall intensity and recurrence interval for streams in this area was likely close to a 50-year flood event. High water marks from the New Year's

Eve flood on Colgan Creek and Roseland Creek were surveyed. These elevations are available as data points to calibrate future drainage analyses of these streams.

HYDRAULIC ASSESSMENT

A hydraulic assessment was conducted for those creek reaches where actions recommended in the Citywide Creek Master Plan have the potential to impact flood carrying capacity. Findings for each creek reach are described below. Detailed descriptions of the watershed and the existing conditions of these reaches are included in Chapter 4 of the Master Plan.

Many of the reaches included in the hydraulic analyses are existing Sonoma County Water Agency flood control channels. Vegetative growth and instream structure slows the flow of water through channels and impacts the flood carrying capacity. Most flood control channels in the Santa Rosa area were designed with the expectation that maintenance activities would limit vegetative growth within the flood-carrying portion of the channel to cut grass with no trees or shrubs on the banks and no vegetation in the channel bottom. This allowed for a smaller area of land to be used to convey the design flows in the flood control channels. In recent years, maintenance practices have been modified to retain some riparian vegetation to provide cover, shade, and cooler water temperatures for federally listed fish species. Per the Hydraulic Assessment of Flood Control Channels prepared for the Sonoma County Water Agency, the “post-maintenance” scenario is associated with the following vegetation maintenance practices:

- a) Top 2/3 of the channel bank is subject to only very limited thinning to prevent dense under-story of willows, blackberries and other shrubs. Existing trees are not removed, and the banks may become well vegetated.
- b) Bottom 1/3 of bank has no more than a couple years of growth, allowing only scattered small shrubs and young willows (less than 5 feet height).
- c) Channel bed is near original design condition, however some encroachment of vegetation from banks and aquatic vegetation, primarily tules and grasses, is initially establishing (up to 2 years growth).

This scenario represents the recent vegetation maintenance activities currently practiced by the Sonoma County Water Agency to maintain flood control channels.

Hydraulic analysis of various channel conditions requires a measure of impedance to flow, or roughness, created by vegetation and in-stream structure. The condition of the existing and proposed channels was represented by Manning’s roughness coefficient “n”. Channel characteristics that affect the value of “n” include surface roughness, vegetation, channel irregularity, channel alignment, size and shape of channel, obstructions, and depth of flow. Roughness coefficients may vary along a particular stream cross section, resulting in different “n” values for the banks than for the channel bed. Different “n” values may even be appropriate for the lower and upper bank of a particular cross section. For this analysis, “n” values were assigned to channel reaches based on previous or ongoing hydraulic analyses where available. Other “n” values were assigned to channel reaches based on field investigation, comparison to reaches previously analyzed, and consultation with reference materials. Field surveys were conducted by Sonoma County Water Agency staff and the project team to estimate the

channel roughness of each reach of creek where recommended actions have the potential to impact flood-carrying capacity. Most of these field surveys were conducted as part of the U.S. Army Corps Santa Rosa Creek project. Existing and proposed post-maintenance “n” values for the creek reaches analyzed are included in Table 2.

In reaches where conceptual plans have been developed, roughness values were estimated based on the channel configuration and vegetation envisioned in each concept plan. Although some maintenance of the restored channels would be provided, the concept plans generally envision a higher level of vegetation than would remain in the Sonoma County Water Agency post-maintenance condition. These roughness values are shown in Table 2 as the post-maintenance/restored condition.

In some reaches, an existing service road is proposed to be removed to create a greater flow area in the channel. This will allow more vegetation and instream structure to be added to the channel without decreasing its flood-carrying capacity. Removing one access road will also protect habitat. The recommended actions have been selected to maintain the existing flood-carrying capacity of these reaches.

I. Brush Creek - Montecito Boulevard to Austin Creek Confluence

This reach is a Sonoma County Water Agency trapezoidal flood control channel with some existing instream vegetation and service roads along both banks. Proposed natural resources enhancements include removal of any concrete along the channel bottom, creation of a low flow channel, installation of instream habitat structures and planting of native vegetation. The service road on the left bank would be removed to provide a larger flow area and to protect habitat. Hydraulic maintenance would continue to be provided by the Sonoma County Water Agency. Since post-maintenance roughness is less than estimated existing roughness, a hydraulic analysis was not conducted. The proposed improvements would not decrease the existing flood-carrying capacity of the channel.

