City of Yucaipa

Flood Plan Annex

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DRAFT

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City of Yucaipa
34272 Yucaipa Boulevard
Yucaipa, CA 92399
yucaipa.org

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SECTION 1 - Introduction

1.1 Purpose of the Plan

The purpose of this plan is to identify the City of Yucaipa's floodplain hazards, calculate the effects of human activities on Yucaipa's floodplain, and develop program and project opportunities and solutions that will mitigate the short- and long-term risks associated with the City of Yucaipa's floodplain. Another significant aspect of the Plan is to describe the floodplain ecosystems associated with the City of Yucaipa's beneficial floodplains and how mitigation programs and projects can enhance the social, economic and physical benefits of our local environment.

1.2 Authority

This plan fulfills the requirements of the following programs:

1. Pre-Disaster Mitigation (PDM – CFDA 97-047)
2. National Flood Insurance Programs (NFIP)
3. Hazard Mitigation Grant Program (HMGP – CFDA 97-039)
4. Flood Mitigation Assistance Grant Program (FMA – CFDA 97.029)

1.3 Community Profile

1.3.1 Physical Setting

Yucaipa is located in the eastern portion of the San Bernardino Valley area, at the foot of the San Bernardino Mountains, between the cities of Redlands and Calimesa. The City is bounded on the northwest by the Crafton Hills, on the south by the City of Calimesa, and on the north and east by mountainous terrain.

The topography of the City begins at an approximate elevation of 2,000 feet at the west end, adjacent to the point at which the 10 freeway enters Yucaipa from the west. Elevations increase in the northeast and eastern portions of the City to approximately 4,000+ feet, which represents an elevation change of 2,000 feet.

Within the potential Sphere of Influence, elevations may range as high as 5,000 feet. The heart of the City's elevation is between 2,000 and 3,000 feet. Much of the area on the northwest portion of the City above 2,400 feet has been designated by the City as an open space preserve.

The City exists in a valley. The Yucaipa Valley is located within the Upper Santa Ana River Valley in the extreme eastern portion of the San Bernardino Valley. "Yukaipa't," the Indian name from which Yucaipa was derived, means a village around a marshy area. This area was formed from Wilson Creek, which bisects the City along a northeast to southwesterly direction. Another major creek bisects the City from east to west in the southern part of the City and is known as Wildwood Creek. Through erosion, each of these major tributaries have created definite elevation changes adjacent to these creeks and are sometimes referred to as "benches". These "bench" areas give a definite

character to the City, and the entire northern section of Yucaipa is referred to as the "North Bench".

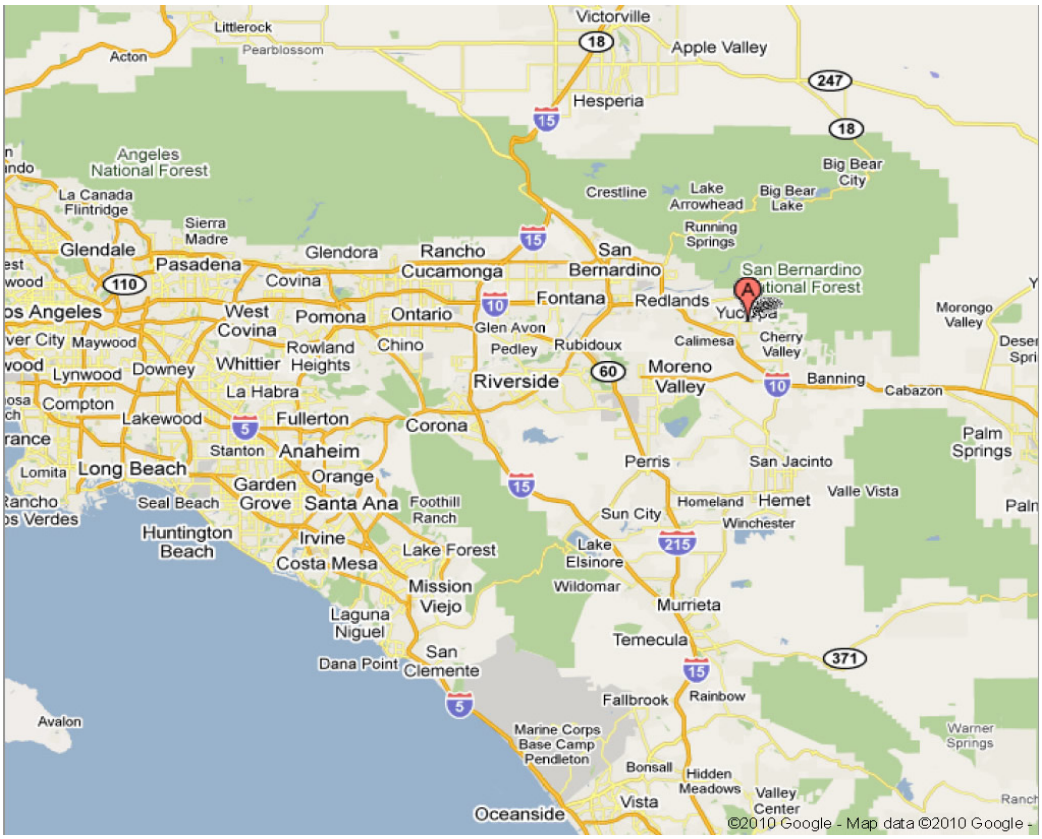


Figure 1: Regional Map (Credit: 2010 Google Map data)

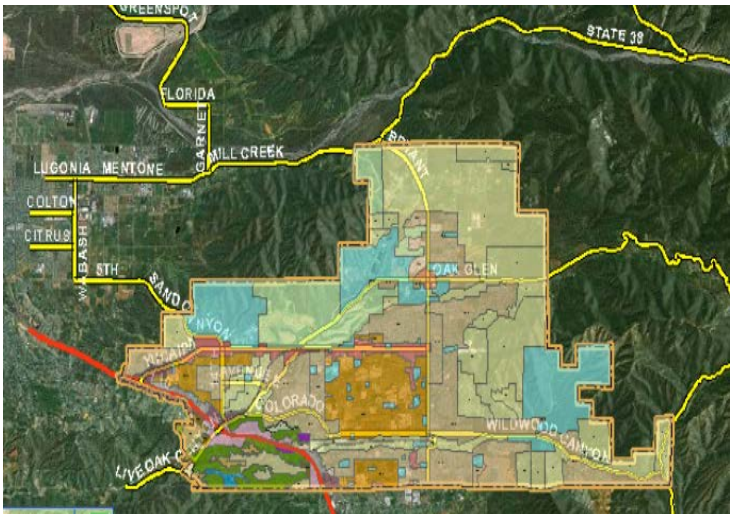


Figure 2: City Map

The flatland portions of the City are gently sloping from the west to the east to the higher elevations toward Oak Glen. These flatter areas contain the "North Bench" area to the north, Dunlap Acres to the west and the Central Core area, which is bisected by Wildwood Creek. This creek leads to the southeast, whose canyon and adjacent hills form another distinctive area of Yucaipa known as "Wildwood Canyon".

The confluence of the two major creeks through Yucaipa create the Live Oak Canyon area, which is in the southwest portion of the City. Scenic resources within the City have been formed by both natural and man-made elements. Those natural resources include the surrounding hills and mountains and the two major creek areas which transverse the

City and create major "bench areas". The gently sloping flatlands also contribute to the scenic quality of the City, providing view orientation over a great area of the City along roadways and in developed areas for an array of scenic vistas and a unique visual orientation to the City.

Another scenic aspect of the area is its vegetation, specifically the concentration of oak woodlands along Wildwood Canyon. The grasslands, coastal sage scrub and other areas of vegetation within the northern portion of the City add to its scenic character. The introduced vegetation, which includes many mature trees, within the developed portion of the City is another of the City's important scenic resources. Other distinctive areas of introduced vegetation include Yucaipa Valley Golf Course along the foothills of the Crafton Hills, the Yucaipa Regional Park, and the local parks within the City.

Temperatures in the Valley range from an average high of 80ºF and an average low of 53ºF. The record high for the area is 117ºF and the record low is 17ºF. The annual average rainfall for the area is 15.6 inches. The climate is characterized by hot dry summers when temperatures can rise above 100º, and moderate winters, with rare freezing temperatures. A major portion of the precipitation occurs between December and March. Snow in the upper reaches of the area is possible, but is not considered an important contributing factor to runoff.

The Yucaipa watershed encompasses approximately 40 square miles and is generally defined as the area that drains Wilson Creek and Wildwood Creek to Live Oak Canyon. The topography of the area is one of steep hills and broad, steeply sloping valleys. Elevations range from about 8,700 feet in the upper reaches of the watershed to about 1,900 feet at the lower end of the watershed. Wilson Creek divides into three main tributaries, with Gateway Wash as the north fork, Oak Glen Creek the south fork, and Wilson Creek located between the two. The central area of Yucaipa is divided into two main drainage systems, which are the area drained by Chicken Springs Wash (a tributary of Wilson Creek), and the area drained by Yucaipa Creek, which is tributary to Wildwood Creek. Wildwood Creek flows westerly through the southern portion of the watershed and joins Wilson Creek at the City limits. The watershed also includes several additional areas. They are an area tributary to Mill Creek, a large natural area in the easterly portion which is tributary to Little San Gorgonio Creek, a relatively small area adjacent to the southerly limits (tributary to the County Line Channel) whose flows go southwesterly into Riverside County, a relatively small area in the easterly limits along the San Bernardino Freeway (I-10) (and drains into the City of Redlands), and a relatively small area in the northeasterly portion which is tributary to the unincorporated area of Crafton.

1.3.2 History

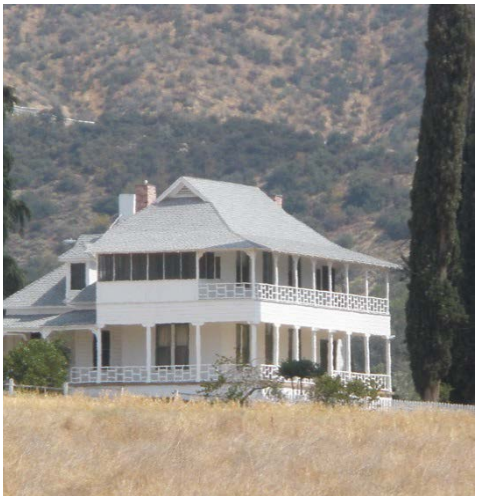
Where it all Began

The community that became Yucaipa grew out of the natural landscape. Rivers flowing southwest from the San Bernardino mountains deposited minerals downstream over thousands of years, creating a fertile environment for inhabitants of the valley. The Yuhaviatam, referred to as Serrano Indians by later explorers, were the first inhabitants of the Yucaipa Valley. Later missionaries, homesteaders, and pioneers would be drawn by the grassy plains, creeks, shaded canyons, and rich grassy lands of the Yucaipa Valley. Under the name Yucaipa Ranchería, the Yukaipat site is presently designated California Historical Landmark No. 620.

Agriculture Takes Root

Fed by downstream wash from the mountains, Yucaipa's fertile valley and climate were well suited for agriculture, its first industry. During the 1800s, the Yucaipa Valley was used as grazing land for a satellite property of San Gabriel Mission's Rancho San Bernardino. For the next 100 years, the Yucaipa Valley became known for its agriculture and ranching enterprises. Yucaipa lands were transferred from the missions to Antonio Maria Lugo in 1842, and later to Diego Sepulveda. Sepulveda built the Rancho Yucaipa, which stands today as California Historical Landmark 528. Vestiges of this ranching history are still visible around the area.

Early California Settlements



Casa Blanca was the home of John Dunlap, 1

Shortly following California statehood in 1850, settlers began to migrate to the Yucaipa Valley. John Dunlap settled on the Sepulveda Ranch, which became known as "Dunlap Acres." In 1869, Dunlap expanded agricultural operations to include grain. The Dunlaps also built Casa Blanca in 1882 and the first school on Cherrycroft Drive, now restored under private ownership. Ranches were also established in Wildwood Canyon, the North Bench area, and Live Oak Canyon. The only other early industry in the Yucaipa Valley to generate as much excitement was gold mining, which had a short-lived success due to mining in the Crafton Hills.

"Where the Big Red Apple Grows"

U-KI-PA (Yucaipa) brand apples, patent 1

The early 1900s saw changes in Yucaipa Valley's agriculture, from large-scale ranching to apple orchards. From 1900 to 1910, the Redlands-Yucaipa Land Company bought 11,000 acres in Yucaipa, and soon thereafter, developers began to sell ranches to make way for a burgeoning apple industry. For several decades, apple production became a staple for the local economy, and the goal was to create the "apple kingdom" of the Southwest. As people migrated to Yucaipa in search of wealth, a town center began to form at the corner of Yucaipa Boulevard and California Street.

Surviving the Great Depression

The Great Depression brought significant change to Yucaipa Valley's agricultural industry. Lower prices in the apple markets caused growers to shift production to peaches, citrus, walnuts, grain, and other fruit. Unemployment was the defining sign of that time. In those difficult conditions, Yucaipans lived off the land and supported one another through the Yucaipa Cooperative Exchange. One of Yucaipa's most notable successes dates back to the 1930s, when Leo and Cleo Stater founded Stater Brothers in Yucaipa.

World War II and Transition

The 1940s marked another significant turning point in Yucaipa. Yucaipans were actively involved in the worldwide war effort. From sending soldiers abroad to running top-secret projects, Yucaipa residents lent their time and experience to the war effort. During this time, Yucaipa became known as "The Egg Basket of Southern California" for its poultry operations. Peach production replaced the apple industry, which gradually moved to Oak Glen. A landing strip was also established in the area known now as Chapman Heights, and a volunteer fire department was established.

Yucaipans Settle Down

By the 1950s, Yucaipans had survived the Depression and the war, and now settled down to focus on family and community. The 1950s and 1960s were boom years, with ranches giving way to housing for residents. Yucaipa saw arrival of a hospital and sheriff's station. The first mobile-home park was built in 1947, and many other parks followed. In 1963, the Yucaipa Joint Unified School District was established after more than a decade of discussions. Devastating floods during the 1960s also led to drainage infrastructure projects to guard against future flooding.

Present Day Yucaipa

Yucaipa's recent history is denoted by its transition to cityhood. The 1970s brought Crafton Hills College, one of only 113 in California. The 1980s and 1990s saw the redevelopment of citrus groves into the Chapman Heights planned development. During the 1980s, the Yucaipa Valley Water District opened a modern wastewater treatment plant and built water systems to serve the community. This period also brought the County Regional Park. After many attempts at cityhood, Yucaipa voters passed Measure K and became an incorporated city on November 27, 1989.

Since incorporation, the City of Yucaipa has continued to preserve the community's character and maintain a careful balance between the needs of business, residents, and the environment. The City adopted a new plan for the freeway corridor that will support Yucaipa's local economy. Civic leaders, residents, and stakeholders have preserved Crafton Hills and Wildwood Canyon State Park. Capital improvements have improved water, sanitation, roads, and other infrastructure. Revitalization efforts have also strengthened the Uptown as a central gathering place for the community.

1.3.3 General Population

(Source: 2014-2021 City of Yucaipa Housing Element)

Today, the City of Yucaipa is the 16th most populous city in San Bernardino County, with a population of 51,376 as of the 2010 Census. In recent decades, San Bernardino County has been one of the fastest growing counties in the region. Between 1990 and 2000, the City's population increased 25% as new single-family housing tracts, like Chapman Heights and other developments, were built. This rate of growth continued in the early 2000s, fueled by a regional housing construction boom that peaked in 2006.

Development has significantly slowed in the last few years, largely in part due to the national recession and downturn of the housing market. The recession is expected to have a slowing effect on growth over the next few years. Yucaipa is projected to grow in population by 9% between 2010 and 2020. Buildout of the community is anticipated to be about 75,000 residents.

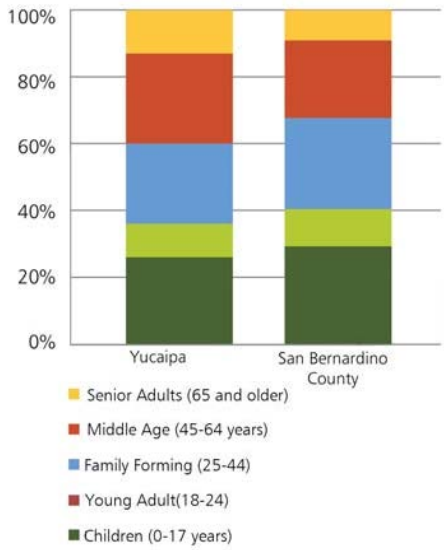


Figure 3 Age Characteristics

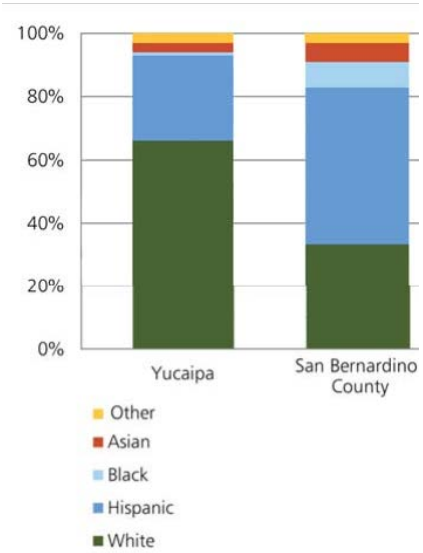


Figure 4: Race & Ethnicity

1.3.4 Age Characteristics

(Source: 2014-2021 City of Yucaipa Housing Element)

Yucaipa's population characteristics have a key influence on housing need. One of these characteristics is the age of the population. Some differences in housing preferences are affected by wealth and income, while others are affected by household type and age. Both household formation and housing choice are linked to life cycle events such as leaving home, getting married, having children, changing jobs, retirement, and death of spouse. These break points define increasingly lengthy stays in the same housing unit.

Different age groups have different housing needs based on lifestyles, family types, income levels, and housing preference. Typically, younger households seek affordable rental housing opportunities as they begin their careers. As adults spend more time in the workforce and form families they may seek larger homes and opportunities to build equity through home ownership. Seniors may eventually choose to trade down larger homes that once accommodated children to smaller and more affordable homes.

Yucaipa has an older population than San Bernardino County as a whole (Figure 3), with a higher percentage of middle age and senior adults. Figure 5 show changes in the age of Yucaipa residents from 2000 to 2010. Over the past decade, the largest increase in Yucaipa residents was among middle- aged adults, ages 45-64 years, who are presumably attracted to Yucaipa's single-family detached housing with large homes and yards. Seniors did not increase much in number, and actually declined as a share of residents. However, seniors still comprise a much larger share of Yucaipa's population than seniors living in San Bernardino County as a whole.

Age Groups	2000		2010	
	Number of Residents	Percent of Total	Number of Residents	Percent of Total
0-17 years (dependent)	11,762	29%	13,444	26%
18-24 years (household forming)	3,134	8%	4,489	10%
25-44 years (family forming years)	11,213	27%	12,536	24%
45-64 years (move up housing)	8,723	21%	14,064	27%
65+ years (retirement years)	6,375	15%	6,834	13%
Total	41,207	100%	51,376	100%

Figure 5: Age Characteristics in Yucaipa
Source: U.S. Census, 2000 and 2010. Note: May not total to 100% due to rounding.

For decades, the southern California region has become more diverse. Countywide, Hispanics are the largest group, with 49% the total population, followed by Whites at 33%. Following are African Americans at 9% of the population and Asians at 7%. These demographic trends are evident to a lesser degree in Yucaipa. In Yucaipa, Whites have declined from 77% in 2000 to 66% by 2010, while Hispanics have increased in share to 27%. There has also been a marked increase in Asian/Pacific Islander residents.

1.3.5 Household Characteristics

(Source: 2014-2021 City of Yucaipa Housing Element)

Household type also influences housing need. For instance, single-person households often occupy smaller apartments or condominiums, such as one- bedroom units. Couples often prefer larger single-family homes, particularly if they have children. As the baby boom generation continues to age, there has been an increased demand from empty nesters and retirees to downsize to more affordable units that are easier to maintain. These patterns underscore the need for housing opportunities for people of all ages and income.

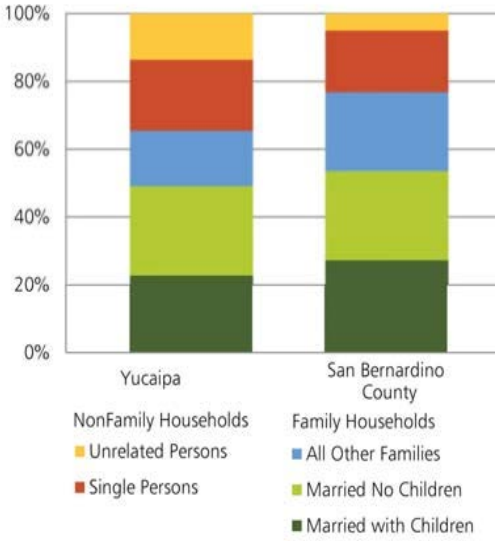


Figure 6: Household Composition in Yucaipa

Figure 6 compares the household composition of San Bernardino County and Yucaipa residents. In 2010, married family households with children comprised 25% of Yucaipa's households, lower than in San Bernardino County. Yucaipa also has a larger share of seniors. As a result, Yucaipa has a smaller average household size (2.8 versus 3.3) than San Bernardino County.

As shown in Figure 7, several key trends occurred in Yucaipa since 2000. Over the decade, 80% of household growth was attributable to families that moved to Yucaipa. All other households groups also increased in number, but collectively contributed to only 20% of the City's entire growth in households.

Household Type	2000		2010	
	Number of Households	Percent of Total	Number of Households	Percent of Total
Total Households	15,193	100%	18,231	100%
Family Households				
+ Married with Children	3,924	26%	4,469	25%
+ Married No Children	4,300	28%	5,373	29%
+ All Other Families	2,455	16%	3,257	18%
Nonfamily Households				
+ Single Persons	3,838	25%	4,198	23%
+ Unrelated Persons	676	4%	934	5%
Average household size	2.7		2.8	

Figure 7: Household Types Source: U.S. Census, 2000 and 2010.

1.3.6 Vulnerable Populations

(Source: 2008 City of Yucaipa Housing Element)

- **Disabilities** - In 2000, approximately 3,239 people between 16 and 64 years of age, or about 13% of the working age population, reported an employment disability. Of those aged 65 and over, 1,874 people (about 30%) reported some form of physical disability. Reported disabilities included persons whose disability hinders their ability to go outside the home (6.5% of the working age population and 22.5% of the senior population).
- **Elderly** - In 2000, there were 4,271 households in Yucaipa where the householder was 65 or older. Of these, 429 persons were below the poverty level in 1999. Many elderly persons are dependent on fixed incomes and a high percentage are disabled. Elderly homeowners may be physically unable to maintain their homes or cope with living alone. The housing needs of this group can be partially addressed through smaller units, second units on lots with existing homes, shared living arrangements, congregate housing and housing assistance programs.
- **Homeless** - Yucaipa is fortunate as studies and surveys by government agencies and homeless advocacy groups have shown that homelessness is not pervasive in the community. A homeless count conducted by San Bernardino County in 2007 indicated that on any given day there are approximately 135 homeless persons in Yucaipa, which represents less than 1% of the City's population, and approximately 2% of the County's total homeless population. These include families that might be displaced through evictions, women and children displaced through abusive family life, or persons with substance abuse problems. Of the 7,331 homeless people identified in the 2007 San Bernardino County Homeless Census and Survey (a point-in-time count), 17% were in shelter facilities and 83% were considered unsheltered. A jurisdictional breakdown of the homeless census data showed that all of Yucaipa's homeless were unsheltered at the time of the survey.
    - **Families with Children** - According to the National Coalition for the Homeless (NCH), families with children are one of the fastest-growing segments of the homeless population. The NCH reports that a survey conducted in 2000 found families with children accounted for 36% of the homeless population. Poverty and the lack of affordable housing are listed as the principal causes for homelessness among families. Additional factors include a relative decline in wages and changes in welfare programs approved in the late 1990s. The San Bernardino County's 2007 homeless survey indicated that approximately 20% of the respondents lived with other homeless family or friends. However, the data provided was not sufficient to draw any conclusions about the families with children homeless population in Yucaipa.
    - **Chronically Homeless** -A chronically homeless person is defined as an unaccompanied homeless individual with a disabling condition who has either been continuously homeless for a year or more, or has had at least four episodes of homelessness in the past three years. In recent years, HUD has placed significant importance on chronic homelessness by establishing a goal to end chronic homelessness by the year 2012. The U.S. Interagency Council on Homelessness estimates that 10% of the homeless population is chronically homeless. The San

Bernardino County's 2007 homeless survey indicated that approximately 38.3% of the County's homeless (2,808 individuals) can be considered chronic homeless. Using the regional survey percentage it is estimated that up to 52 of the City's homeless population may be chronically homeless.

- **Mentally Ill** - Mental illness is often defined as a disorder that prevents an individual from carrying out essential aspects of daily life such as self-care, household management, and interpersonal relationships. Severe mental illness is defined as persistent (i.e., more than one year) mental/emotional impairment that substantially interferes with or limits one or more major life activities including: basic daily living skills (eating, bathing, dressing), living skills (maintaining a household, managing money, taking prescribed medication), and functioning in a social, family, vocational and/or educational context. According to the NCH, 20 to 25% of the single adult homeless population suffers from some form of severe mental illness. NCH reports that the mentally ill remain homeless for longer periods and have less contact with family and friends. They also encounter more barriers to employment, tend to be in poorer physical health, and have more contact with the legal system than homeless people who do not suffer from mental illness. As reported in the 2005-2010 Consolidated Plan for San Bernardino County, homeless persons afflicted with mental illness most likely comprise the largest homeless subpopulation with special housing needs. San Bernardino County's 2007 homeless survey indicated that 26.3% of the respondents were experiencing mental illness. This figure represents 3,950 individuals countywide. Once again, using the regional survey percentage it is estimated that up to 35 of the City's homeless may be mentally ill.
- **Alcohol and Substance Addicted** - Alcohol and substance addicted is defined as an individual with serious and persistent alcohol or substance addiction that significantly limits his/her ability to live independently. Homeless surveys conducted in the 1980s found consistently high rates of addiction, particularly among single men; however, according to the NCH, more recent studies have questioned the high prevalence rates cited by these studies, arguing early studies over-represented long-term shelter users and single men. While there is no generally accepted "magic number," the NCH concedes that a 30% prevalence rate is more or less within reason. The San Bernardino County's 2007 homeless survey reported that 45.1% of the homeless population surveyed was experiencing substance abuse and 23.5% of the survey respondents indicated alcohol or drug use as the primary reason for their homelessness. This data confirms the contributory role played by alcohol and substance as a cause of homelessness, but is insufficient to draw firm conclusions about the numbers of addicted homeless persons in the County or City.
- **Dually Diagnosed** - Dually diagnosed is defined as an individual that suffers both severe mental illness and substance abuse problems. According to the U.S. Department of Health and Human Services (HHS), adults with a substance use disorder are almost three times as likely to have serious mental illness. HHS also estimates that 50% of homeless adults with mental illness also have a substance use problem. The San Bernardino County's 2007 homeless survey did not include a specific analysis of dually diagnosed homeless.

- **Victim of Domestic Violence** - According to the NCH, when a woman leaves an abusive relationship, she often has nowhere to go. The lack of affordable housing and long waiting lists for assisted housing often mean that women must choose between abuse at home or the street. Recent studies estimate that 22% to 46% of homeless women are victims of domestic violence. According to the 2007 San Bernardino homeless survey, the number of homeless persons affected by domestic violence was estimated to be 670 persons countywide. In the 2005-2010 Consolidated Plan for San Bernardino County, a Homeless Coalition Survey found that 293 persons were homeless because of domestic violence. According to the Arrowhead United Way study, there were an estimated 13,400 cases of domestic violence; approximately 16% of all married women in the county are physically abused at some time during their marriage. Several agencies provide domestic violence services to County of San Bernardino residents. Providers of crisis intervention, rape treatment, counseling, temporary shelter services and other domestic shelter providers have seen a dramatic increase in the number of clients who have suffered from domestic violence. These individuals require a variety of services, including child care, counseling, job training and shelter. Option House provides shelter and support services to victims of domestic violence and their children. The Option House facility, located in the City of San Bernardino, has an average capacity of 30 persons (approximately nine women and their children). The average stay is 45 days with extended stays allowed for special circumstances. Option House also operates a Domestic Violence Outreach Center which coordinates counseling, paralegal, education awareness, employment, and money management support services for victims of domestic violence.
- **Homeless Youth** - The NCH defines homeless youth as an individual under the age of 18 who lacks parental, foster, or institutional care. The NCH estimates that within urban centers, 3% of the homeless are unaccompanied youth. Homelessness among youth is typically a result of physical/sexual abuse and/or parental neglect, or family economic problems such as the lack of sufficient income to afford housing. Another prevalent factor is residential instability, i.e., a history of foster care. One national study reports that one in five youth who arrived at shelters come directly from foster care or had been in foster care in the previous year. The San Bernardino County's 2007 homeless survey estimated that approximately 2.1% of the homeless population in the County (153 persons) were unaccompanied youth under 18 years of age.
- **Persons Living with AIDS** - The NCH reports that the lack of affordable housing is a critical problem facing a growing number of people living with HIV and AIDS. Individuals living with HIV/AIDS that are fortunate enough to reside in affordable housing often find themselves in a tenuous financial situation. They may lose their job because of discrimination, fatigue and periodic hospitalization caused by related illnesses. They also run the risk of an income drain caused by the cost of medical treatment. The NCH estimates an HIV prevalence rate of 3% to 20% among homeless people. The NCH also reports that 36% of people with AIDS have been homeless at least once since learning that they had HIV/AIDS. The San Bernardino County's 2007 homeless survey estimated that approximately 2.9% of the homeless population in the County (215 persons) were living with

HIV/AIDS. Applying the regional ratio to Yucaipa's homeless estimate, up to five of City's homeless may be living with AIDS.

- **Veterans** – It is estimated that 23% of the homeless population (and 33% of homeless men) are veterans. The National Coalition for Homeless Veterans estimates that on any given night, 299,320 veterans are homeless and over 500,000 experience homelessness over the course of a year. The NCH and the U.S. Department of Veterans Affairs (VA) cite the primary reasons for homelessness among veterans are a shortage of affordable housing, a lack of jobs providing a livable income, and access to health care. A large number of displaced and at-risk veterans also live with the effects of Post-Traumatic Stress Disorder. The San Bernardino County's 2007 homeless survey estimated that approximately 14.6% of the homeless population in the County (1,068 persons) were veterans. Using this percentage, it is estimated that up to 20 of the city's homeless may be veterans.
- **Elderly Homeless** - According to the National Coalition for the Homeless (NCH), an elderly head of household has a one-in-three chance of paying more than 50% of their income for housing. Faced with the added challenge of paying for other necessities such as food, medicine and health care, senior citizens are particularly vulnerable to homelessness. The NCH estimates that 2.5% to 19.4% of the nation's homeless are age 55-60. San Bernardino County's 2007 homeless survey estimated that 2.4% of the region's homeless are 60 years of age or older. For Yucaipa, this estimate translates to 3 to 4 elderly homeless. This estimate may be low as Yucaipa has twice the percentage of seniors as San Bernardino County as a whole.

- **Households and Families** - In 2010 there were 17,227 households in the City of Yucaipa. The average household size was 2.9 people. Families made up 74 percent of the households in the City of Yucaipa. This figure includes both married-couple families (59 percent) and other families (15 percent). Nonfamily households made up 26 percent of all households in the City of Yucaipa. Most of the nonfamily households were people living alone, but some were composed of people living in households in which no one was related to the householder. (Percent of households - Source: U. S. Census)
- **Education** - In 2010, 88.4 percent of people 25 years and over had at least graduated from high school and 21.8 percent had a bachelor's degree or higher. Thirteen percent were dropouts; they were not enrolled in school and had not graduated from high school. The total school enrollment in the City of Yucaipa was 15,000 in 2006-2008. Nursery school and kindergarten enrollment was 1,600 and elementary or high school enrollment was 10,000 children. College or graduate school enrollment was 3,600.

San Bernardino County Designated as a Coastal County within the State of California

The number of Americans residing in a coastal county passed the 150 million mark in 2005, making the coastal population larger than the entire U.S. population in 1950. Today, more than half of the U.S. population lives in a coastal area (as defined by the National Oceanic and Atmospheric Administration), even though the 673 coastal counties constitute only about one fourth of the country's landmass.

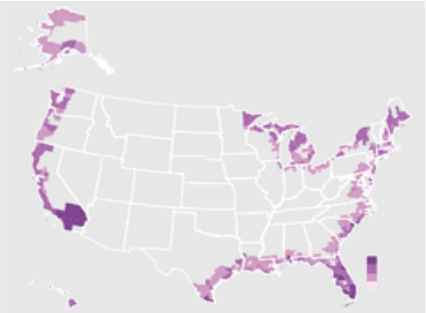


Figure 8: U.S. Census Bureau

As indicated by the map prepared by the U. S. Census Bureau, San Bernardino County is designated as a Coastal County within the State of California. Particular data exists demonstrating the effects of various types of risks within the county. It is important to use this information as a source point for evaluating the various risks that prevail not only in San Bernardino County, but the City of Yucaipa.

The growth in population of coastal areas illustrates the importance of emergency planning and preparedness for areas that are more susceptible to inclement weather conditions. The U.S. Census Bureau's official population estimates, along with annually updated socioeconomic data from the new American Community Survey, provide a detailed look at the nation's growing coastal population. Emergency planners and community leaders can better assess the needs of coastal populations using census data.

1.3.7 Land Use Plan

The General Plan Land Use Plan guides for how land is developed in the community. Yucaipa's Land Use Plan includes three related parts: 1) description of allowed land uses; 2) overlay districts; and 3) the location of allowed land uses. These are described below.

Allowed Land Uses

The Land Use Plan contains a general description of the allowed uses of land (referred to as land uses) in the community. Yucaipa Land Use Designations describe each "land use" category and the general uses allowed within each category. Additional descriptions of allowable land uses and the associated permitting processes (e.g., by-right, conditional, or other) for these land uses are provided in the municipal code. As projects are considered and General Plan amendments considered, reference should be made to the General Plan and the municipal code.

Land Use Map

The Land Use Map (Figure 9) illustrates the location of allowed land uses within Yucaipa. For clarity, the Land Use Plan also shows the land use designations within specific plan areas. This map is intended to identify allowed land uses and how they complement Yucaipa's community form. However, one should refer to the specific plans for the Freeway Corridor and Uptown to understand the allowed uses.

Overlay Districts

In planning for different land uses, certain areas of Yucaipa merit oversight to address specific concerns. These site-specific concerns may be due to steep topography, public safety hazards, habitat, or other issues. In these areas, the General Plan designates parcels with overlay districts. Projects or land uses within an overlay district must adhere to specific siting, development, or environmental regulations in addition to the regulations of the underlying land use district.

Within the various land use areas, equal attention was directed to special areas vulnerable to risks:

- Critical Facilities (including fire stations, government facilities major roads/bridges, police station, schools, telecommunications, and utilities)
- North-East Yucaipa (Chapman Heights Development Project)
- Oak Glen Basins Project (east of Bryant Street within the Oak Glen Creek Watershed)
- Wildwood Creek Basins Project (south of Wildwood Canyon Road east of Holmes Street)
- Private Drainage Courses
- Dunlap Acres
- Dunlap Business Corridor
- Wilson Creek
- Low Flow Crossings

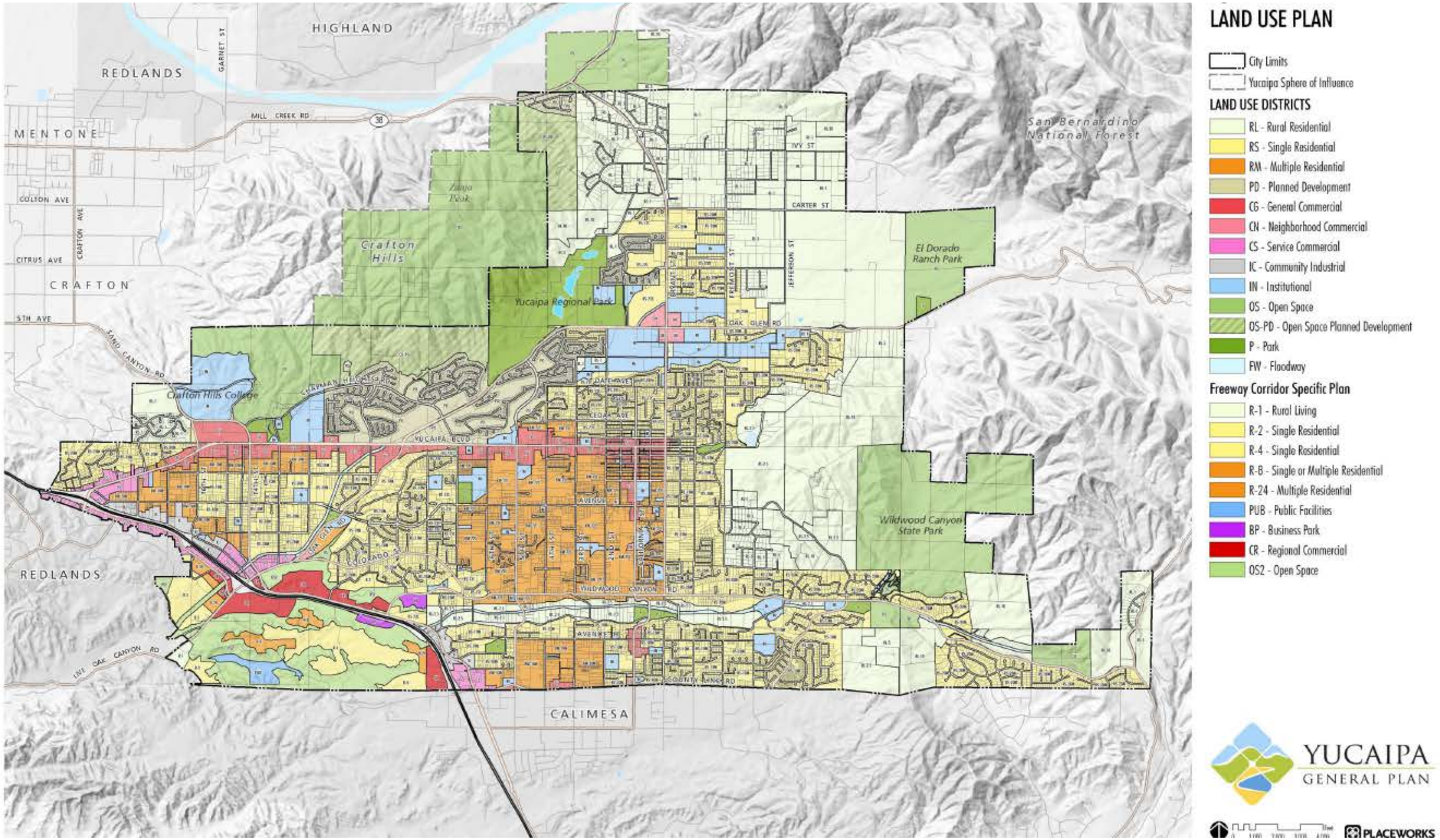


Figure 9: Yucaipa Land Use Plan

1.3.8 Community Structure

Yucaipa's community structure, its form and pattern of land uses, is a function of its natural environment and the needs of a developing and maturing community. An understanding of community structure provides the foundation for responsive goals and policies that further the long-term vision of the community. (Reference Figure 10)

Features

Yucaipa's community structure is derived from its history, natural environment, and design vision. The Crafton Hills, national forest, and Yucaipa Hills provide a visual backdrop for the valley. Major tributaries have etched channels into Yucaipa's landscape, creating defined elevation changes called benches. The major tributaries converge at Live Oak Canyon, at the southwest portion of the City. Yucaipa's "flatlands" at the base of the hills provide locations for residential, commercial, industrial, institutional, and other uses.

Within that context, the features that collectively contribute to Yucaipa's community design include the following.

Districts and Neighborhoods

Yucaipa has a variety of residential and commercial districts, each with a distinct purpose and identity. Residential neighborhoods or larger planning areas range from the rustic North Bench and Wildwood Canyon areas, to the established Central Core (including Uptown) and Chapman Heights, to the lower density Dunlap Acres. Dunlap Industrial and Uptown each have different types of businesses that cater to different consumers. Looking forward, the Freeway Corridor and College Village will also have distinct districts.

Paths and Corridors

Paths and corridors are the circulation or transportation links of a community and are vital to the way people perceive their city. Yucaipa's long, straight corridors span the community and give motorists views of commercial areas, neighborhoods, and the mountains.

Prominent scenic corridors are Yucaipa Boulevard, Bryant Street, Oak Glen Road, and Live Oak Canyon Road, and Wildwood Canyon Road.

An extensive network of trails complements these resources.

Landmarks

Yucaipa's visually prominent buildings, topography, and landmarks create a memorable sense of place and orient visitors and residents as they move about the community. Unlike many cities, Yucaipa's major landmarks include its hillsides—Yucaipa Hills, Crafton Hills, and Wildwood Canyon—which offer panoramic vistas throughout the community. Zanja Peak and other peaks and ridgelines are natural landmarks that overlook Yucaipa. Major creeks (e.g., Wilson Creek, Wildwood Creek), drainage channels, and elevated benches are also defining landmarks or features of Yucaipa.

Gateways

Yucaipa's visual impression is expressed by its entry points (often referred to as gateways) along its major transportation corridors. These entry points help to define one's entrance or sense of arrival to the community, a particular neighborhood, or district.

The quality of gateways communicates an impression. Some gateways are located near the freeway, and others are located along major streets.

Activity Centers

Activity centers are clusters or concentrations of uses that provide vibrancy, convenience, and variety in a community. Yucaipa envisions its centrally located Uptown, College Village, Yucaipa High School, Yucaipa Regional Park, Yucaipa/Oak Glen shopping center, Yucaipa City Hall, and Yucaipa Community Center as more dynamic activity centers. This element calls for focused development, coordinated landscaping, pedestrian features, and other infrastructure and aesthetic improvements along Yucaipa Boulevard to link these activity centers. Future opportunities for activity centers may also exist at other locations as residential neighborhoods more fully develop in the future.

Edges

Unlike many communities, Yucaipa is bounded by hills and natural open space that frame the community and serve as the edge or boundary of the community. These include the Crafton Hills, Yucaipa Hills, and San Bernardino National Forest. Roadways also define the edges of the City's neighborhoods and districts. Yucaipa Boulevard and Oak Glen Road are dividing lines for Dunlap Acres and the North Bench. Wildwood Canyon Road generally separates Wildwood Canyon and the Central Core, while the Interstate 10 serves as the edge to the Freeway Corridor. Figure 10, Community Structure, graphically illustrates some of the many design elements and natural features that help define the physical layout of the City of Yucaipa.

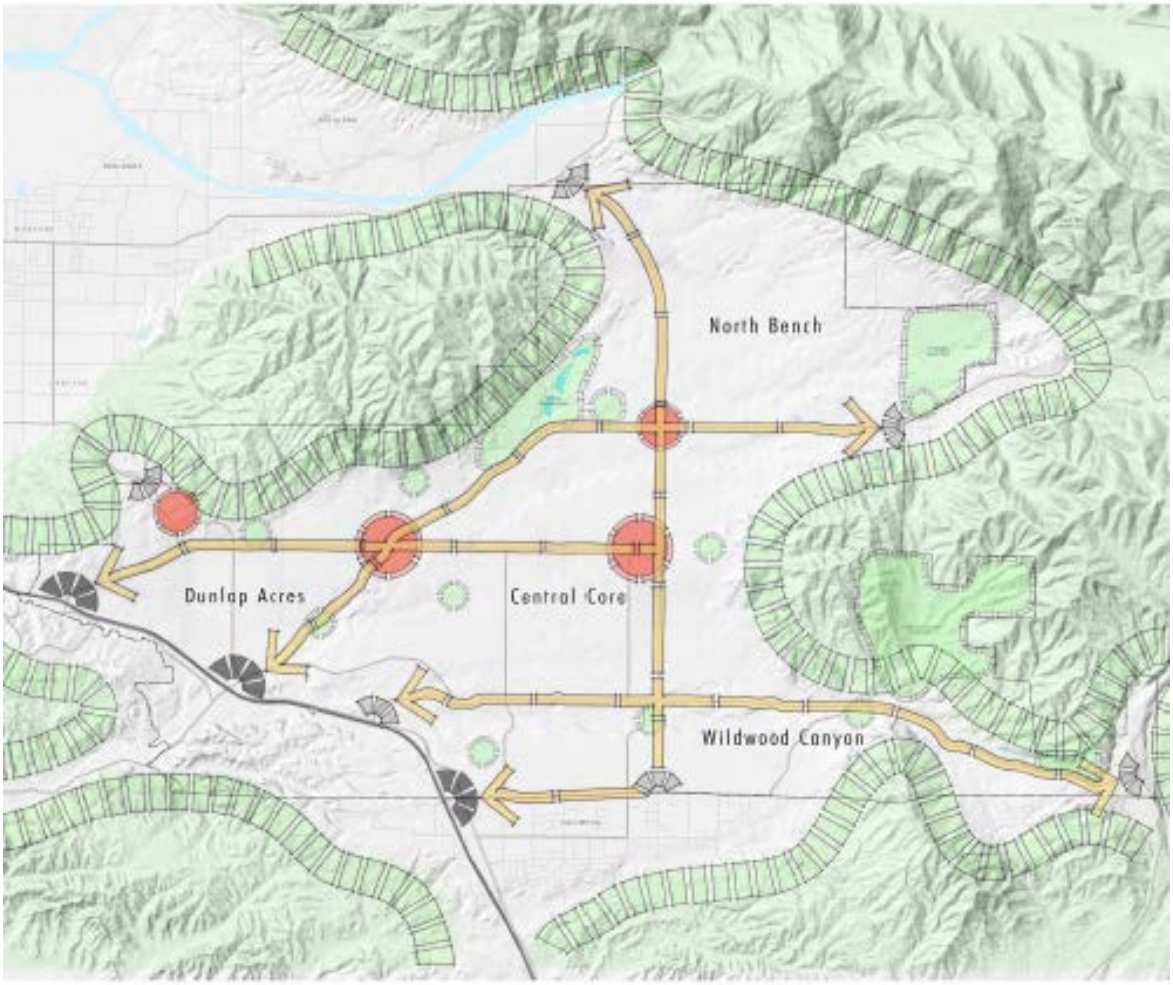


Figure 10 – Community Structure

1.3.9 Development Trends

Strategically located 75 miles east of Los Angeles, with 4 miles of mostly undeveloped frontage on Interstate 10, Yucaipa offers exceptional development opportunities to new or expanding businesses. The City's immediate market area population currently exceeds 75,000 residents, and with strong growth projected to occur for several more decades, Yucaipa will remain a highly desirable location for new investments. Local government is business friendly and fiscally sound - there are no utility taxes levied on residents or businesses, and recent improvements to waste water treatment and water supply systems provide adequate capacity to meet almost any need.

An ambitious program to revitalize the Uptown Business District has been completed, and other commercial/industrial development projects may be available. Long known as one of the premier residential communities of the Inland Empire, Yucaipa also provides one of the greatest untapped economic development opportunities in the Southern California region.

The City of Yucaipa adopted a comprehensive General Plan Update in April 2016. This Update was the first comprehensive 20-year update since the inaugural 1992 General Plan adopted shortly after incorporation. The General Plan Update is a 20-year document that meets the long-term challenges of adopting land use plans and integrates strategies to support state priorities consistent with AB 32 and SB 375.

The update affords added ability to heavily concentrate on strategic development of targeted land use, circulation, air quality, infrastructure and public facilities, and open space and conservation elements. It enables the community to create long-term prosperity, promote equity, strengthen the economy, protect the environment, and create a safe and healthy community as it moves forward for the next twenty years.

An important influence on future development and planning for the City includes major ownership patterns and areas currently proposed for development, which include the Dunlap Industrial Corridor, College Village, and the Freeway Corridor. All future development projects will be constructed to current design standards and building codes, and are not expected to contribute to community vulnerability from natural or technological hazards.

This Updated Local Hazard Mitigation Plan also reflects the City of Yucaipa’s commitment to sustainable development and recognition of Climate Action Strategies adopted at the state and regional levels in California. The City of Yucaipa, as one of 20 community partners in San Bernardino County member cities, engaged in a consortium focused on development of a regional Climate Action Plan (CAP). The Draft CAP was made available for public review by City residents and stakeholders and the CAP was developed in consideration of public comments and brought to the City Council for adoption on September 14, 2015. Its Community Economic Development Strategy was adopted in 2010. The Housing Element Update was completed and state-approved in 2013.

SECTION 2 - Plan Adoption

ELEMENT E. PLAN ADOPTION			
E1. Does the Plan include documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval? (Requirement §201.6(c)(5))			
E2. For multi-jurisdictional plans, has each jurisdiction requesting approval of the plan documented formal plan adoption? (Requirement §201.6(c)(5))			

2.1 Adoption by Local Governing Body

The Yucaipa City Council adopted the Plan on _____. A Resolution of the City Council of the City of Yucaipa, California, adopting the City of Yucaipa Flood Plan is included in this Plan (located before the Table of Contents).

2.2 Promulgation Authority

This Flood Plan will be reviewed and approved by the following Promulgation Authorities or their successors:

Name	Title	Email Contact
Denise Hoyt	Mayor	dhoyt@yucaipa.org
Greg Bogh	Mayor Pro Tem	gbogh@yucaipa.org
David Avila	Councilmember	davilla@yucaipa.org
Bob Duncan	Councilmember	bduncan@yucaipa.org
Dick Riddell	Councilmember	driddell@yucaipa.org

2.3 Primary Point of Contact

The Point of Contact listed below is the Chairperson and Director of the Flood Planning Team:

Fermin Preciado, City Engineer
City of Yucaipa
34272 Yucaipa Blvd., Yucaipa, CA 92399
909-797-2489 (Office) 909-790-9203 (Fax)
fpreciado@yucaipa.org

SECTION 3 - PLANNING PROCESS

1. REGULATION CHECKLIST	
ELEMENT A. PLANNING PROCESS	
A1. Does the Plan document the planning process, including how it was prepared and who was involved in the process for each jurisdiction? (Requirement §201.6(c)(1))	
A2. Does the Plan document an opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, agencies that have the authority to regulate development as well as other interests to be involved in the planning process? (Requirement §201.6(b)(2))	
A3. Does the Plan document how the public was involved in the planning process during the drafting stage? (Requirement §201.6(b)(1))	
A4. Does the Plan describe the review and incorporation of existing plans, studies, reports, and technical information? (Requirement §201.6(b)(3))	
A5. Is there discussion of how the community(ies) will continue public participation in the plan maintenance process? (Requirement §201.6(c)(4)(iii))	
A6. Is there a description of the method and schedule for keeping the plan current (monitoring, evaluating and updating the mitigation plan within a 5-year cycle)? (Requirement §201.6(c)(4)(i))	

3.1 Preparing for the Plan

The City of Yucaipa began plan preparation using as its guide the FEMA Region IX –Cal/EMA Local Hazard Mitigation Plan (LHMP) Crosswalk, December 2005 (includes Flood Mitigation Assistance (FMA) requirements). The City of Yucaipa adopted the comprehensive (STAPLEE) approach to development of the City of Yucaipa Flood Plan.

Additionally, it was concluded that the Plan will include information and data supplied by supporting local agencies as listed in Section 3.2 “Coordination with Other Jurisdictions, Agencies, and Organizations”, and 3.3 “Public Involvement”, of this Plan, along with Internet surveys published on the City’s website, public comments received during community-wide events and from recent fire evacuees, after-action reports prepared for the 2010 wildland fires and subsequent flooding, and similar sources developed through discussions during Planning Team meetings.

Drafting the Flood Plan was accomplished in 8 Phases.

- Phase I – Establish the Planning Team
- Phase 2 – Coordination with Other Jurisdictions, Agencies, and Organizations
- Phase 3 – Public Involvement
- Phase 4 – Assess the Hazards
- Phase 5 – Set Goals
- Phase 6 – Review and Propose Possible Mitigation Measures
- Phase 7 – Draft the Hazard Mitigation Plan Phase 8 – Adopt the Plan

The City initiated its Plan Update by meeting the requirements of Title 44, Code of Federal Regulations, Part 201 (44 CFR 201.6). The Planning Team agreed that the Flood Plan will conform to the requirements of 44 CFR Section 201.6 and will include a description and documentation of:

1. Why the Plan is necessary and how it will enhance the flood component of the existing approved City of Yucaipa Hazard Mitigation plan;
2. The process and data deficiencies/limitations that will be addressed;
3. The participatory planning process used to develop the plan to include how each section was reviewed and analyzed and how/why the decision was made to modify (or not) specific areas in the plan.
4. The opportunities provided for public participation, modified as necessary, based on previous experience;
5. The contribution from other stakeholders;
6. The new/additional research conducted and data included in the plan;
7. The modified risk assessment based on latest best available data;
8. The prioritized mitigation action plan;
9. The progress made in local mitigation efforts.

3.1.1 Planning Team

Leadership, management and oversight for the plan development process were provided through the City's Planning Team. Team members were selected based on their direct leadership and abilities within the City of Yucaipa as pertain to floodplain management. The Planning Team met monthly (or more frequently as necessary) to provide guidance, review progress, identify issues, and to coordinate stakeholder meetings. The Planning Team also provided background documents, facilitated data collection, and reviewed all draft documents.

In its earliest meetings the Planning Team concurred that at least during the planning process Planning Team members would review each flood-related activity taken by the City of Yucaipa and where necessary, comments and recommendations added.

The resulting plan, along with the entire planning process, is a living document that will continue to place flood mitigation as a priority in the City of Yucaipa. This Flood Plan was compiled and authored under the direction of the following Planning Team members:

Name	Title	Email Contact
Raymond Casey	City Manager	rcasey@yucaipa.org
Greg Franklin	Assistant City Manager	gfranklin@yucaipa.org
William Hemsley	Director of Public Works	bhemsley@yucaipa.org
Frances Hernandez	Director of Community Services	fhernandez@yucaipa.org
Ron Janssen	Fire Chief	Ronald.janssen@fire.ca.gov

Name	Title	Email Contact
Joseph Lambert	Director of Development Services	jlambert@yucaipa.org
Anthony Onodera	Chief of Police	yucaipa2@sbcsd.org
Mary Petite	Consultant	mpetite@yucaipa.org
Fermin Preciado	City Engineer	fpreciado@yucaipa.org
Jennifer Shankland	Deputy City Manager/City Clerk	jshankland@yucaipa.org
Paul Toomey	Director of Community Development	ptoomey@yucaipa.org

3.2 Coordination with Other Jurisdictions, Agencies, and Organizations

The City of Yucaipa has an historic record of flood events and has, since its incorporation, considered and responded to the need for a Master Plan of Drainage. The most recent update was published and adopted in September 2012, and included the requisite Initial Study/Mitigated Negative Declaration. The Master Plan of Drainage is adopted by reference in the City of Yucaipa Flood Plan.

There are many agencies, organizations, businesses and non-governmental entities that contend with natural hazards. Planning Team members contacted representatives of these various entities to solicit input and concerns relative to natural and man-made hazards and to determine how their programs could best collaborate with the City's mitigation program.

The following agencies and organizations that were contacted include, but are not limited to, the following:

- State Clearinghouse – Scott Morgan, Director (dated August 23, 2011)
- California Department of Transportation – Daniel Kopulsky (dated August 15, 2011)
- California Department of Toxic Substances Control – Greg Holmes (dated August 16, 2011)
- California Department of Fish and Game – Jeff Brandt (dated August 17, 2011)
- Regional Water Quality Control Board – Mark G. Adelson (dated August 22, 2011)
- San Bernardino County Department of Public Works – Erma J. Hurse (dated August 24, 2011)
- Yucaipa Valley Water District

3.2.1 Chronologic List of Meetings

Date	Item	Location
2010		
18 Nov	City Council approved the Traffic Facility Fee (TFF) update from RBF. RBF was still working on the Drainage Facility Fees (DFF) and MPD II updates.	Yucaipa City Hall
2011		
14 Mar	Team meeting to discuss DFF and MPDII study status and direction. Meeting attended by Ray Casey, Bill Hemsley, John McMains, Preciado, Mike Seal.	Yucaipa City Hall
11 Apr	City Council approved the recommendation of the Planning Team to contract amendment No. 1 to original contract with RBF. Addendum Scope of Work was to add additional drainage areas to the MPD/DIF.	Yucaipa City Hall
12 Apr	Team meeting to discuss project status. Attended by Fermin Preciado, James Neilson and Mike Seal.	Yucaipa City Hall
11 May	Team meeting with RBF and San Bernardino County Flood Control District to discuss the modeling software used for the MPDII update. Attended by Erwin Forgerson (SBCFCD Design Division Chief), Tom Ryan of RBF and Planning Team Member Mike Seal.	San Bernardino County Flood Control District Office, San Bernardino
25 May	Study status meeting with RBF. Meeting attended by Tom Ryan, John McCarthy (RBF), Bill Hemsley, Fermin Preciado, Mike Seal.	Yucaipa City Hall
26 May	Planning Team meeting to discuss study progress. Meeting attended by Ray Casey, Bill Hemsley, John McMains, Mike Seal.	Yucaipa City Hall
1 June	Planning Team meeting to discuss study progress. Meeting attended by Ray Casey, Bill Hemsley, John McMains, Mike Seal.	Yucaipa City Hall
1 July	Planning Team meeting to discuss study progress to finalize the study. Meeting attended by Ray Casey, Bill Hemsley, Fermin Preciado, Mike Seal.	Yucaipa City Hall
12 Sept	City Council approved the recommendation of the Planning Team to approve the MPD II and DIF Program.	Yucaipa City Hall
24 Nov 2009	City of Yucaipa submits Flood Mitigation Assistance Grant Application to prepare Flood Plan.	Yucaipa City Hall
2 Aug	City of Yucaipa receives Notification of Application Approval for Flood Mitigation Assistance Grant to prepare Flood Plan	Yucaipa City Hall
12 Aug	Community Assistance Visit satisfactorily closed, Yucaipa in full compliance with NFIP.	Yucaipa City Hall

Date	Item	Location
22 Sept	Planning Team reviews letter from U.S. Senator Dianne Feinstein to Mayor Riddell re appeal of Flood Insurance Rate Map determinations.	Yucaipa City Hall
5 Oct.	NFIP/CRS Verification Meeting with Dave Arkens, NFIP/CRS Planning Team Members.	Yucaipa City Hall.
30 Oct	Assignment of Existing Professional Staff to Planning Team	Yucaipa City Hall
10 Dec	Letters of Invitation to Potential Stakeholders	Yucaipa City Hall
2011		
1 Jan.	FMA Grant Program begins.	Yucaipa City Hall
5 Jan.	Establishment of Planning Team	Yucaipa City Hall
5 Jan.	Planning Team establishes meeting dates	Yucaipa City Hall
5 Jan.	Planning Team establishes goals and objectives	Yucaipa City Hall
10 Jan.	Team recommendations re December 2010 Severe Winter Storm Local Emergency Funding	Yucaipa City Hall
10 Jan.	Upon recommendation of Planning Team, City Council adopts Resolution No. 2011-02 approving an application for the NFIP/CRS Application.	Yucaipa City Hall
12 Jan.	Planning Team submits City of Yucaipa's completed CRS application.	Yucaipa City Hall.
18 Jan.	Planning Team meeting to initiate a response to ISO/CRS David Arkens regarding additional materials requested.	Yucaipa City Hall.
24 Jan.	Team recommends extension of Declaration of Local Emergency re December 2010 Severe Winter Storm	Yucaipa City Hall
24 Jan.	Team meeting re additional engineering support meeting re Wildwood Creek Basin	Yucaipa City Hall
24 Jan.	Team amends CIP adding Wilson Creek Improvement Project between 14th Street and I-10 Freeway	Yucaipa City Hall
24 Jan.	Team recommends additional allocation of $2,500,000 to combined Dunlap Channel and Wilson Creek Improvement Projects and allocation of $1 million from 2010 RDA Tax Allocation Bond proceeds to same	Yucaipa City Hall
14 Feb.	"ARkSTORM Training, co-hosted by the City of Yucaipa	Yucaipa Community Center
14 Feb.	Team authorizes Resolution 2011-05 recommending and authorizing Floodway Corridor Program to acquire parcels in the 100-year Floodplain	Yucaipa City Hall
14 Feb.	Team recommends acquisition of right-of-way for Wildwood Creek Basin Project	Yucaipa City Hall

14 Feb.	Team recommends award of Contract/Professional engineering Services for the Santa Ana River and Tributaries – Yucaipa Streams Ecosystem Restoration Study re Wildwood Creek Drainage.	Yucaipa City Hall
28 Feb.	Team recommends award of Contracts – Technical Environmental Review and Permitting Services for the 13th Street at Wilson Creek and Avenue D at Wilson Creek Low Water Crossing Replacement Projects	Yucaipa City Hall
28 Feb.	Team recommends Award of Contracts – Technical Environmental Review and Permitting Services for the Pendleton Avenue at Oak Glen Creek, Fremont Street at Wilson Creek and the 6th Place at Wildwood Creek Low Water Crossing Replacement Projects	Yucaipa City Hall
14 March	Team recommends Short-Term (Wilson Creek Feasibility Study), Mid-Term (Wildwood Creek Feasibility Study) and Long-Term Goals/Action (Wilson and Wildwood Creek Basins Construction) items related to flood prevention and mitigation infrastructure	Yucaipa City Hall
14 March	Team recommends approval and authorization for Professional Services Agreement to prepare EIR for Wilson Creek Business Park Specific Plan	Yucaipa City Hall
28 March	Planning Team receives and reviews results regarding credits for Yucaipa's CRS application visit.	Yucaipa City Hall
1 April	Planning Team recommends authorization to apply for an Economic Development Assistance Grant to construct the Dunlap Channel and storm drain project associated with expansion of Sorenson Engineering to mitigate future impacts to local businesses and homes affected by the 100-year floodplain.	Yucaipa City Hall
11 April	Team recommends authorization re Drainage Impact Fee Assessments and Master Plan of Drainage Update	Yucaipa City Hall
13 June	Team recommends termination of December 2010 Severe Winter Storm Local Emergency	Yucaipa City Hall
27 June	Team recommends agreement for participation in Santa Ana River and Tributaries – Yucaipa Streams Ecosystem Restoration Study – Wildwood Creek Drainage with the San Bernardino County Flood Control District	Yucaipa City Hall
20 July	NFIP/CRS Users Group Southern California Kick-off Meeting, attended by James Nielson, CRS Coordinator	Riverside County Flood Control and Water Conservation District
25 July	Team recommends study session to review selected Components of the proposed Wilson Creek Business Park Specific Plan and multi-purpose Wilson III Basin project and provide recommendations to staff, as appropriate.	Yucaipa City Hall

Date	Item	Location
25 July	2012 CRS Coordinator's Manual Update Webinar re FEMA and the ISO/General Overview. Attended by James Nielson, CRS Coordinator.	Yucaipa City Hall
31 July	Planning Team receives and reviews CRS Recertification request Letter from Dave Arkens, ISO/CRS Specialist	Yucaipa City Hall
25 August	Planning Team receives and reviews annual recertification documentation letter from Dave Arkens, ISO/CRS Specialist.	Yucaipa City Hall
29 Sept.	Team recommends publication of news release pertaining to NFIP/CRS participation. (Yucaipa News-Mirror)	Yucaipa City Hall
10 Oct.	Team recommends award of contract Phase III Wildwood Creek Basins Project/Phase III	Yucaipa City Hall
28 Nov.	Team recommends adoption of Ordinance No. 313 to update development standards and Variance procedures for properties located in FEMA designated floodplains and floodways.	Yucaipa City Hall
7 Dec	Oak Glen Basin Quarterly Meeting (City, Flood Control, Yucaipa Valley Water District Working Group)	Yucaipa City Hall
12 Dec.	Pendleton LWC Progress Meeting (City, Stantec Engineering)	
21 Dec.	Wilson Creek Feasibility Meeting (City, Corps of Engineers, Flood Control, RBF Consulting)	
2012		
13 Jan.	Wilson Creek Spreading Grounds Design Modifications (City Working Group)	
17 Jan.	Wilson Creek Channel Improvements (City Working Group, Webb Consultants)	
23 Feb.	MPD Update Meeting (City Working Group, RBF Consulting)	
29 Feb.	Wilson Creek Feasibility Meeting (City Working Group, Corps of Engineers, Flood Control)	
7 March	Oak Glen Basin Quarterly Meeting (City Working Group, Flood Control, YVWD)	
1 April	Team recommends acceptance of grant funding from Department of Water Resources to acquire properties in the 100-year floodplain for conservation in perpetuity.	Yucaipa City Hall
10 April	Wilson Creek Channel Improvements (City Working Group, Webb Consultants)	Yucaipa City Hall
16 April	Team recommends filing of Disaster Relief Application through the Department of Commerce, Economic Development Assistance Program, related to flood disaster DR-FEMA 1952-CA for Dunlap Channel construction and	Yucaipa City Hall

Date	Item	Location
	storm drain improvements in support of Dunlap Area.	
21 April	City of Yucaipa files Disaster Relief application per team recommendations.	Yucaipa City Hall
25 April	Flood Corridor Grant Meeting (City Working Group)	Yucaipa City Hall
26 April	Zone 3 Advisory Committee (City Working Group, Flood Control District)	
26 April	Wilson III Basin Design (City Working Group)	Yucaipa City Hall
16 May	Planning Team meeting to review Mitigation Measures, benefit/cost analysis, funding potential, and construction time frames	Yucaipa City Hall
22 May	Planning Team holds public meeting with California Department of Water Resources explaining the Flood Corridor Protection Program Grant, property acquisition information.	Yucaipa City Hall
9 July	Award of Contract – Design of a Multi-Purpose Flood Control Basin with Appurtenant Channel and Preliminary Street Improvements at the Confluence of Wilson and Oak Glen Creek (Wilson III Project)	Yucaipa City Hall
27 Aug.	Approve Participation in the Yucaipa Groundwater Management Plan	Yucaipa City Hall
2013		
9 January	One Water One Watershed (OWOW) Kick-Off Meeting	Santa Ana Water Project Authority (SAWPA)
18 January	OWOW Project Meeting	Santa Ana Water Project Authority (SAWPA)
28 January	Adoption of Amended "One Water One Watershed" Plan	Yucaipa City Hall
28 January	Review, Wilson Creek Business Park Specific Plan Wilson III Project – Multi-Purpose Flood Control Basin Alternatives Analysis	Yucaipa City Hall
28 January	Review and Approve Wilson III Project – Multi-Purpose Flood Control Basin Alternatives Analysis	Yucaipa City Hall
1 February	OWOW Project Meeting – Wilson III Project	Santa Ana Water Project Authority (SAWPA)
8 February	OWOW Project Meeting – Wilson III Project	Santa Ana Water Project Authority (SAWPA)
15 February	OWOW Project Meeting – Wilson III Project	Santa Ana Water Project Authority (SAWPA)

Date	Item	Location
6 March	Oak Glen Basin Quarterly Meeting	City Staff, YVWD, SBCFCD, Yucaipa City Hall
8 April	Approve Memorandum of Understanding with San Bernardino County Flood Control District: Wilson III Basin Project	Yucaipa City Hall
8 May	Zone 3 Public Information Workshop	SBCFCD/Zone 3 Representatives, County Flood Control Offices
13 May	Approve Memorandum of Understanding with San Bernardino County Flood Control District: Wilson III Basin Project	Yucaipa City Hall
14 May	LWC Projects at Avenue D and 13th Street	City Staff, Caltrans Local Assistance, Yucaipa City Hall
22 May	Appraisal Services Contract DWR Flood Corridor Grant/Oak Creek	City Staff, Appraiser, Yucaipa City Hall
23 May	Corps Study CAP Section 206 Meeting: Wildwood Creek	City Staff/Army Corps of Engineers, Yucaipa City Hall
29 May	Flood Control Right-of-Way Policies Regarding purchase of Flood Control Land related to proposed box culvers improvement projects.	City Staff, SBCFCD, SB County Flood Control Offices
30 May	SAR Tributary – Yucaipa – Funding Study, WIK Status	City Staff, Army Corps, Yucaipa City Hall
12 June	Pendleton Low Water Crossing DesignMeeting	City Staff, SBCFCD, Yucaipa City Hall
20 June	13th and Avenue D LWC Environmental Permits	City Staff, Caltrans Local Assistance, Yucaipa City Hall
3 July	Oak Glen Basin Quarterly Meeting	City Staff, YVWD, SBCFCD, Yucaipa City Hall
18 July	Explore potential for Inland Empire Resource Conservation District at Wildwood Basin	City Staff, IERCD, Yucaipa City Hall
1 August	California Street Basin at Wildwood Creek Design Meeting	City Staff, PACE, Yucaipa City Hall
22 August	Team meeting to discuss funding application for Wilson III Basins through State Revolving Loan Fund	Yucaipa City Hall

Date	Item	Location
23 August	Wilson Creek Innovation Center (Business Park) EIR	City Staff, RBF, Planning Center, Yucaipa City Hall
4 Sept.	Oak Glen Basin Quarterly Meeting	City Staff/ YVWD, SBCFCD, Yucaipa City Hall
10 Oct.	Team Field Meeting – Review Basin Operations	City Staff, YVWD, SBCFCD
30 Oct.	NEPA Clearance Reviews for LWC's at 6th Place, Freemont and Pendleton	City Staff, Webb/Caltrans Local Assistance, Yucaipa City Hall
2014		
7 Jan.	Final Mitigation Workshop and CIP Introductions (link to Power Point)	City Staff, City Consultants, City Hall
9 Jan.	ACE Field Review, status updates	City Staff, ACE, Field
	Draft Plan submitted for Team Review and Comments	
	Plan Edits	
	Final Draft submitted to City Council for review and approval	
	30 day Public Comment Period begins	
	30 day Public Comment Period ends	
	Submittal of Final Draft with Edits to California Office of Emergency Services	

3.3 Assess the Hazards

Data collection and document review are important first steps in the identification and screening of hazards. The Planning Team identified new or emerging hazards, obtained updated hazard maps, hazard probability research studies and reports, reviewed data from new or updated local plans (i.e. safety element of the General Plan, threat assessments, disaster planning scenarios, etc.) and obtained information about floods that have occurred since City of Yucaipa incorporation in 1989 to provide insights into which parts of the risk assessment warrants updates.

The first step in this process was to identify risks associated with flooding as applies to not only the City of Yucaipa, but also its greater regional effects to help prioritize which added hazards associated with flooding present the greatest risk to the community.

As with the City's 2009 Hazard Mitigation Plan update, the Planning Team utilized a non-numerical ranking system for the update process. This process consisted of generating a non-numerical ranking (High, Medium, or Low) rating for the 1) probability and 2) impact from each

screened hazard. The hazards were then placed in the appropriate/corresponding box/cell. The table below is an example of how the hazards were ranked. In this example the "Red" boxes represent the higher priority hazards; and the "Orange" and "Yellow" boxes represent additional levels of priority.

The definition of "High", "Medium", and "Low" probability and impacts are as follows:

Probability

High- Highly Likely/Likely
Medium- Possible
Low- Unlikely

Impact

High- Catastrophic/Critical
Medium- Limited
Low- Negligible

		Impact		
		High	Medium	Low
Probability	High			
	Medium			
	Low			

3.4 Set Goals

Project and community hazard mitigation goals and objectives for the City of Yucaipa were set by the Planning Team to guide the development of the Plan using FEMA National Mitigation Strategies and Goals to substantially increase public awareness of natural hazard risks so that the public demands safer communities in which to live and work; and to significantly reduce the risk of loss of life, injuries, economic costs, and destruction of natural and cultural resources that result from natural hazards.

These were then commented on by the community stakeholders to refine the goals, resulting in a consensus agreement.

3.5 Review and Propose Possible Mitigation Measures

A wide variety of mitigation measures that can be identified to help reduce the impact of the hazards or the severity of damage from hazards were examined. The projects were identified to help ensure the implementation of the Planning Team's goals and objectives. The following categories were used in the review of possible mitigation measures:

1. Public Information and Education- Outreach projects and technical assistance.
2. Preventive Activities- Zoning, building codes, storm water ordinances
3. Structural Projects- Detention basins, reservoirs, road and bridge improvements
4. Property Protection- Acquisition, retrofitting
5. Emergency Services- Warning, sandbagging, road signs/closures, evacuation

6. Natural Resource Protection: Wetlands, protection, best management practices.

Once the projects were identified, the Planning Team utilized the STAPLEE methodology to assess and prioritize the projects.

STAPLEE stands for the following:

- **Social:** Social criteria are based on the idea that community consensus is a necessary precondition for successful implementation of mitigation measures (i.e., measures should be supported and accepted by the entire community). This also means that measures should not affect adversely a particular segment of the population or a particular neighborhood, or adversely impact local cultural values or resources.
- **Technical:** Technical criteria address the technical feasibility of the proposed measures, in terms of effectiveness, secondary impacts, and the technical capabilities of the community to implement and sustain these measures.
- **Administrative:** Administrative criteria address the administrative capabilities required to implement each mitigation measure. For example, does the City have the necessary organization, staff, and funding sources to implement and sustain the mitigation process?
- **Political:** Political criteria consider the need for political support for mitigation measures. This means that all stakeholders in the political process, especially political organizations and institutions both inside and outside of the community, should support the measure.
- **Legal:** Legal criteria are used to determine the appropriate legal authority necessary to implement each mitigation measure and whether such an authority can be delegated. The mitigation measure is examined from the standpoint of current statutes, codes, ordinances, and other regulations, as well as the possible legal ramifications of the measure's implementation.
- **Economic:** Economic criteria address the cost-effectiveness of the proposed measure and its economic impact on the community. It is only reasonable to expect that the benefits of implementation will exceed the costs incurred. Economic considerations also consider the economic impact on the community's future development.
- **Environmental:** Environmental criteria have become an important consideration in examining mitigation options. Although most mitigation measures are usually beneficial for the environment, some measures may have adverse effects, which must be considered and addressed.

Based on STAPLEE, the Planning Team addressed the following questions to determine mitigation options:

Does the Action:

1. Solve the problem?
2. Address Vulnerability Assessment?
3. Reduce the exposure or vulnerability to the highest priority hazard?
4. Address multiple hazards?
5. Address more than one (1) Goal/Objective?

6. Benefits equal or exceed costs?

Can the Action:

1. Be implemented with existing funds?
2. Be implemented by existing state or federal grant programs?
3. Be completed within the 5-year life cycle of the LHMP?
4. Be implemented with currently available technologies?

Will the Action:

1. Be accepted by the community?
2. Be supported by community leaders?
3. Adversely impact segments of the population or neighborhoods?
4. Require a change in local ordinances or zoning laws?
5. Result in legal action such as a lawsuit?
6. Positively or negatively impact the environment?
7. Comply with all local, state and federal environmental laws and regulations?

Is there:

1. Sufficient staffing to undertake the project?
2. Existing authority to undertake the project?

3.6 Draft the City of Yucaipa Flood Mitigation Plan

The Planning Team members drafted the Flood Mitigation Plan and guidance provided by the consultant, and input from all stakeholders and City departments. The Planning Team provided opportunity for public comment and input and uploaded the draft Plan to the City's website http://www.yucaipa.org.

FEMA Guidance documents were used extensively as additional reference materials. The results of the mitigation activities review are summarized in the Flood Mitigation Plan. The draft plan will be circulated for additional comment and review and made available at Yucaipa City Hall and on the City's website.

3.7 Adopt the Plan

After the public review, the draft plan will be submitted to Cal EMA/FEMA for review and approval. FEMA will provide the City with an "Approval Pending Adoption" letter if the Flood Mitigation Plan update meets all federal requirements. Upon receipt of this letter, the final plan will be submitted to the Yucaipa City Council for consideration and adoption. Once adopted, the final Resolution will be submitted to FEMA for incorporation into the Flood Plan Annex.

SECTION 4 - RISK ASSESSMENT

ELEMENT B. HAZARD IDENTIFICATION AND RISK ASSESSMENT			
B1. Does the Plan include a description of the type, location, and extent of all natural hazards that can affect each jurisdiction(s)? (Requirement §201.6(c)(2)(i))			
B2. Does the Plan include information on previous occurrences of hazard events and on the probability of future hazard events for each jurisdiction? (Requirement §201.6(c)(2)(i))			
B3. Is there a description of each identified hazard's impact on the community as well as an overall summary of the community's vulnerability for each jurisdiction? (Requirement §201.6(c)(2)(ii))			
B4. Does the Plan address NFIP insured structures within the jurisdiction that have been repetitively damaged by floods? (Requirement §201.6(c)(2)(ii))			

The goal of mitigation is to reduce the future impacts of a hazard including property damage, disruption to local and regional economies, and the amount of public and private funds spent to assist with recovery; however, mitigation should be based on risk assessment.

This section discusses the risk assessment approach for the City of Yucaipa's Flood Mitigation Plan. FEMA defines the risk assessment process as a multi-step effort in "Understanding Your Risks: Identifying Hazards and Estimating Losses (FEMA 2001)". The steps include:

1. Identify and Screen your Hazards
2. Profile Hazard Events
3. Inventory Assets
4. Estimate Losses

Figure 11: 4-Step Risk Assessment - Source: FEMA

The risk assessment approach for Yucaipa is composed of these four steps, and each step is organized in a separate subsection of Chapter 4. Section 4.1 (step 1) includes hazard identification and screening. During this process, all reasonably possible hazards affecting the City are considered and ranked by the City of Yucaipa Planning Team and stakeholders. Section 4.2 (step 2) provides a profile for each of the significant hazards identified during the screening process. In general, the hazard profiles are addressed on a regional level. Wherever possible the profile includes a discussion of local characteristics and possible impacts on the community. Section 4.3 (step 3) discusses the process of creating an inventory of the City's assets. This step includes the comprehensive information gathering and prioritization process essential to perform the vulnerability assessment and loss estimation. Section 4.4 (step 4) presents the methodologies and results of loss estimation for the key hazards identified in step 2.

4.1 Hazard Identification

4.1.1 Hazard Screening Criteria

The City of Yucaipa Planning Team determined that expansion of flooding as a natural hazard is necessary in order to help protect private and public lands and in order to become eligible for flood mitigation funds following any future declared disaster after November 1, 2004. Through selectively identified analysis following hazard-specific meetings, the Planning team determined that the flood hazard ranked "High" in the Hazard Assessment Matrix.

The hazard data was analyzed in view of how it impacts public safety, health, buildings, transportation, infrastructure, critical facilities and the economy.

The identification of the flood hazard was based upon the following sources:

1. Historic Occurrence of the Hazard - Assessment is based on frequency, magnitude and potential impact of the hazard.
2. Mitigation Potential for the Hazard - This criteria considers if there are mitigation or counter measures possible to prevent or alleviate the risk.
3. Expert Opinion - Evaluation of threats includes a literature review and the expertise of the Planning Team.
4. Published Data and Information - Assessment is based on data and/or information from credible publications or websites. (i.e., U.S. Geological Survey, California Geological Survey, National Weather Service - National Climatic Data Center, or academic publications)

4.1.2 Hazard Assessment Matrix

Rankings used for the hazard screening were defined as follows:

Probability		**Impact**	
High:	Highly Likely/Likely	High:	Catastrophic/Critical
Medium:	Possible	Medium:	Limited
Low:	Unlikely	Low:	Negligible

High- There may or may not have been historic occurrences of the hazard in the community or region but experts feel that it is likely that the hazard will occur in the community and the risk is significant. Citizens feel that there is a likelihood of occurrence and the consequences will be significant in terms of building damage and loss of life.

Medium- There may or may not have been a historic occurrence of the hazard in the community or region but experts feel that it is possible that the hazard could occur in the community. Citizens may feel that there is a likelihood of occurrence but the consequences will be negligible in terms of building damage and loss of life.

Low- There have been no historic occurrences of the hazard in the community or region and experts feel that it is highly unlikely that the hazard will occur in the community. The citizens agree.

4.1.3 Hazards Identified

The effects of flood hazards identified by the Planning Team were similar to those hazards identified in the 2009 Hazard Mitigation Plan Update. However, updated information has become available and more recent flood events, projects, studies, and programs have modified the mitigation vision offering an opportunity to present a more succinct list of viable flood mitigation programs and projects in a flood-directed planning document.

Flooding ranks as a very high hazard in Yucaipa due to the community's annual seasonal rainfall and topography. Areas subject to flooding in Yucaipa are adjacent to the Wilson and Wildwood Creeks, and the Dunlap Acres/Business Corridor. Wilson Creek flows from the North/East to the South/West corner of the Yucaipa City boundary. Wildwood Creek flows in the East to West direction. Dunlap Channel lies between Yucaipa Boulevard and Wilson Creek. Floodway areas adjacent to these creeks may be subject to damage and isolation during storm events. Winter storms in the past have caused waters in one or more of the natural drainage channels to overflow onto City streets, parks and private property. Street embankments adjacent to the storm channels have been damaged and required road closure. Normal traffic flow is significantly affected by water and silt deposits in the seven low water crossings.

Again due to topography and Yucaipa's proximity to the San Bernardino National Forest, wildfires continue to rank as a high hazard and acerbate rainy seasons leading to mud and debris flow hazards as risks associated with flooding. Wildfires present a significant potential for disaster in the southwest, a region of relatively high temperatures, low humidity, and low precipitation during the summer, and during the spring, moderately strong daytime winds. Combine these severe burning conditions with people or lightning and the stage is set for the occurrence of large, destructive wildfires. Wildfires occurring in August 2009 left homes in extreme peril, not just from effects of wildfire, but from loss of vegetation and the ability of hillsides to retain moisture and prevent debris flow.

The results of the screening process described above are presented as a hazard assessment matrix in Table 2 below. The matrix illustrates the nature and potential of threats from natural disasters to the City of Yucaipa. The Planning Team developed the preliminary matrix, which was reviewed and modified during stakeholder meetings.

	Impact		
	High	**Medium**	**Low**
Probability	Floodwater Inundation, Particularly Dunlap Area of the Community		
		Strong Potential for: Mud and Debris Flow in Neighborhoods with Close Proximity to Hillsides Movement and Transportation Creek Erosion Levee Breach Evacuations Loss of Business /Dunlap Corridor Area Potential Increase in Unemployment Pending Reopening of Businesses	
			Movement and Transportation Associated with Low Flow Crossings

Figure 12: Hazard Assessment Matrix

4.1.4 Hazard Prioritization

By combining the Hazard Ranking Matrix above showing 1) probability and 2) impact for each screened hazard and indicating the potential for implementing mitigation measures to reduce the risk, a prioritized ranking of the hazards was developed. As shown in the table below, flood hazards are given high priority in the community.

		Impact		
		High	**Medium**	**Low**
Probability	**High**	Flooding		
	Medium		Access Economic Loss Disruption of Households	
	Low			

Red boxes represent the higher priority hazards; “Orange” and “Yellow” boxes represent additional levels of priority.

In 2012 the City of Yucaipa conducted a Flood Elevation Study in support of a benefit cost analysis related to a Hazard Mitigation Grant proposal associated with Wilson Creek. Results of that study are available in the office of the City Engineer.

The following sections profile flood hazards (Section 4.2), inventory assets in the City (Section 4.3), and estimate losses or assess risk for significant events associated with this hazard (Section 4.4).

4.2 Hazard Profile

4.2.1 Flooding

4.2.1.1 Hazard Definition for Flooding

Floods are the most common and widespread of all natural disasters--except fire. Most communities in the United States have experienced some kind of flooding, after spring rains, heavy thunderstorms, or winter snow thaws.

A flood, as defined by the National Flood Insurance Program is:

"A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties (at least one of which is your property) from:

**Overflow of inland or tidal waters,*Unusual and rapid accumulation or runoff of surface waters from any source, or a mudflow.*

The collapse or subsidence of land along the shore of a lake or similar body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels that result in a flood."

Floods can be slow or fast rising but generally develop over a period of days. Mitigation includes any activities that prevent an emergency, reduce the chance of an emergency happening, or lessen the damaging effects of unavoidable emergencies. Investing in mitigation steps now, such as engaging in floodplain management activities, constructing barriers such as levees, and purchasing flood insurance will help reduce the amount of structural damage to your home and financial loss from building and crop damage should a flood or flash flood occur.

Flooding tends to occur in the summer and early fall because of the monsoon and is typified by increased humidity and high summer temperatures. Flooding also occurs during the winter months, from December at least through April of the following year.

The standard for flooding is the so-called "100-year flood," a benchmark used by the Federal Emergency Management Agency to establish a standard of flood control in communities throughout the country. Thus, the 100-year flood is also referred to as the "regulatory" or "base" flood. Actually, there is little difference between a 100-year flood and what is known as the 10-year flood. Both terms are really statements of probability that scientists and engineers use to describe how one flood compares to others that are likely to occur. In fact, the 500-year flood and the 10-year flood are only a foot apart on flood elevation-which means that the elevation of the 100-year flood falls somewhere in between. The term 100-year flood is often incorrectly used and can be misleading. It does not mean that only one flood of that size will occur every 100 years. What it actually means is that there is a one percent chance of a flood of that intensity and elevation happening in any given year. In other words, it is the flood elevation that has a one percent chance of being equaled or exceeded each year. And it could occur more than once in a relatively short period of time. (By comparison, the 10-year flood means that there is a ten percent chance for a flood of its intensity and elevation to happen in any given year.) Rod Bolin, The Ponca City News, July 18, 2002. Page 5-A.

4.2.1.2 Flood Hazard Setting

Floods are natural and recurrent events that generally do not pose a hazard in an undeveloped area; it is only when floods interact with the built environment - typically, structures built in the floodplain, where they obstruct floodwaters - that they become hazardous to property, structures, and people.

Yucaipa is bisected by several waterways. Wilson Creek runs in a southwesterly direction and Wildwood Creek runs to the southeast. Drainage occurs through many small, fluctuating creeks - Yucaipa Creek, Oak Glen Creek, Chicken Springs Wash, Spoor Creek, and Gateway Wash. Wilson and Wildwood creeks and their tributaries converge in Live Oak Canyon, west of Interstate 10, and then flow to the San Timoteo River.

Yucaipa has generally warm to dry weather and averages only 20 inches of rainfall annually. Therefore, most of the creeks are dry during most of the year, except along their upper reaches, which may have small, sustained year-round

flow. However, Yucaipa is also subject to intense local storms. Floodwaters from the upper reaches of the mountains converge in Yucaipa's waterways, creating the potential for flooding and safety hazards.

The 2010 flash floods damaged roadways and homes in Yucaipa

During the late 1960s, Yucaipa storms caused widespread damage to roads, homes, utilities, and property. Since then, the City has completed multimillion-dollar projects to protect the community from flooding.

Although channel improvements have significantly reduced the occurrence and severity of flooding, storms continue to cause local flooding.

Recent flooding events include:

- 2011 January Flash Flood/Mudslides
- 2010 January Flash Flood/Mudslides
- 2005 August Flash Flood
- 2002 November Flash Flood
- 1999 August Flash Flood
- 1995 January Storm
- 1993 February Storm
- 1992 Winter Storms

To prevent and control flooding, Yucaipa and the San Bernardino County Flood Control District manage a network of channels, detention basins, and other flood control infrastructure. More than 28 miles of drainage infrastructure, a dozen detention basins, and natural streams divert floodwaters and recharge groundwater. Additional facilities and flood protection infrastructure are planned.

Figure 13 Drainage and Recharge Facilities, shows areas capable of accommodating floodwaters and groundwater recharge.

Flood Hazards

Because of Yucaipa's steep terrain and seasonal storm events, the community is subject to a wide range of flooding hazards. The predominant flooding hazards are riverine flooding, mudflows, dam inundation, and urban flooding. These flooding hazards are described below and mapped on subsequent pages.

Riverine Floods

Riverine flooding is the most prevalent flood hazard in Yucaipa and the source for the most devastating floods in the city. Yucaipa has many fluctuating waterways - Yucaipa Creek, Oak Glen Creek, Wildwood Creek, Chicken Springs Wash, and Spoor Creek. Although generally dry, these creeks can quickly accumulate water during storm events, as intense rainfall at higher elevations in the Yucaipa Ridge or Crafton Hills converges downstream in Yucaipa. T hese floods can overflow channels or adjacent floodways, quickly creating hazardous conditions for residents and motorists.

The Federal Emergency Management Agency (FEMA) is responsible for identifying flood hazards for communities across the nation. FEMA prepares maps that delineate Special Flood Hazard Areas - a 100-year and 500-year flood event. A 100-year flood is a flood event that has a 1% probability of occurring in any given year; a 500-year flood has 0.2% probability of occurring in any given year. The California Department of Water Resources also has identified areas prone to a 100-year flood using approximate assessment procedures, without specific depths and other flood hazard data. These maps are not FEMA regulatory floodplain maps.

Mudflow/Debris Flow

A mud/debris flow refers to a moving mass of loose mud, sand, soil, rock, water, and air that travels down a slope under the influence of gravity. A mud/debris flow can also flow down a stream, ravine, canyon, arroyo, or gulch. These flows develop when water rapidly accumulates in the ground during heavy rainfall or rapid snowmelt, changing loose earth into a flowing river of mud. Mud/debris flows can travel miles from the source, growing as they pick up trees, boulders, cars, and other materials.

The 2010 storms flooded low water crossings and created safety hazards.

Generally, areas most susceptible to mud/debris flow include steep slopes, landforms subject to erosion, and river channels. In areas burned by forest and brush fires, a lower threshold of rainfall may trigger mud/debris flows. In the past few decades, Yucaipa has experienced many smaller mud/debris flows and landslides along the Crafton Hills, northern Yucaipa, the Yucaipa Hills, and Oak Glen area that have damaged structures and roads. Planning for these situations is an essential post-fire recovery operation.

Figure 14, Floodplain Safety Overlay District, shows Yucaipa's potential safety hazards of riverine flooding and dam inundation.

Dam Inundation

Yucaipa continues to prioritize flood control projects to reduce potential flooding hazards. The $6.1 million Oak Glen Creek Basin Project, $7.2 million Wildwood Creek Basin Project, and other projects have significantly reduced flooding hazards in Dunlap Acres and other areas of the community.

Yucaipa has four open reservoirs. Built in 1978, three reservoirs are located in Yucaipa Regional Park and serve recreational purposes. These dams are owned and operated by the San Bernardino Valley Municipal Water District. The fourth reservoir is located in Crafton Hills, above the Yucaipa Regional Park. Originally built in 2001, the Crafton Hills Dam was improved in 2013, and the reservoir was tripled in size in 2014. An intertie along Mills Creek diverts water from the State Water Project to fill the expanded Crafton Reservoir.

Dam inundation refers to flooding when water retention structures and dams fail during an earthquake or other emergency. In the event of an earthquake or other catastrophic event, these reservoirs present a remote risk of failure or breach. In that event, floodwaters would extend southward along Oak Glen Road, potentially affecting 50 homes in Chapman Heights. To mitigate this hazard, dams are required to pass safety standards and annual inspections by the California Department of Water Resources.

The City of Yucaipa has additional closed reservoirs (either above or below grade) that are owned, operated, and maintained by the Yucaipa Valley Water District, Western Heights Water Company, and South Mesa Water Company. During a significant natural disaster, these reservoirs could fail and lead to localized inundation, although to a significantly lesser degree than dams. Water districts are required to ensure that closed reservoirs are built, maintained, and retrofitted in accordance with state safety standards.

Urban Flooding

Completion of the Oak Glen Creek Basins resulted in lifting floodplain restrictions for most properties in Dunlap Acres.

Urban flooding refers to the built environment of the City. Although Yucaipa's flood control and drainage infrastructure direct the majority of floodwaters, flooding during intense storms is inevitable due to the volume of water draining from the mountains. Moving debris can quickly overwhelm or impede well- designed channels and basins, spilling onto streets and property. Typically, storm drains are designed for normal rainfall and provide protection from a normal storm event. However, when larger storms occur or storm drains are blocked, flooding may occur.

Several areas in Yucaipa are more susceptible to urban flooding. In particular, Dunlap Acres and areas below the confluence at Yucaipa Creek and Wildwood Creek are subject to flooding. Areas where roads decline below grade (low water crossings) or where limited infrastructure is in place are also susceptible to flooding. The City continues to invest in flood control projects (detention basins, storm drains, streets, and sidewalks, etc.) to reduce flood risks. However, due to Yucaipa's unique topography and built environment, urban flooding remains a concern in Yucaipa.

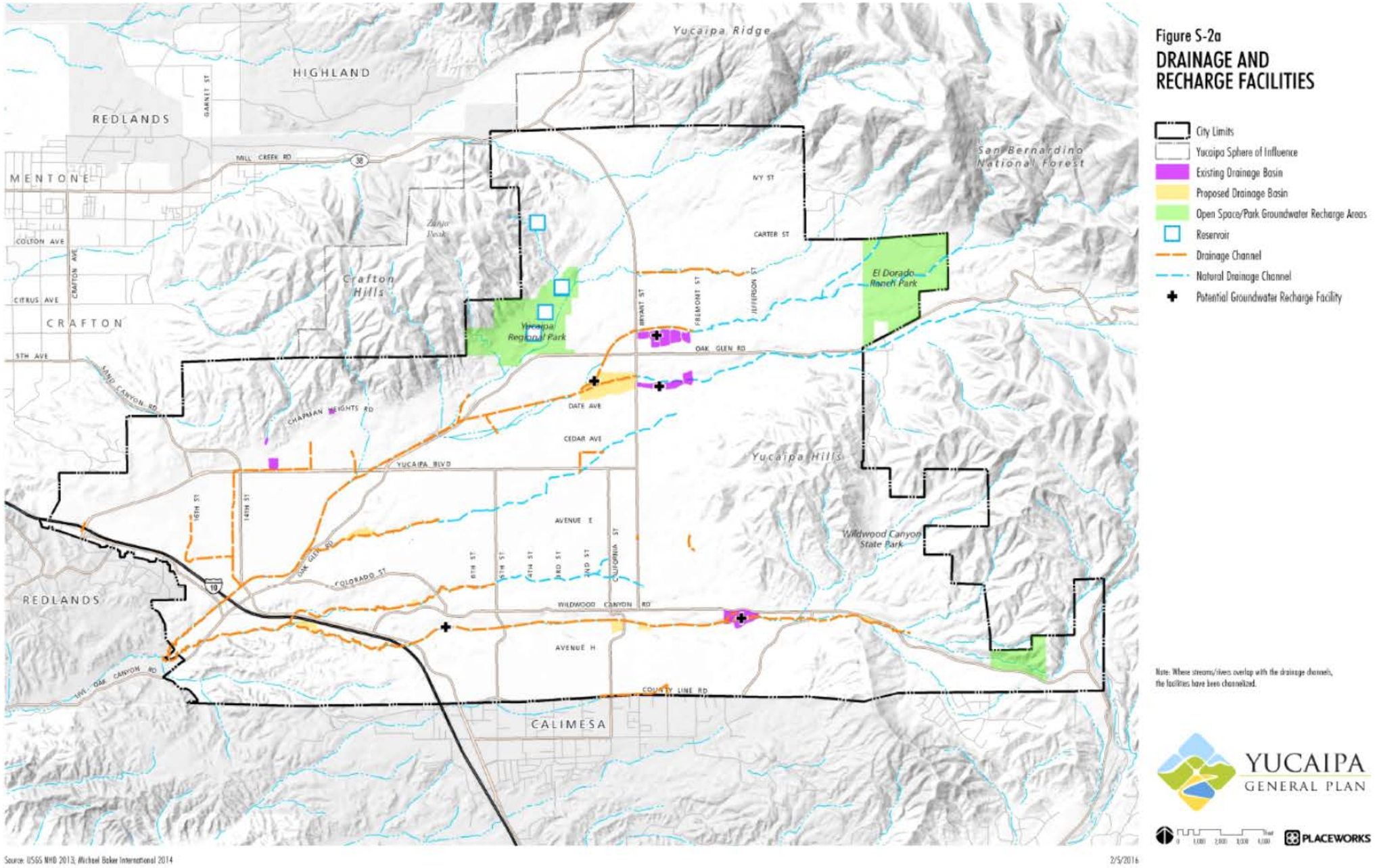


Figure 13 - Drainage and Recharge Facilities

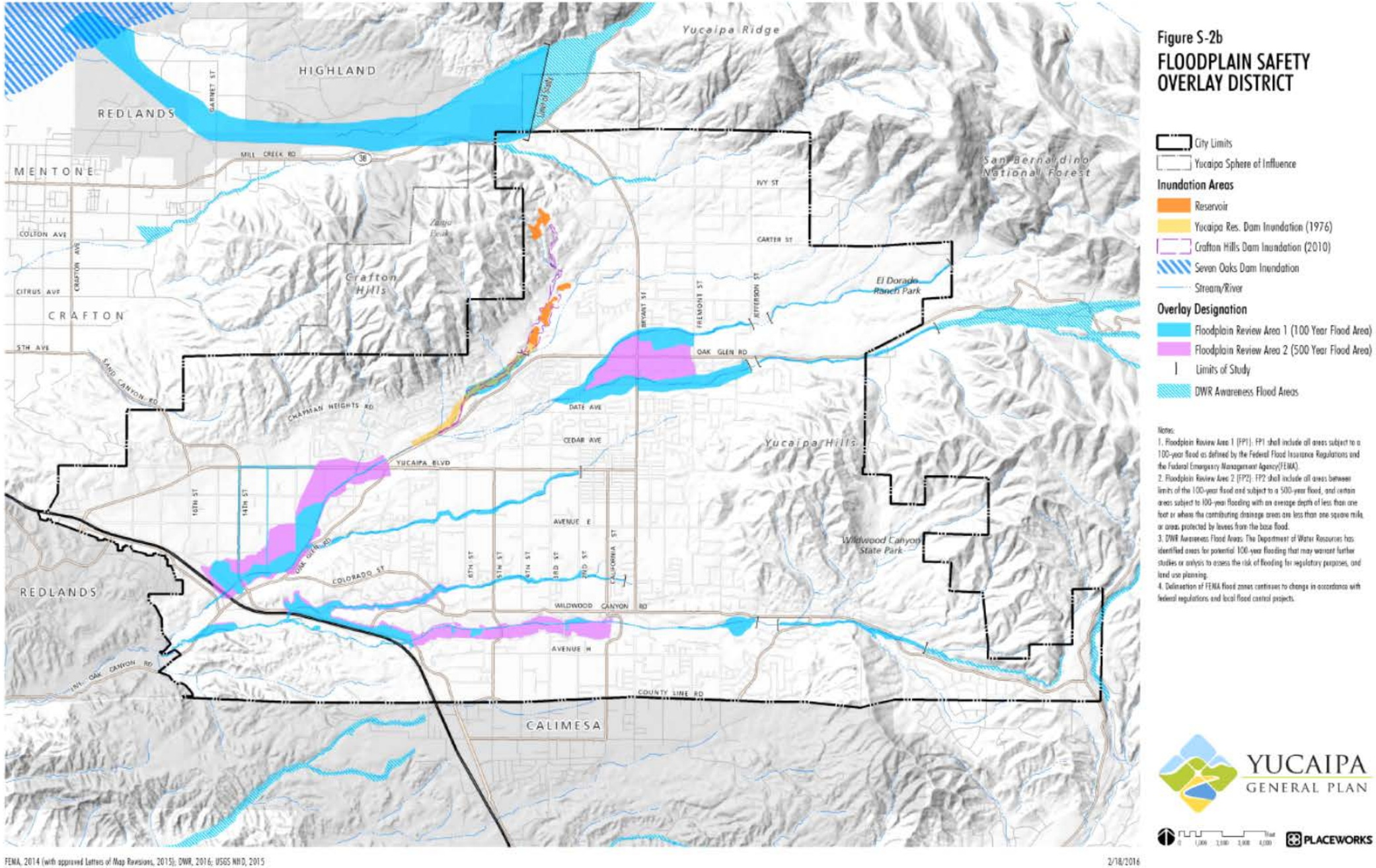


Figure 14 - Floodplain Safety Overlay District

4.2.1.3 Identification of Flood-Prone Areas

Substantial floodplain areas in Yucaipa are generally associated with the dry river washes known as Gateway Wash, Wilson Creek, Oak Glen Creek and Wildwood Creek, as well as Chicken Springs Wash and Yucaipa Creek. These areas have been mapped by the Federal Emergency Management Agency (FEMA) on their Flood Insurance Rate Maps (FIRM). The first version of these maps for the City of Yucaipa were prepared in March of 1996 and are reflected in the Fire and Flood Hazard Zones. In August of 2008 FEMA revised the FIRMS to reflect the Letters of Map Revisions (CLOMRS) that have been recorded and affected the Flood Prone areas within the City. There are two categories of flood zones in Yucaipa; FP1 indicates areas inside the 100-year floodplain, while FP2 indicates areas inside the 500-year floodplain.