II. Austin Creek – Middle Rincon Road to Tesoro Lane

This reach is a Sonoma County Water Agency trapezoidal flood control channel or dual parallel channels with some instream vegetation and a service road. Proposed natural resources enhancements include creation of a low flow channel, installation of instream habitat structures and planting of native vegetation. The two parallel channels through this reach would be combined to form a single channel. The service road would be eliminated in some areas to provide a larger flow area. Hydraulic maintenance would continue to be provided by the Sonoma County Water Agency. Since post-maintenance roughness is less than estimated existing roughness, a hydraulic analysis was not conducted. The proposed improvements would not decrease the existing flood-carrying capacity of the channel.

III. Ducker Creek through Rincon Valley Park

Ducker Creek enters Rincon Valley Park from the northeast through a 54 inch diameter storm drain pipe. The park reach consists of an upstream trapezoidal grouted rock channel, three ponds, and a downstream trapezoidal grouted rock channel. The entire reach has very little vegetation in the existing condition. Proposed natural resources enhancements include creation of meanders and a low flow channel, installation of

instream habitat structures and planting of native vegetation. The ponds and grouted rock channels would be replaced with a naturalized channel with greater roughness and a larger flow area. Hydraulic maintenance would be provided by the City of Santa Rosa. The post-maintenance roughness of the naturalized channel would be more than twice the roughness of the existing concrete ponds and grouted rock channel. Approximately double the existing flow area would be needed in the proposed naturalized channel to maintain the existing flood-carrying capacity of the drainage system. The enlarged flow area would be confined to City park property.

IV. Spring Creek - Summerfield Road to Mayette Avenue

This reach of Spring Creek flows through Caltrans right-of-way that was acquired for potential future extension of Highway 12. A portion of the storm flow is diverted underground through the Spring Creek Bypass conduit from Summerfield Road to downstream of Farmers Lane. The conduit is maintained by the Sonoma County Water Agency. The remaining flow is conveyed in a grass and blackberry lined channel from Summerfield Road to Mayette Avenue. Proposed natural resource enhancements include channel contouring, creation of meanders and planting of native vegetation. Hydraulic maintenance responsibility would be determined at the time that rights are obtained for implementation of the proposed enhancements. Since post-maintenance roughness is the same as the estimated existing roughness, a hydraulic analysis was not conducted. The proposed improvements would not decrease the existing flood-carrying capacity of the channel.

V. Lornadell Creek – Mesquite Park to Tachevah Drive

This reach of Lornadell Creek is a concrete trapezoidal channel bordered on one side by a City park and an elementary school. The areas of the school and park immediately adjacent to the channel do not contain structures. The land at top of bank on the other side of the channel consists of residential lots. In some areas, a minor amount of sediment has deposited on the concrete channel bottom and cattails are growing in the sediment. A detailed hydrology analysis of the watershed for this creek will be necessary before development of a habitat restoration plan. Natural resource enhancements could include removing the concrete lining on the left bank and bottom, contouring the channel and restoring meanders into the park and school sites, placing instream structures and planting native vegetation. The concrete lining on the right bank (along the residential lots) would remain. Hydraulic maintenance would continue to be provided by the Sonoma County Water Agency. The post-maintenance roughness of the enhanced portion of the channel would be approximately three times higher than the roughness of the existing concrete channel. A significant increase in flow area from contouring the channel is needed to maintain the existing flood-carrying capacity of the channel.

VI. Piner Creek – Marlow Road to Santa Rosa Creek

This reach of Piner Creek is a trapezoidal channel with some trees and other vegetation in the channel and service roads along both banks. Proposed natural resources enhancements include channel contouring, creation of a low flow channel, installation of instream habitat structures and planting of native vegetation. One service road would be eliminated as identified in Chapter 4 of the Master Plan to provide a larger flow area. Hydraulic maintenance would continue to be provided by the Sonoma County Water Agency. Since post-maintenance roughness is equal to or less than average estimated existing roughness, a hydraulic analysis was not conducted. The proposed improvements would not decrease the existing flood-carrying capacity of the channel.

VII. Peterson Creek – Guerneville Road to Santa Rosa Creek

This reach of Peterson Creek is a trapezoidal channel with service roads along both banks. Existing vegetation includes grass, some trees, and non-native vegetation. Proposed natural resources enhancements include channel contouring, removal of invasive plants and planting of native vegetation. One service road would be eliminated to provide a larger flow area. Hydraulic maintenance would continue to be provided by the Sonoma County Water Agency. Since post-maintenance roughness is less than estimated existing roughness, a hydraulic analysis was not conducted. The proposed improvements would not decrease the existing flood-carrying capacity of the channel.