The majority of the floodplains in Yucaipa are categorized as FP1 and comprise over 1,225 acres. FP2 areas cover over 300 acres. According to the National Flood Insurance Program, the City of Yucaipa has no repetitive loss properties within its jurisdiction. However, it is important to consider that the community has grown exponentially since the census of 2000. According to San Bernardino County the population as of 2007 was 51,046 with a Projected Population in 2012 of 58,187. This is a significant level of growth since the 2000 census when the City had a population of 41,207. The City's web site indicates that Yucaipa has grown over 27 percent since the census of 2000.

The Yucaipa Master Plan of Drainage carefully addresses development near floodplains, and the potential effects of upstream development that can create a certain level of impact at lower elevations. It is important to continue ongoing mitigation measures to reduce the risk of short- and long-term effects from flooding, and maintain the absence of repetitive loss properties within the community.

Floods are generally classed as either slow-rise or flash floods. Slow-rise floods may be preceded by a warning time lasting from hours, to days, or possibly weeks. Evacuation and sandbagging for a slow-rise flood may lessen flood related damage. Conversely, flash floods are the most difficult to prepare for, due to the extremely short warning time, if available at all. Flash flood warnings usually require immediate evacuation within the hour.

4.2.1.4 Previous Occurrences

Damaging floods have been reported in the Yucaipa area as early as 1862. Major floods are known to have occurred also in 1884, 1914, 1927, 1938, 1943, 1950, 1963, and 1969. San Bernardino County Flood Control District provides a link for visitors to review past flood history and view photographs commemorating some of the damage from those storms, at http://www.sbcounty.gov/dpw/floodcontrol/history.asp.

The National Weather Service offers an interesting perspective at its website, www.noaa.gov, where "This Day in History" publishes a daily critique of

Southern California's weather dating as far back as previous occurrences permit for the years in question.

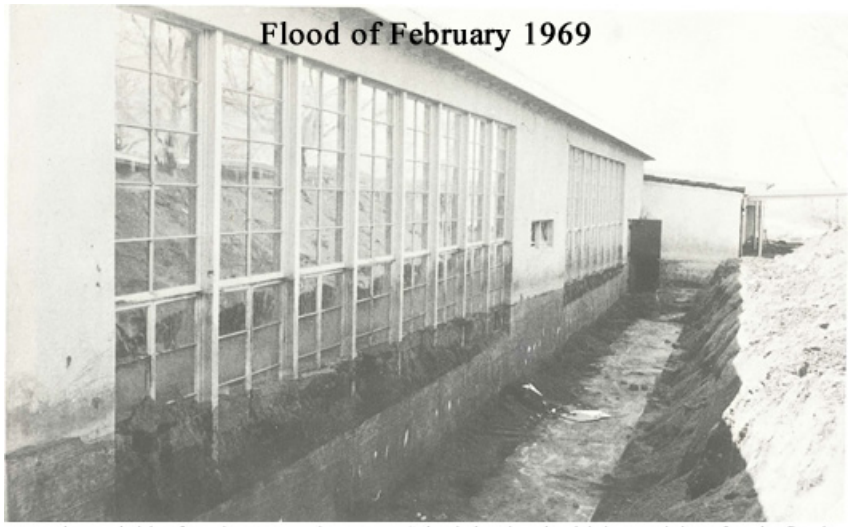
Nine major flood events have been recorded in the last 145 years or about one every 16 years. The 1969 flood event, which was actually two separate flood events in January and February 1969, were the most damaging on record for the Yucaipa Valley.

1969: Heavy rains of tropical origin began on 1/18/1969 ended on 1/28/1969. As much as 50 inches of rain fell at 7,700 feet. 31 inches of rain fell on the south slopes of Mt. San Gorgonio, 15.5 inches at San Jacinto Peak, around ten inches at Banning, less than 1 inch from Indio southeast. 87 were reported dead from flooding and mud slides all over California. Scores died in traffic accidents. Hundreds of homes and buildings were destroyed in slides, including 14 destroyed and 11 damaged homes in Mt. Baldy Village. 50 homes near Forest Home (Forest Falls) were damaged by flooding. Highways and railroads washed out. Power outages occurred. Cucamonga Creek itself caused $10 million in damage. The Mojave River took out numerous bridges and flooded farmlands in the upper desert. Strong storm winds felled trees which killed four and caused power outages.

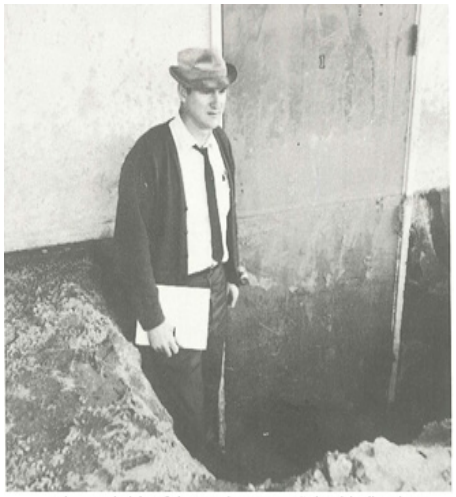
The flooding resulted from a total of 11.5 inches of rain that fell on the community in January 1969 and another 9.1 inches in February 1969. The floods resulted in damage to residential, business and agricultural properties. Floodwaters overtopped the channel in several locations.

Southwest corner of Avenue "E" and 12th Street in the Dunlap Acres area. Note the debris ranging from fine sand to large rocks.

Over 180 homes were flooded, one elementary school was inundated by water and mud to a depth of over 5 feet, numerous road crossings were damaged and over 400 acres of the community in the "Dunlap" area was flooded, with debris deposition in some areas reaching as much as 6 feet. About 300 families were evacuated during that flood, some narrowly escaping with their lives. The dollar damages in the 1969 storms amounted to approximately $4.1 million in 1969 dollars.



The northside of Dunlap Acres Elementary School showing the debris remaining after the flood. The debris was as deep as six feet.



The southside of the Dunlap Acres School indicating the debris depth after flooding.

House and car being flooded in the Dunlap Acreas area.

August 30 – September 5, 2009 Oak Glen and Pendleton Fires

On August 30, 2009 a vegetation fire was reported at Oak Glen Road and Potato Canyon Road. On August 31 a new fire was reported by air resources assigned to the Oak Glen incident. The arson-set fire areas had experienced above average temperatures and lower than average humidity in Southern California for 5 days prior to the incident. Wind was a minor contributor to the overall growth of the fire.

Thunderstorm development and dry lightning occurred during the third and fourth day of the incident. This produced measurable rainfall during the fourth day of 0.71 inches. With no recorded fire history since 1924 (85 years) this produced a major threat to now populated areas of the community, and resulted in evacuations lasting for several days. The two fires resulted in cumulative burn areas of 2,019 acres of prime watershed, setting the stage for flooding and major debris flow during the storm period of December 2009/January 2010. This same area is subject to winter storm snowfall and subsequent snowmelt.

Figure 15: December 2010/January 2011 Floods (DR-FEMA 1952-ca

The storm period began on December 18, 2010 and posed a significant threat and left in its wake dangerous conditions. On December 21st, the City Council met and declared a State of Local Emergency, further ratifying that proclamation on December 27, 2011. Fire personnel assisted dozens of residents in the Dunlap Acres area after floodwaters inundated the interiors of homes. The City's Public Works Department was active throughout the week initiating road closures, clearing debris in the roadway and responding to floods in various areas of the community. All of the detention basins and washes were pushed to capacity with the heavy downpours. Fast moving waters such as the Bryant Street wash were seen throughout the City.

The road to the Jerry Lewis Soccer complex was completely washed away by the storm. Residents in the Dunlap area were hit the hardest y the rains. Fire personnel assisted many residents from this location was water flooded homes. Crews used industrial equipment to remove some water from flooded homes near Dunlap Boulevard and 15th Street. Trees came down throughout Yucaipa, including one on the corner of Cedar and California Streets that fell from a circa 1900's residence onto a neighboring home. A voluntary evacuation was issued to residents in the Chapman Heights neighborhood of Comstock Street following a small mud slide. The homes are at the base of a portion of Crafton Hills that was burned in the arson fires of August 2009.

Date	Flooding Event Name	Annual Damage	Adjusted for Inflation (2013)
2011 – 1-	January 2011 Flood/Mud Slides	$78,863.00	$87,997.00
2010 1 22	Jan 2010 Flash Flood/Mud Slides	$20,000.00	$21,451.00
2005-1	Jan 2005 Flash Flooding	$20,000.00	$23,951.00
2002 11 30	Nov 2002 Stream Flood	Not documented	-
1999 7 11	Aug 1999 Flash Flood	$1,313,000	$1,843,220.00
1995 1 11	Storm 95-2		
1993 Jan.	Major Winter Storms	$106,365.00	$172,155.00
1992 Feb.	Winter Storm	$85,765.00	$142,968.00
1989-11-21	**Yucaipa Incorporation**		
1969 2 25	Feb 1969 Flood	$4,279,000.00	$27,268,656.00
1969 1 25	Jan 1969 Flood	$1,209,000.00	$7,704,558.00
1967 8 23	Aug 1967 Flood	$20,000.00	$140,046.00
1966 12 8	Dec 1966 Flood		
1965 – 11	November 1965 Flood	$34,000.00	$252,439.00
1965 8 14	Aug 1965 Flood	$5,000.00	$37,123.00
1965 4 10	April 1965 Flood	$2,000.00	$14,849.00
1963 8	August 1963 Flash Flood	$300,000.00	$2,292,912.00
1950 7 1	July 1950 Flood	$2,000.00	$19,409.00

Event Source: California Office of Emergency Services 2013; Inflation Adjustment Source: www.data.bls.gov

4.2.1.5 Hazard Summary for Flooding

The following map illustrates the probability of occurrences in the Special Flood Hazard Area (SFHA) for the City of Yucaipa.

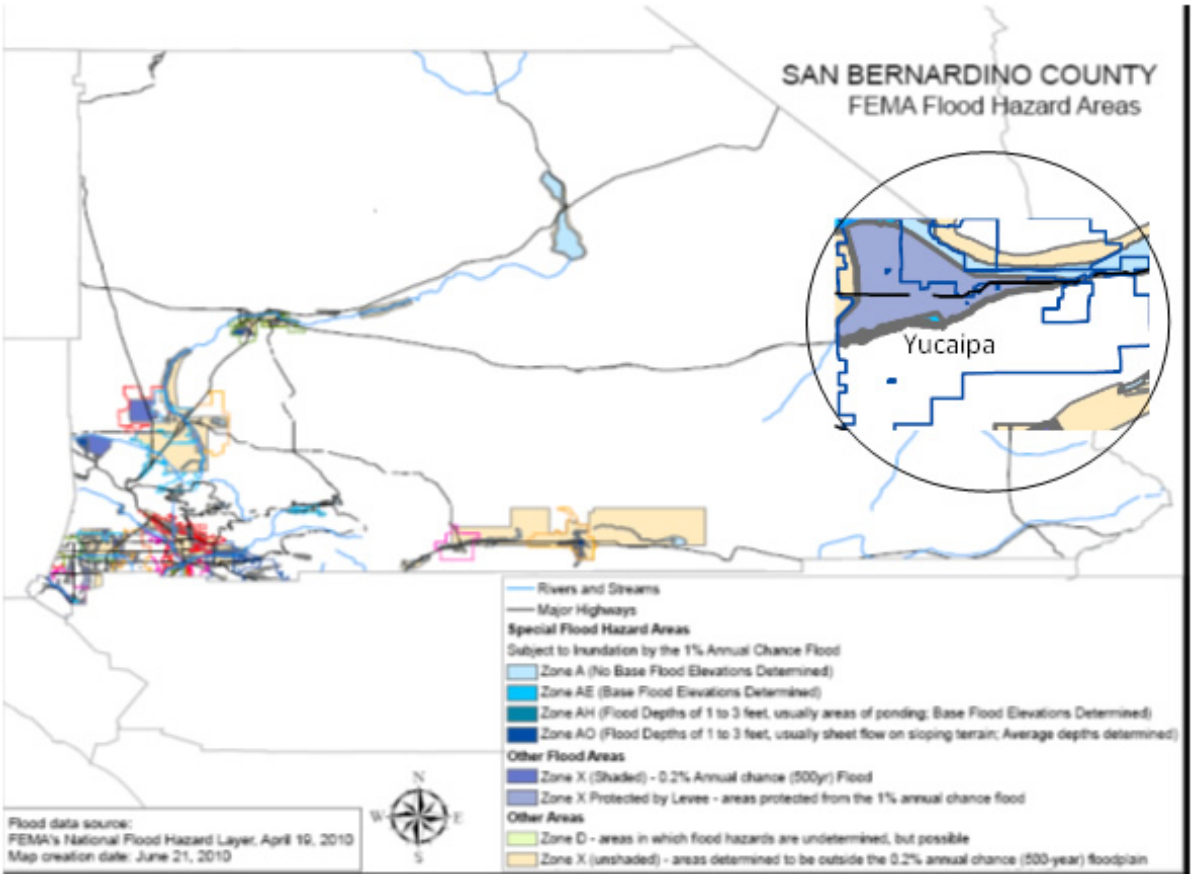


Figure 16: FEMA Flood Map

4.3 Inventory Assets

Step three in the risk assessment process involves inventorying assets located in the community. Section 4.1 profiled the hazards in Yucaipa. This information was used to identify the assets at risk from those hazards. Some hazards (such as earthquakes) may affect the entire community while some affect limited areas (flooding incidents). This section provides a description of the inventory development and prioritization process.

4.3.1 Population

Pursuant to population statistics provided through the 2010 Census, the impacts of natural hazards in terms of ability to recover vary greatly among the population. As the events associated with the Hurricane Katrina in the Gulf Coast have shown, vulnerable populations, including seniors, disabled citizens, women, and children, as well as those people living below the poverty level, are often disproportionately impacted by natural hazards.

With the recent adoption of the General Plan Update, the Freeway Corridor Specific Plan and the General Plan Housing Element, there have been some substantial changes in land use categories as well as in future levels of anticipated development. The proposed revisions reflect land use designations and they do not include any changes related to the proposed annexation. The total number of projected dwelling units has increased from 25,456 to 30,077, which results in an increase in the projected "buildout" population of the City from 68,690 to 77,328.

4.3.2 Critical Facility List

The City of Yucaipa incorporated on November 27, 1989 and inherited nearly all of the critical facilities currently in use today. Many of the facilities were built to 1987 Uniform Building Code Standards. And, as such, did not reflect the codes and standards of latter day construction. The following critical infrastructure and critical facilities include fire stations, government facilities, major roads/bridges, police station, schools, telecommunications, and utilities.

Fire Stations

The City assumed responsibility for fire protection and paramedic services on July 1, 1999. Fire protection and paramedic services are provided to the City through a contractual agreement with the California Department of Forestry and Fire Protection (CAL Fire). The City and the County Fire Department developed an agreement to provide similar services to Oak Glen and the unincorporated regions along the eastern boundaries of the City. The agreement was renewed in July 2000 for a five-year period and is continuous until cancelled by either party. The administration of fire and paramedic services for Oak Glen is included in the agreement. CAL Fire currently provides the following emergency services: fire suppression, hazardous materials protection, emergency medical treatment including basic and advanced life support transportation, earthquake and fire safety planning, fire inspections and building plan reviews. There are three fire stations located within the City.

- Fire Station No. 1, 11416 Bryant Street, Yucaipa, CA 92399

- Fire Station No. 2, 32664 Yucaipa Blvd, Yucaipa, CA 92399
- Fire Station No. 3, 34259 Wildwood Canyon Road, Yucaipa, CA 92399

Government Facilities
The critical government facilities that are located in the City include: City Hall, EOC, Public Works Yard, Records Center, Scherer Community Center, Yucaipa Community Center, and the Yucaipa Police Department.

- City Hall, 34272 Yucaipa Blvd., Yucaipa, CA 92399
- Yucaipa Police Department/San Bernardino County Sheriff, 34144 Yucaipa Blvd., Yucaipa, CA
- EOC, 34272 Yucaipa Blvd., Yucaipa, CA 92399
- Public Works Yard, 11377 2nd Street, Yucaipa, CA 92399
- Records Center, 11377 2nd Street, Yucaipa, CA 92399
- Scherer Community Center, 12202 1st Street, Yucaipa, CA 92399
- Yucaipa Community Center, 34900 Oak Glen Road, Yucaipa, CA 92399

Public Facilities
The critical public facilities that are located in the City of Yucaipa include the following:

- San Bernardino County Library, Yucaipa Branch, 5th Street, Yucaipa, CA 92399
- Yucaipa Transit Center, Yucaipa Blvd., Yucaipa, CA 92399

EOC
Local emergency operations may be managed in three phases (Pre-Impact Phase, Immediate Impact Phase and Sustained Emergency Phase) depending on the magnitude of the emergency. The City Emergency Operating Center (EOC), which is located at 34272 Yucaipa Blvd., will be activated for Levels II and III. Level I activation will be determined by inter-agency coordination. The new police department facility serves as the City's Alternate EOC. The new facility is located at 34144 Yucaipa Blvd (adjacent to Yucaipa City Hall).

Major Roads and Bridges
The Interstate 10 freeway travels an east/west direction immediately adjacent to the City of Yucaipa. There are several arterials and collector streets that make up the City's circulation system. Caltrans maintains and operates several bridges on the highways and roads in and around the City. These bridges form the backbone of the transportation infrastructure of the City of Yucaipa. Figure 25 depicts the City's Transportation Network Map.

- 3rd Street Bridge
- 5th Street
- 5th Street Bridge

- 10th Street Bridge
- 14th Street
- 14th Street Bridge
- Avenue "E" Bridge
- Avenue E
- Bryant Street
- Bryant Street Bridge
- California Street
- Oak Glen Road
- Wildwood Canyon Road
- Yucaipa Blvd. Bridge
- Yucaipa Boulevard

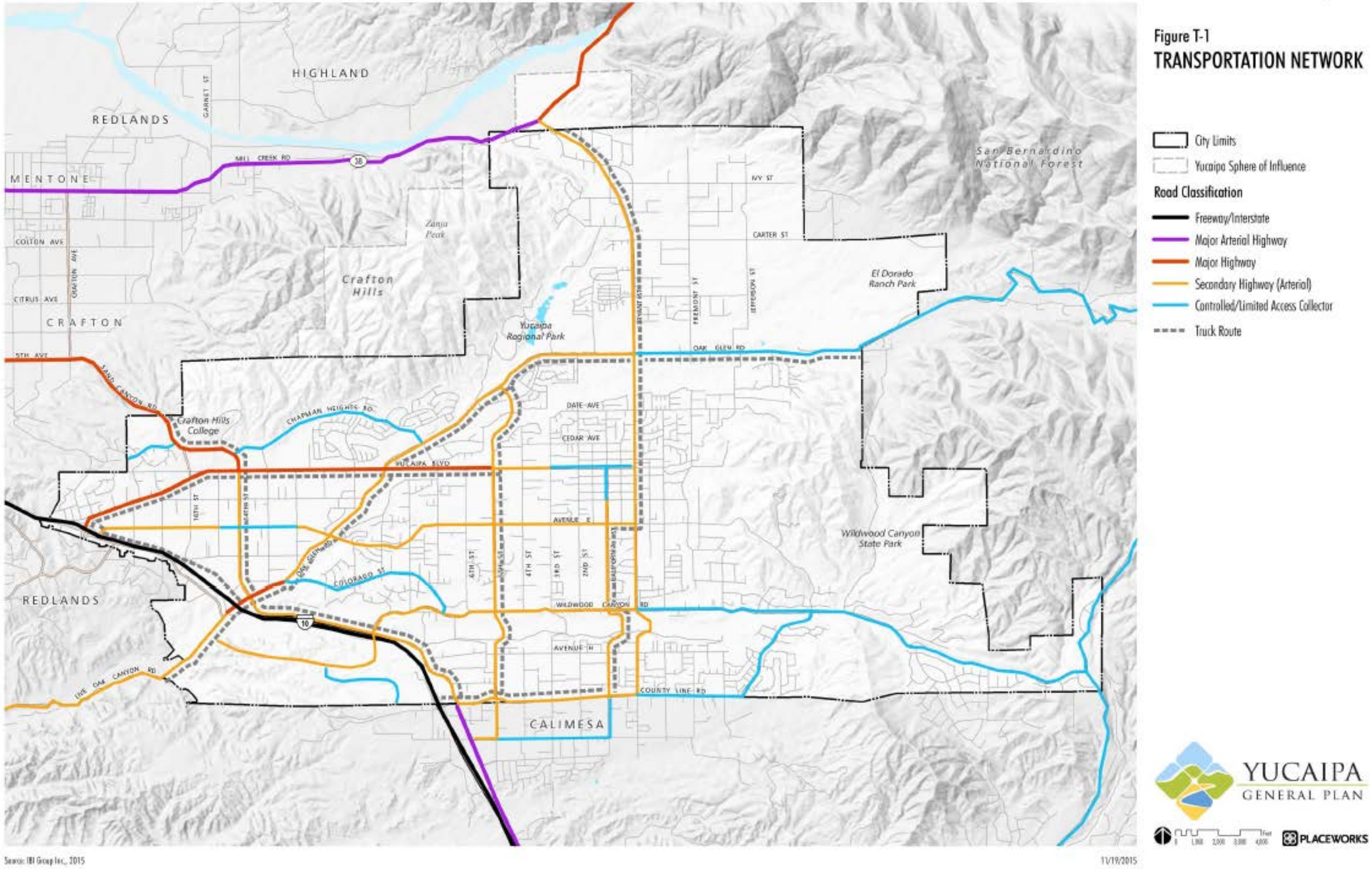


Figure 17 - Transportation Network Map

Police Station
The Yucaipa Police Department operates one police station located at 34144 Yucaipa Boulevard. The Law Enforcement Incident Command System, the Master Mutual Aid Plan, and the National Incident Management System (NIMS) are used to coordinate response to local and state emergencies.

Schools
The Yucaipa-Calimesa Joint Unified School District has eight elementary schools, two middle schools, and three high schools, many of which are on a year-round schedule.

School	Address	Telephone
Calimesa Elementary School	13523 2nd Street, Yucaipa, CA 92399	909-790-8570
Competitive Edge Charter Academy (Formerly Meadow Creek Elementary School)	34450 Stonewood Drive Yucaipa, CA 92399	909-790-3207
Chapman Heights Elementary School	33692 Cramer Road Yucaipa, CA 92399	909-790-8080
Dunlap Elementary School	32870 Avenue E Yucaipa, CA 92399	909-7975171
Green Valley High School	35948 Susan Street Yucaipa, CA 92399	909-790-8580
Inland Leaders Charter School	12375 California Street Yucaipa, CA 92399	909-446-1100
Mesa View Middle School	800 Mustang Way Yucaipa, CA 92399	909-790-8008
Oak View High School (Educational Center)	12358 Sixth Street Yucaipa, CA 92399	909-797-7931
Park View Middle School	34875 Tahoe Drive Yucaipa, CA 92399	909-790-3285
Ridgeview Elementary School	11021 Sunnyside Drive Yucaipa, CA 92399	909-790-3270
Valley Elementary School	12333 8th Street Yucaipa, CA 92399	909-797-1125
Wildwood Elementary School	35972 Susan Street Yucaipa, CA 92399	909-790-8521
Yucaipa High School	33000 Yucaipa Blvd. Yucaipa, CA 92399	909-797-0106
Crafton Hills College and Crafton Hills Fire Academy	11711 Sand Canyon Road Yucaipa, CA 92399	909-389-3323

Figure 18: Yucaipa-Calimesa JUSFD - Listing of Schools

Telecommunications
Local telephone service is provided by Verizon. Several providers, including Verizon, provide long distance phone service to Yucaipa and also provide internet access via FIOS,

DSL, cable modem, satellite, and dialup features. City residents have a number of options for internet service, including service by Verizon, Time Warner cable, and local ISPs. All major cellular phone service provider companies are licensed and monitored by the California Public Utilities Commission (CPUC).

Utilities

Electric Power
Southern California Edison (SCE) supplies electrical energy to the City of Yucaipa.

Natural Gas
Southern California Gas Company (SoCal Gas) is the supplier of natural gas to the City of Yucaipa. Currently, SoCal Gas maintains transmission and distribution lines throughout the City. Most lines operate at a medium pressure of approximately 30 to 60 pounds per square inch (psi). Most Yucaipa streets have SoCal Gas network pipelines running under them. The Public Utilities Commission (PUC) regulates So Cal Gas.

Utilities – Water

- Yucaipa Valley Water District
- Yucaipa Valley Water District Wastewater Treatment Plant
- South Mesa Water Company
- Western Heights Water Company

Wastehauler

- Burrtec Industries

4.3.3 Protection and Preservation of Public Facilities, Critical Infrastructure, and Lifeline Services

Disaster planning and recovery depend on a reliable network of public facilities, critical infrastructure, and lifeline services. Public facilities include police and fire stations, schools, community centers, and emergency operations and communication centers. Critical infrastructure includes generators, water and sewer lines, utilities, transportation routes, etc. Lifeline services critical to health and safety include water, sewer, energy, waste disposal, communications, and others. Figure 18, Critical Facilities and Infrastructure, identifies critical facilities and infrastructure.

Emergency preparedness extends beyond construction activities to planning in system redundancies so that a single event (e.g., power failure or road failure) does not prevent the provision of essential services, such as paramedics, water supply, or other service. California law mandates that buildings, bridges, and infrastructure be built in accordance with state and federal building standards to protect from flooding, earthquakes, fire, and other disasters. The City periodically upgrades facilities in accordance with the above.

Evacuation Routes

With its location in the foothills and near wildlands, Yucaipa is subject to natural hazards. These include 100-year floodplains, active faults and geological hazards, very high fire severity zones, and other natural hazards. During an emergency, evacuation routes are needed to move people to safe locations and move equipment to affected hazard areas. Yucaipa has three levels of evacuation routes, depending on the emergency.

Local Routes. Eight arterials (Bryant, Oak Glen, Yucaipa, 14th Street, Wildwood Canyon, County Line, Calimesa Boulevard, and Mesa Grande) are designated as evacuation routes.

Regional Routes. The San Bernardino County General Plan has designated Oak Glen Road as the primary regional evacuation routes for the Oak Glen Mountain community.

Federal and State Routes. Interstate 10 is the primary federal evacuation route while Highway 38 is the primary state- designated evacuation route from the mountain communities.

The precise evacuation route to use during an emergency depends on many factors, including the type of natural disaster, location of incident, weather conditions, road conditions, and traffic volume. Figure 19, Evacuation Routes in Yucaipa, identifies the local, regional, and state/federal evacuation routes in the City.

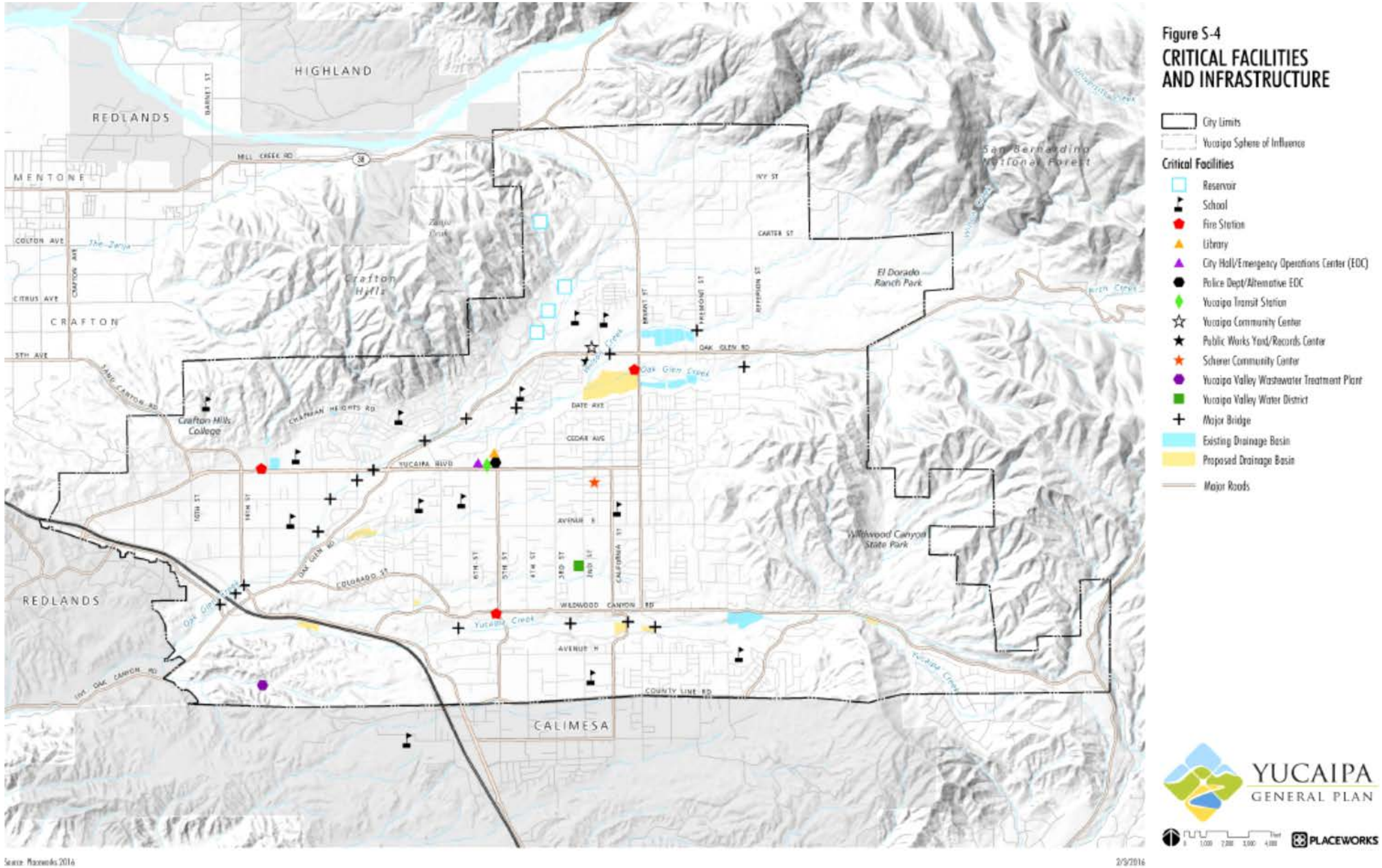


Figure 19 - Critical Facilities and Infrastructure

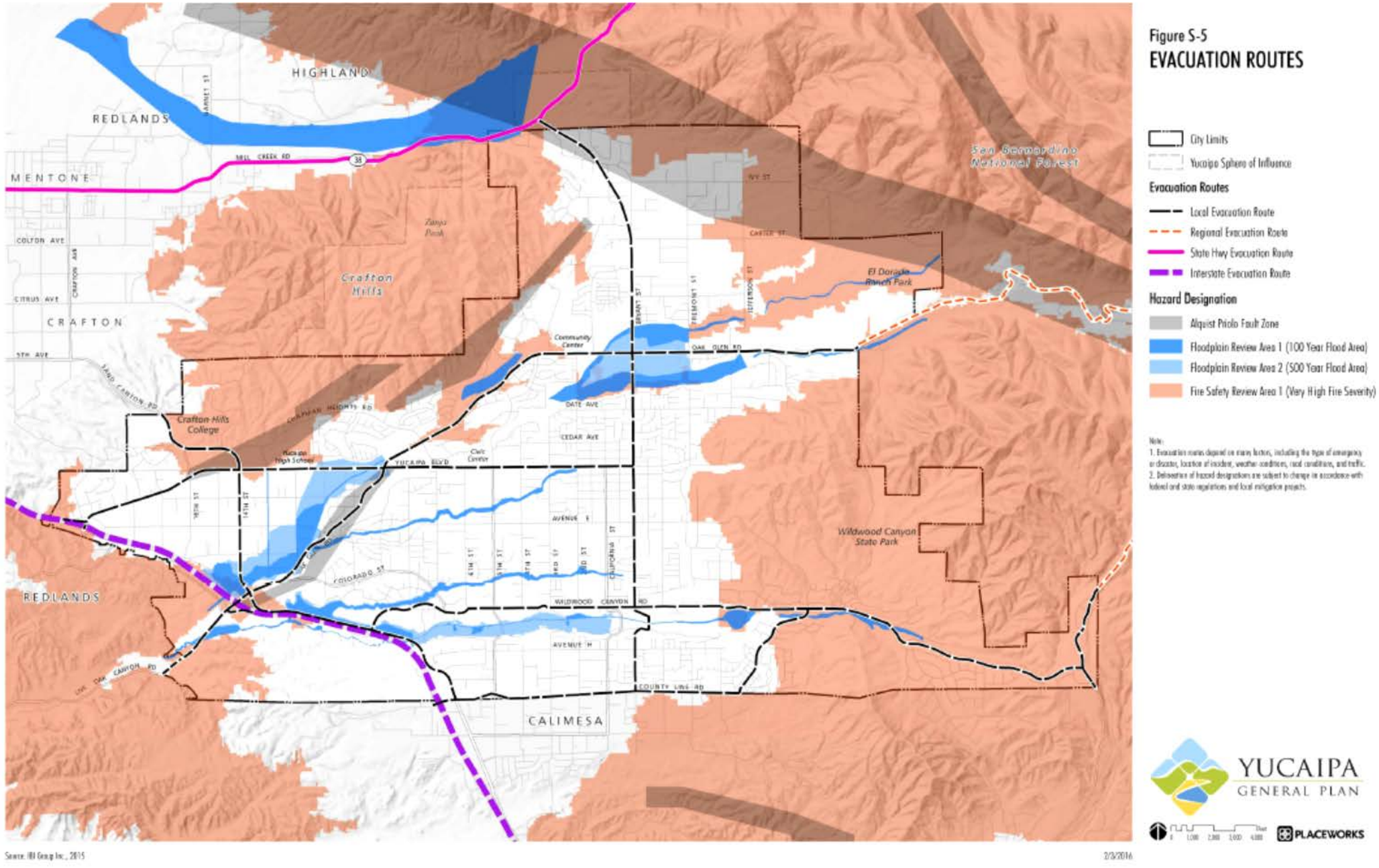


Figure 20 - Evacuation Routes

4.4 Vulnerability Assessment

The Federal Emergency Management Agency (FEMA) sponsored a pilot project to perform a risk assessment of essential facilities using its HAZUS-MH. The objective of the pilot project was to demonstrate the synergy between HAZUS-MH and FEMA's Map Modernization program to update Digital Flood Insurance Rate Maps (DFIRMs) for three Southern California counties (Orange, Riverside, and San Bernardino) and to illustrate the types of information HAZUS-MH can generate for hazard mitigation planning. In the pilot, HAZUS-MH was used to estimate the impact of two different earthquakes and three different riverine floods on each county's infrastructure, including both regional building inventories (referred to within HAZUS-MH as the "general building stock") and essential facilities.

This section provides an assessment of vulnerability for flood hazard areas that pose significant threats to the City of Yucaipa. This is the final step in the four-step risk assessment process and utilizes data and information collected from the City and various external agencies. It provides loss estimates and vulnerability of general buildings, key facilities with critical functions and governance relationships, and people living and working in the City of Yucaipa. The vulnerability assessment provides a solid basis for analyzing the risk, the potential exposure, and consequences to City operations and safety.

The following were taken into account when assessing the vulnerability:

- Updates to inventories of existing structures in hazard areas, including new development, redeveloped areas or structures located in annexed areas
- Potential impacts of future land development, including areas that may be annexed in the future
- New buildings that house special high-risk populations (i.e., elderly, low-income, disabled)
- Completed mitigation actions that reduced overall vulnerability

4.4.1 Methodology

In accordance with the updated Master Plan of Drainage, the flood vulnerability assessment was conducted using a hydrology analysis using the Army Corp of Engineers HEC-RAS River Analysis System. Reports are available from the City and various other public sources, including the FEMA-funded SBEFRA Project.

4.4.1.1 Methodology and Results for Flooding

The City is using two separate models to present the methodology for this section. The first model represents the U.S Army Corps of Engineers HEC-RAS Analysis System (4.4.3.1); the second model represents the County level results of the FEMA-funded SBEFRA Project (4.4.3.2).

4.4.1.2 HEC-RAS Analysis System

The U.S Army Corps of Engineers HEC-RAS Analysis System was used to compute one-dimension steady flow calculations. A 100-year floodplain hydraulic model was created based on cross-sections defining channel and overbank geometry. A total of 17 cross-

sections defines the Wilson Creek study reach and a total of 17 cross sections define the Wildwood Creek. Figure 3 (*captioned as Figure 21 in this plan*) shows the locations of the HEC-RAS cross sections. Floodplain overbank roughness coefficients (Manning's "n" values) were estimated based on development structural density. The overbank "n" value is assumed as 0.05.

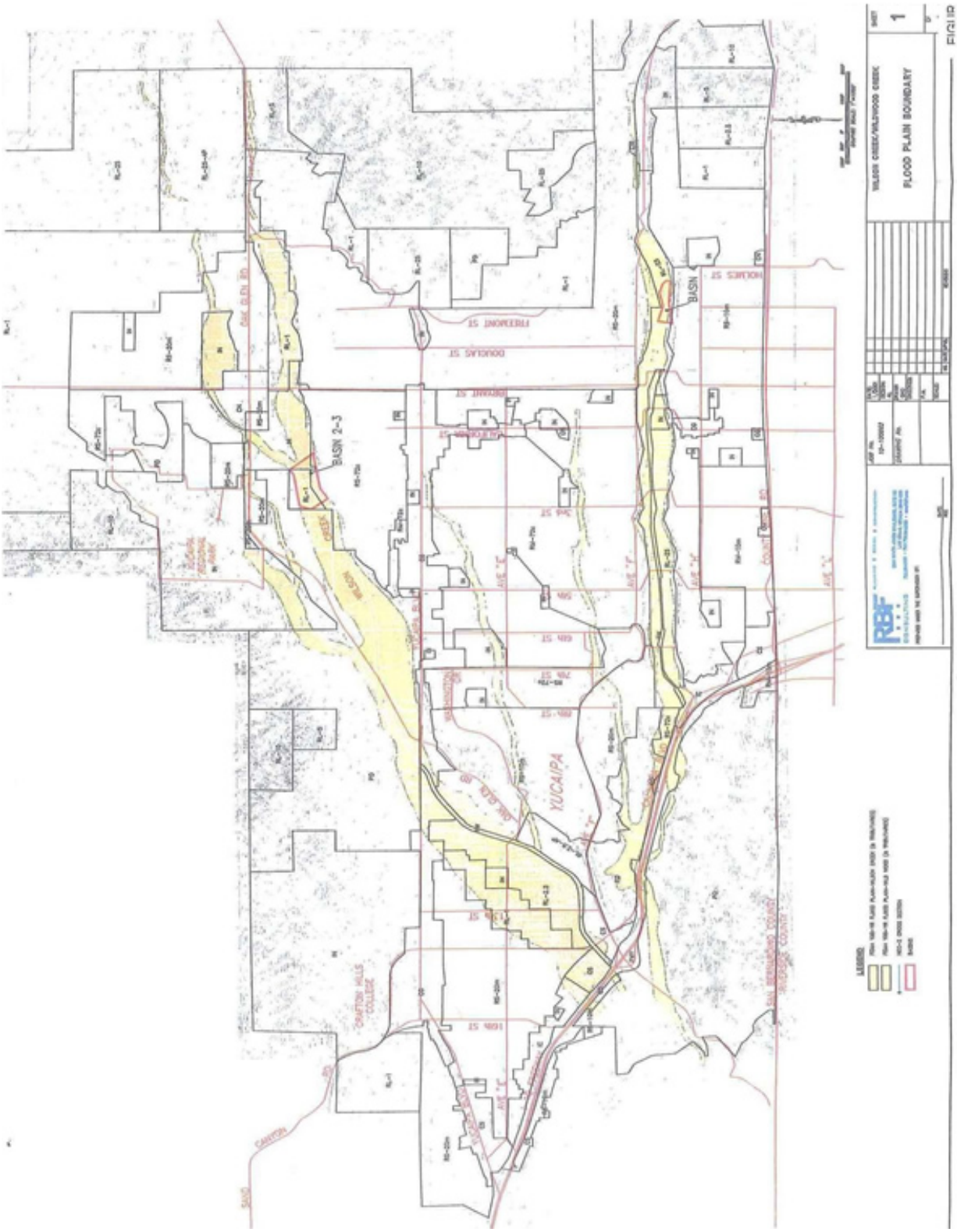


Figure 21: Cross -Section Locations (Figure 3)

The 100-year floodplain width ranges from approximately 900 feet to as wide as 3, 00 feet along Wilson Creek. For Wildwood Creek, the 100-year floodplain has a uniform width of approximately 900 feet. Since the floodplain is relatively wide for both channels, the flood depth along the structures was based on hydraulic depth (the ratio of flow area and top width.) Results of the analysis indicate that the structures along Wilson Creek are currently subject to a 100-year flooding depth ranging from 1.2 feet to 3.2 feet. Along Wildwood Creek, the structures are currently subject to a 100-year flooding depth ranging from 1.2 feet to 3.2 feet. Tables 5 and 6 (captioned as Tables 8 and 9 in this plan) summarize the floodplain hydraulics for Wilson Creek and Wildwood Creek for each scenario evaluated.

The Wilson Creek study reach is divided into six reaches (W1 through W6). Reaches have been defined based on similarities in flooding depth and floodplain width. Similarly, the Wildwood Creek study reach is divided into six reaches (WW1-WW6). Figure 3 (captioned as Figure 21 in this plan) shows the limits of each subreach.

The results of the floodplain hydraulic analysis performed for this study may vary compared to the analysis used to determine the FEMA floodplain. The analysis used to define the FEMA floodplain was not available at the time of this study. The FEMA Flood Insurance Rate Map (FIRM) which shows the 100-year floodplain was available at the time of the study. Differences in hydraulic characteristics may slightly vary due to different assumptions used in the study. If the FEMA effective floodplain boundaries exceeded the floodplain limits based on the analysis performed for this study, FEMA floodplain limits were conservatively used for flood damage determination. Portions of the FIRM maps were enclosed in Appendix E (of the study) for reference. Separate hydraulic models were created to reflect the three channel scenarios. Summaries of the channel hydraulics based on each channel scenario are provided in the following tables.

Table 5. Wilson Creek Floodplain Hydraulics - Scenario 1: Existing Condition
No Detention Basins or Channel Improvements

HECRAS Section Number	100-Yr Peak Discharge (cfs)	Water Surface Elevation (ft)	Flow Area (sf)	Top Width (ft)	Hydraulic Depth (ft)	Reach Average Hydraulic Depth (ft)	Reach ID
1	15,730	2042.6	2249.4	1505	1.5		
2	15,730	2062.8	2777.7	1063	2.6	2.1	W1
4	15,730	2078.9	2502.0	1520	1.6		
5	15,730	2092.4	3206.3	1517	2.1		
6	15,120	2101.0	1993.8	743	2.7	2.1	W2
7	15,120	2123.8	1529.8	469	3.3	3.3	W3
8	13,990	2173.1	1557.4	625	2.5		
9	13,990	2202.3	1803.8	954	1.9	2.2	W4
10	13,630	2241.4	1878.9	1151	1.6		
11	13,630	2271.0	1478.9	535	2.8		
12	13,630	2310.2	1475.0	557	2.6		
13	13,630	2340.3	1382.5	458	3.0		
14	13,630	2366.1	1832.0	868	2.1	2.4	W5
15	10,320	2401.2	1635.7	1335	1.2		
16	10,320	2441.2	1626.7	1332	1.2		
17	10,320	2474.5	1143.0	457	2.5	1.6	W6

Figure 22: Wilson Creek Floodplain Hydraulics

Table 6. Wildwood Creek Floodplain Hydraulics- Scenario 1: Existing Conditions

No Detention Basin and No Channel Improvements

HECRAS Section Number	100-Yr Peak Discharge (cfs)	Water Surface Elevation (ft)	Flow Area (sf)	Top Width (ft)	Hydraulic Depth (ft)	Reach Average Hydraulic Depth (ft)	Reach ID
1	7,700	2307.4	797.5	282	2.8	2.8	WW1
2	7,700	2322.0	1856.6	957	1.9		
3	7,700	2327.0	1479.9	299	4.9		
4	7,700	2361.4	1130.7	794	1.4		
5	7,700	2375.4	1300.3	375	3.5	2.9	WW2
6	7,700	2401.9	1004.4	557	1.8		
7	7,700	2441.7	1060.5	650	1.6		
8	7,700	2471.5	814.6	294	2.8	2.1	WW3
9	7,500	2483.6	1473.6	446	3.3		
10	7,500	2521.1	1188.1	969	1.2		
11	7,500	2551.3	1004.0	536	1.9	2.1	WW4
12	7,500	2579.2	724.1	218	3.3		
13	7,300	2604.5	733.7	242	3.0		
14	7,300	2652.8	921.7	481	1.9		
15	7,300	2681.6	1067.3	672	1.6		
16	6,960	2722.8	863.1	431	2.0		

Figure 23: Wildwood Creek Floodplain Hydraulics

The estimation of the property damage is based on damage curves developed by the Federal Emergency Management Agency (FEMA) on estimating the percent of value of the structure and contents as a result of flooding. Current available damage curves (FEMA damage curves, 1998) for residential and non-residential structures were used for this analysis. The following Figures show the residential and non-residential structural and content damage curves, respectively. Non-Residential Structure Flood Damage Curves

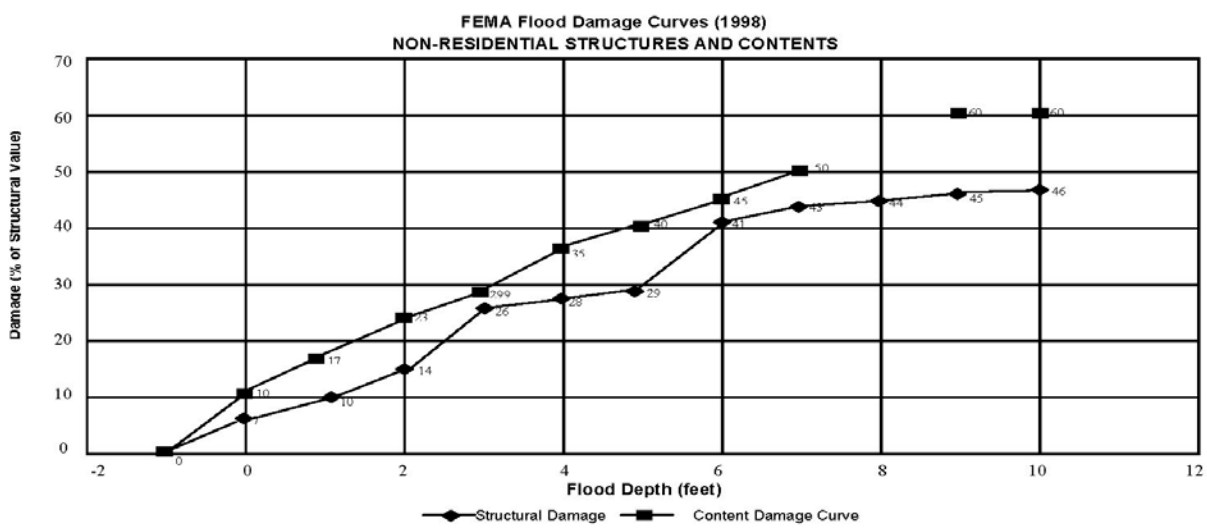


Figure 24: Non-Residential Structure Flood Damage Curves

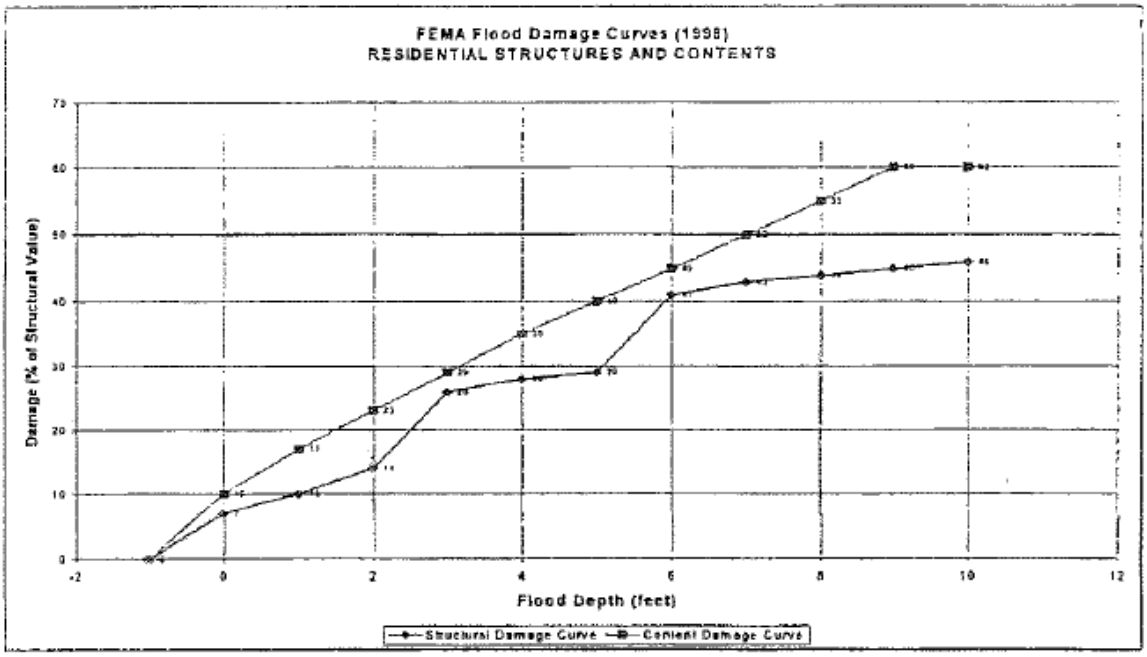


Figure 25: Residential Structures FEMA Flood Damage Curves

The cost of potential floodplain damage is based on the following components: (1) flooding depth, (2) number of structures in the floodplain, and (3) estimated structural cost. The derivation of each of these components is described below.

Flooding Depth

The estimation of the average flooding depth is described in Section 3. An adjusted flooding depth was determined based on field observation of the existing structures within the floodplain. Field survey of some structures indicate that most home are elevated at least 0.5 feet above the ground. For structural damage analysis, the effective flooding depth is assumed to be 0.5 feet less than the average flooding depth for the reach.

Number of Structures

The number of structures within the floodplain was determined based on the City of Yucaipa's General Land Use Plan as well as the 1994 Development Code. The floodplain limits were overlayed on the Land use plan to determine the area of each land use type within the floodplain. The Development Code provides the density of number of dwelling units or non-residential units for each land use type.

Estimated Structural Cost

Structural cost is based on a review of available real estate values based on recent listings of residential and non-residential properties for sales. This analysis assumes an average residential structural cost of $130,000 and the non-residential structural cost is $400,000 for a non-residential structure within 2/3 to 1 acre lot. This estimation can be further refined by obtaining assessed values of homes within the floodplain reaches. The following Tables summarize the potential damage costs for structures (existing and

future) along the Wilson Creek and Wildwood Creek floodplain. The tables provide a total damage cost for each study sub-reach based on the number of structures (existing and future) within the reach, the average flooding depth, and assumed structural cost. The Tables summarize the floodplain damage cost under existing condition.

Table 11. Wilson Creek Summary of Potential Structure Flood Damage - 100-Year Flood Existing Condition (Scenario 1)

		Reach						
		W1	W2	W3	W4	W5	W6	Total $
Residential	No. Structures	101	131	84	202	461	505	
	Avg. Value	$120,000	$120,000	$120,000	$120,000	$120,000	$120,000	
	Flood Depth (ft)	2.1	2.1	3.3	2.2	2.4	1.6	
	Adjust Flood Depth (ft)	1.6	1.6	2.8	1.7	1.9	1.1	
	%Damage	12.2	12.6	23.2	12.8	13.7	10.6	
	Struct Damage ($)	$1,480,700	$1,979,300	$2,336,800	$3,095,200	$7,600,700	$6,423,300	$22,916,000
	%Content Damage	20.3	20.9	27.6	21.2	22.6	17.9	
	Content Damage ($)	$2,463,500	$3,283,300	$2,781,200	$5,127,700	$12,507,500	$10,847,000	$37,010,200
Comm/Ind	No. Structures	39	2	9	28	4	0	
	Avg. Value	$400,000	$400,000	$400,000	$400,000	$400,000	$400,000	
	Flood Depth (ft)	2.1	2.1	3.3	2.2	2.4	1.6	
	Adjust Flood Depth (ft)	1.6	1.6	2.8	1.7	1.9	1.1	
	%Damage	12.2	12.6	23.2	12.8	13.7	10.6	
	Struct Damage ($)	$1,905,900	$100,700	$834,600	$1,430,100	$219,800	$0	$4,491,100
	%Content Damage	20.3	20.9	27.6	21.2	22.6	17.9	
	Content Damage ($)	$3,170,850	$167,090	$993,290	$2,369,220	$361,750	$0	$7,062,200
Total Damage per Reach		$9,020,950	$5,530,390	$6,945,890	$12,022,220	$20,689,750	$17,270,300	
Wilson Creek Total Damage								$71,479,500

Figure 26: Wilson Creek Summary of Potential Structure Flood Damage - 100 Year Flood Existing Conditions (Scenario 1)

Table 12. Wildwood Creek Summary of Potential Structure Flood Damage - 100-Year Flood Existing Condition (Scenario 1)								
		Reach						
		WW0	WW1	WW2	WW3	WW4	WW5	Total $
Residential	No. Structures	205	212	69	51	48	0	
	Avg. Value	$120,000	$120,000	$120,000	$120,000	$120,000	$120,000	
	Flood Depth (ft)	2.8	2.8	2.9	2.1	2.1	2.4	
	Adjust Flood Depth (ft)	2.3	2.3	2.4	1.6	1.6	1.9	
	%Damage	15.3	15.3	19.3	12.3	12.5	13.5	
	Struct Damage ($)	$3,768,300	$3,896,900	$1,601,400	$751,200	$722,400	$0	**$10,740,200**
	%Content Damage	25.0	25.0	25.7	20.4	20.8	22.2	
	Content Damage ($)	$6,144,400	$6,354,200	$2,125,500	$1,249,200	$1,198,800	$0	**$17,072,100**
Comm/Ind	No. Structures	0	5	2	0	8	3	
	Avg. Value	$400,000	$400,000	$400,000	$400,000	$400,000	$400,000	
	Flood Depth (ft)	2.8	2.8	2.9	2.1	2.1	2.4	
	Adjust Flood Depth (ft)	2.3	2.3	2.4	1.6	1.6	1.9	
	%Damage	15.3	15.3	19.3	12.3	12.5	13.5	
	Struct Damage ($)	$0	$306,400	$154,700	$0	$401,300	$161,900	**$1,024,300**
	%Content Damage	25.0	25.0	25.7	20.4	20.8	22.2	
	Content Damage ($)	$0	$499,550	$205,360	$0	$665,990	$266,900	**$1,637,800**
Total Damage per Reach		$9,912,700	$11,057,050	$4,086,960	$2,000,400	$2,988,490	$428,800	
Wildwood Creek Total Damage								**$30,474,400**

Figure 27- Wildwood Creek Summary of Potential Structure Flood Damage - 100 Year Flood Existing Conditions (Scenario 1)

The Existing Condition assumes complete construction of the MPD defined facilities which include detention basins and channel improvements. Construction of the basins and the downstream channel improvements would completely eliminate the 100-year floodplain beyond the defined channel banks. The estimated total potential floodplain damage to structures (existing and future) within the Wilson Creek floodplain is approximately $71.5 million. Similarly, for the Wildwood Creek, the potential floodplain damage cost is $30.5 million.

4.4.1.3 FEMA-Funded SBEFRA Project

The HAZUS-MH Flood Model can be used to assess both riverine and coastal flooding and estimates potential damage to buildings, essential facilities, transportation lifelines, utility lifelines, vehicles, and agricultural crops. The model addresses building debris generation and shelter requirements. Direct losses are estimated based on physical damage to structures, contents, and building interiors. The effects of flood warning are taken into account, as are flow velocity effects. The flood model provides a dam/levee analysis capability and incorporates NFIP entry dates that permit the Flood model to distinguish between census blocks that are Pre-FIRM and those that are Post-FIRM; modifies topological data for Census Track and Census Block geometrics; provides for consistent generation of debris results; allows digital elevation mapping for Hawaii; and corrects mapping in the Inventory tables for utilities and day time and night time vehicle count and dollar exposure among other enhancements and fixes.

4.4.2 Methodology and Results

Results of the FEMA-funded SBEFRA Project completed in 2009 include county-wide flood loss estimates for areas subject to the 100-year flood (with and without levee protection) and the 500-year flood. The county level results are listed below:

	Regional Risk Assessment Results	Flood Scenario		
		100-year Flood (1% Annual Chance Flood)	**100-yr Flood (without levee protection)**	**500-year Flood (0.2% Annual Chance Flood)**
Regional Risk	Economic loss due to building damage ($B)	0.46	1.6	2.7
	Total building-related direct economic loss ($B)	1.4	5.4	8.6
	Number of buildings in the Complete Damage State	345	350	1,105
	Total # Displaced Households	14,828	52,856	86,062
	Total # people needing short-term shelter	32,095	138,991	231,452
	Debris Generated (million tons)	0.1	0.23	0.37
Essential Facilities	Fire Stations - # Non-functional buildings	2	5	12
	EOCs - # Non-functional buildings	0	0	2
	Police facilities - # Non-functional buildings	0	0	1
	Schools - # Non-functional buildings	149	466	791

Source: FEMA's San Bernardino County Essential Facilities Risk Assessment (SBEFRA) Study (2009)

Figure 28: FEMA's San Bernardino County Essential Facilities Risk Assessment

SECTION 5 - COMMUNITY CAPABILITY ASSESSMENT

The City of Yucaipa strives to protect and maintain the health, safety and welfare of the community on a day-to-day basis, and takes extra measures to reduce the impacts of natural or technological hazards. The City can use a variety of different tools, assets, and authorities to effectively prepare for, mitigate against, respond to and recover from emergencies and disasters. These include voluntary and mandatory measures; individual and community efforts; private and public actions; and preventive as well as responsive approaches. Example mitigation activities include educating citizens, enforcing building and development codes, constructing capital improvement projects, adopting plans, establishing incentive programs, and improving emergency preparedness and response.

The capabilities available to the City of Yucaipa fall into the following broad categories: Agencies and People, Plans, Codes and Regulations, Mitigation Programs and Financial Resources. Identifying and documenting these capabilities provides the basis for developing future mitigation opportunities and how they can be implemented within existing City programs.

City of Yucaipa Capability Assessment

- Storm Water Management Ordinances: Yes
- Stream Maintenance Ordinances: Yes
- Zoning Management Ordinances: Yes
- Subdivision Management Ordinances: Yes
- Erosion Management Ordinances: Yes
- Floodplain Management Ordinances: Yes
- Fire Insurance Rating: ISO Rating 5
- Floodplain Management Plan Published Date: 10/2008
- Floodplain Management Last Delineation Date: 10/2008
- Elevation Certificates Maintained: Yes
- National Flood Insurance Program Community: Yes
- National Flood Insurance Program Join Date: 1/28/1991
- National Flood Insurance Program Number: 060739
- National Flood Insurance Program Rating: x
- National Flood Insurance Program Rating Date: 10/2008
- Land Use Plan: Yes
- Land Use Plan Last Update: 4/2016
- Community Zoned: Yes
- Zoned Date: 4/2016
- Established Building Codes: Yes
- Building Codes Last Updated: 1/2014
- Type of Building Codes: Uniform Building Code
- Local Electric Utilities: Southern California Edison
- Local Water Utilities: Yucaipa Valley Water District, South Mesa, Western Heights
- Local Sewage Treatment Utilities: Yucaipa Valley Water District
- Local Natural Gas Utilities: Gas Company
- Local Telephone Utilities: Verizon

5.1 Agencies and People

5.1.1 City of Yucaipa

Key Personnel

Key Personnel

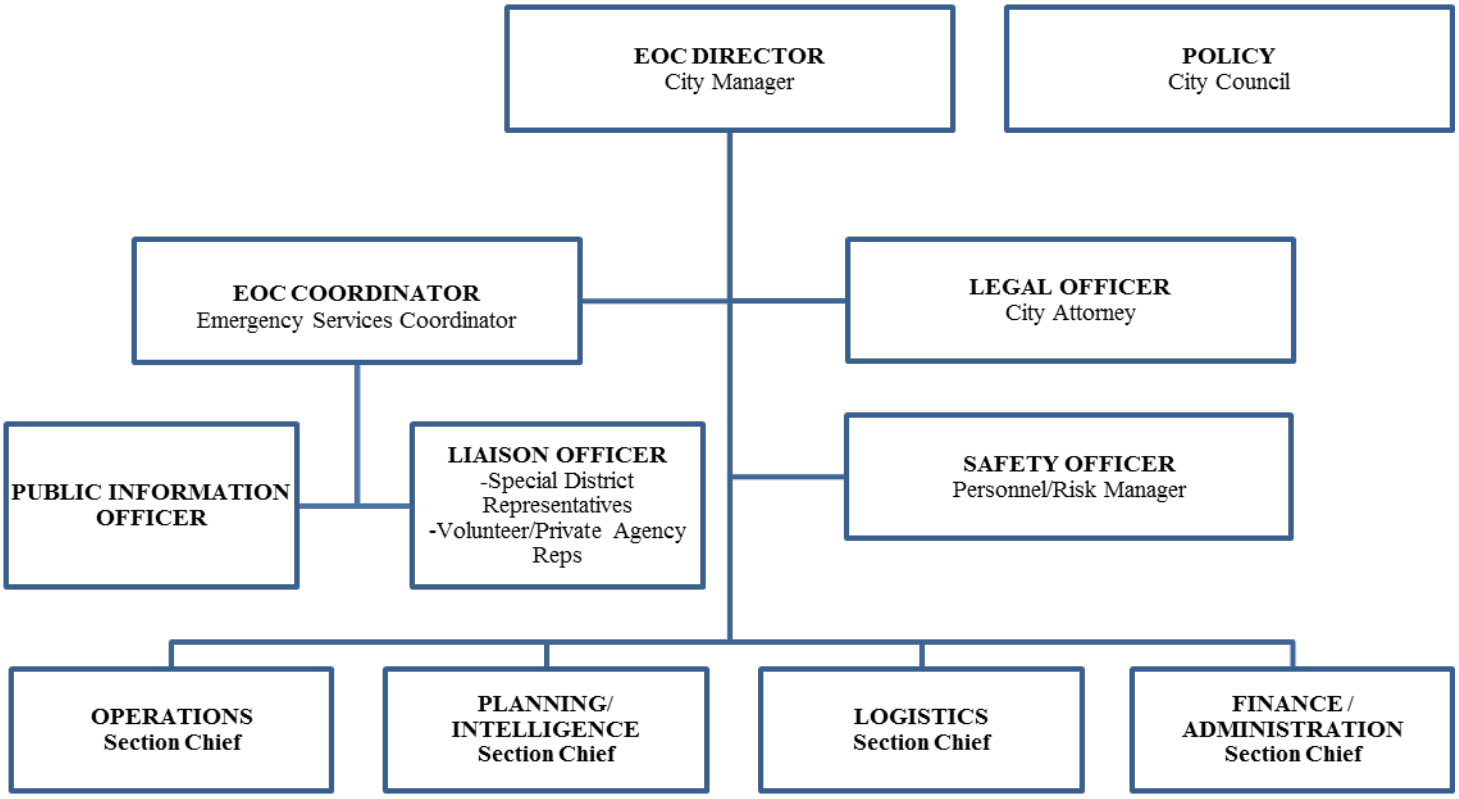
Yucaipa departments have specific responsibilities and related activities/actions assigned to them for each identified hazard and threat. Each department is responsible for ensuring coordination with the other departments. In an emergency, all employees are disaster service workers. "Subject to such disaster service activities as may be assigned to them by their supervisors, or by law." (CA CG §3100)

The City Manager of Yucaipa is responsible for identifying key management personnel, with alternates, and alternative facilities to conduct government operations, based on the hazard analysis. Each department will be responsible for identifying key departmental personnel with backups and alternates for each position in the City's organization.

Alert List
The City Emergency Management Coordinator is responsible for developing and maintaining an emergency alert list, which will be used to notify the key City personnel. Each department will develop their own departmental alert list, which will be used by the departments to alert departmental personnel. Special rules related to disaster service workers are outlined in California Labor Codes Sections 3211.9, 3352.94, 4351, 4381, 4453, 4702.

Special Districts
Special Districts with responsibilities under this plan will coordinate all planning efforts with the Yucaipa Emergency Management Coordinator.

City EOC
The City Manager of Yucaipa has overall responsibility for coordinating the City's response to each emergency.



- Fire and Rescue
  - Fire Operations
  - Search and Rescue
  - Evacuation
  - Security
  - HazMat
- Law Enforcement
  - Traffic Control
  - Evacuation
  - Security
  - HazMat
  - Fatalities Mgt.
- Public Works Unit
  - Route Recovery
  - Debris Removal
  - Flood Control
  - Utilities

- Situation Status
- Initial Action Plan
- Develops Alternative Strategies
- Documentation
- Damage Assessment
  - Facility Inspection
- Recovery Planning

- Communication Systems
- Information Systems
- Resources Unit
- Transportation
- Equipment Maintenance/Fueling
- Facilities Coordination
- Care/Shelter Unit
  - *Medical and Health
  - *Animal Control

*Coordinate with the County of San Bernardino

- Personnel
- Time Recording
- Compensation / Claims
- Supply / Procurement
- Purchasing Unit
- Contract Negotiations and Monitoring
- Cost Analysis Unit

Figure 29: City Departments and Staff Involved in Disaster Management

5.2 Existing Plans

The City of Yucaipa has adopted the philosophy that Plan integration is an essential element to future and long-term community sustainability. The City's long-term goal is to integrate all aspects of comprehensive planning and development to correlate with a continuum of adopted codes and standards to support this philosophy. Current and future Plans will define important City policies and support the ordinances and activities described below. For example, the goal is to enhance the objectives of hazard mitigation, including the Health and Safety Element of the General Plan. Other Plans focus on different aspects of disaster management such as emergency response. Other Plans have implications that are relevant to hazard mitigation, such as plans related to spending on public facilities and storage of hazardous materials. This section reviews City plans and highlights the elements that are relevant to mitigation and can support future implementation of activities identified in this Plan.

General Plan

All cities and counties in California are required to adopt a General Plan that lays out major policy goals. The City of Yucaipa adopted a comprehensive General Plan Update in April 2016. This Update was the first comprehensive 20-year update since the inaugural 1992 General Plan adopted shortly after incorporation. The General Plan includes elements, which are sections that address a variety of important topics. The element most closely related to this Hazard Mitigation Plan is the Public Safety Element, which focuses on reducing risks posed by natural and technological hazards and other human caused emergency events. Other elements also provide guidance relevant to mitigation, including the Community Design and Land Use, Housing and Neighborhoods, Parks/Recreation/Trails/Open Space, Economic Development, Transportation, and Public Services and Facilities.

For example, the Community Design and Land Use Element restricts land uses and density in hazardous areas, thereby limiting the number of people and buildings exposed to hazards. The City of Yucaipa Local Hazard Mitigation Plan was adopted into the Health and Safety Element of the General Plan on February 8, 2010.

The Public Safety Element

Protecting the public's health, safety, and welfare is a fundamental goal of any municipality, and this goal is a central part of Yucaipa's mission. Yucaipa is committed to protecting its residents from natural and human-caused hazards due to geology, flooding, wildfires, severe weather, air pollution, and climate change. The Public Safety Element is designed to address the community's safety, health, and welfare as they relate to these hazards.

Yucaipans cherish the hills, landforms, and creeks in their community. When coupled with a built environment of homes, buildings, and infrastructure systems, however, these features are also the source of hazards. Earthquake faults that flank the hills can trigger landslides. The streams and rivers that created the "benches" and canyons over time can overflow channels and lead to flooding. The grasslands covering the hills present a risk of wildland fires. Even severe weather can present safety hazards.

In light of these concerns, this Public Safety Element is intended to: (1) recognize the local hazards associated with Yucaipa's natural environment (geology, landforms, waterways, and weather), and (2) identify methods to manage these risks and protect people, property, infrastructure, and structures from harm. As the policies and actions are implemented over the next 20 years, the City of Yucaipa will be increasingly less impacted by disasters, and in the process, become more self-reliant, sustainable, and prosperous.

Related Plans

Yucaipa's Public Safety Element is implemented by various plans for protecting the community. Some of these plans are provided by the City of Yucaipa; others are provided by other organizations.

Drainage and Flooding

The City's Master Plan of Drainage (MPD) provides an assessment of drainage and infrastructure needs and a plan for the maintenance and construction of detention basins to protect from flooding hazards.

Fire Service Planning

The Yucaipa Fire Department, through a contract with the California Department of Forestry and Fire Protection (CAL FIRE), prepares a fire services plan to provide fire protection and emergency medical services to the City.

Emergency Operations Plan

The City's Emergency Operations Plan provides a comprehensive organizational and procedural guide for preparing for, responding to, and recovering from natural disasters or human-caused emergencies.

Urban Water Management Plan

The Yucaipa Valley Water District's Urban Water Management Plan was updated in 2010 in conformance with the requirements of the California Urban Water Management Planning Act and the Water Conservation Bill of 2009. The 2010 Plan describes and evaluates the District's water supply sources, the efficient uses of that water supply, demand management measures with an implementation strategy and schedule, and other relevant information and programs.

Master Plan of Drainage

The City updated the Master Plan of Drainage (MPD) in 2012. The approved study allows staff to use the information as a new basis for design of all future drainage improvement projects within the City. The possibility of reducing drainage flows downstream by adding detention basin facilities upstream will result in cost savings for future drainage improvement projects while enhancing water quality, groundwater recharge, aesthetics, and reducing environmental impacts throughout the system. The results of the MPD update indicate that it will result in a substantive reduction in peak flow rates during a 100-year design storm.

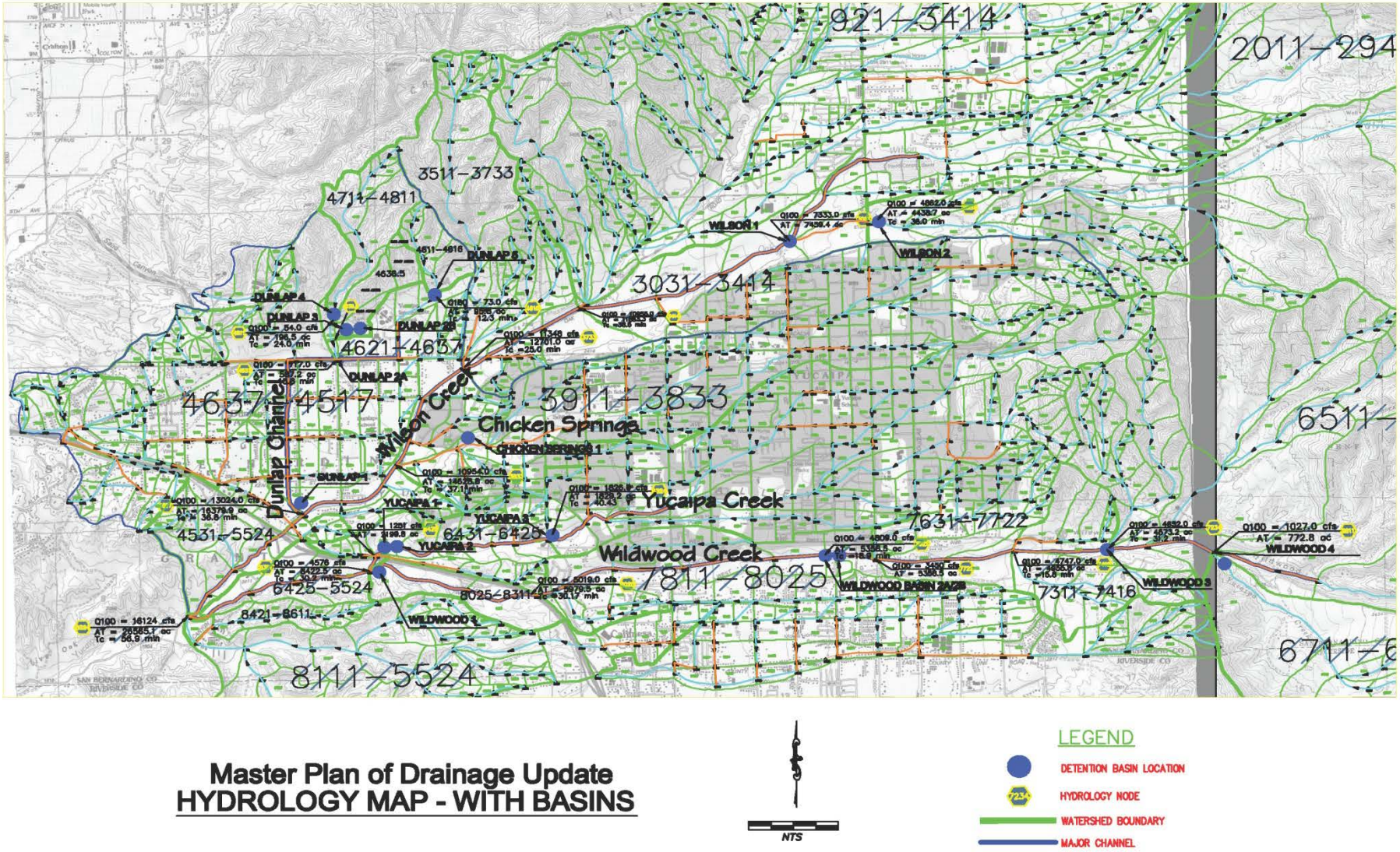


Figure 30: Master Plan of Drainage

Capital Improvement Program (CIP)
The CIP outlines the annual appropriations in the City's budget for capital improvement projects such as street or park improvements, building construction, and various kinds of major facility maintenance. Capital improvement projects are supported by expenditure plans, which detail funding sources and expenditure amounts. They are often multi-year projects, which require funding beyond the one-year period of the annual budget.

Emergency Operations Plan
The City's Emergency Operations Plan provides a comprehensive organizational and procedural guide for preparing for, responding to, and recovering from natural disasters or human-caused emergencies.

Mutual Aid Agreements
Inter-jurisdictional arrangements to assure public safety, protection and other assistance services today generally are in the form of "mutual aid" agreements. Mutual aid and other agreements provide for voluntary cooperative efforts and for provision or receipt of services and aid to or from other agencies or jurisdictions when local capabilities are exceeded by an emergency event. Through mutual aid agreements, individual City agencies coordinate emergency response planning with adjacent cities, the County of San Bernardino, the State, federal agencies and other public and private organizations, such as the School District and the American Red Cross. The California Emergency Management Agency (CalEMA) is designated by law to provide coordination and State resources to regions or local areas that are declared disaster areas by the Governor.

Comprehensive Economic Development Strategies (CEDS)
The City of Yucaipa is in the process of developing a Comprehensive Economic Development Strategies Plan that will bring together the public and private sectors in the creation of an economic roadmap to diversify and strengthen regional economics. Future adoption of this Plan will help to insure economic preservation of the community, and can be used as a social and financial component of successful hazard mitigation programs and projects.

Freeway Corridor Specific Plan
The City of Yucaipa Freeway Corridor Specific Plan provides the planning tools necessary to guide development for the 1,242-acre Freeway Corridor planning area. The Plan offers a mixture of residential, commercial, and business park development and provides community amenities such as trails, two potential elementary schools, and open space areas that help to create a cohesive community.

Senior Mobilehome Overlay District
The Mobilehome Park Overlay District is intended to promote the maintenance and viability of existing mobilehome parks through appropriate zoning. It is an overlay district where mobilehome parks are established as the primary permitted land use in order to limit the conversion of existing affordable housing to other land uses and to provide a variety and balance of housing types within the City.

Wilson Creek Business Park Specific Plan
(Pending Adoption)

Oak Glen Creek Specific Plan
(Pending Adoption)

College Village Overlay Guidelines
(Pending Adoption)

5.3 Regulations, Codes, Policies, and Ordinances

The City has adopted codes and regulations to govern development, construction and land use activities. They include construction standards, siting requirements, use limitations, study requirements and mitigation requirements which help directly or indirectly minimize the exposure of people and property to loss or injury resulting from disasters. As such, they are an effective tool and capability which the City may continue to use to reduce the amount of damage or harm arising from disasters. This plan provides an opportunity to review existing regulations to determine if they are effective or whether they need to be revised in certain areas to more adequately prevent loss or injury from disasters.

Zoning Regulations
The Development Code regulates the use of land and buildings, the height, bulk, location of structures, the amount of open space and the density of population by establishing zone classifications.

Subdivision Regulations
The City's subdivision regulations are outlined in the Development Code, which establishes standards to regulate the division and merger of land and defines minimum lot sizes, densities and development standards.

Building Code
Chapter 15.04.010 of the Yucaipa Municipal Code adopted by reference the California Building Code Volumes 1 and 2, 2013 Edition (Part 2, Title 24, California Code of Regulations), which incorporates and amends the International Building Code, 2012 Edition, including California Building Code Appendices F, G, H, I and J, (published by the International Code Council) as the Building Code of the City of Yucaipa.

Fire Code
Chapter 15.04.110 of the Yucaipa Municipal Code adopted by reference the California Fire Code, 2013 Edition (Part 9, Title 24, California Code of Regulations), including all appendices, which incorporates and amends the International Fire Code, 2012 Edition, published by the International Code Council

Urban Runoff Pollution Control
Title 13, Chapter 13.04 of the Municipal Code addresses water quality and stormwater runoff. The purpose of this Chapter is to promote and ensure the future health, safety and general welfare of inhabitants of the City by controlling discharges into the City storm drain system. This will be accomplished by federal, state and local laws and regulations prescribing regulations to effectively prohibit non-stormwater discharges into the City's stormwater drainage system and to specifically achieve the following objectives: (A.) Control discharges from spills, dumping or disposal of materials other than stormwater; (B.) Reduce the discharge of pollutants in all stormwater discharges to the maximum extent

practicable; (C.) Protect and enhance the water quality of local, state and federal watercourses, water bodies, ground water and wetlands in a manner pursuant to and consistent with federal, state and local laws and regulations; and (D.) Establish penalties for violations of the provisions of the Chapter.

Floodplain Management Regulations

The City has adopted floodplain management regulations in Division 5, Chapter 2, Article 2 of the Development Code. The purpose of the article is to promote the public health, safety, and general welfare and to minimize public and private losses due to flood conditions in specific areas.

5.4 Mitigation Programs

Below is a partial listing of potential mitigation-based programs that may be available to property owners and small business owners through other agencies:

Agency	Program	Details
FEMA	National Flood Insurance Program (NFIP)	Enables property owners to purchase insurance as a protection against flood losses in exchange for state and community floodplain management regulations that reduce future flood damages. http://www.fema.gov/business/nfip/
HUD	Community Development Block Grants (CDBG)	Grants to develop viable communities, principally for low and moderate income persons. CDBG funds available through Disaster Recovery Initiative. http://www.hud.gov/offices/cpd/communitydevelopment/programs/
HUD	Disaster Recovery Assistance	Disaster relief and recovery assistance in the form of special mortgage financing for rehabilitation of impacted homes. http://www.hud.gov/offices/cpd/communitydevelopment/programs/dri/assistance.cfm
HUD	Neighborhood Stabilization Program	Funding for the purchase and rehabilitation of foreclosed and vacant property in order to renew neighborhoods devastated by the economic crisis. http://www.hud.gov/offices/cpd/communitydevelopment/programs/neighborhoodspg/
U.S. Small Business Administration	Small Business Administration Loan Program	Low-interest, fixed rate loans to small businesses for the purpose of implementing mitigation measures. Also available for disaster damaged property. http://www.sba.gov/services/financialassistance/index.html

5.5 Fiscal Resources

5.5.1 General Fund Sources

The City of Yucaipa has a General Fund Budget of $23,543,039 for FY 2016-2017. The combined Capital Improvement Program for FY 2016-2017 is $10,481,000.

One of the key analytical tools used during the budget process is a comprehensive seven-year financial forecast for the General Fund. This forecast considers key revenue and expenditure projection factors such as population, increases in the consumer price index (CPI) and other growth factors. The trending of these key factors and their effect on revenues and expenditures for the past ten years provides a historical basis for the seven-year financial forecast.

As part of the mid-year budget review process, the revenue assumptions included in the forecast are comprehensively reexamined based on actuals for the prior year, as well as emerging trends at the mid-point of the year. Accordingly, with a few notable exceptions, the revenue projections reflected in the Budget rely heavily on the projections made as part of the seven-year forecast.

Sources used in developing these revised projections include economic trends as reported in the national media, forecast data for San Bernardino County, economic and fiscal information developed by the State Legislative Analyst and the State Department of Finance, and materials prepared by the League of California Cities and State Controller's Office. Ultimately, however, the revenue projections reflect the staff's best judgment about the performance of the local economy over the next two years and how it will affect City revenues.

The following provides a brief description of the City's top general revenue sources along with the general assumptions used in preparing revenue projections. These sources account for over 80% of total general revenues.

General Property Taxes
Under Proposition 13 (adopted in June of 1978) property taxes for general purposes may not exceed 1% of market value. Property tax assessment, collection and apportionment are performed by the County. The City receives approximately 20%-25% of the levy within its limits. Assessment increases to reflect current market value are allowed when property ownership changes or when improvements are made; otherwise, increases in assessed value are limited to 2% annually.

Sales and Use Tax
The City receives 1% from all taxable retail sales occurring in its limits. This is collected for the City by the State of California, along with their component of the sales tax (6.25% for the State General Fund, 0.25% for San Bernardino County and 0.5% for local transportation purposes and public safety purposes (Measure I), for a total sales tax rate in San Bernardino County of 8.00%).

Franchise Fees
Franchise Fees are levied by the City on a variety of utilities at various rates. The State sets franchise fees for utilities regulated by them (most notably gas and electricity): 1% of gross sales or 2% of revenues attributable to their investment in infrastructure, whichever is greater. The City sets rates on a gross receipts basis for the following utilities: cable television (5%), and solid waste collections (10%).

Motor Vehicle In-Lieu
The State Revenue and Taxation code imposes an annual license fee of 2% of the market value of motor vehicles in lieu of a local motor vehicle property tax. Cities and counties equally share 81.25% of the total tax collected statewide; the State then distributes this revenue to cities and counties on a per capita basis. Motor Vehicle In-Lieu taxes have increased over the last several years, but were reduced during 2000-2001 due to the calculation method imposed by the State to utilize actual population estimates. During 2003-2004 the City experienced a decrease in VLF by the State as a bailout measure employed by the State in the amount of approximately $550,000. An additional bailout contribution occurred in both 2004-2005 and 2005-2006 in the amount of approximately $330,000 per year.

Development Related Fees
Development related fees recover costs for planning, building and safety, engineering, and fire plan check services. Cost recovery for these services is generally set at 100% of total costs.

Hazard Mitigation Grant Program (HMGP)
Hazard Mitigation Grant Program (HMGP): This FEMA administered program provides grants to states and local governments following a presidential disaster declaration. The funds can be used to implement long-term hazard mitigation measures. According to the Disaster Mitigation Act of 2000, communities must have a Local Hazard Mitigation Plan (LHMP) approved to receive HMGP funds after May 1, 2005. Funds will be granted only to projects that conform to local and state mitigation plans. Federal grant funds can provide 75% of a project's total cost; other sources must provide 25% matching funds. After any federally declared disaster, up to 20% of the amount spent by FEMA on disaster response and relief costs is made available in the form of HMGP grants to communities in the affected state.

Flood Mitigation Assistance Program (FMA)
FMA provides funding to assist states and communities in implementing measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the National Flood Insurance Program. On July 29, 2010 the City of Yucaipa was awarded a Flood Mitigation Assistance Grant to prepare a risk-based flood plan. This project will be completed by June 30, 2013.

Pre-Disaster Mitigation Program (PDM)
FEMA developed the PDM program to coincide with the requirements of the Disaster Mitigation Act of 2000 that requires communities to prepare local hazard mitigation plans, such as this plan. Funds are authorized by Congress on an annual basis for PDM competitive grants, technical assistance and program support. FEMA grants can fund 75 percent of a project; other non-federal sources must provide 25 percent matching funds.

Funds are only granted to communities with an approved LHMP, and supported projects must be identified in those plans.

Severe Repetitive Loss (SRL)
According to the National Flood Insurance Program, the City of Yucaipa has zero repetitive loss properties within its jurisdiction.

Community Development Block Grants
Block grants are administered by the Department of Housing and Urban Development to fund housing, economic development, public works, community facilities and public service activities serving lower income people. These funds can be used for mitigation works. CDBG funds are considered local funds once they are received, and thereby are eligible to provide the 25 percent local match required for receipt of the HMGP funds. There are other federal programs that support emergency and rebuilding costs in communities, such as FEMA's Public and Individual Assistance Programs which are activated following federally declared disasters. These funds primarily support repair projects, but may also include the cost of code upgrades or other mitigation measures as part of the repair if they are cost effective.

All Other Grant Programs
The City of Yucaipa participates in an extensive list of federal and state grant programs, each designed to supplement the City's budget and allow flexibility to increase infrastructure and opportunity capabilities allowing for more efficient use of tax dollars.

SECTION 6 - Mitigation Strategies

ELEMENT C. MITIGATION STRATEGY			
C1. Does the plan document each jurisdiction's existing authorities, policies, programs and resources and its ability to expand on and improve these existing policies and programs? (Requirement §201.6(c)(3))			
C2. Does the Plan address each jurisdiction's participation in the NFIP and continued compliance with NFIP requirements, as appropriate? (Requirement §201.6(c)(3)(ii))			
C3. Does the Plan include goals to reduce/avoid long-term vulnerabilities to the identified hazards? (Requirement §201.6(c)(3)(i))			
C4. Does the Plan identify and analyze a comprehensive range of specific mitigation actions and projects for each jurisdiction being considered to reduce the effects of hazards, with emphasis on new and existing buildings and infrastructure? (Requirement §201.6(c)(3)(ii))			
C5. Does the Plan contain an action plan that describes how the actions identified will be prioritized (including cost benefit review), implemented, and administered by each jurisdiction? (Requirement §201.6(c)(3)(iv)); (Requirement §201.6(c)(3)(iii))			

6.1 Overview

Substantial floodplain areas in Yucaipa are generally associated with the dry river washes known as Gateway Wash, Wilson Creek, Oak Glen Creek and Wildwood Creek, as well as Chicken Springs Wash and Yucaipa Creek. The Federal Emergency Management Agency (FEMA) on their Flood Insurance Rate Maps (FIRM) has mapped these areas. The first version of these maps for the City of Yucaipa was prepared in March of 1996 and is reflected in the Fire and Flood Hazard Zones. In August of 2008 and April 2014 (Wilson Creek LOMR) FEMA revised the FIRMS to reflect the Letters of Map Revisions (LOMRS) that have been recorded and affected the Flood Prone areas within the City. There are two categories of flood zones in Yucaipa; FP1 indicates areas inside the 100-year floodplain, while FP2 indicates areas inside the 500-year floodplain.

While the City of Yucaipa is working toward eliminating low flow crossings, in some areas they continue to need improvements as neighborhoods are threatened by public safety concerns and access, and damages continue to erode pavement.

Significant efforts have been made during the past twenty-four years to mitigate the short- and long-term effects of flooding that originates from these creeks. As a result, major flooding has been significantly reduced or in some instances eliminated due to construction of multi-partnered major flood control projects.

Oak Glen Creek Basins Project – Completed 2009

Yucaipa is located in a valley at the base of the eastern portion of the San Bernardino Mountain range. Small creeks cross the community from east to west. Through collaboration and needs assessment, these problematic low-flow crossings were improved with substantive and theme-specific bridges.

The larger Wildwood and Oak Glen/Wilson Creeks create the strongest potential to flood western areas of the community as drainage proceeds to San Timoteo Creek and eventually, to the Santa Ana River, Orange County and the Pacific Ocean. Through community meetings, scoping sessions, and consensus, the community along with federal, state, county and local project partnerships gained two important flood control projects: Wildwood Creek Detention Basin and the Oak Glen Creek 3-Basins project.

Of the two flood control projects, the Oak Glen Creek Basins project is the single-most introduction to flood control resolution that, coupled with another future project, will remove over 450 properties from the FEMA 100-year Floodplain.

The project was awarded the 2009 Project of the Year from the American Public Works Association, Southern California Chapter, Inland Empire Branch, and another on April 26, 2010 from the Santa Ana Watershed Project Authority (SAWPA) (Reference Appendix D). The SAWPA Award of the year was based upon recognition of policies, procedures and projects that have demonstrated understanding of the importance of local groundwater protection and recharge to insure protection and preservation of the aquifer for future generations.

Before: Using the Ahwahnee principles, a set of guidelines to help foster sustainable and livable communities, the $6.1 million dollar project was completed in partnership with the community, San Bernardino County Flood Control District, the Yucaipa Valley Water District (Yucaipa's main water district provider), the Inland Empire Resource Conservation District, the California State Water Resources Control Board, and the U. S. Environmental Protection Agency. The Oak Glen Creek Detention Basins Project goals are to control flooding, improve water quality, promote the infiltration of storm water, recharge groundwater supplies, create wildlife habitat, and educate the public about the water cycle and ways to improve the environment.

The project was designed to accomplish the following primary goals: 1) Reduce flooding along Oak Glen Creek downstream of Bryant Street; 2) Collect debris and sediment in basins to improve water quality downstream and reduce the potential for flooding caused by clogged storm drains and culverts; 3) Provide groundwater recharge not only by allowing storm water to infiltrate into the ground rather than flow wastefully downstream but also by facilitating active recharge efforts through the infiltration of non-potable water; 4) Provide open space and habitat for wildlife and native plants; 5) Provide opportunities to educate the public about the water cycle and the importance of water conservation and groundwater recharge.

After: Design included a series of three basins varying in size from 45 to 50 acre-feet to contain peak storm-water flows and reduce flooding downstream within Oak Glen Creek and Wilson Creek. Overlook and rest areas would be provided, and defined hiking trails would be designated to replace existing informal trails. The team designed the project to preserve some existing oak trees at the site, while areas that were graded or otherwise disturbed were subsequently planted with native materials.

For operation and maintenance purposes, access roads are provided around and into all of the basins. The roads extend into the bottoms of each of the basins so that sediment and debris can be removed from the basin bottoms and other maintenance activities can be carried out. Near the spillways, the access road is concrete pavement. Elsewhere, however, it is of natural material compacted to 90 percent. The road, which complies with the requirements of the Americans with Disabilities Act, also serves as a hiking trail that constitutes an important segment of the trail system outlined in the city's master plan, a segment that links a state park to the rest of the community trails. Split-rail-type fencing has been placed around all of the basins, and a10-space paved parking lot has been provided off Bryant Street for those using the trails.

Also at the site are designated trails from the entry point at Bryant Street that connect to an overlook and rest area. Located on the northeastern portion of the project site, this area is approximately 30 ft. above the creek. Serving as a rest stop for hikers, equestrian enthusiasts, and bicyclists, the area includes trees, shrubs, benches, decorative boulders, and an information kiosk. In the event that debris must be removed from the basins after a storm, maintenance crews will temporarily store the material in the eastern section of this area.

The site includes two other rest areas—one at the southeastern section, the other at the northwestern section. The southeastern rest area includes equestrian hitching posts and informational signs. The northwestern picnic area includes decorative boulders and informational signs. Trees, shrubs, and other native and drought-tolerant plants have been

planted at the overlook and rest areas along the northern perimeter of the site and along the eastern slope of the first basin. The slopes of the basins will be revegetated with a mix of native and drought tolerant plants, the seeds of which will be mixed with water and fertilizer and spread by means of a sprayer. The use of native materials is expected to help minimize maintenance requirements and increase wildlife habitat.

Educational signs are located strategically along the site paths. The signs will convey information to the public about aspects of the water cycle within the context of the site itself and in the broader watershed. As people travel along the paths, a story will unfold before them and they will also learn about jurisdictional waters, watersheds, the hydrologic cycle, flooding, natural processes, groundwater recharge, sediment transport, desilting basins, ecosystems, and local flora and fauna. The signs are arranged hierarchically, the primary signs detailing the "Journey of Water" and the secondary ones providing the supporting information. Educational kiosks also provide information on the water cycle, helping people understand the importance of water and how they can conserve and recycle it.

Wildwood Creek Basins Project – Completed 2010

The $7,180,966 Wildwood Creek Basin Project is located along Wildwood Creek, south of Wildwood Canyon Road and easterly of Holmes Street in the City of Yucaipa. The primary purpose of the project is to reduce sedimentation and downstream flooding along Wildwood Creek including City roadways, other public infrastructure and private properties. Other project purposes and benefits include groundwater recharge, improved downstream water quality, and implementation of multi-purpose recreational trails. Construction was initiated on April 17, 2010 and completed on June 21, 2011. A "ribbon cutting" was conducted on April 19, 2011 and included support from Congressman Jerry Lewis, San Bernardino County Supervisor Neil Derry, the San Bernardino Valley Municipal Water District, the San Bernardino County Flood Control District, the City's Mayor and Council and staff members.

This project's model, the Oak Glen Creek Basins Project, was the subject of a paper delivered at the World Environmental and Water Resources Congress 2008, which was sponsored by ASCE and its Environmental and Water Resources Institute and held in Honolulu. That Project won the 2010 Santa Ana River Watershed Integrated Project Award and was a component of Yucaipa's status as one of 26 finalists from cities throughout the United States in the June 2011 All America Cities competition.

Before: The Project includes a series of three basins and a by-pass channel. The first or most easterly of the basins serves as a debris catchments facility, and the next two basins in line to the west provide areas for storm flow detention as well as for areas to capture and percolate natural storm flows for recharge of the local underground basin/aquifer, which is currently in a state of overdraft. It has been estimated that annual groundwater recharge of natural storm flows will be in the range of 400 to 600 acre-feet. The by-pass channel was designed and constructed with a soft or natural bottom to allow for the re-establishment of natural vegetation. The basins have a combined capacity of approximately 125 acre-feet and in a 100-year storm flow event create an approximate 39% reduction in downstream flow, thus providing much needed flood protection for the downstream community.

After: The Wildwood Creek Basin project became a reality only through the cooperation and funding participation by multiple public agencies. While the City was the lead agency for the planning, design and construction of the project, the financial assistance given by the Pre-Disaster Mitigation Grant from FEMA in combination with the funding assistance and cooperation from the San Bernardino County Flood Control District (SBCFCD), the San Bernardino Valley Municipal Water District, and local property owners enabled the project to be successfully completed. Financial contributions included FEMA ($2,572,000), City Drainage Facilities Fund ($1,611,000), Developer Contribution ($60,000), San Bernardino County Flood Control District ($1,457,000), San Bernardino Valley Municipal Water District ($589,000), Stater Bros. (purchase of excess soil), ($550,000), Private Developer (Purchase of excess soil), ($170,000), and Measure I Road Funding for Road Widening ($171,966) for a grand total of $7,180,966. The financial contribution from Stater Bros. and the private developer resulted in a project cost savings, and enabled them to acquire excess soil for future development that will aid in the economic redevelopment of the area in which their future projects are located.

The project design required the fee acquisition of portions of eleven properties and slope easements on two of the properties. All the property acquired was located within or adjacent to Wildwood Creek and was necessary for the project construction. The 26.33 acres of land acquired by the City will be transferred to the SBCFCD pursuant to the requirements of the cooperative agreement between the City and SBCFCD.

Some minor delays were encountered on the project, but generally the project was completed on time. The most serious delay originated during the period of December 18 through 22, 2010 when an extremely intense winter storm event caused considerable damage to the Project, which was nearing completion at the time. Approximately 25,000 cubic yards of earthen debris washed into the debris basin from the upstream channel. In addition, the by-pass channel below the last or downstream channel grade control structure experienced considerable erosion with undermining of soil cement slope protection, degrading of the channel flowline as much as a 1.5 feet in depth and washing out an approximate 800 foot long section of Yucaipa Valley Water District sewer line. This damage was repaired and the project was eventually completed per design. The storm damage repair costs totaled an estimated $240,000.

The combined volumes of the basins is sufficient to reduce peak runoff in a 100-year storm event by approximately 39%, which will provide for substantial reduction of downstream flood risk to commercial, residential and public properties. This project will enable some properties to be completely removed from the FEMA designated floodway and the floodway width and base flood elevations to be reduced. Many property owners will be relieved of the burden of paying for flood insurance.