VIII. Paulin Creek – West Steele Lane to Piner Creek

This reach of Paulin Creek is a grass and tree-lined trapezoidal channel with service roads along both banks. Proposed natural resources enhancements include channel contouring, installation of instream habitat structures and planting of native vegetation. The service road would be eliminated along the left bank from West Steele Lane to Piner Creek to provide a larger flow area. Hydraulic maintenance would continue to be provided by the Sonoma County Water Agency. Since post-maintenance roughness is less than estimated existing roughness, a hydraulic analysis was not conducted. The proposed improvements would not decrease the existing flood-carrying capacity of the channel.

IX. Poppy Creek through Franklin Park

This reach of Poppy Creek is a fairly narrow channel flowing along one edge of Franklin Park. The channel banks are reinforced with concrete in some places. Proposed natural resource enhancements include contouring the channel to meander somewhat into the park, removal of invasive plants and planting native trees along top of bank. Hydraulic maintenance would continue to be provided by the City of Santa Rosa. Since post-maintenance roughness is the same as estimated existing roughness, a hydraulic analysis was not conducted. The proposed improvements would not decrease the existing flood-carrying capacity of the channel.

X. Roseland Creek - Downstream of Burbank Avenue to Stony Point Road

This concept plan reach of Roseland Creek is characterized by a grass-lined flood control channel with some instream trees and shrubs and a service road along both

banks. Proposed natural resources enhancements include regrading and enlarging the channel to increase flood carrying capacity, creation of a low flow channel, installation of instream habitat structures and planting of native vegetation. The service road along the left bank would be eliminated to provide a larger flow area. Hydraulic maintenance would continue to be provided by the Sonoma County Water Agency. The proposed improvements would increase the flood carrying capacity of the channel.

XI. Roseland Creek – Fresno Avenue to Ludwig Avenue

This reach of Roseland Creek consists of a grass-lined flood control channel with service roads along both banks. Proposed natural resources enhancements include regrading the channel, creation of a low flow channel, installation of instream habitat structures and planting of native vegetation. The service road along the right bank would be removed to provide a larger flow area. Hydraulic maintenance would continue to be provided by the Sonoma County Water Agency. The proposed improvements would increase the flood carrying capacity of the channel.

XII. Colgan Creek - Petaluma Hill Road to Santa Rosa Marketplace

This concept plan reach of upper Colgan Creek consists of a flood control channel lined with grass and some instream vegetation and with a service road along the left bank. At the downstream end of the reach the creek becomes a concrete box culvert behind the Costco store in the Santa Rosa Marketplace shopping center. Proposed natural resource enhancements include channel contouring, creation of a low flow channel, removal of invasive plants and planting of native vegetation. This reach of Colgan Creek was designed and constructed to convey a 25 year flood event, consistent with Sonoma County Water Agency Flood Control Design Criteria. The conceptual design hydraulic analysis predicts that the channel would convey a 100 year flood event within the banks. Hydraulic maintenance would continue to be provided by the Sonoma County Water Agency. The proposed improvements would increase the flood carrying capacity of the channel.

XIII. Colgan Creek - Victoria Drive to Bellevue Avenue

This concept plan reach of lower Colgan Creek consists of a grass-lined flood control channel with stretches of concrete lining and grouted riprap, some instream trees and shrubs and service roads along both banks. There are grade control structures just downstream of Victoria Drive and at Elsie Allen High School upstream of Bellevue Avenue. This reach of Colgan Creek was designed and constructed to convey a 25 year flood event, consistent with Sonoma County Water Agency Flood Control Design Criteria. The conceptual design hydraulic analysis predicts that the channel would convey a 100 year flood event within the banks. Hydraulic maintenance would continue to be provided by the Sonoma County Water Agency. The proposed improvements would increase the flood carrying capacity of the channel.

XIV. Todd Creek – Robles Avenue to Scenic Avenue

This reach of Todd Creek is a trapezoidal channel with limited instream vegetation and service roads along both banks. Proposed natural resource enhancements include creation of a low flow channel, installation of instream habitat structures and planting of native vegetation. The service road along the right bank would be removed to provide a

larger flow area. Hydraulic maintenance would continue to be provided by the Sonoma County Water Agency. Post-maintenance roughness would be approximately 25% greater than estimated existing condition roughness. Removal of the service road and channel regrading would need to increase the flow area by approximately 25% to maintain the flood carrying capacity of the channel.