The Wildwood Creek Basin Project had strong participation from the public at-large, wherein they expressed a desire for a project that would be compatible with the existing creek environment, including trails/recreational uses and public education. Signage (preliminary draft attached) has been developed for the project to provide information to the public users of the project's trail system and about the purposes and functions of the project including flood and sediment control, watersheds, ground water replenishment, and natural environmental habitats. This educational signage will be installed at the project site in conjunction with the subsequent projects to provide landscaping/vegetation of disturbed areas, parking lot and road widening improvements.

The project was nearing completion when, during the January 2011 Winter Storms, Yucaipa and all of Southern California was faced with a significant rain event that left the Wildwood Creek Basins Project in a state of jeopardy. Additional damages exceeded $220,000 and delayed the project for another 45 days.

During the storm events major damage occurred to the Wildwood Basin Project construction site while the project was under construction. The damages consisted of undermining of the soil cement levees, erosion and voids to the rip rap sections, damages to the culverts conveying flows between the basins, and general erosion to the bypass channel. The storm damage to the bypass channel at the downstream end of the project was due to the excessive storm runoff. The contractor estimated that the bypass channel dropped as much as 15 feet from the existing flow line undermining the improvements that were in place. The contractor

has made repairs to the damage sites to avoid further damage during the rainy season. (Estimated cost of damages for the FEMA claim is $80,000)

During the storm events the upstream debris basin received a high volume of sediment and debris from the creek; estimated at approximately 30,000 cubic yards. The sediment covered the bottom of the basin by an approximate depth of 10 feet. To illustrate the magnitude of the storm at this location San Bernardino County Flood Control District has a rain gage immediately upstream of the basin project that measured approximately 11 inches of rain in a six day time period in December of 2010. In order to complete the Basin project the Contractor has removed the excess debris and was able to utilize it onsite. (Estimates Cost of damages for the FEMA claim as $170,000)

The completed project is now fully operational and is available to provide the long awaited enhanced flood and sediment control for the community during the upcoming winter storm season of 2011/2012. Residents are seen each day utilizing the project's trail facilities. As the project matures, the trees, shrubs, plants and native grasses planted with the project work will re-establish natural habitats that were disturbed by project construction and will provide a natural open space area for both wildlife and residents alike.

Chapman Heights Basins and Flood Mitigation – Completed 2004

Chapman Heights is a 1,000 acre specific plan project that entailed the construction of a championship golf course, over 2,200 dwelling units, two schools and a 25-acre retail center. Perhaps the greatest amenity, however, is the abundance of open space, preserved to enjoy for many generations. The habitat encompasses coast sage scrub, coast live oak woodlands, native grasslands and miles of multi-use trails that connect with the greater Adopted Master Plan of Trails as defined in Yucaipa's General Plan document.

Three major watercourses impacted the project: Wilson Creek and Gateway Wash originate easterly and northerly of the site respectively and confluences near the center of the site. Oak Glen Creek is also tributary to the site but confluences with Wilson Creek immediately easterly of the site. FEMA has performed a Flood Insurance Study (FIS) of Wilson Creek downstream of the existing Yucaipa Boulevard culvert crossing at the project southerly boundary.

The floodplain management approach was essentially the elimination of 100-year flooding within the plan boundary through the construction of three City Master Plan Storm Drain Systems. Tributary runoff is intercepted at the project boundary within concrete-lined training levees and returned to the current downstream discharge point southerly of Yucaipa Boulevard. The third major drainage system, Storm Drain Line A-1, was already constructed; that floodplain was already addressed in another Letter of Map Revision (LOMR). This watercourse was a branch flow from Wilson Creek that splits and diverges easterly of Second Street.

The aforementioned drainage systems and mass grading were completed in accordance with the plans submitted and approved by the San Bernardino County Flood Control District and the City of Yucaipa for ownership and maintenance.

Subsequently, Southwest Communities under the National Flood Insurance Program (NFIP) regulations, sought and received the issuance of a Letter of Map Revision (LOMR) under the National Flood Insurance Program (NFIP) regulations, Code of Federal Regulations (CFR) 44, in order to remove portions of Chapman Heights that lay within then current Zone A flood plain and Zone AE floodway limits.

Dunlap Channel – Portions Completed 2011

The Dunlap Channel drainage system extends from the Chapman Heights Development and the Crafton Hills on the northwest end of Yucaipa to Wilson Creek to the south. The Dunlap Channel Improvement Project includes improvements to the existing 5,300-foot long channel, located 300 feet west of 14th Street and the three (3) culvert crossings along the channel between Yucaipa Blvd and Wilson Creek (Exhibit 1). The project also includes improvements to the existing detention basins north of Chapman Heights Road and a storm drain system from these basins along 13th Street and Yucaipa Blvd to Dunlap Channel. Several of the project's benefits include flood control, water quality, environmentally sensitive development, and a passive recreational component that includes multi-purpose trails adjacent to the channel.

The City of Yucaipa anticipates implementing the proposed improvements to the drainage system in phases:

First Phase: The first phase, completed in May 2012 installed the underground storm drain system within the Yucaipa Blvd right-of-way between 13th Street and Dunlap Channel, approximately 300 feet west of 14th Street. This phase included the storm drain connection to the channel and associated transitions structures, riprap and channel improvements to accommodate the connection.

Second Phase: The second phase will include enhancing the retention/detention capabilities of the two existing basins north of Chapman Heights Road. The footprint for the improvements to these basins will be restricted by the boundary/lot lines identified in exhibits 1 and 2. At this time, the extent of the grading/excavating associated with the basin improvements is not known. Once the preliminary environmental assessment of the area within the boundary/lot lines is completed and an environmental assessment is provided to the City of Yucaipa, further review of the engineering design criteria for enhancing the existing basins will determine the extent of the grading/excavating activities that will need to occur to accommodate the proposed improvements.

Final Phase: The final phase(s) will include improvements to the channel's storm water and landscape irrigation run-off capabilities from Yucaipa Blvd to Wilson Creek, a distance of approximately 1.1 miles. The existing earth bottomed channel will be graded to accommodate a series of flow-through and flow-by detention/de-silting basins as well as riprap energy dissipaters along the channels reach. The area that will be used for the by-pass detention basins (shown on exhibit 1) is currently vacant and is currently San Bernardino County Flood Control District property. Currently, Dunlap Channel is graded on an on-going basis after significant rain events for maintenance purposes. Improvements to accommodate the existing culvert crossing at three collector streets are also proposed as part of this project phase.

Economic Development Administration - Dunlap Storm Drain – Under Construction

In 2011 the City of Yucaipa was approached by an international manufacturing firm that had established its initial corporate offices in Yucaipa in 1946. The firm, Sorenson Engineering, was considering relocation to an adjacent community because of increased flooding concerns in the Dunlap Area. Sorenson Engineering offers high volume, high precision micro machining for a wide range of industries. Through exceptional customer service, engineering collaboration and solid quality control standards, they are able to deliver consistent, ready to use products that become critical components for highly advanced machinery and equipment. Their core business serves the Aerospace, Electronic Interconnect, Defense & Military, Test Probe, Microwave Test Equipment, Telecommunications, Fiber Optics, Medical & Dental, Electronic Test Equipment, Computer, Automotive and Hydraulic Industries.

The City of Yucaipa and owners of Sorenson Engineering, Inc. established an aggressive program to mitigate flooding concerns and allow the business to remain in Yucaipa. In 2012 the City of Yucaipa was awarded a $1.3 million dollar EDA Disaster Fund grant to construct

the storm drain improvements, effectively encouraging Sorenson Engineering to retain its business presence in Yucaipa, continue to employ its current cadre of 160 employees, and anticipate a future expansion to include additional square footage and approximately 100 additional employees. This project is anticipated to begin construction by December 2013.

6.1.1 National Flood Insurance Program (NFIP)

According to the National Flood Insurance Program, the City of Yucaipa has no repetitive loss properties within its jurisdiction. However, it is important to consider that the community has grown exponentially since the census of 2000. According to San Bernardino County the population as of 2007 was 51,046 with a Projected Population in 2012 of 58,187. This is a significant level of growth since the 2000 census when the City had a population of 41,207. The City's web site indicates that Yucaipa has grown over 27 percent since the census of 2000.

The City joined the National Flood Insurance Program (NFIP) on January 28, 1991. The federal government administers the NFIP with communities that have been identified as flood prone. The Federal Emergency Management Agency (FEMA), through the Federal Insurance Administration, makes flood insurance available to the residents of Yucaipa, provided the City adopts and enforces adequate floodplain management regulations that meet the minimum NFIP requirements. The City's Floodplain Safety Overlay District (Article 2 of Chapter 2 of Division 5 of Volume II of the Yucaipa Municipal Code (the "Development Code") establishes regulations for development and construction within flood prone areas.

Every seven years FEMA schedules a Community Assistance Visit (CAV) with the City to maintain periodic contact and evaluate the effectiveness of local floodplain management practices and to offer assistance if needed. A CAV was conducted after the date of this Draft Plan (1/2015). The purpose of the CAV meetings is to provide City staff with the most current information on the NFIP, give them an opportunity to discuss concerns they may have, and assess the City's enforcement of the local ordinance that was adopted to meet requirements of the NFIP.

The last report reflected that the Yucaipa floodplain management program appropriately and effectively regulates development in the floodplain. The procedures and methodology in which development permits, inspections, and guidance are provided to builders and homeowners are satisfactory. The CAV was satisfactorily closed, with Yucaipa in full compliance with NFIP regulations.

6.2 Mitigation Goals, Objectives, Actions and Projects

The goals, objectives, actions and projects that follow are an excerpt from Yucaipa's current General Plan.

6.2.1 Floods

6.2.1.1 Protecting Our Community

Yucaipa protects the community from flooding hazards through the identification of hazards, enforcement of building codes and development standards, implementation of a

master plan of drainage and capital improvements, and participation in mutual aid agreements, described below.

Hazard Identification

Yucaipa's Municipal Code has a Floodplain Safety Overlay District that corresponds to FEMA 100-year and 500-year floodplains. These are included on these flood zone boundaries. The Floodplain Safety Overlay District Map identifies areas within Yucaipa needing additional protection from flooding hazards. Floodplain Review Area 1 (FP 1) includes areas subject to a 100-year flood. Floodplain Review Area 1 (FP2) includes all areas between limits of the 100- year flood and subject to a 500-year flood.

Building Codes and Development Standards

Proposed development projects within the Floodplain Safety Overlay District must be designed to meet applicable California building codes and required amendments. Additional mitigation measures for flood hazards may be required, including structure anchoring, construction materials and methods, utility standards, and others as required by the Floodplain Safety Overlay District. Projects must also comply with requirements of the National Flood Insurance Protection Floodplain Management program.

Master Plan of Drainage

The City continuously works on flood control projects to remove properties from delineated floodplains/ floodways and works with FEMA to make map revisions in accordance with federal law. Yucaipa's Master Plan of Drainage (MPD) and the City's Capital Improvement Program outlines planned improvements to flood control infrastructure - including detention basins, desilting basins, flood channel stabilization, and improvements to drainage facilities and infrastructure needed to provide protection from flooding events. MPD projects are consistent with the Hazard Mitigation Plan and Yucaipa's annual Capital Improvement Program.

Mutual Aid Agreements

Yucaipa maintains mutual aid agreements that provide for voluntary cooperative efforts and provision of services from other agencies when local capabilities are exceeded during an emergency. Yucaipa has mutual aid agreements with adjacent jurisdictions, San Bernardino County Flood Control District, Yucaipa Valley Water District, the State of California, federal agencies, Yucaipa-Calimesa Joint Unified School District, and American Red Cross, etc. The California Emergency Management Agency also provides coordination and funding to local disaster areas.

Adherence to the following goal and policies will help mitigate potential harm from Yucaipa's geologic and seismic hazards.

GOAL S-2: FLOOD SAFETY

A community well versed in flood control hazards and protected from or minimally disrupted by flooding and inundation hazards

Policies

S-2.1 Flood Hazard Identification. Maintain and continuously update the City's floodplain safety hazards map in concert with FEMA map amendments and improvements to local drainage facilities.

S-2.2 Floodplain Development. Promote the dedication of land within the 100-year floodplain and adjacent areas for park, multi-purpose trails, recreational uses, open spaces, and habitat conservation/mitigation.

S-2.3 Land Use Regulations. Prohibit development of new essential and critical facilities and lifeline services in the 100-year floodplain. Prohibit facilities that use, store, transport, or dispose of hazardous materials from developing in the Floodplain Safety Overlay District.

S-2.4 Building Codes. Require adherence to the latest building, site, and design codes in the California Building Code, FEMA flood control guidelines, and Floodplain Safety Overlay District to avoid or minimize the risk of flooding hazards in the community.

S-2.5 Special Flood Hazard Areas. Support policies, procedures, and recommendations of the National Flood Insurance Program for SFHAs with respect to zoning, subdivision, building codes, and overlays.

S-2.6 Flood Control Facilities. Prioritize and fund maintenance and construction of improvements to drainage facilities and roadways identified in the City's Master Plan of Drainage and Hazard Mitigation Plan.

S-2.7. Stormwater Runoff. Require new developments that add substantial amounts of impervious surfaces to integrate low impact development best management practices to reduce stormwater runoff.

S-2.8 Interagency Coordination. Establish and maintain cooperative working relationships among public agencies with responsibility for flood protection, including San Bernardino County Flood Control District, County Public Works, and other entities.

S-2.9 Public Education and Preparedness. Compile and distribute flooding prevention information to Yucaipa residents and business owners; conduct periodic inspections and preparedness events.

6.3 Mitigation Priorities

During the development of the updated flood risk assessment for the City of Yucaipa, the Planning Team proposed and discussed alternative mitigation goals, objectives, and specific mitigation measures that the City should undertake to reduce the risks emanating from Yucaipa's floodplain.

Yucaipa's September 2011 Master Plan of Drainage Update played a strategic role in evaluating specific projects and programs considered critical to the City of Yucaipa's floodplain management mitigation priorities.

Multiple factors were considered to establish the mitigation priorities included in this plan. The Planning Team utilized the STAPLEE system (identified in Section 3.6) to help assess mitigation priorities and determined that the highest priority rankings would be assigned to those mitigation measures that met three primary criteria:

1. Greatest potential for protecting life and property
2. Greatest potential for maintaining critical City functions and operability following a disaster; and
3. Achievability in terms of community support and cost effectiveness

All rankings were determined by the consensus of the Planning Team. As described in the previous section on hazard and risk assessment, flooding has the capability to inflict short- and long-term damage and could have the potential to affect large numbers of people, critical facilities and buildings, and to cause great economic losses.

Flood mitigation actions are identified and assigned a priority according to their importance, cost, funding availability, to what degree project planning has been completed, and the anticipated time to implement the measures.

Using the above rationale for establishing mitigation priorities, each mitigation measure is assigned a priority ranking as follows:

- High – Projects that will be the primary focus of implementation over the next five years
- Medium – Projects that may be implemented over the next five years
- Low – Projects that will not be implemented over the next five years unless conditions change (new program/funding source)

The Team discussed alternative mitigation strategies and mitigation measures during workshops, provided their preferences, and also suggested additional mitigation measures that the City should consider. National literature and sources were researched to identify best practices measures considered by the City. The Planning Team reviewed the list of possible objectives and mitigation measures, made a final selection, and then prioritized the individual mitigation measures considered the most appropriate for Yucaipa.

6.4 Implementation Strategy

An implementation strategy is the key to any successful planning effort. The implementation strategy identifies who has lead responsibility for the action, the estimated timeframe for completion, and potential funding source(s) to support implementation, and the priority ranking. Following team meetings, study sessions, public input, reports, analysis, and public hearings, the City of Yucaipa City Council approached the following report and its findings relative to short- and long-term implementation strategies:

- Lead Agency: City of Yucaipa and/or other agency assigned lead responsibility
- Timeframe: Short-term (less than 2 years); long-term (more than 2 years)
- Funding source(s): Potential internal and external funding source(s)
- Priority Ranking: High, Medium or Low

HAZARD MITIGATION PROJECT OBJECTIVES											
Project Description	**Priority**	**Public Safety**	**All Hazards**	**Flood / Water Resource Mgmt**	**Earthquake**	**Wildfire**	**Extreme Heat**	**Drought**	**Energy**	**GHGs**	**Wind**
Security Cameras (Phases I & II)	H	X									
(Phase III SLO in 14/15)	H	X									
Utility Pole Relocation/Underground	M				X	X				X	X
Regional Detention Basin 4 Wildwood Creek	H			X				X	X	X	
Dunlap Drain Phase Ia	H			X				X	X	X	
Dunlap Drain Phase II	H			X				X	X	X	
California St. @ Wildwood Creek Multipurpose Basin	H			X				X	X	X	
13th Street Sports Complex	H			X		X					
El Dorado Ranch Park	H			X		X	X	X	X	X	
Wide Area Network in Uptown and Parks	M	X	X							X	
Library and Education Center	H	X					X		X	X	
Performing Arts Center	H	X							X	X	
7th Street Pool Slide & Shade	H						X		X	X	

HAZARD MITIGATION PROJECT OBJECTIVES - CAPITAL PROJECTS											
Project Description	**Priority**	**Public Safety**	**All Hazards**	**Flood / Water Resource Mgmt**	**Earthquake**	**Wildfire**	**Extreme Heat**	**Drought**	**Energy**	**GHGs**	**Wind**
Storm Drain Improvements -- 4th St. (Total Project is estimated to be $463,481, with $75,000 from the Air Quality Management District Fund)	H			X				X			
5th St Sidewalk - Ave E - Yucaipa Blvd. (Total Project is estimated to be $635,000, with $154,000 from the Traffic Fund, $325,174 - TDA and $55,000 Measure I Arterial CPNA)	H			X					X	X	
18th St. Sidewalk - Ave E - Yucaipa Blvd. (Total Project is estimated to be $139,000, with $34,000 from the General Fund Sidewalk Account)	H			X					X	X	
Street Lighting in Uptown Target Areas	H	X							X	X	
ADA Accessible Curb Ramps	H			X					X	X	

HAZARD MITIGATION PROJECT OBJECTIVES – DRAINAGE FACILITIES											
Project Description	**Priority**	**Public Safety**	**All Hazards**	**Flood / Water Resource Mgmt**	**Earthquake**	**Wildfire**	**Extreme Heat**	**Drought**	**Energy**	**GHGs**	**Wind**
Wilson I Ecosystem Restoration (Estimated Cost $2,000,000) (Project separated to Wilson 3 in 2010-2011)	H			X				X	X	X	
Wilson II *(Phases I and II)* 1 (Estimated Cost Phase I $6,284,000 -- Estimated Cost Phase II $400,000)	H			X				X	X	X	
Wilson III / Innovation Center Improvements [1] Regional Detention Basin 2&3 Wilson Creek (Phase I Estimated Cost - $8,981,000)	H			X				X	X	X	
Regional Detention Basin 4 Wildwood Creek	H			X				X	X	X	
Wildwood Creek Trails Program	M			X				X	X	X	

HAZARD MITIGATION PROJECT OBJECTIVES – DRAINAGE FACILITIES											
Project Description	**Priority**	**Public Safety**	**All Hazards**	**Flood / Water Resource Mgmt**	**Earthquake**	**Wildfire**	**Extreme Heat**	**Drought**	**Energy**	**GHGs**	**Wind**
Santa Ana and Tributary Ecosystem Restoration Project	M			X			X	X	X	X	
Master Plan of Drainage Update	M			X				X	X	X	
Dunlap Drain Phase Ia ($351,600 to tie in to Yucaipa Blvd. 12th to 15th)	H			X				X	X	X	
Dunlap Drain Phase Ib (from $1 million on RDA page) **Avenue E Storm Drain	H			X				X	X	X	
Wilson Creek/Dunlap Drain Phase II	H			X				X	X	X	
11th St. Storm Drain (Estimated Cost-$414,817)	H			X				X	X	X	
13th St. Detention Basin	H			X				X	X	X	
Yucaipa Blvd., Civic Center, 6th St. Commercial Storm Drain System	H			X				X	X	X	
California St. @ Wildwood Creek Multipurpose Basin. Total Project Cost Est. $1.6M.	H			X				X	X	X	

HAZARD MITIGATION PROJECT OBJECTIVES – DRAINAGE FACILITIES											
Project Description	**Priority**	**Public Safety**	**All Hazards**	**Flood / Water Resource Mgmt**	**Earthquake**	**Wildfire**	**Extreme Heat**	**Drought**	**Energy**	**GHGs**	**Wind**
Misc. Drainage Capacity Enhancing Improvements	H			X				X	X	X	
Flood Corridor Program (Property Acquisition near Pendleton)	M			X							
LOW WATER CROSSINGS											
Wilson Creek at 10th St. *(Estimated Cost- $1,884,152)*	H			X				X			
Wildwood Creek at Live Oak Canyon (Estimated Cost - $1,800,000)	M			X				X			
Wilson Creek at Ave. "D" *(Estimated Cost- $1,800,000)*	H			X				X			
Wilson Creek at 13th St. *(Estimated Cost- $1,800,000)*	H			X				X			
Wildwood Creek at 3rd St. *(Est. Cost- $1,876,184)*	H			X				X			

HAZARD MITIGATION PROJECT OBJECTIVES – DRAINAGE FACILITIES												
Project Description	**Priority**	**Public Safety**	**All Hazards**	**Flood / Water Resource Mgmt**	**Earthquake**	**Wildfire**	**Extreme Heat**	**Drought**	**Energy**	**GHGs**	**Wind**
Wildwood Creek at 6th Pl. *(Est. Cost-$1,800,000)*	H			X				X			
Wilson Creek at Fremont St. *(Est. Cost- $1,800,000)*	H			X				X	X	X	
Pendleton Drive *(Est. Cost - $1,800,000) ($100K in PMP for approaches)*$49k to Flood Corridor*	H			X				X	X	X	
Wildwood Creek at Live Oak Canyon Road *(Est. Cost- $3,534,000) (HBRR-2,995,855; Match- $405,350)*	L			X				X			
Wilson III Detention Basin Project: Construct 90-Acre Foot Water Source	H	X	X	X	X	X	X	X	X	X	X
Dunlap Neighborhood Park: Construct 20-Acre Foot Water Source	H	X	X	X	X	X	X	X	X	X	X

HAZARD MITIGATION PROJECT OBJECTIVES – FIRE CAPITAL REPLACEMENT												
Project Description	**Priority**	**Public Safety**	**All Hazards**	**Flood / Water Resource Mgmt**	**Earthquake**	**Wildfire**	**Extreme Heat**	**Drought**	**Energy**	**GHGs**	**Wind**
Fire Marshal Vehicle	H	X	X								
Fire Engine (w/equip.)	H	X	X								
Computer	H	X	X								
Radio, Fire Vehicle	H	X	X								
Radio, Fire (Hand-Held)	H	X	X								
Radio, Fire (Fixed)	H	X	X								
Smoke Ejector	H	X	X								
Large Nozzles	H	X	X								
Rescue Tool (Jaws)	H	X	X								
Self-Cont. Breath App.	H	X	X								
Personal Protective Clothing	H	X	X								
Concrete Driveway	H	-									
Radio, Medic	H	X	X								
Heart Monitor Defib. Unit	H	X	X								
Fire Station 2 Seismic Retrofit and Additional Improvements	H	X	X								
FIRE FACILITIES:											
Station No. 4 (Total estimated cost including land and equipment $4,609,771)	H	X	X								

HAZARD MITIGATION PROJECT OBJECTIVES – PARK DEVELOPMENT											
Project Description	**Priority**	**Public Safety**	**All Hazards**	**Flood / Water Resource Mgmt**	**Earthquake**	**Wildfire**	**Extreme Heat**	**Drought**	**Energy**	**GHGs**	**Wind**
13th Street Sports Complex (Total Estimated Cost $3.5 million, includes amount from agreement with Yucaipa Valley National Little League)	H					X	X		X	X	
El Dorado Ranch Park (Total Estimated Cost--$605,000) There is an estimated 17 acres that may be used for mitigation for loss of habitat related to drainage-impacting projects.	M			X			X	X	X	X	
The estimated cost is $70,000 per acre. Standard in-lieu fee program credits are $190,000 per acre.											
Dunlap Neighborhood Park--SW	M	X					X	X	X	X	
Oak Glen/Zanja Neighborhood Park	M	X					X		X	X	
BMX Park	M	X					X		X	X	
Sand Canyon Parking Lot for Future Tennis Center	H	X				X			X	X	
Equestrian Center/ Neighborhood Park (Estimated Cost-$650,000) Funds reallocated in 2010-11 to reflect available resources	M									X	
Maxicom Irrigation System	H			X				X	X	X	
Photovoltaic Carport Canopy System-Community Park	H						X		X	X	
Citywide Photovoltaic Carport Canopy System - City-Owned Facilities	H						X		X	X	

Figure 31 - Implementation Projects (Reference Appendix A, Capital Improvement Program)

SECTION 7 - PLAN MAINTENANCE

ELEMENT D. PLAN REVIEW, EVALUATION, AND IMPLEMENTATION (applicable to plan updates only)			
D1. Was the plan revised to reflect changes in development? (Requirement §201.6(d)(3))			
D2. Was the plan revised to reflect progress in local mitigation efforts? (Requirement §201.6(d)(3))			
D3. Was the plan revised to reflect changes in priorities? (Requirement §201.6(d)(3))			

7.1 Monitoring, Evaluating and Updating the Plan

The inclusion of the Flood Mitigation Assistance (FMA) Plan into other existing City plans will continue to be a collaborative process that involves multiple stakeholders from associated agencies and departments. Because the FMA Plan is a living document that reflects ongoing flood mitigation activities, the process of monitoring, evaluating, and updating will be critical to the effectiveness of flood mitigation within the City. To facilitate the planning process, the Flood Mitigation Plan will be reviewed annually within the scope of the City of Yucaipa's adopted Hazard Mitigation Plan and revisions will be provided to FEMA in a five-year cycle, as required.

The City of Yucaipa Emergency Management Coordinator will be responsible for overseeing the Plan's implementation and maintenance and will be supported by the Police Captain and the Fire Chief for emergency response, and by the existing Planning Team. The Emergency Management Coordinator will assume lead responsibility for facilitating plan implementation and the maintenance meetings of the Planning Team. The Planning Team will be tasked with oversight, review, evaluation, and update of the Plan.

The City of Yucaipa Planning Team will review the Plan at least annually and update project status and other Plan elements as applicable. Departments with projects (i.e., Administrative Services, Community Development, Community Services, Development Services, Fire Services, General Services, Police Services, and Public Works) track the status of the projects through the entire life cycle from concept to completion. Each year proposed projects are reviewed by their respective Department Heads and the City Manager during budget development and selected projects are submitted for funding to the appropriate funding source (Capital Improvement Program). In order for recommendations to be considered by the City in the budget process, the annual review will be completed and submitted to the City Council before July 1 of every calendar year.

7.2 Implementation through Existing Programs

The City of Yucaipa addresses statewide planning goals and legislative requirements through its General Plan, Capital Improvement Projects, and City Building and Safety Codes. The Flood Mitigation Plan will implement a series of recommendations, many of which are closely related to the goals and objectives of existing planning programs. The City of Yucaipa will have the opportunity to implement recommended mitigation action items through existing programs and procedures.

The Flood Mitigation Plan goals and actions will be incorporated into various general operations of government. For example, the Local Hazard Mitigation Plan was recently adopted into the Safety Element of the General Plan and much of the information from the Hazard Mitigation Plan will be included in the City of Yucaipa Emergency Operations Plan (EOP). As any future City plans are developed, the Flood Mitigation Plan will be a great asset in any plan development efforts. As noted earlier, much of the information contained in this Flood Mitigation Plan is from the City's General Plan and is already part of the planning process.

7.3 Continued Public Involvement

A critical part of maintaining an effective and relevant Flood Mitigation Plan is ongoing public review and comment. Consequently, the City is dedicated to the direct involvement of its citizens in providing feedback and comments on the plan on a continued basis.

The public will continue to be apprised of Flood Mitigation Plan actions through the City's website (http://www.yucaipa.org) and through the local media. All proposed changes to the plan will be subject to citizen review prior to City Council action. The City will follow its standard public input process, consistent with the process used in the initial plan development, which is described in Section 3 of this Plan.

MITIGATION WORKSHOP CIP PROJECTS

January 7, 2014

Santa Ana River Tributary

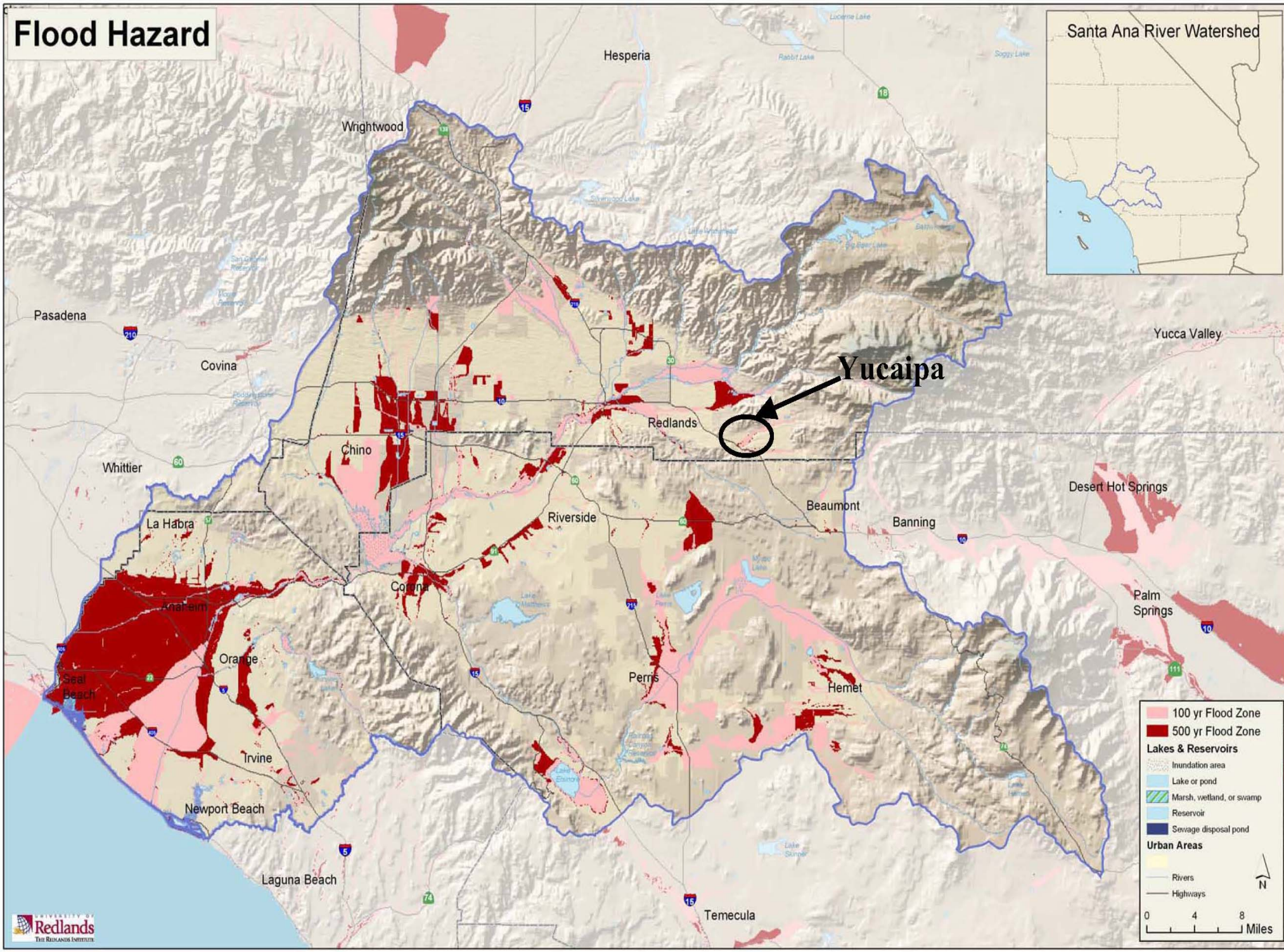


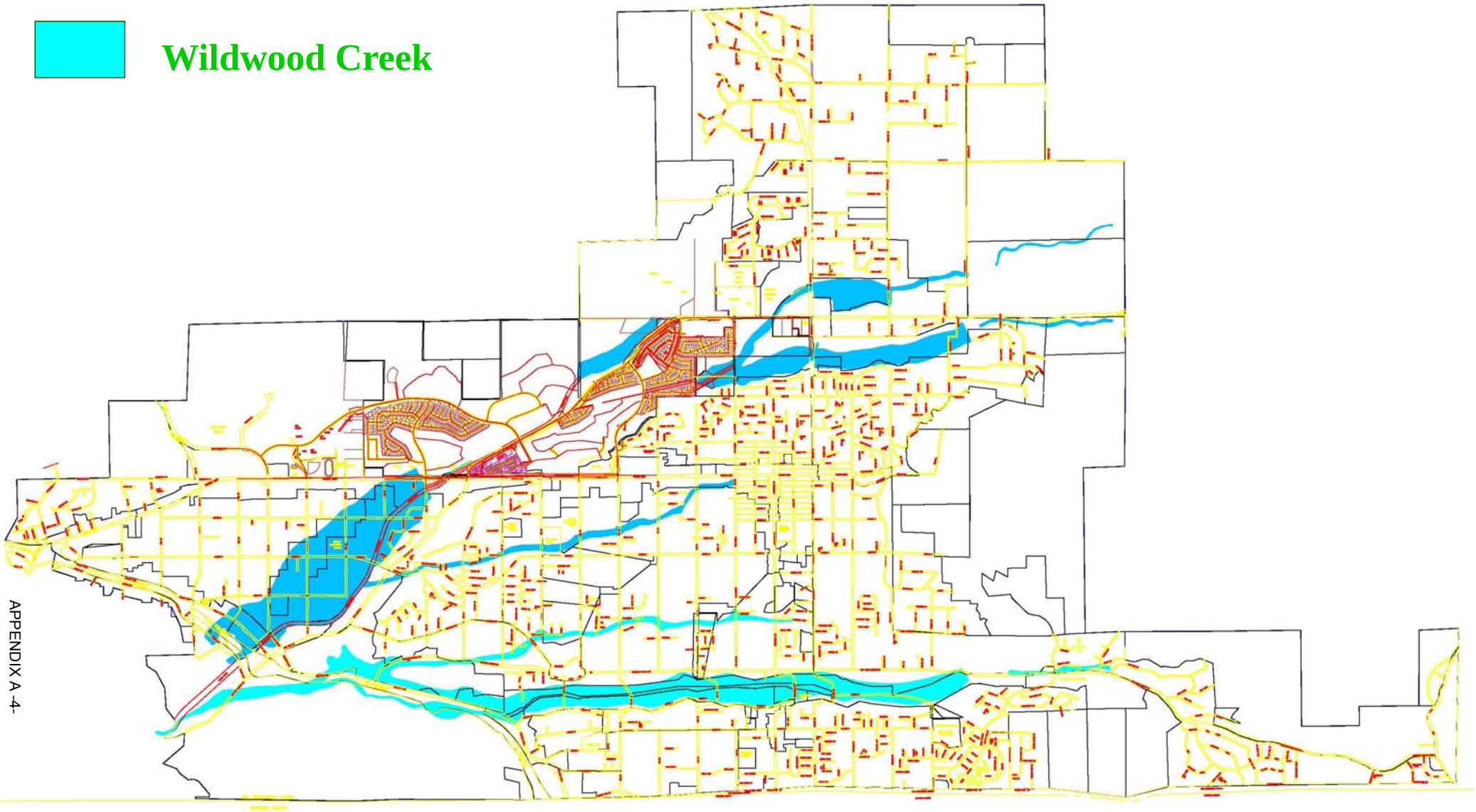
Figure 4 - Santa Ana River Watershed Flood Hazard Zones

Cartography by Lisa Benvenuti and Margaret Gooding, Redlands Institute, University of Redlands, 2004. All Rights reserved.

Floodplains

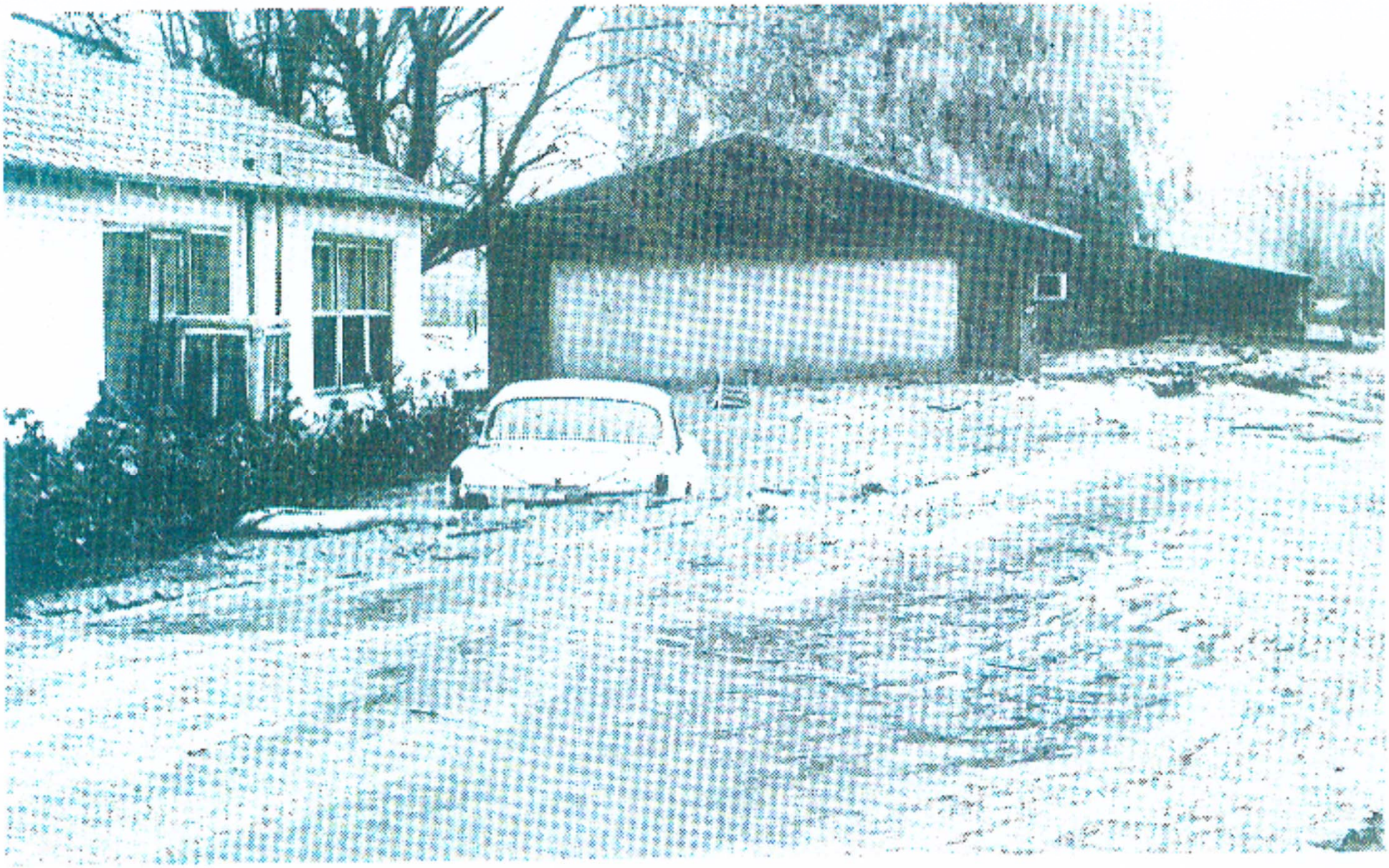
Wilson Creek

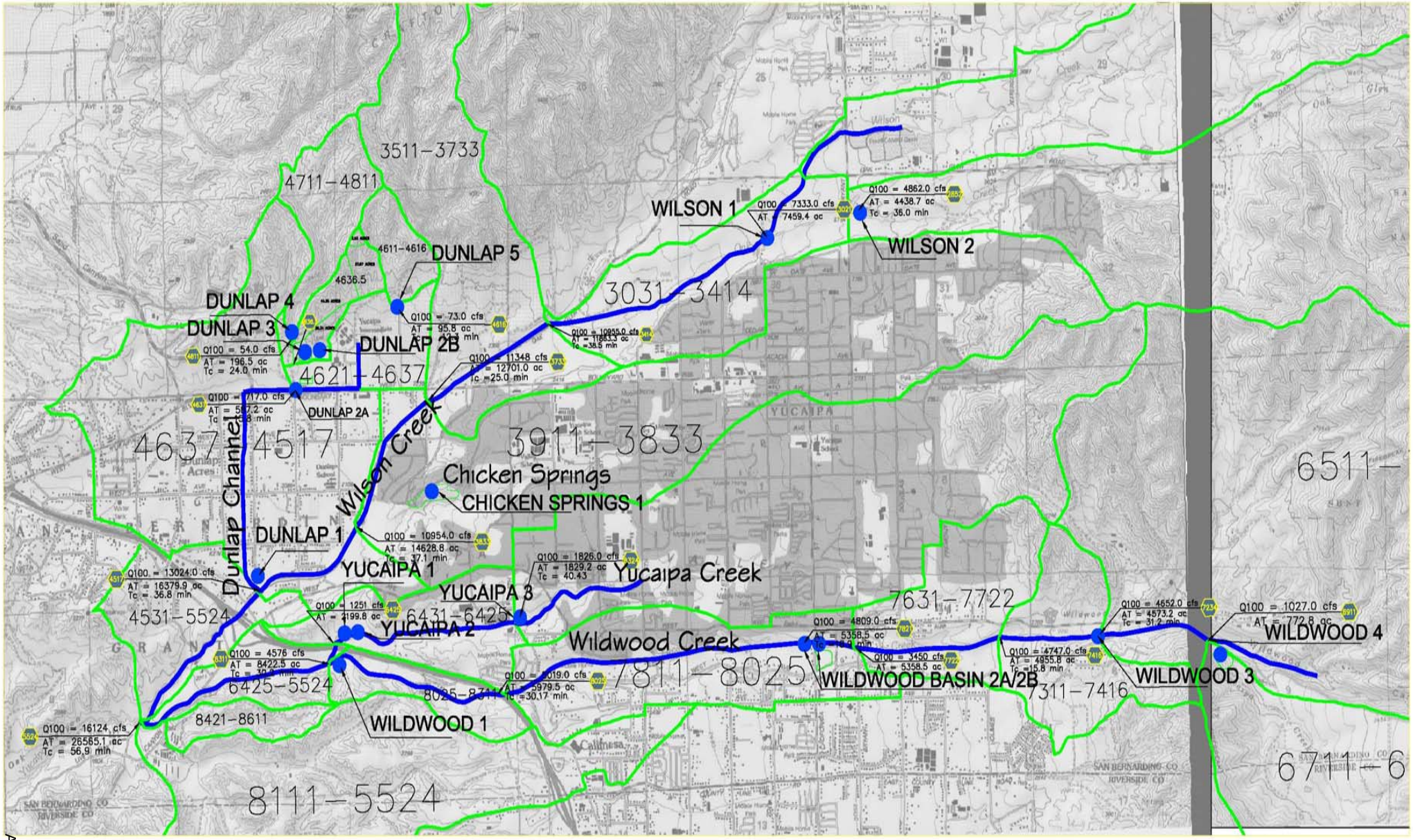
Wildwood Creek



1969 Flood

1969 Flood





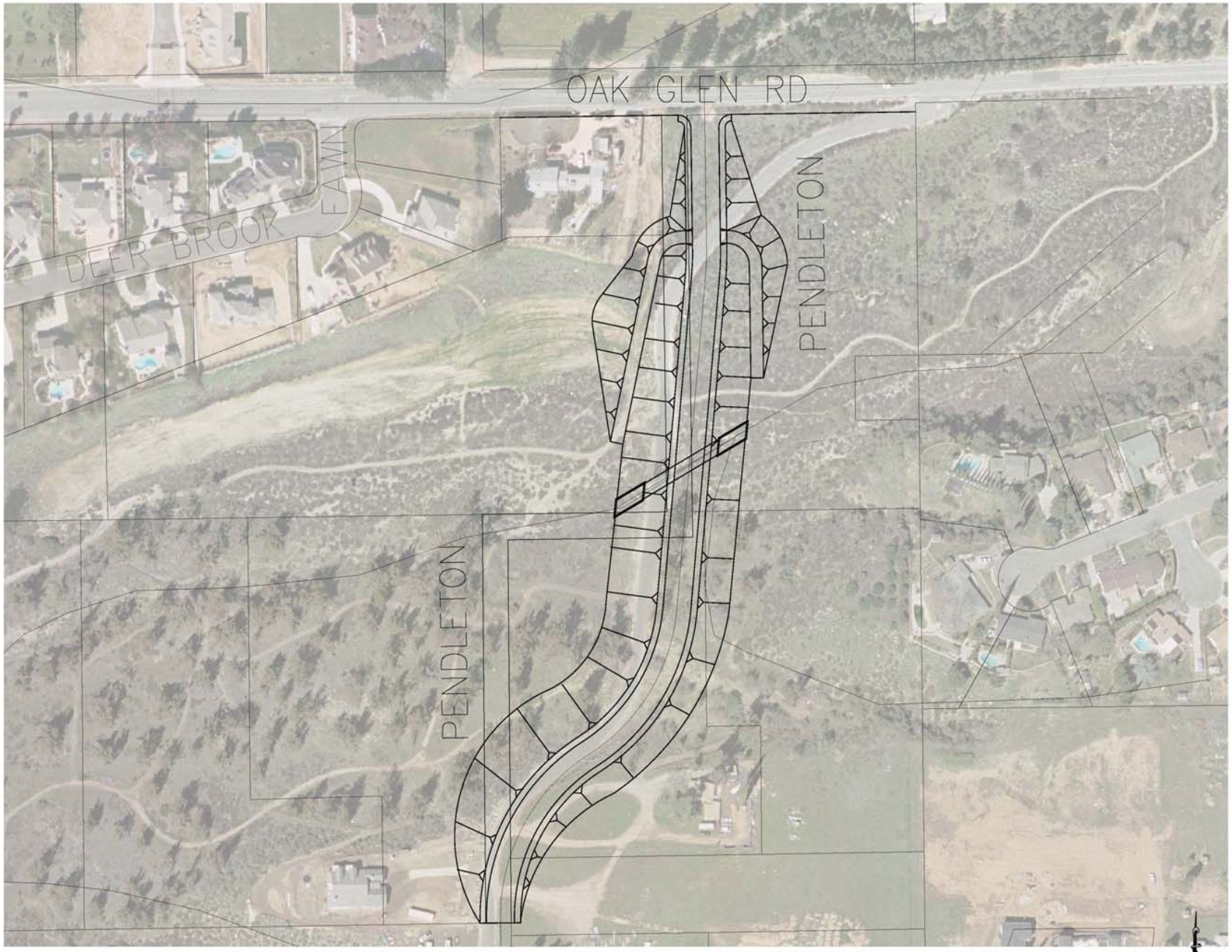
Master Plan of Drainage Update
HYDROLOGY MAP - WITH BASINS

NTS

LEGEND

- DETENTION BASIN LOCATION
- 7234 HYDROLOGY NODE
- WATERSHED BOUNDARY
- MAJOR CHANNEL

Pendleton Avenue at Oak Glen Creek

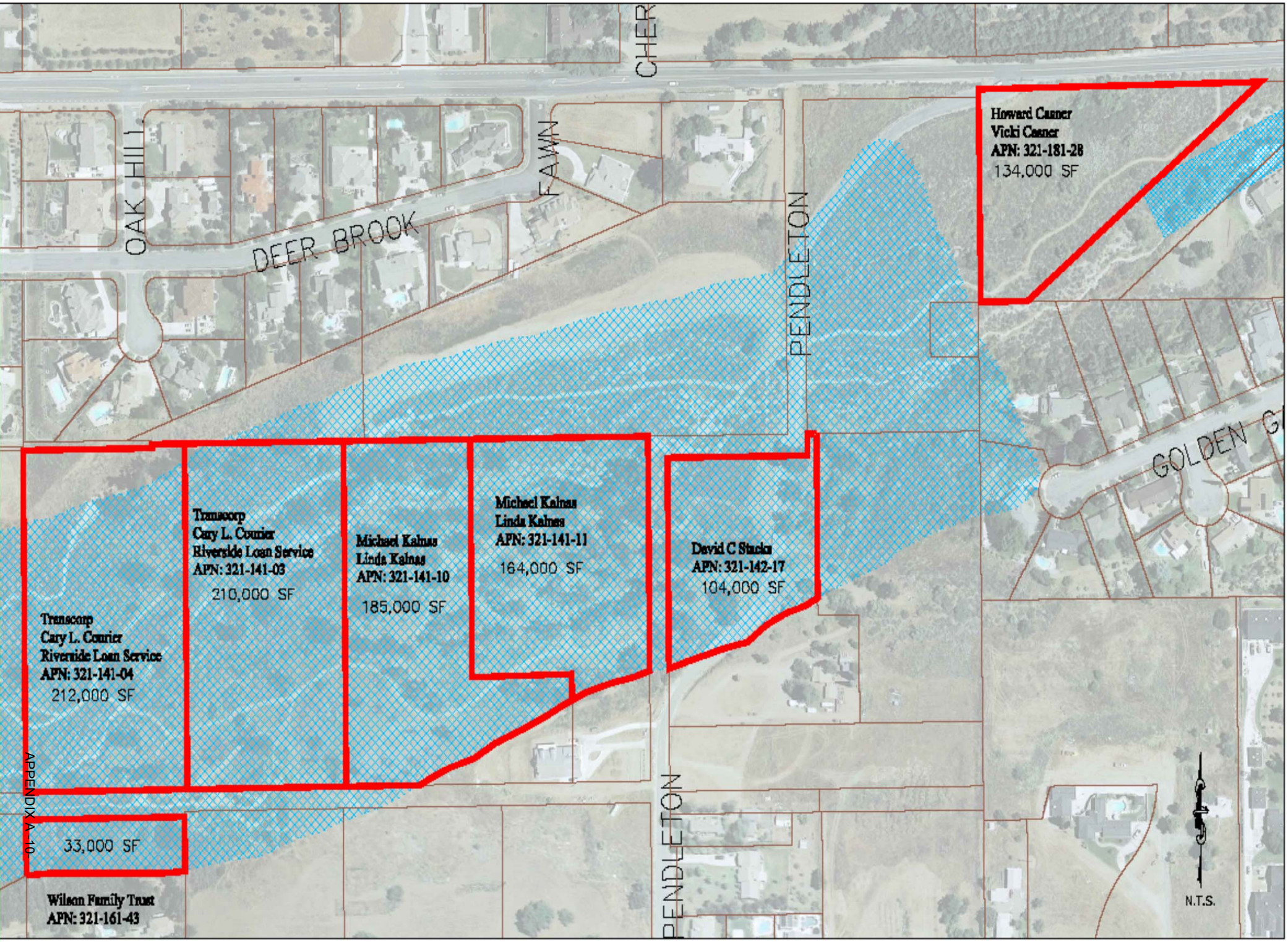


SEGMENT 1

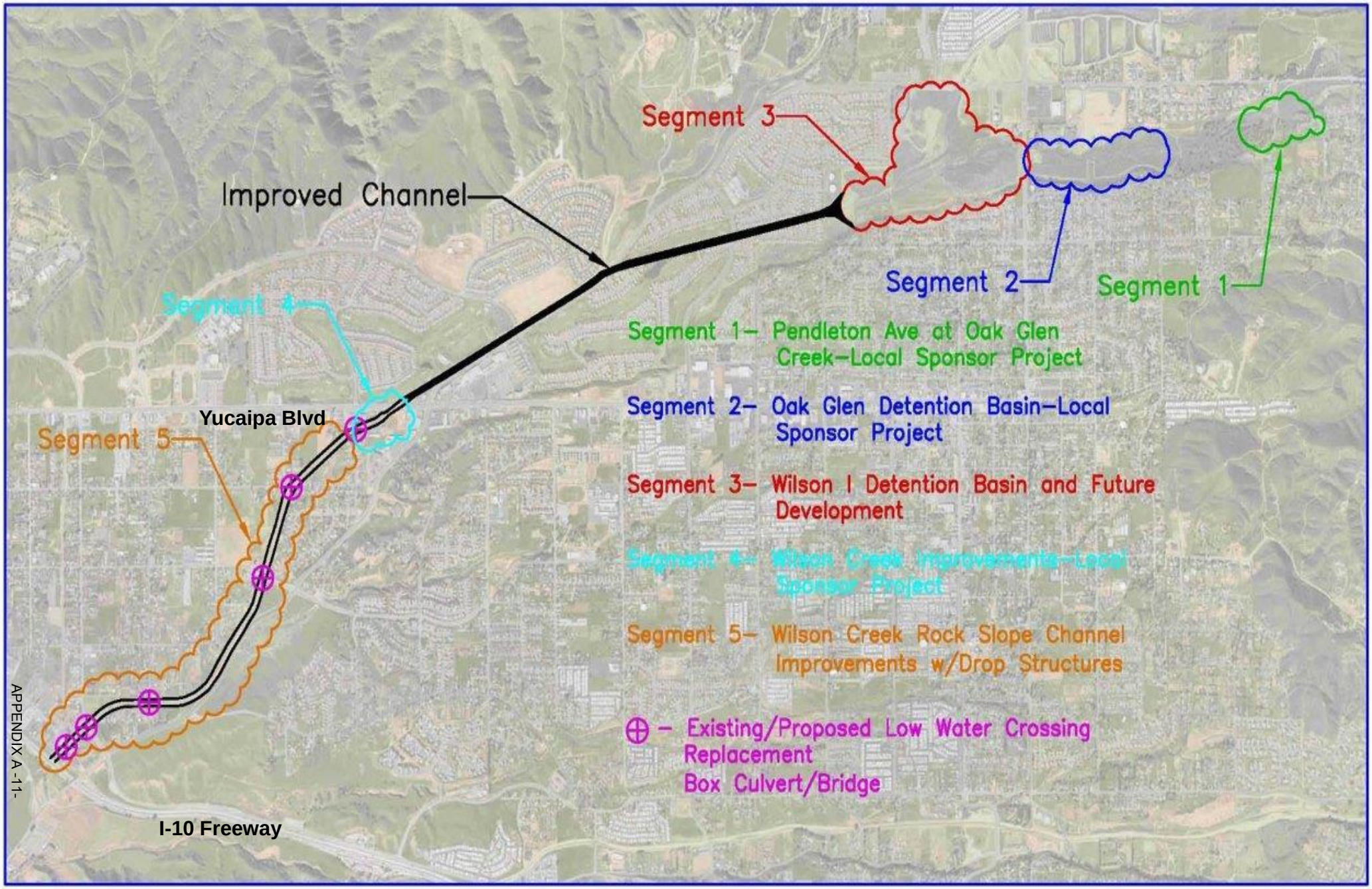
GRAPHIC SCALE

City of Yucaipa
WILSON CREEK
PENDLETON ROAD

Recommended for Approval By : _____ Date ____
Approved By : _____ Date ____
William B. Hensley, City Engineer
Job No. | Drawing No.
Sheet No. 1 of 1 sheets
City of Yucaipa Public Works Department


CHER
OAK HILL
DEER BROOK
FAWN
PENDLETON
GOLDEN G
Howard Casner
Vicki Casner
APN: 321-181-28
134,000 SF
Transcorp
Cary L. Courier
Riverside Loan Service
APN: 321-141-03
210,000 SF
Michael Kalnas
Linda Kalnas
APN: 321-141-10
185,000 SF
Michael Kalnas
Linda Kalnas
APN: 321-141-11
164,000 SF
David C Stacks
APN: 321-142-17
104,000 SF
Transcorp
Cary L. Courier
Riverside Loan Service
APN: 321-141-04
212,000 SF
33,000 SF
Wilson Family Trust
APN: 321-161-43
N.T.S.

WILSON CREEK SEGMENTS



1993 Master Plan of Drainage
Proposed Basin Locations

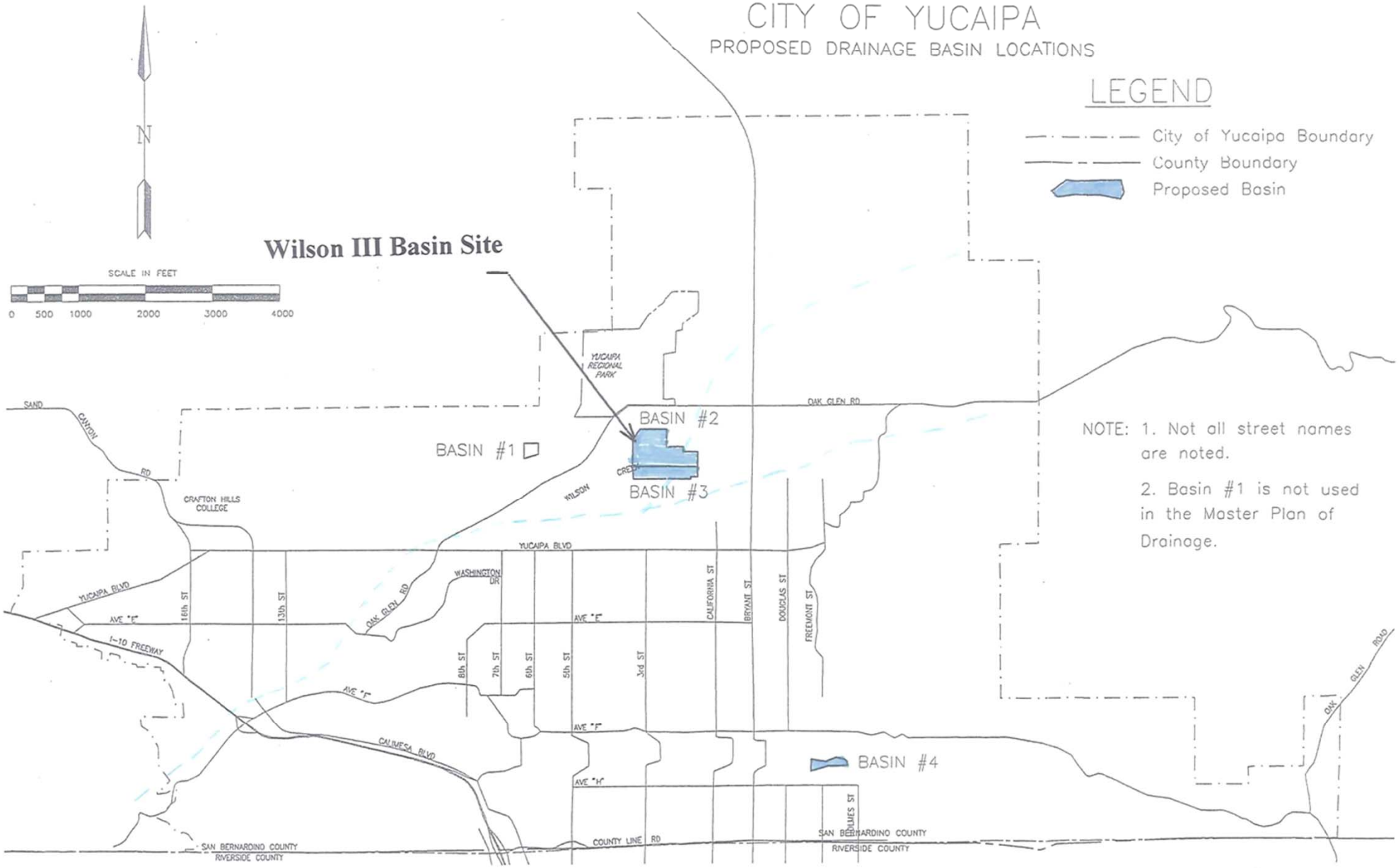
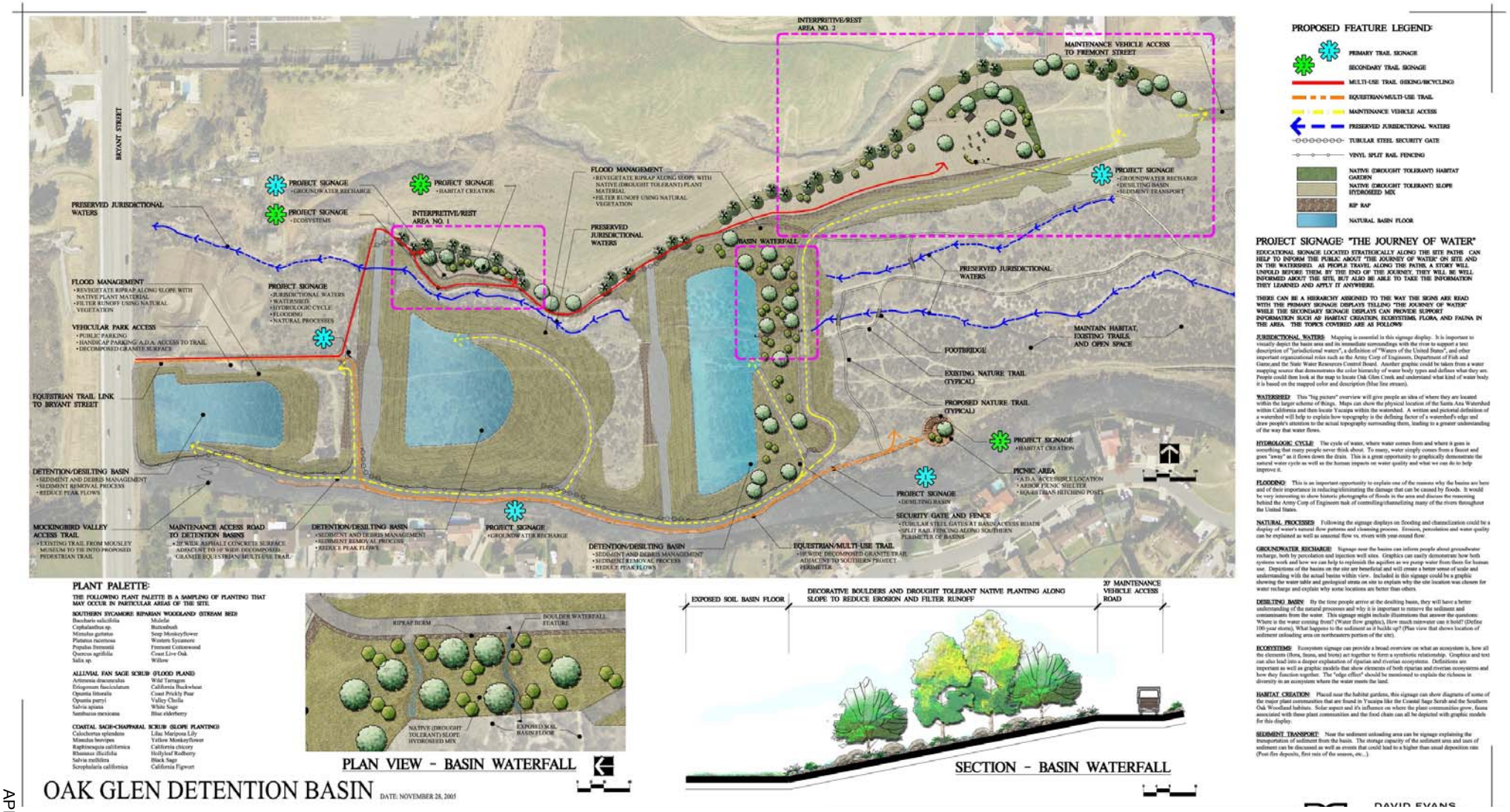


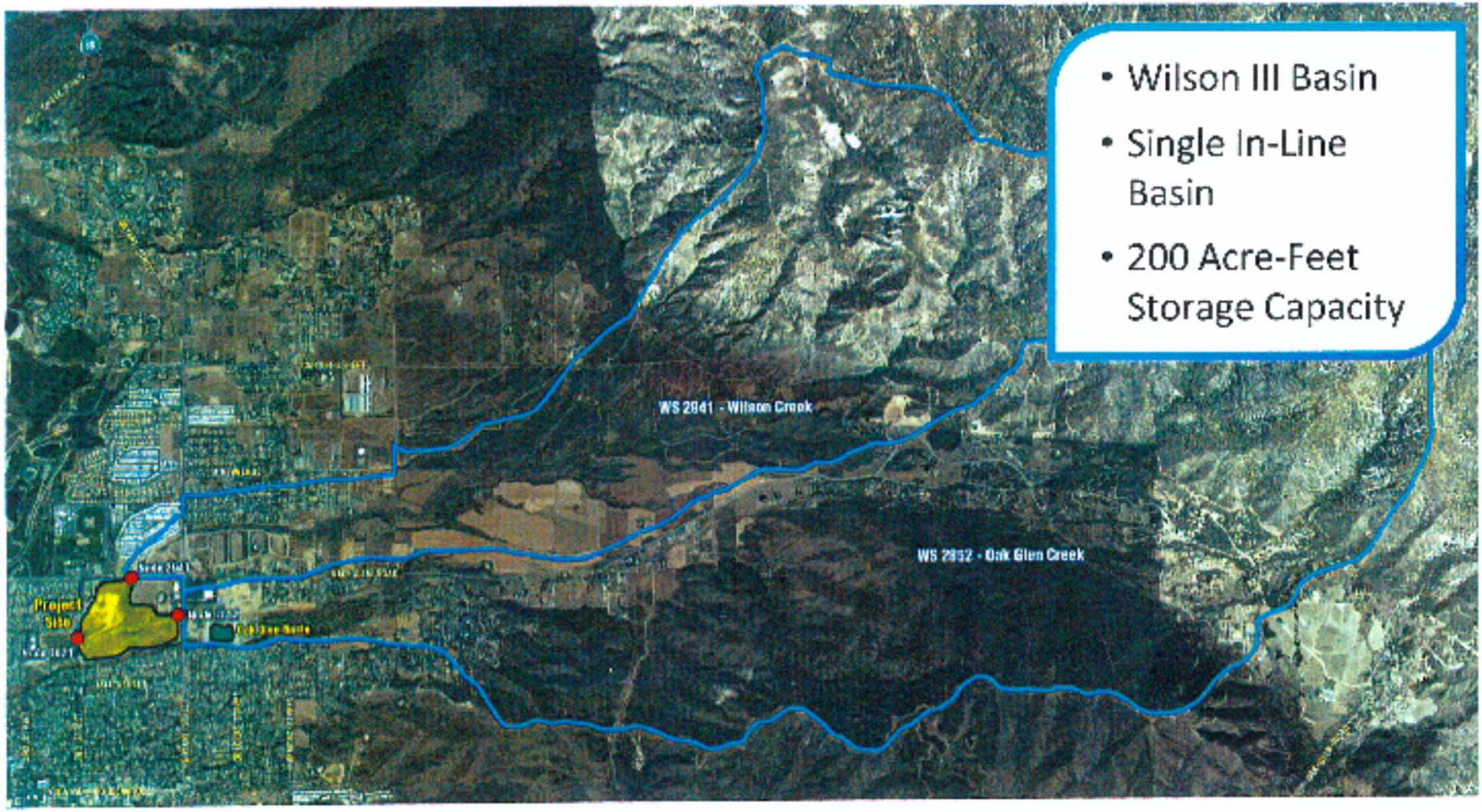
Figure 6.2. Locations of Proposed Basins

Oak Glen Creek/Wilson II Basin



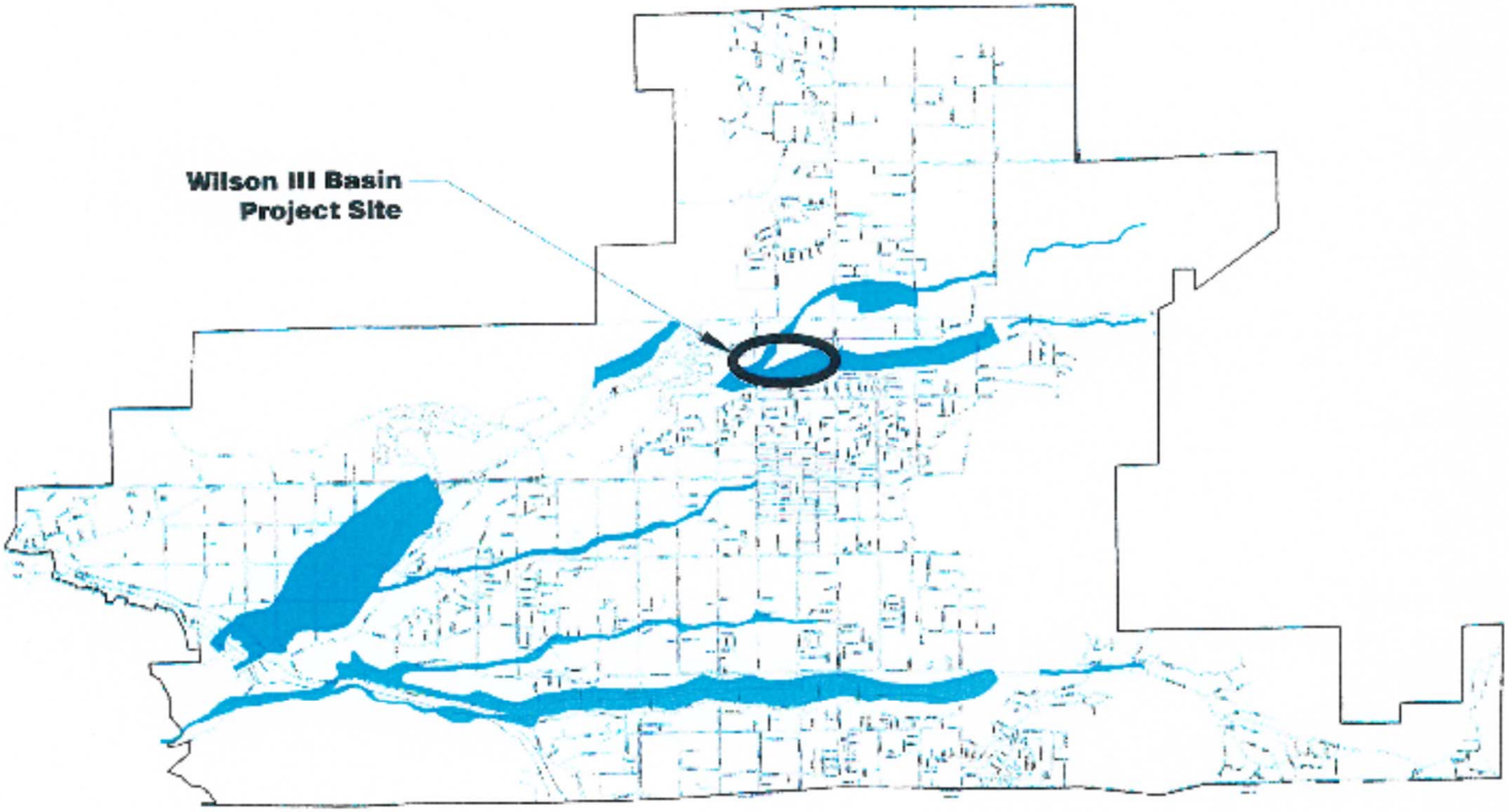
SEGMENT 2

Master Plan of Drainage



- Wilson III Basin
- Single In-Line Basin
- 200 Acre-Feet Storage Capacity

FEMA Flood Mapping



not to scale

WILSON III BASIN DESIGN ALTERNATIVES

Site Map

Figure 1-3

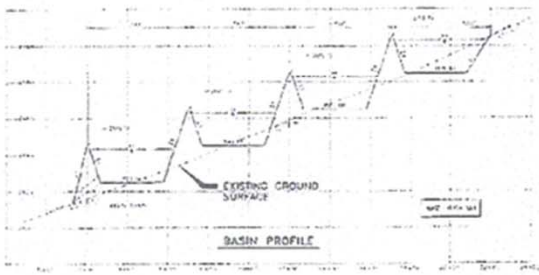
Existing Conditions

2002 Conceptual Plan
Proposed Basin Project

Yucaipa Valley Water District

City of Yucaipa

San Bernardino County
Flood Control District



Legend

1. Flood Control Basin
2. Concrete Spillway
3. "Look-Out" Area
4. New Parking Lot
5. Pedestrian Bridge
6. YVWD Well Site
7. City of Yucaipa Storage Facility
8. Basin Drains
9. 100' Greenbelt Buffer w/ Hiking Trail
10. New Paved Road
11. Nature Trail

Yucaipa Valley Flood Control & Groundwater Recharge Basins

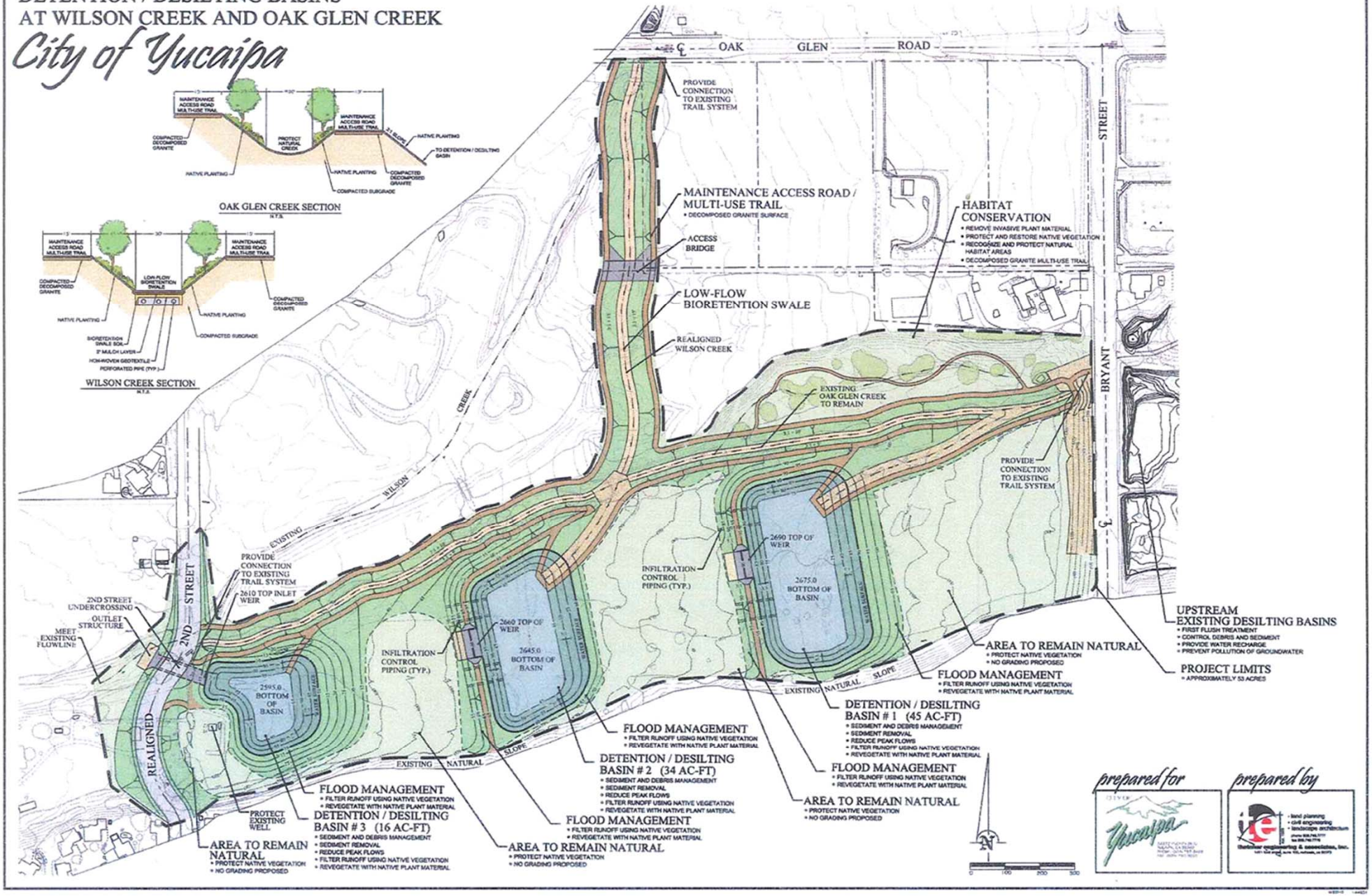
Preliminary Site Design

KRIEGER & STEWA

PRELIMINARY CONCEPTUAL DESIGN SCHEME A.1 2010

DETENTION / DESILTING BASINS
AT WILSON CREEK AND OAK GLEN CREEK

City of Yucaipa



2011 WILSON III BASIN CONCEPTUAL SITE PLAN

WILSON III BASINS
Maximum Ground Water Recharge 2012

City of Yucaipa
WILSON III
BASINS

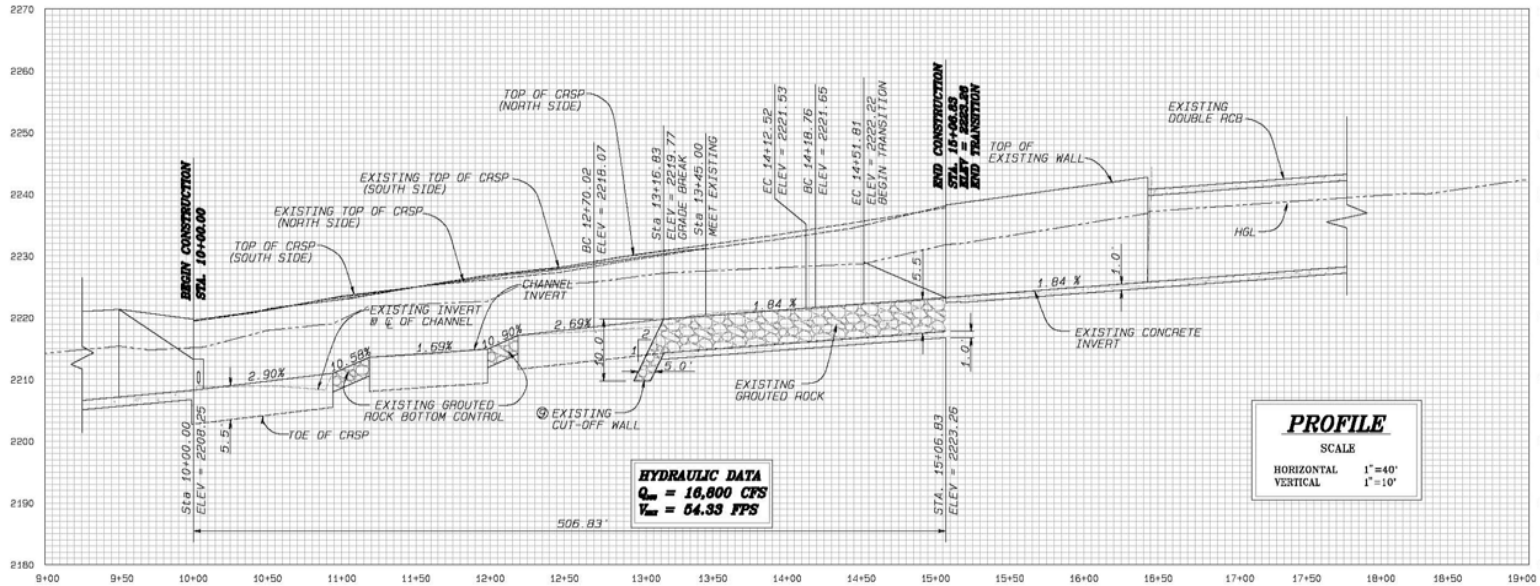
WILSON III BASIN DESIGN ALTERNATIVES

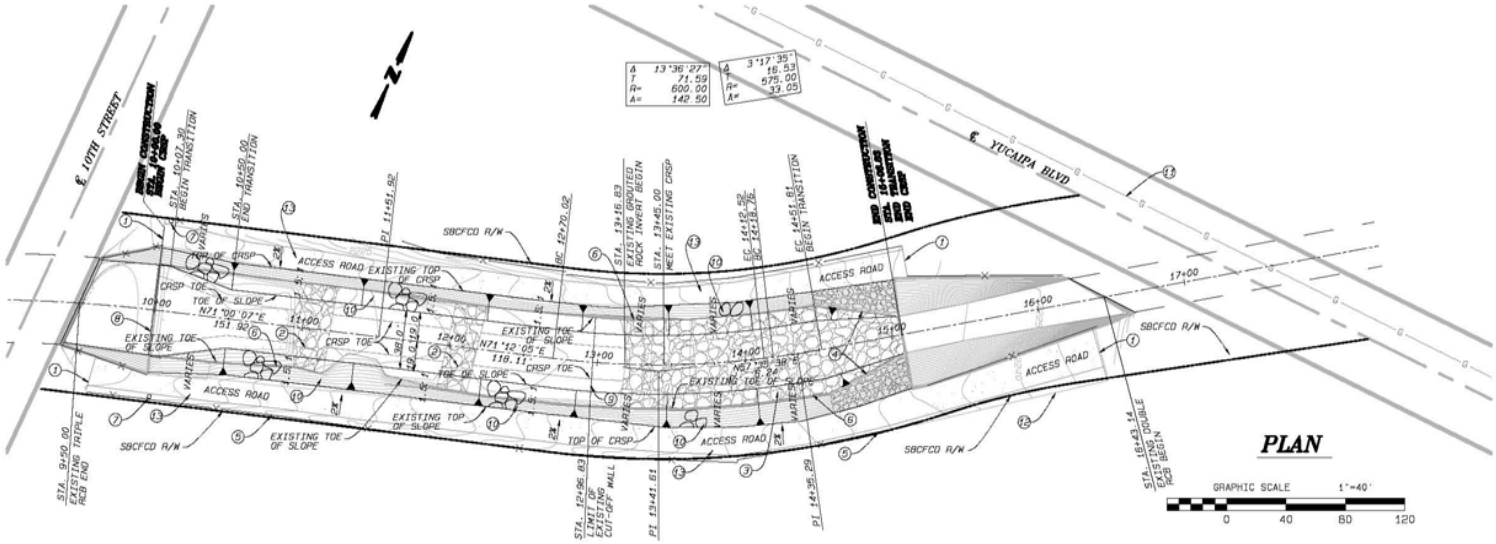
Alternative No. 6 - Wide Basin Footprint with 12' Permanent Recharge Pond, and Wilson Creek Re-Alignment

RBF A Company

01/18/13 JN 130351-18868 MAS

Figure 4-7





CONSTRUCTION NOTES:

1. REMOVE AND REINSTALL EXISTING 16' DOUBLE DRIVE GATES.
2. PROTECT IN PLACE EXISTING RIP-RAP BOTTOM CONTROL.
3. PROTECT IN PLACE EXISTING GROUTED ROCK INVERT.
4. PROTECT IN PLACE EXISTING CONCRETE CHANNEL WALL AND FOOTING.
5. REMOVE AND REINSTALL EXISTING FENCE.
6. CUT RAILS BELOW ROCK SLOPE PROTECTION. REMOVE RAIL, WIRE REVETMENT AND METAL BACKING.
7. PROTECT IN PLACE EXISTING DRAIN INLET.
8. PROTECT IN PLACE EXISTING CONCRETE CUT-OFF WALL.
9. PROTECT IN PLACE EXISTING GROUTED ROCK CUT-OFF WALL.
10. CONSTRUCT 1/4 TON CRSP 18" PENETRATION PER PLAN AND PROFILE.
11. PROTECT IN PLACE EXISTING 4" GAS MAINLINE.
12. PROTECT IN PLACE EXISTING BLOCK WALL.
13. CONSTRUCT DECOMPOSED GRANITE ACCESS ROAD

PRELIMINARY

REVISIONS			
MARK	DATE	DESCRIPTION	BY:

SUBMITTED BY: CHIEF, ENGINEERING DIVISION Date
RECOMMENDED BY: ASSIST. FLOOD CONTROL ENGINEER Date
APPROVED BY: FLOOD CONTROL ENGINEER Date

PROJ. ENG.	DES. BY	REVIEW BY	DRAWN BY
M.M.	M.M./D.B.	J.B.	D.B.

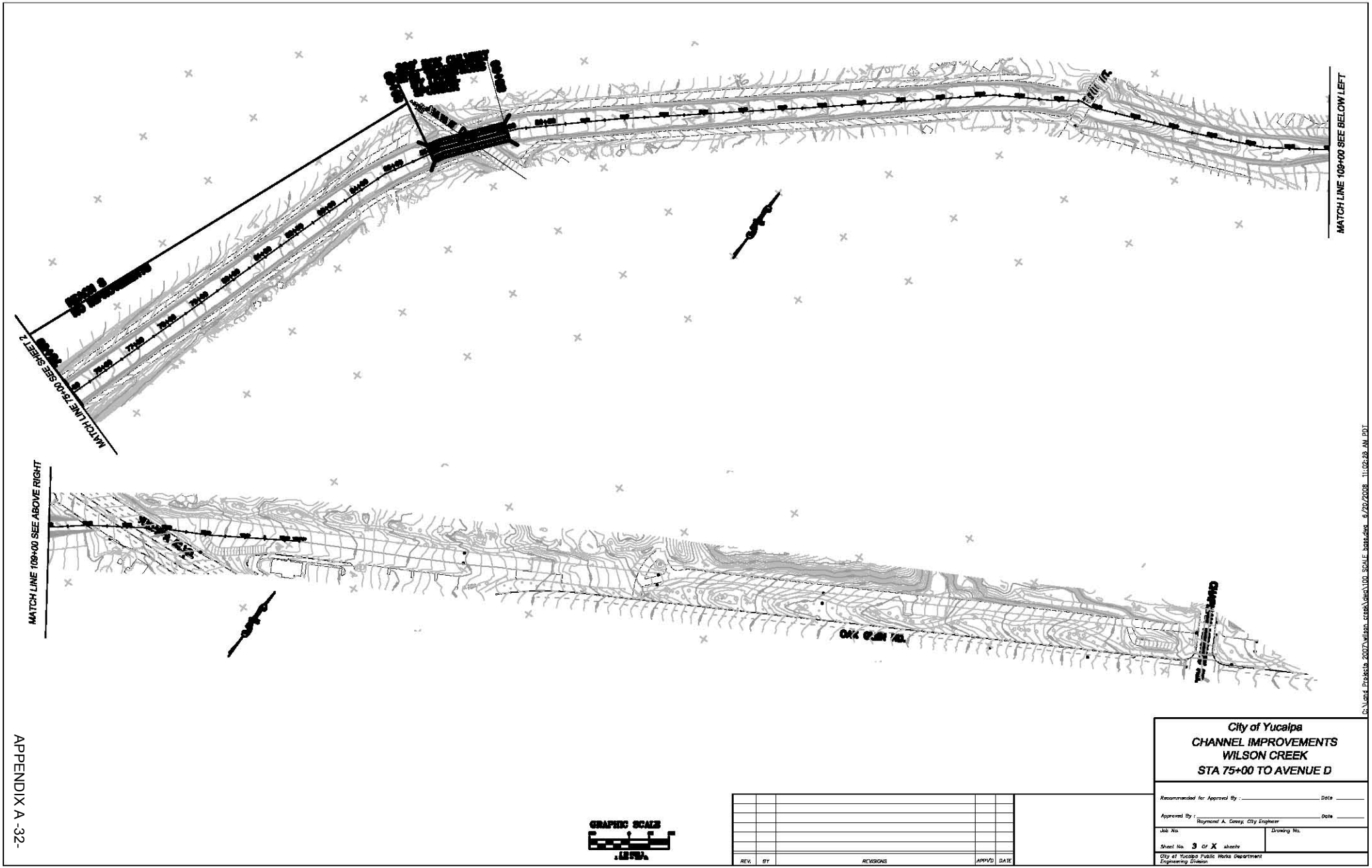
SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT

WILSON CREEK SYSTEM
WILSON CREEK

PLAN AND PROFILE
STA 10+00.00
TO STA 15+06.83

DATE NOV 2006
F.B. REF. F02234
FILE NO. 3-601-
SHEET NO. 2 OF 4

SEGMENT 4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MATCH LINE 78+00 SEE SHEET 2
MATCH LINE 109+00 SEE ABOVE RIGHT
GRAPHIC SCALE
City of Yucaipa
CHANNEL IMPROVEMENTS
WILSON CREEK
STA 75+00 TO AVENUE D
Recommended for Approval By : Date
Approved By : Raymond A. Casey, City Engineer Date
Job No.
Drawing No.
Sheet No. 3 Of X sheets
City of Yucaipa Public Works Department
Engineering Division
REV. BY REVISIONS APPV'D DATE
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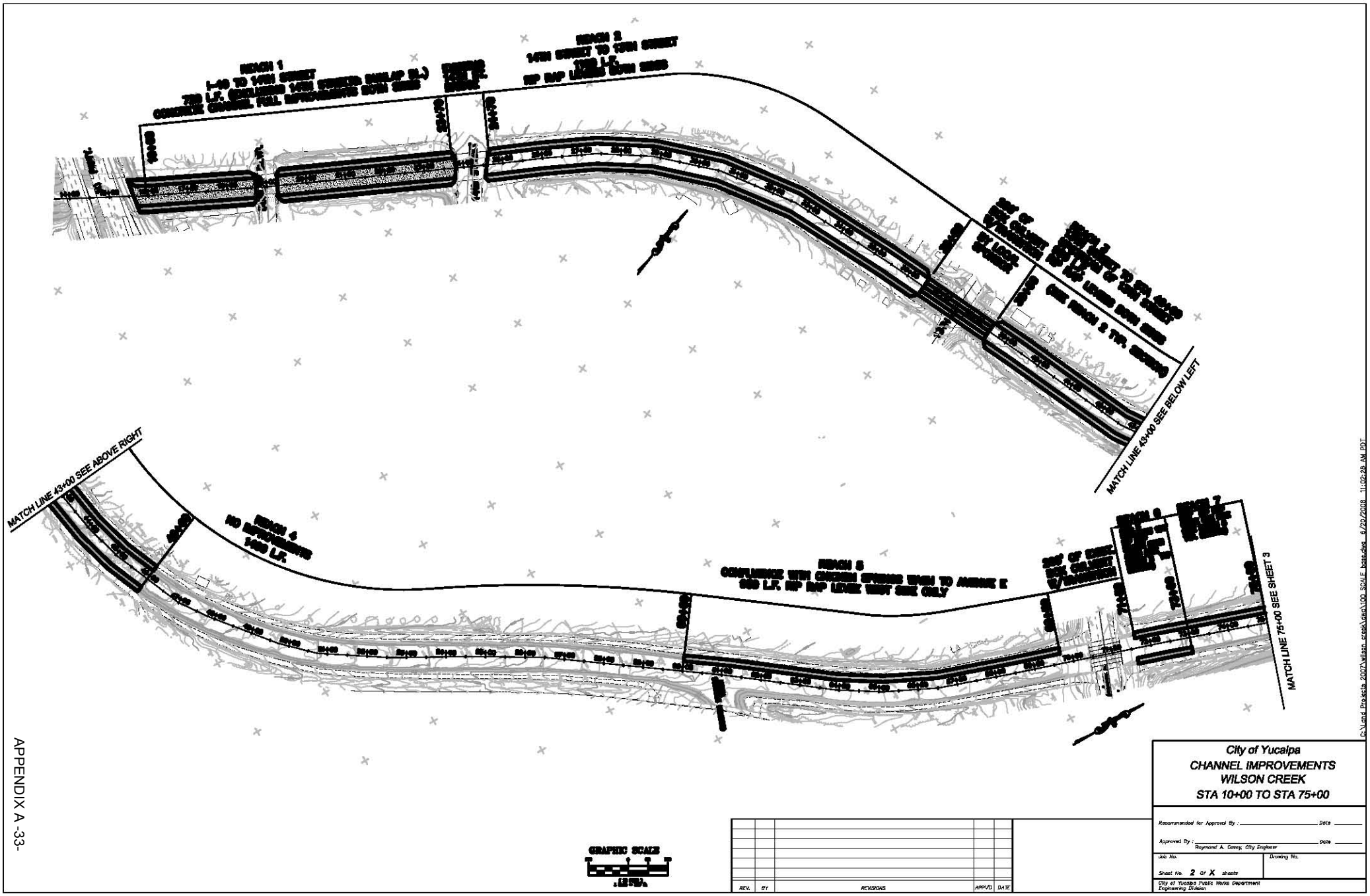
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REACH 2
REACH 3
REACH 4
REACH 5
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MATCH LINE 43+00 SEE ABOVE RIGHT
MATCH LINE 75+00 SEE SHEET 3
GRAPHIC SCALE
City of Yucaipa
CHANNEL IMPROVEMENTS
WILSON CREEK
STA 10+00 TO STA 75+00
Recommended for Approval By :
Date
Approved By :
Raymond A. Casey, City Engineer
Date
Job No.
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Sheet No. 2 of X sheets
City of Yucaipa Public Works Department
Engineering Division
REV.
BY
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DATE
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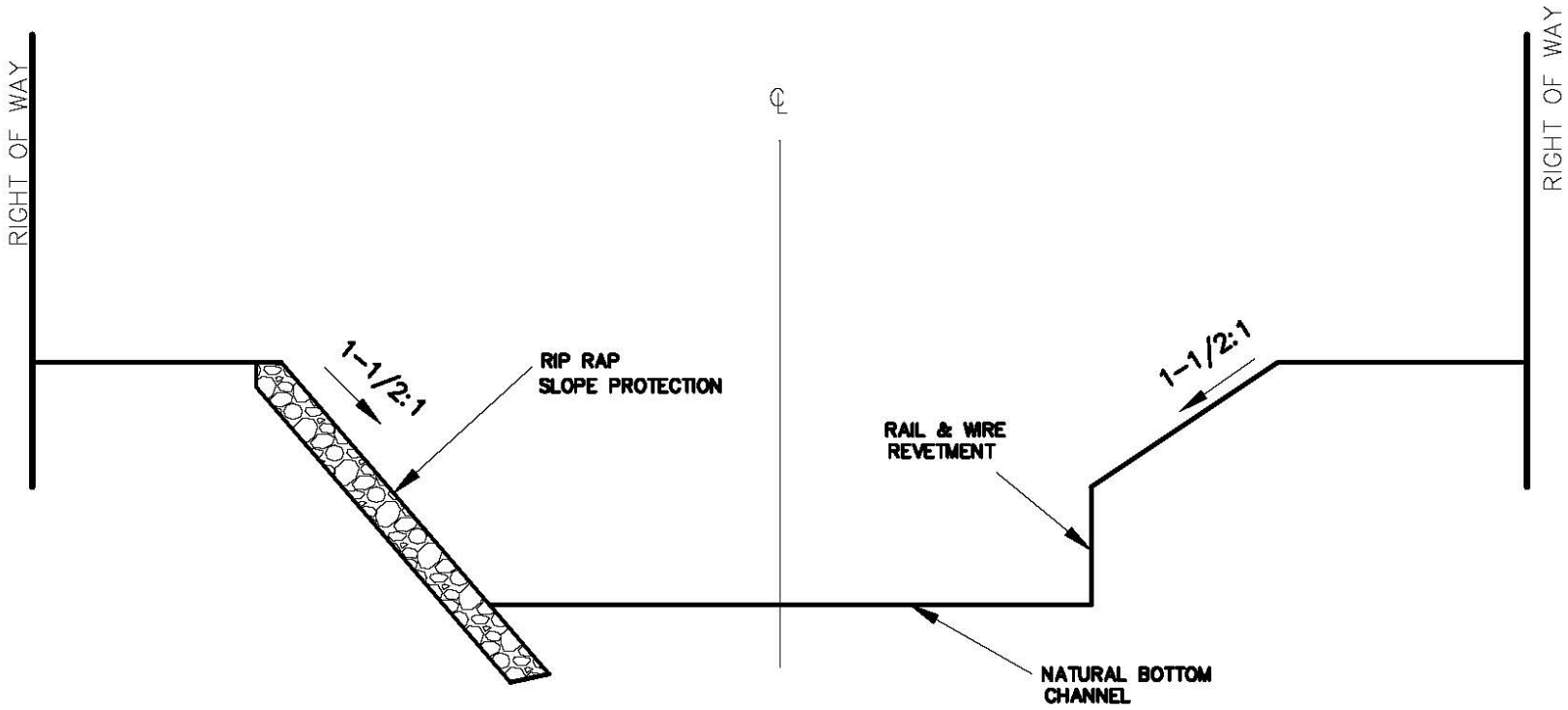
SEGMENT 5