XV. Hunter Creek – Hunter Lane to Todd Creek

This reach of Hunter Creek is a trapezoidal channel with limited instream vegetation and service roads along both banks. Proposed natural resource enhancements include creation of a low flow channel, installation of instream habitat structures and planting of native vegetation. The service road along the right bank would be removed to provide a larger flow area. Hydraulic maintenance would continue to be provided by the Sonoma County Water Agency. Post-maintenance roughness would be approximately 25% greater than estimated existing condition roughness. Removal of the service road and channel regrading would need to increase the flow area by approximately 25% to maintain the flood carrying capacity of the channel.

XVI. Santa Rosa Creek – E Street to Santa Rosa Avenue

This reach is part of Reach C of the Santa Rosa Creek Master Plan. This reach of Santa Rosa Creek flows through a 1300 foot long twin box culvert under federal property and the City Hall buildings and grounds. At Santa Rosa Avenue, the box culvert containing Matanzas Creek and the box culvert containing Santa Rosa Creek together empty into the upstream end of the Prince Greenway as Santa Rosa Creek. The community is in the process of developing a vision for redevelopment of the City Hall site and some of the surrounding area. Options for daylighting Santa Rosa Creek will be considered as part of the visioning process. Hydraulic analysis of daylighting options is not part of the Master Plan.

XVII. Matanzas Creek- E Street to confluence with Santa Rosa Creek

Immediately downstream of “E” Street, Matanzas Creek is a grouted, riprapped channel. Downstream of “E” Street and upstream of Sonoma Avenue, Matanzas Creek is routed underground in a concrete box culvert to its confluence with Santa Rosa Creek. At Santa Rosa Avenue, the box culvert containing Matanzas Creek and the twin box culverts containing Santa Rosa Creek together empty into the upstream end of the Prince Greenway as Santa Rosa Creek. The community is in the process of developing a vision for redevelopment of the City Hall site and some of the surrounding area. Options for daylighting Matanzas Creek will be considered as part of the visioning process. Hydraulic analysis of daylighting options is not part of the Master Plan.

DISCUSSION AND RECOMMENDATIONS

General Discussion of Assessment Results

In creek reaches where recommended actions have potential drainage impacts, the current flood carrying capacity was assessed using available information and field surveys. In most reaches, the current flood carrying capacity is less than the design capacity due to growth of vegetation that has resulted in a channel roughness that is

higher than the design condition. In many reaches, estimated existing channel roughness was greater than estimated post-maintenance roughness that would result from implementation of the recommended actions. In those reaches it was determined that the recommended actions would not decrease the existing flood carrying capacity of the channel; detailed hydraulic analysis was not needed. In other reaches, the proposed condition roughness was greater than estimated existing roughness. In those reaches initial recommended actions were analyzed to determine impacts on flood carrying capacity that could result from implementation of these actions. Based on the results of this hydraulic assessment, the initial recommended actions were modified as needed to retain the current flood carrying capacity of these creek reaches. The result was a reach-by-reach description of recommended actions included Chapter 4 of the Master Plan that were selected to be self-mitigating with respect to flood conveyance. In some reaches the amount of channel recontouring and vegetation that could be recommended was less than would be optimal if the only habitat enhancement was considered. In other reaches there was sufficient right of way or available underdeveloped land for the creek flow area to be enlarged and thereby allow the recommended actions to include a greater amount of channel recontouring and instream vegetation than under existing conditions.

Stream maintenance is appropriate for the creek reaches included in the hydraulic assessment. Stream maintenance would be consistent with the practices currently used by the Sonoma County Water Agency and described above as the “post-maintenance” scenario, including selective thinning and limbing up of alder and willow trunks to promote additional canopy while retaining hydraulic capacity of the channel.

Recommendations for Future Study

Two major drainage studies in currently in process will provide a great deal of additional information about the creeks addressed in the Master Plan, specifically the Santa Rosa Creek Ecosystem Restoration and Flood Damage Reduction Feasibility Study and the Southern Santa Rosa Drainage Study. The drainage analyses conducted for the Master Plan should be updated based on information from these drainage studies when each is completed.

The hydraulic assessment was conducted based on a master plan level of hydraulic analysis. When designs are developed for implementation of recommended enhancements described in the Master Plan, a detail hydraulic analysis of each reach should be completed to identify allowable “roughness” values and to interpret those values in a Vegetation Planting and Monitoring Plan. The detailed hydraulic analyses should be based on the results of any drainage studies currently in process that are completed at that time.

Stream gauge information for streams throughout the Santa Rosa area and rainfall data for the watersheds should continue to be collected and analyzed to assess the validity of estimated peak flow rates and flooding risks.

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Table 1. Creek Reaches for Hydraulic Assessment

Reach	Creek	Limits	Existing Condition	Proposed Condition	Creek Master Plan Reach
I	Brush	Austin Creek Confluence to Montecito Boulevard	Channel with a service road on both banks. Some concrete on bottom. Blackberry and cattail growing in channel. Some shading from trees on bank.	Service road on left bank removed and flow area enlarged. Concrete along bottom removed, low flow channel created, instream habitat structures installed, native sedges and trees planted.	2
II	Austin	Calistoga Road to Brush Creek	Channel with two channels parallel in some locations. Cattails, blackberries, and some natives growing in channel.	Dual channels united, service road stub removed, low-flow channel created, some instream habitat structures installed, invasive plants removed and replaced with native plantings.	2
III	Ducker	Through Rincon Valley Park	Grouted rock channel with portions in concrete lined flow-through ponds. Minor weedy vegetation growing in channel.	Meanders and low flow channel created, instream habitat structures installed, sedges and other native vegetation planted, additional trees planted for shade.	2
IV	Spring	Summerfield Road to Mayette Avenue (through Caltrans Right of Way)	Grass lined channel with some blackberry growing along banks.	Channel contoured to create meanders. Native sedges and trees planted.	1
V	Lornadell	Mesquite Park to Tachevah Drive	Rectangular concrete lined channel.	Channel contoured next to park and Manzanita School. Concrete removed on bottom and left bank, meanders restored, instream habitat structures installed, native sedges planted in channel, trees planted on bank for shade.	1
VI	Piner	Marlow Road to Santa Rosa Creek	Channel with cattails and some trees growing in channel. Service road on both sides.	One service road removed, channel contoured to create meanders and low flow channel, instream habitat structures installed, native sedges and trees planted.	3
VII	Peterson	Youth Community Park to Santa Rosa Creek	Channel with service road on one bank, mainly grass lined with some trees on bank, lots of invasive plants. Adjacent open land in some areas.	Channel contoured, one service road removed below Guerneville Road. Invasive plants removed. Native sedges and trees planted in channel.	1
VIII	Paulin	West Steele Lane to Piner Creek	Grass and tree-lined channel with service road on both banks.	Channel contoured, service road removed along left bank, instream habitat structures installed, native sedges and trees planted.	5
IX	Poppy	Wright Avenue to Paulin Creek	Narrow channel with blackberry and weedy vegetation.	Invasive plants removed, channel contoured to meander somewhat into Franklin Park, native trees planted.	2

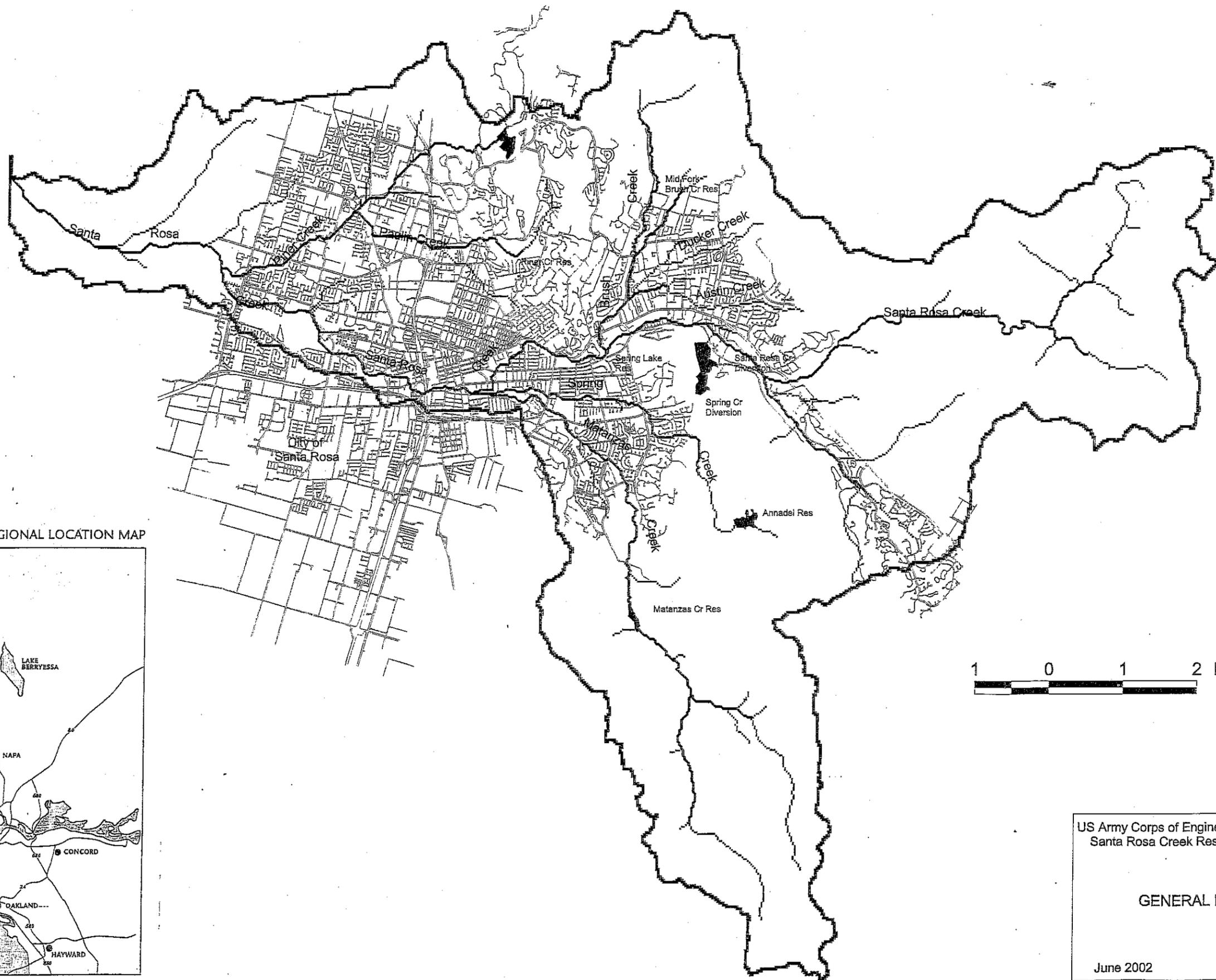
Table 1. Creek Reaches for Hydraulic Assessment