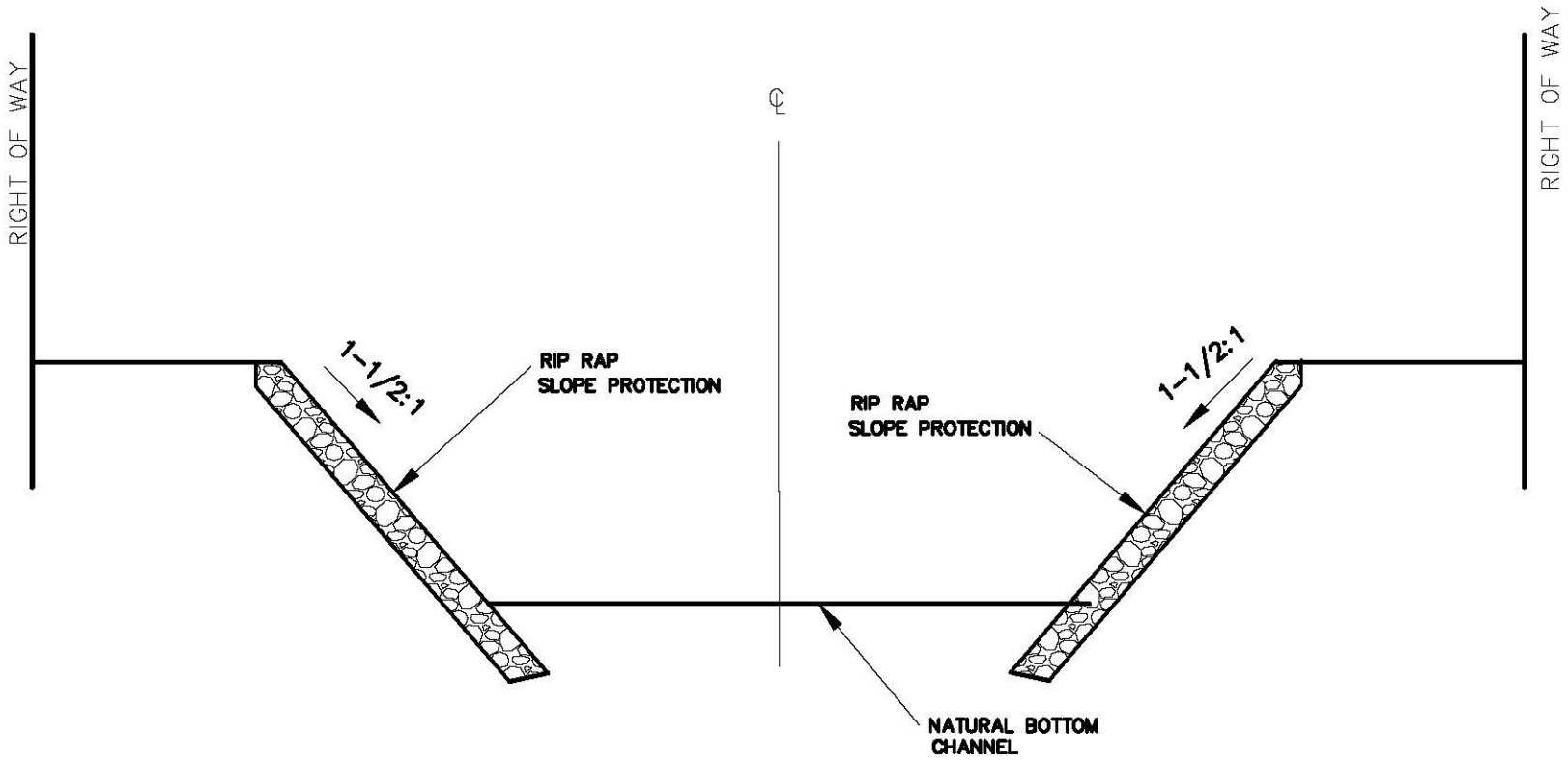
SEGMENT 5



TYPICAL SECTION A

NTS

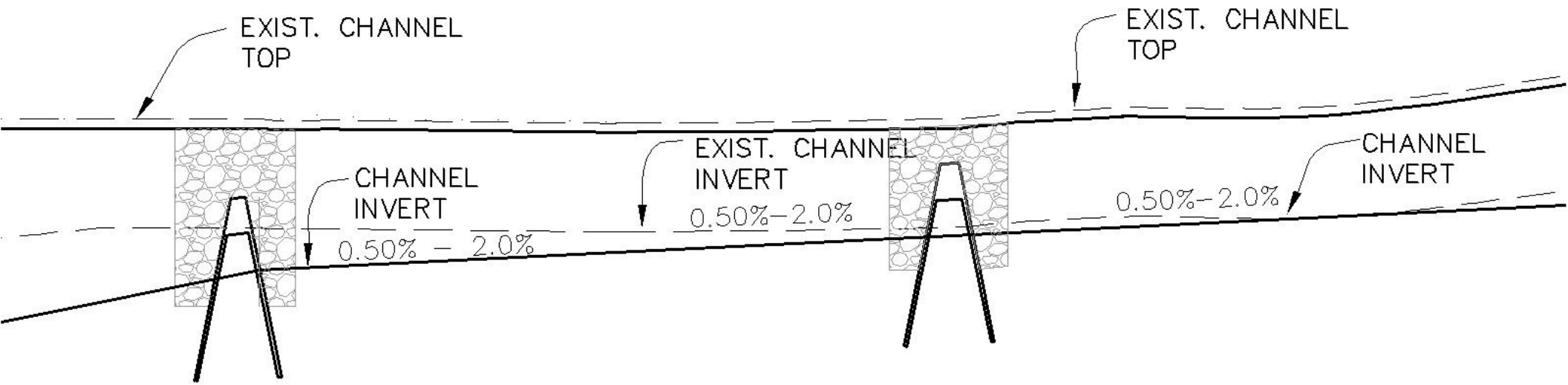
SEGMENT 5



TYPICAL SECTION B

NTS

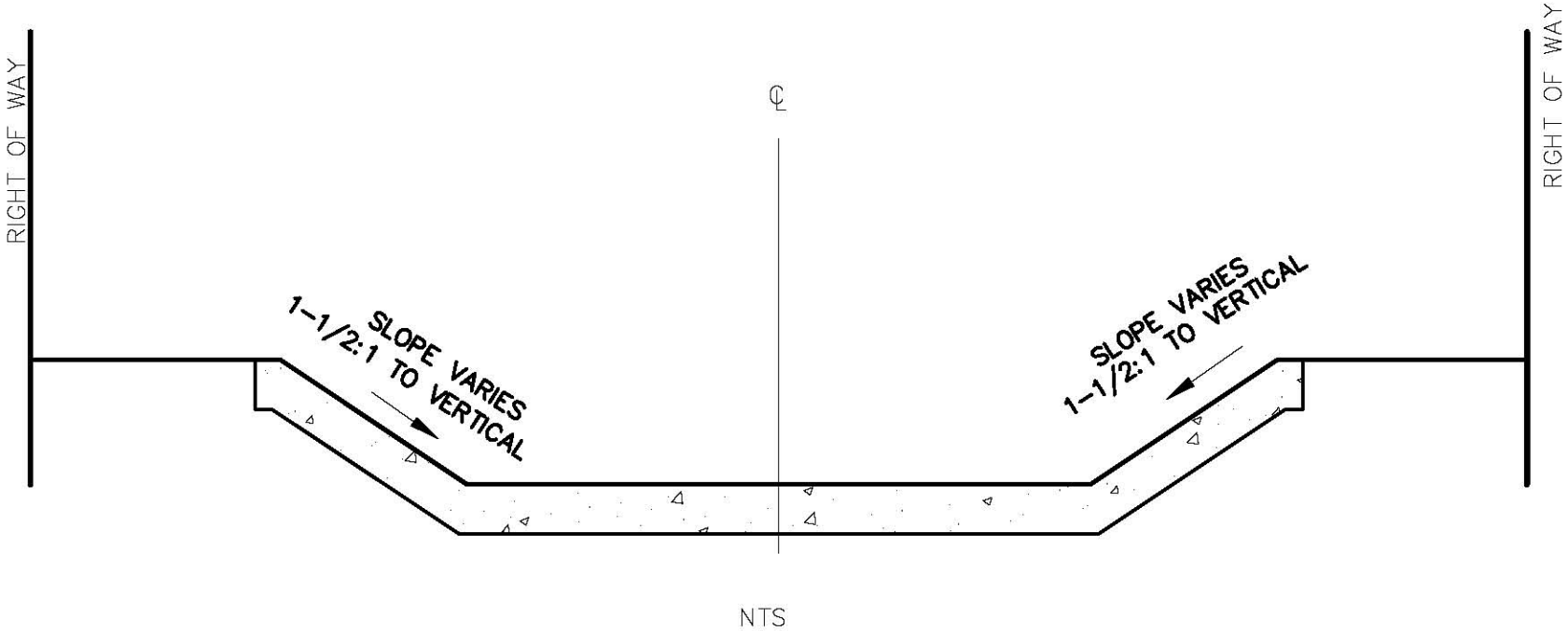
SEGMENT 5



PROFILE VIEW

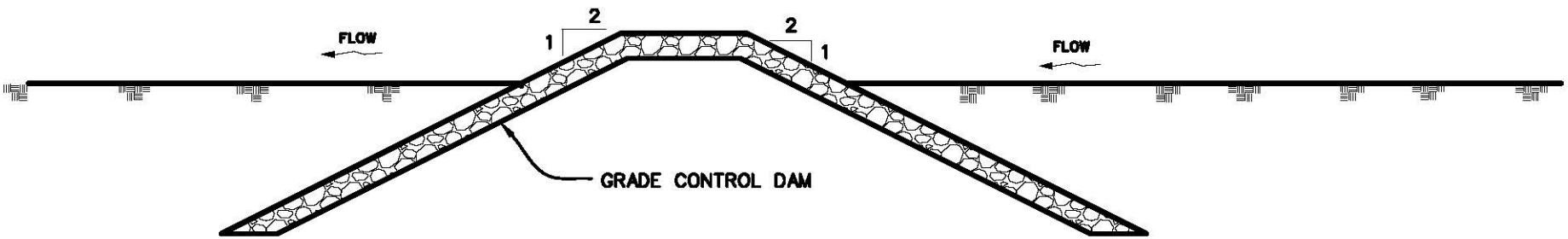
NTS

SEGMENT 5



TYPICAL SECTION C

SEGMENT 5



LONGITUDINAL SECTION

Figure 1. Regional Location Map

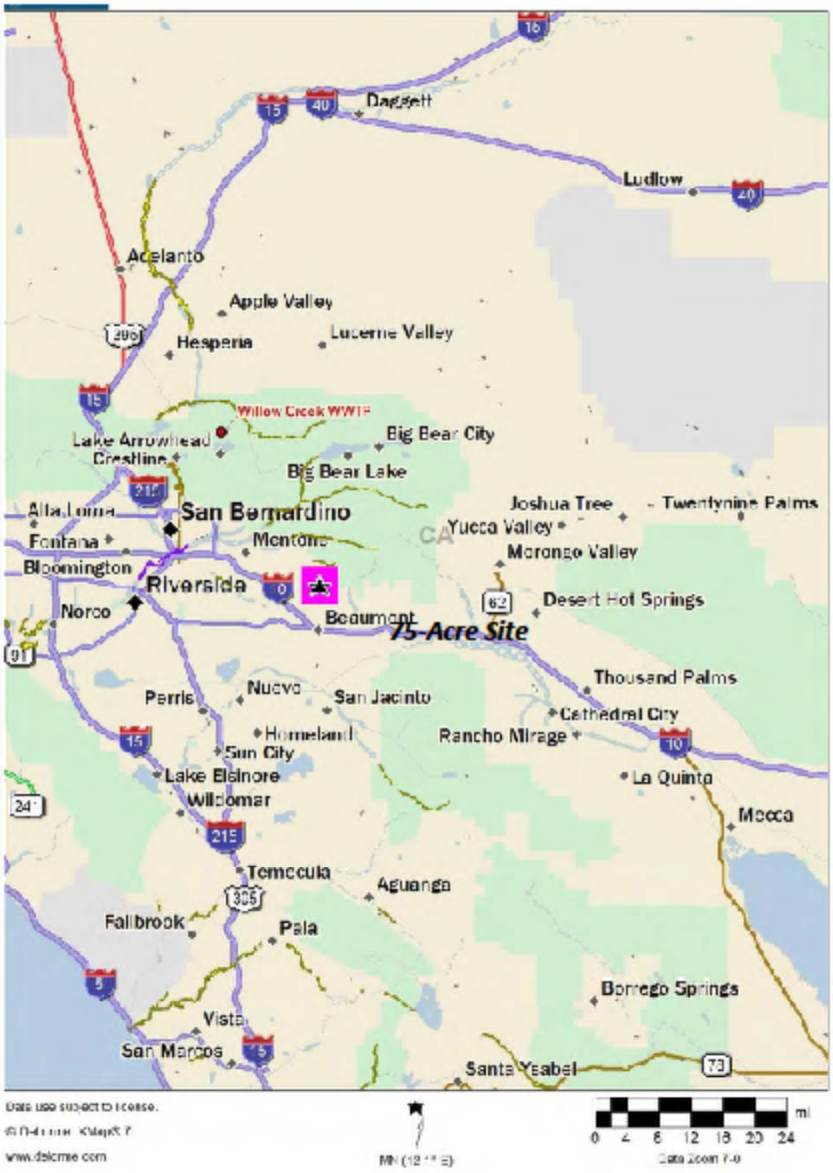
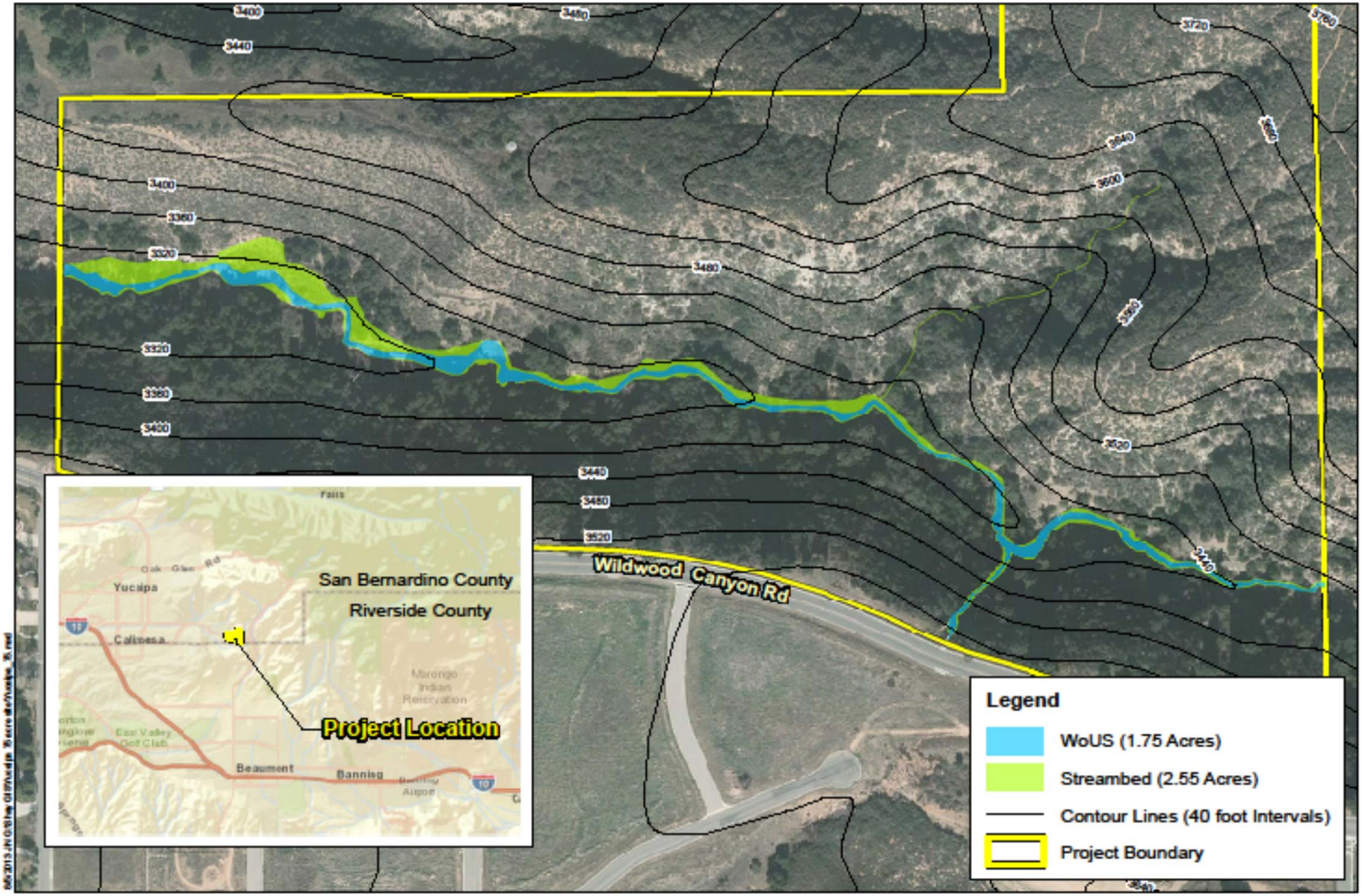


Figure 4. Local Hydrology Map

Jurisdictional Waters Determination and
Biological Resources Assessment



0 125 250 500 Feet

Source: USGS National Map, Eagle Aerial 2012, ESRI World Street Map

JURISDICTIONAL WATERS EVALUATION

Jurisdictional Waters

Figure 2

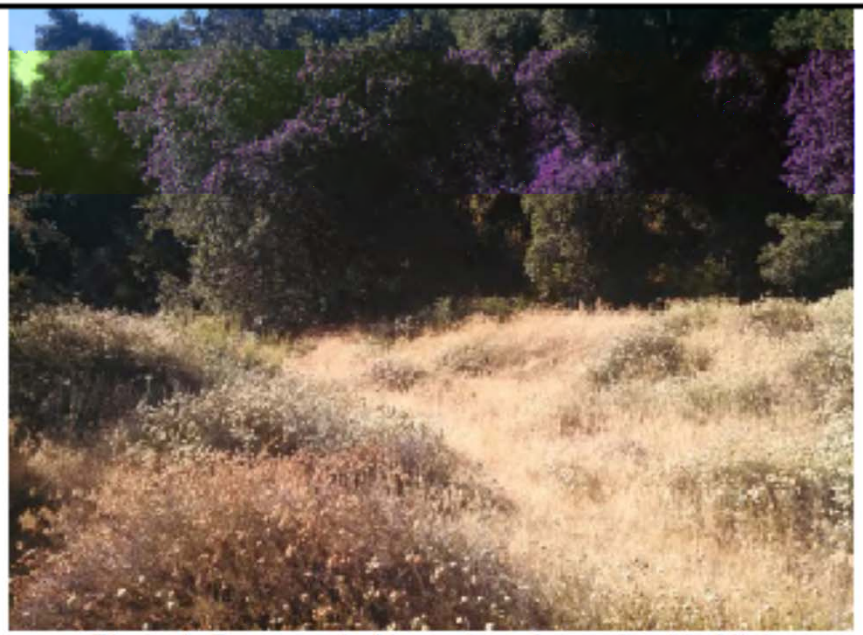


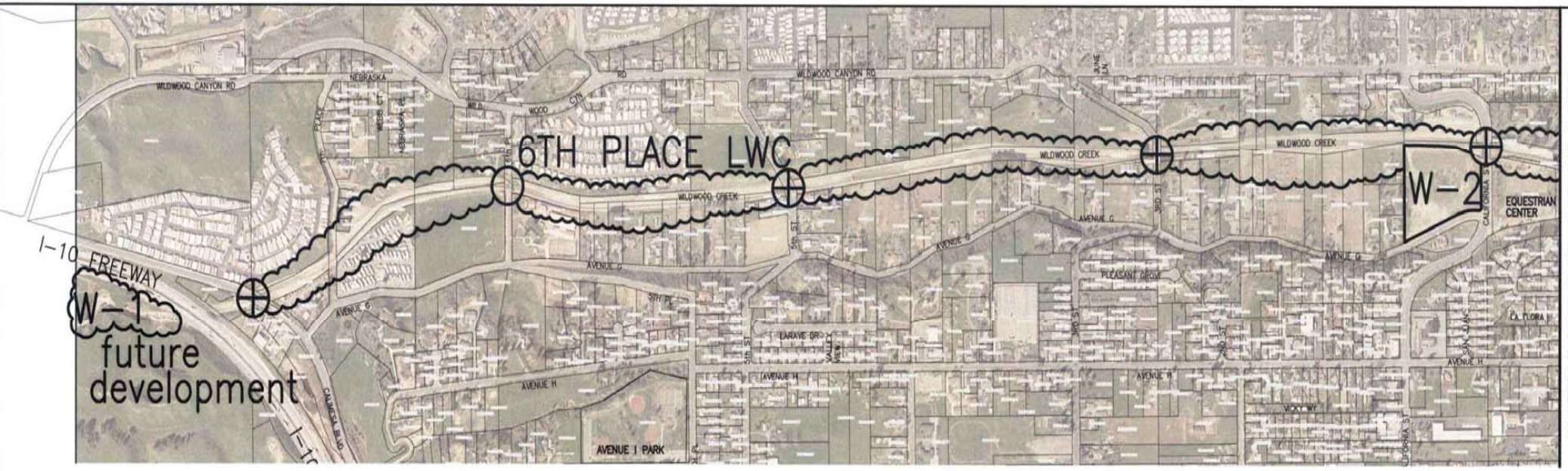
Photo 1. Sage scrub, Live oak and grassland habitat

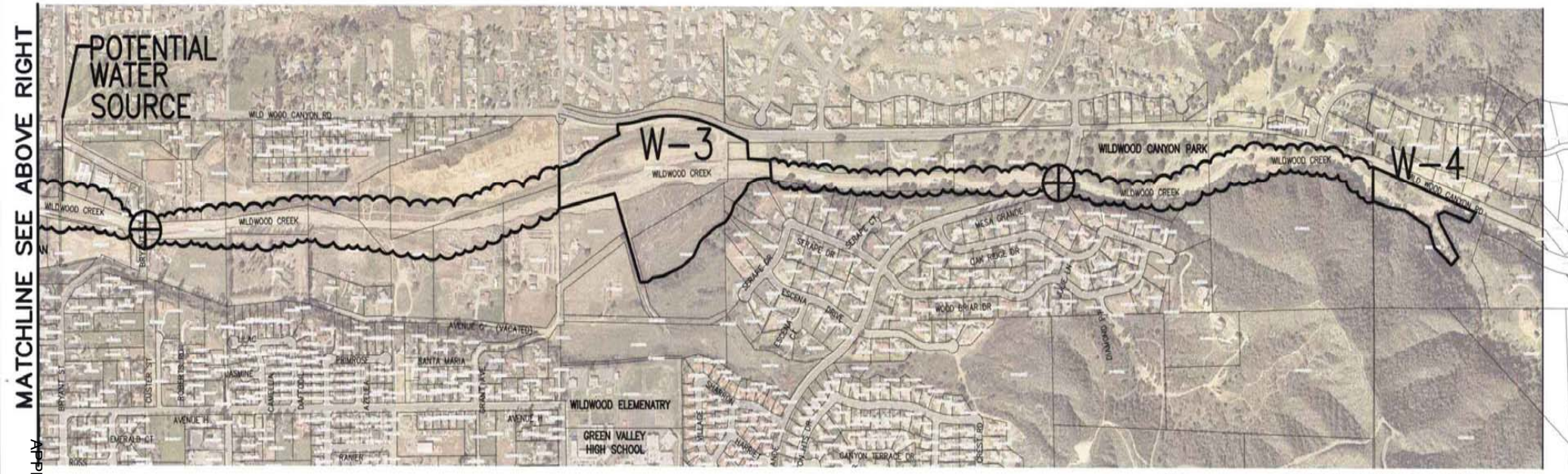
Photo 2. In channel bottom looking at steep cut bank

Photo 3. Riparian habitat showing willow and tamarisk

Photo. 4. From NE, looking down at jurisdictional channel.

WILDWOOD CREEK SYSTEM





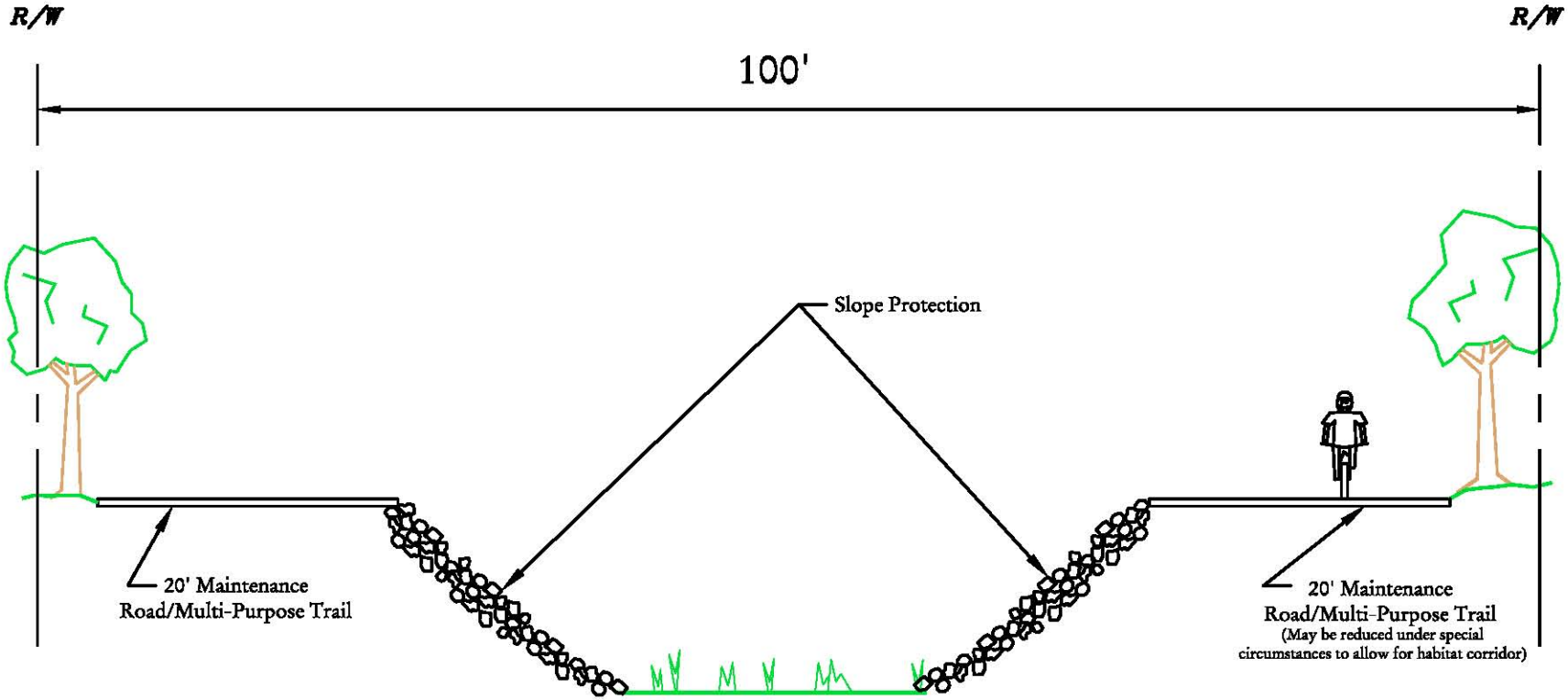
W- DETENTION BASINS (LOCAL SPONSOR)

WILDWOOD CREEK NATURAL CHANNEL DESIGN

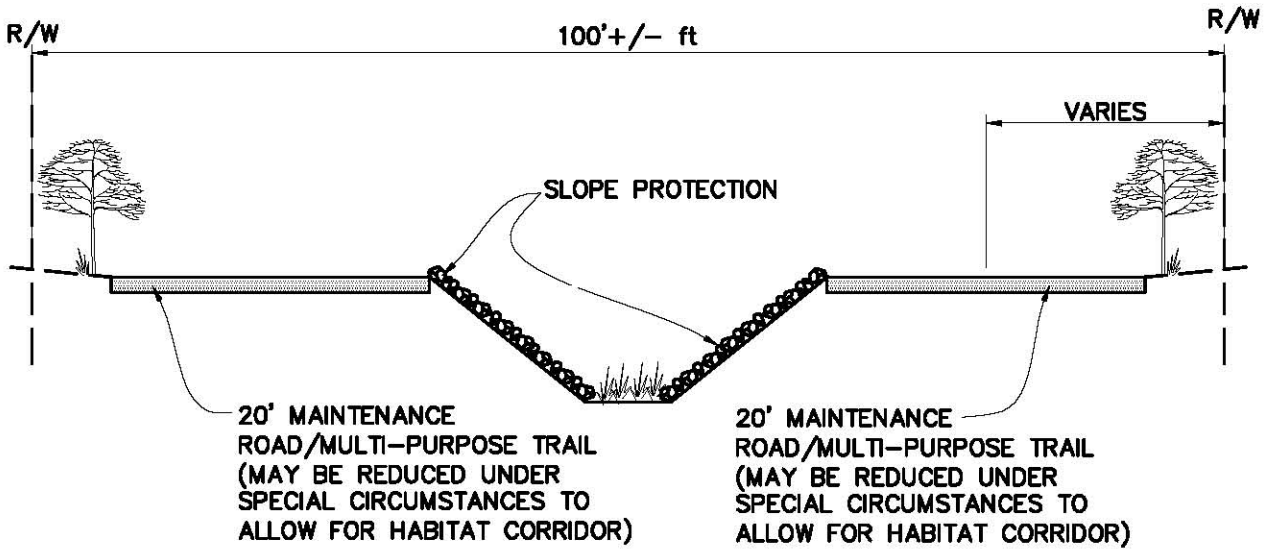
PROPOSED LOW WATER X-ING REPLACEMENT LOCAL SPONSOR

EXISTING BOX/BRIDGE X-ING

Wildwood Creek System

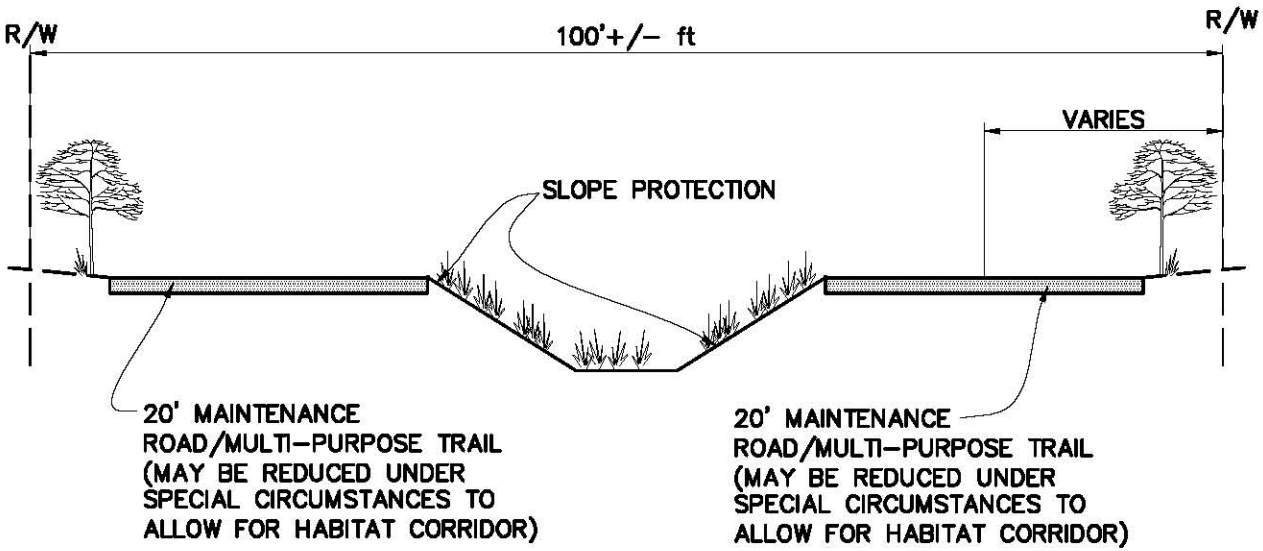


Proposed Typical Section



SECTION A-A

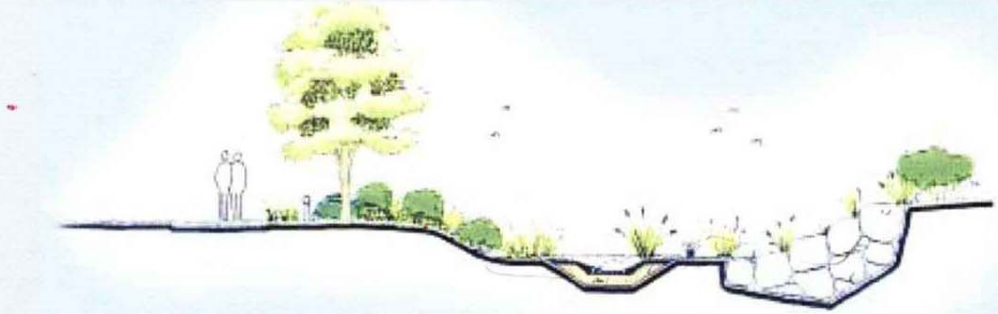
NTS



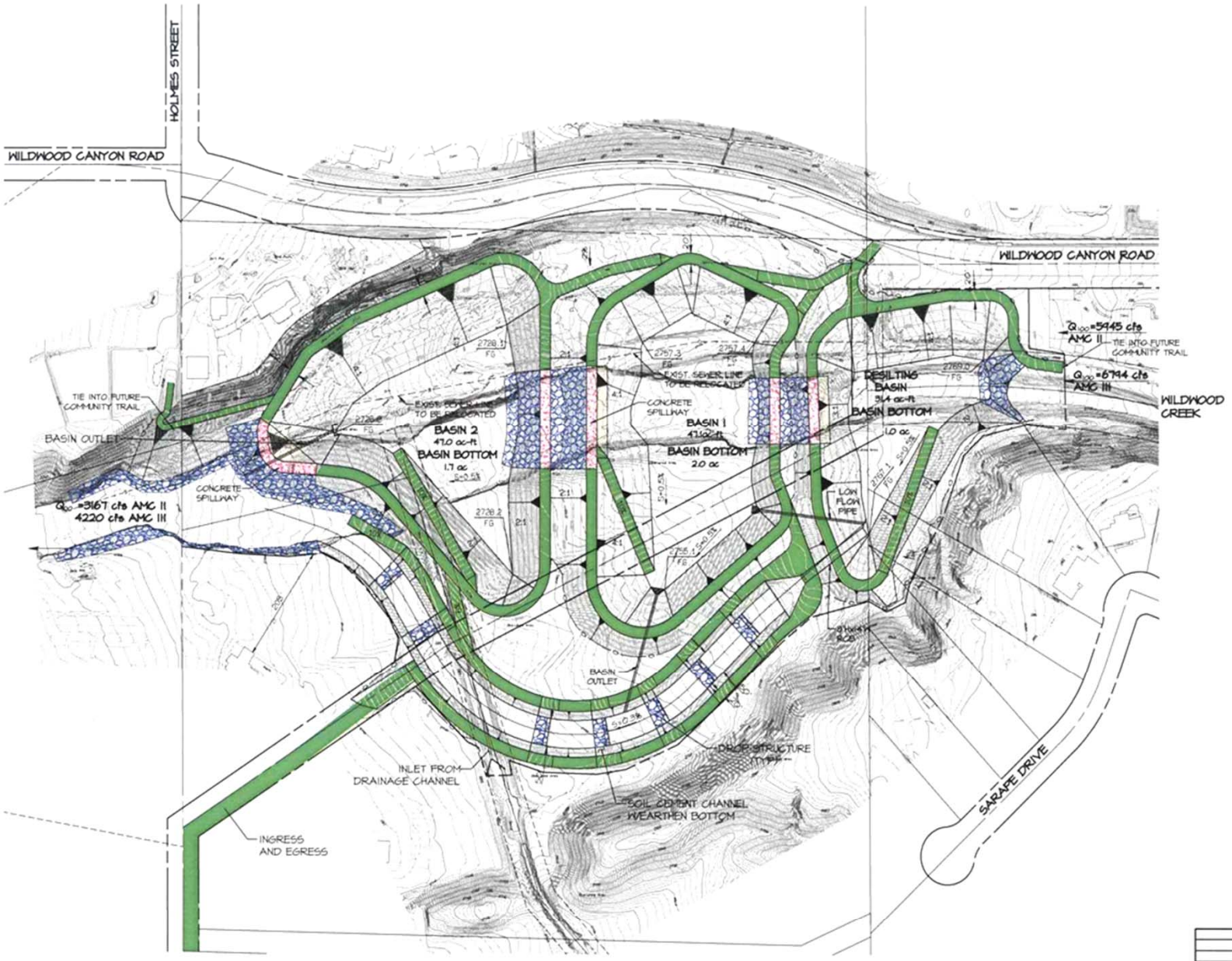
SECTION B-B

NTS

Natural Channel Design



WILDWOOD CREEK
WILD WOOD CANYON RD
25 A/F
W-4



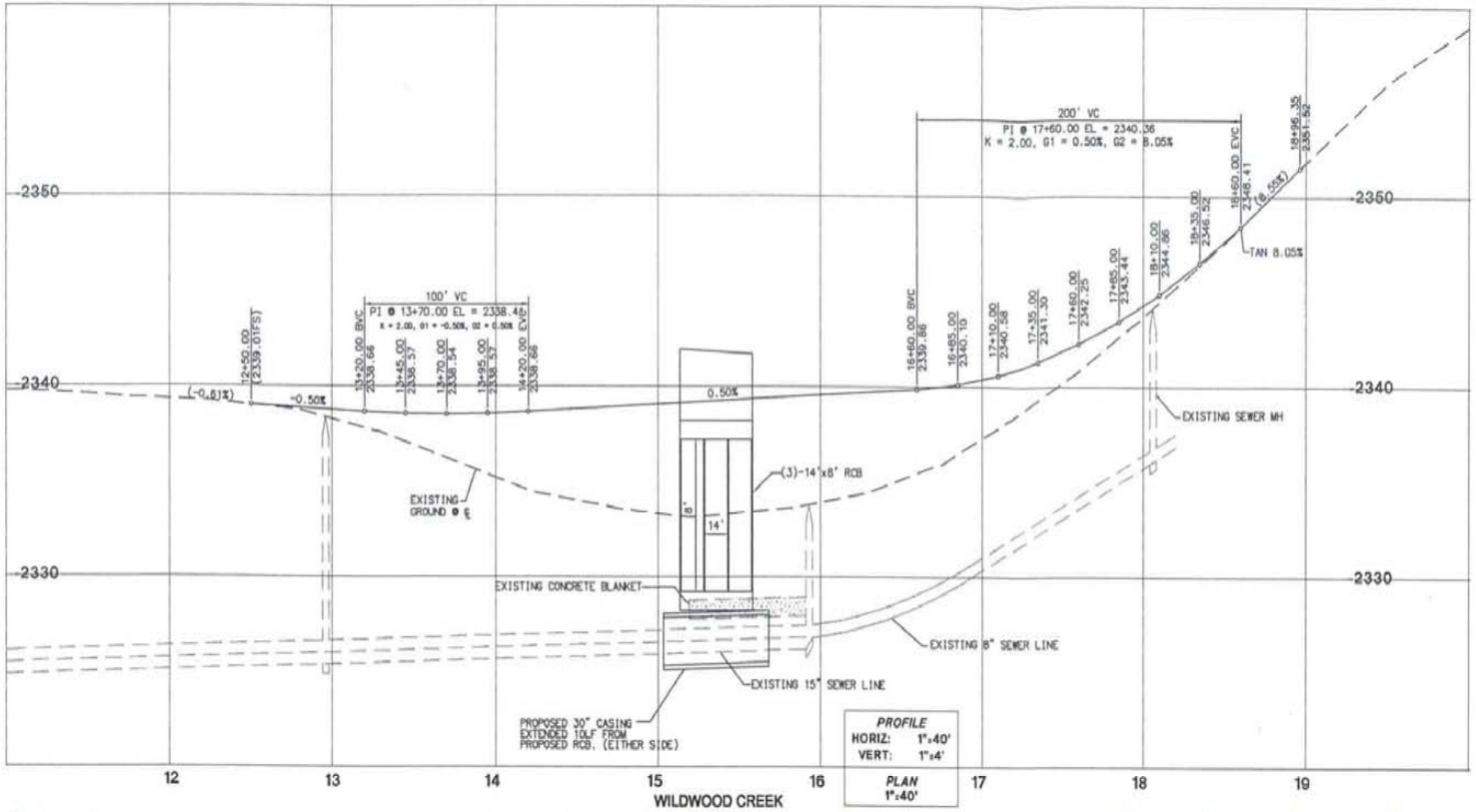
REVISIONS	DATE	BY

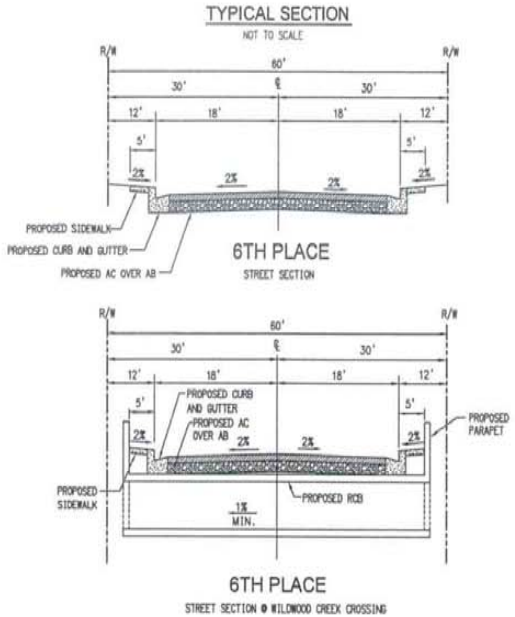
WILDWOOD BASIN

REVISED ALTERNATIVE 2
NON-DSOD FLOW BY BASINS

SCALE N.T.S.	ALBERT A. WEBB ASSOCIATES	CIVIL ENGINEERS 3788 McCRAY ST. RIVERSIDE CA. 92506 (951) 686-1070	W.O. 08-0044
DATE 6/26/2008			SHEET 1
DESIGNED			OF 2 SHEETS
CHECKED			DWG. NO.
PLN CK REF:	FILE		

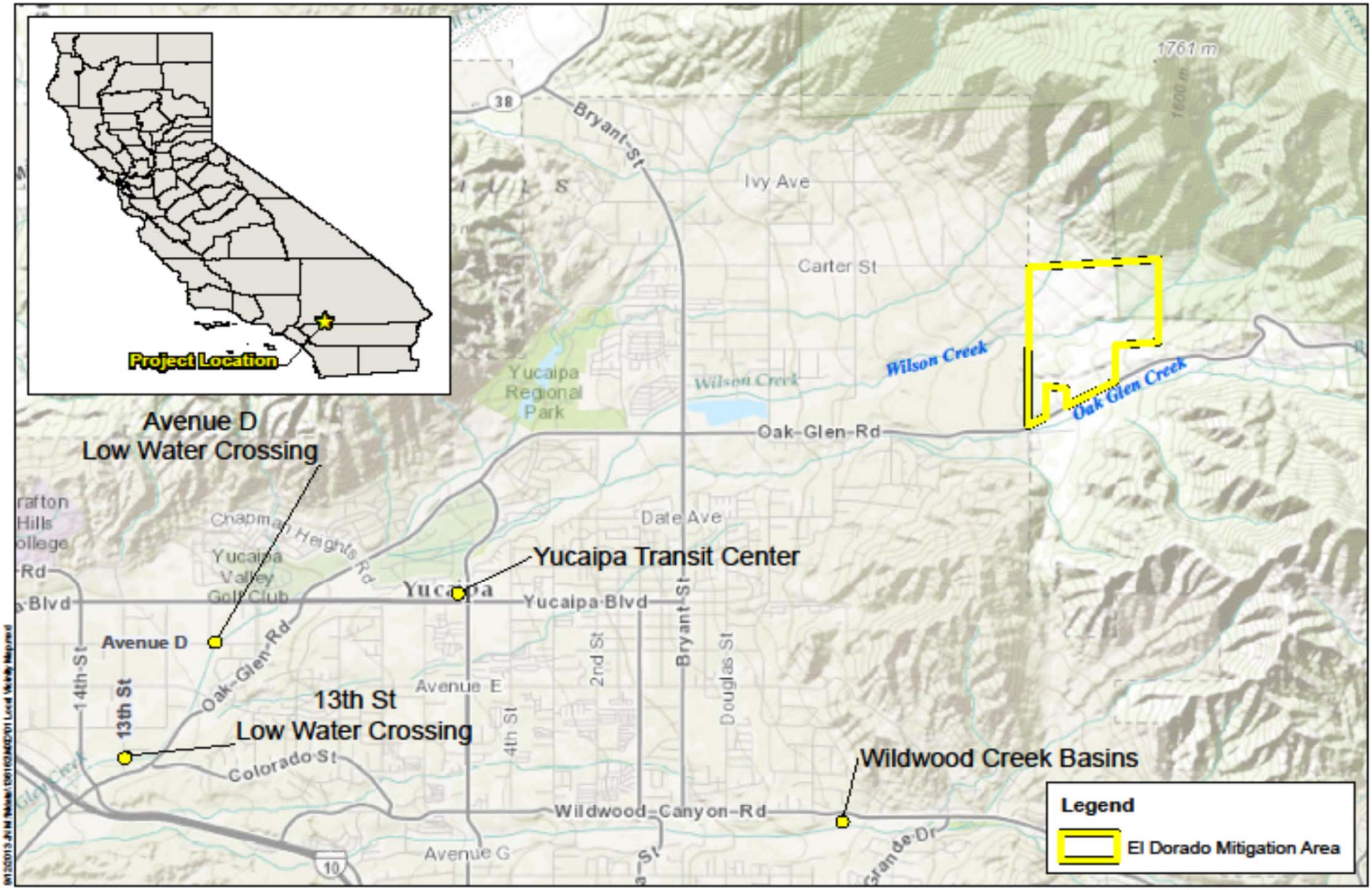
35 A/F
W-2





PRELIMINARY CONCEPT DESIGN BOX CROSSING OPTION

6TH PLACE



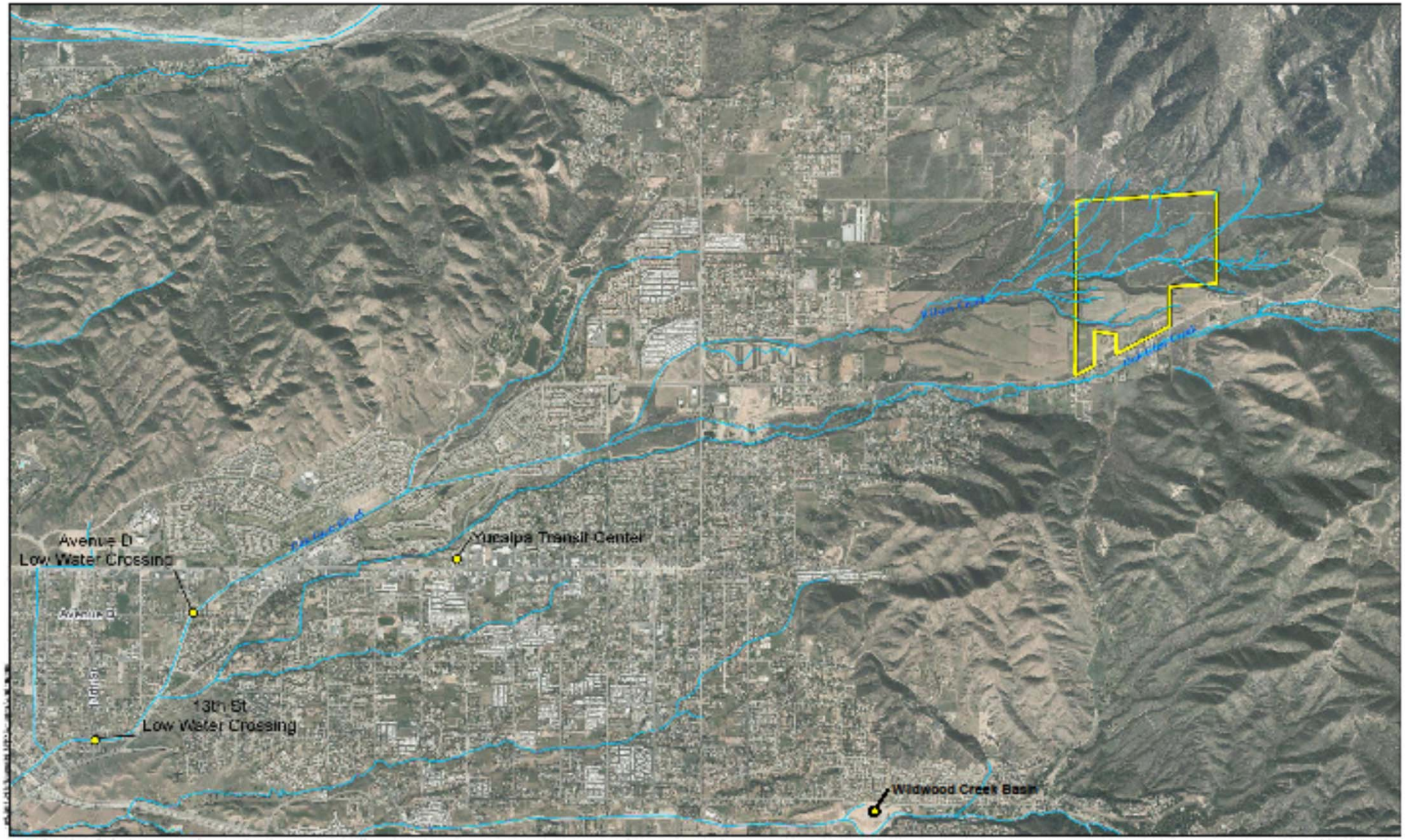
0 0.5 1 2 Miles

Source: ESRI World Topographic Map

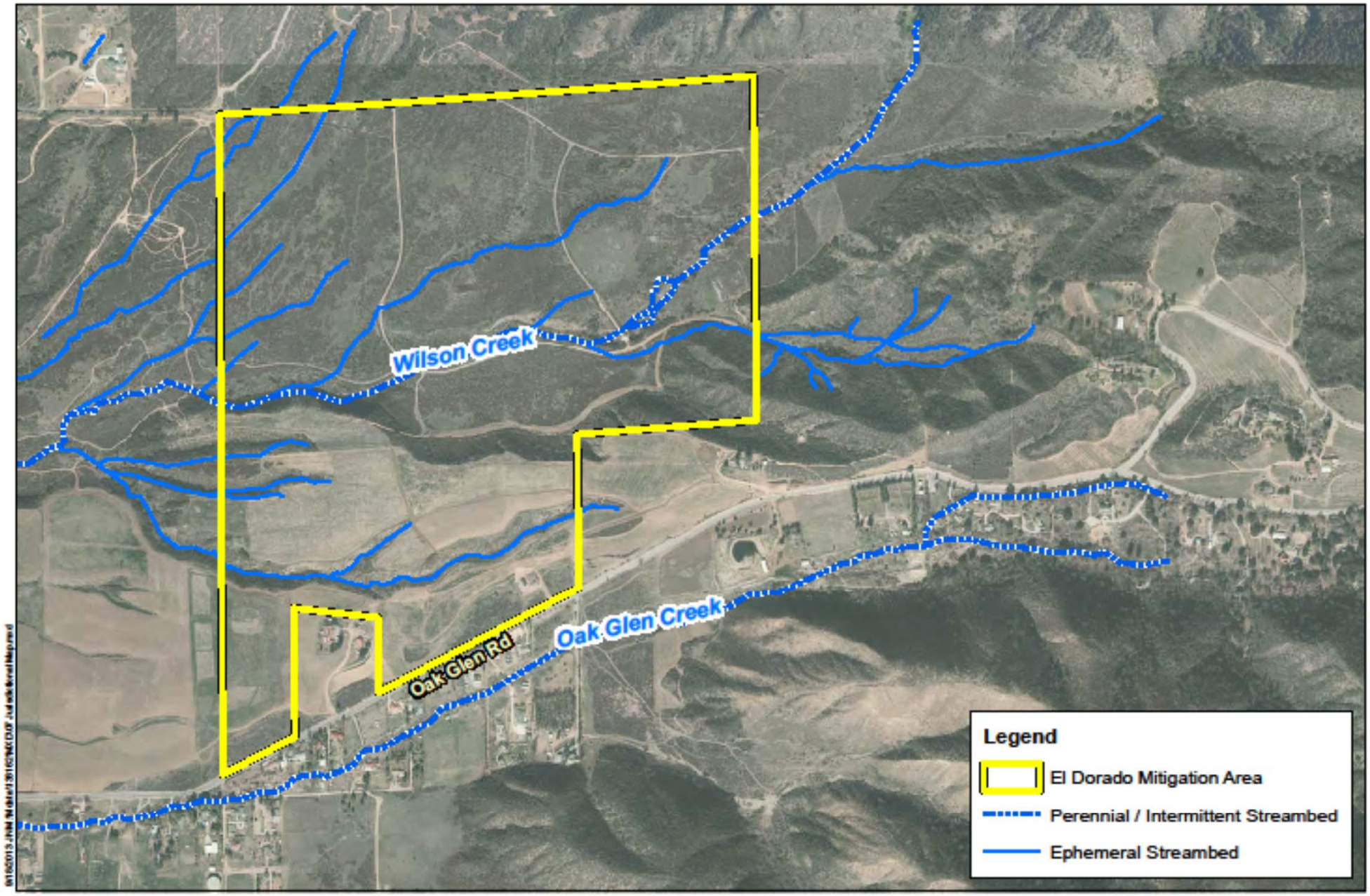
EL DORADO MITIGATION AREA
City of Yucaipa

Location Map

Exhibit 1



PROJECT NAME
Map Title
Exhibit X



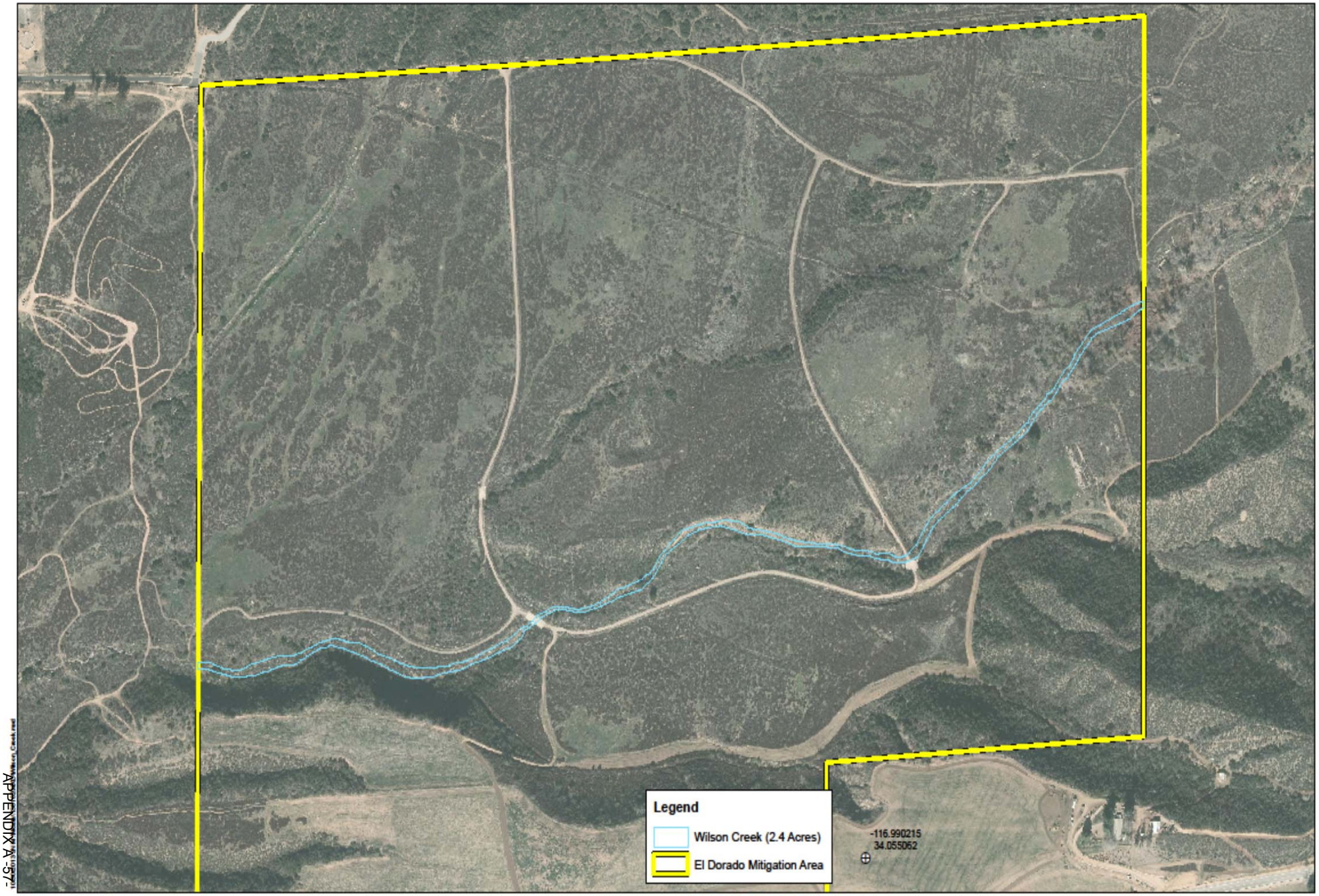
EL DORADO MITIGATION AREA
City of Yucaipa

Waters of the U.S.

0 500 1,000 2,000 Feet

Source: NRCS Soil Data Mart ca677, Eagle Aerial 2012

Exhibit 7



RBF

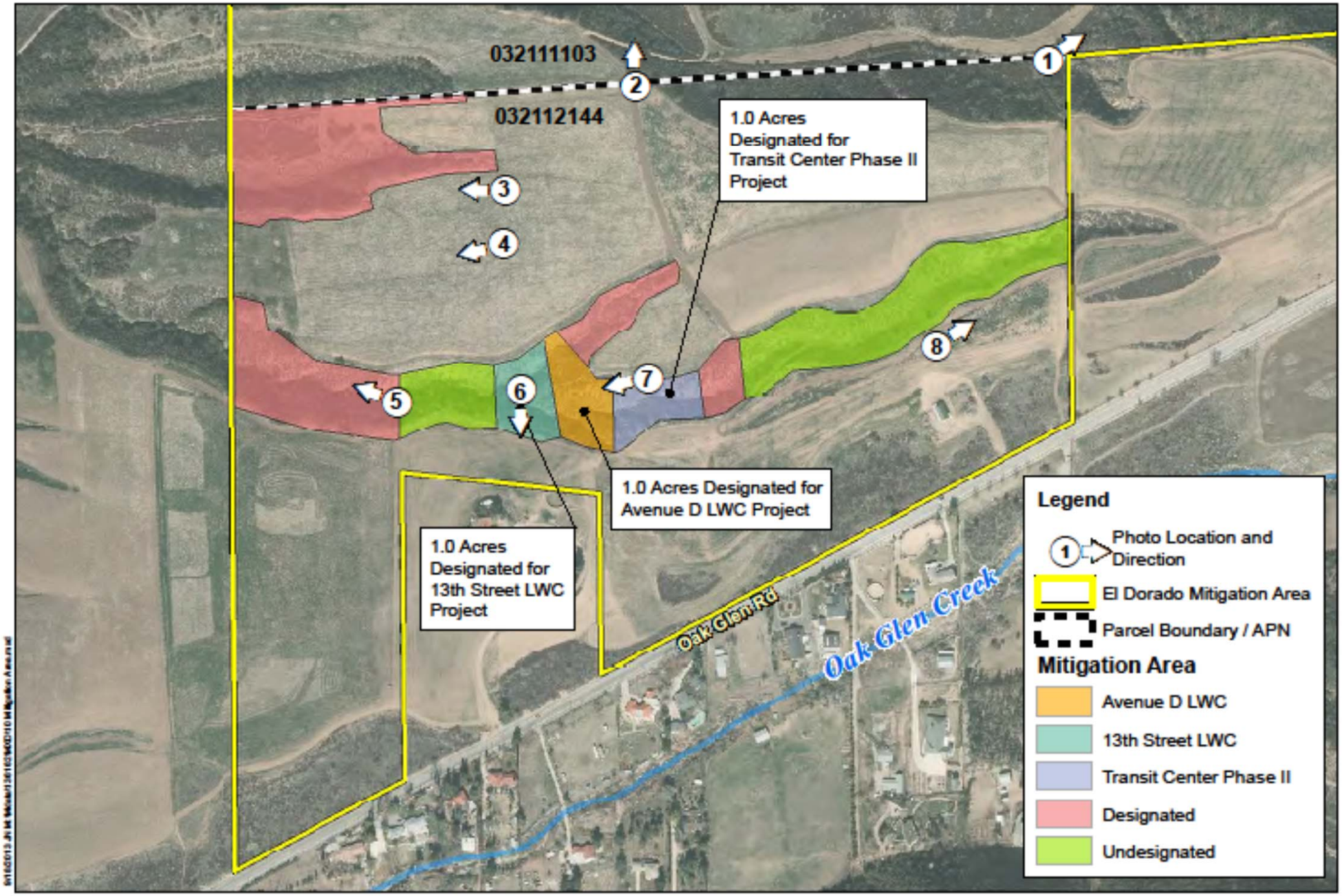
0 150 300 600 Feet

Source: NRCS Soil Data Mart cal677, Eagle Aerial 2012

EL DORADO MITIGATION AREA
City of Yucaipa

Wilson Creek

Exhibit



0 150 300 600 Feet

Source: Eagle Aerial 2012

EL DORADO MITIGATION AREA
City of Yucaipa

El Dorado Mitigation Area

Exhibit 10

LOCATION MAP

Ave "D" Low Water Crossing at Wilson Creek Channel
Located on Avenue "D" between 10th Street and 11th Street.

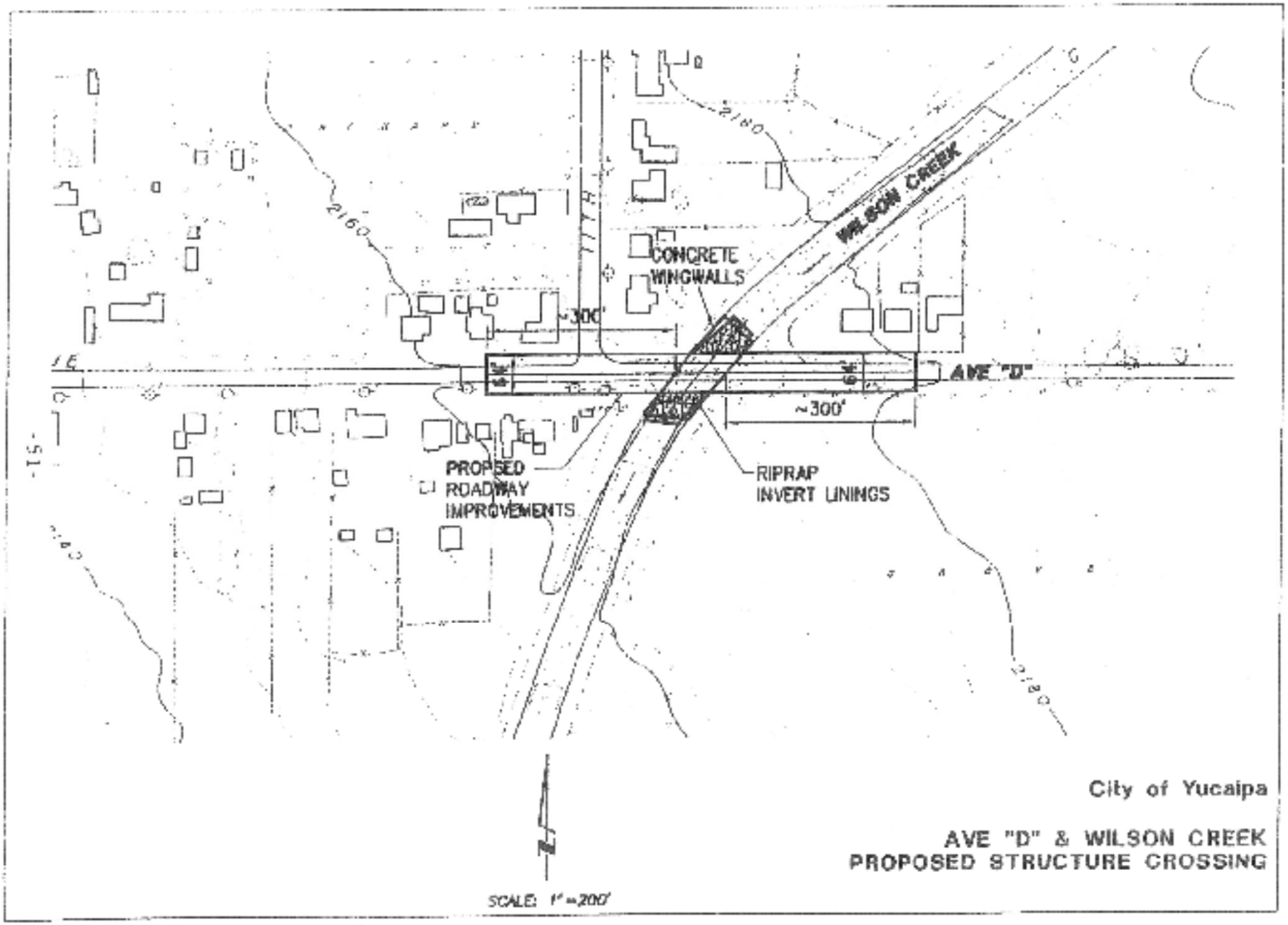
2A: Looking Downstream

2B: Looking Upstream

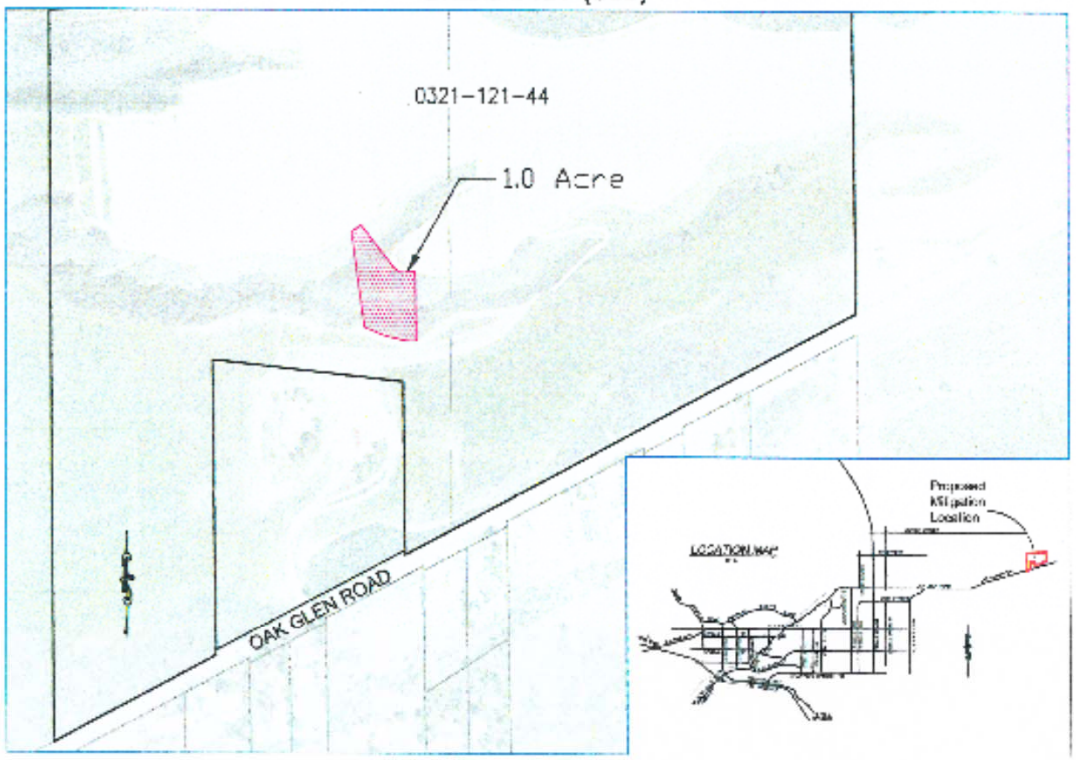
EL DORADO MITIGATION AREA
City of Yucaipa

Avenue D - Low Water Crossing

Exhibit 2


WILSON CREEK
CONCRETE WINGWALLS
~300'
AVE "D"
~300'
PROPSED ROADWAY IMPROVEMENTS
RIPRAP INVERT LININGS
2160
2180
City of Yucaipa
AVE "D" & WILSON CREEK
PROPOSED STRUCTURE CROSSING
SCALE: 1" = 200'

Avenue D at Wilson Creek - Low Water Crossing Replacement Mitigation Area
BRLKS 5457 (009)



LOCATION MAP

13th Street Low Water Crossing at Wilson Creek Channel
Located on 13th Street between Fairmont Street and Texas Drive.

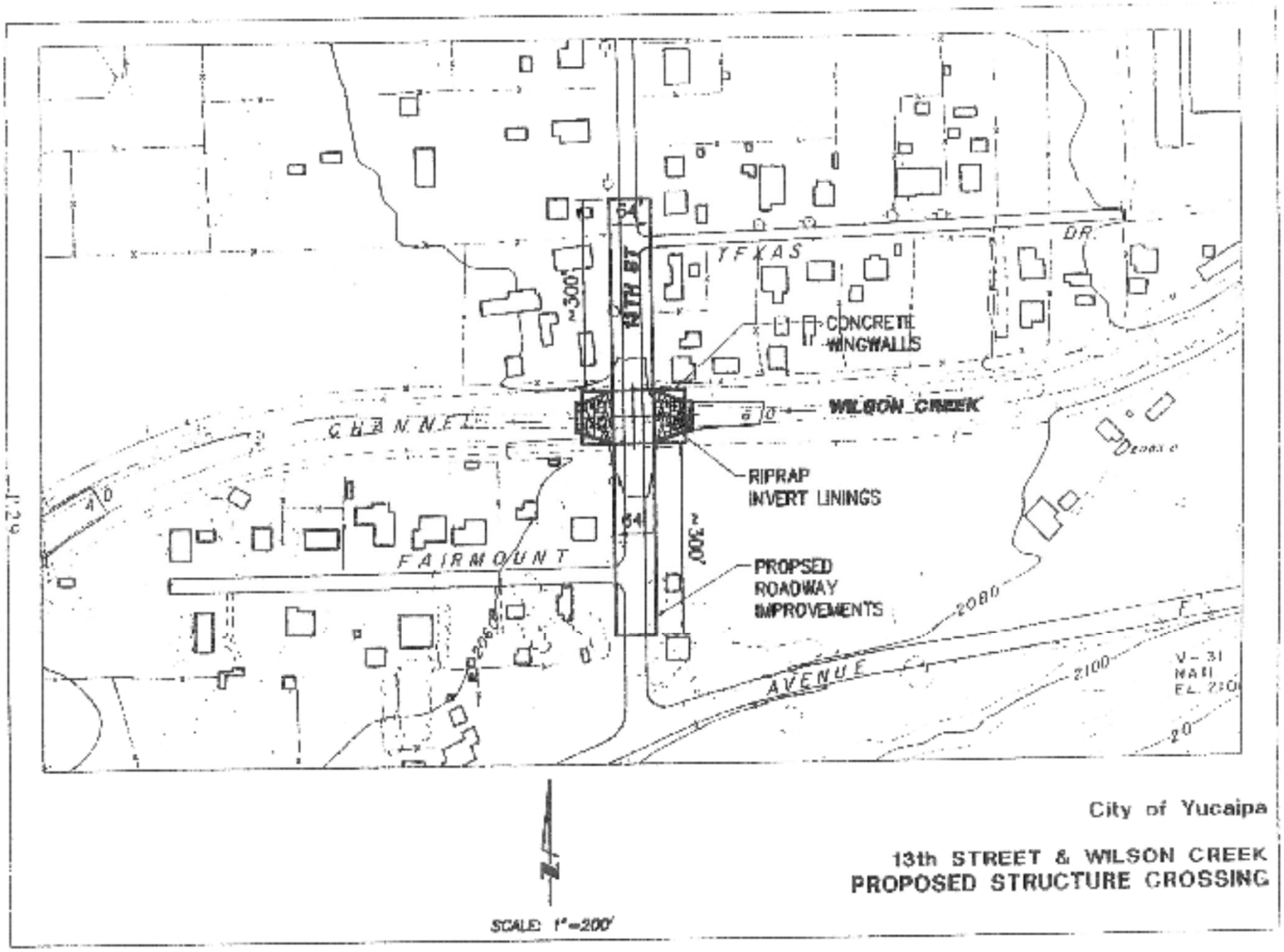
3A: Looking South

3B: Looking Downstream

EL DORADO MITIGATION AREA
City of Yucaipa

13th Street - Low Water Crossing

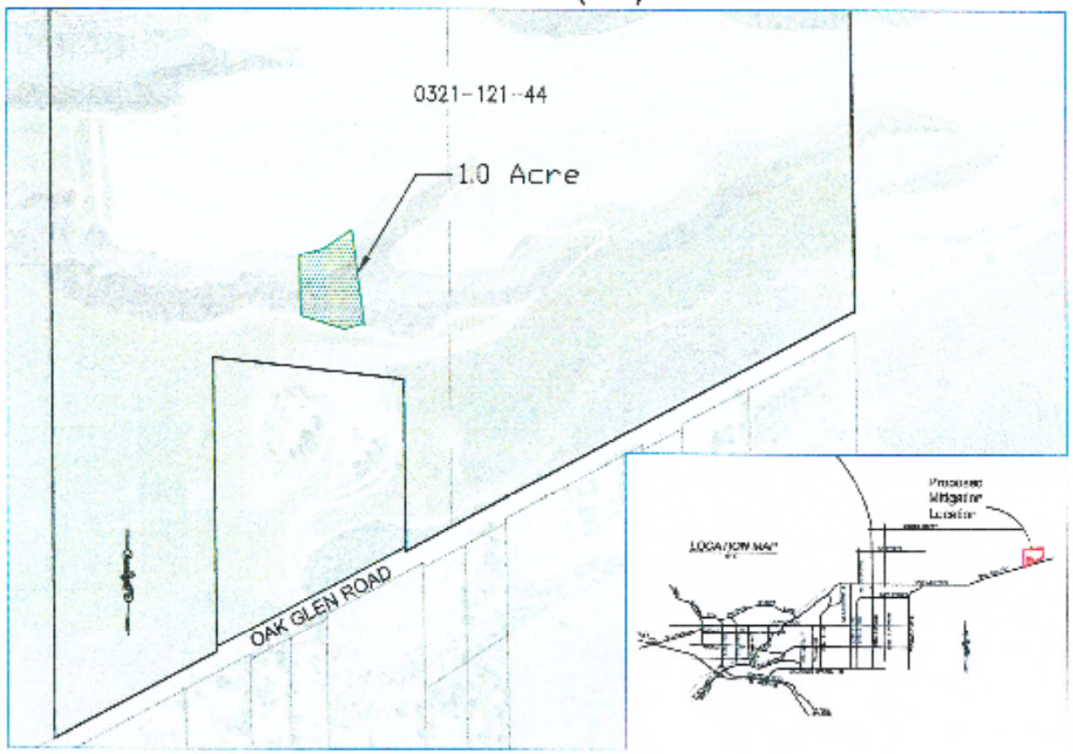
Exhibit 3



City of Yucaipa

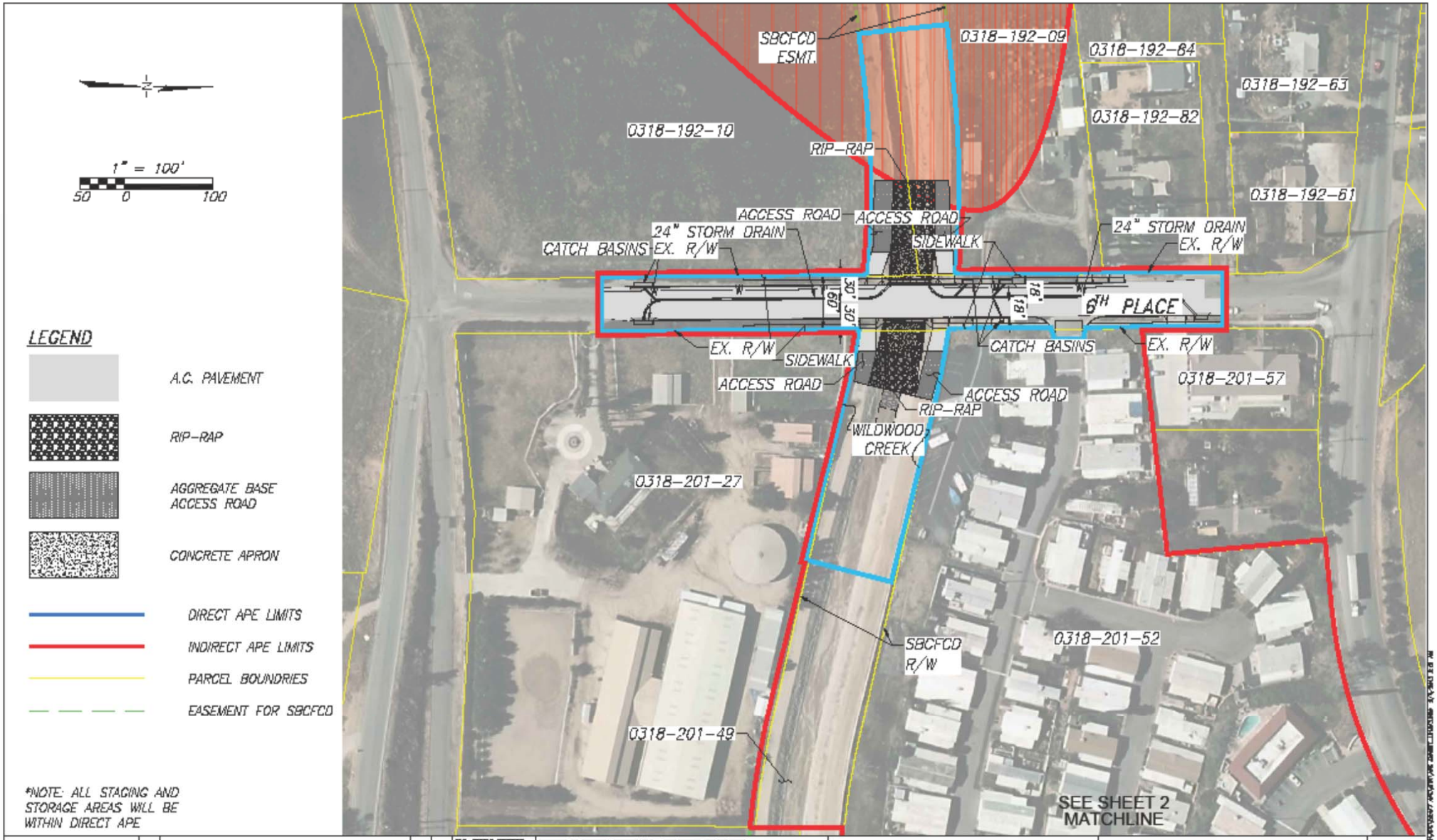
13th STREET & WILSON CREEK
PROPOSED STRUCTURE CROSSING

13th Street at Wilson Creek - Low Water Crossing Replacement Mitigation Area
BRLKS 5457 (011)



LOCATION MAP

Transit Center Channel
Located to the north of 12040 5th St, Yucaipa, CA 92399 (Yucaipa Public Library).



DIGALERT

MARK	REVISIONS	APPR.	DATE

DESIGNED BY:_____ DRAWN BY:_____ CHECKED BY:_____

REGISTERED ENGINEER

APPROVED BY PRINCIPAL INVESTIGATOR - PREHISTORIC ARCHEOLOGIST _____ DATE

APPROVED BY CALTRANS LOCAL ASSISTANCE ENGINEER: _____ DATE

ALBERT A. WEBB ASSOCIATES
ENGINEERING CONSULTANTS
3788 McCRAY STREET
RIVERSIDE CA. 92506
PH. (951) 686-1070
FAX (951) 788-1256

BENCH MARK:

CITY OF YUCAIPA

AREA OF POTENTIAL EFFECT MAP

6TH PLACE AT WILDWOOD CREEK

2 OF 3

PCN: CITY OF YUCAIPA

FPN: BR-NBIL (507)

MATCHLINE - SEE SHEET 2

LEGEND

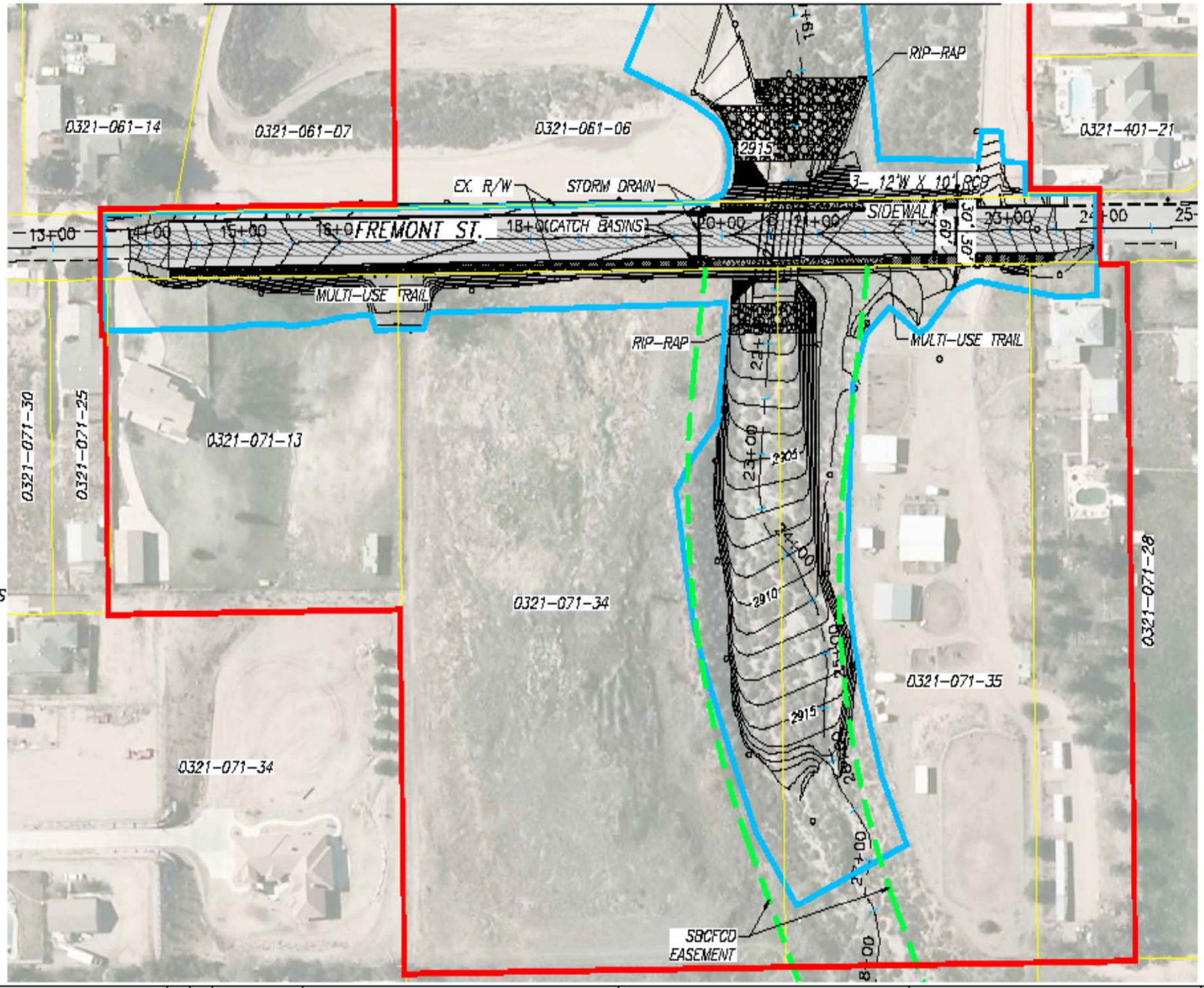
- A.C. PAVEMENT
- RIP-RAP
- DECOMPOSED GRANITE MULTI-USE TRAIL
- CONCRETE SIDEWALK/ CONCRETE ACCESS ROAD
- TRAIL FENCE
- DIRECT APE
- INDIRECT APE
- PARCEL BOUNDRIES
- GRADING LIMITS
- EASEMENT PER SBCFCD
- PROPOSED CONTOURS

*NOTE: ALL STAGING AND STORAGE AREAS WILL BE WITHIN DIRECT APE

-N-

1" = 100'

50 0 100



DIGALERT

DESIGNED BY: DRAWN BY: CHECKED BY:

REVISIONS

SEAL-DESIGN ENGINEER

APPROVED BY PRINCIPAL INVESTIGATOR - PREHISTORIC ARCHEOLOGIST

APPROVED BY CALTRANS LOCAL ASSISTANCE ENGINEER

ALBERT A. WEBB ASSOCIATES
ENGINEERING CONSULTANTS
3788 McCRAY STREET
RIVERSIDE CA. 92506
PH. (951) 686-1070
FAX (951) 788-1256

BENCH MARK

CITY OF YUCAIPA

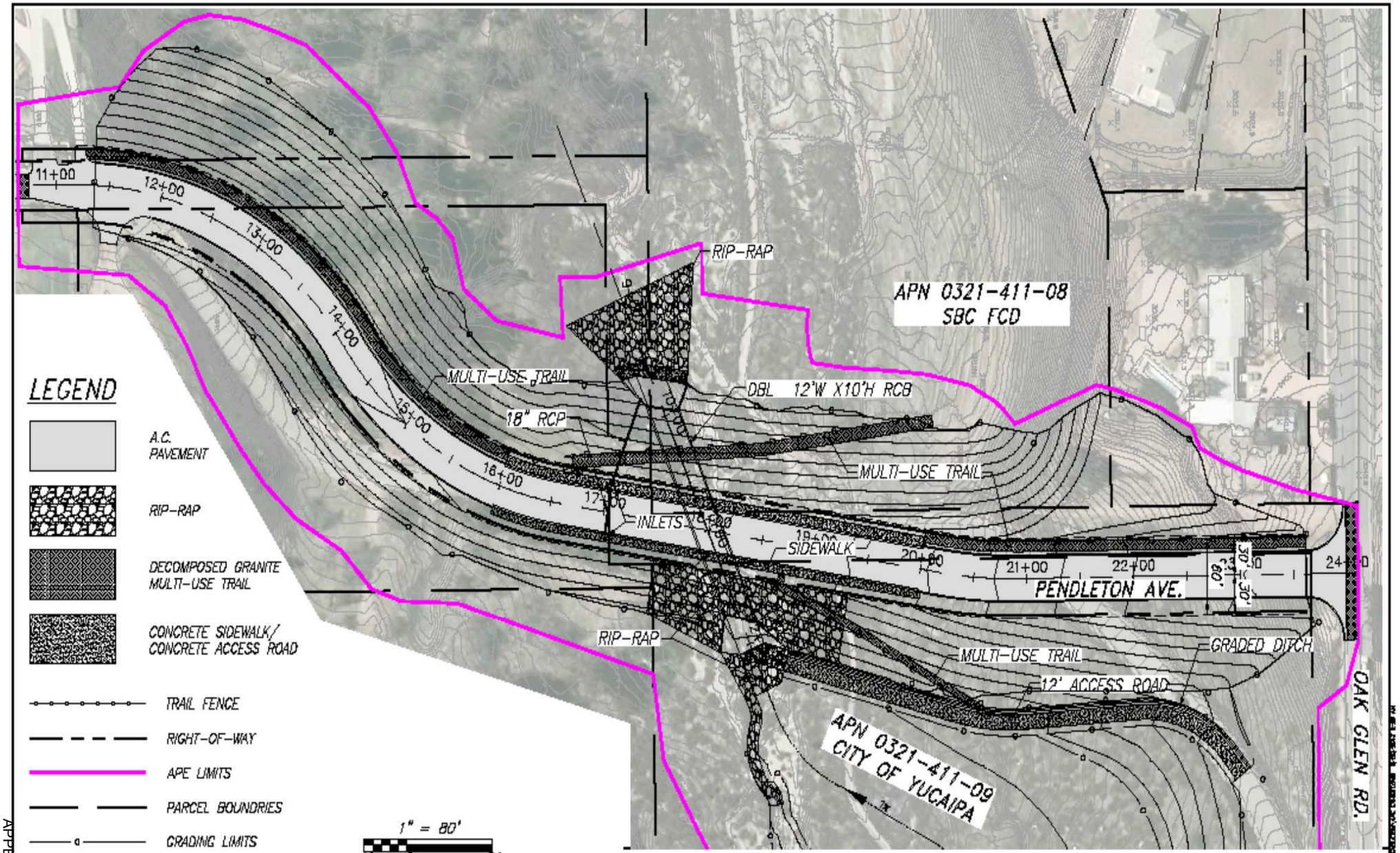
AREA OF POTENTIAL EFFECT MAP

FREMONT ST. AT WILSON CREEK

1 OF 2

CITY OF YUCAIPA

FPN: BR-NBIL (508)



DIGALERT

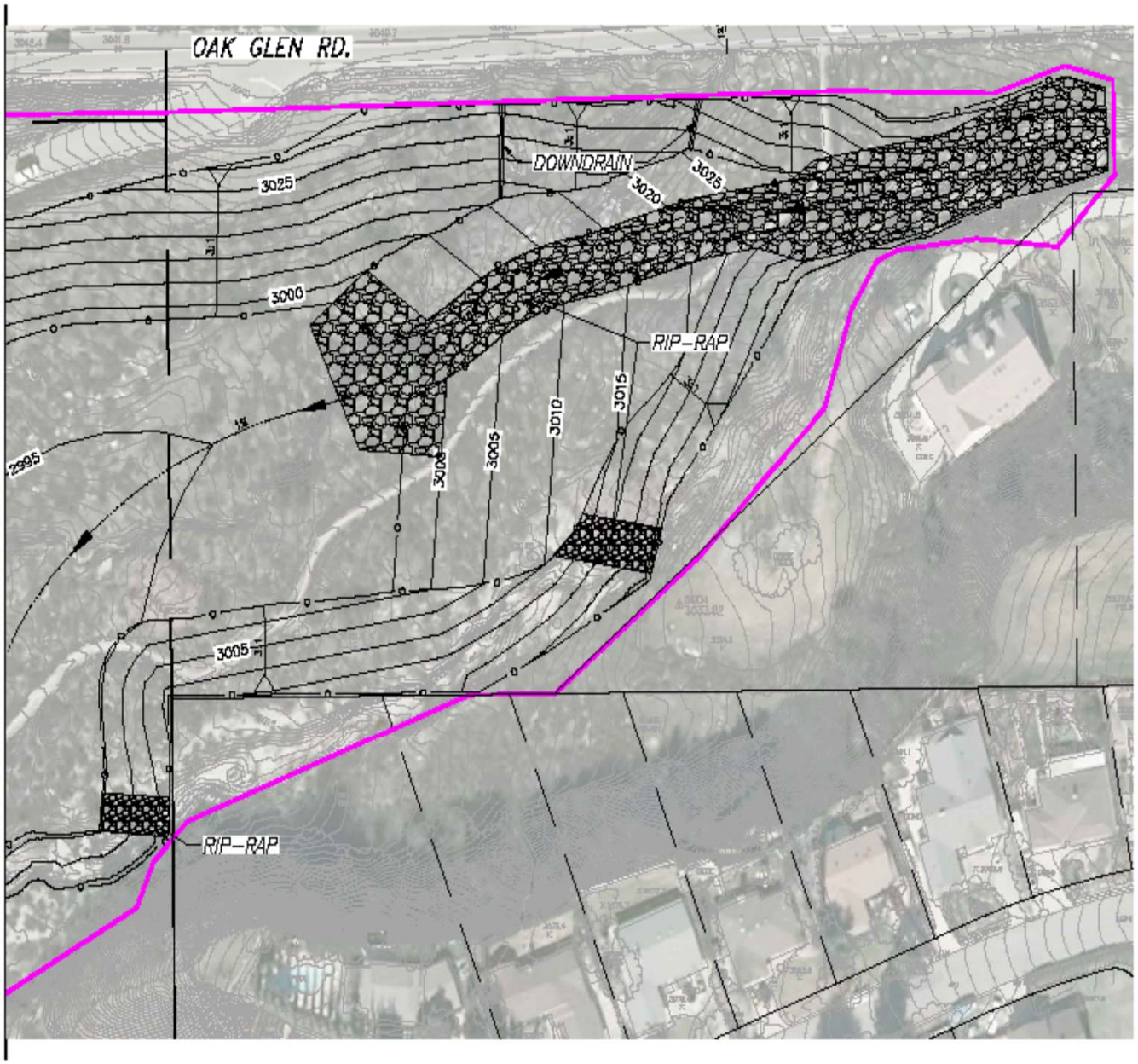
ALBERT A. WEBB ASSOCIATES
ENGINEERING CONSULTANTS
3788 McCRAY STREET
RIVERSIDE CA. 92506
PH. (951) 686-1070
FAX (951) 788-1256

CITY OF YUCAIPA
AREA OF POTENTIAL EFFECT MAP
PENDLETON AVE. AT OAK GLEN CREEK

1 OF 2

CITY OF YUCAIPA

FPN: BR-NBIL (506)



-N-

1" = 80'

40 0 80

LEGEND

- A.C. PAVEMENT
- RIP-RAP
- DECOMPOSED GRANITE MULTI-USE TRAIL
- CONCRETE SIDEWALK/ CONCRETE ACCESS ROAD
- TRAIL FENCE
- RIGHT-OF-WAY
- APE LIMITS
- PARCEL BOUNDRIES
- GRADING LIMITS
- PROPOSED CONTOURS

DIGALERT

MARK | REVISIONS | APPR. | DATE

DESIGNED BY:_____ DRAWN BY:_____ CHECKED BY:_____

REGISTERED ENGINEER

APPROVED BY PRINCIPAL INVESTIGATOR - PREHISTORIC ARCHAEOLOGIST

DATE

APPROVED BY CALTRANS LOCAL ASSISTANCE ENGINEER

DATE

ALBERT A. WEBB ASSOCIATES
ENGINEERING CONSULTANTS
3788 McCRAY STREET
RIVERSIDE CA. 92506
PH. (951) 686-1070
FAX (951) 788-1256

BENCH MARK

CITY OF YUCAIPA

AREA OF POTENTIAL EFFECT MAP

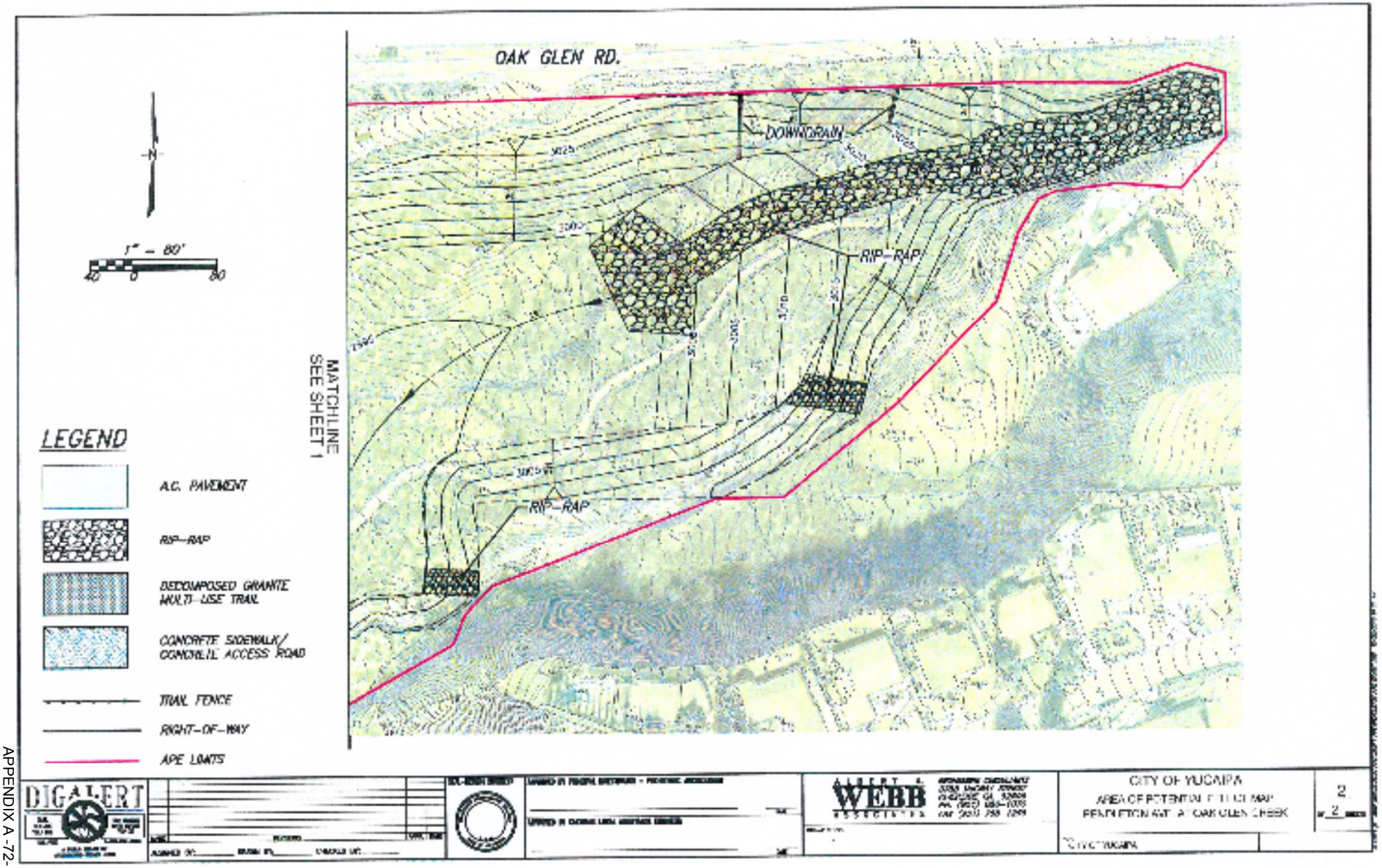
PENDLETON AVE. AT OAK GLEN CREEK

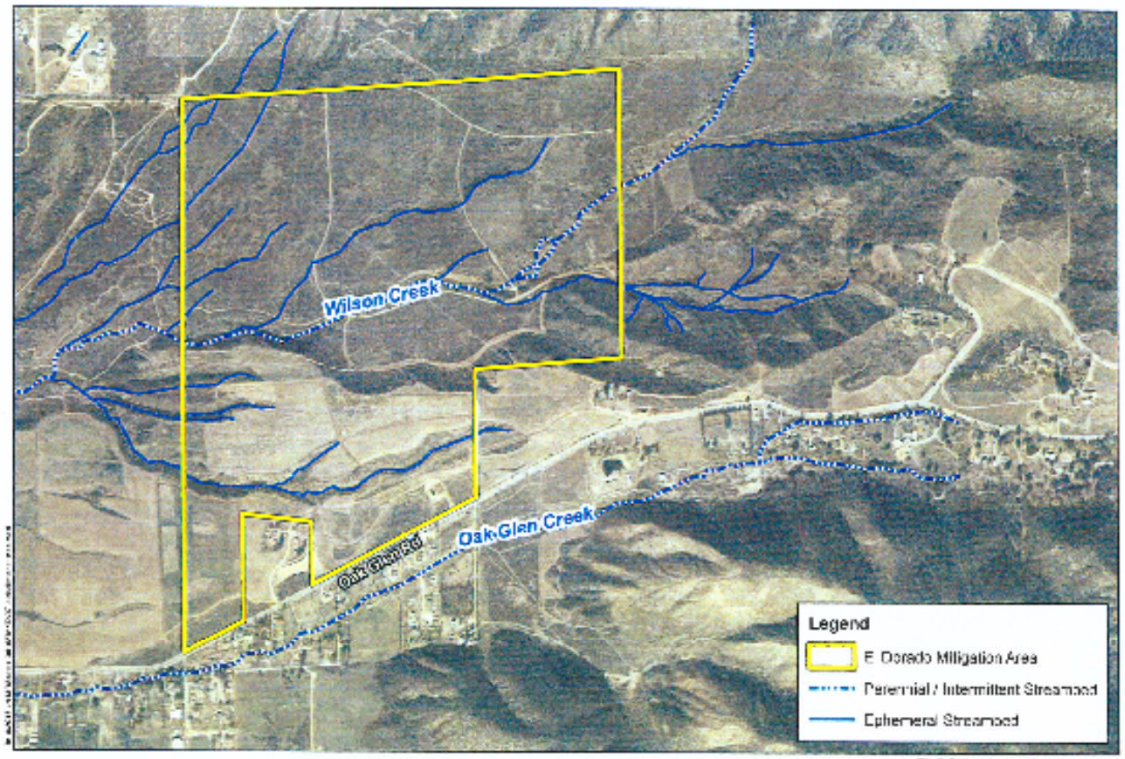
2 OF 2

PCN

CITY OF YUCAIPA

FPN: BR-NBIL (506)


OAK GLEN RD.
DOWNDRAIN
RIP-RAP
RIP-RAP
MATCHLINE
SEE SHEET 1
N
1" = 80'
40 0 80
LEGEND
A.C. PAVEMENT
RIP-RAP
DECOMPOSED GRANITE MULTI-USE TRAIL
CONCRETE SIDEWALK/ CONCRETE ACCESS ROAD
TRAIL FENCE
RIGHT-OF-WAY
APE LIMITS
DIGALERT
ALBERT A. WEBB ASSOCIATES
CITY OF YUCAIPA
AREA OF POTENTIAL FILL OF MAP
PENDLETON AVE. AT OAK GLEN CREEK
2
CITY OF YUCAIPA



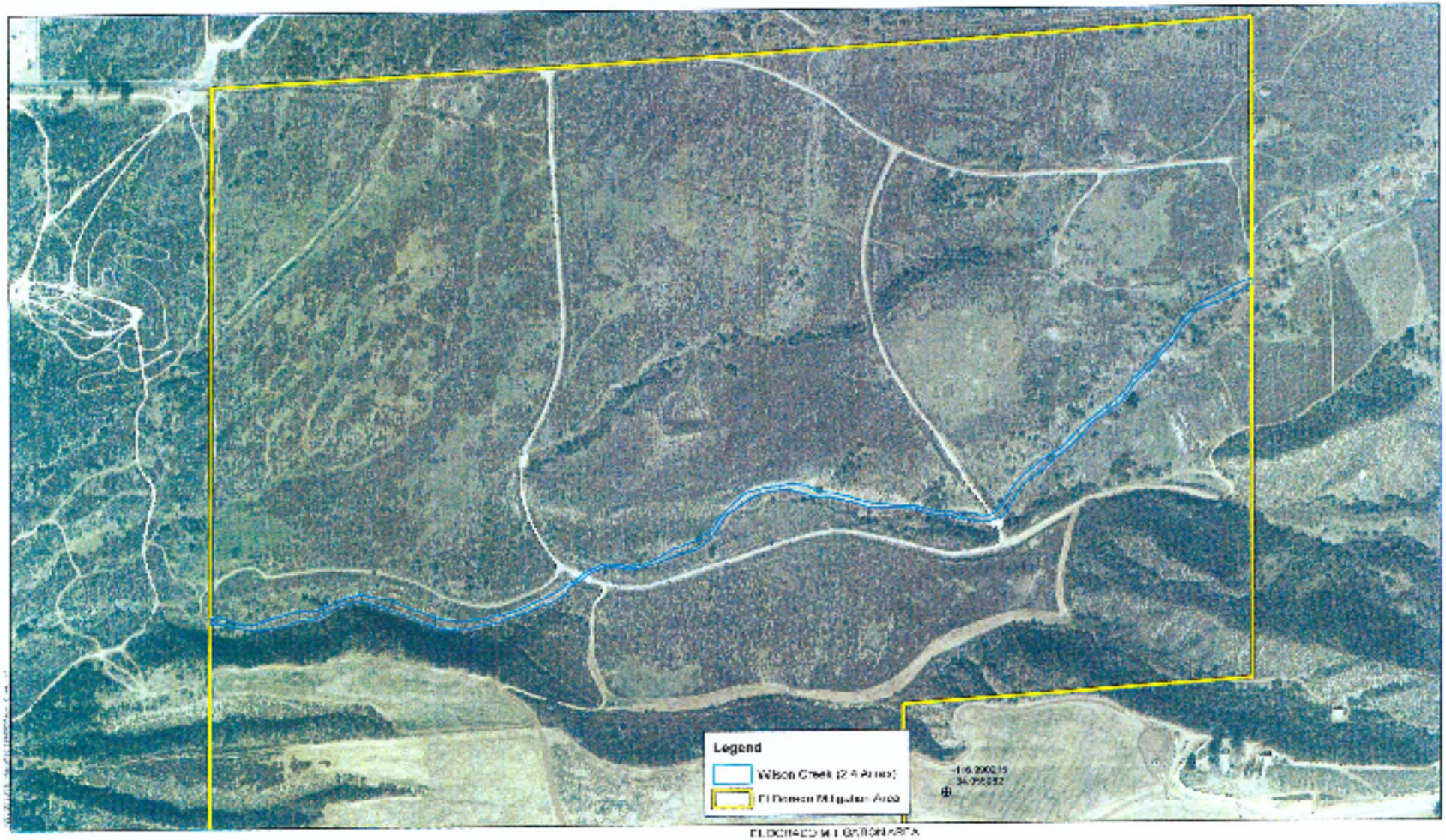
RBF

0 500 1,000 2,000 Feet

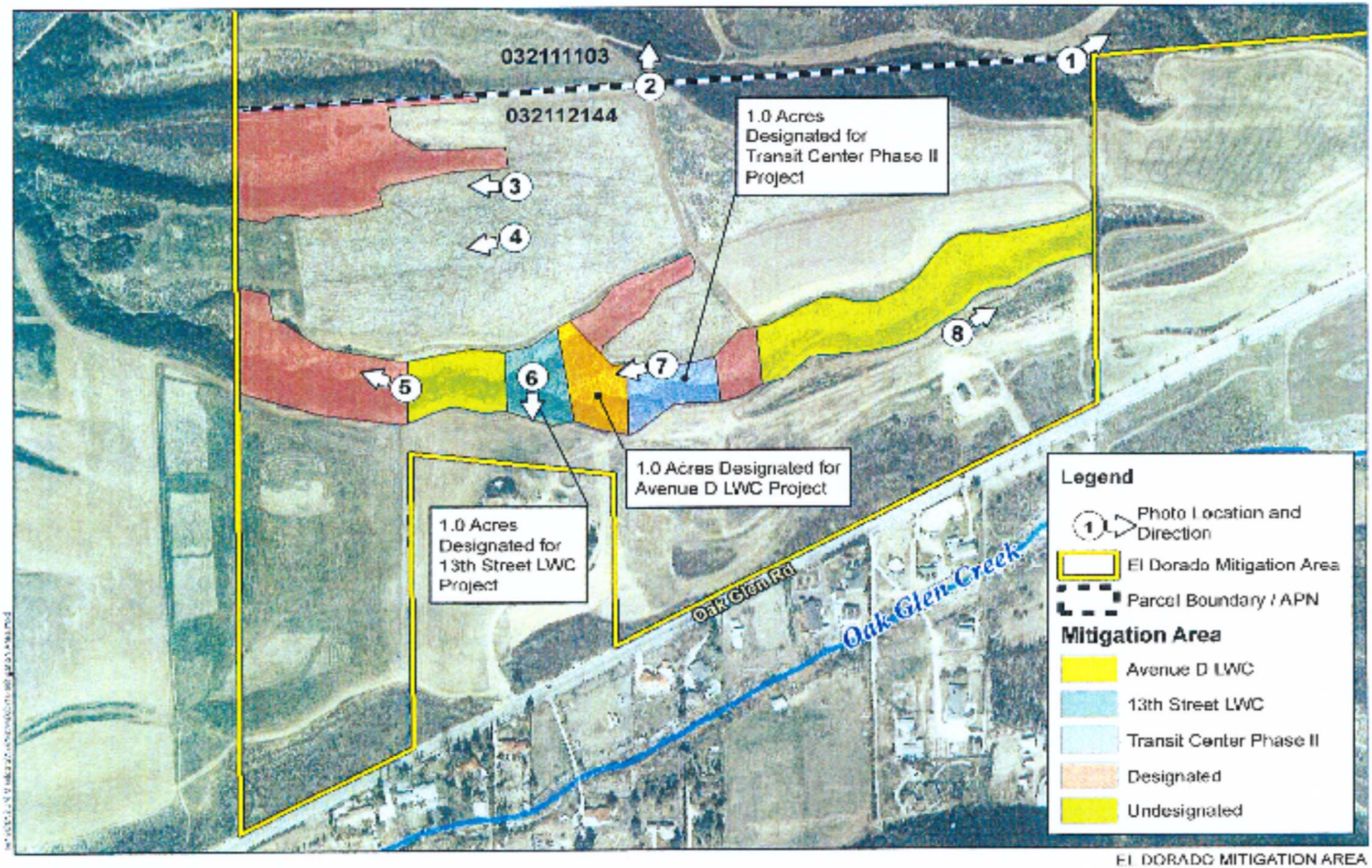
EL DORADO MITIGATION AREA
City of Yucaipa

Waters of the U.S.

Exhibit 7



EL DORADO MITIGATION AREA
City of Yucaipa
Wilson Creek
Exhibit



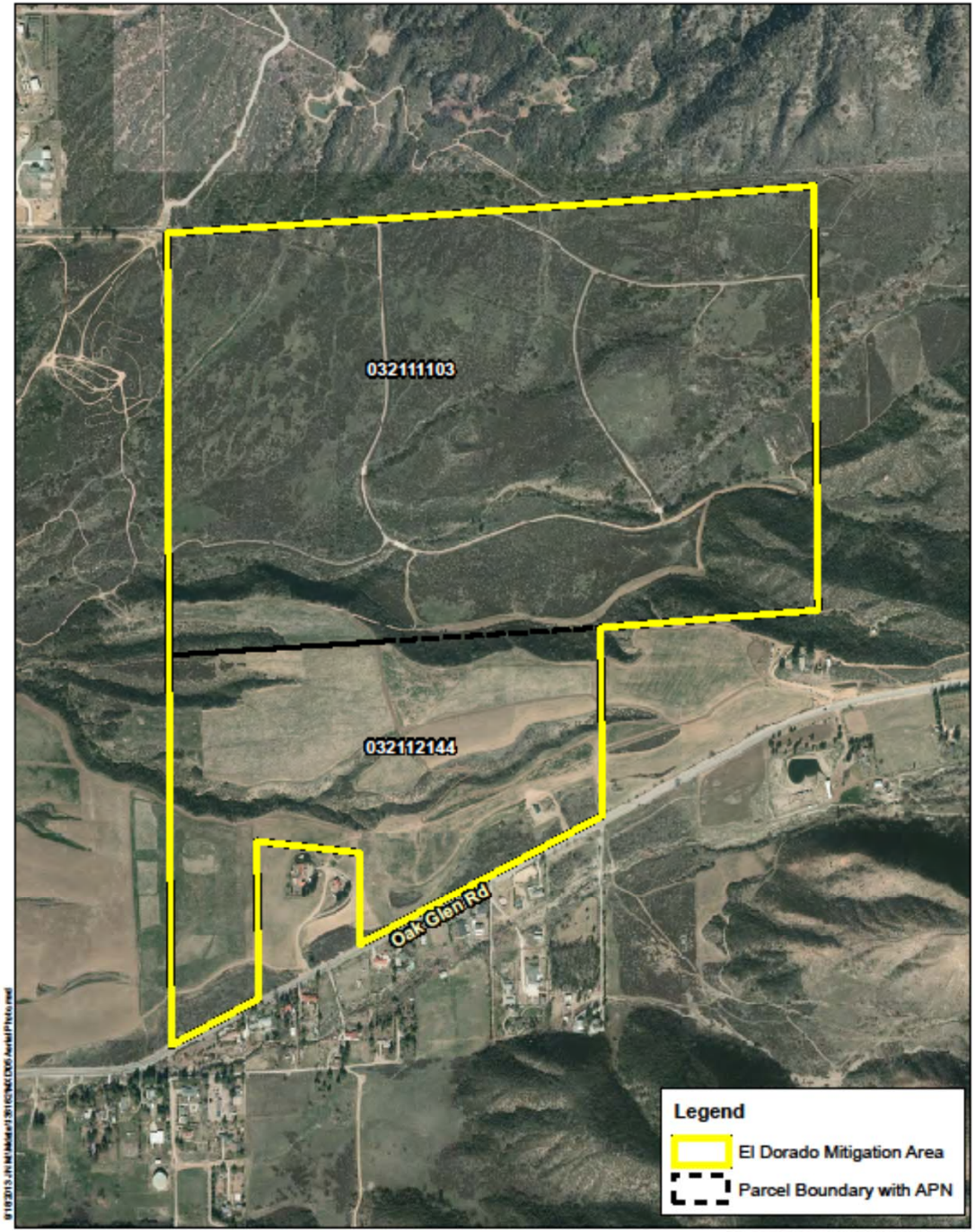
EL DORADO MITIGATION AREA
City of Yucaipa

RBF CONSULTING

0 150 300 600 Feet

El Dorado Mitigation Area

Exhibit 10



RBF CONSULTING

0 400 800 1,600 Feet

Source: Eagle Aerial 2012

EL DORADO MITIGATION AREA
City of Yucaipa

Aerial Photograph

Exhibit 5

* See Exhibit 10 for Photo Locations and Orientation

1: Wilson Creek Upstream Portion

2: Wilson Creek Downstream Portion

* See Exhibit 10 for Photo Locations and Orientation

3: Unnamed Ephemeral Drainage

4: Non-Native Grassland

EL DORADO MITIGATION AREA
City of Yucaipa

Photos of Mitigation Area

Exhibit 6A

* See Exhibit 10 for Photo Locations and Orientation

5: Unnamed Ephemeral Drainage - Oak Woodland

6: Unnamed Ephemeral Drainage - North Slope

* See Exhibit 10 for Photo Locations and Orientation

7: Unnamed Ephemeral Drainage

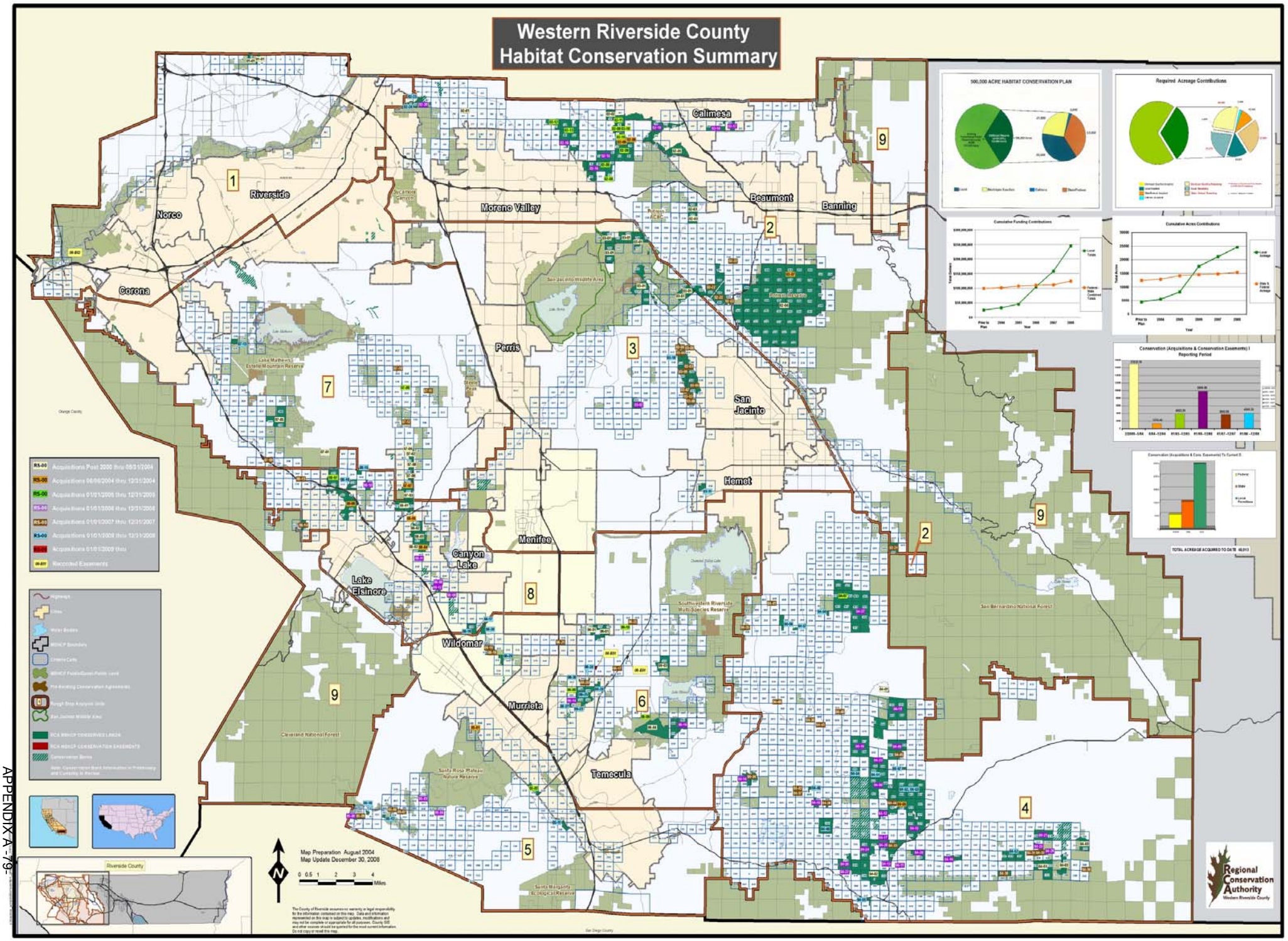
8: Unnamed Ephemeral Drainage

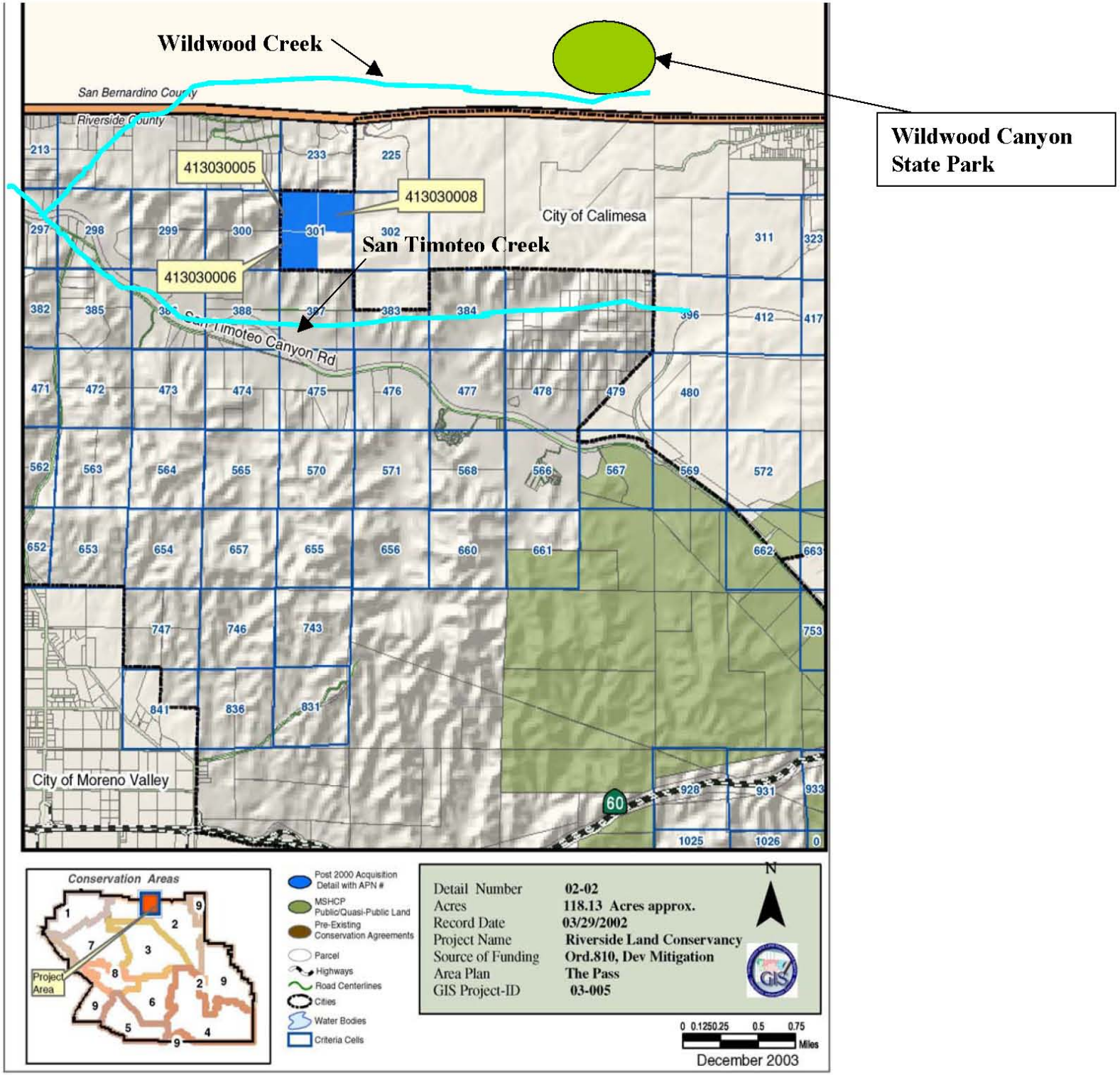
EL DORADO MITIGATION AREA
City of Yucaipa

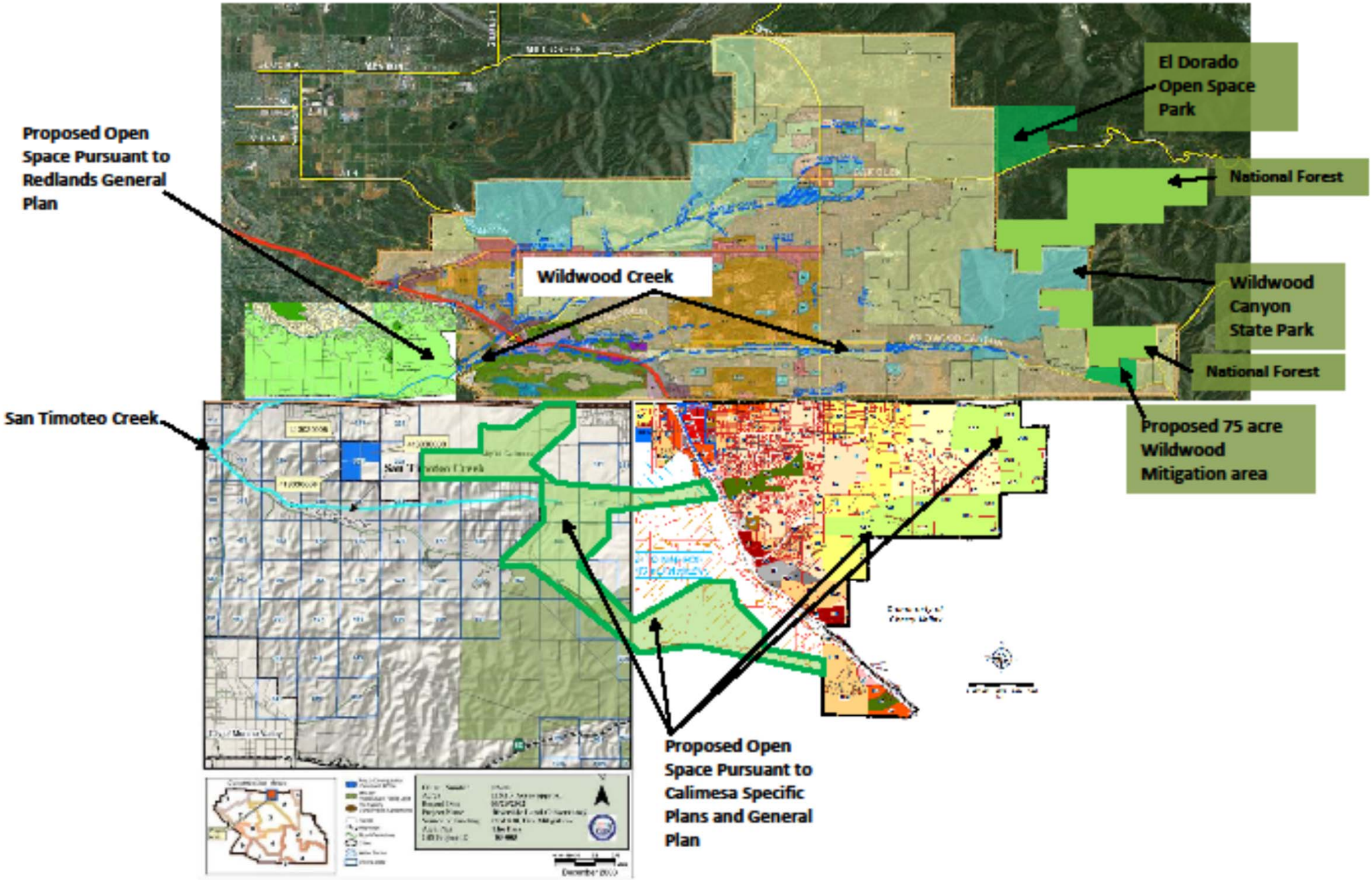
Photos of Mitigation Area

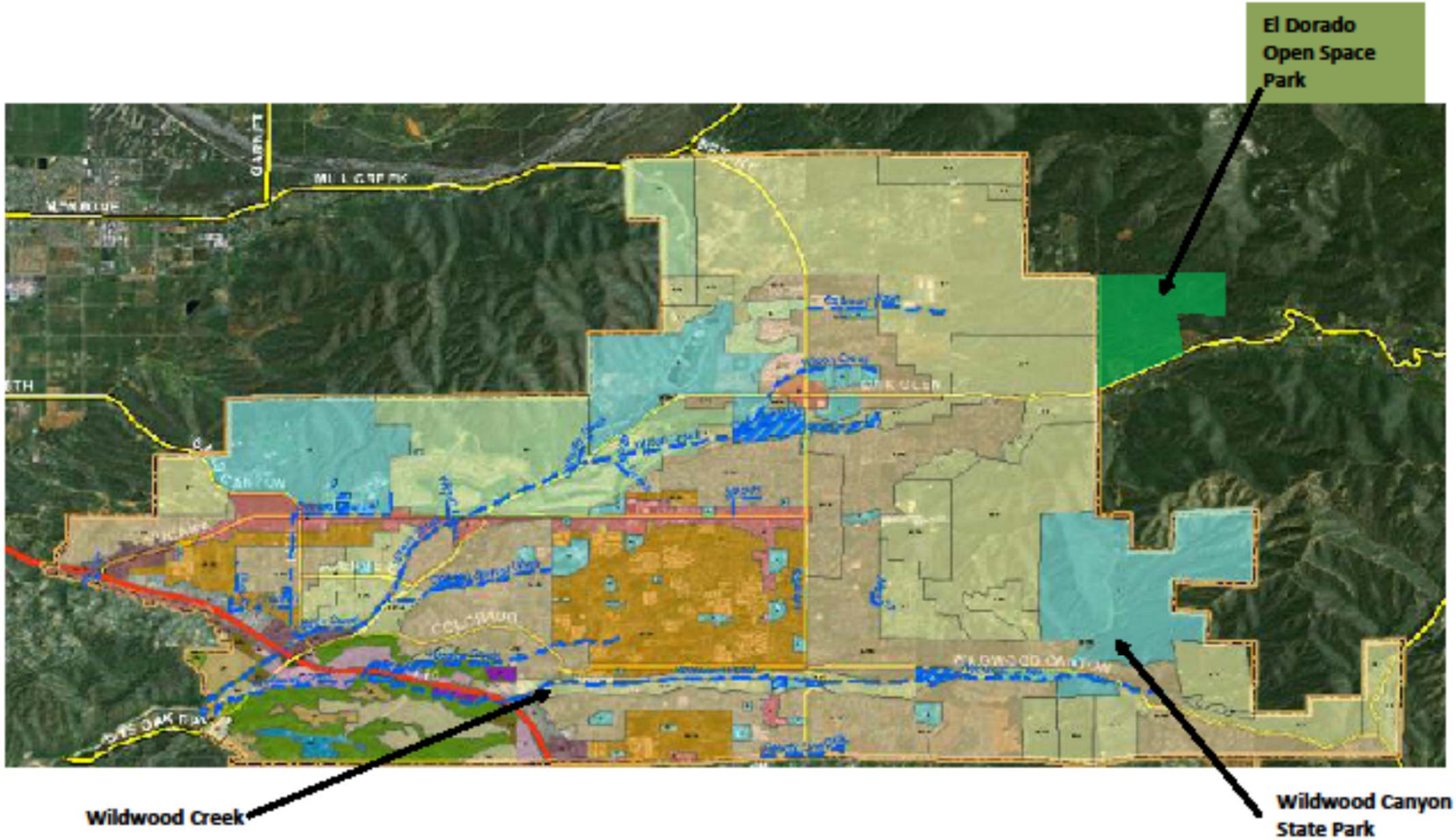
Exhibit 6B

Western Riverside County Habitat Conservation Summary




Wildwood Creek
Wildwood Canyon State Park
San Bernardino County
Riverside County
413030005
413030008
413030006
San Timoteo Creek
City of Calimesa
San Timoteo Canyon Rd
City of Moreno Valley
60
Conservation Areas
Project Area
Post 2000 Acquisition Detail with APN #
MSHCP Public/Quasi-Public Land
Pre-Existing Conservation Agreements
Parcel
Highways
Road Centerlines
Cities
Water Bodies
Criteria Cells
Detail Number 02-02
Acres 118.13 Acres approx.
Record Date 03/29/2002
Project Name Riverside Land Conservancy
Source of Funding Ord.810, Dev Mitigation
Area Plan The Pass
GIS Project-ID 03-005
N
0 0.1250.25 0.5 0.75 Miles
December 2003


El Dorado Open Space Park
National Forest
Proposed Open Space Pursuant to Redlands General Plan
Wildwood Creek
Wildwood Canyon State Park
National Forest
San Timoteo Creek
Proposed 75 acre Wildwood Mitigation area
Proposed Open Space Pursuant to Calimesa Specific Plans and General Plan


El Dorado
Open Space
Park
Wildwood Creek
Wildwood Canyon
State Park

CONNECTIVITY

a. Mountain Lions
b. Deer
c. Bobcats
d. Eagles

City of Yucaipa
Master Plan of Drainage (MPD) Update
Addendum 1

Prepared For:

City of Yucaipa

Prepared By:

RBF CONSULTING

PLANNING ■ DESIGN ■ CONSTRUCTION

Contact Person:
Tom Ryan, RCE 61701
Mujahid Chandoo
Tim Muli

Prepared On:
July, 2010
Revised July 2011
Revised September 2011
Submitted: January 2012

JN 10-106948

Table of Contents

1.0 INTRODUCTION 2
1.1 BACKGROUND 2
2.0 HYDROLOGY (Modifications to 2008 Phase I MPD Update) 4
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3.1 NORMAL DEPTH CALCULATIONS 7
3.1.1 Open Channels 8
3.1.2 Pipe Facilities 8
3.1.3 Culvert Crossings 8
4.0 DETENTION BASINS 9
5.0 PROGRAMMATIC ENVIRONMENTAL ASSESSMENT 13
6.0 GEOGRAPHIC INFORMATION SYSTEM (GIS) DATABASE 13
7.0 RESULTS & RECOMMENDATIONS 13
7.0 REFERENCES 15

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Exhibit 1 – Regional Vicinity Map 3
Exhibit 2 – Basin Locations Map 6
Exhibit 3 – Hydrology Map

LIST OF APPENDICES

Appendix A Drainage Facility Profiles

Appendix B: Hydrologic Calculations – 100 Year Design Discharge

Appendix C Hydraulic Calculations – 100 Year Design Discharge

Appendix D Initial Study/Mitigated Negative Declaration

Appendix E Special Studies

1.0 INTRODUCTION

This study is an addendum to the Phase I Master Plan of Drainage (MPD) Update for the City of Yucaipa prepared by RBF Consulting in July 2008. The Phase I study included updating the hydrology for the implementation of fourteen (14) constructed and proposed detention basins within the City Master Plan watershed boundary. An additional proposed detention basin has been added to this Update on Oak Glen Creek at Pendleton Street, within the Wilson Creek watershed and two (2) basins removed from the Dunlap Watershed (Dunlap 1 and Dunlap 3) and Yucaipa Creek Watershed (Yucaipa 1 and Yucaipa 2).

This study incorporates and revises the hydrology from the Phase I Update and provides new hydraulic calculations for the impacted drainage facilities within the City of Yucaipa watersheds. The results of the hydraulic calculations were also used to support the 2011 City of Yucaipa Drainage Impact Fee estimations and are the basis for the structures identified in the recently completed City of Yucaipa Drainage Master Plan GIS database.

As part of this Phase II MPD Update effort, a programmatic-level Initial Study/Mitigated Negative Declaration was prepared for the City proposed detention basins. The purpose of this study is to create a framework and the initial groundwork for future CEQA compliance for the construction of the proposed detention basins.

1.1 Background

The City of Yucaipa MPD Update encompasses the city limits and additional tributary areas outside the city boundaries, which totals approximately 26,000 acres. Drainage from this area is conveyed to two main receiving creeks, Wilson Creek and Wildwood Creek. The hydrology for these areas are incorporated and discussed in the Phase I Update which was approved by San Bernardino Flood Control District in September 2008.

The City has identified five (6) existing, four of which will be modified, and eight (8) proposed storm water detention basins to be included in the MPD Update. These basins include:

1. Chicken Springs Wash (Proposed)
2. Dunlap Basin 2A & B (Existing) – Proposed to be modified.
3. Dunlap Basin 4 (Existing) – Proposed to be modified.
4. Dunlap Basin 5 (Existing) – Proposed to be modified.
5. Wildwood Creek 2a (Proposed)
6. Wildwood Creek 2b (Proposed)
7. Wildwood Creek Basin 1 (Proposed)
8. Wildwood Creek 4 (Proposed)
9. Wildwood Creek Basin 3 (Existing)
10. Yucaipa Basin 3 (Proposed)
11. Wilson Creek Basin 3 (Proposed)
12. Wilson Creek Basin 2- Oak Glen Basin (Existing)
13. Pendleton Road Crossing (Proposed)
14. 13th Street Sports Complex (Existing)

Exhibit 1 – Regional Vicinity Map

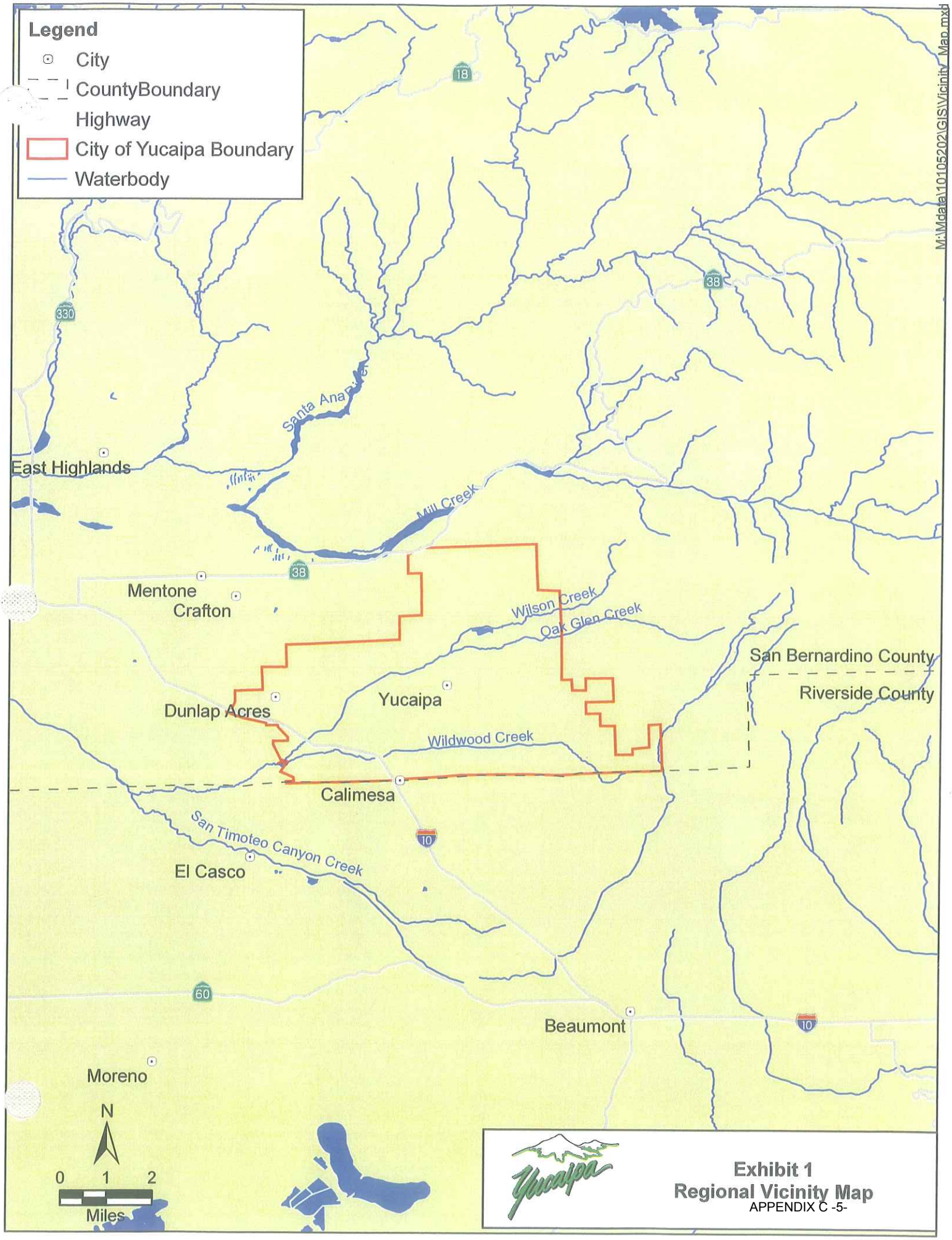


Exhibit 1
Regional Vicinity Map

Additional details of the basins are included in Section 4.0. The development of the flood routing models was completed in accordance with the guidelines in the *San Bernardino County Hydrology Manual.*

2.0 HYDROLOGY (Modifications to 2008 Phase I MPD Update)

City of Yucaipa is divided into 2 Major watersheds, Wilson Creek Watershed and Wildwood Creek Watershed. Wilson Creek Watershed consists of 4 distinct sub watershed; Wilson Creek, Oak Glen, Dunlap and Chicken Springs. Wildwood Watershed consists of Wildwood and Yucaipa Creek sub watersheds.

The hydraulic calculations in this MPD Update are based on the 2008 MPD Update hydrology calculations. Some of the hydrology from the 2008 MPD Update has been updated in this study for Wilson Creek, Oak Glen Wash, and Dunlap Channel. These studies were prepared to "optimize" the drainage facilities within their respective watersheds in conjunction with future City plans. These hydrology studies supersede the hydrology prepared for the MPD 2008 Update. The hydrologic calculations to determine the 100-year peak flow rates were performed using the criteria in the *San Bernardino County Hydrology Manual* and can be found in *Appendix E.*

Bulking Factors
All of the flow rates given in this Study are clear-water. San Bernardino County Flood Control (SBCFCD) may require the use of a bulking factor for each earthen flood conveyance facility, and those systems conveying offsite runoff due to potential sediment loading. As a result, flows could be as much as twice the predicted MPD flowrates, and consequently significantly increase the facility size and costs. Accepted SBCFCD bulking factors used in this study are listed below.

Channel	Bulking Factor
Wilson Creek	1.30
Wildwood Creek – Downstream of WW-3 Basin	1.33
Wildwood Creek – Upstream of WW-3 Basin	1.37

Wilson Creek Watershed – Optimization Study
The Wilson Creek optimization study evaluated options for maximizing the proposed detention basins (from 2008 MPD Update) and channel facility. This was completed in order to understand the most feasible combination of attenuation and facility improvements within the main drainage facilities.

The evaluated alternatives included potential basins locations at Pendleton road crossing, Freemont Spreading grounds, and Wilson III basin. The newly constructed Wilson II detention basins were also included in the models. Coordinating with the City, concept layouts for these basins were maximized, including sizes that would require right-of-way purchases. Several basin alignments and outlet configurations were evaluated to yield the maximize attenuation at each site. Flow through and flow by, and combinations of both, where evaluated at each basin site.

Several basin configurations and channel improvement "Options" were created for comparison. These options consisted of only a few of the many scenarios run but were

selected due to their relevance and ease of comparison in identifying how each basin impacted the system flows.

Baseline hydrology was run with the newly constructed Wilson II (Oak Glen) Detention basin. This basin rating curve was established using XPSWMM since a complex model was needed to establish hydraulic communication between the three basins and the main channel. Traditional hydraulic models were found to not produce reliable results. Models such as HEC-RAS and Pondpack, do not adequately calculate surcharging or reversal of flows within the sideweir channel that feeds two of the three basins.

The main calculation engine of XPSWMM (SWMM) was developed by U.S. Environmental Protection Agency (EPA). XP Software refined the model and added a user friendly interface. The program is a dynamic unsteady flow model (utilizing the St. Venant Equations) that allows for effects of storage and backwater in conduits and surface flows, and the timing of the hydrographs to yield a true representation of the water surface elevation at any point in space and time.

Coordinating with the City, concept layouts for all basin modeled were maximized, including sizes that would require right-of-way purchases. The recommended option (alternative 5) included modifying Pendleton Basin to 130 ac-ft, Wilson III to 200 ac-ft in combination with the existing Wilson II (Oak Glen Basin). The basin descriptions are as follows:

Based on the results from a cost summary perspective, it was found that the most economical approach would be to not include any basins upstream, as improvements would need to be introduced in the channel sections regardless of the upstream basin improvements. This is primarily a result of the steepness of the channel and the locations within the watershed of the future proposed basin locations. However, the Wilson III basin project location was identified in the City's original Master Plan of Drainage and subsequent updates, as a high priority project to assist in reducing flood risk in the City. The recommended alternative (Option 5) results show that the combination of existing and proposed basins, in combination with downstream channel improvements, will result in a reduction of flood flows of approximately 20% at Yucaipa Boulevard. Other benefits to the upstream basins include reduced sedimentation downstream, groundwater recharge of natural stream flows, improved downstream water quality, economic development opportunities and environmental restoration and enhancements.

Pendleton (Configuration 3 – Used in Option 5)
Create Storage Based on City recommendations
Storage: 130 ac-ft
Max Depth: 22-ft
Outlet Culvert: 2-12'Wx10'H RCB

Wilson III (Configuration 4 – City Revised Concept – Used in Option 5)
Total Storage: 200 ac-ft
Outlet Culvert: 3-12'Wx10'H RCB
Channel Realignment – Full armored trap channel for both Wilson and Oak Glen

For each Option, hydrology was calculated using the appropriate depth-area reductions for the tributary watersheds. Each basin was evaluated based on these parameters for each option. Bulking factors of 1.30 were used for Wilson Creek for the entire channel section from Yucaipa Boulevard to I-10.

Chicken Springs Watershed Study
RBF has analyzed the Chicken Springs Wash Watershed to identify ultimate facilities along the channel. Chicken Springs Wash was extended from 7th Street to 200' downstream of 2nd Street.

The City of Yucaipa proposed a potential detention basin location upstream of 7th street. This location was analyzed with different basins geometry and sizes. Due to the existing discharges and limited upstream attenuation along Chicken Springs Wash, the basin would require extensive structural improvements along the South edge of the parking lot to avoid flooding of the adjacent properties. The resulting basin was not modeled in this study. The City is choosing to potentially utilize the area for water quality treatment options.

The discharges along Chicken Springs were extrapolated from the approved MPD hydrology prepared by Boyle. The USACE HEC-RAS software was used to run the hydraulics for the main channel of Chicken Spring Wash. Cross-sections were identified using existing topography, obtained from the City of Yucaipa. WSPG, FHWA Nomographs and HEC-RAS were used to size the ultimate crossings along 5th Street, 6th Street and 7th Street. The ultimate crossings were designed to convey only the 10-yr flows and higher discharges would weir over the street. No bulking factor was used for this watershed since the watershed is fully developed. The result of the study identified type crossing and channel material type within specific sections of Chicken Springs Wash. These can be identified in the study located in *Appendix E.*

Dunlap Watershed Study
RBF has prepared an Optimization study of the Dunlap Channel watershed. The purpose of this study is to optimize the proposed detention basins and drainage facilities identified in the approved 2008 MPD Update. XPSWMM was used to run the hydraulics along Dunlap Channel. Normal depth calculations, as used in the facility sizing calculations for the MPD Update, may not adequately size and/or take backwater effects, into account due to the downstream constraints at Wilson Creek.

This analysis includes evaluations of conveyances in streets, storm drains, proposed (and existing) detention basins, and the Dunlap channel. Streets analyzed include Yucaipa Blvd, Ave D, Ave E, Kentucky St., 11th St., 12th St., 13th St., 14th St.,15th St, and 16th St. Drainage systems include Dunlap Channel, the storm drains along Yucaipa Blvd, 7-ft catch basin at the intersection of 11th Street and Yucaipa Blvd, 30-in RCP along 11th St., Ave D storm drain, Ave E storm drain, and Kentucky St. storm drain.

The discharges used for this watershed update are based on the approved MPD prepared by Boyle and the 2008 MPD Update by RBF Consulting. Unit Hydrograph method was used to evaluate basins D-2A, D-2B, D-4, and D-5 using the Advanced Engineering Software (AES) programs. Based on the analysis 100-yr peak flows at four locations within Dunlap channel were as follows:

100-Year Peak Flow Summary Results

Location	Q, cfs (UH)
Upstream Channel/Yucaipa Blvd	554
D/S of Ave D	728
D/S of Ave E	949
D/S of Kentucky St.	1,173

Several alternatives were reviewed and analyzed to understand the most practical and feasible solutions to reach the desired goal of attenuation of peak flows while providing 100-year flood protection to the Dunlap Channel watershed. The basins analyzed include the following:

Dunlap Basin 2A & 2B (D-2A/B) – The D-2A is a MPD proposed 9 ac-ft basin, located at the intersection of 13th St. and Yucaipa Blvd. The D-2B basin is a MPD proposed 9 ac-ft basin, located upstream of D-2A. The recommendation is to combine these two basins to not impact existing sports fields. The design details of this basin will be identified in a detailed evaluation during the design process.

Dunlap Basin 3 (D-3) – This is a proposed basin as part of the MPD. D-3 is located adjacent to D-2B. Basin D-3 was modeled as a flow-by basin in the MPD. The flow reduction with D-3 was found to be insignificant and the recommendation is not to pursue construction of this basin.

Dunlap Basin 4 (D-4) – MPD proposed 20 ac-ft basin, located at the intersection of Chapman Heights and 13th Street. Analysis results showed this basin functions adequately in its current proposed condition. Recommendation is not to change.

Dunlap Basin 5 (D-5) - MPD proposed 15 ac-ft basin, located at the intersection of Chapman Heights Rd and Golden Mountain. Analysis results showed this basin functions adequately in its current proposed condition. Recommendation is not to change.

13th Street Sports Complex – This recently constructed basin is located at the intersection of Chapman Heights Road and 13th Street. This basin has a capacity of approximately 7 ac-ft. with 3-30" RCP outlet.

Dunlap Basin 1 (D-1) – This is a proposed basin as part of the MPD. D-1 is located adjacent along Dunlap Channel, north of 14th Street and just upstream of the existing 48" CMP. The recommendation is not to pursue construction of this basin.

3.0 HYDRAULICS

The drainage facility hydraulics were performed for the 100-year peak flow based on the results of the Phase I Update (2008 MPD Update) and the revisions to the Wilson Creek, Dunlap and Chicken Springs study. Hydraulic calculations consisted identifying the peak flow normal depth of each facility, using the revised flowrates identified in the Phase I Update, and 2011 MPD revisions. For drainage facilities not included in the Wilson Creek, Dunlap Channel, or Chicken Springs optimizations studies, hydraulics were performed using normal depth calculations.

3.1 Normal Depth Calculations

Facility hydraulics was performed using Bentley's FlowMaster program, solving the Manning's Equation for normal depth. Following the San Bernardino County Flood Control District's criteria for freeboard, each facility was sized based on the approved Phase I Update

peak flows (with basins). Portions of Wilson Creek, Dunlap Channel and Chicken Springs were sized using HEC-RAS, WSPG and/or FHWA Nomograph charts.

This method is used for planning purposes only. Prior to design of a conduit, more detailed hydraulic calculations will be necessary. The normal depth hydraulic results can be found in *Appendix C.*

3.1.1 Open Channels

The open channels were analyzed assuming a composite manning's roughness coefficient based on the proposed construction material established in the 1993 MPD. Normal depth hydraulics was performed using established proposed invert values estimated in the 1993 MPD report. In some instances, where invert data was not reliable, conveyance system slopes were estimated using surface elevations based on current topography maps.

For the drainage facilities located in the Special Studies, more advanced hydraulic models were used. Wilson Creek, between Yucaipa Blvd. and the I-10 freeway was analyzed using the USACE's HEC-RAS model. Dunlap Channel and a portion of Chicken Springs wash were evaluated using HEC-RAS. These results can be seen in *Appendix B and E.*

The sizes of each facility were calculated based on the Phase I MPD Update peak flows (with basins). Given the facility slope and freeboard requirements, the most feasible sections were calculated. Channel maximum velocities were used to evaluate the material integrity.

Proposed channel construction material includes soil cement, armor flex, grouted riprap, and loose riprap. These materials were used for the planning purposes of this study. Prior to facility design, more detailed analyses should be performed to select the best material alternative.

3.1.2 Pipe Facilities

Pipe conduits were analyzed using a manning's roughness coefficient of 0.013 for reinforced concrete (RCP). Pipe system slopes were estimated using existing topographic map data. It was assumed that the pipe system flowlines are parallel to existing ground elevations. Using the peak flows established in the Phase I MPD Update, pipe sizes were calculated using normal depth for full-flow capacity. Actual required sizes of pipe drainage systems would be identified prior to design assuming pressure flow conditions, where possible, to minimize conduit sizes.

3.1.3 Culvert Crossings

Proposed culvert crossings were analyzed assuming rectangular reinforced concrete sections. A peak discharge freeboard of three (3) feet was used for estimating the required capacity heights and widths. The slopes were estimated based on upstream and downstream proposed flowline slopes. Culvert crossings along Dunlap Channel and Chicken Springs Wash were sized based on City recommendations at lowflow crossing.

Transition structures are placed immediately upstream and downstream of the culverts. For the MPD purposes, these facilities were estimated to be 25 feet in length. Actual lengths may vary when further analyses are performed during the design processes.

4.0 DETENTION BASINS

The Phase Update of the City of Yucaipa MPD incorporated both existing and proposed detention basins to attenuate peak flow downstream. Fourteen (14) detention basins were evaluated ranging in size and function. Some detention basins were modeled as flow-by and others as flow-through basins.

This study incorporates 14 basins, with the addition of proposed basins at Pendleton/Oak Glen Creek, 13th Street Sports Complex, combining the Dunlap D-2a and D-2b basins, and removal of Dunlap 3 (D-3) and Dunlap 1 (D-1) basins.

The City of Yucaipa proposed to implement these flood control detention basins to mitigate the potential for flooding within the local facilities and to alleviate overburdened downstream mainline structures.

The following is a summary of the detention basins included in this update:

1. **Chicken Springs Wash** will be located north of Avenue E. The basin will have an estimated capacity of 35 acre-ft. The basin is proposed to be a flow-through basin with a triple 10' X 10' RCB outlet structure.

2. **Dunlap Basin 2A/2B (Existing/Modified)** D-2A is located north of Yucaipa Blvd. at 13th Street within a high school baseball field. This basin is currently has a capacity of 9 ac-ft. D-2B is located north of Yucaipa Blvd. at 13th Street, within a high school baseball field, upstream of Basin 2A. This basin is approximately 9 ac-ft. The recommendation is to combine these basins. Actual design volume and outlet facility will be evaluated during the design phase when a more detailed evaluation can be performed..

3. **Dunlap Basin 4 (Existing/Modified)** was proposed to be revised from its existing 3 acre-ft basin to an estimated 22 acre-ft basin. The basin outlet is estimated to be a 66-inch RCP. At the time of this report the basin was being acquired by the City.

4. **Dunlap Basin 5 (Existing/Modified)** is located north of Chapman Heights Road. This basin is proposed to be enlarged to increase its capacity from 3 acre-ft to approximately 15 acre-ft. The basin is proposed to have a 42-inch RCP outlet.

5. **Wildwood Creek Basin 2a (Proposed)** is located east of California Street. This basin is proposed to be a flow-by basin. The basin has an estimated volume capacity of 20 ac-ft. A low flow pipe will be used to drain the basin after major storm events.

6. **Wildwood Creek Basin 2b (Proposed)** is located west of California Street. This basin is estimated to be a flow-by basin with a peak flow reduction of 1,019 cfs. The basin is estimated to have a volume capacity of 35 ac-ft. This offline basin will be equipped with a 36-inch riser drain pipe to release flows after large storm events.

7. **Wildwood Creek Basin 1 (Proposed)** is located on Wildwood Creek at Calimesa Road, south of the I-10 freeway. The basin is proposed to include 3 separate flow-by basins with interior levees. The basin is estimated to be a flow-by basin with a peak reduction of 1,500 cfs. Preliminary design was prepared by Fuscoe Engineering.

8. **Wildwood Creek Basin 4 (Proposed)** is located along Wildwood Creek, south of Wildwood View Drive. The basin is proposed to be a flow-through basin with a capacity of 25 acre-ft and with a 114" RCP outlet pipe.

9. **Wildwood Basin 3 (Existing)** is located south of Wildwood Canyon Road. The basin is proposed to have 3 flow-through basins with interior levee. David Evans and Associates prepared preliminary calculations for the stage-storage-outflow rating curve. Albert Webb has completed the final design. This basin was completed in March 2011.

10. **Yucaipa Basin 3 (Proposed)** is located east of 8th Street and proposed to be a flow-through basin. A schematic plan was provided by City of Yucaipa. This basin is estimated to have a total of 45 acre-feet of potential storage and discharges to a double 12'X10' RCB.

11. **Wilson Basin III (Proposed)** is located west of Bryant Street. Wilson Basin I has an estimated capacity of 45 ac-ft. Based on previous initial calculations, Wilson I was modeled as a flow-through basin with a peak reduction of approximately 1000 cfs.

12. **Wilson Basin 2/ Oak Glen Basin (Existing)** is located east of Bryant Street. Wilson II has 1 flow-through basin with 2 flow-by basins with interior levees. This basin was constructed in 2009. An unsteady flow hydraulic analysis was prepared by West Consulting for the basin routing. For this flood routing analysis, Wilson II/ Oak Glen Basin was modeled as a flow-by basin with a reduction of 1,337 cfs. per the request of the City. *This basin is not included in the Initial Study/Mitigated Negative Declaration.*

13. **Pendleton Road Crossing (Proposed)** located east of Pendleton Street. This basin is proposed to be a flow-through basin with a multiple-celled culvert outlet. Pendleton Street will be raised to impound flows and inundate the overbanks immediately upstream of the crossing. The culvert sizes and hydraulic performance have not been completed at this time. As a result, the hydraulics for the drainage facilities downstream of this proposed basin could not be appropriately modified. The City's goal is to utilize an impoundment volume of 50 acre-ft of runoff. For this facility to remain out of DSOD jurisdiction, the maximum depth of impounded flow must be less than 6 feet from maximum water surface elevation, to downstream toe of embankment, and/or the volume of impoundment must be less than 50 acre-feet.

14. **13th Street Sports Complex (Existing)** is located at the intersection of Chapman Heights Road and 13th Street. This basin was modeled as a flow-through basin with a storage capacity of approximately 7 ac-ft. with 3-30" RCP outlet pipe.

The detention basins in this MPD update include both existing and proposed basins. *Exhibit No.2* shows the locations of each basin.

Not all of these detention basins are covered in the Initial Study/Mitigated Negative Declaration, since some of these basins are existing facilities. Existing basins, not included were the Dunlap Basin 2, Wilson Creek Basin 2 and Wildwood Creek Basin 3.

Table.1 shows a comparison between the peak flow rates with and without the basins. The Unit Hydrograph models can be found in *Appendix B.*

Exhibit 2 – Basins Map

TABLE 1
CITY OF YUCAIPA
Master Plan of Drainage (Ultimate Conditions)
Flow Rate Summary with BASINS

Basin Location			Unit Hydrograph (UH) without Basins			UH with Basins			
	Basin Capacity (ac-ft)	Node	Area (ac)	Tributary Area (ac)	Flow rate (cfs)	Tributary Area (ac)	Flow rate (cfs) - Upstream	Flow rate (cfs) - Downstream	Flow rate reduction per ac-ft
WILSON CREEK									
		3414	3883.3						
Pendleton	130	2852	4438.7	4438.7	6199	4438.7	6199		
Wilson – II/ Oak Glen	129[4]	2852	4438.7	4438.7	6199	4438.7	6199	4432	
Wilson - III	200	3021	3020.7	7459.4	9102	7459.4	6207	5287	
		3414	520.6	11863.3	11819	11863.3	-	-	
		3733	837.7	12701.0	11954	12701.0		8189	
Chicken Springs*[1]	35	3833A	1771.7	1771.7	2490	1771.7	2490	2266	
		3833		14472.7	12840	14472.7		9447	
Dunlap - 4	20	4811	196.5	196.5	336	196.5	336	54	
Dunlap – 5	15	4616	95.8	95.8	291	95.8	291	73	
Dunlap – 2B[6]	22	4636.5	102.6	198.4	402	198.4			
Dunlap – 2A[6]	30	4637	192.3	587.2	1109	587.2			
13th St. Sports Complex	7	4821	158.5	158.5	283.6	158.5	284	143	
		4517A	1320.0	1907.0	2542	1907.0		1932	
		4517	1320.0	16379.9	13690	16379.9		10029	
		5524A	387.9	16767.8	13650	16767.8		10121	
YUCAIPA CREEK									
Yucaipa - 3	45	6324	1829.2	1829.2	2307	1829.2	2307	1826	11.2
		6425	370.6	2199.8	2349	2199.8	1902	1902[2]	
WILDWOOD CREEK									
Wildwood – 4*	25	6911	772.8	772.8	1394	772.8	1394	1028	14.7
		7234	3800.4	4573.2	6070	4573.2		5706	
Wildwood - 3	78	7416	382.6	4955.8	6218	4955.8	5838	4878	12.3
		7722	402.7	5358.5	6405	5358.5		4958	
Wildwood – 2a[3]	20[5]	7821A		5358.5	6299	5358.5	4937	4000	46.9
Wildwood – 2b[3]	35[5]	7821B		5358.5	6299	5358.5	4000	3450	15.7
		8025	621.0	5979.5	6647	5979.5		4127	
Wildwood - 1	50[5]	311A	243.2	6221.3	6660	6221.3	4243	3350	17.9
	Confluence w/Yucaipa Creek	8311		8422.5	7970	8422.5		4943	
		8611	92.0	92.0	172	92.0		172	
		8612	1141.0	1233.0	1447	1233.0		1233	
		5524B	143.3	9801.5	8619	9801.5		5694	
CONFLUENCE POINT	5524			26565.1	17773	26565.1		14191	

Note:
1. Existing downstream capacity is 1,900 cfs.
2. Existing downstream capacity at I-10 freeway crossing is 3,200 cfs.
3. Existing downstream capacity at I-10 freeway crossing is 3,200 cfs.
4. Modeled in SWMM
5. Basins were modeled as flow-by.
6. Dunlap 2(A) and 2(B) have a total capacity of approximately 50 ac-ft.

5.0 PROGRAMMATIC ENVIRONMENTAL ASSESSMENT

As part of the development of the Phase II Master Plan of Drainage Update, a review of the cumulative environmental effects of constructing *proposed* (12 total) detention basins in accordance with the guidelines and regulations of the California Environmental Quality Act (CEQA). Refer to *Appendix D,"* Initial Study/Mitigated Negative Declaration". This study was prepared per the request of the City of Yucaipa to identify potential environmental issues regarding the implementation of construction the proposed basins. The findings of this report will provide the City with information and understanding of potential required subsequent discretional actions necessary to complete the projects. This document is not a policy document requiring immediate action or approval and/or certification from environmental agencies.

6.0 GEOGRAPHIC INFORMATION SYSTEM (GIS) DATABASE

The results of this study, in conjunction with the results of the Phase I MPD hydrology were prepared in a GIS database for the City of Yucaipa. Among other information, the master planned drainage facilities can be viewed at (http://gis.rbf.com/yucaipa/), or simply by visiting the City of Yucaipa website. Drainage facilities, such as channels, pipes, crossings, and detention basins can be selected and overlaid on either a topographic map or an aerial image. The database includes existing and proposed facilities. By selecting a facility, geometric, hydraulic, and hydrologic parameters of that facility can be viewed. Additional information that can be viewed include major watersheds, land uses, and hydrologic nodes (from the Phase I MPD hydrology).

The database has the capability to plot user customized maps of the drainage facilities. Two templates exist; 8.5"x11", or 11"x17". This feature replaces the 1993 Map Book, and allows the user to quickly identify the area of interest, and to plot personal information of relevance.

The website provides an easy to use format that allows several layer options to view. Additional layers have been added to this site for reference, such as: FEMA Flood zones, parcel locations, earthquake fault locations, District information, fire information, and known landsides.

7.0 RESULTS & RECOMMENDATIONS

This study implements the hydrologic changes identified in the 2008 Phase I Master Plan of Drainage Update, supplemental reports for Wilson and Dunlap Watershed and identifies corresponding drainage facility sizes within the City of Yucaipa. The 2008 report hydrology was accepted by the County of San Bernardino for the estimation of Master Plan peak flowrates throughout the tributaries within the City of Yucaipa. Using normal depth hydraulic calculations, facility sizes were estimated based on the accepted hydrology. Profiles were developed (*Appendix A*) for each facility, identifying reach, length, geometry, and type based on the results of the hydraulic calculations.

Estimated construction costs were prepared based on the results of the hydraulic calculations. Results can be found in the *Drainage & Traffic Impact Fee Assessment Update and Evaluation for the City of Yucaipa* prepared by RBF Consulting in July 2010. *Table 1* shows the summary of the individual facility resulting cost estimates.

These costs and facility sizes are prepared for Master Plan use only. Prior to final design of these facilities, detailed hydraulic calculations must be prepared to accurately size each facility.

Table 2: Drainage Facility Construction Costs Summary

Channel System	Segment Code	Segment Length (Ft.)	Segment Cost	Total Cost
Chicken Springs	CS-01	12,494	$19,098,674	$19,098,674
County Line Drain	CL-01	3,162	$2,931,205	$3,292,593
Dunlap Channel	CL-01-01	486	$361,387	
	DC-01	5,510	$5,955,440	
	DC-02 (Only Basin)	-	$1,375,306	
	DC-01-02	687	$360,822	
	DC-01-03	303	$171,338	
	DC-01-04	1,924	$1,344,722	
	DC-01-05	422	$238,307	
	DC-01-06	2,738	$2,050,424	
	DC-01-07	394	$175,451	$12,425,762
Gateway Wash	GW-01	250	$286,249	
	GW-02	5,410	$139,646	$425,895
MAP 41	M41-01	1,896	$2,488,922	$2,488,922
MAP 57	M57-01	813	$531,475	$531,475
MAP 58	M58-01	230	$150,356	$150,356
MAP 91	M91-01	465	$256,214	$256,214
Oak Glenn Wash	OG-01	6,000	$12,537,056	$12,537,056
Wildwood Creek	WW-01	16,977	$32,956,634	
	WW-02	20,793	$40,081,951	
	WW-02-01	350	$115,897	$73,154,482
Wilson Creek	WC-01	23,690	$77,926,615	
	WC-01-01	2,161	$1,275,094	
	WC-01-02	993	$386,389	
	WC-02-01	150	$627,215	$80,215,314
			Grand Total:	**215,706,481**

The proposed detention basins identified in this study were conceptually evaluated in the 2008 MPD Update I report and further evaluated in the Wilson Creek and Dunlap Optimization study.

7.0 REFERENCES

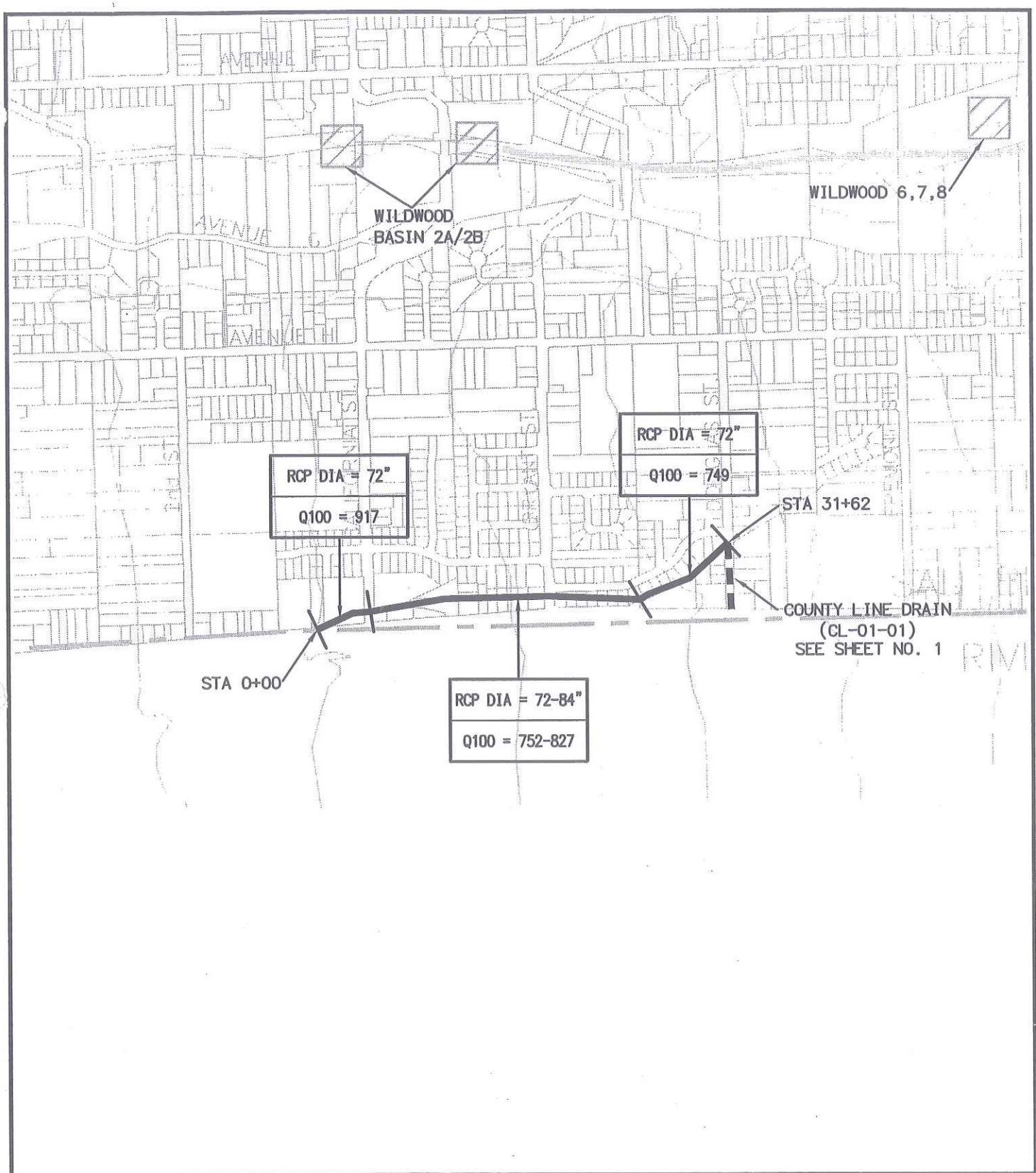
Boyle Engineering Corporation, 1993. *City of Yucaipa Master Plan of Drainage.*

RBF Consulting, 2008. *City of Yucaipa Master Plan of Drainage Update (Phase 1)*

RBF Consulting 2010, Drainage & Traffic Impact Fee Assessment Update and Evaluation for the City of Yucaipa.

APPENDIX A

Drainage Facility Profiles



LEGEND

PROPOSED FACILITY

FACILITY SHOWN ELSEWHERE

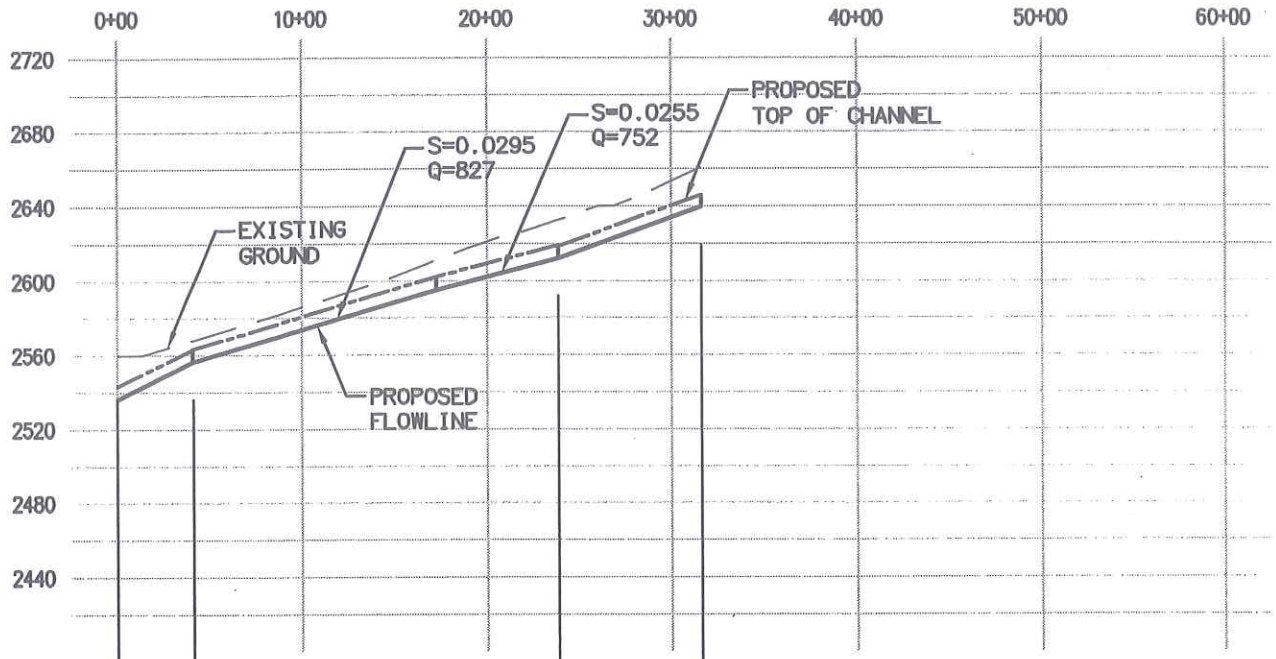
BASIN LOCATION

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA COUNTY LINE DRAIN (CL-01) SHEET 1 OF 1	N SCALE" 1"=1000'

H:\PDATA\1010\6948\CADD\STRMWATER\EXHIBITS\6948-PLAN-CL-01.DWG MCHANDOO 7/29/11 12:51 pm

RBF CONSULTING

PLANNING DESIGN CONSTRUCTION

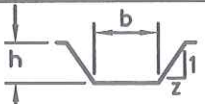


	0+00	4+11	23+87	31+62
LENGTH	411'	1976'	775'	
SLOPE	0.0484	VARIES	0.0356	
FLOW	Q100 = 917	Q100 = 752-827	Q100 = 749	
SIZE	RCP DIA = 72" RCP	RCP DIA = 84" RCP	RCP DIA = 72" RCP	
FACILITY TYPE	TYP. SEC. NO. 1	TYP. SEC. NO. 1	TYP. SEC. NO. 1	

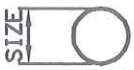
LEGEND

- — — — EXISTING
- —·—·— PROPOSED TOP OF CHANNEL
- ——— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL

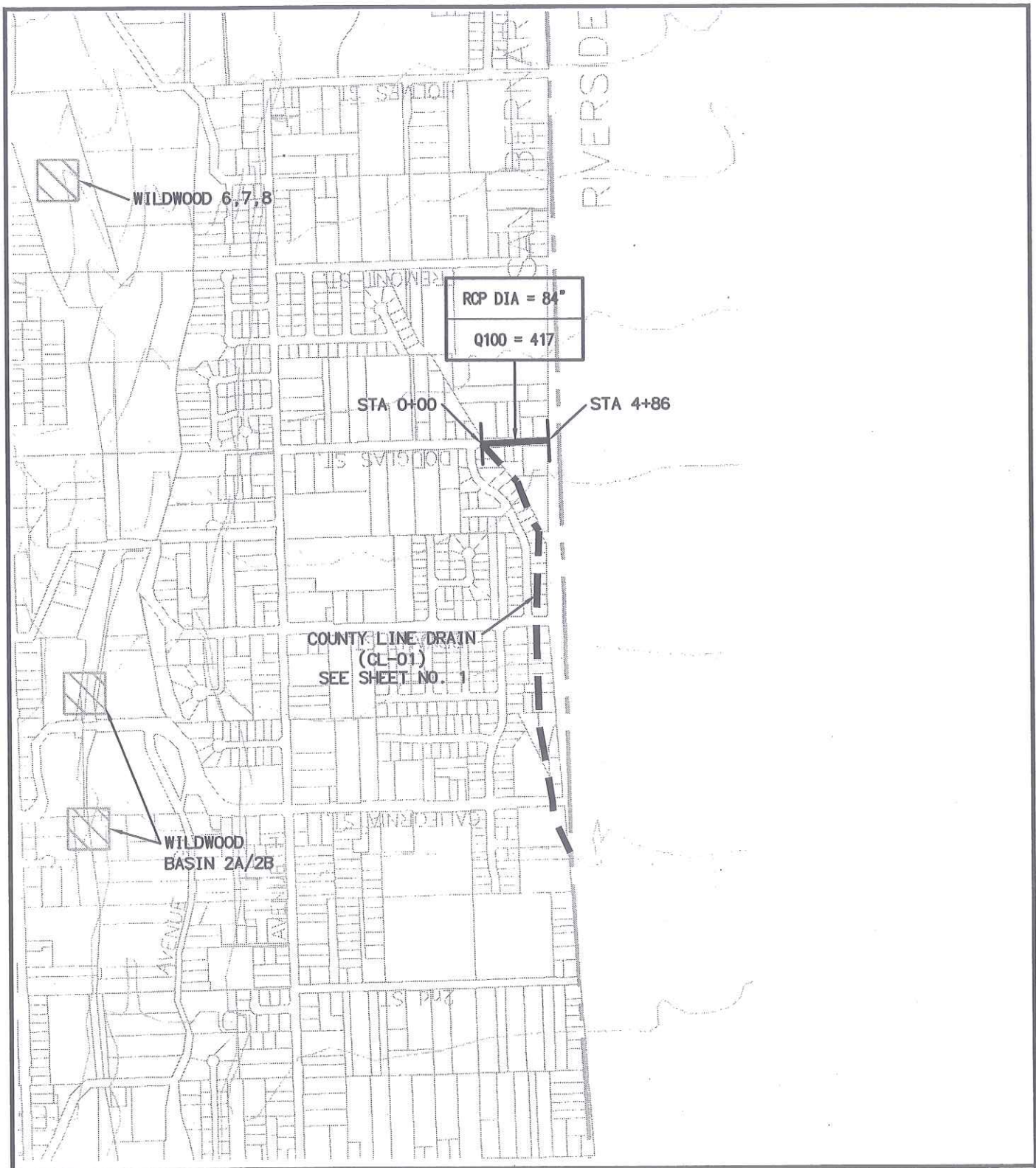


REINFORCED CONCRETE PIPE (RCP)

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA COUNTY LINE DRAIN (CL-01) SHEET 1 OF 1	SCALE: H: 1"=1000' V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-CL-01.DWG EGC 6/27/11 8:46 am

RBF CONSULTING — PLANNING ■ DESIGN ■ CONSTRUCTION

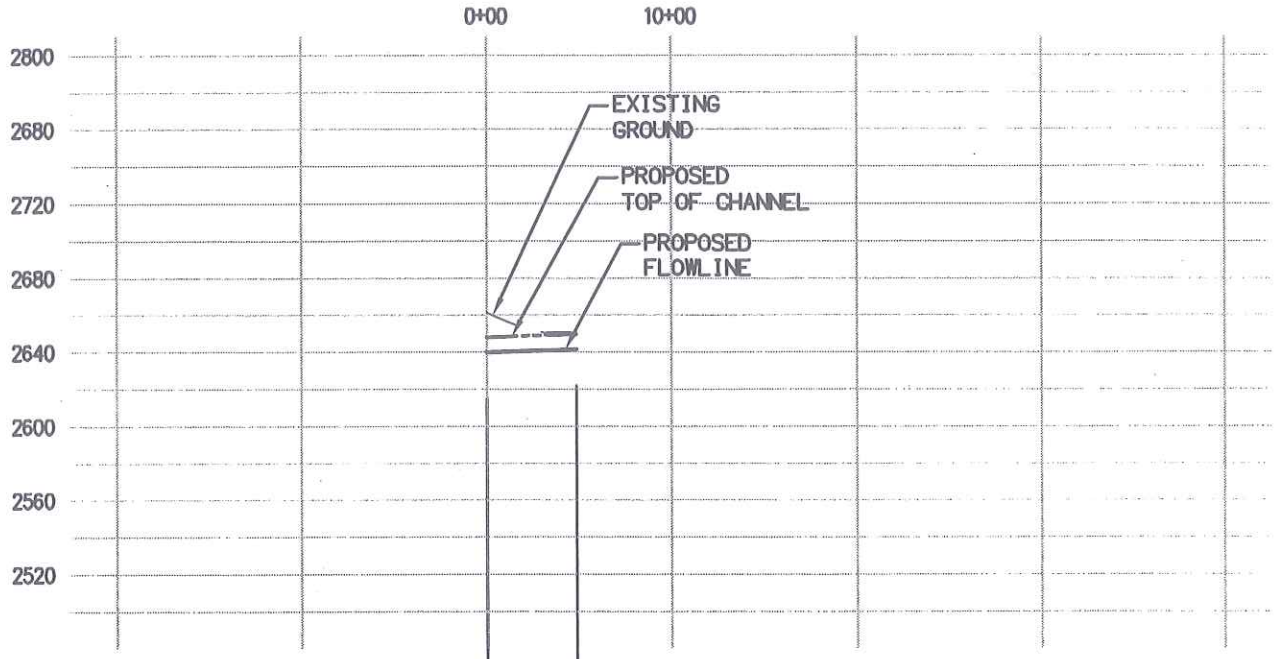


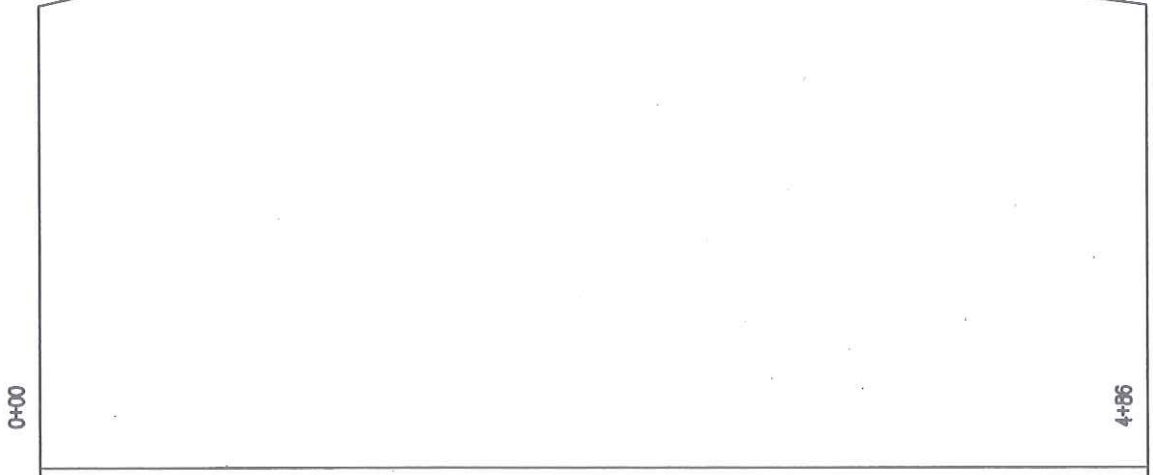
LEGEND	PROPOSED FACILITY FACILITY SHOWN ELSEWHERE	BASIN LOCATION	

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA COUNTY LINE DRAIN (CL-01-01) SHEET 1 OF 1	N SCALE" 1"=1000'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PLAN-CL-01-01.DWG MCHANDOO 7/29/11 12:49 pm

RBF PLANNING ■ DESIGN ■ CONSTRUCTION
CONSULTING





LENGTH	486'
SLOPE	0.0040
FLOW	Q100 = 417
SIZE	RCP DIA = 84" RCP
FACILITY TYPE	TYP. SEC. NO. 1

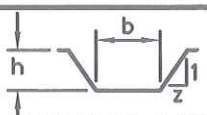
LEGEND

— — — EXISTING

—·—·— PROPOSED TOP OF CHANNEL

——— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



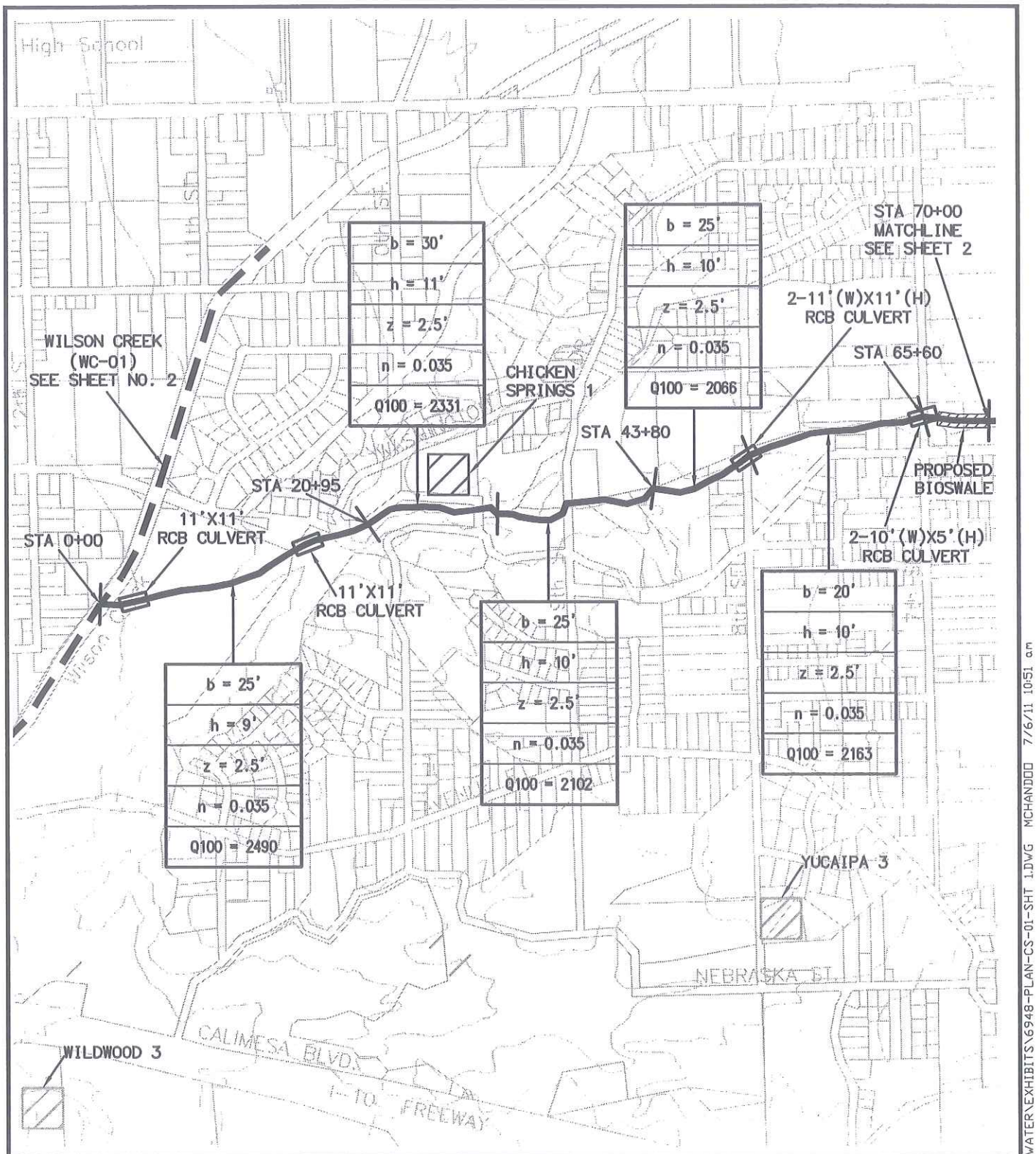
TRAPEZOIDAL CHANNEL

REINFORCED CONCRETE PIPE (RCP)

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA COUNTY LINE DRAIN (CL-01-01) SHEET 1 OF 1	SCALE: H: 1"=1000' V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-CL-01-01.DWG EGC 6/27/11 8:45 am

RBF CONSULTING — PLANNING ■ DESIGN ■ CONSTRUCTION



LEGEND

PROPOSED FACILITY

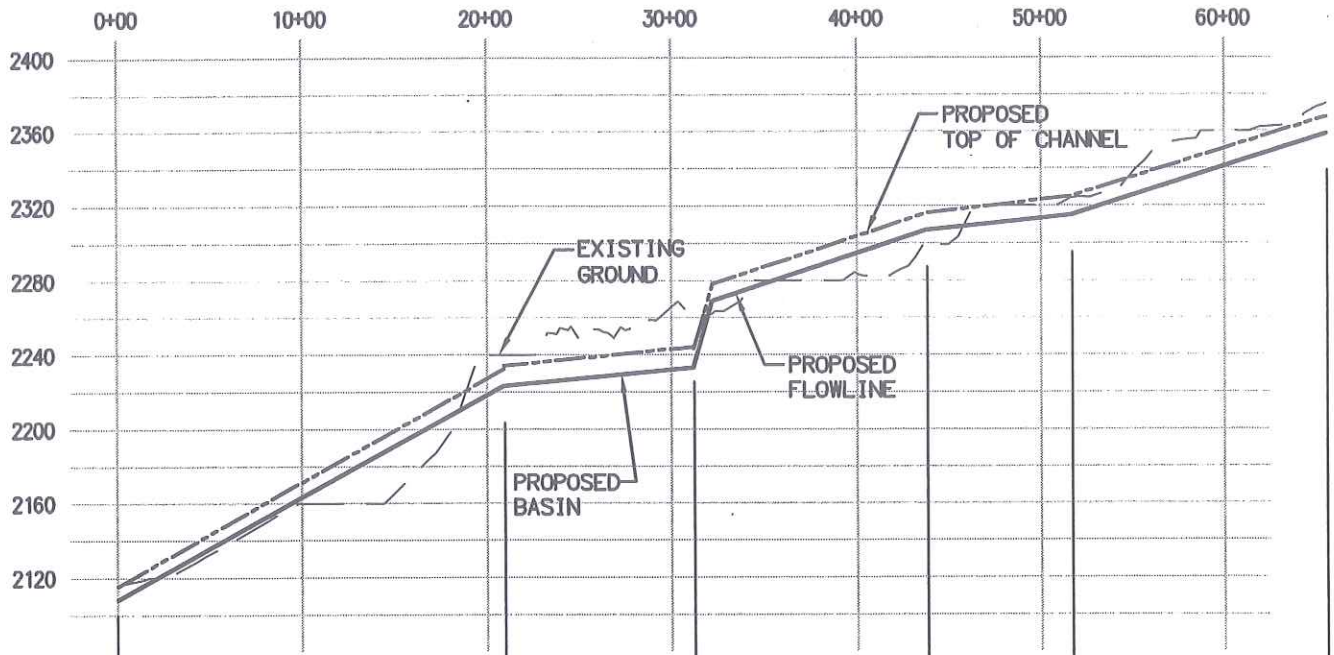
FACILITY SHOWN ELSEWHERE

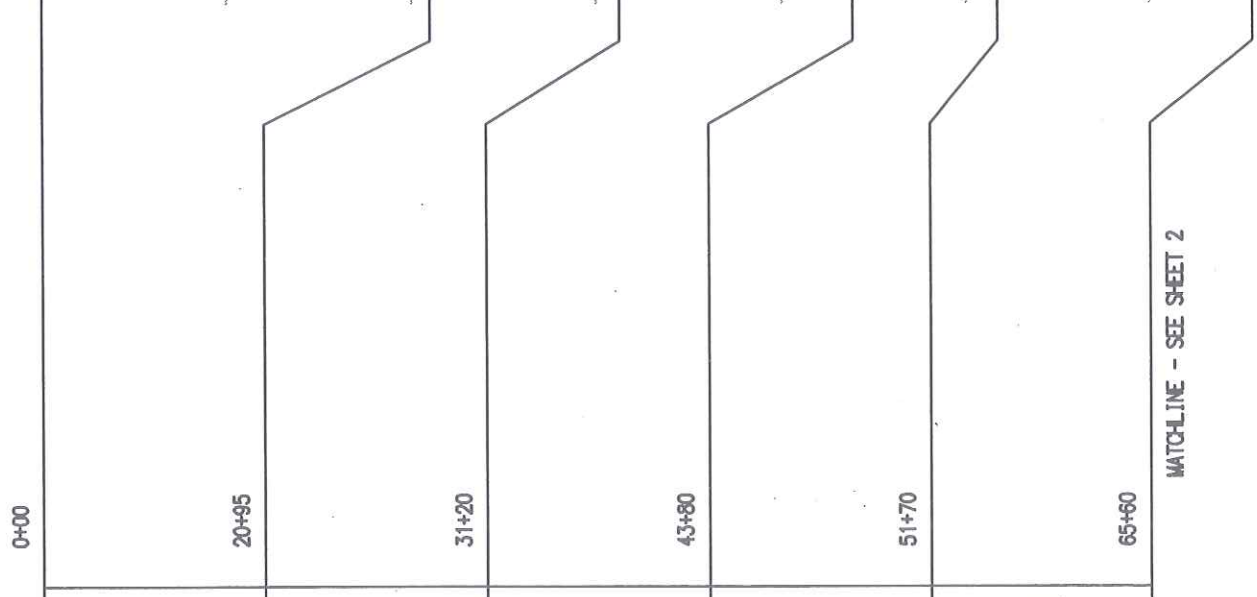
BASIN LOCATION

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA CHICKEN SPRINGS (CS-01) SHEET 1 OF 2	N SCALE" 1"=1000'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PLAN-CS-01-SHT 1.DWG MCHANDDO 7/6/11 10:51 am

RBF CONSULTING
PLANNING ■ DESIGN ■ CONSTRUCTION





	0+00 to 20+95	20+95 to 31+20	31+20 to 43+80	43+80 to 51+70	51+70 to 65+60
LENGTH	2095'	1025'	1260'	790'	1390'
SLOPE	0.0548	0.0100	0.0329	0.0100	0.0315
FLOW	Q100 = 2490	Q100 = 2331	Q100 = 2102	Q100 = 2066	Q100 = 2163
SIZE	b=25', h=9', Z=2.5	b=30', h=11', Z=2.5	b=25', h=10', Z=2.5	b=25', h=10', Z=2.5	b=20', h=10', Z=2.5
FACILITY TYPE	TYP. SEC. NO. 10	TYP. SEC. NO. 10	TYP. SEC. NO. 10	TYP. SEC. NO. 10	TYP. SEC. NO. 10

LEGEND

- EXISTING
- PROPOSED TOP OF CHANNEL
- PROPOSED FLOWLINE

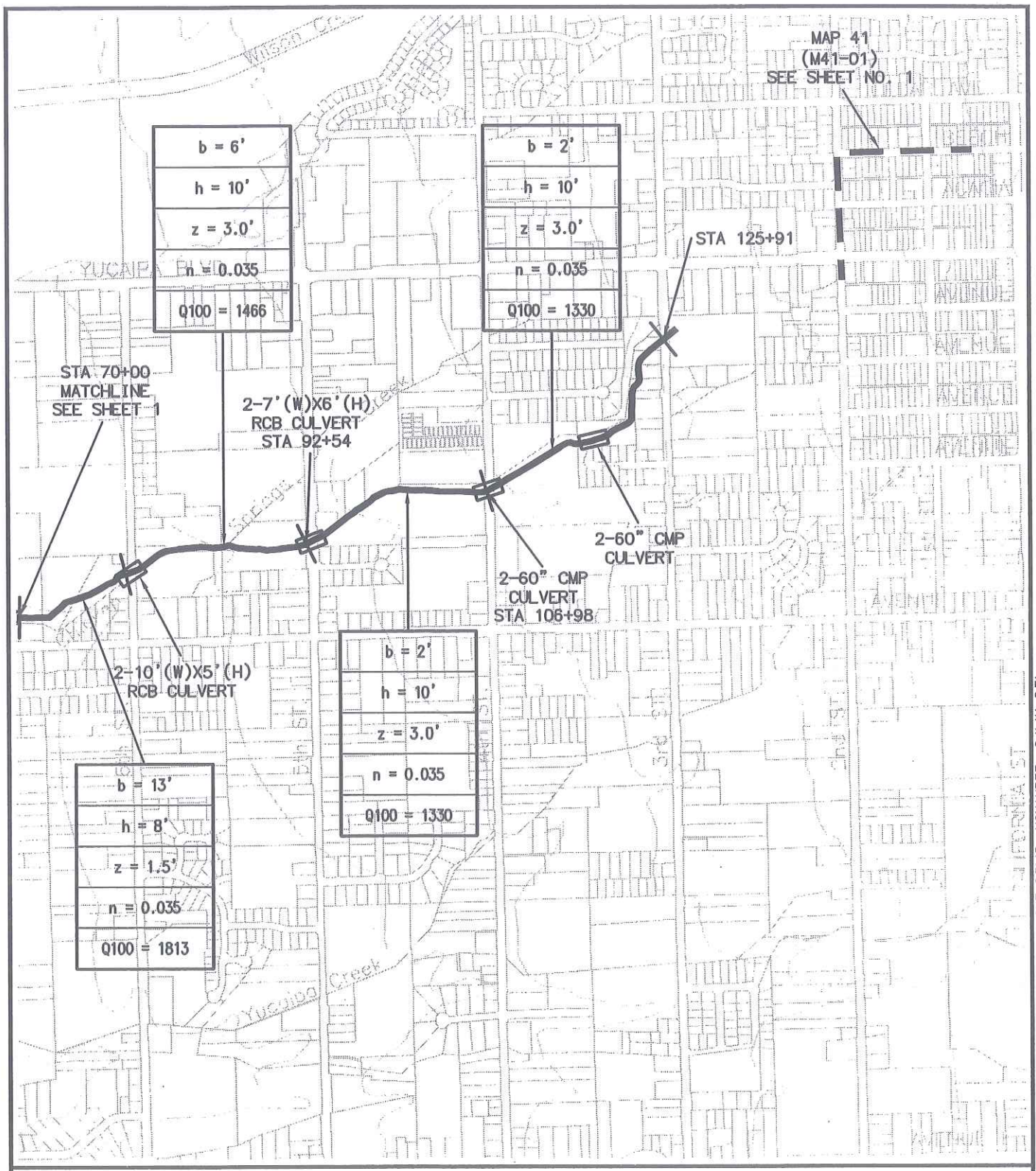
MASTER PLAN OF DRAINAGE

CITY OF YUCAIPA
CHICKEN SPRINGS (CS-01)
SHEET 1 OF 2

SCALE:
H: 1"=1000'
V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-CS-01-SHT 1.DWG EGC 6/27/11 8:48 am

RBF CONSULTING
PLANNING ■ DESIGN ■ CONSTRUCTION



LEGEND

PROPOSED FACILITY

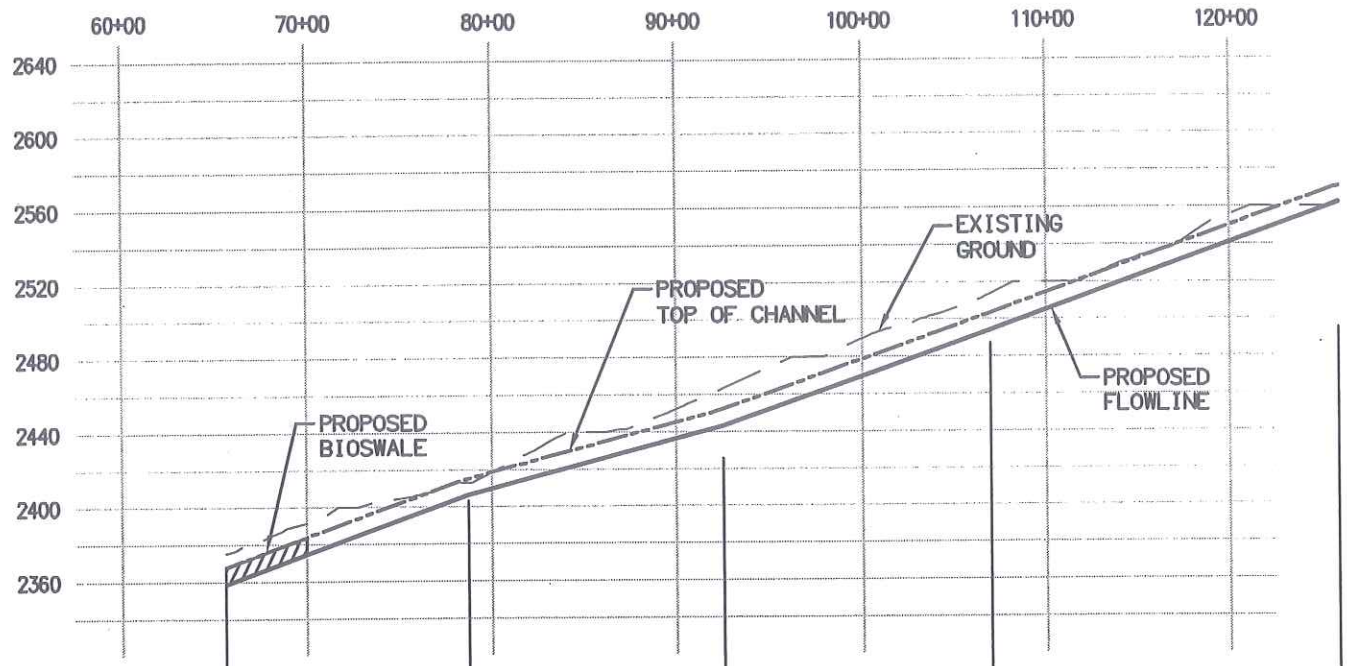
FACILITY SHOWN ELSEWHERE

BASIN LOCATION

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA CHICKEN SPRINGS (CS-01) SHEET 2 OF 2	N SCALE" 1"=1000'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PLAN-CS-01-SHT 2.DWG MCHANDDO 9/1/11 8:51 am