Reach	Creek	Limits	Existing Condition	Proposed Condition	Creek Master Plan Reach
X	Roseland	100 feet downstream of Burbank Avenue to Stony Point Road	Channel with herbaceous vegetation, a few shrubs and some blackberry. Remnant service road on both sides of channel.	<i>Roseland Creek Restoration Project:</i> Service road along left bank removed, channel regraded, low-flow channel created, instream habitat structures installed, native sedges and trees planted.	3
XI	Roseland	Stony Point Road to Ludwig Avenue	Channel with herbaceous vegetation, a few shrubs and some blackberry in channel. Remnant service road on both sides of channel.	Service road removed along right bank between Fresno and Ludwig, channel regraded throughout reach, low-flow channel created, instream habitat structures installed, native sedges and trees planted.	4
XII	Colgan	Petaluma Hill Road to Culvert at Costco	Grass-lined channel with service road on left bank. Blackberry and grasses growing in channel along with some trees.	<i>Upper Colgan Creek Restoration Project:</i> Low flow channel created, invasive plants removed and replaced with native sedges and trees.	2
XIII	Colgan	Victoria Drive to Bellevue Avenue	Grass lined channel with blackberry and some trees along top of bank. Service roads on both sides of channel.	<i>Lower Colgan Creek Restoration Project:</i> Service road removed along left bank, channel recontoured to create low flow channel and more meanders, instream habitat structures installed, blackberry removed, native sedges and trees planted.	4
XIV	Todd	Robles Avenue to Santa Rosa Avenue	Channel with cattails and non-native blackberry growing in channel.	Service road removed on right bank, low flow channel created, instream habitat structures installed, native sedges and trees planted.	1
XV	Hunter	Hunter Lane to Todd Creek	Channel with cattails and non-native blackberry.	Service road removed on right bank, low flow channel created, instream habitat structures installed, native sedges and trees planted.	1
XVI	Santa Rosa	E Street to Santa Rosa Avenue	Concrete dual box culvert	Creek potentially daylighted as government center redevelops. One alternative is to keep culvert active as a bypass.	4
XVII	Matanzas	E Street to Santa Rosa Creek	Concrete box culvert under Sonoma Avenue	Creek potentially daylighted as government center redevelops. Fish passage provided to upstream reaches.	4