RBF CONSULTING — PLANNING ■ DESIGN ■ CONSTRUCTION



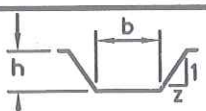
MATCHLINE - SEE SHEET 1

	65+60	78+73	92+54	106+98	125+91
LENGTH	1313'	1381'	1444'	1893'	
SLOPE	0.0315	0.0300	0.0400	0.0400	
FLOW	Q100 = 1813	Q100 = 1466	Q100 = 1330	Q100 = 1330	
SIZE	b=13', h=8', z=1.5	b=6', h=10', z=3.0	b=2', h=10', z=3.0	b=2', h=10', z=3.0	
FACILITY TYPE	TYP. SEC. NO. 10	TYP. SEC. NO. 10	TYP. SEC. NO. 10	TYP. SEC. NO. 10	

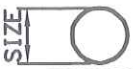
LEGEND

- — — — EXISTING
- —·—·— PROPOSED TOP OF CHANNEL
- ——— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL



REINFORCED CONCRETE PIPE (RCP)

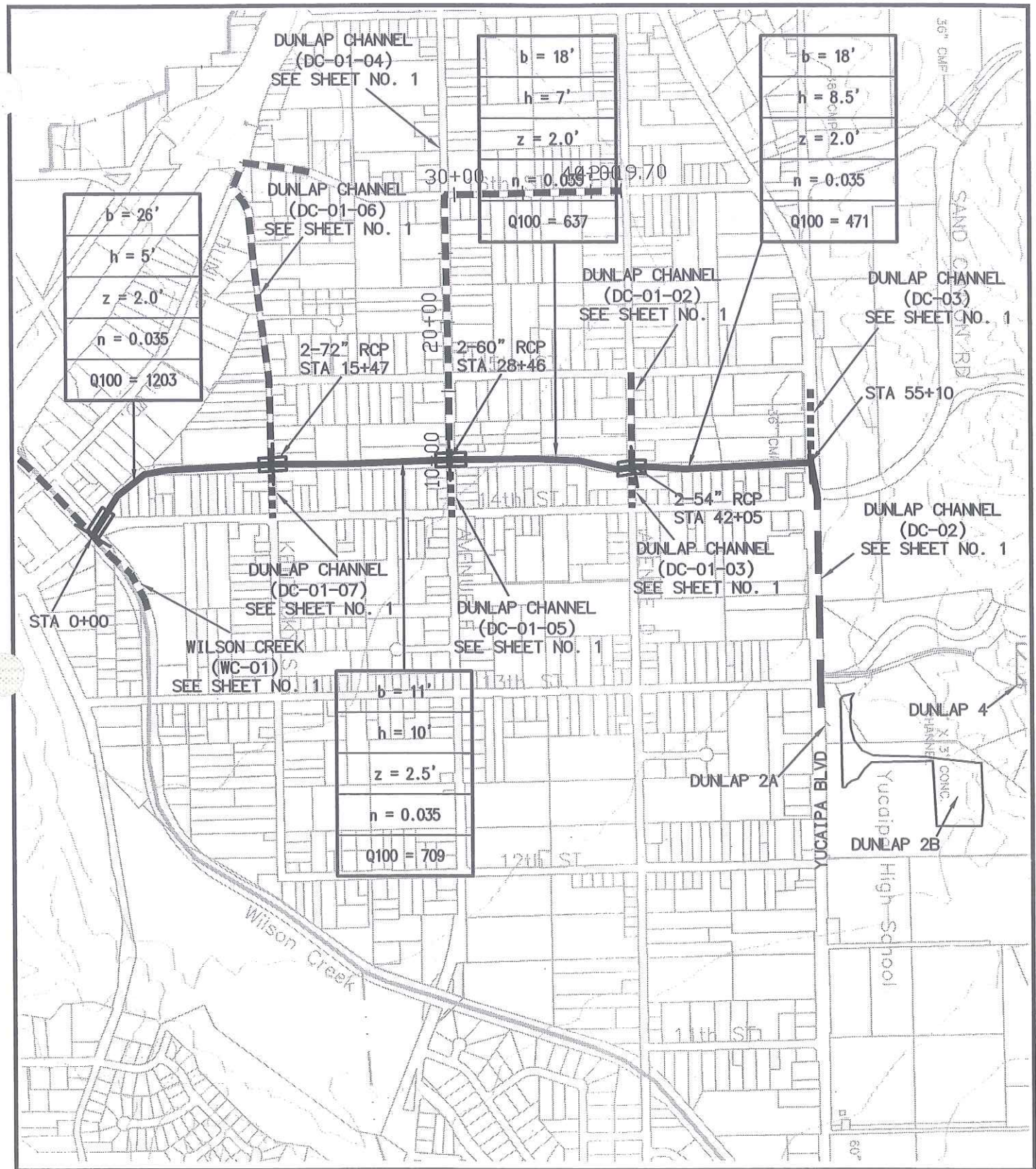
MASTER PLAN OF DRAINAGE

CITY OF YUCAIPA
CHICKEN SPRINGS (CS-01)
SHEET 2 OF 2

SCALE:
H: 1"=1000'
V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-CS-01-SHT 2.DWG EGC 7/5/11 8:35 am

RBF CONSULTING
PLANNING ■ DESIGN ■ CONSTRUCTION



LEGEND

PROPOSED FACILITY

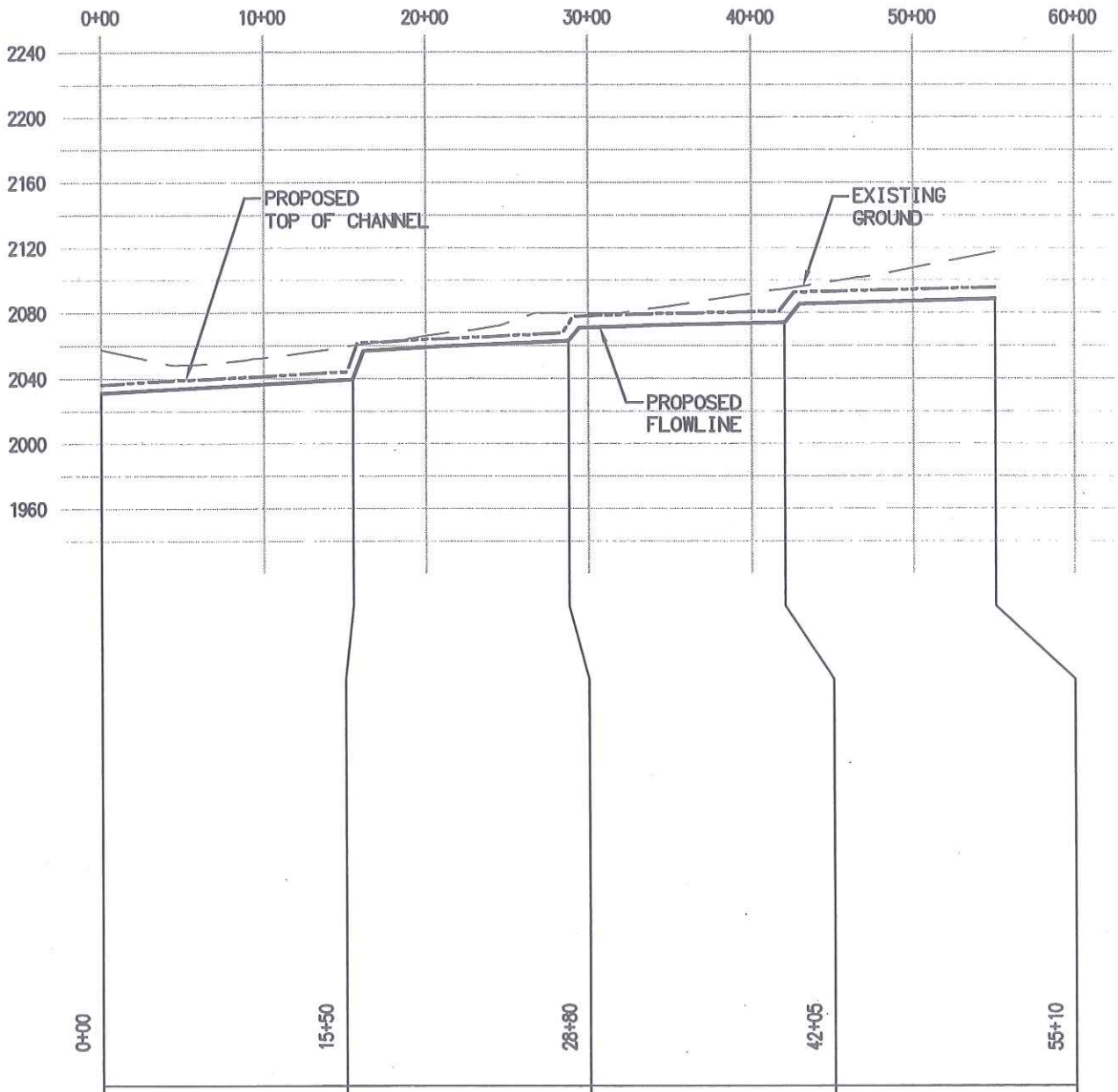
FACILITY SHOWN ELSEWHERE

BASIN LOCATION

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA DUNLAP CHANNEL (DC-01) SHEET 1 OF 1	N SCALE: 1"=1000'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PLAN-DC-01.DWG EGC 7/5/11 7:43 am

RBF PLANNING ■ DESIGN ■ CONSTRUCTION CONSULTING



LENGTH	1550'	1330'	1325'	1305'
SLOPE	0.0025	0.0050	0.0050	0.0025
FLOW	Q100 = 1203	Q100 = 709	Q100 = 637	Q100 = 471
SIZE	b=26', h=5', z=2.0	b=11', h=10', z=2.5	b=18', h=7', z=2.0	b=18', h=8.5', z=2.0
FACILITY TYPE	TYP. SEC. NO. 11	TYP. SEC. NO. 11	TYP. SEC. NO. 11	TYP. SEC. NO. 11

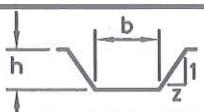
LEGEND

— — — EXISTING

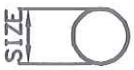
—·—·— PROPOSED TOP OF CHANNEL

——— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL



REINFORCED CONCRETE PIPE (RCP)

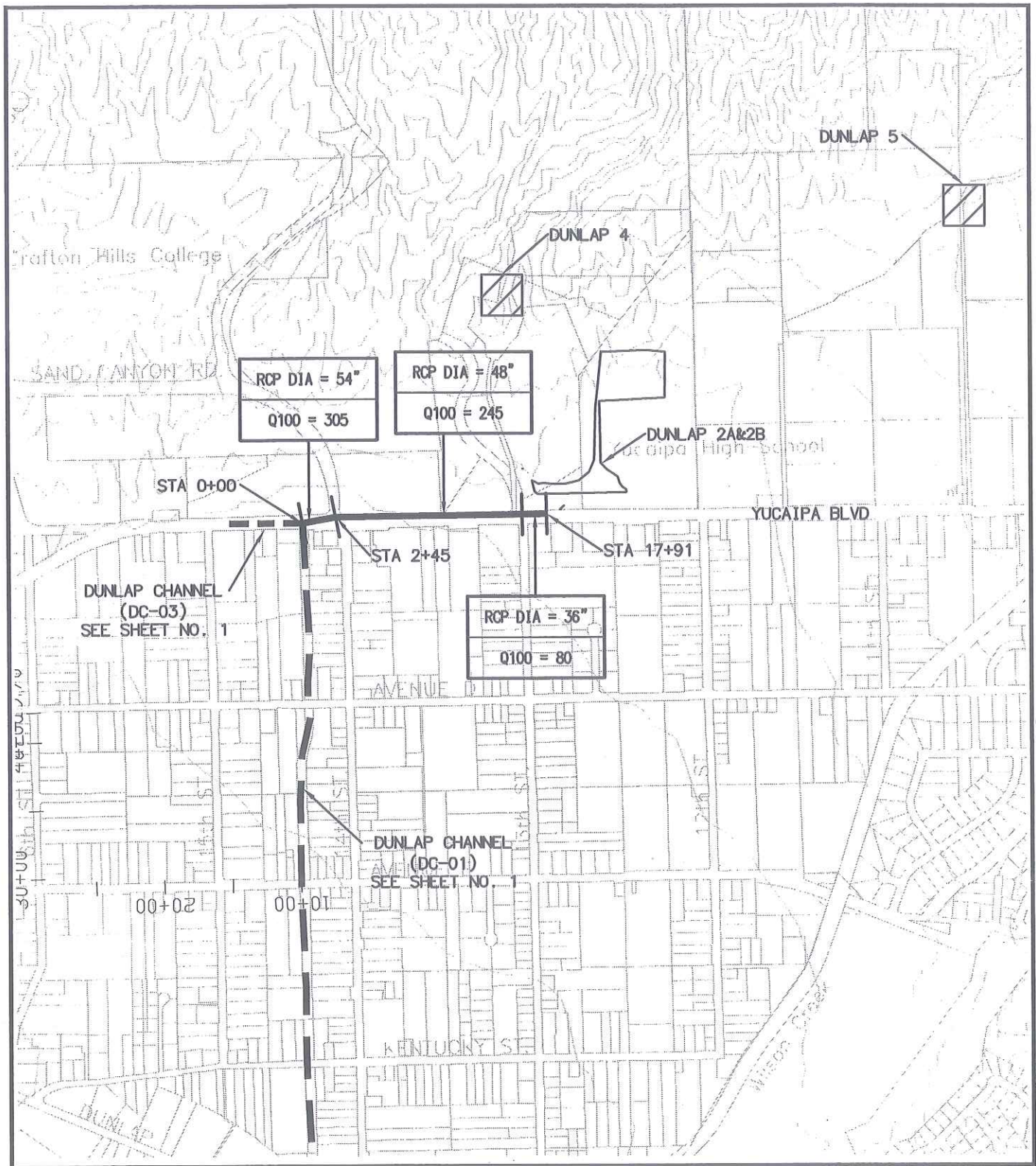
MASTER PLAN OF DRAINAGE

CITY OF YUCAIPA
DUNLAP CHANNEL (DC-01)
SHEET 1 OF 1

SCALE:
H: 1"=1000'
V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-DC-01.DWG MCHANDOO 7/29/11 12:54 pm

RBF CONSULTING
PLANNING ■ DESIGN ■ CONSTRUCTION



LEGEND

PROPOSED FACILITY

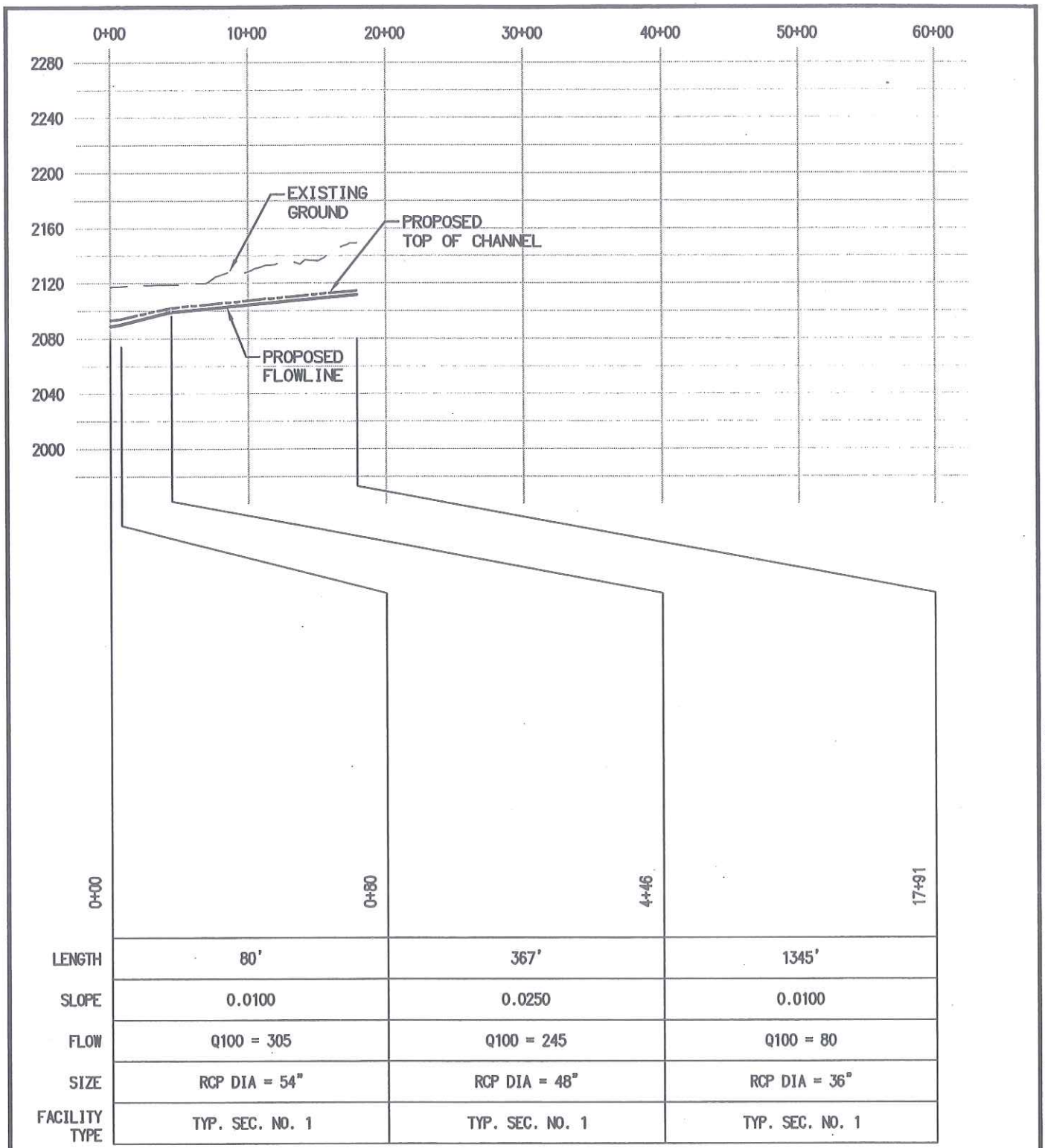
FACILITY SHOWN ELSEWHERE

BASIN LOCATION

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA DUNLAP CHANNEL (DC-02) SHEET 1 OF 1	N SCALE" 1"=1000'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PLAN-DC-02.DWG MCHANDOO 8/2/11 2:17 pm

RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION

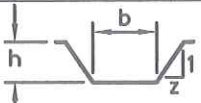


LENGTH	80'	367'	1345'
SLOPE	0.0100	0.0250	0.0100
FLOW	Q100 = 305	Q100 = 245	Q100 = 80
SIZE	RCP DIA = 54"	RCP DIA = 48"	RCP DIA = 36"
FACILITY TYPE	TYP. SEC. NO. 1	TYP. SEC. NO. 1	TYP. SEC. NO. 1

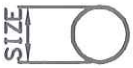
LEGEND

- EXISTING
- PROPOSED TOP OF CHANNEL
- PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL

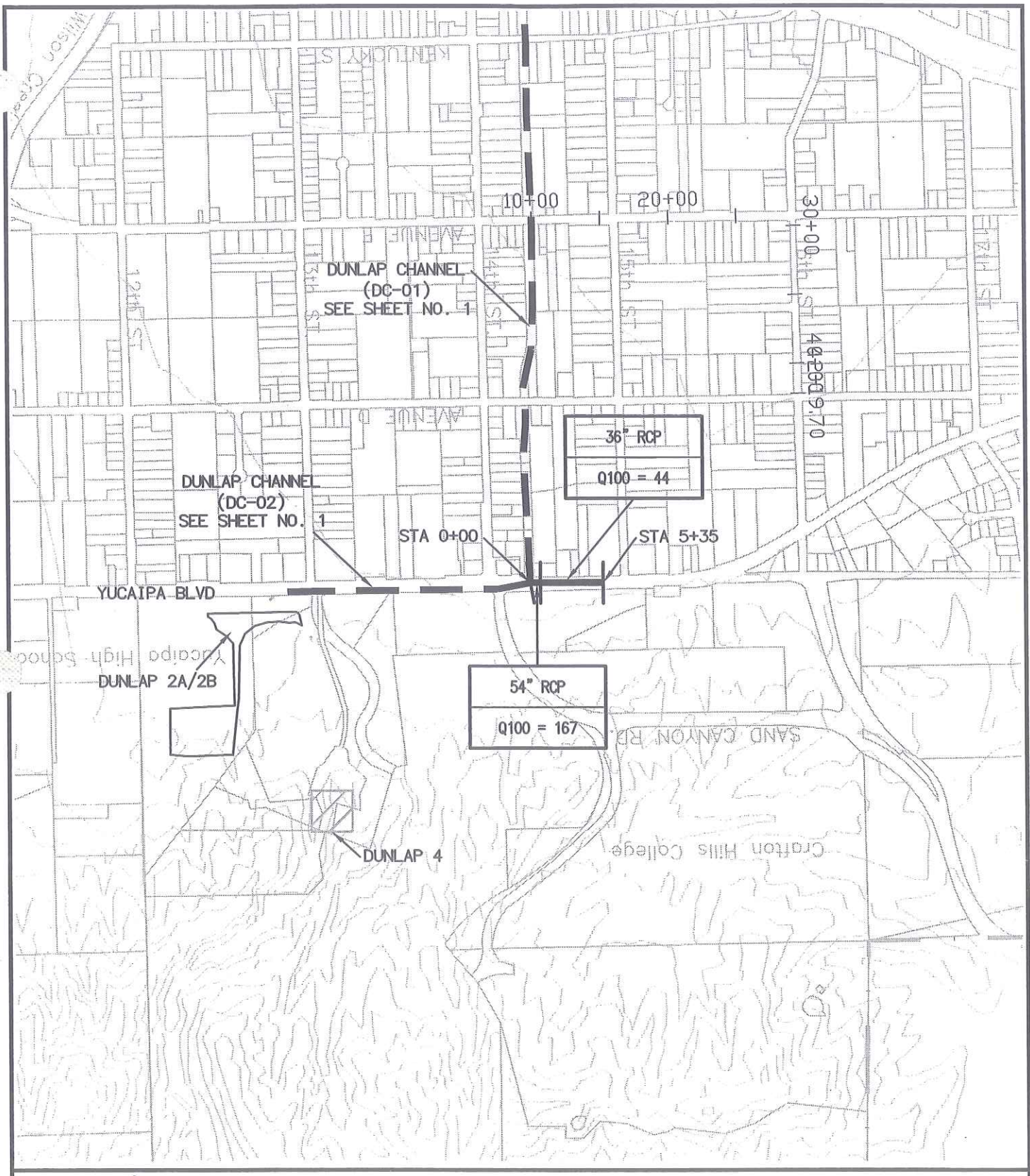


REINFORCED CONCRETE PIPE (RCP)

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA DUNLAP CHANNEL (DC-02) SHEET 1 OF 1	SCALE: H: 1"=1000' V: 1"=100'

RBF CONSULTING — PLANNING ■ DESIGN ■ CONSTRUCTION

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-DC-02.DWG MCHANDOO 7/29/11 1:36 pm



LEGEND

PROPOSED FACILITY

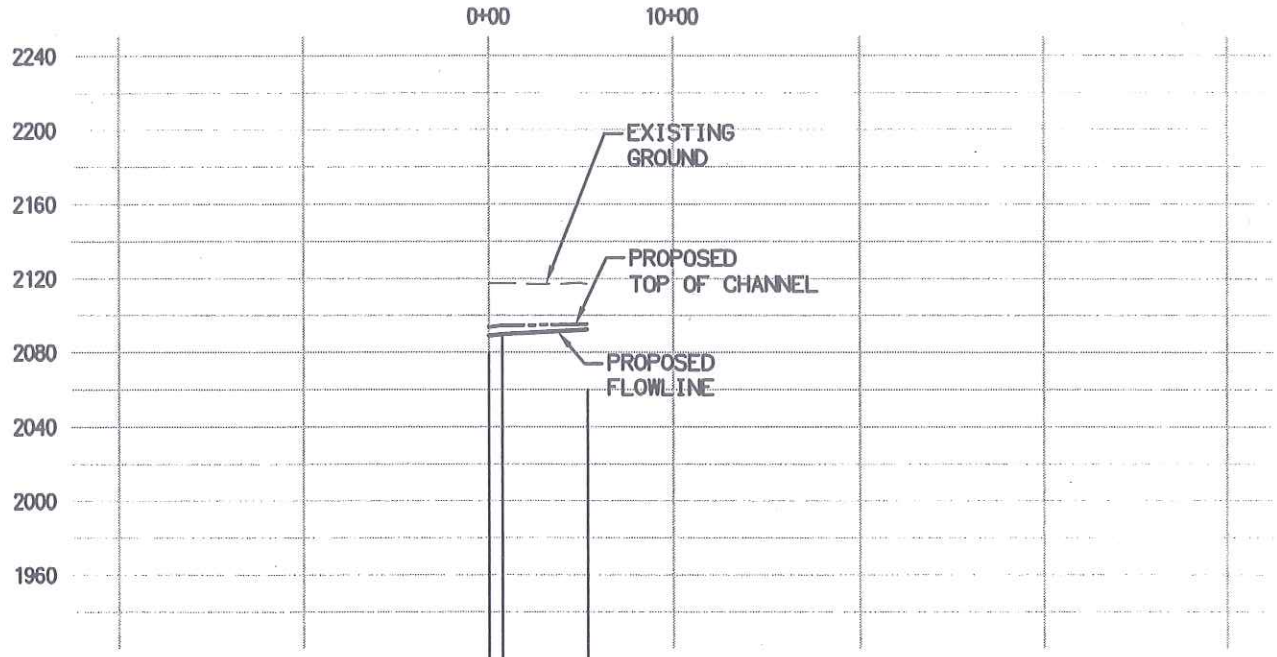
FACILITY SHOWN ELSEWHERE

BASIN LOCATION

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA DUNLAP CHANNEL (DC-03) SHEET 1 OF 1	N SCALE: 1"=1000'

RBF PLANNING ■ DESIGN ■ CONSTRUCTION CONSULTING

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PLAN-DC-03.DWG MCHANDOO 8/30/11 1:35 pm



	0+00	0+74	5+35
LENGTH	74'		461'
SLOPE	0.0100		0.0100
FLOW	Q100 = 167		Q100 = 44
SIZE	RCP DIA = 54"		RCP DIA = 36" RCP
FACILITY TYPE	TYP. SEC. NO. 1A		TYP. SEC. NO. 1

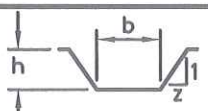
LEGEND

— — — EXISTING

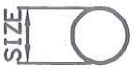
—-----— PROPOSED TOP OF CHANNEL

——— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL

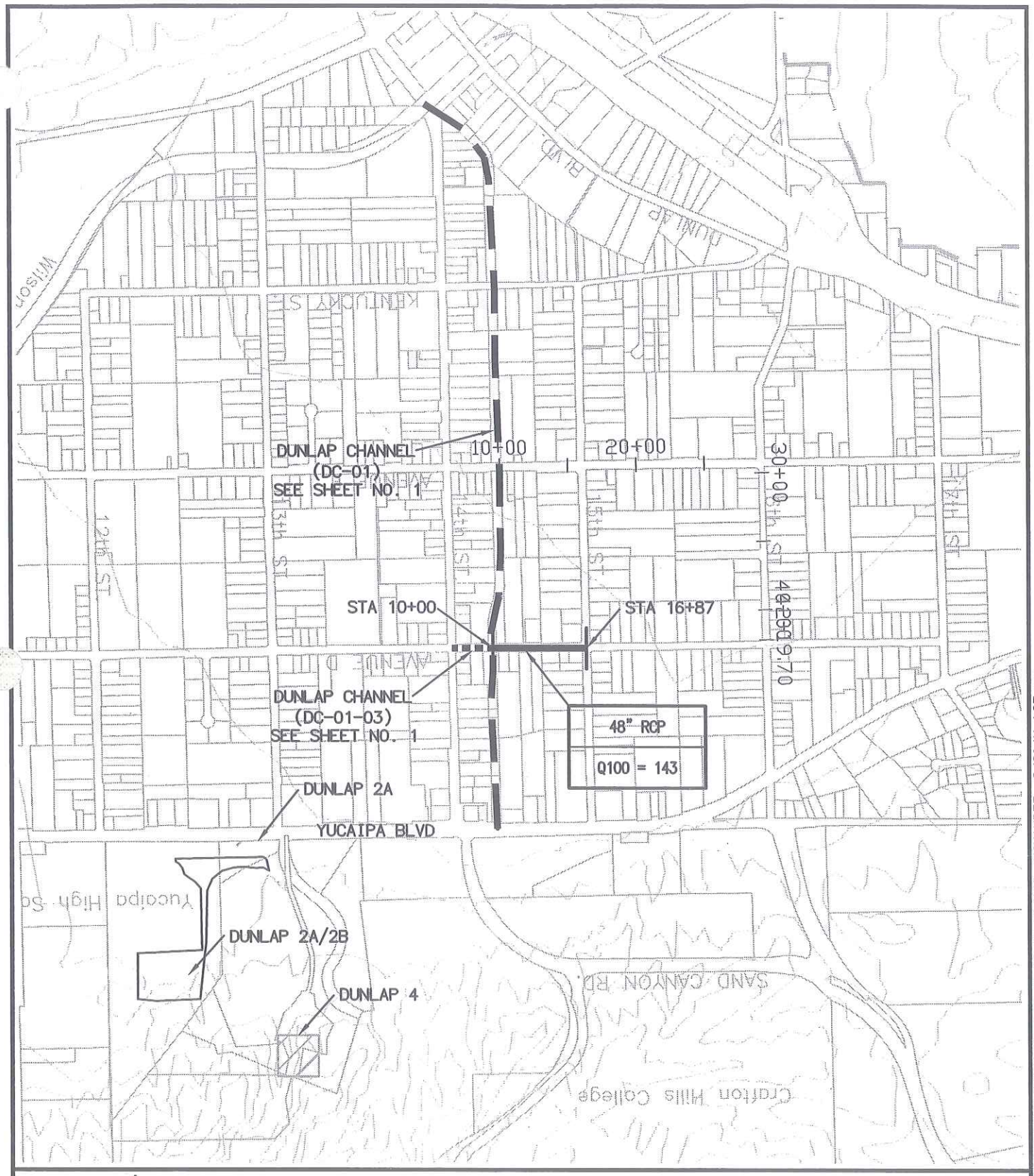


REINFORCED CONCRETE PIPE (RCP)

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA DUNLAP CHANNEL (DC-03) SHEET 1 OF 1	SCALE: H: 1"=1000' V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-DC-03.DWG EGC 6/27/11 9:02 am

RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION



LEGEND

PROPOSED FACILITY

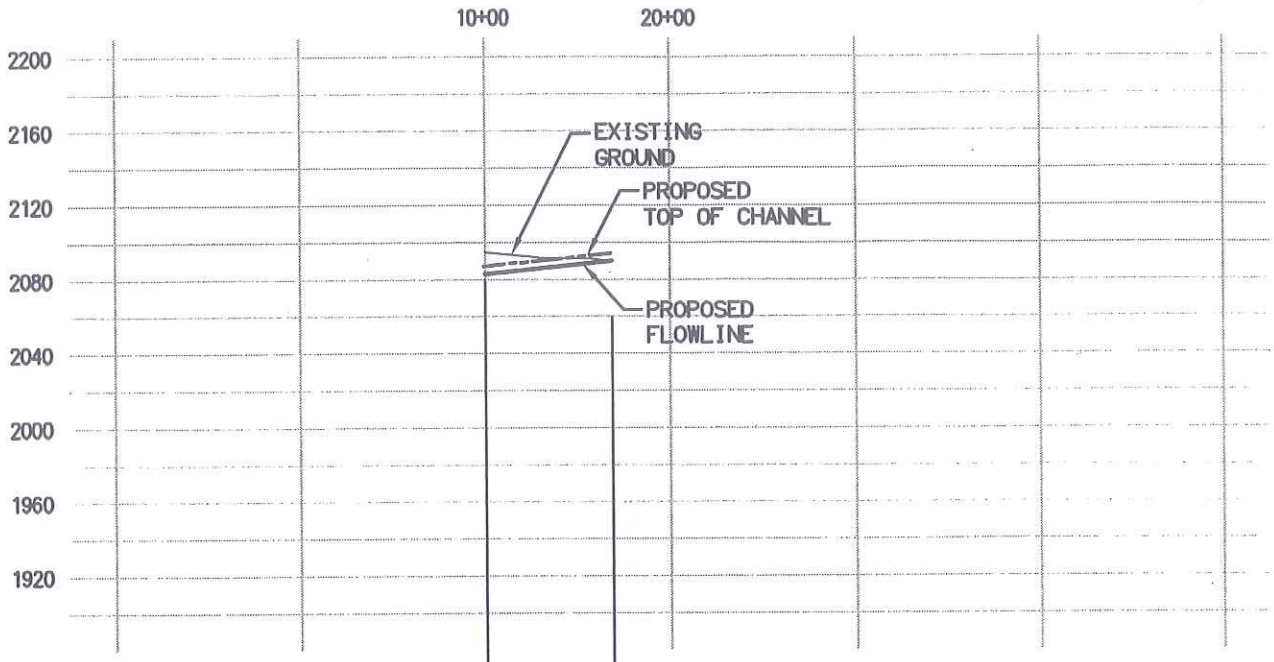
FACILITY SHOWN ELSEWHERE

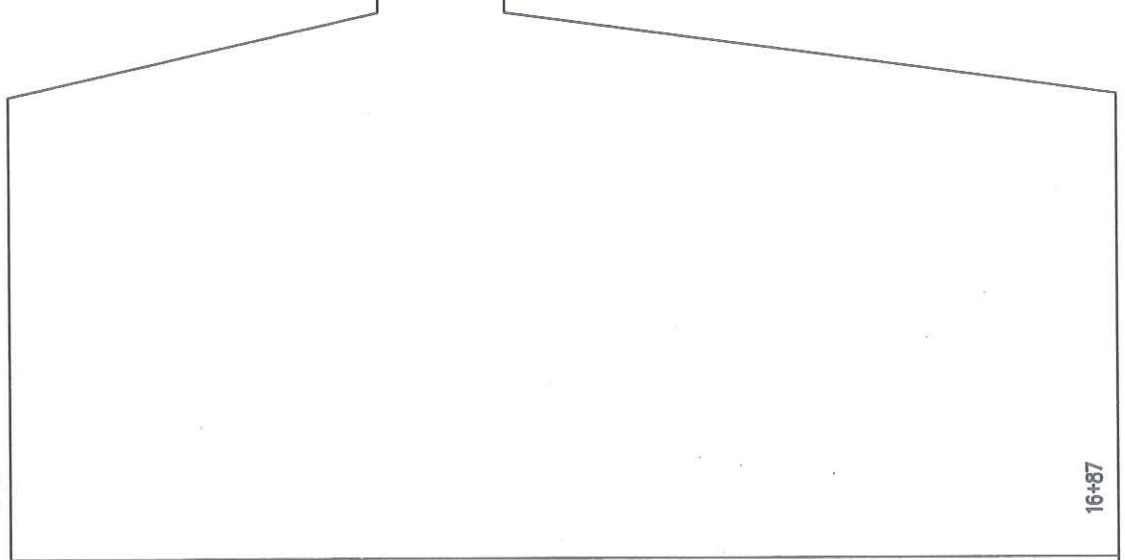
BASIN LOCATION

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA DUNLAP CHANNEL (DC-01-02) SHEET 1 OF 1	N SCALE: 1"=1000'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PLAN-DC-01-02.DWG MCHANDOO 8/30/11 1:37 pm

RBF CONSULTING — PLANNING ■ DESIGN ■ CONSTRUCTION





LENGTH	687'
SLOPE	0.0100
FLOW	Q100 = 143
SIZE	RCP DIA = 48" RCP
FACILITY TYPE	TYP. SEC. NO. 1

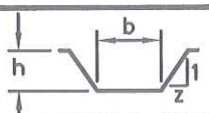
LEGEND

— — — EXISTING

—·—·— PROPOSED TOP OF CHANNEL

——— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



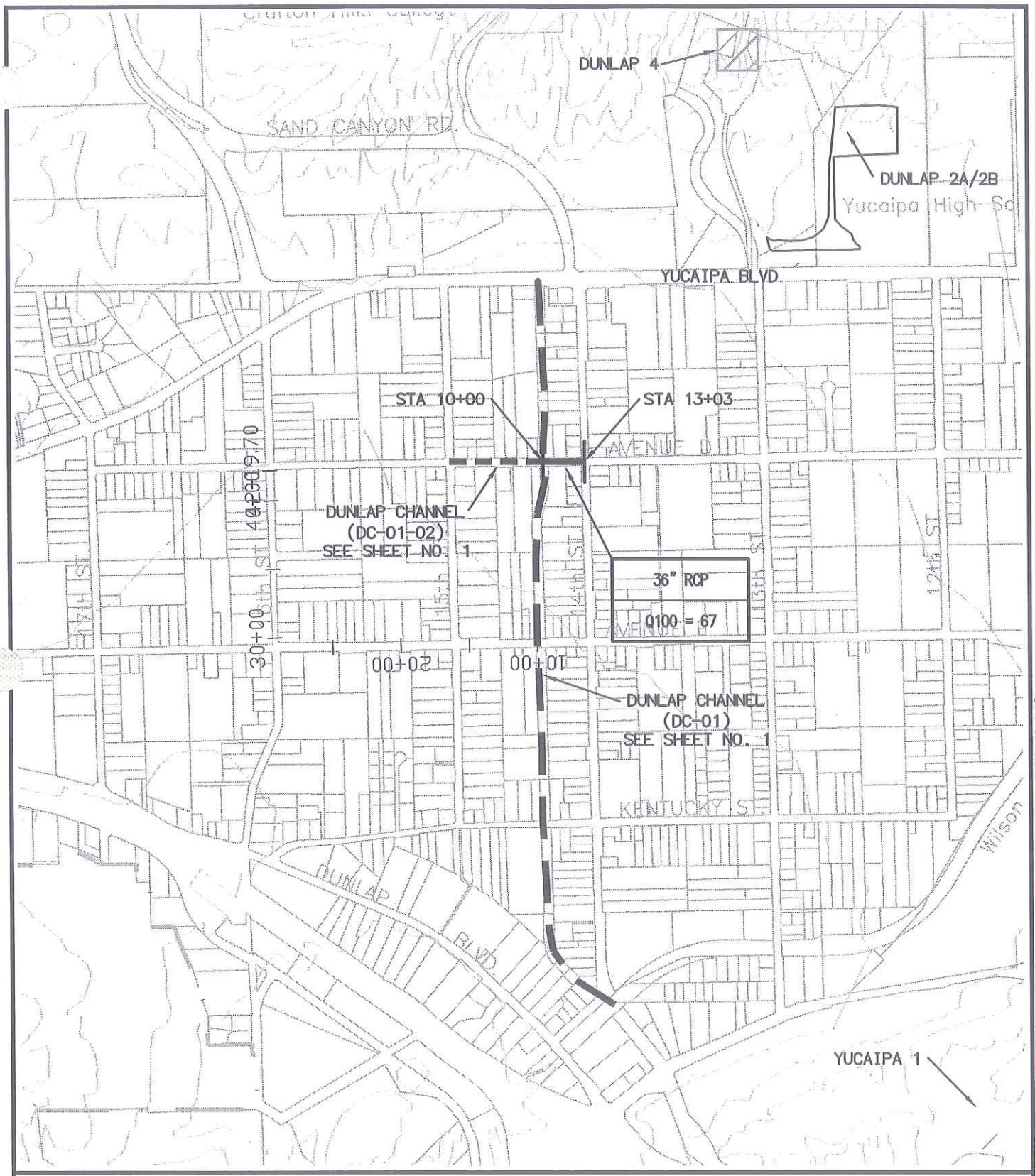
TRAPEZOIDAL CHANNEL

REINFORCED CONCRETE PIPE (RCP)

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA DUNLAP CHANNEL (DC-01-02) SHEET 1 OF 1	SCALE: H: 1"=1000' V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-DC-01-02.DWG EGC 6/27/11 8:51 am

RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION



LEGEND

PROPOSED FACILITY

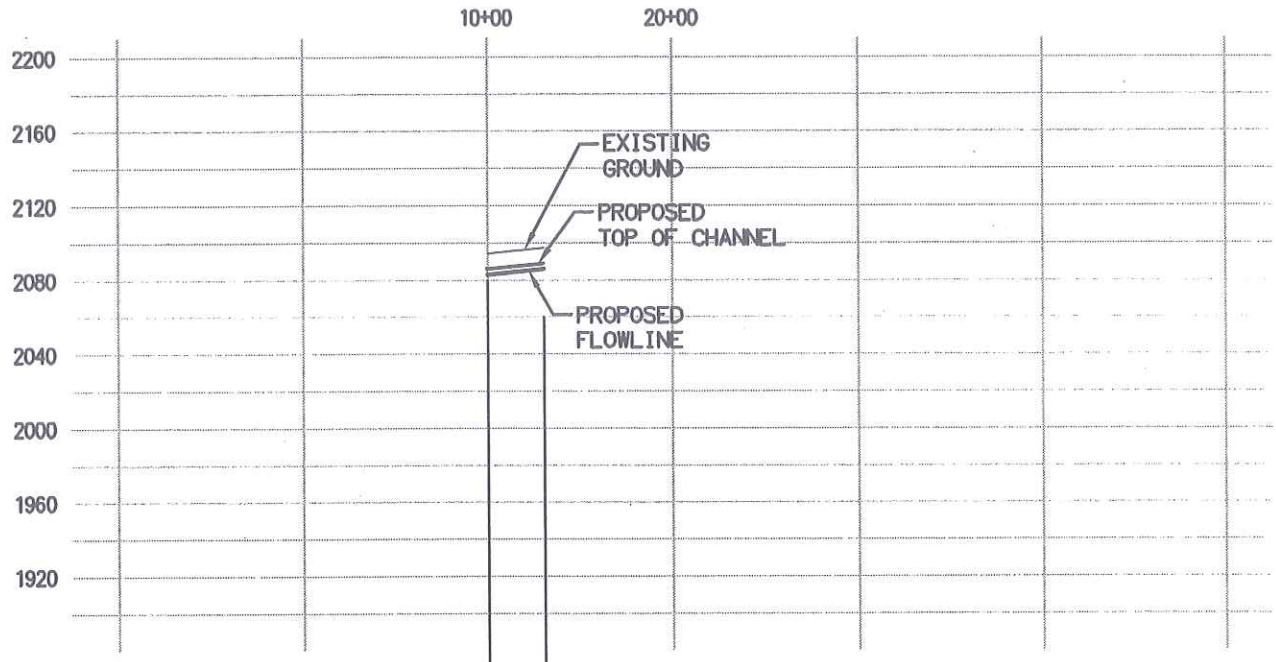
FACILITY SHOWN ELSEWHERE

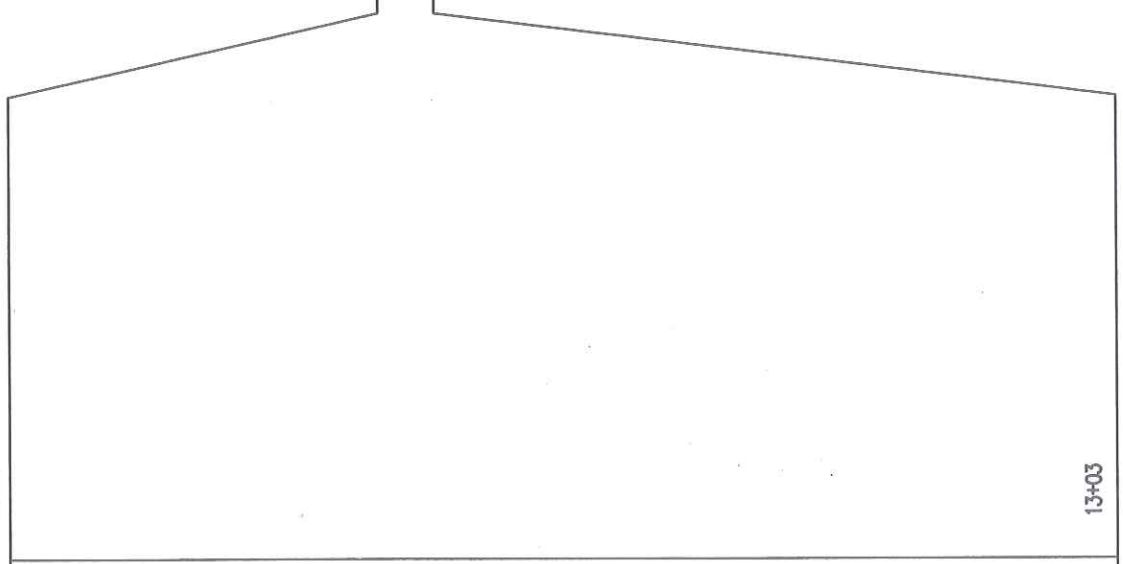
BASIN LOCATION

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA DUNLAP CHANNEL (DC-01-03) SHEET 1 OF 1	N SCALE: 1"=1000'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PLAN-DC-01-03.DWG MCHANDDO 8/30/11 1:43 pm

RBF CONSULTING — PLANNING ■ DESIGN ■ CONSTRUCTION



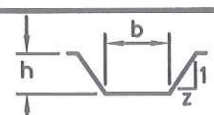


LENGTH	303'
SLOPE	0.0100
FLOW	Q100 = 67
SIZE	RCP DIA = 36" RCP
FACILITY TYPE	TYP. SEC. NO. 1

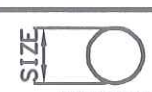
LEGEND

- — — — EXISTING
- —-·-·— PROPOSED TOP OF CHANNEL
- ——— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL

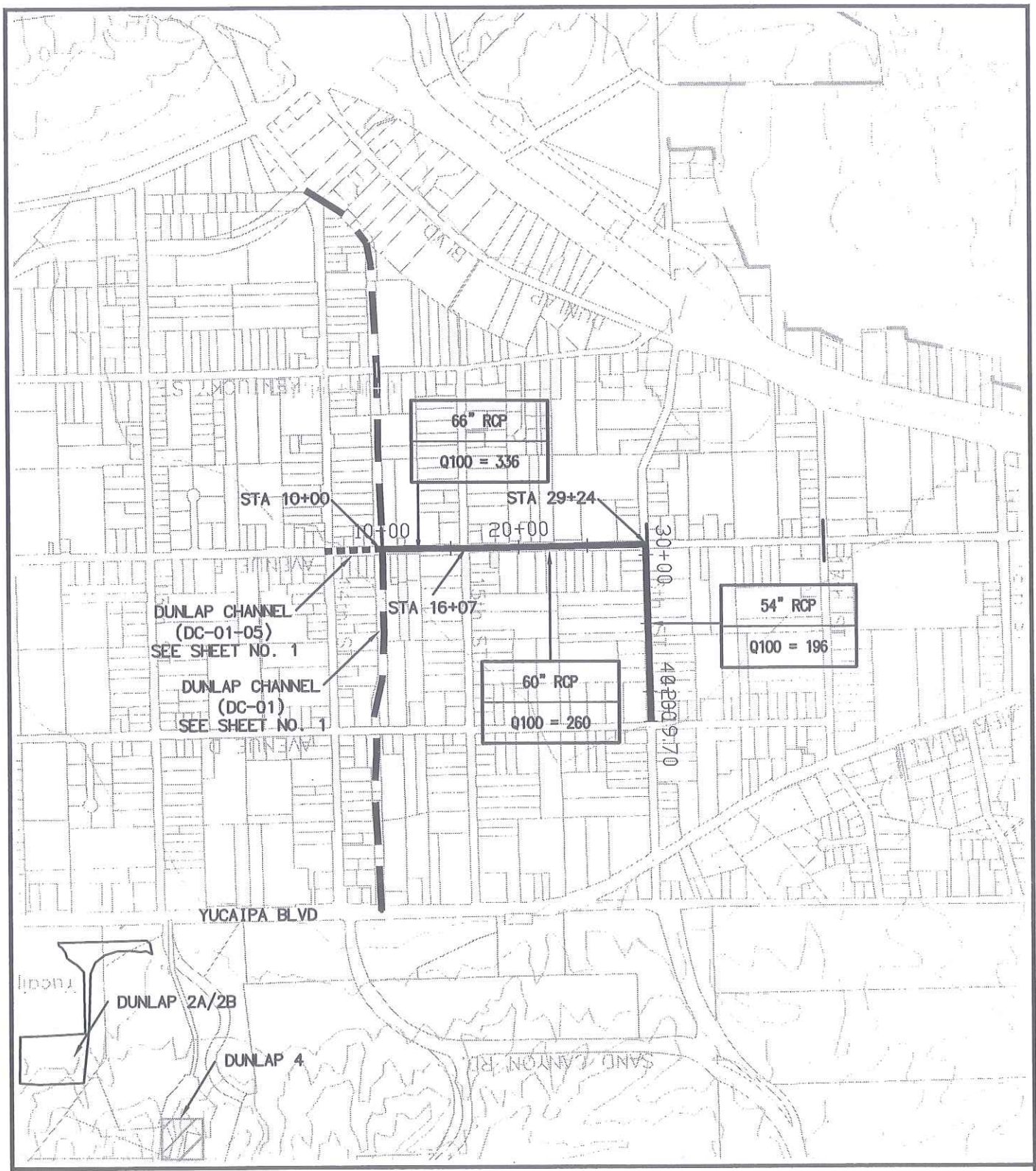


REINFORCED CONCRETE PIPE (RCP)

MASTER PLAN OF DRAINAGE	**CITY OF YUCAIPA DUNLAP CHANNEL (DC-01-03) SHEET 1 OF 1**	SCALE: H: 1"=1000' V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-DC-01-03.DWG EGC 6/27/11 8:54 am

RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION



LEGEND

PROPOSED FACILITY

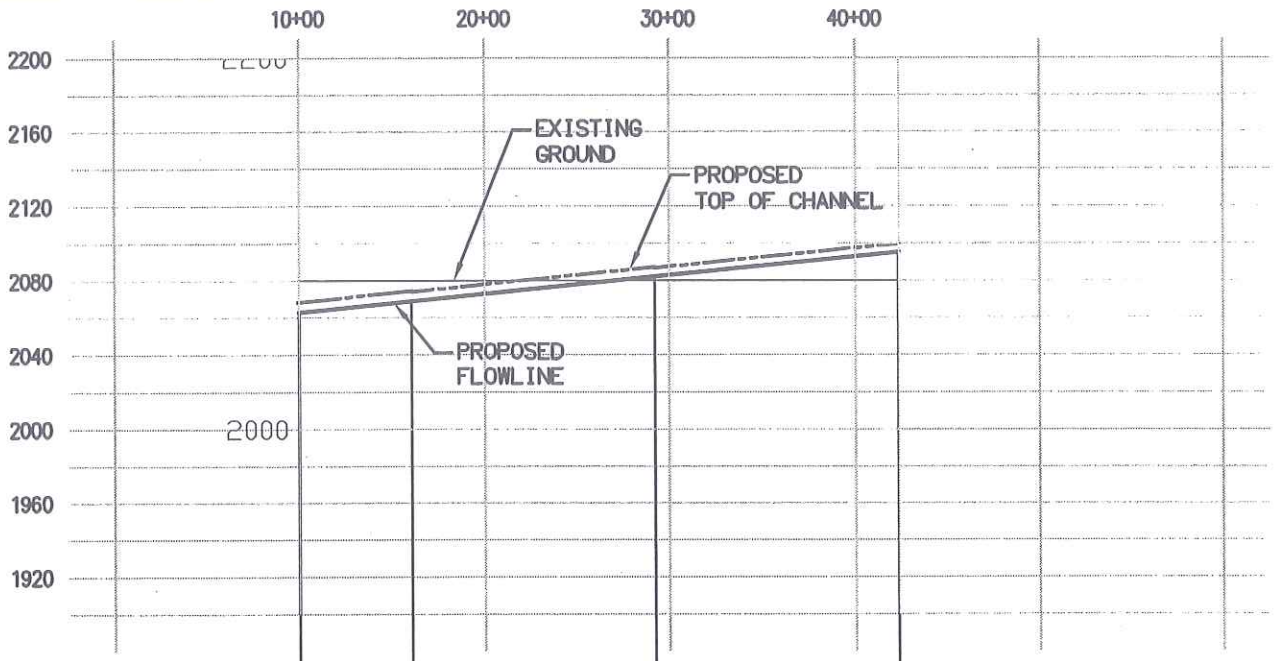
FACILITY SHOWN ELSEWHERE

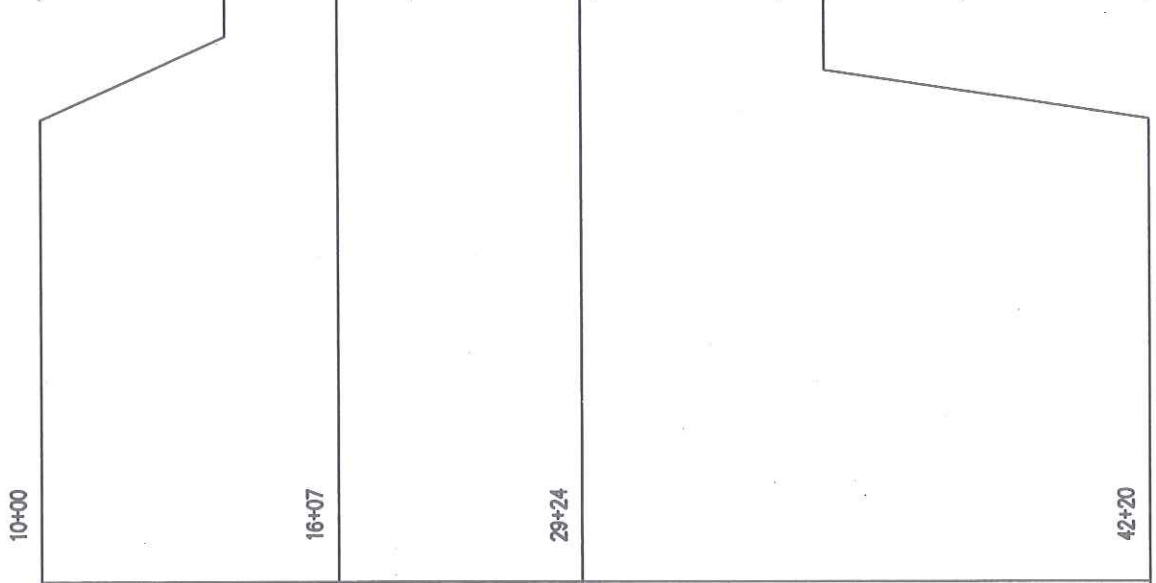
BASIN LOCATION

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA DUNLAP CHANNEL (DC-01-04) SHEET 1 OF 1	N SCALE" 1"=1000'

H:\PDATA\1010\6948\CADD\STRMWATER\EXHIBITS\6948-PLAN-DC-01-04.DWG MCHANDOO 8/30/11 1:44 pm

RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION

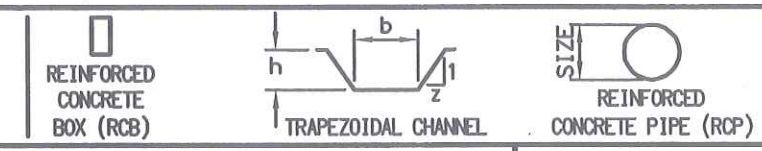




	10+00 to 16+07	16+07 to 29+24	29+24 to 42+20
LENGTH	607'	1317'	1296'
SLOPE	0.0100	0.0100	0.0100
FLOW	Q100 = 336	Q100 = 260	Q100 = 196
SIZE	RCP DIA = 66" RCP	RCP DIA = 60" RCP	RCP DIA = 54" RCP
FACILITY TYPE	TYP. SEC. NO. 1	TYP. SEC. NO. 1	TYP. SEC. NO. 1

LEGEND

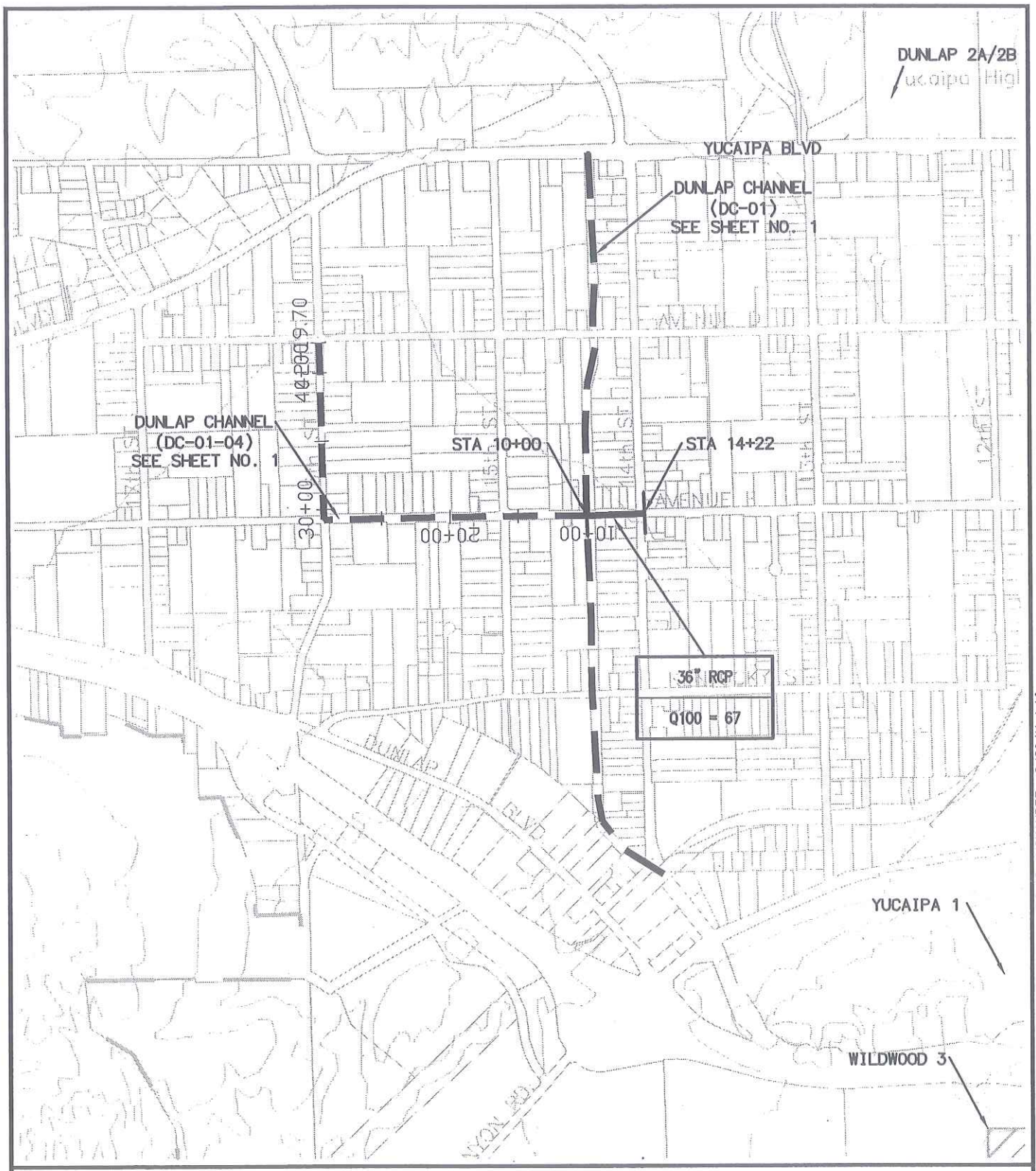
- — — — EXISTING
- ——— PROPOSED TOP OF CHANNEL
- ——— PROPOSED FLOWLINE



MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA DUNLAP CHANNEL (DC01-04) SHEET 1 OF 1	SCALE: H: 1"=1000' V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-DC-01-04.DWG MCHANDOO 7/29/11 12:41 pm

RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION

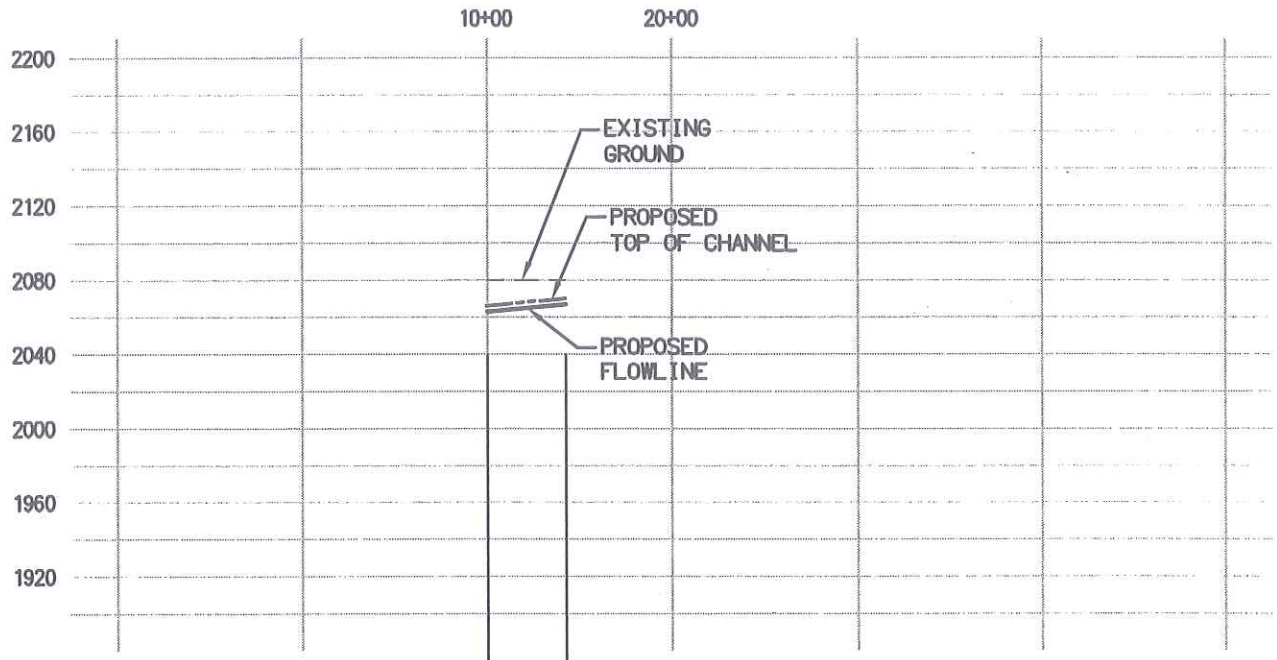


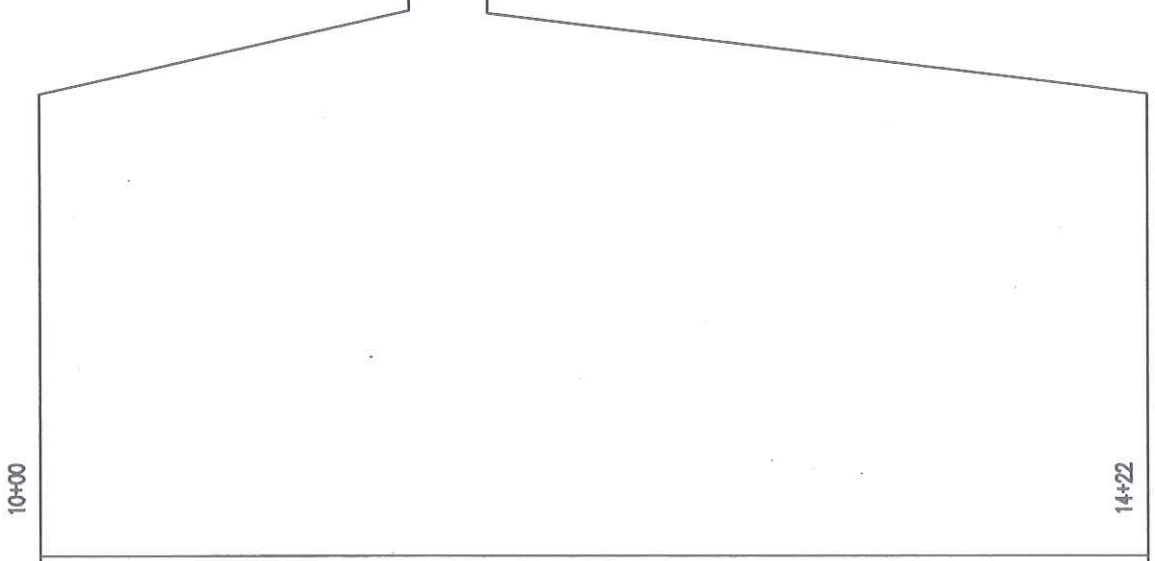
LEGEND		
	PROPOSED FACILITY	BASIN LOCATION
	FACILITY SHOWN ELSEWHERE	

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA DUNLAP CHANNEL (DC-01-05) SHEET 1 OF 1	N SCALE" 1"=1000'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PLAN-DC-01-05.DWG MCHANDOO 8/30/11 1:46 pm

RBF CONSULTING
PLANNING ■ DESIGN ■ CONSTRUCTION





LENGTH	422'
SLOPE	0.0100
FLOW	Q100 = 67
SIZE	RCP DIA = 36" RCP
FACILITY TYPE	TYP. SEC. NO. 1

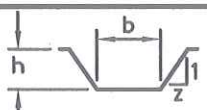
LEGEND

— — — EXISTING

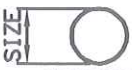
—·-·— PROPOSED TOP OF CHANNEL

——— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL

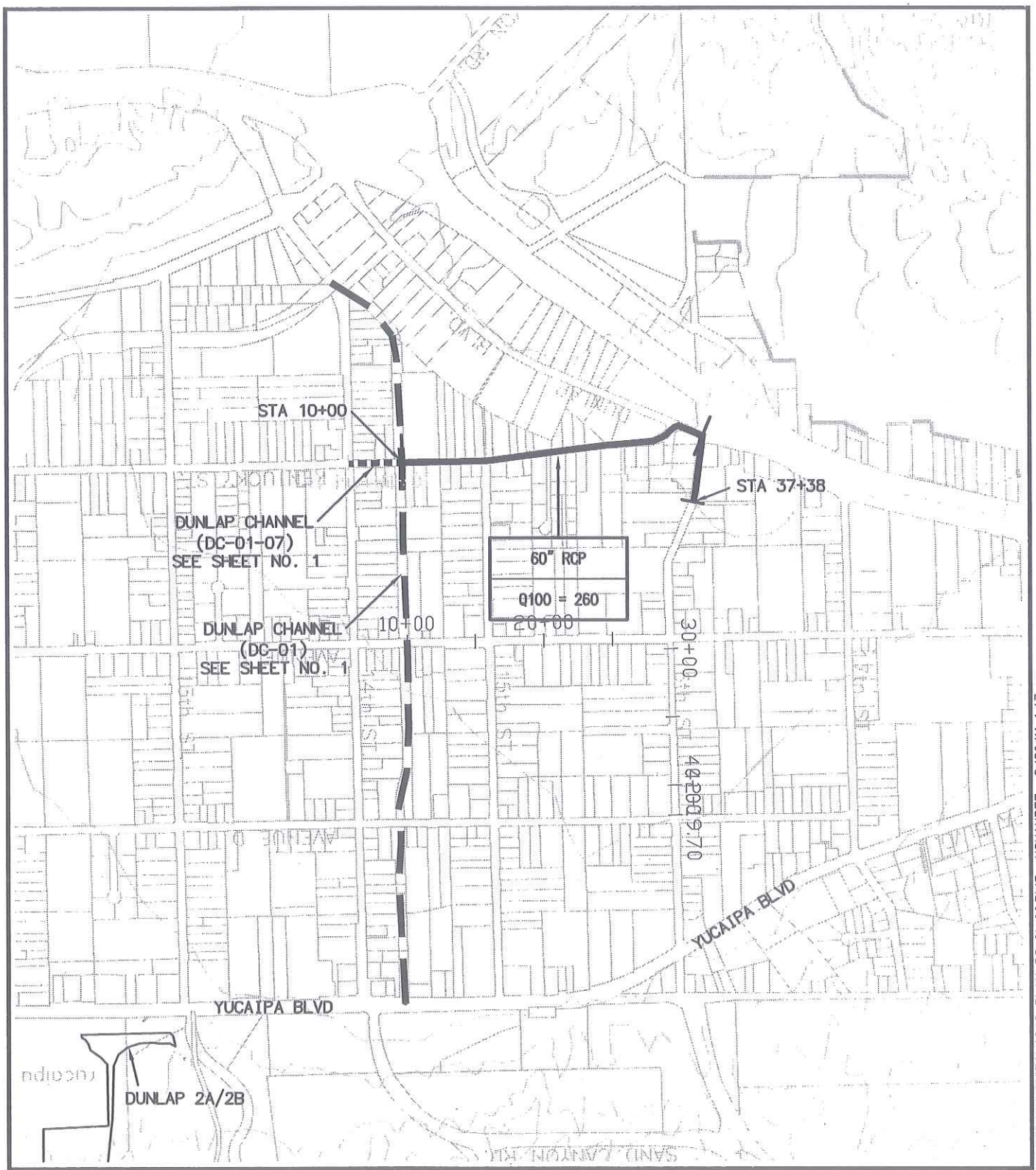


REINFORCED CONCRETE PIPE (RCP)

MASTER PLAN OF DRAINAGE	**CITY OF YUCAIPA DUNLAP CHANNEL (DC01-05) SHEET 1 OF 1**	SCALE: H: 1"=1000' V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-DC-01-05.DWG EGC 6/27/11 8:56 am

RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION



LEGEND

PROPOSED FACILITY

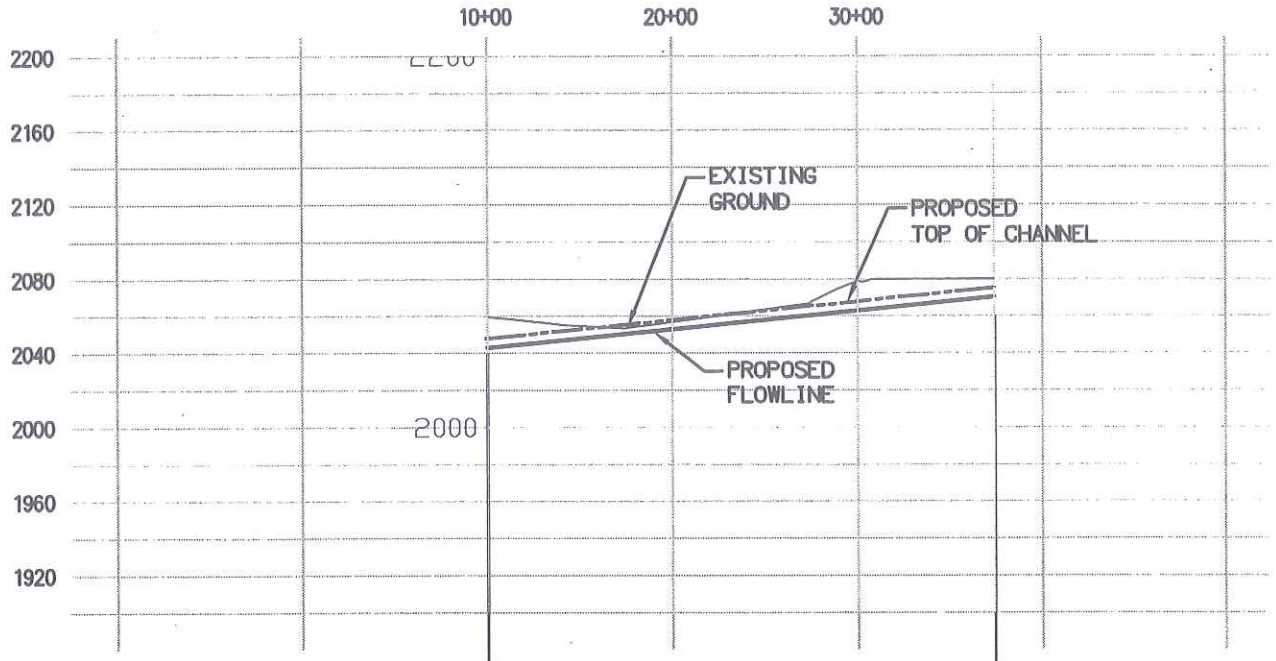
FACILITY SHOWN ELSEWHERE

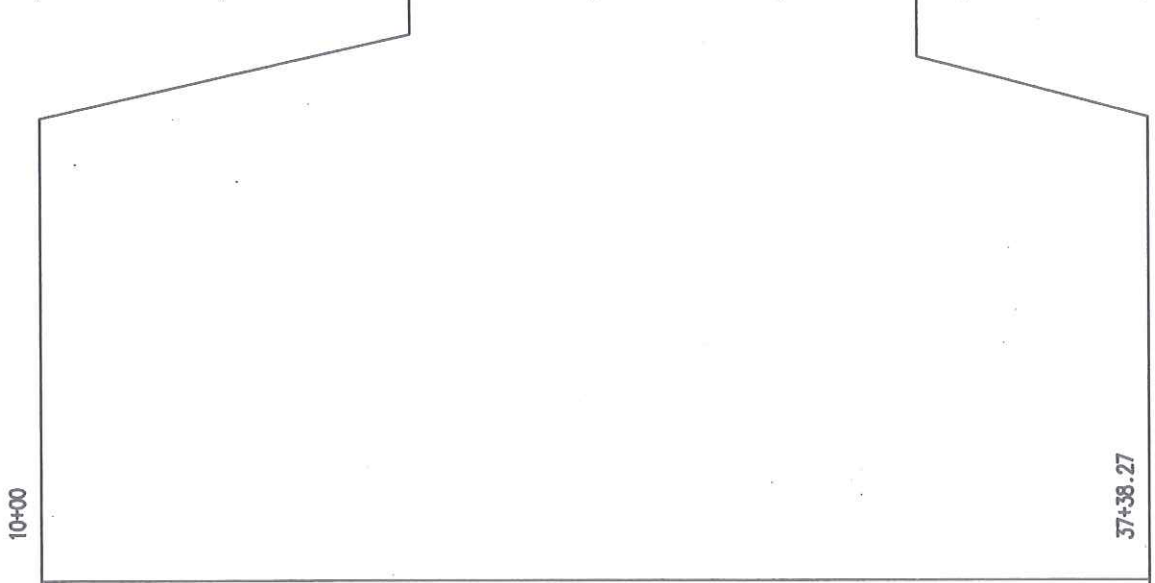
BASIN LOCATION

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA DUNLAP CHANNEL (DC-01-06) SHEET 1 OF 1	N SCALE" 1"=1000'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PLAN-DC-01-06.DWG MCHANDOO 8/30/11 1:47 pm

RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION





LENGTH	2738'
SLOPE	0.0100
FLOW	Q100 = 260
SIZE	RCP DIA = 60" RCP
FACILITY TYPE	TYP. SEC. NO. 1

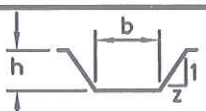
LEGEND

— — — EXISTING

—·—·— PROPOSED TOP OF CHANNEL

——— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL

REINFORCED CONCRETE PIPE (RCP)

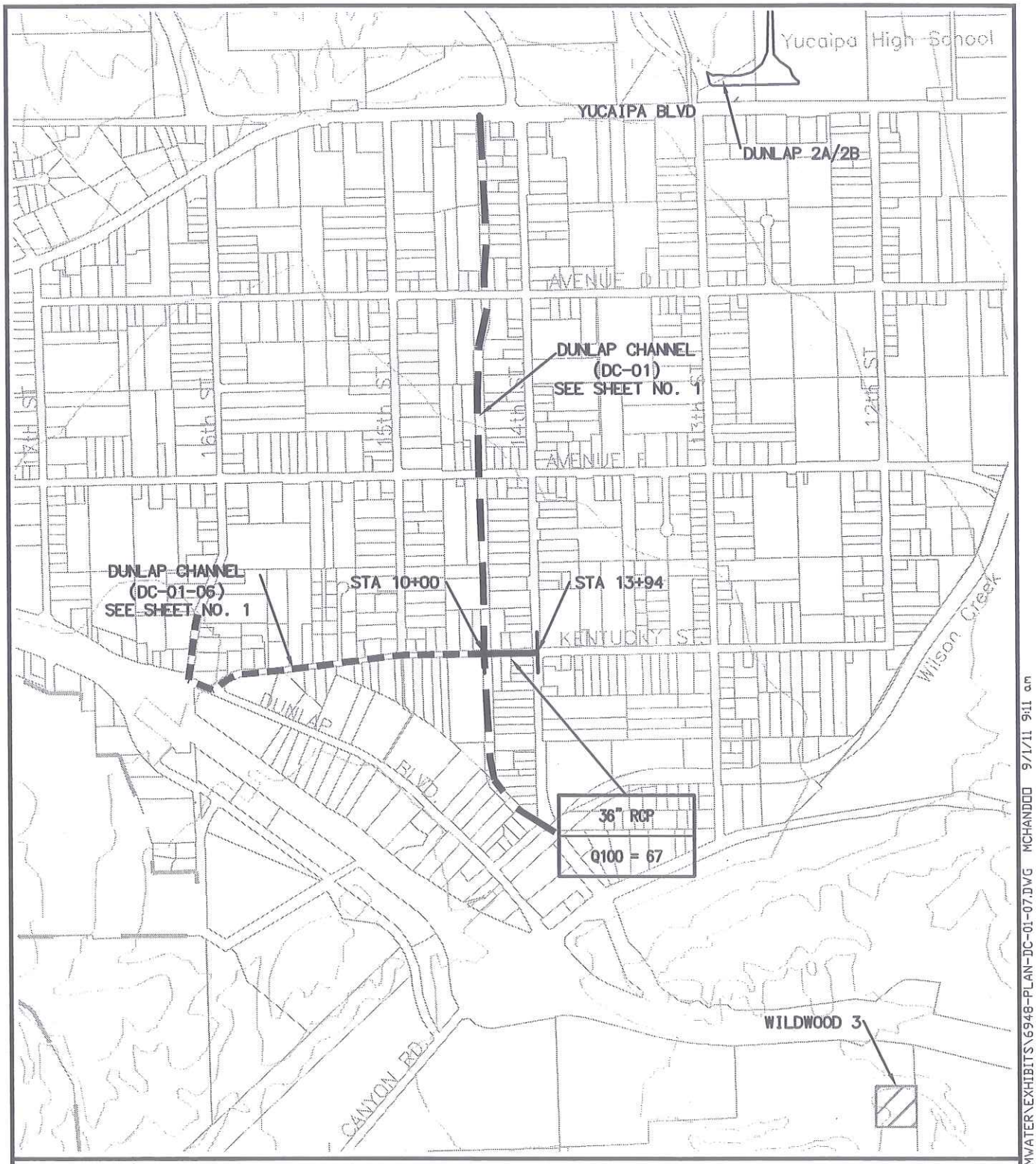
MASTER PLAN OF DRAINAGE

CITY OF YUCAIPA
DUNLAP CHANNEL (DC-01-06)
SHEET 1 OF 1

SCALE:
H: 1"=1000'
V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-DC-01-06.DWG MCHANDOO 7/7/11 11:33 am

RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION

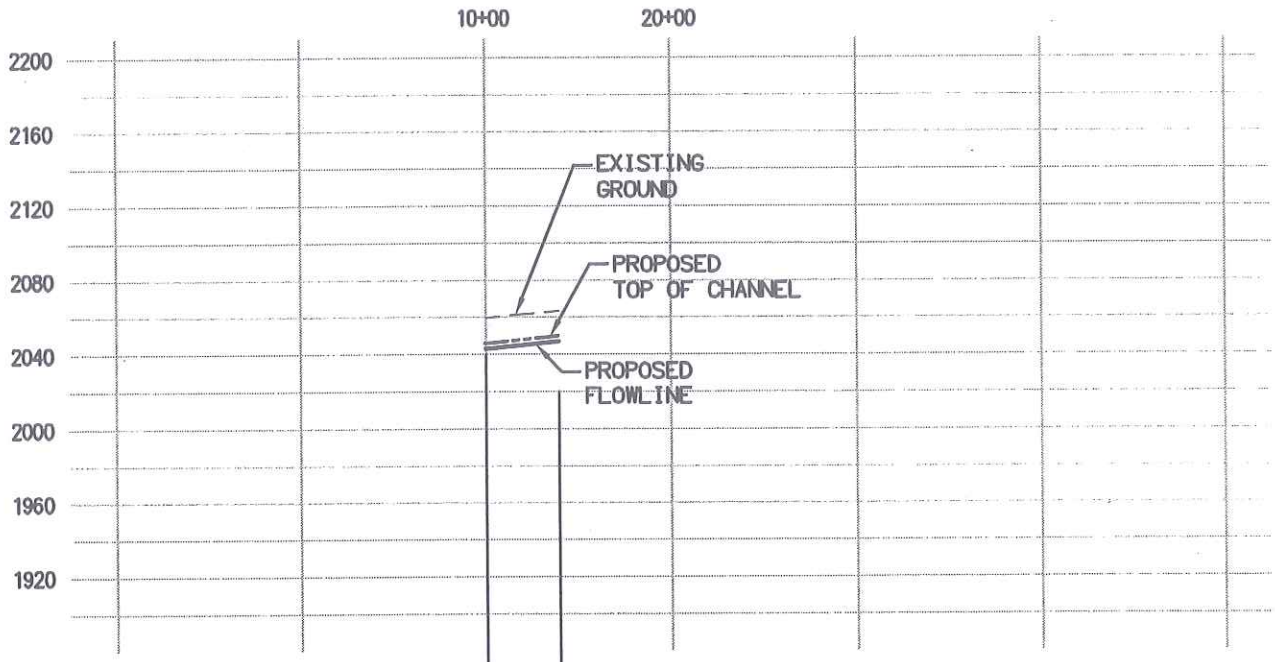


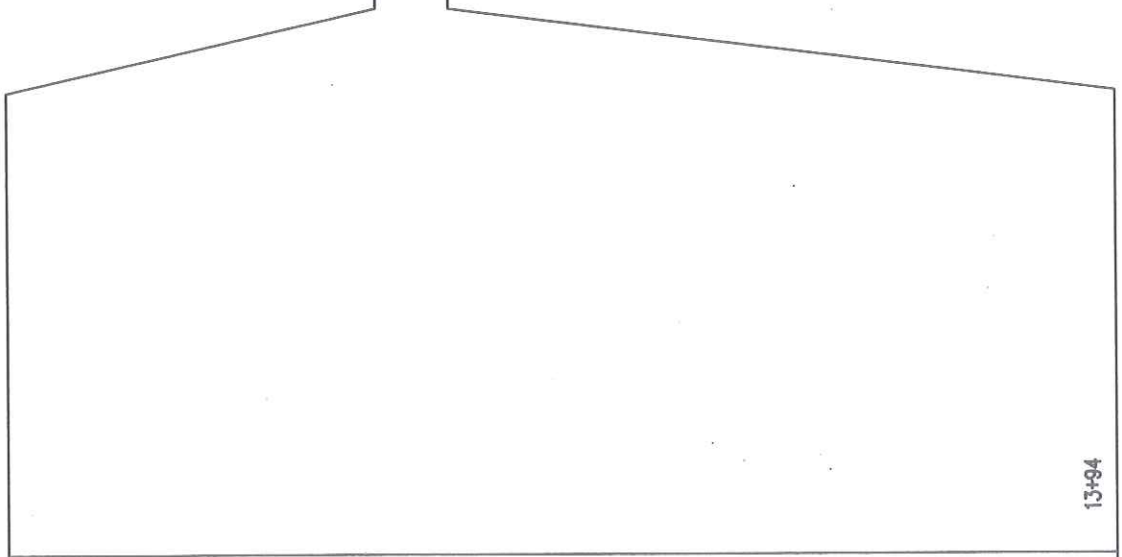
LEGEND		
	PROPOSED FACILITY	BASIN LOCATION
	FACILITY SHOWN ELSEWHERE	

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA DUNLAP CHANNEL (DC-01-07) SHEET 1 OF 1	N SCALE" 1"=1000'

H:\PDATA\1010948\CADD\STRMWATER\EXHIBITS\6948-PLAN-DC-01-07.DWG MCHANDOO 9/1/11 9:11 am

RBF PLANNING ■ DESIGN ■ CONSTRUCTION
CONSULTING



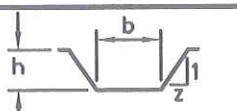


LENGTH	394'
SLOPE	0.0100
FLOW	Q100 = 67
SIZE	RCP DIA = 36" RCP
FACILITY TYPE	TYP. SEC. NO. 1

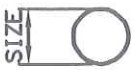
LEGEND

- EXISTING
- PROPOSED TOP OF CHANNEL
- PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL

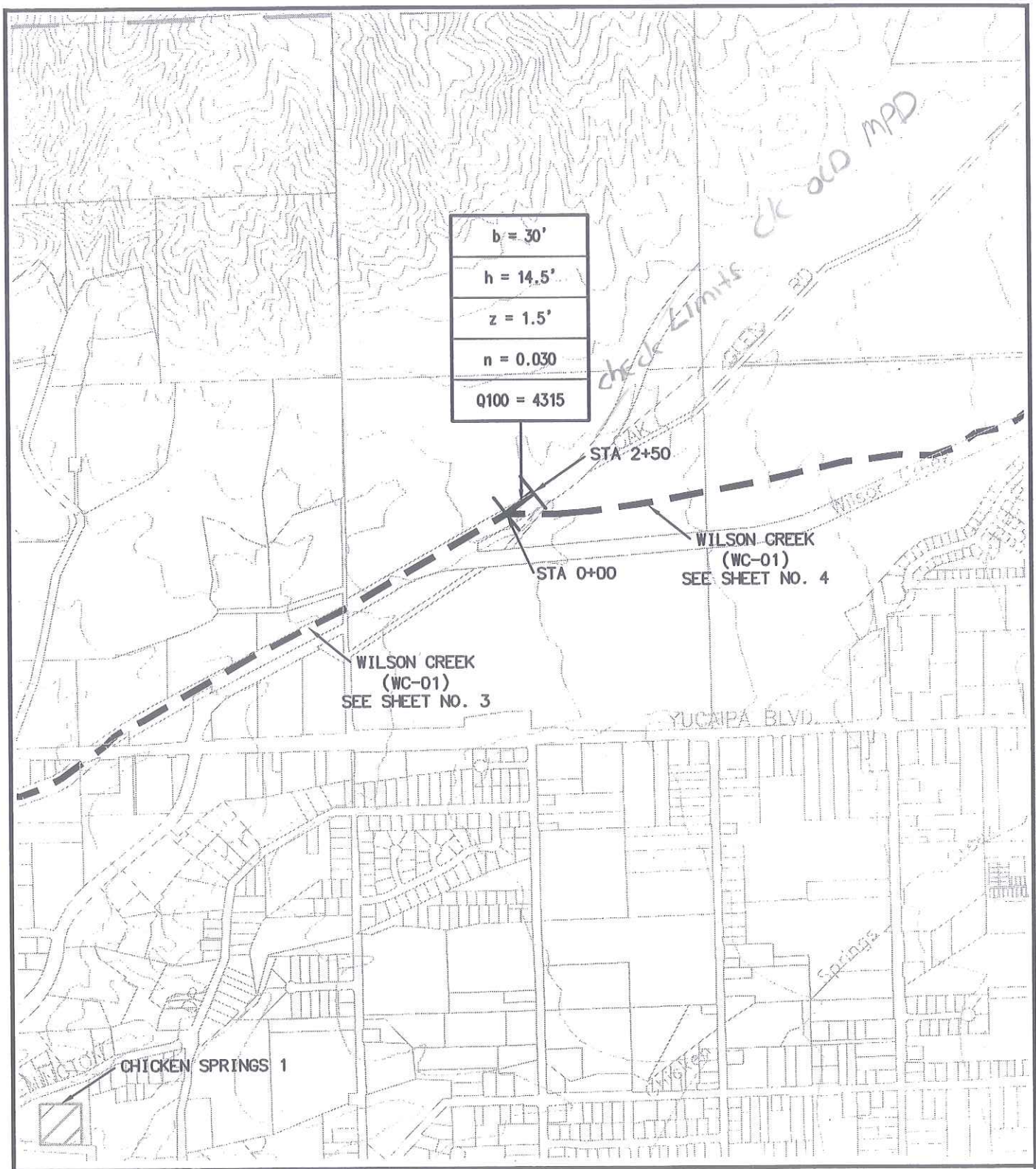


REINFORCED CONCRETE PIPE (RCP)

MASTER PLAN OF DRAINAGE	**CITY OF YUCAIPA DUNLAP CHANNEL (DC-01-07) SHEET 1 OF 1**	SCALE: H: 1"=1000' V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-DC-01-07.DWG EGC 6/27/11 8:58 am

RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION

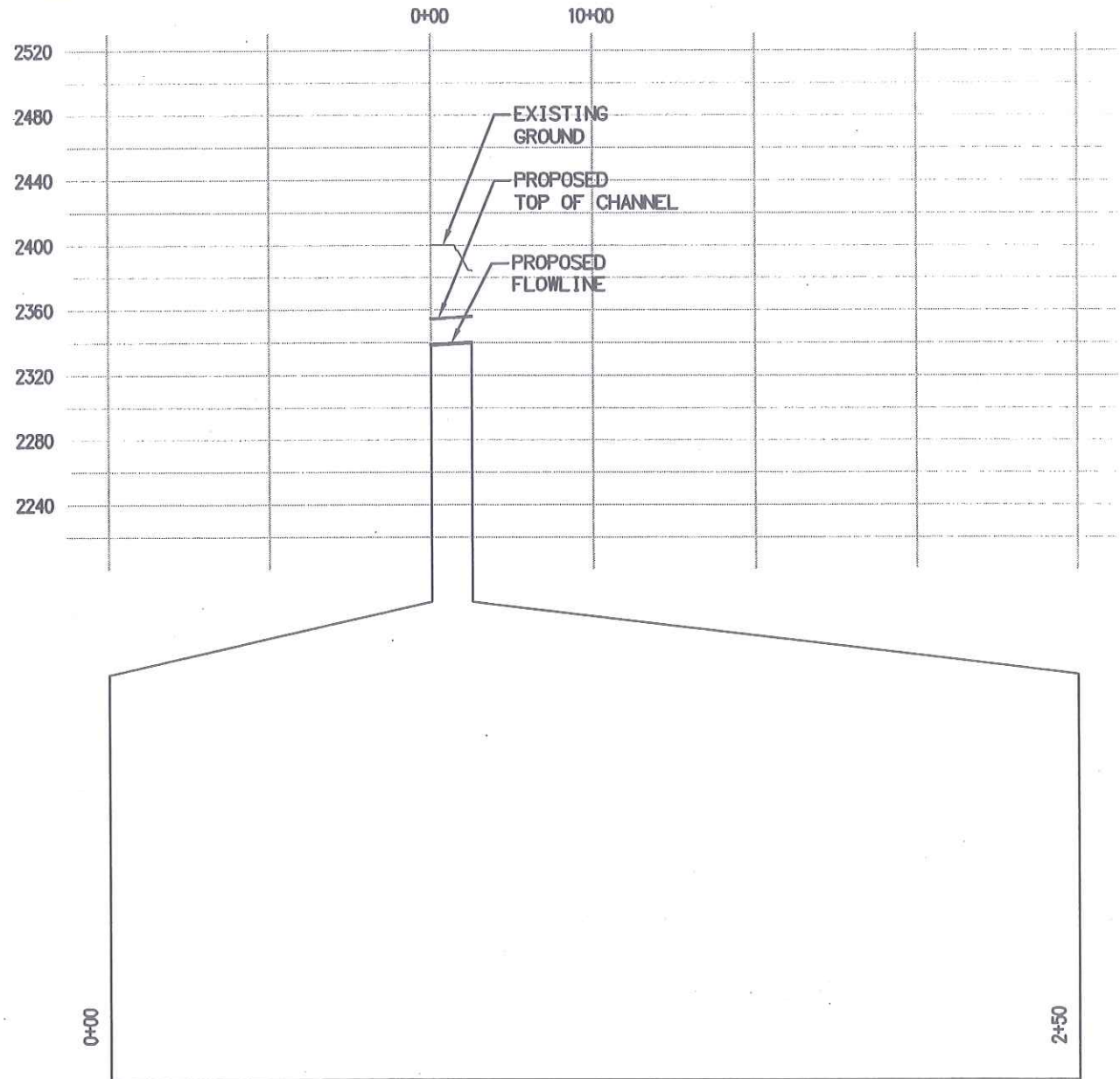


LEGEND		
	PROPOSED FACILITY	BASIN LOCATION
	FACILITY SHOWN ELSEWHERE	

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA GATEWAY WASH (GW-01) SHEET 1 OF 1	N SCALE" 1"=1000'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PLAN-GW-01.DWG EGC 6/30/11 12:59 pm

RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION

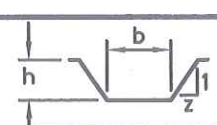


LENGTH	250'
SLOPE	0.0050
FLOW	Q100 = 4315
SIZE	b=30', h=14.5', Z=1.5
FACILITY TYPE	TYP. SEC. NO. 9

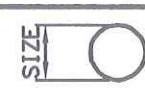
LEGEND

- — — — EXISTING
- —-·-·— PROPOSED TOP OF CHANNEL
- ——— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL

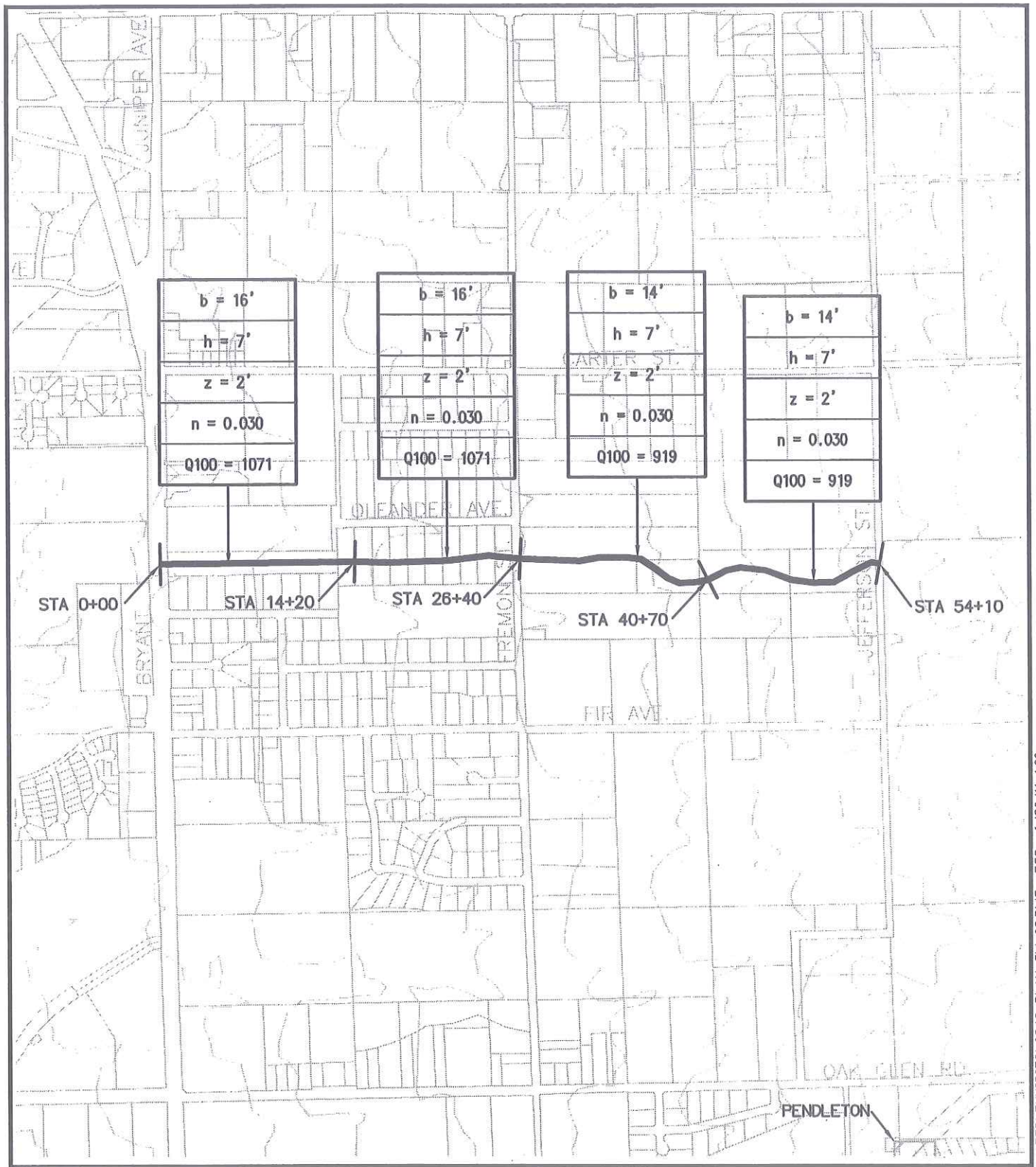


REINFORCED CONCRETE PIPE (RCP)

MASTER PLAN OF DRAINAGE	**CITY OF YUCAIPA GATEWAY WASH (GW-01) SHEET 1 OF 1**	SCALE: H: 1"=1000' V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-GW-01.DWG EGC 6/27/11 9:21 am

RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION



LEGEND

PROPOSED FACILITY

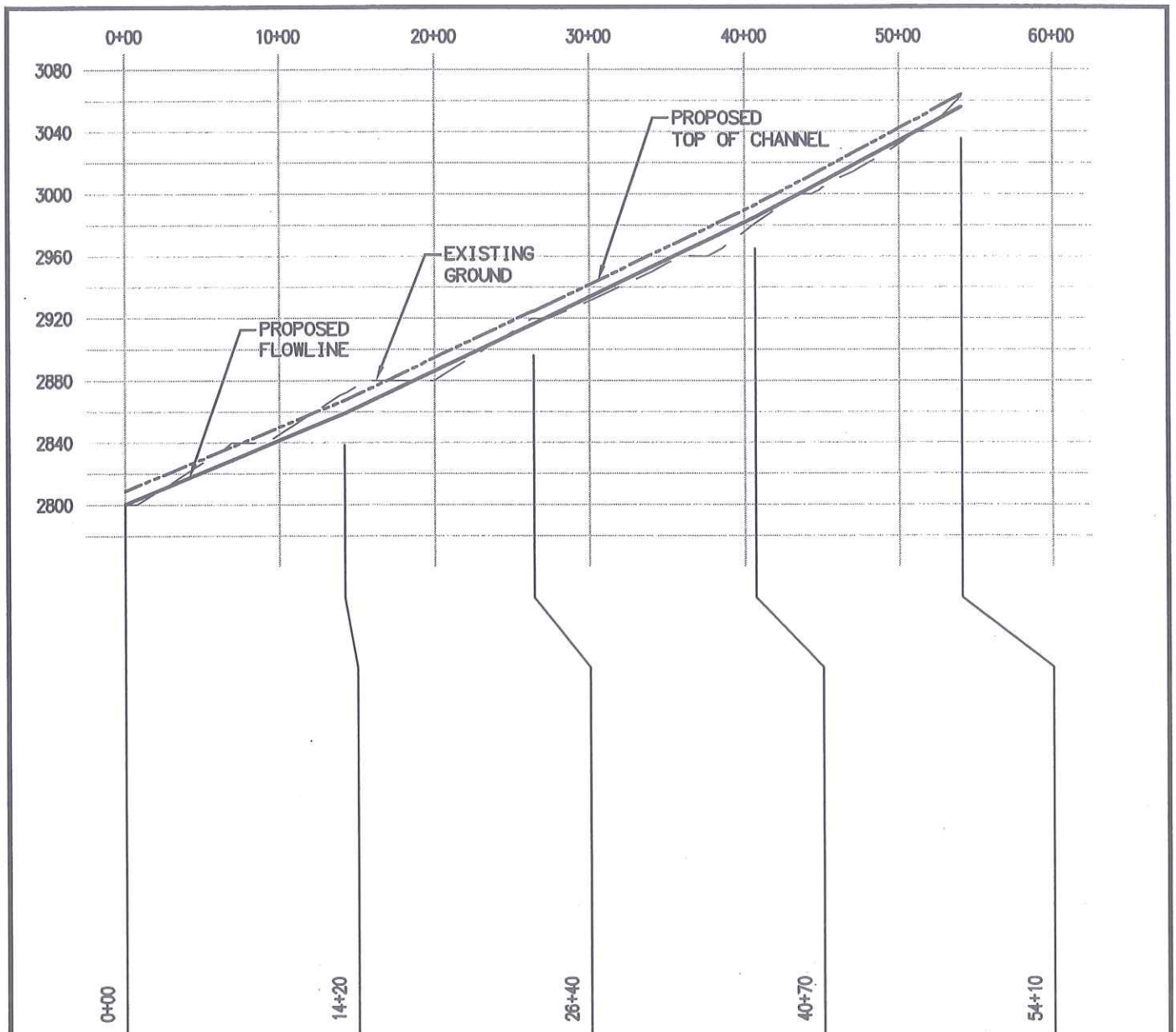
FACILITY SHOWN ELSEWHERE

BASIN LOCATION

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA GATEWAY WASH (GW-02) SHEET 1 OF 1	N SCALE" 1"=1000'

RBF CONSULTING — PLANNING ■ DESIGN ■ CONSTRUCTION

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PLAN-GW-02.DWG EGC 6/30/11 1:00 pm

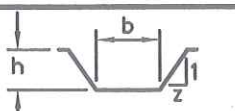


LENGTH	1420'	1220'	1430'	1340'
SLOPE	0.0410	0.0470	0.0480	0.053
FLOW	Q100 = 1071	Q100 = 1071	Q100 = 919	Q100 = 919
SIZE	b=16', h=7', z=2.0	b=16', h=7', z=2.0	b=14', h=7', z=2.0	b=14', h=7', z=2.0
FACILITY TYPE	TYP. SEC. NO. 2	TYP. SEC. NO. 2	TYP. SEC. NO. 2	TYP. SEC. NO. 2

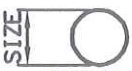
LEGEND

- — — — EXISTING
- —·—·— PROPOSED TOP OF CHANNEL
- ——— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL

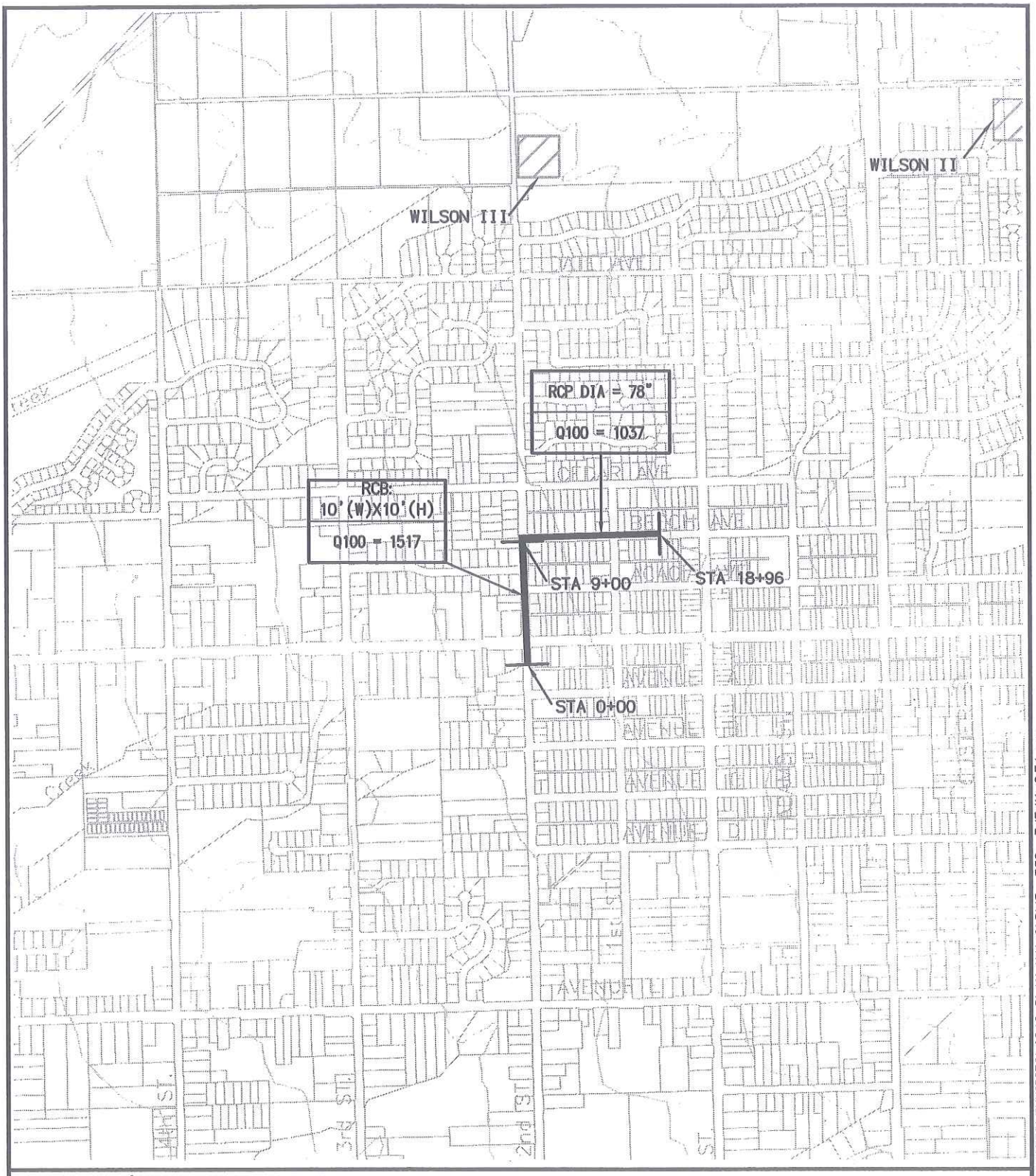


REINFORCED CONCRETE PIPE (RCP)

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA GATEWAY WASH (GW-02) SHEET 1 OF 1	SCALE: H: 1"=1000' V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-GW-02.DWG EGC 6/27/11 9:22 am

RBF CONSULTING — PLANNING ■ DESIGN ■ CONSTRUCTION

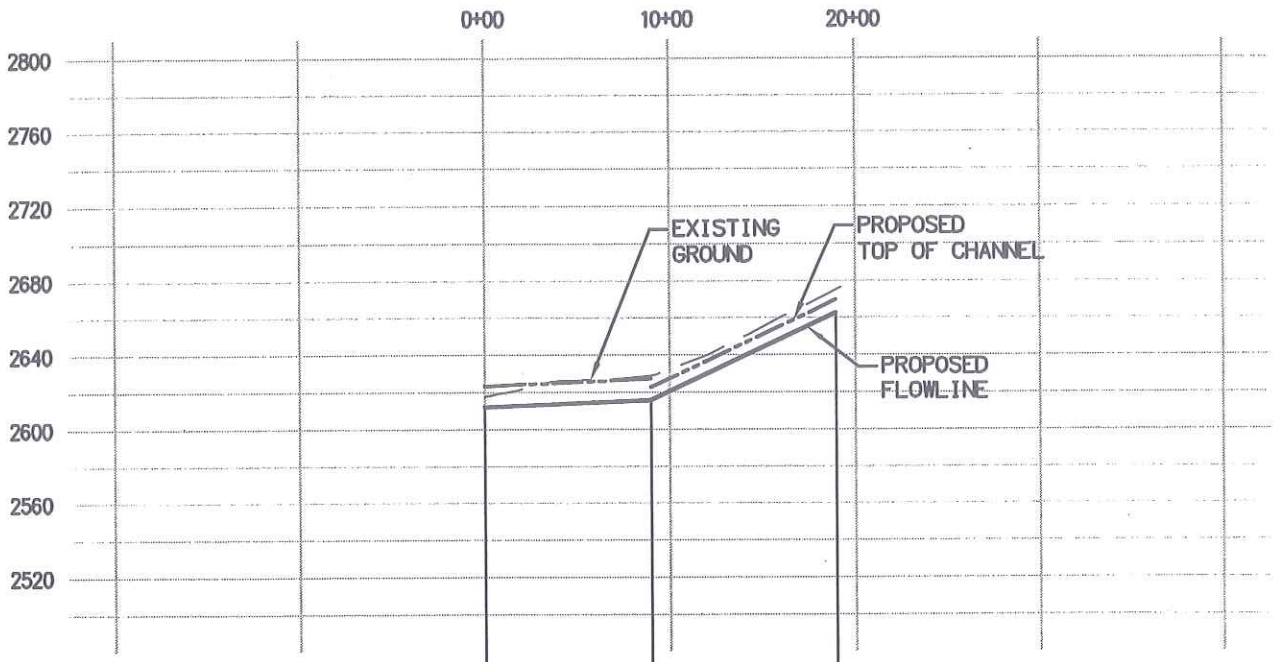


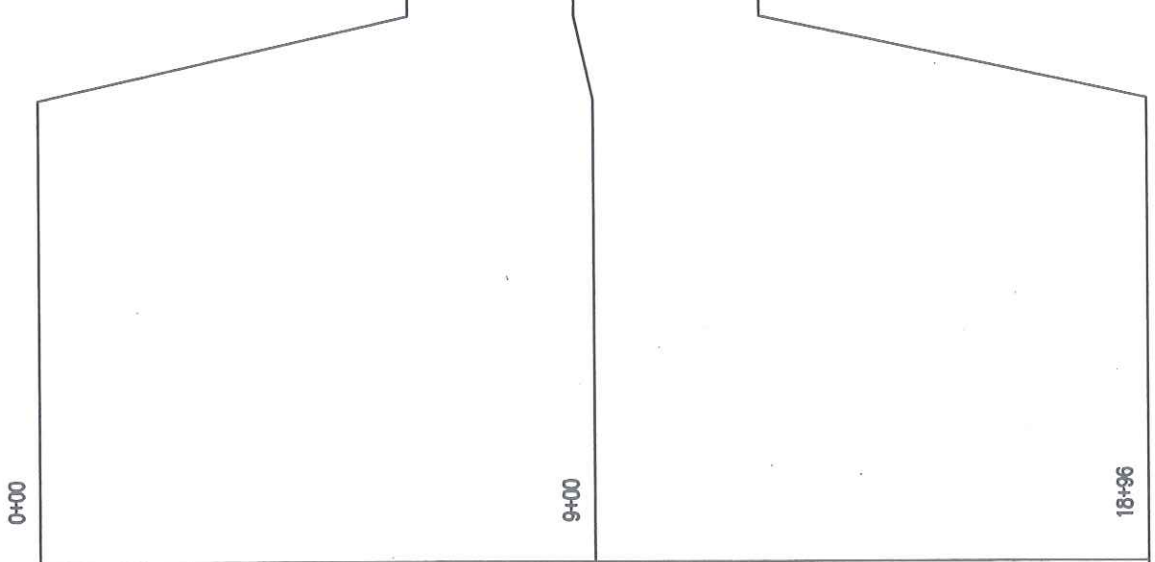
LEGEND		
	PROPOSED FACILITY	BASIN LOCATION
	FACILITY SHOWN ELSEWHERE	

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA MAP 41 (M41-01) SHEET 1 OF 1	N SCALE" 1"=1000'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PLAN-M41-01.DWG EGC 7/5/11 9:54 am

RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION



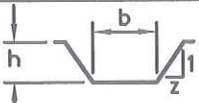


	0+00 – 9+00	9+00 – 18+96
LENGTH	900'	996'
SLOPE	0.0040	0.0470
FLOW	Q100 = 1517	Q100 = 1037
SIZE	RCB: 10'(W) X 10' (H)	RCP DIA = 78" RCP
FACILITY TYPE	TYP. SEC. NO. 1A	TYP. SEC. NO. 1

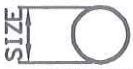
LEGEND

- — — — EXISTING
- —·—·— PROPOSED TOP OF CHANNEL
- ——— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL



REINFORCED CONCRETE PIPE (RCP)

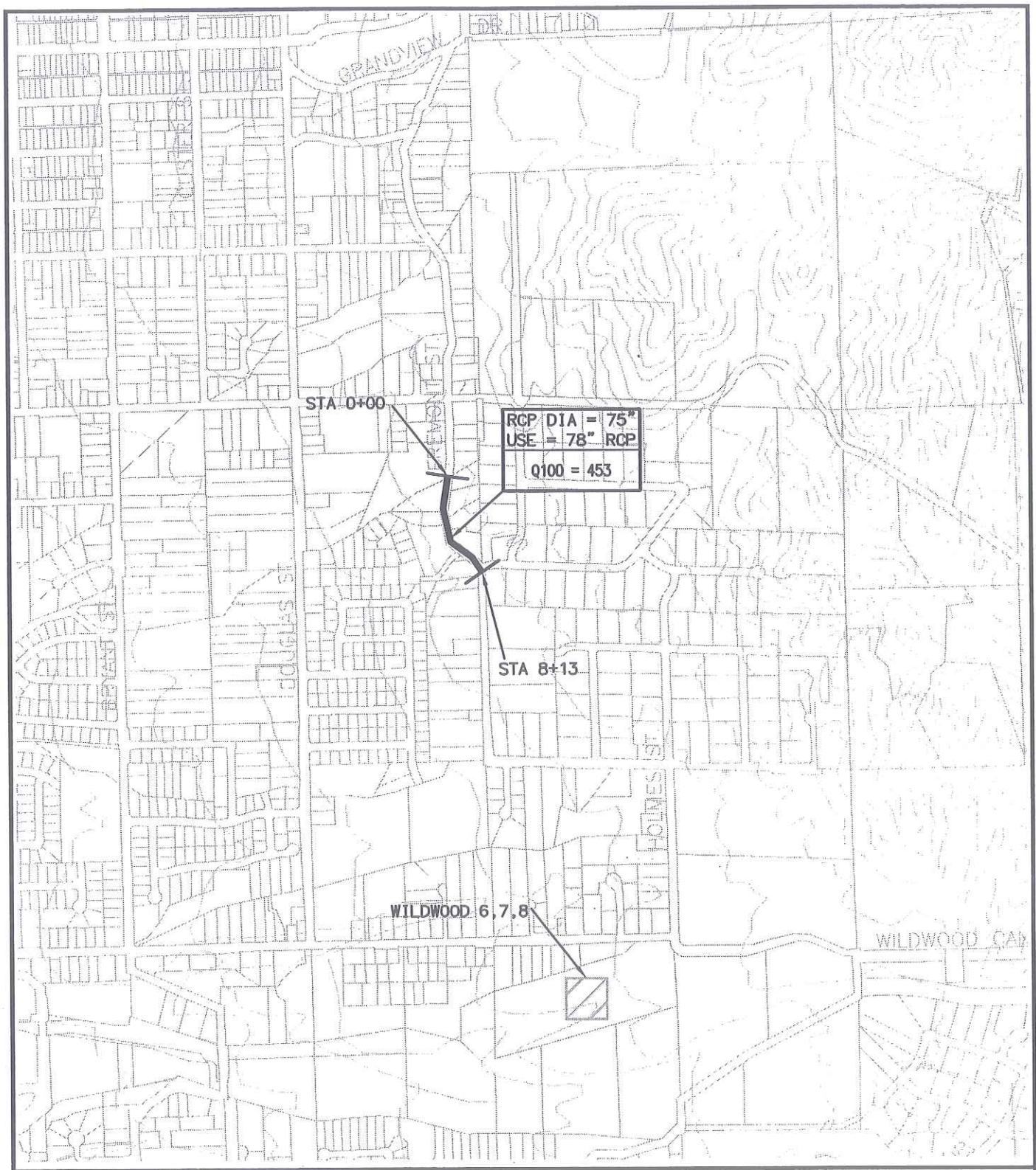
MASTER PLAN OF DRAINAGE

CITY OF YUCAIPA
MAP 41 (M41-01)
SHEET 1 OF 1

SCALE:
H: 1"=1000'
V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-M41-01.DWG EGC 6/27/11 9:23 am

RBF CONSULTING
PLANNING ■ DESIGN ■ CONSTRUCTION

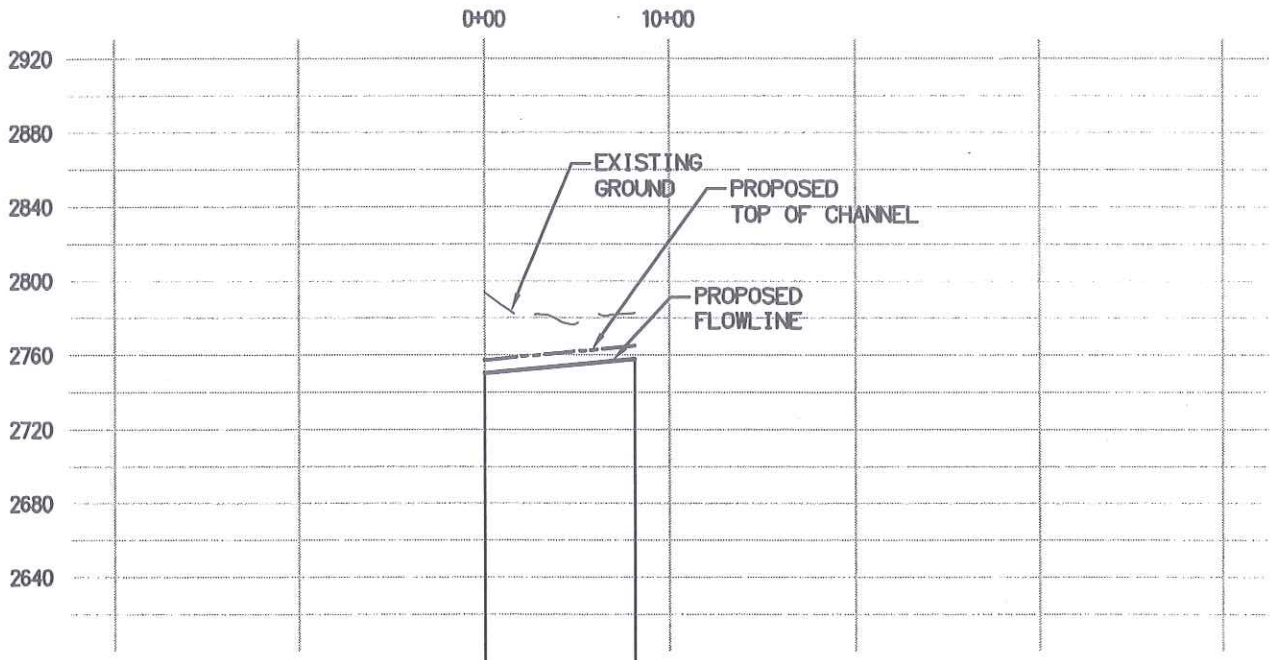


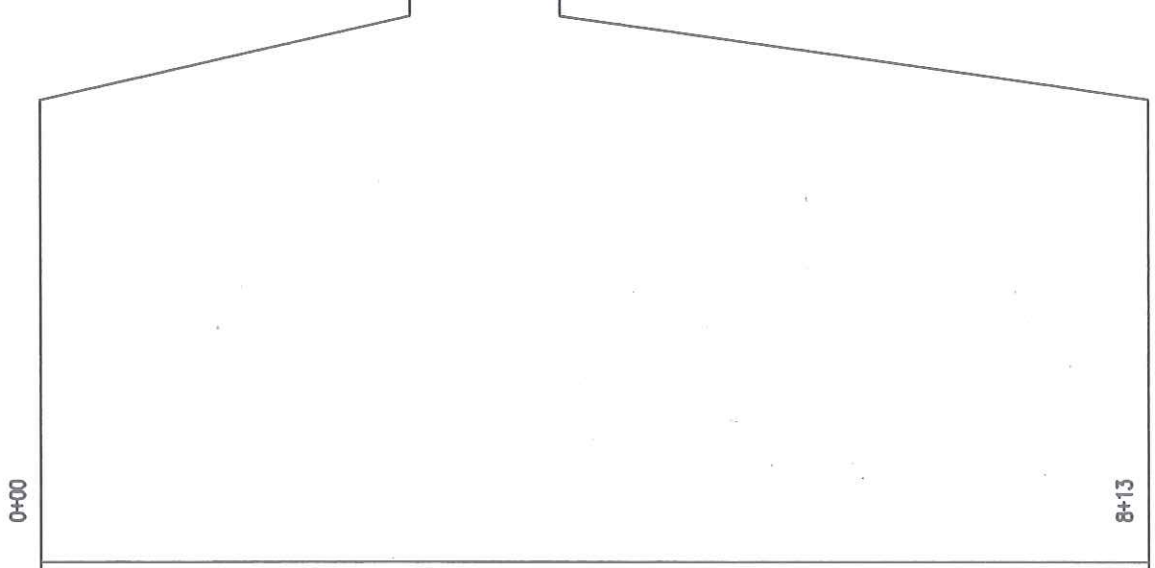
LEGEND		
	PROPOSED FACILITY	BASIN LOCATION
	FACILITY SHOWN ELSEWHERE	

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA MAP 57 (M57-01) SHEET 1 OF 1	N SCALE" 1"=1000'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PLAN-M57-01.DWG EGC 6/30/11 1:02 pm

RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION



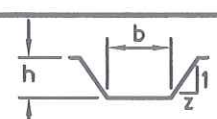


LENGTH	813'
SLOPE	0.0090
FLOW	Q100 = 453
SIZE	RCP DIA = 75", USE = 78" RCP
FACILITY TYPE	TYP. SEC. NO. 1

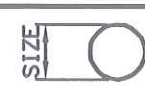
LEGEND

— — — EXISTING
—-·-·— PROPOSED TOP OF CHANNEL
——— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL



REINFORCED CONCRETE PIPE (RCP)

MASTER PLAN OF DRAINAGE	**CITY OF YUCAIPA MAP 57 (M57-01) SHEET 1 OF 1**	SCALE: H: 1"=1000' V: 1"=100'

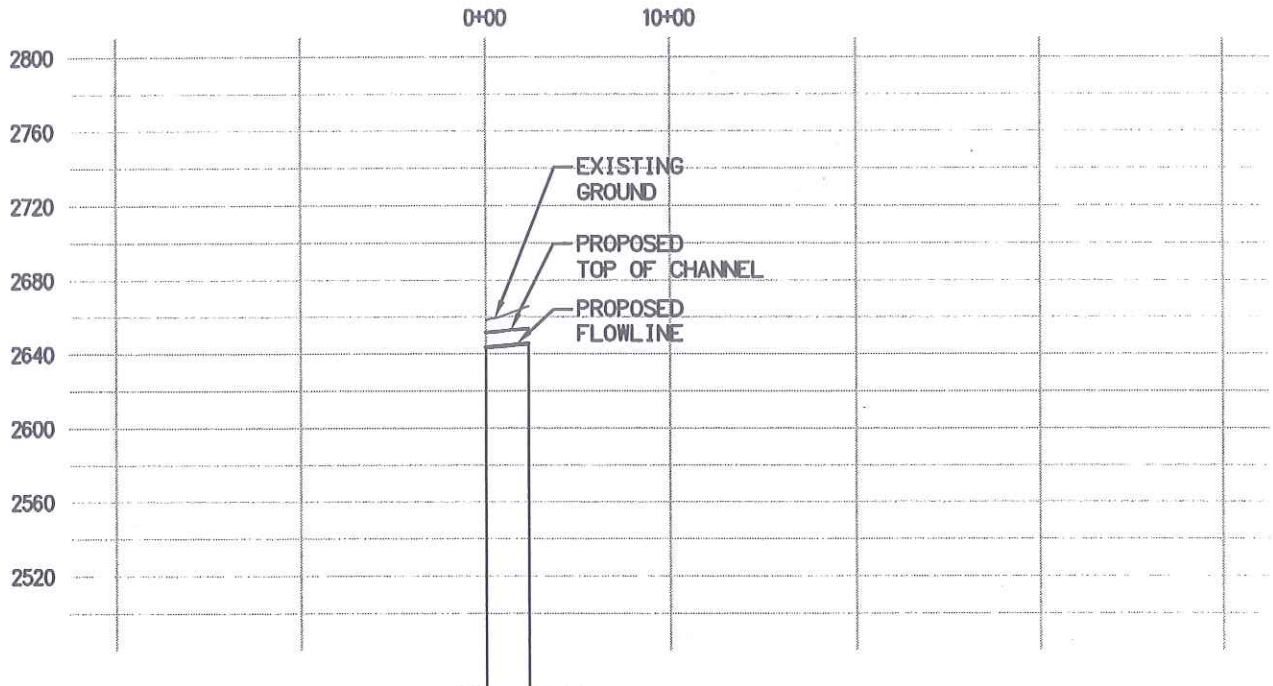
H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-M57-01.DWG EGC 6/27/11 9:24 am

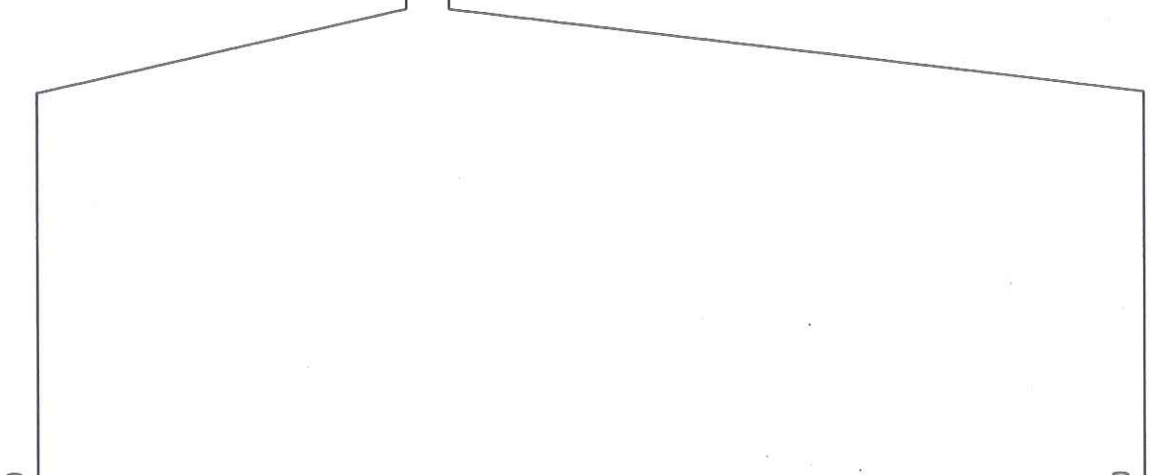
RBF PLANNING ■ DESIGN ■ CONSTRUCTION CONSULTING

LEGEND	PROPOSED FACILITY FACILITY SHOWN ELSEWHERE	BASIN LOCATION	
MASTER PLAN OF DRAINAGE	**CITY OF YUCAIPA MAP 58 (M58-01) SHEET 1 OF 1**		N SCALE" 1"=1000'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PLAN-M58-01.DWG EGC 6/30/11 1:03 pm

RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION





LENGTH	230'
SLOPE	0.0080
FLOW	Q100 = 477
SIZE	RCP DIA = 78" RCP
FACILITY TYPE	TYP. SEC. NO. 1

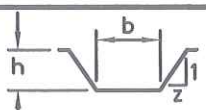
LEGEND

— — — EXISTING

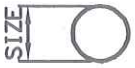
—·—·— PROPOSED TOP OF CHANNEL

——— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL

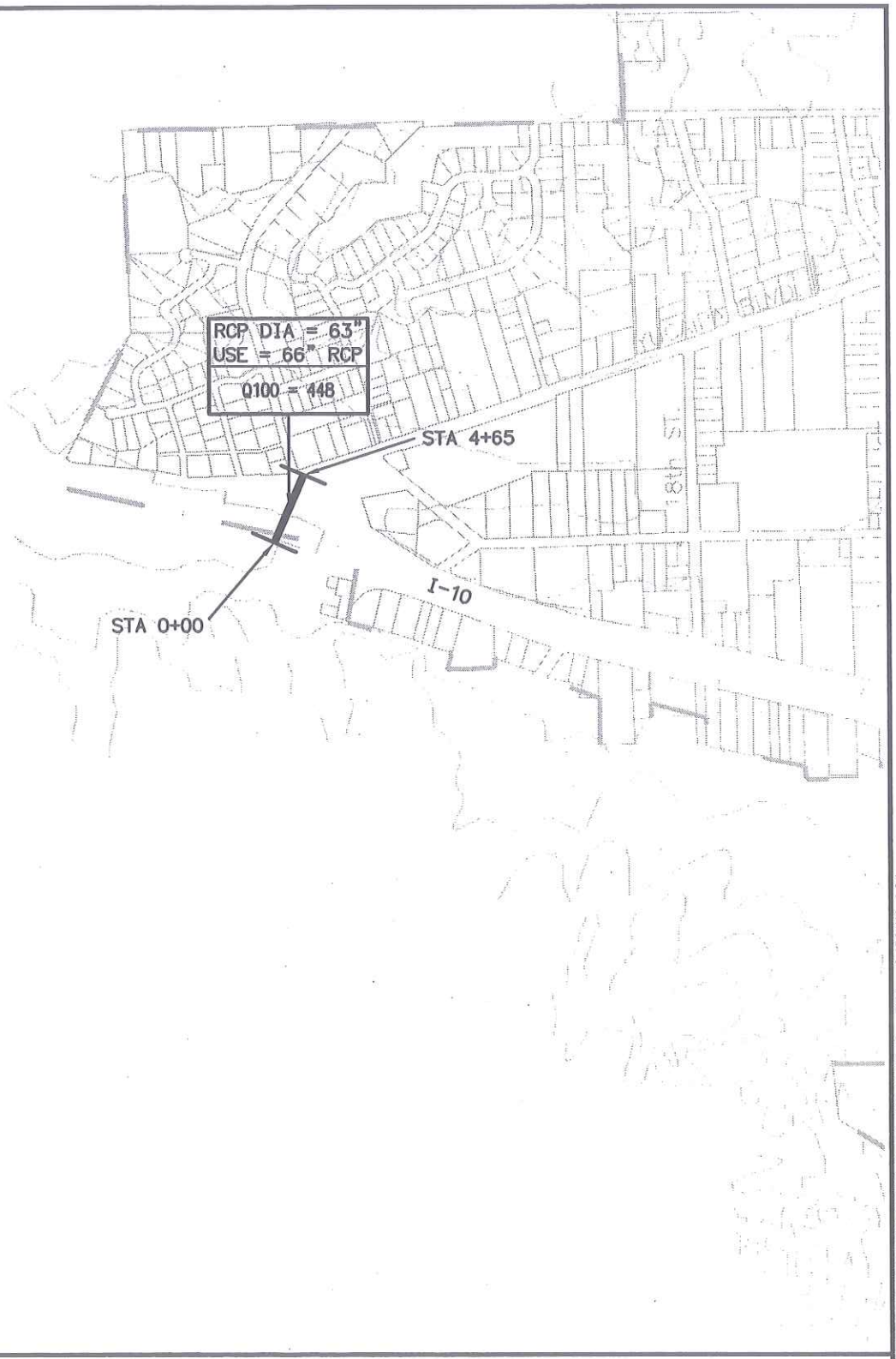


REINFORCED CONCRETE PIPE (RCP)

MASTER PLAN OF DRAINAGE	**CITY OF YUCAIPA MAP 58 (M58-01) SHEET 1 OF 1**	SCALE: H: 1"=1000' V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-M58-01.DWG EGC 6/27/11 9:25 am

RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION

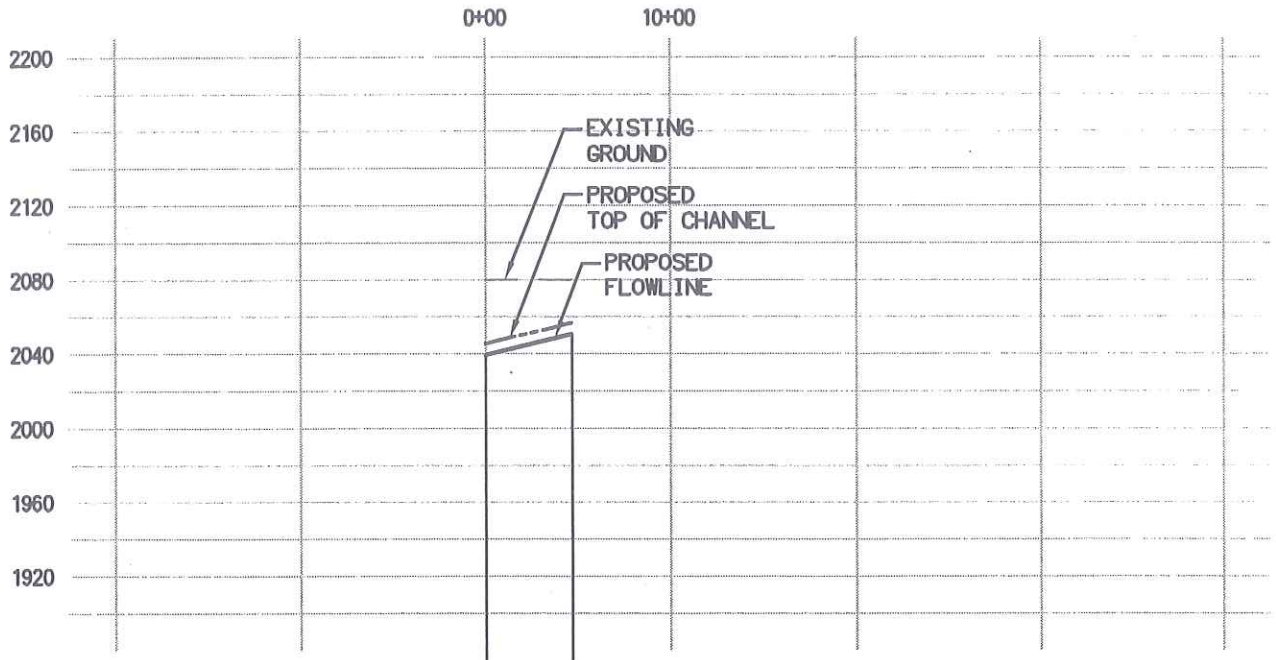


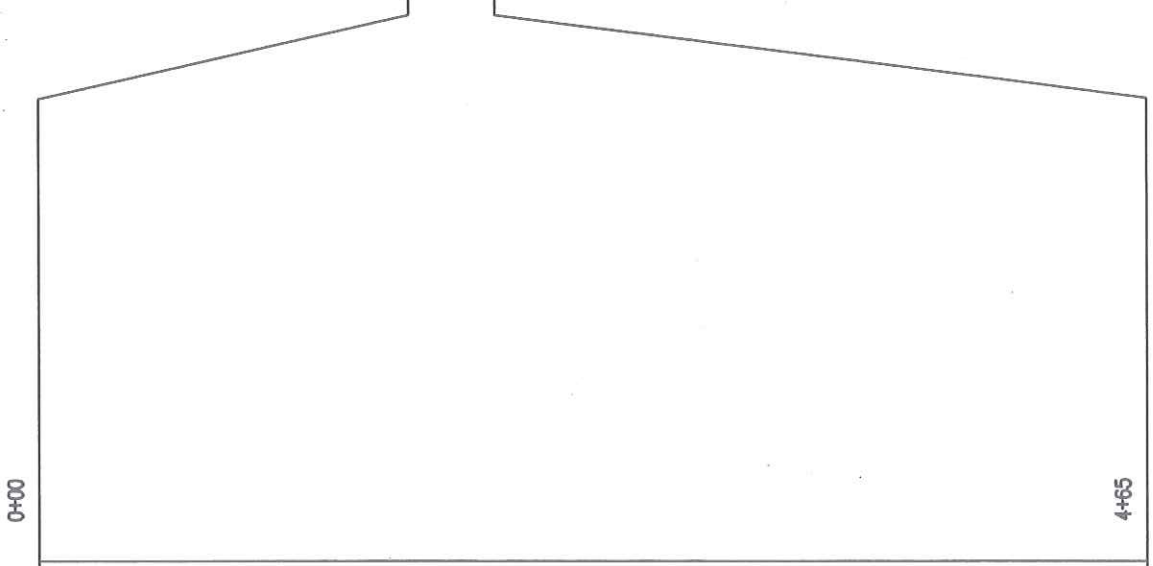
LEGEND		
	PROPOSED FACILITY	BASIN LOCATION
	FACILITY SHOWN ELSEWHERE	

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA MAP 91 (M91-01) SHEET 1 OF 1	N SCALE" 1"=1000'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PLAN-M91-01.DWG EGC 6/30/11 1:04 pm

RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION



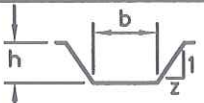


LENGTH	465'
SLOPE	0.0240
FLOW	Q100 = 448
SIZE	RCP DIA = 63", USE = 66" RCP
FACILITY TYPE	TYP. SEC. NO. 1

LEGEND

- — — — EXISTING
- —·-·— PROPOSED TOP OF CHANNEL
- ——— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL

REINFORCED CONCRETE PIPE (RCP)

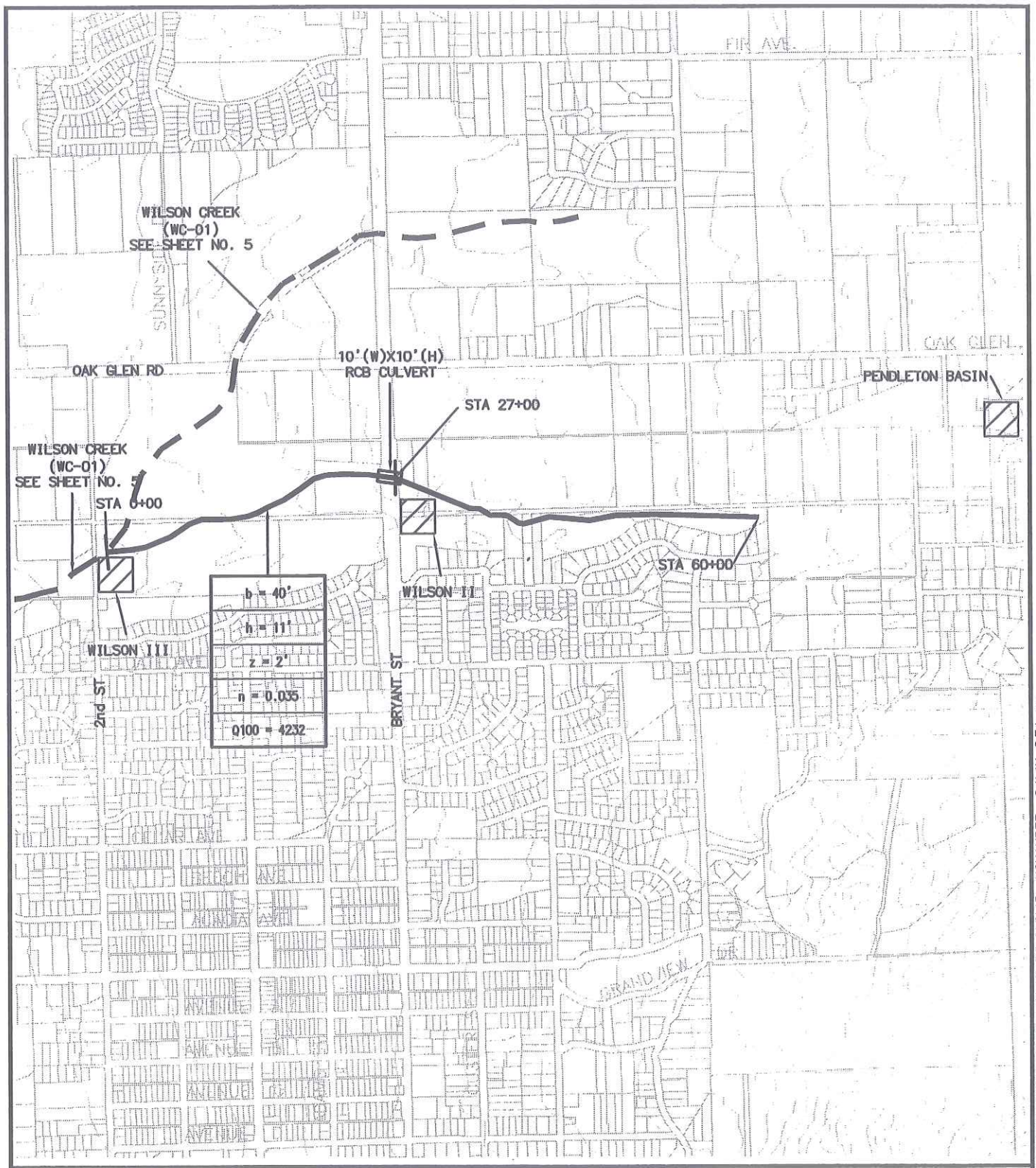
MASTER PLAN OF DRAINAGE

CITY OF YUCAIPA
MAP 91 (M91-01)
SHEET 1 OF 1

SCALE:
H: 1"=1000'
V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-M91-01.DWG EGC 6/27/11 9:26 am

RBF CONSULTING
PLANNING ■ DESIGN ■ CONSTRUCTION



LEGEND

PROPOSED FACILITY

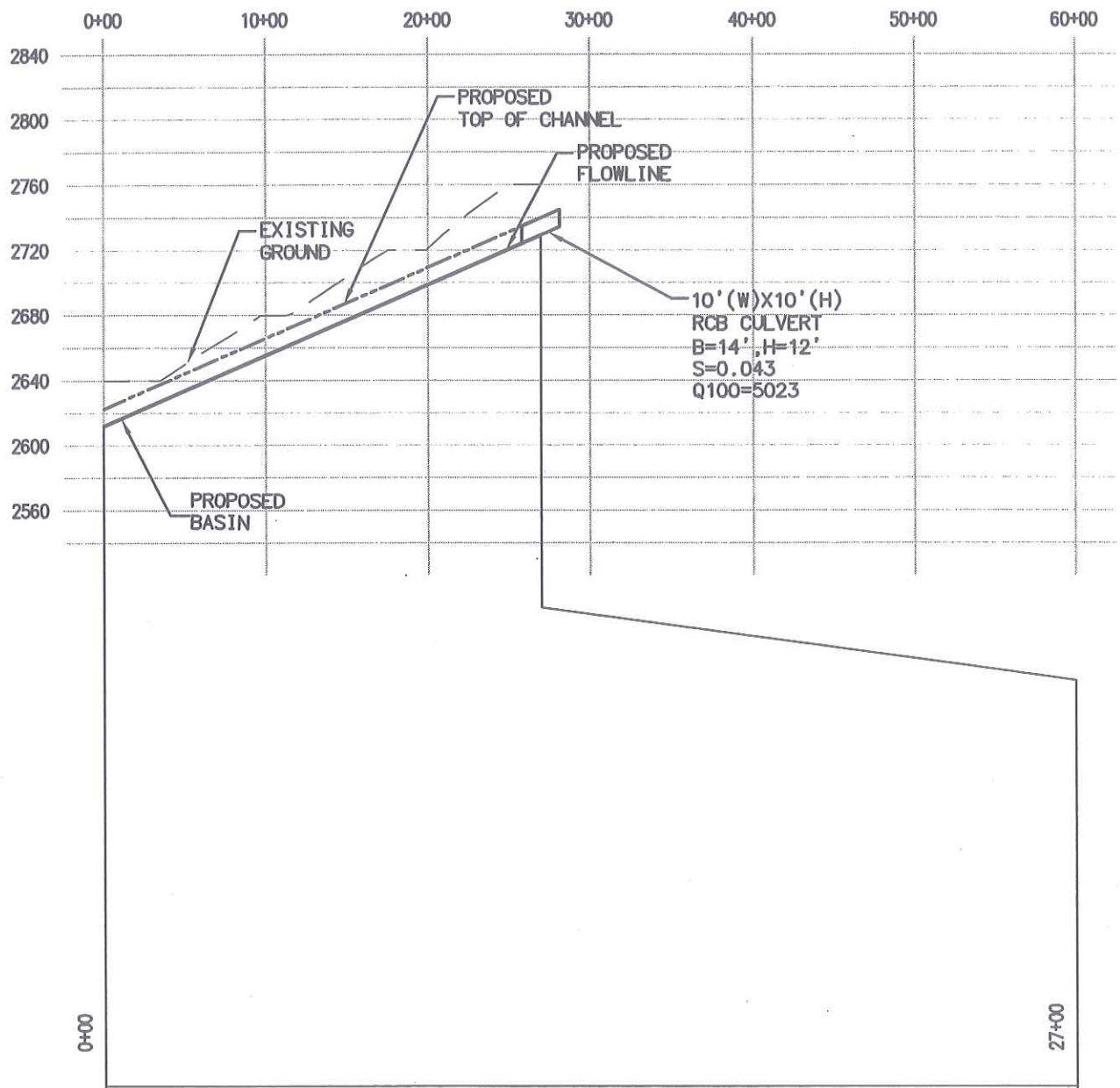
FACILITY SHOWN ELSEWHERE

BASIN LOCATION

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA OAK GLEN WASH (OG-01) SHEET 1 OF 1	N SCALE" 1"=1000'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PLAN-OG-01.DWG MCHANDOO 9/1/11 8:54 am

RBF CONSULTING — PLANNING ■ DESIGN ■ CONSTRUCTION

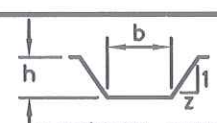


LENGTH	2700'
SLOPE	0.005 (DROP STRUCTURE)
FLOW	Q100 = 4232
SIZE	b=40', h=11', Z=2.0
FACILITY TYPE	TYP. SEC. NO. 10

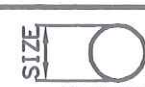
LEGEND

- — — — EXISTING
- —-·-·— PROPOSED TOP OF CHANNEL
- ——— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL

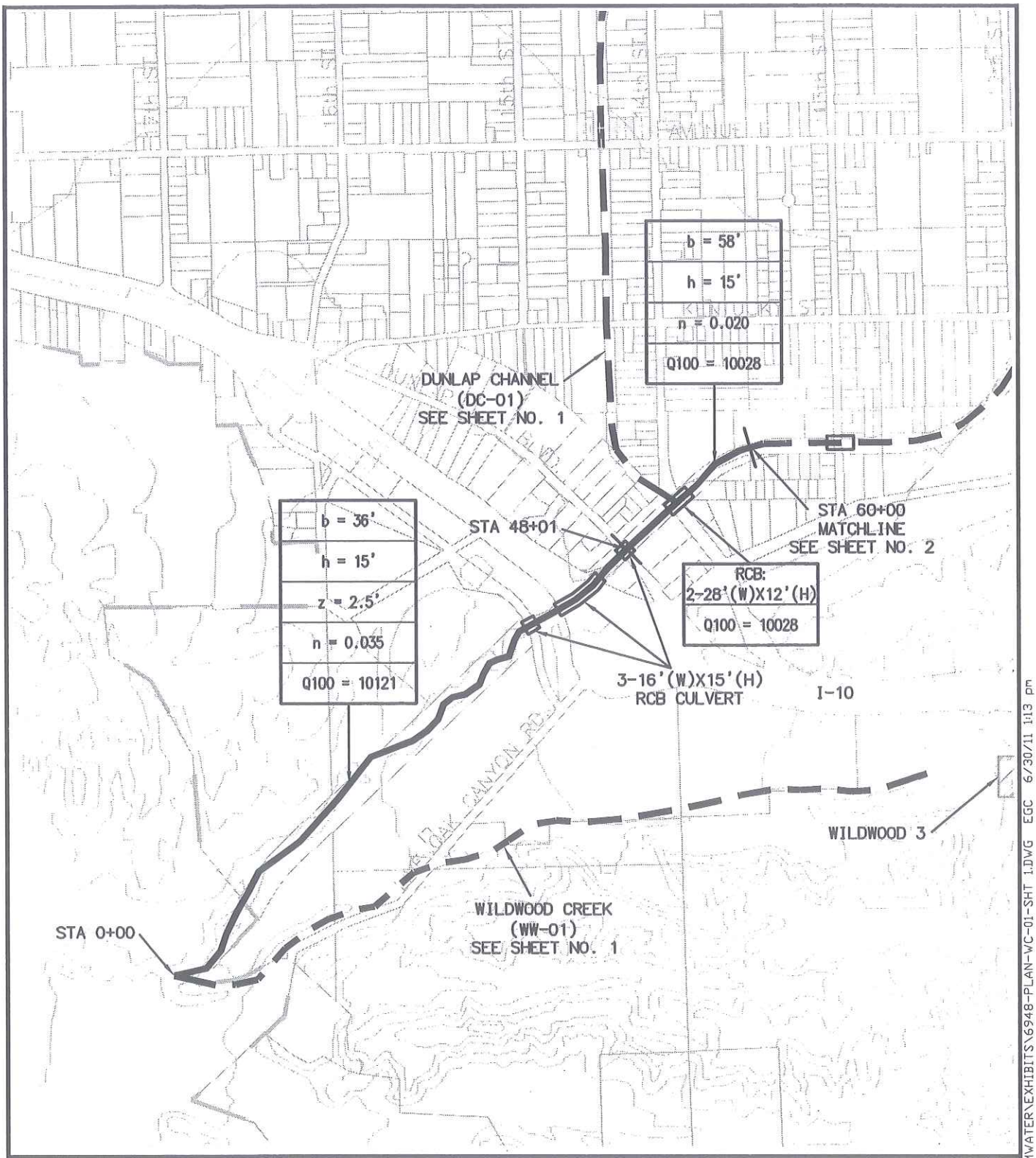


REINFORCED CONCRETE PIPE (RCP)

MASTER PLAN OF DRAINAGE	**CITY OF YUCAIPA OAK GLEN WASH (OG-01) SHEET 1 OF 1**	SCALE: H: 1"=1000' V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-OG-01.DWG MCHANDOO 7/29/11 1:05 pm

RBF PLANNING ■ DESIGN ■ CONSTRUCTION CONSULTING



LEGEND

PROPOSED FACILITY

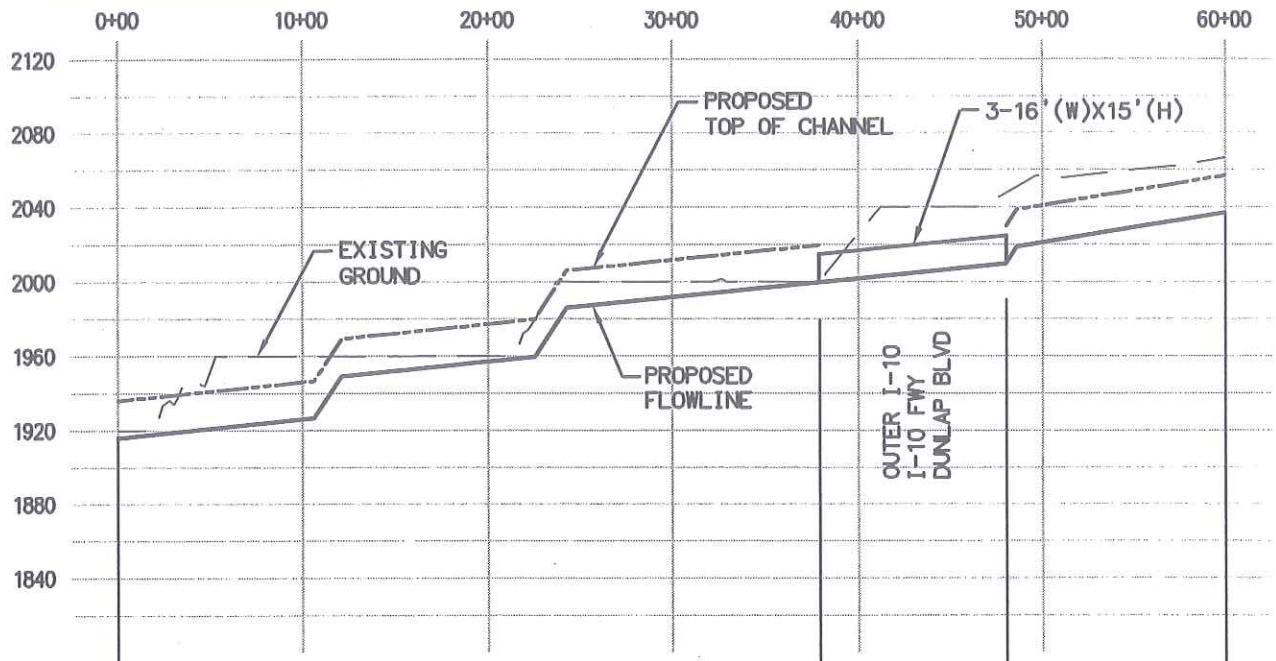
FACILITY SHOWN ELSEWHERE

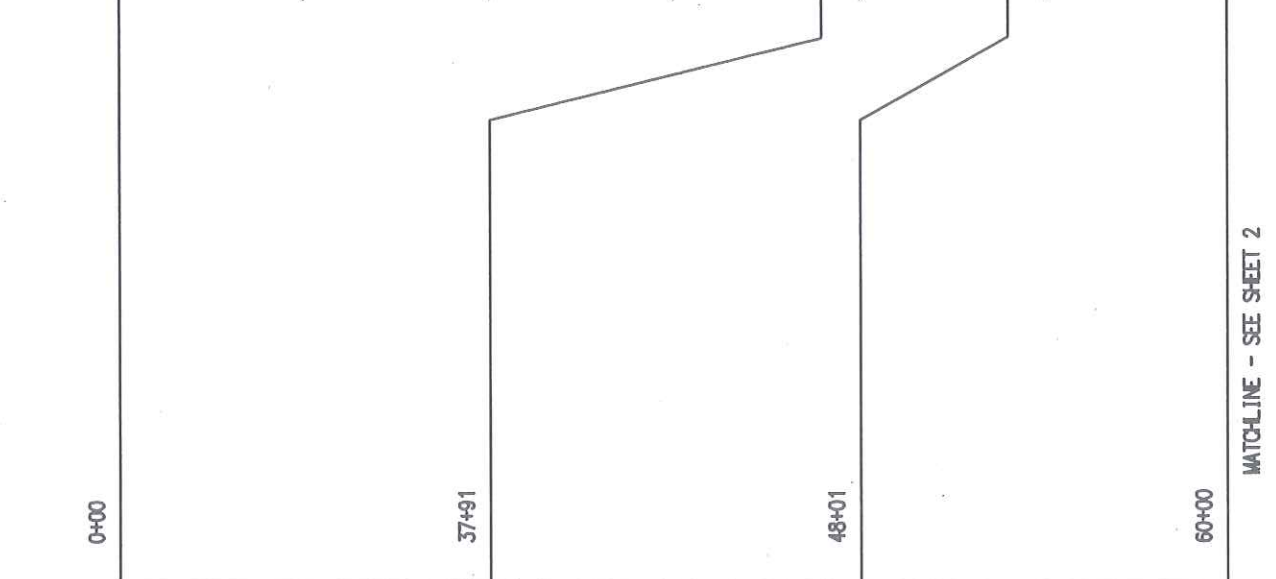
BASIN LOCATION

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA WILSON CREEK (WC-01) SHEET 1 OF 5	N SCALE" 1"=1000'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PLAN-WC-01-SHT 1.DWG EGC 6/30/11 1:13 pm

RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION





	0+00 to 37+91	37+91 to 48+01	48+01 to 60+00
LENGTH	3791'	1010'	1199' Too Far
SLOPE	0.0220	0.0100	0.0160
FLOW	Q100 = 10121	Q100 = 10121	Q100 = 10028
SIZE	b=36', h=15', Z=2.5	RCB: b=16', h=15'	b=58', h=15'
FACILITY TYPE	TYP. SEC. NO. 10	TYP. SEC. NO. 1A	TYP. SEC. NO. 6

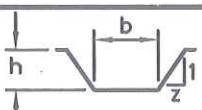
LEGEND

— — — EXISTING

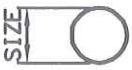
———— PROPOSED TOP OF CHANNEL

———— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL

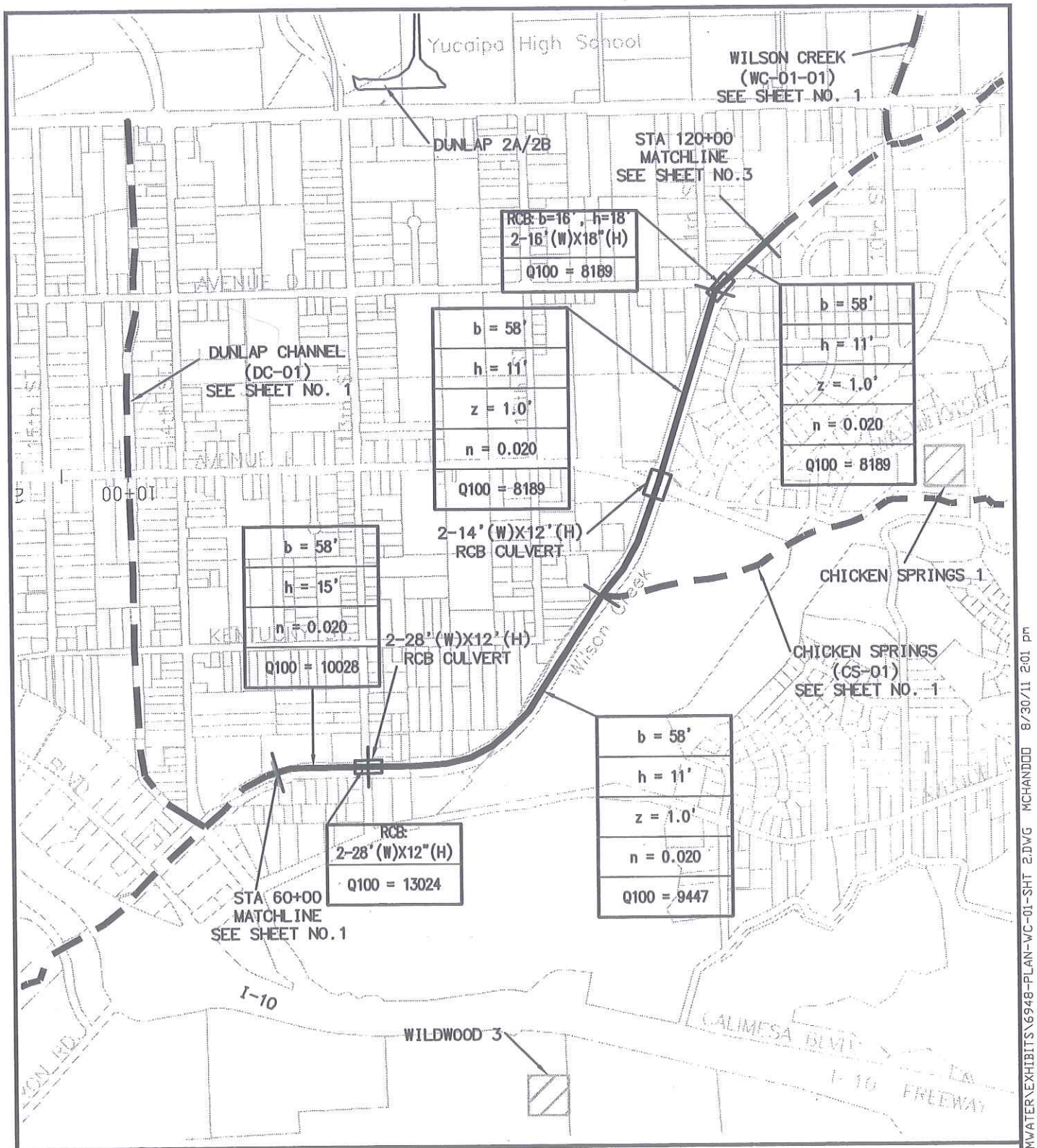


REINFORCED CONCRETE PIPE (RCP)

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA WILSON CREEK (WC-01) SHEET 1 OF 5	SCALE: H: 1"=1000' V: 1"=100'

RBF CONSULTING — PLANNING ■ DESIGN ■ CONSTRUCTION

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-WC-01-SHT 1.DWG MCHANDOO 7/29/11 1:18 pm

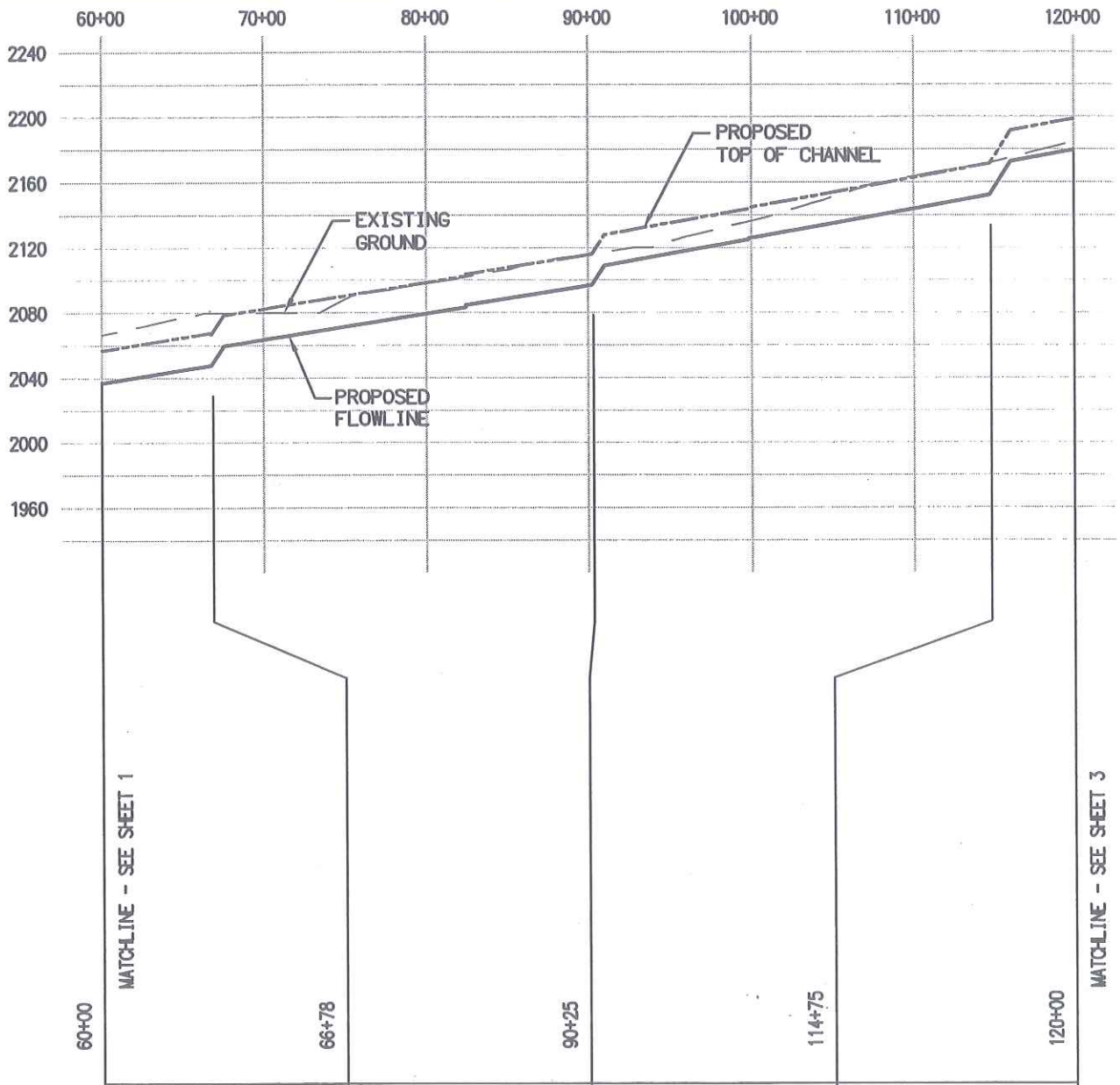


LEGEND		
	PROPOSED FACILITY	BASIN LOCATION
	FACILITY SHOWN ELSEWHERE	

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA WILSON CREEK (WC-01) SHEET 2 OF 5	N SCALE" 1"=1000'

H:\PDATA\1010948\CADD\STRMWATER\EXHIBITS\6948-PLAN-WC-01-SHT 2.DWG MCHANDOO 8/30/11 2:01 pm

RBF CONSULTING
PLANNING ■ DESIGN ■ CONSTRUCTION



LENGTH	678'	2347'	2450'	525'
SLOPE	0.0160	0.0160	0.0180	0.0180
FLOW	Q100 = 10028	Q100 = 9447	Q100 = 8189	Q100 = 8189
SIZE	b=58', h=15'	b=58', h=11', z=1.0	b=58', h=11', z=10	b=58', h=11', z=1.0
FACILITY TYPE	TYP. SEC. NO. 4	TYP. SEC. NO. 4	TYP. SEC. NO. 4	TYP. SEC. NO. 4

W/ DROP St. Soft Bottom or 13

LEGEND

- EXISTING
- PROPOSED TOP OF CHANNEL
- PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)

h, b, z, 1 — TRAPEZOIDAL CHANNEL

SIZE — REINFORCED CONCRETE PIPE (RCP)

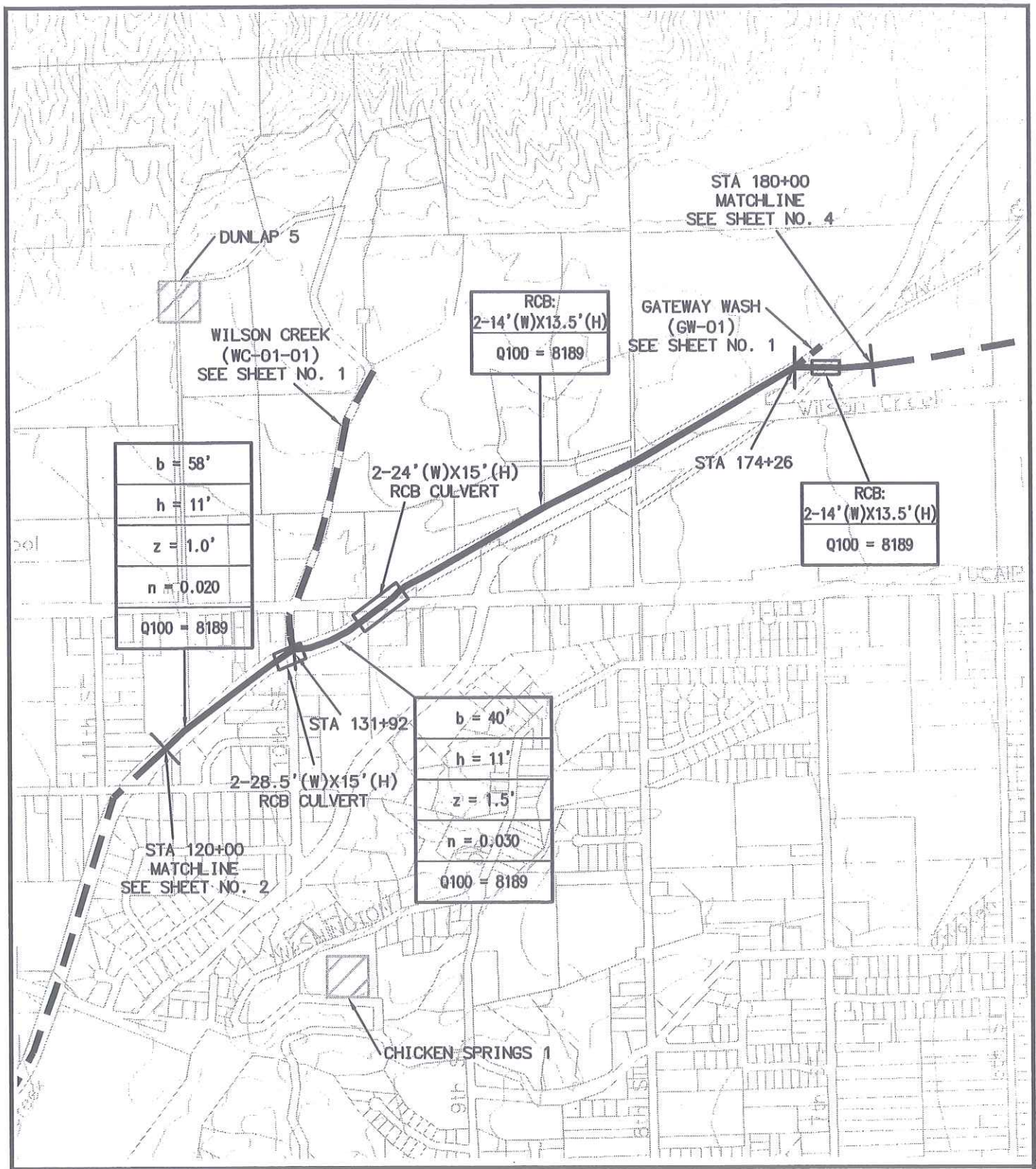
MASTER PLAN OF DRAINAGE

CITY OF YUCAIPA
WILSON CREEK (WC-01)
SHEET 2 OF 5

SCALE:
H: 1"=1000'
V: 1"=100'

RBF CONSULTING — PLANNING ■ DESIGN ■ CONSTRUCTION

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-WC-01-SHT 2.DWG MCHANDOO 8/2/11 1:36 pm



LEGEND

PROPOSED FACILITY

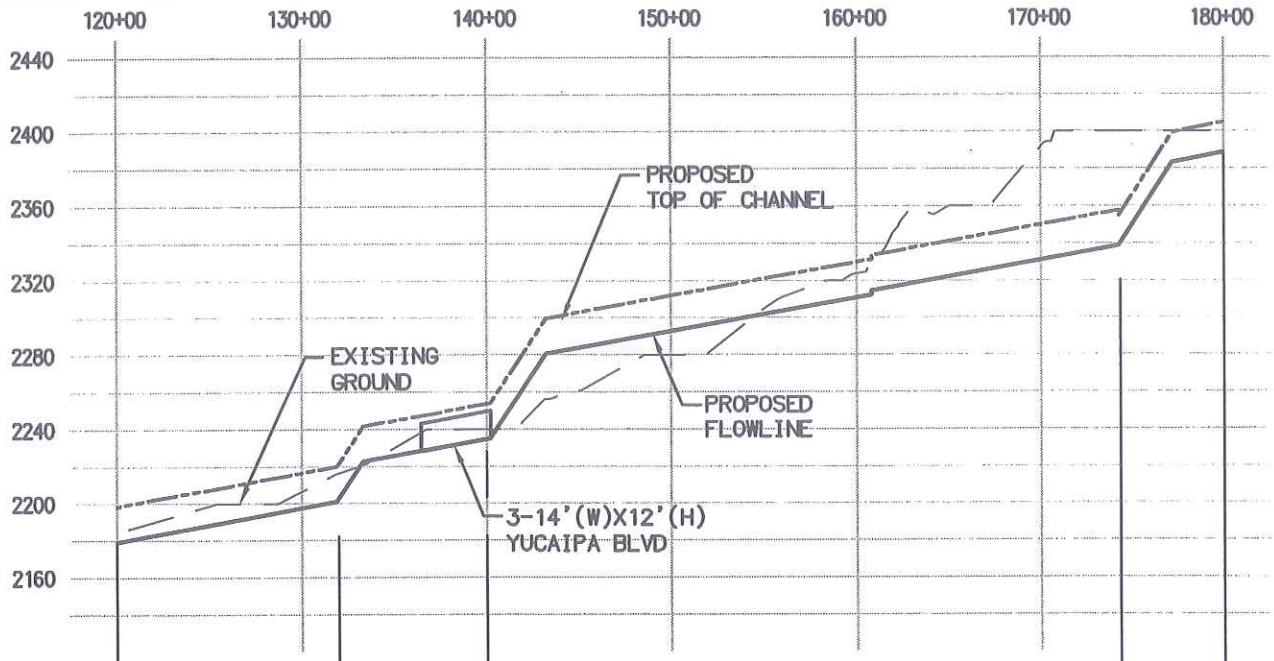
FACILITY SHOWN ELSEWHERE

BASIN LOCATION

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA WILSON CREEK (WC-01) SHEET 3 OF 5	N SCALE" 1"=1000'

H:\PDATA\1010694B\CADD\STRMWATER\EXHIBITS\6948-PLAN-WC-01-SHT 3.DWG EGC 6/30/11 1:19 pm

RBF CONSULTING — PLANNING ■ DESIGN ■ CONSTRUCTION



MATCHLINE - SEE SHEET 2

MATCHLINE - SEE SHEET 4

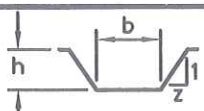
	120+00 – 131+92	131+92 – 140+00	140+00 – 174+26	174+26 – 180+00
LENGTH	1192'	808'	3426'	574'
SLOPE	0.0180	0.0180	0.0180	0.0200
FLOW	Q100 = 8189	Q100 = 8189	Q100 = 8189	Q100 = 5287
SIZE	b=58', h=11', z=1.0	b=40', h=11', z=1.5	RCB: b=14', h=13.5'	RCB: b=14', h=13.5'
FACILITY TYPE	TYP. SEC. NO. 4	TYP. SEC. NO. 10	TYP. SEC. NO. 1A	TYP. SEC. NO. 1A

Soft Bottom

LEGEND

- — — — EXISTING
- ——— PROPOSED TOP OF CHANNEL
- ——— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



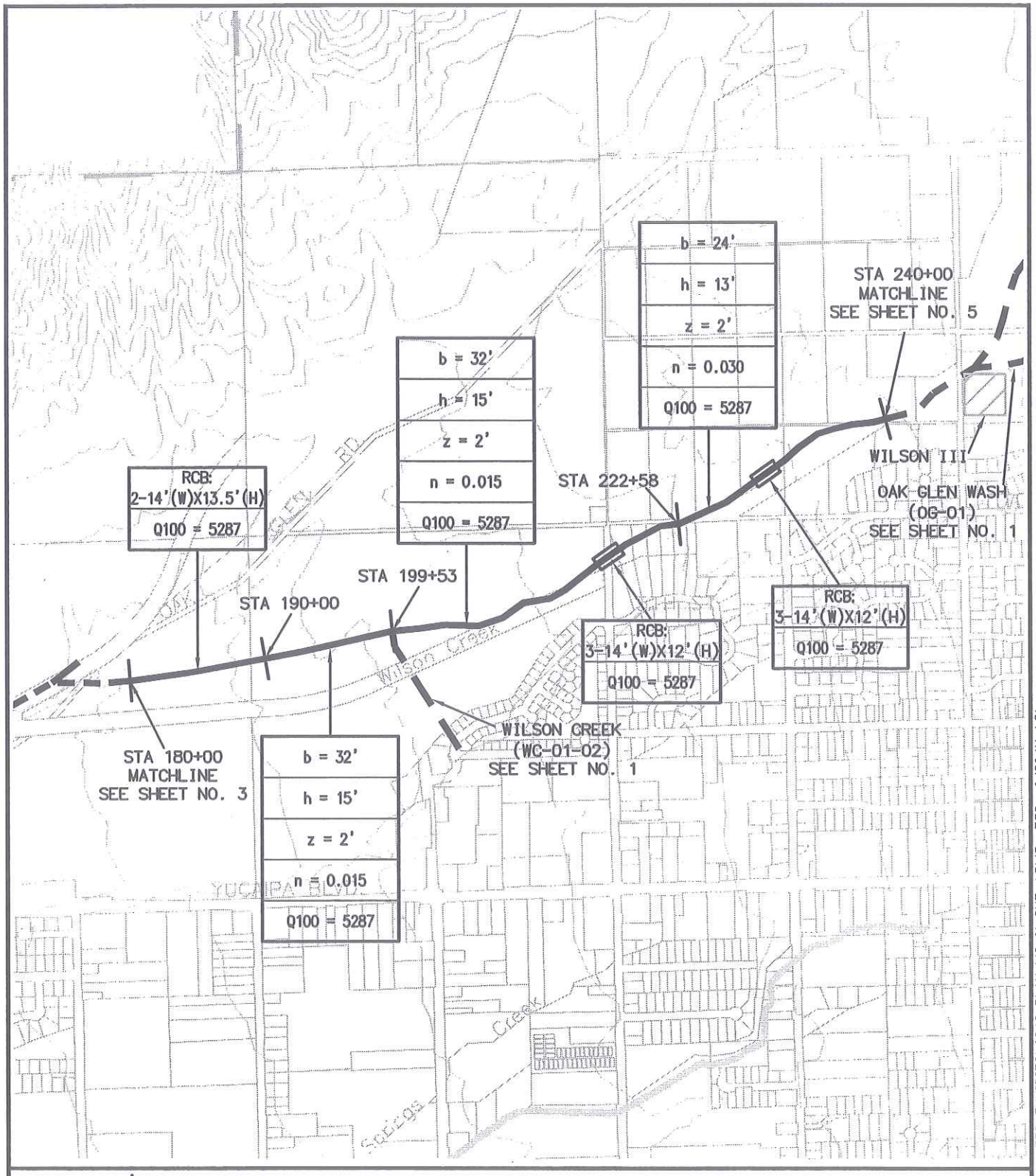
TRAPEZOIDAL CHANNEL

REINFORCED CONCRETE PIPE (RCP)

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA WILSON CREEK (WC-01) SHEET 3 OF 5	SCALE: H: 1"=1000' V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-WC-01-SHT 3.DWG MCHANDOO 7/29/11 1:20 pm

RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION



LEGEND

PROPOSED FACILITY

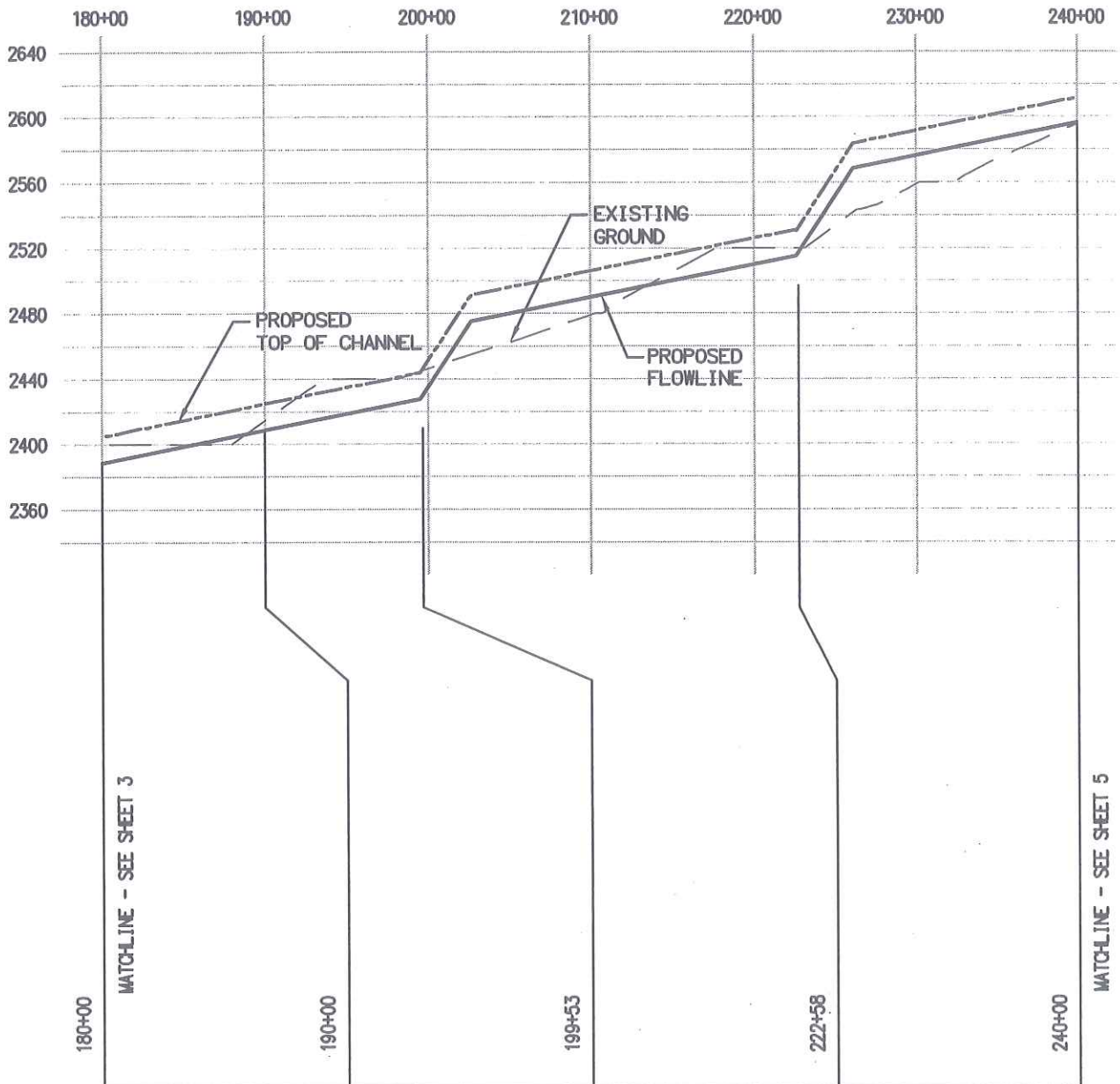
FACILITY SHOWN ELSEWHERE

BASIN LOCATION

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA WILSON CREEK (WC-01) SHEET 4 OF 5	N SCALE" 1"=1000'

RBF CONSULTING — PLANNING ■ DESIGN ■ CONSTRUCTION

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PLAN-WC-01-SHT 4.DWG EGC 6/30/11 1:21 pm



LENGTH	1000'	953'	2305'	1742'
SLOPE	0.0200	0.0200	0.0200	0.0200
FLOW	Q100 = 5287	Q100 = 5287	Q100 = 7914	Q100 = 5287
SIZE	RCB: b=14', h=13.5'	b=32', h=15', z=2	b=32', h=15', z=2	b=24', h=13', z=1.5
FACILITY TYPE	TYP. SEC. NO. 1A	TYP. SEC. NO. 1A	TYP. SEC. NO. 5	TYP. SEC. NO. 8 CONC

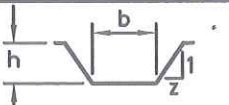
LEGEND

— — — EXISTING

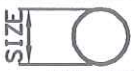
—·-·- PROPOSED TOP OF CHANNEL

——— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL



REINFORCED CONCRETE PIPE (RCP)

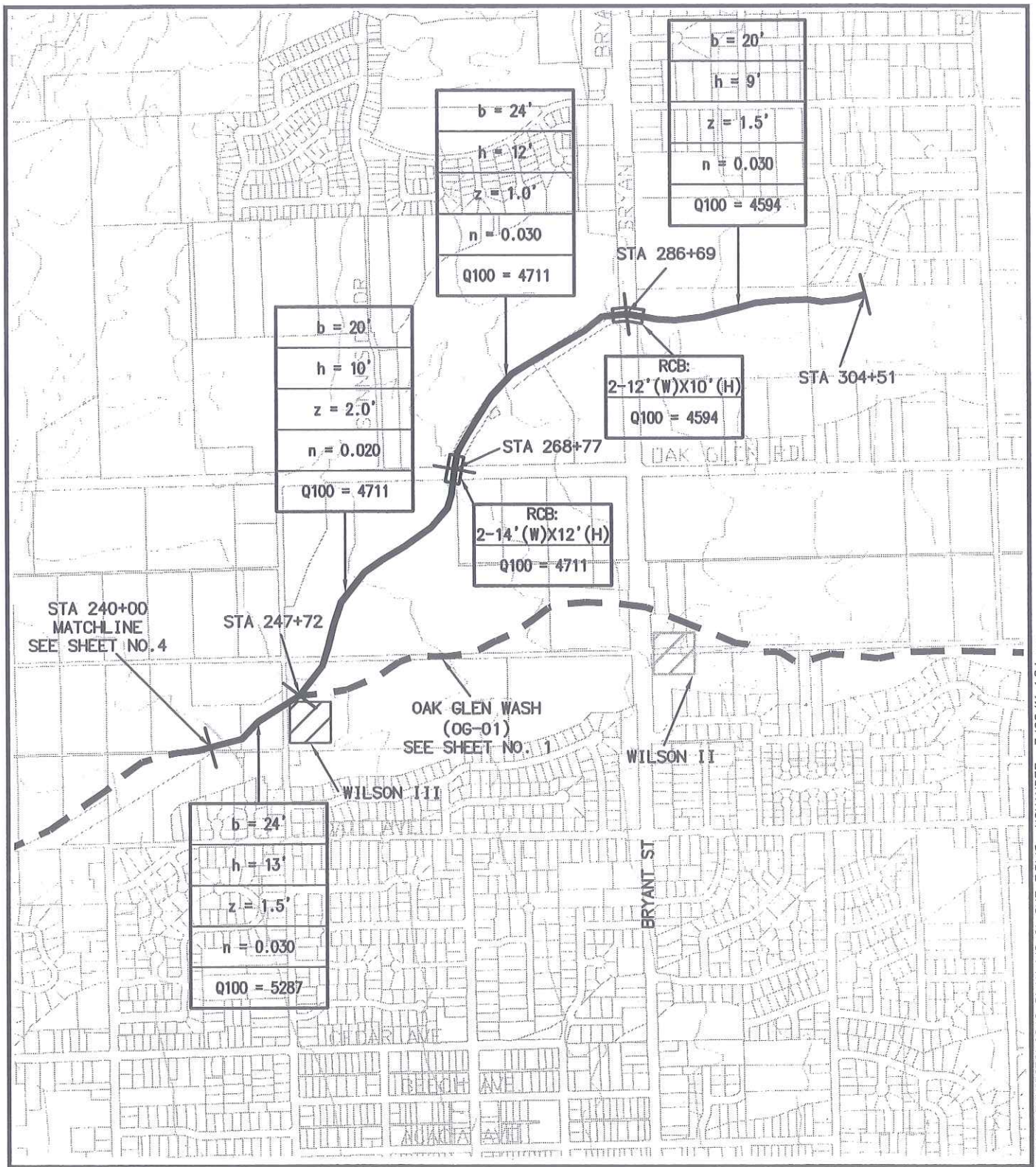
MASTER PLAN OF DRAINAGE

CITY OF YUCAIPA
WILSON CREEK (WC-01)
SHEET 4 OF 5

SCALE:
H: 1"=1000'
V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-WC-01-SHT 4.DWG MCHANDOO 7/29/11 1:22 pm

RBF CONSULTING
PLANNING ■ DESIGN ■ CONSTRUCTION



LEGEND

PROPOSED FACILITY

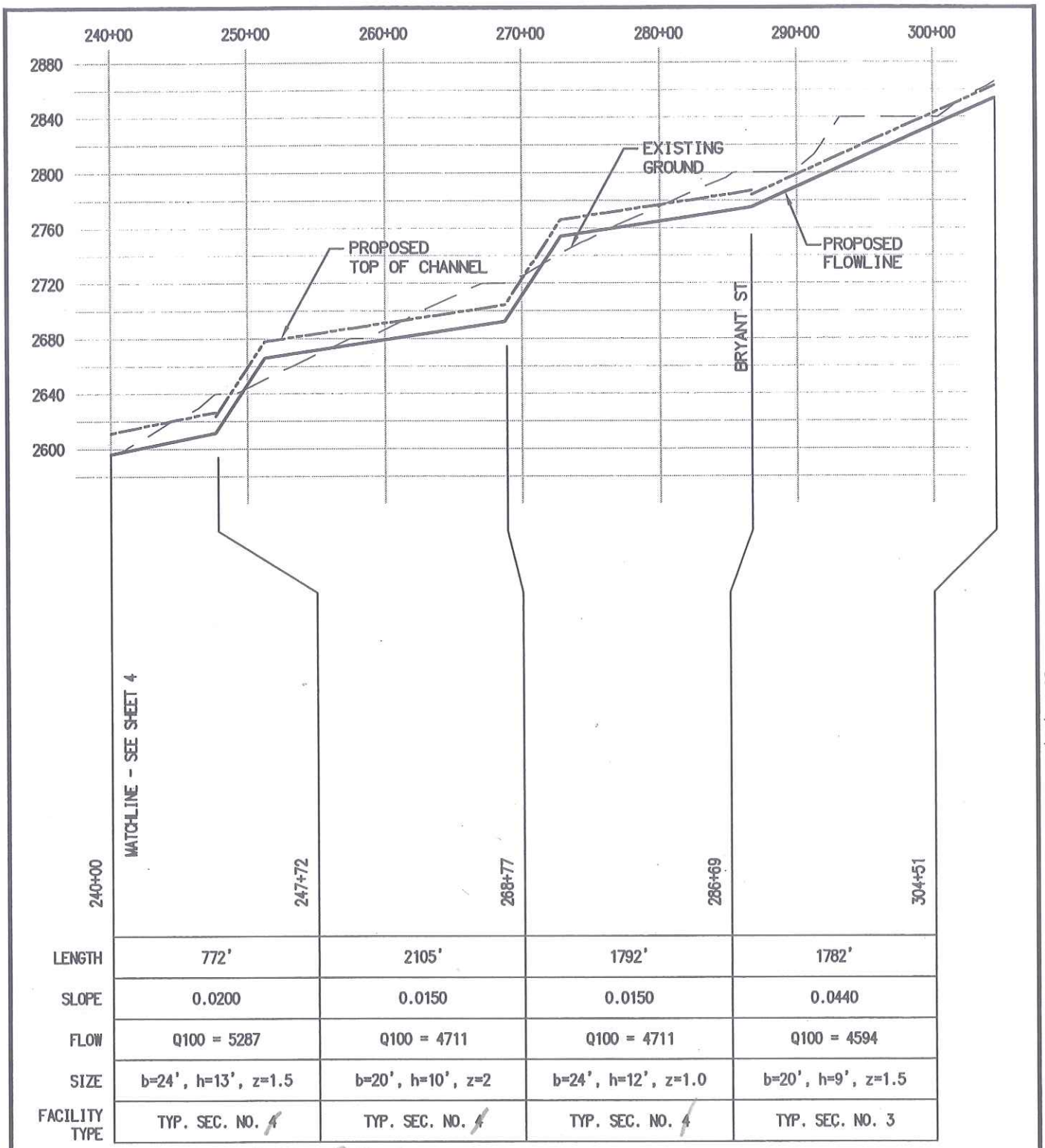
FACILITY SHOWN ELSEWHERE

BASIN LOCATION

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA WILSON CREEK (WC-01) SHEET 5 OF 5	N SCALE" 1"=1000'

H:\PDATA\1010948\CADD\STRMWATER\EXHIBITS\6948-PLAN-WC-01-SHT 5.DWG MCHANDDO 7/29/11 1:24 pm

RBF CONSULTING — PLANNING ■ DESIGN ■ CONSTRUCTION



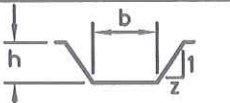
LENGTH	772'	2105'	1792'	1782'
SLOPE	0.0200	0.0150	0.0150	0.0440
FLOW	Q100 = 5287	Q100 = 4711	Q100 = 4711	Q100 = 4594
SIZE	b=24', h=13', z=1.5	b=20', h=10', z=2	b=24', h=12', z=1.0	b=20', h=9', z=1.5
FACILITY TYPE	TYP. SEC. NO. ~~4~~	TYP. SEC. NO. ~~4~~	TYP. SEC. NO. ~~4~~	TYP. SEC. NO. 3

Soft Bottom

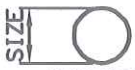
LEGEND

- EXISTING
- PROPOSED TOP OF CHANNEL
- PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL



REINFORCED CONCRETE PIPE (RCP)

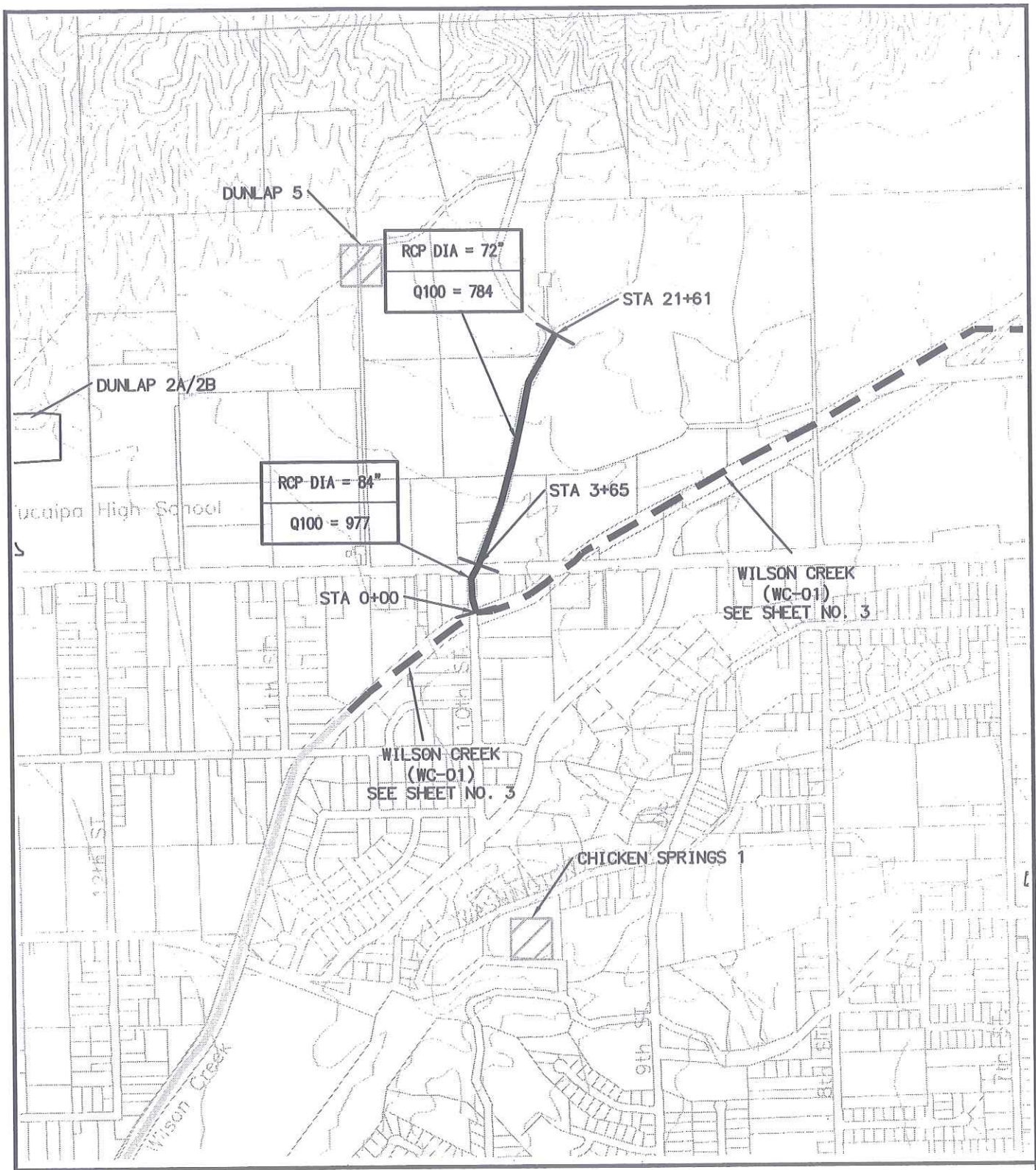
MASTER PLAN OF DRAINAGE

CITY OF YUCAIPA
WILSON CREEK (WC-01)
SHEET 5 OF 5

SCALE:
H: 1"=1000'
V: 1"=100'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PRF-WC-01-SHT 5.DWG MCHANDOO 7/29/11 1:25 pm

RBF CONSULTING
PLANNING ■ DESIGN ■ CONSTRUCTION

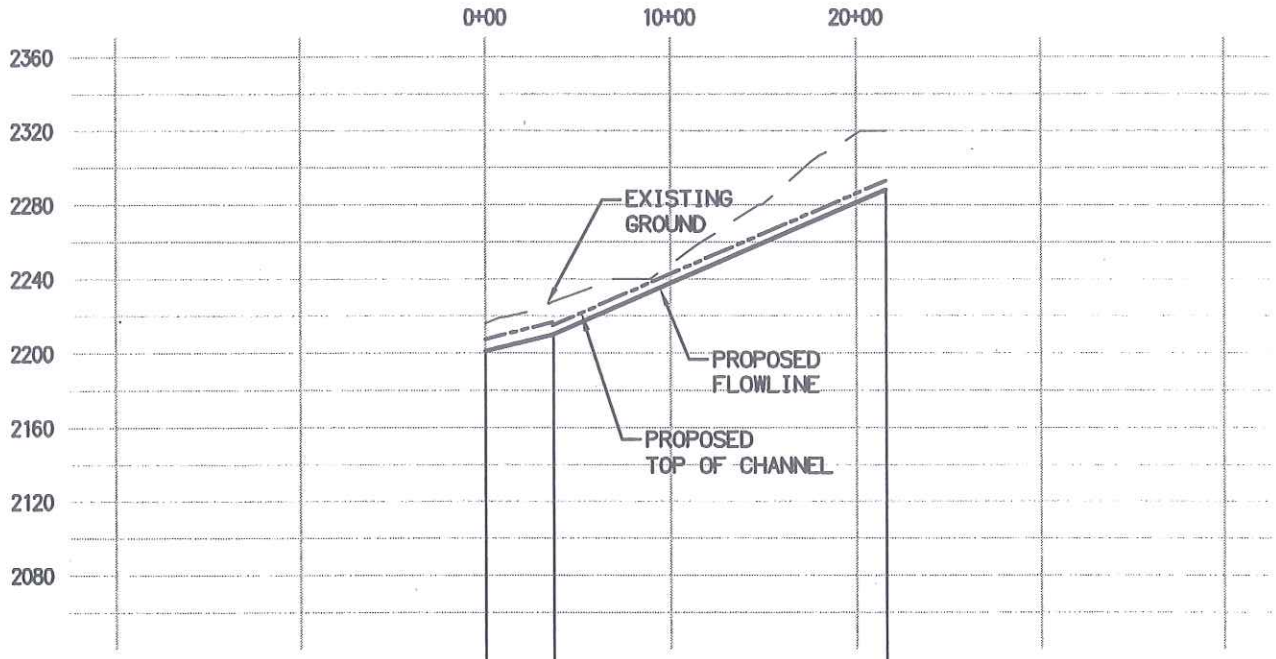


LEGEND		
	PROPOSED FACILITY	BASIN LOCATION
	FACILITY SHOWN ELSEWHERE	

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA WILSON CREEK (WC-01-01) SHEET 1 OF 1	N SCALE" 1"=1000'