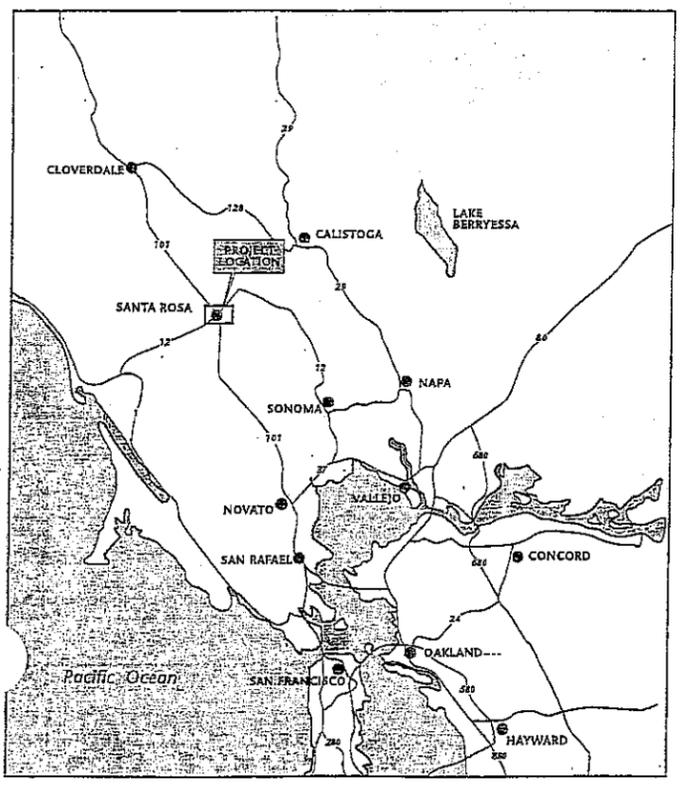
Table 2. Roughness ("n") Values					
		Left		Right	
Reach	Creek and Maintenance Scenario	Channel	Bed	Channel	Detailed
		Bank		Bank	Analysis
I	<i>Brush Creek - Montecito Boulevard to Austin Creek</i>				no
	Existing	0.055	0.055	0.055	
	Post-maintenance	0.045	0.04	0.045	
II	<i>Austin Creek - Middle Rincon Road to Tesero Lane</i>				no
	Existing	0.045	0.045	0.045	
	Post-maintenance	0.045	0.04	0.045	
III	<i>Ducker Creek through Rincon Valley Park</i>				no
	Existing	0.015-0.025	0.015-0.025	0.015-0.025	
	Post-maintenance	0.045	0.04	0.045	
IV	<i>Spring Creek - Summerfield Road to Mayette Avenue</i>				no
	Existing	0.045	0.04	0.045	
	Post-maintenance	0.045	0.04	0.045	
V	<i>Lornadell Creek - Mesquite Park to Tachevah Drive</i>				yes
	Existing	0.015	0.015	0.015	
	Post-maintenance	0.045	0.04	0.015	
VI	<i>Piner Creek - Marlow Road to Santa Rosa Creek</i>				no
	Existing	0.042-0.055	0.042-0.055	0.042-0.055	
	Post-maintenance	0.045	0.04	0.045	
VII	<i>Peterson Creek - Guerneville Road to Santa Rosa Creek</i>				no
	Existing	0.045-0.050	0.045-0.050	0.045-0.050	
	Post-maintenance	0.045	0.04	0.045	
VIII	<i>Paulin Creek - West Steele Lane to Piner Creek</i>				no
	Existing	0.048-0.055	0.048-0.055	0.048-0.055	
	Post-maintenance	0.045	0.04	0.045	

Table 2. Roughness ("n") Values					
		Left		Right	
Reach	Creek and Maintenance Scenario	Channel	Bed	Channel	Detailed
		Bank		Bank	Analysis
IX	<i>Poppy Creek through Franklin Park</i>				no
	Existing	0.045	0.04	0.045	
	Post-maintenance	0.045	0.04	0.045	
X	<i>Roseland Creek - Burbank Avenue to Stony Point Road</i>				yes
	Existing	0.045	0.045	0.045	
	Post-maintenance/restored	0.07	0.045	0.07	
XI	<i>Roseland Creek - Stony Point Road to Ludwig Avenue</i>				no
	Existing	0.045	0.045	0.045	
	Post-maintenance/restored	0.07	0.045	0.07	
XII	<i>Colgan Creek - Petaluma Hill Road to Santa Rosa Marketplace</i>				yes
	Existing	0.035	0.035	0.035	
	Post-maintenance/restored	0.05	0.05	0.05	
XIII	<i>Colgan Creek - Victoria Drive to Bellevue Avenue</i>				yes
	Existing	0.035	0.035	0.035	
	Post-maintenance/restored	0.06	0.035	0.06	
XIV	<i>Todd Creek - Robles Avenue to Scenic Avenue</i>				?
	Existing	0.035	0.035	0.035	
	Post-maintenance	0.045	0.04	0.045	
XV	<i>Hunter Creek - Hunter Lane to Todd Creek</i>				?
	Existing	0.035	0.035	0.035	
	Post-maintenance	0.045	0.04	0.045	

Figure 1. Area for Santa Rosa Creek Feasibility Study



REGIONAL LOCATION MAP

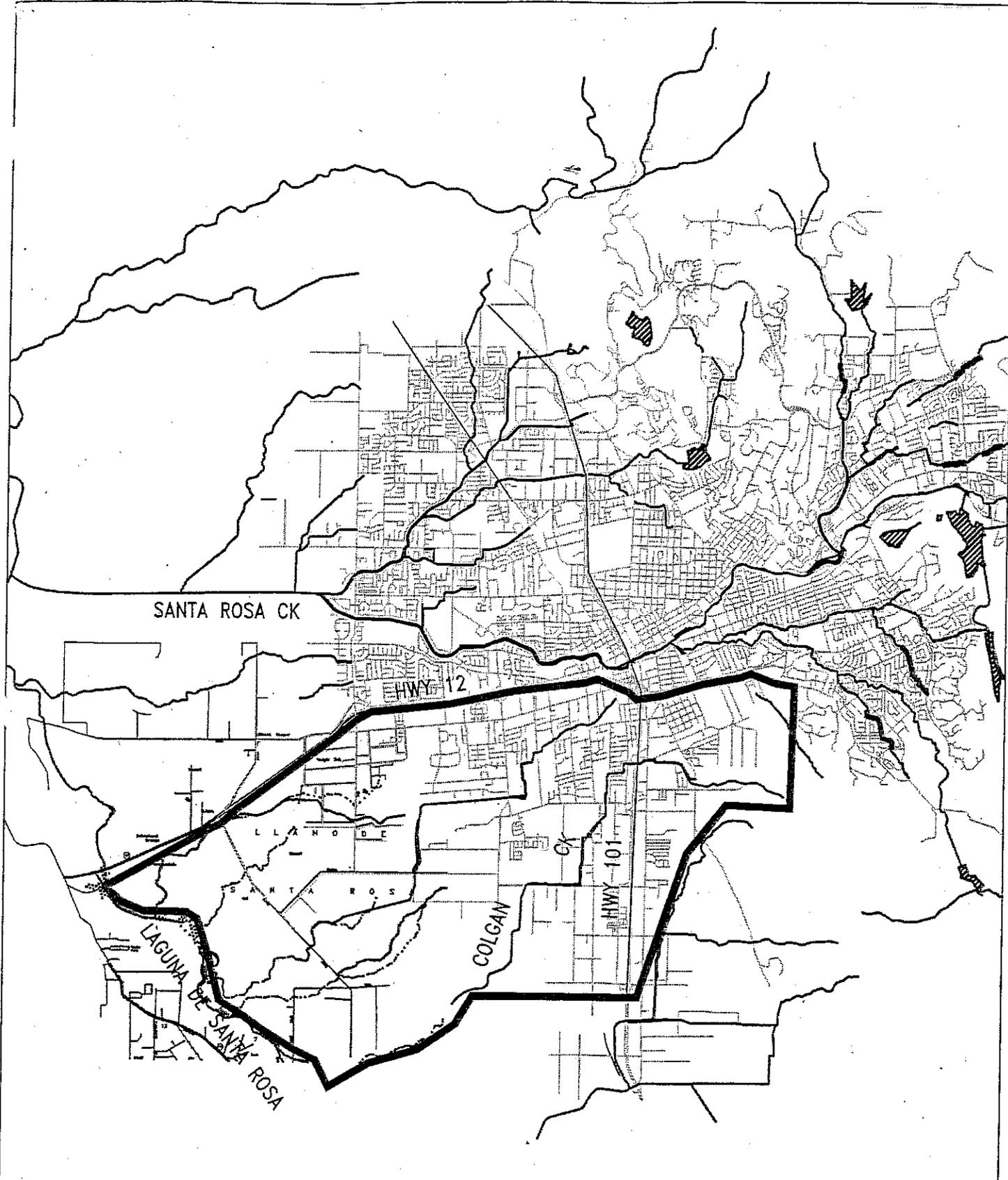


US Army Corps of Engineers, San Francisco District
 Santa Rosa Creek Restoration Feasibility Study

GENERAL BASIN MAP

June 2002 Figure 1

Figure 2. Area for Southern Santa Rosa Drainage Study



SANTA ROSA CK

HWY 12

LAGUNA DE SANTA ROSA

COLGAN CK

HWY 101

SOUTH SANTA ROSA AREA
DRAINAGE STUDY