H:\PDATA\10106948\CADD\STRMWATER\EXHIBITS\6948-PLAN-WC-01-01.DWG MCHANDDD 8/30/11 1:49 pm

RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION



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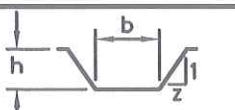
SLOPE	0.0250		0.043
FLOW	Q100 = 977		Q100 = 784
SIZE	RCP DIA = 84" RCP		RCP DIA = 72" RCP
FACILITY TYPE	TYP. SEC. NO. 1		TYP. SEC. NO. 1

LEGEND

- — — — EXISTING
- —·-·— PROPOSED TOP OF CHANNEL
- ——— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL

REINFORCED CONCRETE PIPE (RCP)

MASTER PLAN OF DRAINAGE

CITY OF YUCAIPA
WILSON CREEK (WC-01-01)
SHEET 1 OF 1

SCALE:
H: 1"=1000'
V: 1"=100'

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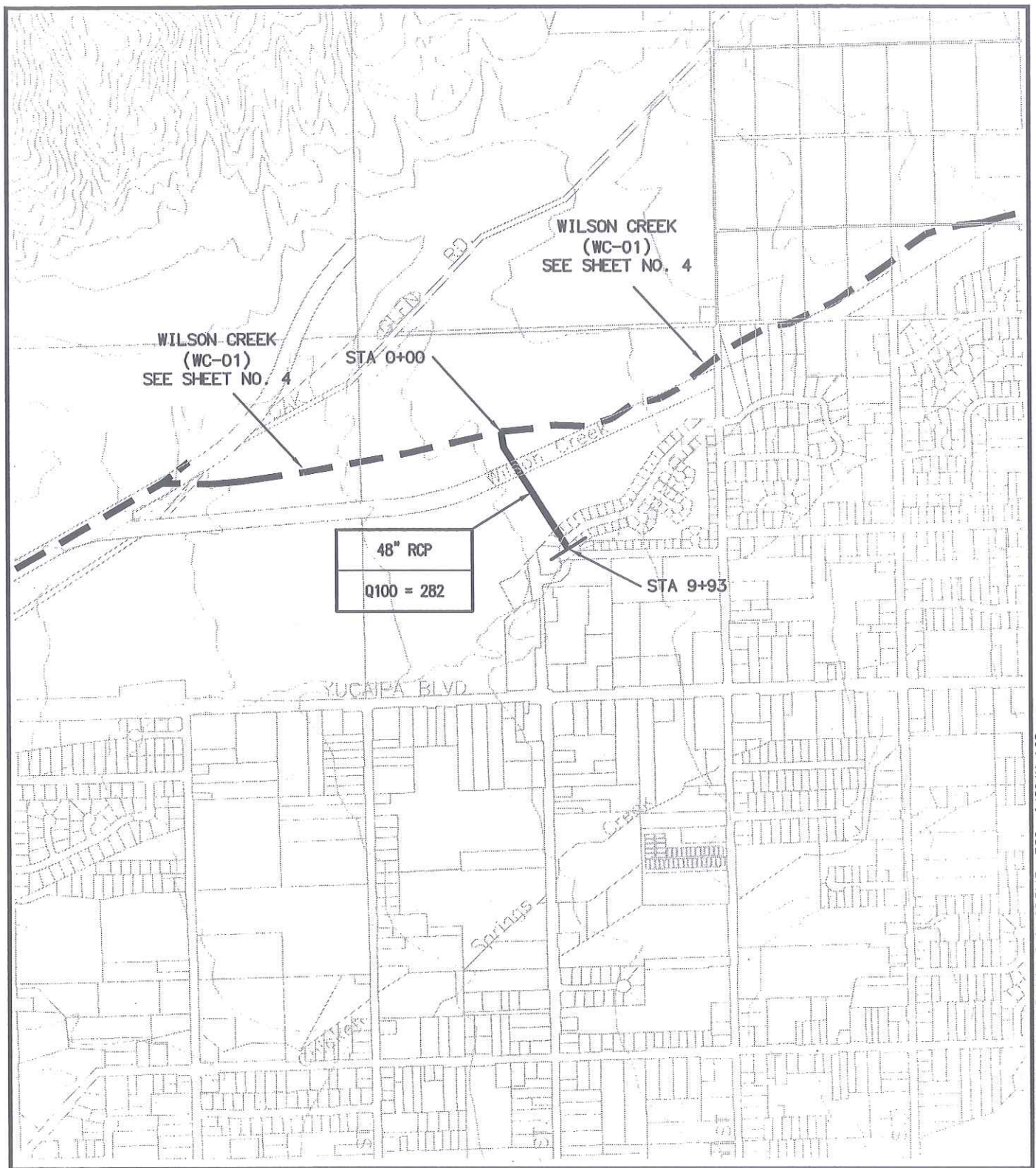
PLANNING ■ DESIGN ■ CONSTRUCTION



LEGEND		
	PROPOSED FACILITY	BASIN LOCATION
	FACILITY SHOWN ELSEWHERE	

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA WILSON CREEK (WC-01-02) SHEET 1 OF 1	N SCALE" 1"=1000'

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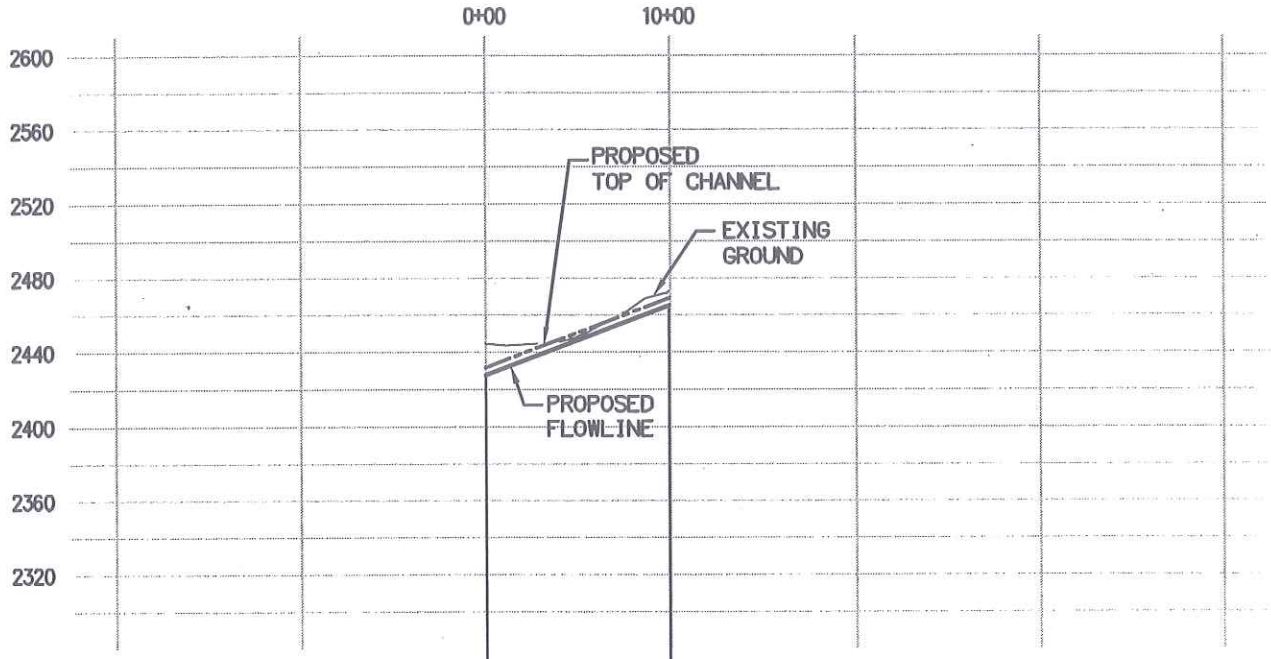
RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION



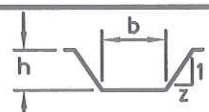
LENGTH	993'
SLOPE	0.037
FLOW	Q100 = 282
SIZE	48" RCP
FACILITY TYPE	TYP. SEC. NO. 1

LEGEND

— — — EXISTING

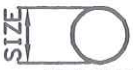
—·—·— PROPOSED TOP OF CHANNEL

——— PROPOSED FLOWLINE



REINFORCED CONCRETE BOX (RCB)

TRAPEZOIDAL CHANNEL



REINFORCED CONCRETE PIPE (RCP)

MASTER PLAN OF DRAINAGE	**CITY OF YUCAIPA WILSON CREEK (WC-01-02) SHEET 1 OF 1**	SCALE: H: 1"=1000' V: 1"=100'

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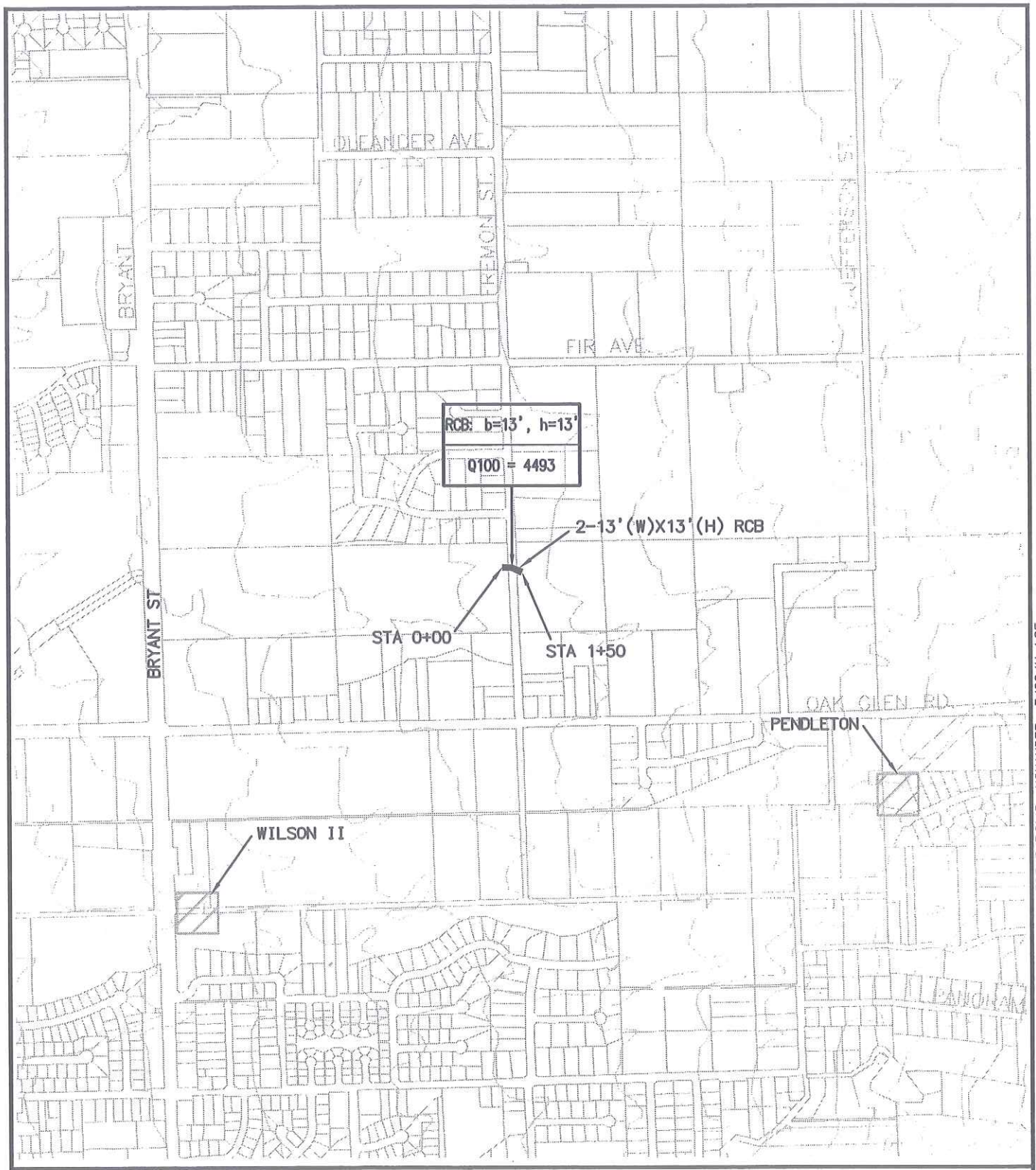
RBF CONSULTING — PLANNING ■ DESIGN ■ CONSTRUCTION



LEGEND		
	PROPOSED FACILITY	BASIN LOCATION
	FACILITY SHOWN ELSEWHERE	

MASTER PLAN OF DRAINAGE	CITY OF YUCAIPA FREMONT CROSSING (WC-02-01) SHEET 1 OF 1	N SCALE" 1"=1000'

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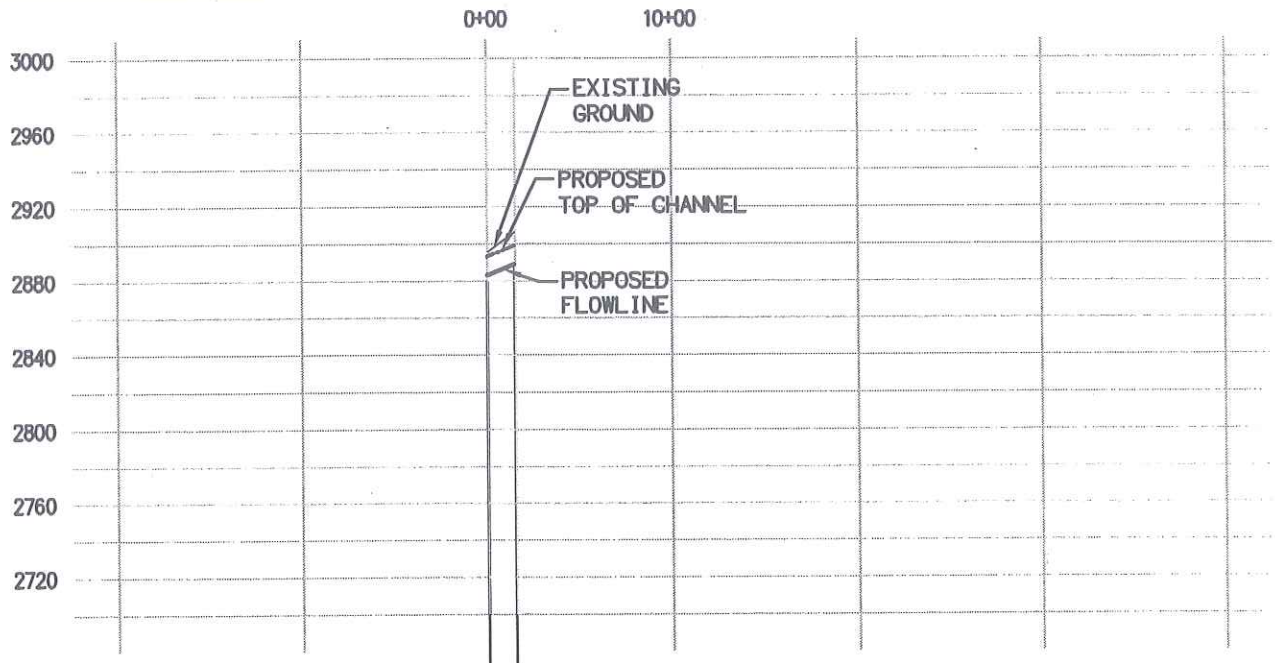
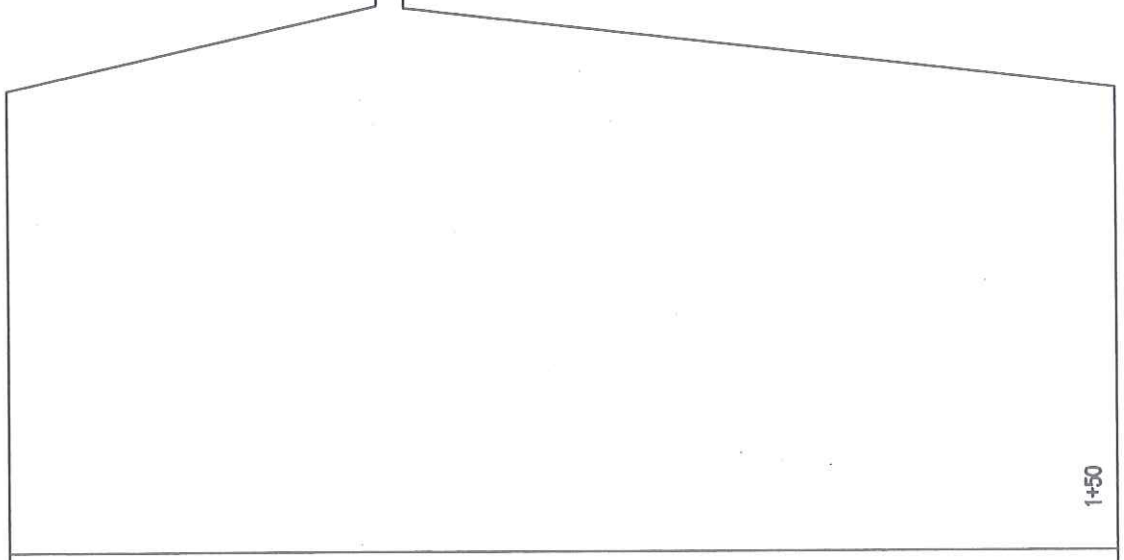


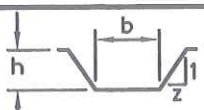


LENGTH	150'
SLOPE	0.0400
FLOW	Q100 = 4493
SIZE	RCB: b=13', h=13'
FACILITY TYPE	TYP. SEC. NO. 1A

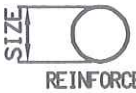
LEGEND

- — — — EXISTING
- —-—-— PROPOSED TOP OF CHANNEL
- ——— PROPOSED FLOWLINE

REINFORCED CONCRETE BOX (RCB)



TRAPEZOIDAL CHANNEL



REINFORCED CONCRETE PIPE (RCP)

MASTER PLAN OF DRAINAGE

CITY OF YUCAIPA
FREMONT CROSSING (WC-02-01)
SHEET 1 OF 1

SCALE:
H: 1"=1000'
V: 1"=100'

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RBF CONSULTING PLANNING ■ DESIGN ■ CONSTRUCTION

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TECHNICAL MEMORANDUM
Wilson/Oak Glen Creek Optimization Study
August, 2011

This study consists of a combination of hydrologic and hydraulic calculations to identify the most feasible and economical watershed-wide drainage solution. This iterative process involved completing several evaluations of different combinations of detention basin routing versus proposed downstream channel and culvert improvements. The channel improvements focused on the reach of Wilson Creek between the I-10 and Yucaipa Blvd.

The first order of the study was to identify a baseline condition for the existing Wilson Creek channel facilities and basins using the San Bernardino County Flood Control District (SBCFCD) Hydrology methodology. This was performed to identify a "target flowrate", where the channel system between Yucaipa Blvd. and I-10 begins to fail. A series of potential basins upstream of these locations were evaluated in conjunction with improvements within the channel itself to identify the most feasible watershed drainage solution.

Hydrology:
The hydrology for this study was performed according to the San Bernardino County methodology, or the hydrology established in the 2008 MPD Update. Baseline hydrology was run with the newly constructed Wilson 2 Detention basin, located along Oak Glen Creek just upstream of Bryant Street. This basin rating curve was established using XPSWMM, since it is an off-line basin. The standard AES software programs, do not accurately evaluate these types of basins. This basin consists of three sub-basins, with one inline, and two offline basins. These three basins are linked by single celled pipe culverts and emergency spillways.

The analysis required an advanced model capable of modeling backwater effects using dynamic modeling capabilities for a continuous simulation model for the inflow storm event. Per the direction of the County, RBF utilized an inflow hydrograph from the AES model as the inflow for the XPSWMM analysis. The resulting outflow hydrograph was then hard coded back into the AES model for the remainder of the Wilson Creek analysis.

Regional hydrology models were prepared with concentration points located at four locations along Wilson Creek; 1) Yucaipa Blvd., 2) confluence of Chicken Springs, 3) Dunlap Channel, and 4) Interstate 10 freeway. These nodes were used for comparison and also for the hydraulic calculations for the Wilson Creek channel optimization.

Several potential detention basin locations were initially considered to attenuate peak flows. These basins included Wilson 3 (at the confluence of Oak Glen Creek and Wilson Creek), Pendleton (Oak Glen Creek at Pendleton Street), Fremont (Wilson Creek at Fremont Street), and modifying the existing SBCFCD spreading ground basins (located just downstream of Fremont Street along Wilson Creek).

As part of the optimization study, each on of these basins was evaluated to maximize their respective peak flow attenuations. Combinations of all basins were also evaluated to understand how they performed in connection with each other to identify, or maximize, total peak flow reduction as a system of basins. Ratios of cost per unit flow attenuated were prepared to understand the cost effectiveness of constructing each basin, in addition to, the combination of particular basins. Although many options and combinations of detention basins

were considered, the final evaluation was condensed down to six (6) options. Each option consisted of differing combinations of basins, and their sizes. Option six included the use of a major basin at the Wilson 3 location.

Several basin configurations were evaluated. Some of the configurations considered include the following:

Pendleton (Configuration 1 – Used in Option 4)
Storage: 84 ac-ft
Max Depth: 25-ft
Outlet Culvert: 3-10'Wx10'H RCB

Pendleton (Configuration 2 – Used in Option 5)
Storage: 130 ac-ft
Max Depth: 25-ft
Outlet Culvert: 2-12'Wx10'H RCB

Wilson III (Configuration 1 – Maximized Alternative – Used in Option 3a)
2-Basins in Series
Total Storage: 313.91 ac-ft & 323.20 ac-ft
Internal Channel Realignment – Full armored trap channel for both Wilson and Oak Glen

Wilson III (Configuration 2 – City Concept – Used in Option 2a)
3-Offline Basins (off-line)
Total Storage: Basin 1 (16 ac-ft), Basin 2 (24 ac-ft), Basin 3 (45 ac-ft) = Total 95 ac-ft
Channel Realignment – Full armored trap channel for both Wilson and Oak Glen

Wilson III (Configuration 3 – City Revised Concept – Used in Option 2, 3, 4, and 4a)
2-Basins off-line and 1 in-line.
Total Storage: Basin 1 (75 ac-ft), Basin 2 (34 ac-ft), Basin 3 (45 ac-ft) = Total 154 ac-ft
Channel Realignment – Full armored trap channel for both Wilson and Oak Glen

Wilson III (Configuration 4 – City Revised Concept – Used in Option 5)
1-Basin (in-line).
Total Storage: 200 ac-ft
Channel Realignment – Full armored trap channel for both Wilson and Oak Glen

Wilson III (Configuration 5 – County Concept – Used in Option 6)
1-Basin (in-line).
Total Storage: 500+ ac-ft
Channel Realignment – Full armored trap channel for both Wilson and Oak Glen

Fremont (Includes SBFCD Spreading Grounds – Used in Options 3, 3a, 4, and 4a)
Small Basin in series with SBCFCD 4 Spreading Grounds Basins.
Total Storage: Freemont (17 ac-ft) + Spreading Grounds (194 ac-ft) = 212 ac-ft

Nodes were established along Wilson Creek for scenario, or "Option" comparison. The node locations were identified at:

1 – Downstream edge of Yucaipa Blvd.
2 – Chicken Springs Confluence
3 – Dunlap Confluence

4 – Interstate 10

For each Option, hydrology was calculated using the appropriate depth-area reductions for the tributary watersheds. Each basin was evaluated based on these parameters for each option. Bulking factors of 1.30 were used for Wilson Creek for the entire channel section from Yucaipa Blvd. to I-10. Refer to "*Wilson Creek/Oak Glen Detention Basin Alternative Analysis, Summary Results (SBCFCD Method)*".

RBF evaluated an option maximizing the proposed detention basins. This was completed in order to understand the "maximum attenuation" possible. This alternative included Pendleton, Fremont, Wilson 3, and the existing Wilson 2 detention basins. Coordinating with the City, concept layouts for these basins were maximized, including sizes that would require right-of-way purchases. Several basin alignments and outlet configurations were evaluated to yield the maximize attenuation at each site. Flow through and flow by, and combinations of both, where evaluated at each basin site.

Once the maximum basin attenuation alternative and the existing capacity of the channel (between Yucaipa Blvd. and I-10) are evaluated, the iterative calculations begin. The hydrologic models focused on the concentration point at Yucaipa Blvd, or the upstream end of the HEC-RAS run.

Several basin configurations "Options" were created for comparison. These options consist of only a few of the many scenarios run but were selected due to their relevance and ease of comparison in identifying how each basin impacted the system flows.

Channel Hydraulics

Using the USACE topography, cross sections were cut between Yucaipa Blvd. and the I-10 freeway for the HEC-RAS model development. An existing condition capacity analysis was performed to identify the sensitive locations within the creek. The initial target flowrate is the existing channel capacity, assuming the culvert crossing at Dunlap would be removed. This flowrate was used as the starting point of the detention basin evaluations. For example, if the maximized detention basins could reduce the 100-year peak flowrate to the "target" flowrate in Wilson Creek, theoretically, no improvements would need to be performed in Wilson Creek. As a result, the channel improvement costs would be zero, but the basin costs would potentially be very high.

Wilson Creek from the I-10 to Yucaipa Blvd. was divided into four reaches for analysis purposes based on the flow characteristics observed in the model. They are as follows:

- Reach 1: I-10 to 14th Street
- Reach 2: 14th Street to 13th Street
- Reach 3: 13th Street to 10th Street
- Reach 4: 10th Street to Yucaipa Blvd.

Using the resulting flowrates from the hydrology scenarios (multiple basin configurations), HEC-RAS calculations was performed. Where flows breeched the channel, improvements were proposed in the model to contain the peak flows. Each scenario resulted in a cost for channel versus basin improvements. These totals were summed to yield a watershed improvement total cost. Multiple iterations were performed using various scenarios to yield the multiple facility costs for City review and Option selection.

All hydraulic calculations were performed per the SBCFCD guidelines including freeboard requirements for structures and channel sections. The resulting channel improvements were evaluated for costs, which included excavation, material type, right-of-way purchase, and grade control.

Channel geometries were evaluated based on existing footprint. When possible, natural linings were used for entire sections or inverts.

The HEC-RAS models were run using several differing Manning's roughness coefficients, depending on what proposed material was to be used. The evaluation resulted in following sections:

- RC Rectangular
- Soil Cement fully lined
- Soil Cement side slope with natural bottom (side slopes extend 5' below invert)
- Grouted Rip Rap fully lined (County Concept upstream of 10th Street)
- Natural or Earthen extension of side slope.

Each proposed section was evaluated with a 3' freeboard section. In some cases, less freeboard was found, similar to the County Concept for the reach between Yucaipa Blvd. and the 10th Street crossing. But in every case, more than 2' of freeboard was established.

Results

The flow results in Table 1 reflect the recommended alternative for optimizing the basins within the Wilson Creek watershed. This alternative included implementing a 130 ac-ft basin at Pendleton (Oak Glen Wash) and a 200 ac-ft basin at the Wilson 3 proposed basin site. These two basins provided the most feasible results when coupled with downstream channel improvements, and are currently in the City's Master Plan of Drainage and Capital Improvement Program. It was found that expanding the Fremont basin or the SBCFCD basins, did not provide effective flow reductions relative to the construction costs. The Pendleton basin did not provide large (watershed) attenuation characteristics, but does have an overall peak flow reduction benefit to the system. The City is currently is moving forward with plans to improve the Pendleton crossing, and a balance site scenario for the roadway embankment will result in a relatively inexpensive addition of a basin at this location.

Table 1: Wilson Creek Recommended Option Flow Results

MPD Node	Location	Existing Conditions Q (cfs)	Optimized Alternative Q (cfs)	Mitigated Q (cfs)	Bulked 1.30 Q (cfs)
3373	Yucaipa Blvd.	10,233	8,189	2,044	10,646
3833	Chicken Springs	11,302	9,447	1,855	12,281
4517	Dunlap Channel	11,753	10,099	1,654	13,129
5524	D/S I-10	11,776	10,173	1,603	13,225

Initial channel hydraulic calculations revealed the existing capacity of the channel is approximately 5,000 cfs, with breakout occurring near the 10th Street crossing just downstream of Yucaipa Blvd. and upstream of 10th Street crossing. Other locations of breakout were identified near the 14th Street crossing at higher flowrates.

In general, it was found that channel improvements along Wilson Creek between Yucaipa Blvd. and I-10 were required even during maximum detention upstream. This section of channel is steep with natural inverts and sideslopes for most of the reach. Erosive velocities were found even during the lowest of flows. Existing grade control structures consist of older wire revetment corrugated steel sheet piles. The cost associated with the channel improvements for reduced flows upstream versus non-reduced flow scenarios were relatively similar compared to the construction costs of the upstream detention basins. As a result, over-mitigating the upstream sections was found not to be the most feasible solution.

Based on the hydrology and hydraulic results for each scenario, the selected alternative included the geometries listed in Table 2 for Wilson Creek between Yucaipa Blvd. and the I-10 freeway.

Table 2: Wilson Creek Optimized Channel Sections (Option 5 – Recommended Alternative)

HECRAS Channel Reach	Segment	Description
1	I-10 to 14th Street	Rectangular RC channel (B=58', H=15')
1	Transition just upstream of I-10	Concrete Transition from Trap channel to 58'X15' Rect channel
1	14th Street bridge	Modify to 15' Clear to match channel depth
2	14th Street to Sta 3600	Channel Soil Cement lining (Bottom & Sides)
2	Sta 3600 to XS 9508	Channel Soil Cement lining (Sides Only)
2	Sta. 2700 to 13th Street (Left)	1' High levee on left bank - for freeboard
2	Sta. 2700 to 13th Street (Left)	Channel Soil Cement lining (Sides Only)
3	Sta. 5700 to Sta. 6300 (Left)	1' High levee on left bank - for freeboard
3	Sta. 5700 to Sta. 6300 (Left)	Channel Soil Cement lining (Sides Only)
3	Avenue D to Sta. 9500 (Left)	3' High Levee on left side - for freeboard
3	Avenue D to Sta. 9500 (Left)	Channel Soil Cement lining (Sides Only)
3	Sta. 5700 to Sta. 6300 (Right)	1' High levee on right bank - for freeboard
3	Sta. 5700 to Sta. 6300 (Right)	Channel Soil Cement lining (Sides Only)
3	Avenue D to Sta. 9500 (Right)	3' High Levee on right side - for freeboard
3	Avenue D to Sta. 9500 (Right)	Channel Soil Cement lining (Sides Only)
1-4	Sta. 3600 to 10th Street	Grade Control Sheet Pile w/ Loose Riprap

The preliminary comparison for construction costs can be seen in the Appendix for all Options. These values are just preliminary and were used for alternative comparison purposes. As can be seen from Table 3, Option 1 is the least expensive overall. But since the City has current plans to develop the Wilson 3 and Pendleton areas, it was feasible to use these sites for attenuation.

Table 3: Preliminary Cost Summary

Option	Basins	Armored Channel Improvements	Total
MPD	$ 8,100,000	$ 20,110,000	$ 28,210,000
1 (Existing)	$0	$ 14,047,000	$ 14,047,000
2	$ 8,660,000	$ 13,619,000	$ 22,279,000
2a	$ 7,960,000	$ 13,937,000	$ 21,897,000
3	$ 11,280,000	$ 13,619,000	$ 24,899,000
3a	$ 17,500,000	$ 12,775,000	$ 30,275,000
4	$ 13,610,000	$ 13,505,000	$ 27,115,000
4a	$ 13,720,000	$ 13,505,000	$ 27,225,000
5	*$ 11,370,000*	*$ 13,505,000*	*$ 24,875,000*
6	$ 18,140,000	$ 12,775,000	$ 30,915,000

Based on the results from a cost summary perspective, it was found that the most economical approach would be to not include any basins upstream, as improvements would need to be introduced in the channel sections regardless of the upstream basin improvements. This is primarily a result of the steepness of the channel and the locations within the watershed of the future proposed basin locations. However, the Wilson III basin project location was identified in the City's original Master Plan of Drainage and subsequent updates, as a high priority project to assist in reducing flood risk in the City. The recommended alternative (Option 5) results show that the combination of existing and proposed basins, in conjunction with downstream channel improvements, will result in a reduction of peak flows of approximately 20% at Yucaipa Boulevard. Other benefits to the upstream basins include reduced sedimentation downstream, groundwater recharge of natural stream flows, improved downstream water quality, economic development opportunities and environmental restoration and enhancements.

The City is currently moving forward with improvement plans for the Wilson 3 and the Pendleton areas. As a result, both of these locations could be constructed with potentially reduced costs if implemented with current project plans. Plans for a commercial development and the 2nd Street crossing are proposed for the Wilson 3 (200 ac-ft) basin area. In addition, a roadway crossing at Pendleton could be constructed to balance the cut-fill quantities with a proposed basin (estimated to be 130 ac-ft). If constructed concurrently, the proposed estimated costs for these two basins, shown above, could be minimized. These potential cost savings will not be accurately identified until a detailed site plan and analysis is performed during the design process. Consequently, Option 5, which includes the implementation of the Wilson 3 and Pendleton basins, has been identified as the recommended alternative.

TECHNICAL MEMORANDUM
Dunlap Channel Watershed Study
August 2, 2011

RBF has prepared an Optimization analysis of the Dunlap Channel watershed. The purpose of this study is to optimize the facilities in the watershed using more advanced models. Normal depth calculations, as used in the MPD, may not adequately size and/or take backwater effects, into account.

This analysis includes evaluations of conveyances in streets, storm drains, proposed (and existing) detention basins, and the Dunlap channel. Streets analyzed include Yucaipa Blvd, Ave D, Ave E, Kentucky St., 11th St., 12th St., 13th St., 14th St., and 15th St. Drainage systems include Dunlap Channel, the storm drains along Yucaipa Blvd, 7-ft catch basin at the intersection of 11th Street and Yucaipa Blvd, 30-in RCP along 11th St., Ave D storm drain, Ave E storm drain, and Kentucky St. storm drain.

Hydrology

The discharges used for this watershed update are based on the approved MPD prepared by Boyle and the 2008 MPD Update by RBF Consulting. Unit Hydrograph method was used to evaluate basins D-2A, D-2B, D-4, and D-5 using the Advanced Engineering Software (AES) programs. Based on the analysis 100-yr peak flows at four locations within Dunlap channel were as follows:

100-Year Peak Flow Summary Results

Location	Q, cfs (UH)
Upstream Channel/Yucaipa Blvd	554
D/S of Ave D	728
D/S of Ave E	949
D/S of Kentucky St.	1173

Detention Basin Evaluations

Several alternatives were reviewed and analyzed to understand the most practical and feasible solutions to reach the desired goal of attenuation of peak flows while providing 100-year flood protection to the Dunlap Channel watershed. The basins analyzed include the following:

Dunlap Basin 2A & 2B (D-2A, D-2B) – MPD proposed D-2A basin is 9 ac-ft and an additional 9 ac-ft for D-2B. Originally identified as two separate basins, located near the intersection of 13th Street and Yucaipa Blvd, it is suggested that one large basin be used. The actual design of this proposed facility will be identified in the future, but for purposes of this MPD and subsequent DIF, a combined 52.9 ac-ft basin would be needed to attenuate the appropriate flow. Hydrology for this basin was performed assuming two separate basins; D-2A of 30.7 ac-ft with a double 30-inch outlet, and D-2B of 22.2 ac-ft with a single 30-inch outlet. A future, single basin, will have to be designed to attenuate flows similar to these two basins.

Dunlap Basin 3 (D-3) – This is a proposed basin as part of the MPD. D-3 is located adjacent to D-2B. Basin D-3 was modeled as a flow-by basin in the MPD. The flow

reduction with D-3 was found to be insignificant and the recommendation is not to pursue construction of this basin.

Dunlap Basin 4 (D-4) – MPD proposed 20 ac-ft basin, located at the intersection of Chapman Heights and 13th Street. Analysis results showed this basin functions adequately in its current proposed condition. Recommendation is not to change.

Dunlap Basin 5 (D-5) - MPD proposed 15 ac-ft basin, located at the intersection of Chapman Heights Rd and Golden Mountain. Analysis results showed this basin functions adequately in its current proposed condition. Recommendation is not to change.

13th Street Sports Complex – This recently constructed basin is located at the intersection of Chapman Heights Road and 13th Street. This basin has a capacity of approximately 7 ac-ft. with 3-30" RCP outlet.

Dunlap Basin 1 (D-1) – This is a proposed basin as part of the MPD. D-1 is located adjacent along Dunlap Channel, north of 14th Street and just upstream of the existing 48" CMP. The recommendation is not to pursue construction of this basin.

Street Capacity Evaluations

The 100-yr proposed street capacity analysis was performed based on right-of-way limits using 8-in curb, per the direction of the City. Street dimensions were based on the City of Yucaipa Design Standard Plans for Public Works Construction. Street slope were determined using the existing topography provided by the City.

Street Hydraulics Results				
Street	***Type***	***ROW Limits***	***Slope***	***Capacity, cfs***
Yucaipa Blvd	Major Highway	104'	0.0110	90.61
Ave. D	Collector	66'	0.0125	179.86
Ave. E	Collector	66'	0.0103	163.26
Kentucky St.	Collector	66'	0.0105	133.28
11th St.	Collector	66'	0.0102	162.47
12th St.	Collector	66'	0.0102	162.47
13th St.	Collector	66'	0.0102	162.47
14th St.	Collector	66'	0.0188	220.57
15th St.	Collector	66'	0.0115	172.52

Exhibit 1 shows the distribution of flows within the Dunlap Watershed. Back-up calculations are attached.

Subsurface Storm Drain Systems

City of Yucaipa currently has Master Planned storm drain facilities to supplement their existing storm drains within the Dunlap Channel Watershed system to reduce flooding during larger storm events. Portions of the existing storm drain are considered Master Planned Facilities, yet were designed to convey flows less than the 100-year discharges. These facilities had to be evaluated using 100-year flowrates to understand their actual conveyance capacities. Some of the existing facilities in Yucaipa Blvd. were evaluated using WSPG, as normal depth would not be sufficient to analyze the effect of tailwater in

the Dunlap Channel. The following Table lists all the flow conveyance facilities within the watershed tributary to the Dunlap Channel.

Storm Drain System				
System	**Street**	**Type**	**Size**	**Capacity**
DC-02	Yucaipa Blvd – East[1]	Existing	36" RCP	80
	"	"	48" RCP	245
	"	"	54" RCP	305
DC-03	Yucaipa Blvd – West[1]	"	36" RCP	44.2
	"	"	36" RCP	44.2
	"	"	48" RCP	78.5
	"	"	54" RCP	166.9
DC-01-03	Ave D - East	"	36" RCP	67
DC-01-04	Ave E - West	"	54" RCP – 60" RCP	196 - 260
DC-01-05	Ave E - East	"	36" RCP	67
DC-01-06	Kentucky St - West	"	60" RCP	260
DC-01-07	Kentucky St - East	"	36" RCP	67
11th Street SD	11th Street	Existing	36" RCP	9.27 [2]

Notes: [1]Yucaipa Blvd system was analyzed using WSPG.
[2]The flow is controlled by the 7' catch basin on the North side of Yucaipa Blvd.

The street flow adjacent to Dunlap channel was analyzed assuming the street improvements as part of the conveyance system. The proposed storm drain network along Ave D, E and Kentucky Street will be constructed to flow at full capacity. Curb and sump inlets will be constructed as part of the storm drain improvements plans which will be designed in a more detailed study in the future. The following discusses the distribution of flow within the Dunlap Watershed.

- At the intersection of 11th Street and Yucaipa Blvd 9.3 cfs will be captured by the existing 7' catch basin along Yucaipa blvd and 29.5 cfs will flow south of 11th street.
- At the intersection of 12th Street and Yucaipa Blvd 17 cfs will flow south of 12th street.
- At the intersection of 13h Street and Yucaipa Blvd, the peak discharge is 288 cfs. The 36" RCP (DC-02, SD Line A) which has a capacity of 80 cfs.
  Assumption: All flows will be captured along Yucaipa blvd with the existing DC-02 and lateral storm drains system. At Yucaipa Blvd and Dunlap channel there is a high point that will prevent flows going west.
- At the intersection of 15h Street and Yucaipa Blvd there is a sump on the North side of Yucaipa blvd with a system DC-03. The 36" RCP will capture 44.2 cfs with flooding on Yucaipa Blvd to Elevation 2099.6 feet (2' above the rim elevation).
  Assumption: For the master plan analysis, it was assumed the west side of Yucaipa blvd is contributing 266 cfs (554 cfs – 288 cfs, Yucaipa East). The 36" RCP has the capacity of 44 cfs which leaves 222 cfs on Yucaipa Blvd. The half street capacity is 45 cfs. 59 cfs will weir over Yucaipa blvd to 15th Street and a culvert will be designed from north of Yucaipa discharging into 15th Street for the remainder of the flow.
  Yucaipa Blvd – 90 cfs

Weir into 15th Street – 59 cfs
36" RCP to Dunlap channel – 44 cfs
Culvert under Yucaipa to 15th Street – 73 cfs, *Total 15th Street = 132 cfs.*

- At 15th Street and Ave D intersection the combined flowrate is 132 cfs. No proposed improvements, flow to be contained within the street.
- At 15th Street and Ave E intersection the combined flowrate is 487 cfs. System DC-01-04 will capture a total of 336 cfs (Assuming a 66" RCP is used on Ave E), which leaves 151 cfs flowing on 15th Street south of Ave E. The street capacity for Ave E is 163 cfs.
- At 15th Street and Kentucky Street intersection the combined flowrate is 411 cfs (assuming the RBF improvements on Ave E). System DC-01-06 will capture a total of 260 cfs (Assuming a 60" RCP is used on Kentucky Street), which leaves 170 cfs flowing on 15th Street. The street capacity for Kentucky St is 133 cfs and 15th St. is 173 cfs. The v-ditch south of the t-junction of 15th and Kentucky has a capacity of 45 cfs assuming 2' deep with 2:1 side sides and earthen bottom. **Assumption:** The storm drain system assumes full capacity. The City will ensure it designs inlet at Ave E and Kentucky Street to maximize the the storm drain capacity and alleviate flooding downstream. The inlet cost has not been included in the Drainage Impact Fees. The flooding area at the I-10 crossing is not part of the Dunlap Watershed.

Channel Hydraulics

XP-SWMM was used to analyze the ultimate condition Dunlap Channel configuration. Discharge shown above was used for the analysis. This program was used to evaluate the effect of implementing a proposed detention basin south of Avenue E. This basin was proposed to be an off-line basin, splitting flows from the channel and routing them through and back into the Dunlap Channel. The Table below summarized the reaches of Dunlap Channel.

Dunlap Channel Hydraulics Result				
Channel Section	Facility	Optimized Discharge Q	Overtopping Weir, Q	Total, Q
Yucaipa Blvd. to U/S Ave. D	Width = 7' – 46' H = 6' – 10', z=2	470.9		470.9
Ave D	2-54" RCP	430.5	40.4	470.9
Ave D - Ave E	Width = 6' – 26' H = 6' – 7', z=2			470.9
Ave E	2-60" RCP	637.4	-	637.4
Ave E - Kentucky St.	Width = 4' – 30' H = 4' – 11', z=2 - 3			637.4
Kentucky St	2-72" RCP	709.3	-	709.3
Kentucky St. – Wilson Crk.	Width = 12' – 60' H = 4' – 10', z=2			709.3

The Ave D culvert is an ultimate facility and was analyzed as an orifice and a weir since peak flows will overtop the road. The channel section between Sta 7+50 to Sta 4+00 (as

shown on the markups) will need to be revised to match cross-section at Sta 8+00.(b=38', H=4', z=2).

The results of this study are and the subsequent improvement cost for the Dunlap Watershed can be found in the revised Drainage Impact Fee. The total cost for the facilities tributary to the Dunlap Channel is $11,671,812 including the culvert under 14th Street (Double 9'W x 6'H RCB) confluence with Wilson Creek. The RCB culvert cost $340,000. The culvert assumes normal depth as the tailwater condition.

Assumptions

West of Dunlap

- DC-03 System (SD Line B): This system which consists of a 36" RCP going west on Yucaipa Blvd, 48" RCP and 36" RCP going east which confluence into the 54" RCP outletting into Dunlap Channel. The hydraulic model using WSPG assumes balanced flow between these 3 lines.
- There is a sump along the north side of Yucaipa Blvd (at the intersection of 15th street). This condition will flood Yucaipa Blvd and the adjacent properties. The existing 36" RCP and street capacity is not enough. RBF assumes some flow will weir over Yucaipa Blvd and flow south of 15th Street. Additionally, a culvert will need to be designed to capture flow on the north and discharge on 15th street.
- The flow distribution at the intersection between 16th and Ave D, 16th and Ave E are assumed to split in half. The street capacity within Dunlap Watershed assumes the proposed street improvements with 8-in curb. There is a high point between and 16th and 15th Street along Ave D.
- The storm drain facilities are proposed to capture full capacity flow of the pipe. The City will design the inlets during final design to meet this criterion. The inlets were not included in the cost estimate. The intersection of Kentucky St and 15th Street will be designed as a sump condition.
- The storm drains along I-10 were not analyzed as they are not part of the master planned facilities and also lie outside the Dunlap Watershed.

East of Dunlap

- The flows on the east side of Dunlap Channel along 11th, 12th, 13th, 14th and 15th will be contained within the proposed street improvements and supplemented by the proposed storm drain lines along Ave D, Ave E and Kentucky Street.
- The City proposed a 2-72" RCP at the outlet of Dunlap channel. Using normal depth at the tailwater condition the reach was upsized to a Dbl 9'W x 6'H RCB.

Dunlap Channel - Hydrology

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****************************************************************************

            F L O O D   R O U T I N G   A N A L Y S I S
        USING COUNTY HYDROLOGY MANUAL OF SAN BERNARDINO(1986)
       (c) Copyright 1989-2004 Advanced Engineering Software (aes)
          Ver. 10.0  Release Date: 01/01/2004  License ID 1264

                    Analysis prepared by:

                       RBF Consulting
                    14725 Alton Parkway
                  Irvine, California  92618
```

@ Yucaipa Blvd & 13th Street

```
 ************************* DESCRIPTION OF STUDY *************************
* CITY OF YUCAIPA                                                      *
* MASTER PLAN OF DRAINAGE UPDATE- Depth Area = 745.6 ac.               *
* UH BASIN MODEL - NODE 4637 MC - ALT 5                                *
 ************************************************************************

  FILE NAME: D5-4637.DAT
  TIME/DATE OF STUDY: 10:03 07/05/2011


****************************************************************************
  FLOW PROCESS FROM NODE   4711.00 TO NODE   4811.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>SUBAREA RUNOFF (UNIT-HYDROGRAPH ANALYSIS)<<<<<
============================================================================

      (UNIT-HYDROGRAPH ADDED TO STREAM #5)

         WATERSHED AREA =     196.500 ACRES
         BASEFLOW =   0.000 CFS/SQUARE-MILE
         *USER ENTERED "LAG" TIME =    0.320 HOURS
          CAUTION: LAG TIME IS LESS THAN 0.50 HOURS.
          THE 5-MINUTE PERIOD UH MODEL (USED IN THIS COMPUTER PROGRAM)
          MAY BE TOO LARGE FOR PEAK FLOW ESTIMATES.
         VALLEY(DEVELOPED):
                  "S"-CURVE PERCENTAGE(DECIMAL NOTATION) =  0.530
         FOOTHILL "S"-CURVE PERCENTAGE(DECIMAL NOTATION) =  0.000
         MOUNTAIN "S"-CURVE PERCENTAGE(DECIMAL NOTATION) =  0.000
         VALLEY(UNDEVELOPED)/DESERT:
                  "S"-CURVE PERCENTAGE(DECIMAL NOTATION) =  0.470
         DESERT(UNDEVELOPED) "S"-CURVE PERCENTAGE(DECIMAL NOTATION) =  0.000
         MAXIMUM WATERSHED LOSS RATE(INCH/HOUR) =  0.526
         LOW LOSS FRACTION = 0.461
         *HYDROGRAPH MODEL #1 SPECIFIED*

         SPECIFIED PEAK  5-MINUTES RAINFALL(INCH)=  0.59
         SPECIFIED PEAK 30-MINUTES RAINFALL(INCH)=  1.02
         SPECIFIED PEAK  1-HOUR RAINFALL(INCH) =  1.25
         SPECIFIED PEAK  3-HOUR RAINFALL(INCH) =  2.07
         SPECIFIED PEAK  6-HOUR RAINFALL(INCH) =  2.85
         SPECIFIED PEAK 24-HOUR RAINFALL(INCH) =  7.50

         *USER SPECIFIED PRECIPITATION DEPTH-AREA REDUCTION FACTORS:
           5-MINUTE FACTOR = 0.967
          30-MINUTE FACTOR = 0.967
           1-HOUR FACTOR = 0.967
           3-HOUR FACTOR = 0.995
           6-HOUR FACTOR = 0.998
          24-HOUR FACTOR = 0.999
```



```
         UNIT HYDROGRAPH TIME UNIT =   5.000 MINUTES
         UNIT INTERVAL PERCENTAGE OF LAG-TIME =  26.042

         RUNOFF HYDROGRAPH LISTING LIMITS:
         MODEL TIME(HOURS) FOR BEGINNING OF RESULTS =  15.00
         MODEL TIME(HOURS) FOR END OF RESULTS =  19.00

============================================================================
                      UNIT HYDROGRAPH DETERMINATION
----------------------------------------------------------------------------
```

INTERVAL NUMBER	"S" GRAPH MEAN VALUES	UNIT HYDROGRAPH ORDINATES(CFS)
1	1.954	46.424
2	9.120	170.311
3	23.597	344.019
4	42.579	451.094
5	61.023	438.305
6	73.701	301.285
7	81.423	183.503
8	86.178	113.010
9	89.277	73.635
10	91.220	46.173
11	92.533	31.205
12	93.666	26.935
13	94.649	23.357
14	95.443	18.868
15	96.055	14.533
16	96.547	11.706
17	97.000	10.760
18	97.397	9.446
19	97.757	8.555
20	98.103	8.201
21	98.356	6.025
22	98.594	5.646
23	98.831	5.649
24	99.047	5.132
25	99.151	2.468
26	99.239	2.091
27	99.327	2.084
28	99.415	2.089
29	99.503	2.088
30	99.590	2.088
31	99.678	2.087
32	99.766	2.088
33	99.854	2.087
34	99.942	2.088
35	100.000	1.383
36	100.000	0.000
37	100.000	0.000
38	100.000	0.000
39	100.000	0.000
40	100.000	0.000
41	100.000	0.000
42	100.000	0.000
43	100.000	0.000
44	100.000	0.000
45	100.000	0.000
46	100.000	0.000
47	100.000	0.000

48	100.000	0.000
49	100.000	0.000
50	100.000	0.000
51	100.000	0.000
52	100.000	0.000
53	100.000	0.000
54	100.000	0.000
55	100.000	0.000
56	100.000	0.000

TOTAL SOIL-LOSS VOLUME(ACRE-FEET) = 52.6454
TOTAL STORM RUNOFF VOLUME(ACRE-FEET) = 69.9470

24-HOUR STORM
RUNOFF HYDROGRAPH

HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
(Note: Time indicated is at END of Each Unit Intervals)

TIME(HRS)	VOLUME(AF)	Q(CFS)
15.000	33.8209	42.12
15.083	34.1205	43.50
15.167	34.4304	45.00
15.250	34.7519	46.68
15.333	35.0863	48.55
15.417	35.4319	50.19
15.500	35.7818	50.81
15.583	36.1260	49.98
15.667	36.4595	48.43
15.750	36.7879	47.69
15.833	37.1284	49.44
15.917	37.5036	54.48
16.000	37.9506	64.91
16.083	38.6637	103.53
16.167	39.9115	161.19
16.250	41.8130	276.10
16.333	44.0649	326.98
16.417	46.1925	308.93
16.500	47.7709	229.18
16.583	48.8829	161.46
16.667	49.7113	120.29
16.750	50.3754	96.42
16.833	50.9204	79.14
16.917	51.3916	68.43
17.000	51.8267	63.16
17.083	52.2295	58.50
17.167	52.5982	53.53
17.250	52.9346	48.85
17.333	53.2459	45.20
17.417	53.5402	42.73
17.500	53.8183	40.37
17.583	54.0829	38.42
17.667	54.3364	36.81
17.750	54.5743	34.54
17.833	54.8034	33.26
17.917	55.0252	32.21
18.000	55.2380	30.90
18.083	55.4373	28.95
18.167	55.6357	28.81
18.250	55.8411	29.82
18.333	56.0578	31.46
18.417	56.2855	33.07
18.500	56.5199	34.03
18.583	56.7572	34.45
18.667	56.9950	34.54
18.750	57.2322	34.44
18.833	57.4676	34.18
18.917	57.6983	33.50
19.000	57.9225	32.55

```
  FLOW PROCESS FROM NODE   4811.00 TO NODE   4811.00 IS CODE = 3.1
 ---------------------------------------------------------------------------
  >>>>>FLOW-THROUGH DETENTION BASIN ROUTING MODEL APPLIED TO STREAM #5<<<<<
 ===========================================================================

                    INFLOW
                  (STREAM 5)
                      |
                      |
                      V                 __effective depth
                 -----------            |   (and volume)
                |           |    |     |
                |           |    |....V........
                | detention |<-->|           outflow
                |   basin   |    |.........______
                 -----------     |     ^    |  \
                      |          |  dead    |   basin outlet
                      V          | storage  |
                   OUTFLOW        ---------
                  (STREAM 5)


        ROUTE RUNOFF HYDROGRAPH FROM STREAM NUMBER 5
        THROUGH A FLOW-THROUGH DETENTION BASIN
        SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
          DEAD STORAGE(AF) =       0.000
          SPECIFIED DEAD STORAGE(AF) FILLED =       0.000
          SPECIFIED EFFECTIVE VOLUME(AF) FILLED ABOVE OUTLET =       0.000
          DETENTION BASIN CONSTANT LOSS RATE(CFS) =     0.00


        BASIN DEPTH VERSUS OUTFLOW AND STORAGE INFORMATION:
```

INTERVAL NUMBER	DEPTH (FT)	OUTFLOW (CFS)	STORAGE (AF)
1	0.00	0.00	0.000
2	1.00	4.55	1.997
3	2.00	14.40	4.050
4	3.00	24.35	6.158
5	4.00	31.45	8.323
6	5.00	37.25	10.545
7	6.00	42.25	12.825
8	7.00	46.70	15.162
9	8.00	50.80	17.559
10	9.00	54.55	20.015

```
 ===========================================================================
  MODIFIED-PULS BASIN ROUTING MODEL RESULTS(5-MINUTE COMPUTATION INTERVALS):
  (Note: Computed EFFECTIVE DEPTH and VOLUME are estimated at the clock time;
         MEAN OUTFLOW is the average value during the unit interval.)
```

CLOCK TIME (HRS)	DEAD-STORAGE FILLED(AF)	INFLOW (CFS)	LOSS (CFS)	EFFECTIVE DEPTH(FT)	MEAN OUTFLOW (CFS)	EFFECTIVE VOLUME(AF)
15.083	0.000	43.50	0.00	3.93	30.8	8.162
15.167	0.000	45.00	0.00	3.97	31.1	8.258
15.250	0.000	46.68	0.00	4.02	31.4	8.363
15.333	0.000	48.55	0.00	4.07	31.7	8.479
15.417	0.000	50.19	0.00	4.13	32.0	8.605
15.500	0.000	50.81	0.00	4.18	32.4	8.732
15.583	0.000	49.98	0.00	4.24	32.7	8.851

15.667	0.000	48.43	0.00	4.29	33.0	8.957
15.750	0.000	47.69	0.00	4.33	33.2	9.057
15.833	0.000	49.44	0.00	4.38	33.5	9.167
15.917	0.000	54.48	0.00	4.44	33.8	9.309
16.000	0.000	64.91	0.00	4.54	34.3	9.519
16.083	0.000	103.53	0.00	4.75	35.2	9.990
16.167	0.000	181.19	0.00	5.19	37.0	10.983
16.250	0.000	276.10	0.00	5.91	40.0	12.609
16.333	0.000	326.98	0.00	6.74	43.7	14.560
16.417	0.000	308.93	0.00	7.50	47.2	16.363
16.500	0.000	229.18	0.00	8.02	49.8	17.599
16.583	0.000	161.46	0.00	8.32	51.4	18.356
16.667	0.000	120.29	0.00	8.52	52.4	18.824
16.750	0.000	96.42	0.00	8.64	53.0	19.123
16.833	0.000	79.14	0.00	8.71	53.3	19.301
16.917	0.000	68.43	0.00	8.75	53.5	19.404
17.000	0.000	63.16	0.00	8.78	53.7	19.469
17.083	0.000	58.50	0.00	8.79	53.7	19.502
17.167	0.000	53.53	0.00	8.79	53.8	19.500
17.250	0.000	48.85	0.00	8.78	53.7	19.467
17.333	0.000	45.20	0.00	8.75	53.7	19.408
17.417	0.000	42.73	0.00	8.72	53.6	19.334
17.500	0.000	40.37	0.00	8.69	53.4	19.244
17.583	0.000	38.42	0.00	8.64	53.3	19.141
17.667	0.000	36.81	0.00	8.60	53.1	19.029
17.750	0.000	34.54	0.00	8.55	52.9	18.902
17.833	0.000	33.26	0.00	8.49	52.7	18.768
17.917	0.000	32.21	0.00	8.44	52.5	18.628
18.000	0.000	30.90	0.00	8.38	52.3	18.480
18.083	0.000	28.95	0.00	8.31	52.1	18.321
18.167	0.000	28.81	0.00	8.25	51.8	18.162
18.250	0.000	29.82	0.00	8.18	51.6	18.012
18.333	0.000	31.46	0.00	8.13	51.4	17.875
18.417	0.000	33.07	0.00	8.08	51.2	17.750
18.500	0.000	34.03	0.00	8.03	51.0	17.633
18.583	0.000	34.45	0.00	7.98	50.8	17.521
18.667	0.000	34.54	0.00	7.94	50.6	17.410
18.750	0.000	34.44	0.00	7.89	50.5	17.299
18.833	0.000	34.18	0.00	7.85	50.3	17.189
18.917	0.000	33.50	0.00	7.80	50.1	17.075
19.000	0.000	32.55	0.00	7.75	49.9	16.955

```
 ---------------------------------------------------------------------------
  PROCESS SUMMARY OF STORAGE:
    INFLOW  VOLUME =      69.947 AF
    BASIN  STORAGE =       0.000 AF (WITH       0.000 AF INITIALLY FILLED)
    OUTFLOW VOLUME =      69.947 AF
    LOSS    VOLUME =       0.000 AF


 ***************************************************************************
  FLOW PROCESS FROM NODE   4811.00 TO NODE   4637.00 IS CODE = 5.2
 ---------------------------------------------------------------------------
  >>>>>MODEL CHANNEL ROUTING OF STREAM #5 BY THE CONVEX METHOD<<<<<
 ===========================================================================

        THE MODIFIED C-ROUTING COEFFICIENT IS ESTIMATED IN ORDER
        TO ROUTE THE STREAM 5 INFLOW HYDROGRAPH BY 5-MINUTE
        INTERVALS(Reference: the National Engineering Handbook,
        Hydrology, Chapter 17, page 17-52, August,1972,
        U.S. Department of Commerce).


        ASSUMED REGULAR CHANNEL INFORMATION:
          BASEWIDTH(FT) =   36.00     CHANNEL Z =  1.50
```

UPSTREAM ELEVATION(FT) = 2219.90
DOWNSTREAM ELEVATION(FT) = 2139.05
CHANNEL LENGTH(FT) = 1349.00 MANNING'S FACTOR = 0.030
CONSTANT LOSS RATE(CFS) = 0.00

CHANNEL ROUTING COEFFICIENT ESTIMATED:
MAXIMUM INFLOW(CFS) = 53.77
AVERAGE FLOWRATE IN EXCESS OF 50% MAXIMUM INFLOW = 38.28
CHANNEL NORMAL VELOCITY FOR Q = 38.28 CFS = 4.45 FPS
ESTIMATED CHANNEL ROUTING COEFFICIENT = 0.724

MODIFIED CHANNEL ROUTING COEFFICIENT FOR 5-MINUTE
UNIT INTERVALS IS CSTAR = 0.798

CONVEX METHOD CHANNEL ROUTING RESULTS:

MODEL TIME (HRS)	INFLOW (STREAM 5) (CFS)	ROUTED FLOW (CFS)	OUTFLOW LESS LOSS (STREAM 5) (CFS)
15.000	30.50	30.26	30.26
15.083	30.78	30.51	30.51
15.167	31.08	30.79	30.79
15.250	31.40	31.09	31.09
15.333	31.71	31.40	31.40
15.417	32.02	31.71	31.71
15.500	32.35	32.03	32.03
15.583	32.67	32.36	32.36
15.667	32.97	32.67	32.67
15.750	33.24	32.97	32.97
15.833	33.51	33.24	33.24
15.917	33.84	33.53	33.53
16.000	34.30	33.87	33.87
16.083	35.19	34.40	34.40
16.167	37.01	35.42	35.42
16.250	39.99	37.33	37.33
16.333	43.67	40.25	40.25
16.417	47.15	43.73	43.73
16.500	49.81	47.03	47.03
16.583	51.44	49.60	49.60
16.667	52.37	51.27	51.27
16.750	52.96	52.28	52.28
16.833	53.32	52.90	52.90
16.917	53.54	53.28	53.28
17.000	53.67	53.51	53.51
17.083	53.74	53.65	53.65
17.167	53.77	53.73	53.73
17.250	53.74	53.75	53.75
17.333	53.67	53.73	53.73
17.417	53.57	53.66	53.66
17.500	53.44	53.56	53.56
17.583	53.29	53.43	53.43
17.667	53.13	53.29	53.29
17.750	52.95	53.12	53.12
17.833	52.75	52.94	52.94
17.917	52.54	52.74	52.74
18.000	52.32	52.53	52.53
18.083	52.08	52.31	52.31
18.167	51.84	52.08	52.08
18.250	51.61	51.84	51.84
18.333	51.39	51.61	51.61
18.417	51.19	51.39	51.39
18.500	51.00	51.19	51.19

18.583	50.82	51.00	51.00
18.667	50.64	50.82	50.82
18.750	50.45	50.64	50.64
18.833	50.26	50.45	50.45
18.917	50.07	50.26	50.26
19.000	49.87	50.06	50.06

==========
PROCESS SUMMARY OF STORAGE:
INFLOW VOLUME = 69.947 AF
OUTFLOW VOLUME = 69.947 AF
LOSS VOLUME = 0.000 AF

****
FLOW PROCESS FROM NODE 4611.00 TO NODE 4616.00 IS CODE = 1

>>>>>SUBAREA RUNOFF (UNIT-HYDROGRAPH ANALYSIS)<<<<<
==========

(UNIT-HYDROGRAPH ADDED TO STREAM #3)

WATERSHED AREA = 95.840 ACRES
BASEFLOW = 0.000 CFS/SQUARE-MILE
*USER ENTERED "LAG" TIME = 0.165 HOURS
CAUTION: LAG TIME IS LESS THAN 0.50 HOURS.
THE 5-MINUTE PERIOD UH MODEL (USED IN THIS COMPUTER PROGRAM)
MAY BE TOO LARGE FOR PEAK FLOW ESTIMATES.
VALLEY(DEVELOPED):
"S"-CURVE PERCENTAGE(DECIMAL NOTATION) = 0.990
FOOTHILL "S"-CURVE PERCENTAGE(DECIMAL NOTATION) = 0.000
MOUNTAIN "S"-CURVE PERCENTAGE(DECIMAL NOTATION) = 0.000
VALLEY(UNDEVELOPED)/DESERT:
"S"-CURVE PERCENTAGE(DECIMAL NOTATION) = 0.010
DESERT(UNDEVELOPED) "S"-CURVE PERCENTAGE(DECIMAL NOTATION) = 0.000
MAXIMUM WATERSHED LOSS RATE(INCH/HOUR) = 0.451
LOW LOSS FRACTION = 0.410
HYDROGRAPH MODEL #1 SPECIFIED

SPECIFIED PEAK 5-MINUTES RAINFALL(INCH)= 0.59
SPECIFIED PEAK 30-MINUTES RAINFALL(INCH)= 1.02
SPECIFIED PEAK 1-HOUR RAINFALL(INCH) = 1.25
SPECIFIED PEAK 3-HOUR RAINFALL(INCH) = 2.03
SPECIFIED PEAK 6-HOUR RAINFALL(INCH) = 2.76
SPECIFIED PEAK 24-HOUR RAINFALL(INCH) = 7.50

*USER SPECIFIED PRECIPITATION DEPTH-AREA REDUCTION FACTORS:
5-MINUTE FACTOR = 0.967
30-MINUTE FACTOR = 0.967
1-HOUR FACTOR = 0.967
3-HOUR FACTOR = 0.995
6-HOUR FACTOR = 0.998
24-HOUR FACTOR = 0.999

UNIT HYDROGRAPH TIME UNIT = 5.000 MINUTES
UNIT INTERVAL PERCENTAGE OF LAG-TIME = 50.505

RUNOFF HYDROGRAPH LISTING LIMITS:
MODEL TIME(HOURS) FOR BEGINNING OF RESULTS = 15.00
MODEL TIME(HOURS) FOR END OF RESULTS = 19.00

==========
UNIT HYDROGRAPH DETERMINATION

INTERVAL NUMBER	"S" GRAPH MEAN VALUES	UNIT HYDROGRAPH ORDINATES(CFS)
1	4.553	52.776
2	30.270	298.069
3	68.792	446.494
4	90.067	246.597
5	97.026	80.658
6	98.673	19.086
7	99.381	8.206
8	99.712	3.843
9	99.885	2.002
10	99.952	0.775
11	99.964	0.146
12	99.974	0.114
13	99.981	0.085
14	99.985	0.042
15	99.989	0.042
16	99.992	0.042
17	99.996	0.042
18	100.000	0.042
19	100.000	0.005

TOTAL SOIL-LOSS VOLUME(ACRE-FEET) = 22.8100
TOTAL STORM RUNOFF VOLUME(ACRE-FEET) = 36.9812

24-HOUR STORM
RUNOFF HYDROGRAPH

HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
(Note: Time indicated is at END of Each Unit Intervals)

TIME(HRS)	VOLUME(AF)	Q(CFS)	0. 75.0 150.0 225.0 300.0
15.000	18.5293	23.14	. Q . V . .
15.083	18.6948	24.02	. Q . V . .
15.167	18.8669	25.00	. Q . V . .
15.250	19.0468	26.11	. Q . V . .
15.333	19.2353	27.37	. Q . V . .
15.417	19.4301	28.28	. Q . .V . .
15.500	19.6150	26.86	. Q . .V . .
15.583	19.7814	24.16	. Q . .V . .
15.667	19.9456	23.84	. Q . .V . .
15.750	20.1239	25.89	. Q . .V . .
15.833	20.3301	29.93	. Q . .V . .
15.917	20.5800	36.29	. Q . . V . .
16.000	20.9125	48.28	. Q . . V . .
16.083	21.5600	94.02	. . Q . . V . .
16.167	23.0885	221.94	. . . V Q. .
16.250	25.0286	281.69	. . . V . Q .
16.333	26.1936	169.16	. . . Q V . .
16.417	26.7153	75.75	. Q . V . .
16.500	26.9906	39.97	. Q . . V. .
16.583	27.2213	33.50	. Q . . V. .
16.667	27.4279	30.01	. Q . . V. .
16.750	27.6142	27.04	. Q . . V. .
16.833	27.7823	24.42	. Q . . V .
16.917	27.9370	22.46	. Q . . V .
17.000	28.0821	21.06	. Q . . V .
17.083	28.2188	19.86	. Q . . V .
17.167	28.3472	18.64	. Q . . V .
17.250	28.4674	17.46	. Q . . V .
17.333	28.5813	16.54	. Q . . V .
17.417	28.6903	15.82	. Q . . .V .
17.500	28.7950	15.20	. Q . . .V .
17.583	28.8958	14.64	.Q . . .V .
17.667	28.9933	14.15	.Q . . .V .
17.750	29.0877	13.71	.Q . . .V .
17.833	29.1793	13.30	.Q . . .V .
17.917	29.2683	12.93	.Q . . .V .
18.000	29.3550	12.58	.Q . . .V .
18.083	29.4417	12.59	.Q . . .V .
18.167	29.5391	14.14	.Q . . .V .
18.250	29.6538	16.65	. Q . . . V .
18.333	29.7774	17.95	. Q . . . V .
18.417	29.9031	18.25	. Q . . . V .
18.500	30.0283	18.17	. Q . . . V .
18.583	30.1525	18.04	. Q . . . V .
18.667	30.2756	17.88	. Q . . . V .
18.750	30.3977	17.73	. Q . . . V .
18.833	30.5188	17.57	. Q . . . V .
18.917	30.6387	17.42	. Q . . . V .
19.000	30.7577	17.27	. Q . . . V .

```
FLOW PROCESS FROM NODE   4616.00 TO NODE   4616.00 IS CODE = 3.1
---------------------------------------------------------------------------
>>>>>FLOW-THROUGH DETENTION BASIN ROUTING MODEL APPLIED TO STREAM #3<<<<<
===========================================================================

                 INFLOW
               (STREAM 3)
                   |
                   |
                   V                 __effective depth
                -----------          |   (and volume)
               |           |    |    |
               |           |    |....V........
               | detention |<-->|           outflow
               |   basin   |    |.........______
                -----------     |     ^     |  \
                   |            |  dead     |   basin outlet
                   V            | storage   |
                 OUTFLOW         ---------
               (STREAM 3)


        ROUTE RUNOFF HYDROGRAPH FROM STREAM NUMBER 3
        THROUGH A FLOW-THROUGH DETENTION BASIN
        SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
          DEAD STORAGE(AF) =          0.000
          SPECIFIED DEAD STORAGE(AF) FILLED =       0.000
          SPECIFIED EFFECTIVE VOLUME(AF) FILLED ABOVE OUTLET =       0.000
          DETENTION BASIN CONSTANT LOSS RATE(CFS) =     0.00


        BASIN DEPTH VERSUS OUTFLOW AND STORAGE INFORMATION:
```

INTERVAL NUMBER	DEPTH (FT)	OUTFLOW (CFS)	STORAGE (AF)
1	0.00	0.00	0.000
2	1.00	6.00	0.120
3	2.00	21.50	0.570
4	3.00	41.40	1.650
5	4.00	61.80	3.490
6	5.00	78.60	5.910
7	6.00	92.20	8.720
8	7.00	104.10	11.830
9	8.00	114.70	15.190

```
===========================================================================
MODIFIED-PULS BASIN ROUTING MODEL RESULTS(5-MINUTE COMPUTATION INTERVALS):
(Note: Computed EFFECTIVE DEPTH and VOLUME are estimated at the clock time;
       MEAN OUTFLOW is the average value during the unit interval.)
```

CLOCK TIME (HRS)	DEAD-STORAGE FILLED(AF)	INFLOW (CFS)	LOSS (CFS)	EFFECTIVE DEPTH(FT)	MEAN OUTFLOW (CFS)	EFFECTIVE VOLUME(AF)
15.083	0.000	24.02	0.00	2.00	21.2	0.570
15.167	0.000	25.00	0.00	2.02	21.7	0.592
15.250	0.000	26.11	0.00	2.05	22.2	0.620
15.333	0.000	27.37	0.00	2.08	22.7	0.652
15.417	0.000	28.28	0.00	2.11	23.3	0.686
15.500	0.000	26.86	0.00	2.13	23.8	0.707
15.583	0.000	24.16	0.00	2.13	24.0	0.708
15.667	0.000	23.84	0.00	2.13	24.0	0.706

15.750	0.000	25.89	0.00	2.14	24.1	0.719
15.833	0.000	29.93	0.00	2.17	24.6	0.755
15.917	0.000	36.29	0.00	2.24	25.6	0.829
16.000	0.000	48.28	0.00	2.37	27.6	0.972
16.083	0.000	94.02	0.00	2.76	32.8	1.393
16.167	0.000	221.94	0.00	3.53	44.4	2.616
16.250	0.000	281.69	0.00	4.27	59.2	4.148
16.333	0.000	169.16	0.00	4.56	68.8	4.840
16.417	0.000	75.75	0.00	4.57	71.3	4.870
16.500	0.000	39.97	0.00	4.48	70.6	4.659
16.583	0.000	33.50	0.00	4.38	69.1	4.414
16.667	0.000	30.01	0.00	4.28	67.3	4.157
16.750	0.000	27.04	0.00	4.17	65.5	3.892
16.833	0.000	24.42	0.00	4.05	63.7	3.622
16.917	0.000	22.46	0.00	3.93	61.5	3.353
17.000	0.000	21.06	0.00	3.78	58.8	3.093
17.083	0.000	19.86	0.00	3.65	56.0	2.844
17.167	0.000	18.64	0.00	3.52	53.3	2.605
17.250	0.000	17.46	0.00	3.39	50.7	2.376
17.333	0.000	16.54	0.00	3.28	48.2	2.158
17.417	0.000	15.82	0.00	3.16	45.9	1.951
17.500	0.000	15.20	0.00	3.06	43.6	1.755
17.583	0.000	14.64	0.00	2.93	41.3	1.571
17.667	0.000	14.15	0.00	2.77	38.4	1.404
17.750	0.000	13.71	0.00	2.63	35.5	1.254
17.833	0.000	13.30	0.00	2.51	32.9	1.120
17.917	0.000	12.93	0.00	2.40	30.5	0.998
18.000	0.000	12.58	0.00	2.30	28.4	0.890
18.083	0.000	12.59	0.00	2.21	26.5	0.794
18.167	0.000	14.14	0.00	2.14	24.9	0.719
18.250	0.000	16.65	0.00	2.09	23.8	0.670
18.333	0.000	17.95	0.00	2.06	23.0	0.635
18.417	0.000	18.25	0.00	2.03	22.4	0.606
18.500	0.000	18.17	0.00	2.01	21.9	0.581
18.583	0.000	18.04	0.00	1.97	21.4	0.557
18.667	0.000	17.88	0.00	1.93	20.7	0.538
18.750	0.000	17.73	0.00	1.89	20.1	0.521
18.833	0.000	17.57	0.00	1.86	19.6	0.508
18.917	0.000	17.42	0.00	1.83	19.1	0.496
19.000	0.000	17.27	0.00	1.81	18.8	0.485

```
---------------------------------------------------------------------------
PROCESS SUMMARY OF STORAGE:
  INFLOW  VOLUME =     36.981 AF
  BASIN  STORAGE =      0.000 AF (WITH      0.000 AF INITIALLY FILLED)
  OUTFLOW VOLUME =     36.981 AF
  LOSS    VOLUME =      0.000 AF


***************************************************************************
FLOW PROCESS FROM NODE   4616.00 TO NODE   4636.50 IS CODE = 5.2
---------------------------------------------------------------------------
>>>>>MODEL CHANNEL ROUTING OF STREAM #3 BY THE CONVEX METHOD<<<<<
===========================================================================

        THE MODIFIED C-ROUTING COEFFICIENT IS ESTIMATED IN ORDER
        TO ROUTE THE STREAM 3 INFLOW HYDROGRAPH BY 5-MINUTE
        INTERVALS(Reference: the National Engineering Handbook,
        Hydrology, Chapter 17, page 17-52, August,1972,
        U.S. Department of Commerce).


        ASSUMED REGULAR CHANNEL INFORMATION:
          BASEWIDTH(FT) =     5.00      CHANNEL Z =  1.00
          UPSTREAM ELEVATION(FT) =     2140.00
```

DOWNSTREAM ELEVATION(FT) = 2139.05
CHANNEL LENGTH(FT) = 1650.00 MANNING'S FACTOR = 0.035
CONSTANT LOSS RATE(CFS) = 0.00

CHANNEL ROUTING COEFFICIENT ESTIMATED:
MAXIMUM INFLOW(CFS) = 71.28
AVERAGE FLOWRATE IN EXCESS OF 50% MAXIMUM INFLOW = 56.72
CHANNEL NORMAL VELOCITY FOR Q = 56.72 CFS = 1.68 FPS
ESTIMATED CHANNEL ROUTING COEFFICIENT = 0.497

MODIFIED CHANNEL ROUTING COEFFICIENT FOR 5-MINUTE
UNIT INTERVALS IS CSTAR = 0.400

CONVEX METHOD CHANNEL ROUTING RESULTS:

MODEL TIME (HRS)	INFLOW (STREAM 3) (CFS)	ROUTED FLOW (CFS)	OUTFLOW LESS LOSS (STREAM 3) (CFS)
15.000	20.50	18.77	18.77
15.083	21.15	19.31	19.31
15.167	21.70	19.88	19.88
15.250	22.16	20.47	20.47
15.333	22.71	21.03	21.03
15.417	23.32	21.57	21.57
15.500	23.83	22.12	22.12
15.583	24.03	22.67	22.67
15.667	24.03	23.17	23.17
15.750	24.13	23.51	23.51
15.833	24.58	23.73	23.73
15.917	25.60	23.96	23.96
16.000	27.59	24.36	24.36
16.083	32.79	25.15	25.15
16.167	44.39	26.90	26.90
16.250	59.24	30.99	30.99
16.333	68.77	38.58	38.58
16.417	71.28	48.27	48.27
16.500	70.65	56.85	56.85
16.583	69.07	62.53	62.53
16.667	67.32	65.54	65.54
16.750	65.51	66.69	66.69
16.833	63.65	66.67	66.67
16.917	61.50	65.93	65.93
17.000	58.84	64.70	64.70
17.083	56.02	63.02	63.02
17.167	53.31	60.92	60.92
17.250	50.72	58.56	58.56
17.333	48.24	56.07	56.07
17.417	45.88	53.56	53.56
17.500	43.65	51.08	51.08
17.583	41.26	48.66	48.66
17.667	38.41	46.30	46.30
17.750	35.49	43.85	43.85
17.833	32.87	41.24	41.24
17.917	30.51	38.55	38.55
18.000	28.39	35.92	35.92
18.083	26.51	33.44	33.44
18.167	24.94	31.14	31.14
18.250	23.80	29.05	29.05
18.333	23.02	27.23	27.23
18.417	22.44	25.74	25.74
18.500	21.93	24.57	24.57
18.583	21.38	23.64	23.64

18.667	20.73	22.87	22.87
18.750	20.11	22.18	22.18
18.833	19.59	21.51	21.51
18.917	19.14	20.87	20.87
19.000	18.76	20.29	20.29

PROCESS SUMMARY OF STORAGE:
INFLOW VOLUME = 36.981 AF
OUTFLOW VOLUME = 36.981 AF
LOSS VOLUME = 0.000 AF

FLOW PROCESS FROM NODE 4636.50 TO NODE 4636.50 IS CODE = 1

>>>>>SUBAREA RUNOFF (UNIT-HYDROGRAPH ANALYSIS)<<<<<

(UNIT-HYDROGRAPH ADDED TO STREAM #3)

WATERSHED AREA = 102.490 ACRES
BASEFLOW = 0.000 CFS/SQUARE-MILE
*USER ENTERED "LAG" TIME = 0.316 HOURS
CAUTION: LAG TIME IS LESS THAN 0.50 HOURS.
THE 5-MINUTE PERIOD UH MODEL (USED IN THIS COMPUTER PROGRAM)
MAY BE TOO LARGE FOR PEAK FLOW ESTIMATES.
VALLEY(DEVELOPED) S-GRAPH SELECTED
MAXIMUM WATERSHED LOSS RATE(INCH/HOUR) = 0.449
LOW LOSS FRACTION = 0.409
HYDROGRAPH MODEL #1 SPECIFIED

SPECIFIED PEAK 5-MINUTES RAINFALL(INCH)= 0.59
SPECIFIED PEAK 30-MINUTES RAINFALL(INCH)= 1.02
SPECIFIED PEAK 1-HOUR RAINFALL(INCH) = 1.25
SPECIFIED PEAK 3-HOUR RAINFALL(INCH) = 2.03
SPECIFIED PEAK 6-HOUR RAINFALL(INCH) = 2.76
SPECIFIED PEAK 24-HOUR RAINFALL(INCH) = 7.50

*USER SPECIFIED PRECIPITATION DEPTH-AREA REDUCTION FACTORS:
5-MINUTE FACTOR = 0.967
30-MINUTE FACTOR = 0.967
1-HOUR FACTOR = 0.967
3-HOUR FACTOR = 0.995
6-HOUR FACTOR = 0.998
24-HOUR FACTOR = 0.999

UNIT HYDROGRAPH TIME UNIT = 5.000 MINUTES
UNIT INTERVAL PERCENTAGE OF LAG-TIME = 26.371

RUNOFF HYDROGRAPH LISTING LIMITS:
MODEL TIME(HOURS) FOR BEGINNING OF RESULTS = 15.00
MODEL TIME(HOURS) FOR END OF RESULTS = 19.00

UNIT HYDROGRAPH DETERMINATION

INTERVAL NUMBER	"S" GRAPH MEAN VALUES	UNIT HYDROGRAPH ORDINATES(CFS)
1	1.596	19.761
2	8.264	82.896

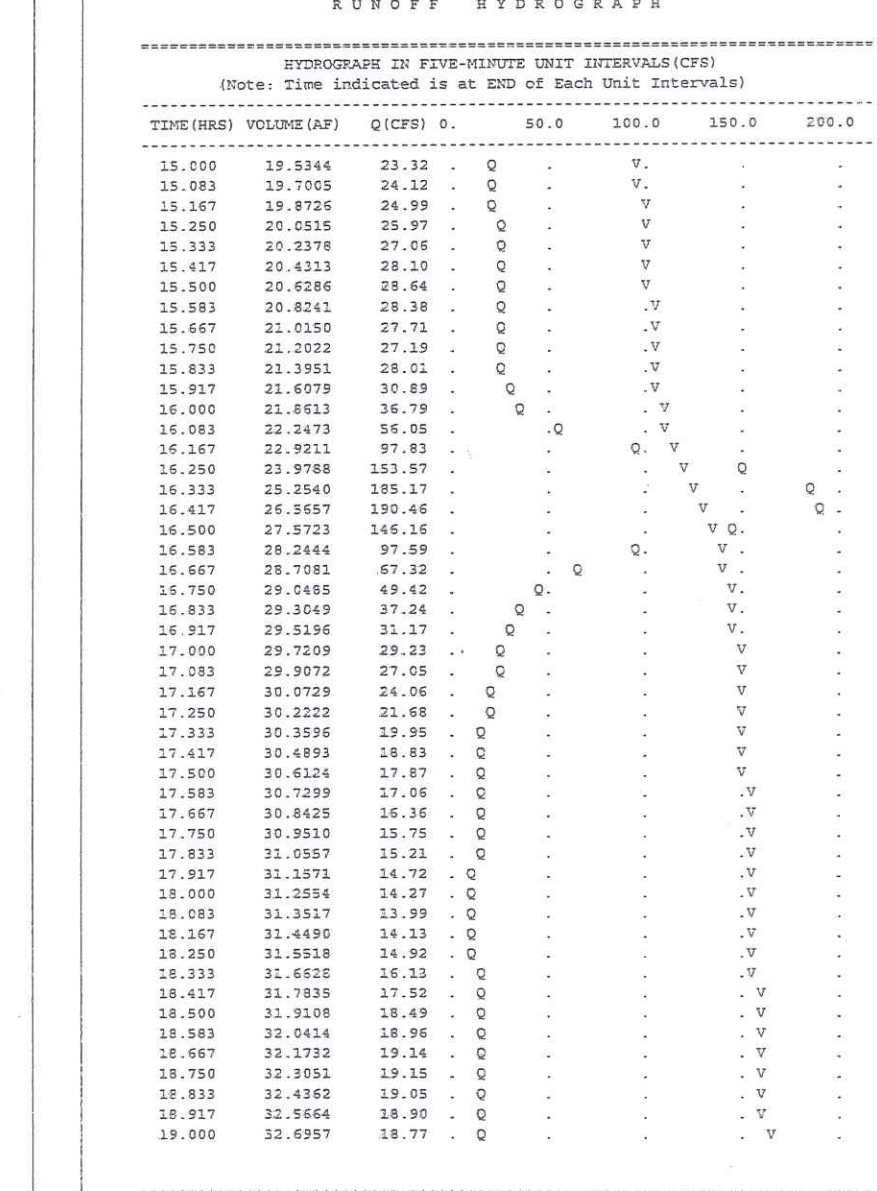
3	22.979	182.147
4	42.645	243.750
5	64.322	268.693
6	80.190	196.678
7	89.326	113.243
8	94.410	63.008
9	97.143	33.884
10	98.291	14.227
11	98.786	6.129
12	99.280	6.123
13	99.712	5.358
14	99.928	2.679
15	100.000	0.893

TOTAL SOIL-LOSS VOLUME(ACRE-FEET) = 24.3313
TOTAL STORM RUNOFF VOLUME(ACRE-FEET) = 39.6086

24-HOUR STORM
RUNOFF HYDROGRAPH

HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
(Note: Time indicated is at END of Each Unit Intervals)

TIME(HRS)	VOLUME(AF)	Q(CFS)
15.000	19.5344	23.32
15.083	19.7005	24.12
15.167	19.8726	24.99
15.250	20.0515	25.97
15.333	20.2378	27.06
15.417	20.4313	28.10
15.500	20.6286	28.64
15.583	20.8241	28.38
15.667	21.0150	27.71
15.750	21.2022	27.19
15.833	21.3951	28.01
15.917	21.6079	30.89
16.000	21.8613	36.79
16.083	22.2473	56.05
16.167	22.9211	97.83
16.250	23.9788	153.57
16.333	25.2540	185.17
16.417	26.5657	190.46
16.500	27.5723	146.16
16.583	28.2444	97.59
16.667	28.7081	67.32
16.750	29.0485	49.42
16.833	29.3049	37.24
16.917	29.5196	31.17
17.000	29.7209	29.23
17.083	29.9072	27.05
17.167	30.0729	24.06
17.250	30.2222	21.68
17.333	30.3596	19.95
17.417	30.4893	18.83
17.500	30.6124	17.87
17.583	30.7299	17.06
17.667	30.8425	16.36
17.750	30.9510	15.75
17.833	31.0557	15.21
17.917	31.1571	14.72
18.000	31.2554	14.27
18.083	31.3517	13.99
18.167	31.4490	14.13
18.250	31.5518	14.92
18.333	31.6628	16.13
18.417	31.7835	17.52
18.500	31.9108	18.49
18.583	32.0414	18.96
18.667	32.1732	19.14
18.750	32.3051	19.15
18.833	32.4362	19.05
18.917	32.5664	18.90
19.000	32.6957	18.77



```
  FLOW PROCESS FROM NODE   4636.50 TO NODE   4636.50 IS CODE = 3.1
-----------------------------------------------------------------------------
  >>>>>FLOW-THROUGH DETENTION BASIN ROUTING MODEL APPLIED TO STREAM #3<<<<<
=============================================================================

                    INFLOW
                  (STREAM 3)
                      |
                      |
                      V                 __effective depth
                 -----------            |   (and volume)
                |          |    |    |
                |          |    |....V........
                | detention |<-->|           outflow
                |   basin   |    |.........______
                 -----------     |    ^     | \
                      |          |  dead    |   basin outlet
                      V          | storage |
                   OUTFLOW        ---------
                  (STREAM 3)


        ROUTE RUNOFF HYDROGRAPH FROM STREAM NUMBER 3
        THROUGH A FLOW-THROUGH DETENTION BASIN
        SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
          DEAD STORAGE(AF) =       0.000
          SPECIFIED DEAD STORAGE(AF) FILLED =       0.000
          SPECIFIED EFFECTIVE VOLUME(AF) FILLED ABOVE OUTLET =       0.000
          DETENTION BASIN CONSTANT LOSS RATE(CFS) =     0.00


        BASIN DEPTH VERSUS OUTFLOW AND STORAGE INFORMATION:
```

INTERVAL NUMBER	DEPTH (FT)	OUTFLOW (CFS)	STORAGE (AF)
1	0.00	0.00	0.000
2	1.00	4.90	2.880
3	2.00	16.00	5.850
4	3.00	27.90	8.920
5	4.00	37.50	12.090
6	5.00	45.00	15.360
7	6.00	51.50	18.740
8	7.00	56.80	22.230

```
=============================================================================
 MODIFIED-PULS BASIN ROUTING MODEL RESULTS(5-MINUTE COMPUTATION INTERVALS):
 (Note: Computed EFFECTIVE DEPTH and VOLUME are estimated at the clock time;
        MEAN OUTFLOW is the average value during the unit interval.)
```

CLOCK TIME (HRS)	DEAD-STORAGE FILLED(AF)	INFLOW (CFS)	LOSS (CFS)	EFFECTIVE DEPTH(FT)	MEAN OUTFLOW (CFS)	EFFECTIVE VOLUME(AF)
15.083	0.000	43.43	0.00	3.48	32.4	10.449
15.167	0.000	44.87	0.00	3.51	32.7	10.533
15.250	0.000	46.44	0.00	3.54	32.9	10.626
15.333	0.000	48.09	0.00	3.57	33.2	10.728
15.417	0.000	49.67	0.00	3.61	33.5	10.839
15.500	0.000	50.76	0.00	3.64	33.9	10.955
15.583	0.000	51.06	0.00	3.68	34.2	11.071
15.667	0.000	50.88	0.00	3.71	34.6	11.184
15.750	0.000	50.70	0.00	3.75	34.9	11.292

15.833	0.000	51.74	0.00	3.78	35.3	11.406
15.917	0.000	54.85	0.00	3.83	35.6	11.538
16.000	0.000	61.15	0.00	3.88	36.1	11.711
16.083	0.000	81.20	0.00	3.98	36.8	12.016
16.167	0.000	124.73	0.00	4.16	38.0	12.614
16.250	0.000	184.57	0.00	4.47	39.8	13.611
16.333	0.000	223.75	0.00	4.85	42.4	14.859
16.417	0.000	238.73	0.00	5.25	45.2	16.192
16.500	0.000	203.01	0.00	5.56	47.6	17.262
16.583	0.000	160.12	0.00	5.79	49.4	18.025
16.667	0.000	132.87	0.00	5.96	50.7	18.591
16.750	0.000	116.11	0.00	6.08	51.6	19.035
16.833	0.000	103.91	0.00	6.19	52.2	19.391
16.917	0.000	97.10	0.00	6.27	52.7	19.697
17.000	0.000	93.93	0.00	6.35	53.2	19.978
17.083	0.000	90.07	0.00	6.43	53.6	20.229
17.167	0.000	84.99	0.00	6.49	53.9	20.443
17.250	0.000	80.23	0.00	6.54	54.2	20.622
17.333	0.000	76.02	0.00	6.58	54.5	20.771
17.417	0.000	72.39	0.00	6.62	54.7	20.893
17.500	0.000	68.95	0.00	6.64	54.8	20.990
17.583	0.000	65.72	0.00	6.67	55.0	21.064
17.667	0.000	62.66	0.00	6.68	55.1	21.116
17.750	0.000	59.60	0.00	6.69	55.1	21.147
17.833	0.000	56.45	0.00	6.69	55.2	21.156
17.917	0.000	53.27	0.00	6.69	55.2	21.143
18.000	0.000	50.20	0.00	6.68	55.1	21.109
18.083	0.000	47.43	0.00	6.66	55.1	21.056
18.167	0.000	45.27	0.00	6.64	55.0	20.989
18.250	0.000	43.97	0.00	6.62	54.9	20.914
18.333	0.000	43.36	0.00	6.60	54.7	20.836
18.417	0.000	43.26	0.00	6.58	54.6	20.758
18.500	0.000	43.05	0.00	6.56	54.5	20.679
18.583	0.000	42.60	0.00	6.53	54.4	20.598
18.667	0.000	42.01	0.00	6.51	54.3	20.513
18.750	0.000	41.33	0.00	6.48	54.1	20.425
18.833	0.000	40.55	0.00	6.46	54.0	20.333
18.917	0.000	39.77	0.00	6.43	53.8	20.236
19.000	0.000	39.06	0.00	6.40	53.7	20.135

```
-----------------------------------------------------------------------------
  PROCESS SUMMARY OF STORAGE:
    INFLOW  VOLUME =     76.590 AF
    BASIN  STORAGE =      0.000 AF (WITH      0.000 AF INITIALLY FILLED)
    OUTFLOW VOLUME =     76.589 AF
    LOSS    VOLUME =      0.000 AF


*****************************************************************************
  FLOW PROCESS FROM NODE   4636.50 TO NODE   4636.50 IS CODE =  11
-----------------------------------------------------------------------------
  >>>>>VIEW STREAM NUMBER 3 HYDROGRAPH<<<<<
=============================================================================

          STREAM HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
       (Note: Time indicated is at END of Each Unit Intervals)
-----------------------------------------------------------------------------
 TIME(HRS) VOLUME(AF)   Q(CFS) 0.        15.0      30.0      45.0      60.0
-----------------------------------------------------------------------------
  15.000     26.7204    32.20  .         .  V      .Q        .         .
  15.083     26.9436    32.41  .         .  V      .Q        .         .
  15.167     27.1685    32.66  .         .  V      .Q        .         .
  15.250     27.3953    32.92  .         .  V      .Q        .         .
  15.333     27.6241    33.22  .         .  V      . Q       .         .
  15.417     27.8551    33.54  .         .  V      . Q       .         .
```

```
15.500    28.0885    33.89  .        .  V     . Q      .        .
15.583    28.3243    34.24  .        .  V     . Q      .        .
15.667    28.5625    34.58  .        .  V     .  Q     .        .
15.750    28.8030    34.92  .        .   V    .  Q     .        .
15.833    29.0458    35.26  .        .   V    .  Q     .        .
15.917    29.2912    35.63  .        .   V    .  Q     .        .
16.000    29.5397    36.09  .        .   V    .   Q    .        .
16.083    29.7933    36.81  .        .   V    .   Q    .        .
16.167    30.0549    37.99  .        .   V    .    Q   .        .
16.250    30.3293    39.84  .        .   V    .     Q  .        .
16.333    30.6215    42.42  .        .   V    .      Q .        .
16.417    30.9329    45.23  .        .    V   .       Q        .
16.500    31.2610    47.63  .        .    V   .       .Q       .
16.583    31.6011    49.39  .        .    V   .       . Q      .
16.667    31.9501    50.67  .        .    V   .       .  Q     .
16.750    32.3053    51.58  .        .    V   .       .   Q    .
16.833    32.6649    52.22  .        .     V  .       .   Q    .
16.917    33.0280    52.72  .        .     V  .       .    Q   .
17.000    33.3942    53.17  .        .     V  .       .    Q   .
17.083    33.7631    53.57  .        .     V  .       .    Q   .
17.167    34.1345    53.92  .        .     V  .       .    Q   .
17.250    34.5080    54.22  .        .      V .       .     Q  .
17.333    34.8831    54.47  .        .      V .       .     Q  .
17.417    35.2597    54.68  .        .      V .       .     Q  .
17.500    35.6374    54.84  .        .      V .       .     Q  .
17.583    36.0160    54.97  .        .      V .       .     Q  .
17.667    36.3952    55.07  .        .       V.       .     Q  .
17.750    36.7749    55.13  .        .       V.       .     Q  .
17.833    37.1548    55.16  .        .       V.       .     Q  .
17.917    37.5347    55.16  .        .       V.       .     Q  .
18.000    37.9143    55.12  .        .       V.       .     Q  .
18.083    38.2935    55.06  .        .       V.       .     Q  .
18.167    38.6721    54.97  .        .        V       .     Q  .
18.250    39.0499    54.86  .        .        V       .     Q  .
18.333    39.4269    54.74  .        .        V       .     Q  .
18.417    39.8031    54.62  .        .        V       .     Q  .
18.500    40.1785    54.50  .        .        V       .     Q  .
18.583    40.5530    54.38  .        .        .V      .     Q  .
18.667    40.9267    54.26  .        .        .V      .     Q  .
18.750    41.2994    54.13  .        .        .V      .     Q  .
18.833    41.6713    53.99  .        .        .V      .    Q   .
18.917    42.0421    53.84  .        .        .V      .    Q   .
19.000    42.4119    53.69  .        .        . V     .    Q   .
```

```
****************************************************************************
  FLOW PROCESS FROM NODE   4636.50 TO NODE   4637.00 IS CODE = 5.2
----------------------------------------------------------------------------
  >>>>>MODEL CHANNEL ROUTING OF STREAM #3 BY THE CONVEX METHOD<<<<<
============================================================================

        THE MODIFIED C-ROUTING COEFFICIENT IS ESTIMATED IN ORDER
        TO ROUTE THE STREAM 3 INFLOW HYDROGRAPH BY 5-MINUTE
        INTERVALS(Reference: the National Engineering Handbook,
        Hydrology, Chapter 17, page 17-52, August,1972,
        U.S. Department of Commerce).

        ASSUMED REGULAR CHANNEL INFORMATION:
          BASEWIDTH(FT) =     5.00      CHANNEL Z =  1.00
          UPSTREAM ELEVATION(FT) =      100.00
          DOWNSTREAM ELEVATION(FT) =       90.00
          CHANNEL LENGTH(FT) =      687.00      MANNING'S FACTOR = 0.030
          CONSTANT LOSS RATE(CFS) =     0.00
```



```
CHANNEL ROUTING COEFFICIENT ESTIMATED:
  MAXIMUM INFLOW(CFS) =     55.16
  AVERAGE FLOWRATE IN EXCESS OF 50% MAXIMUM INFLOW =     39.91
  CHANNEL NORMAL VELOCITY FOR Q =     39.91 CFS =    5.46 FPS
  ESTIMATED CHANNEL ROUTING COEFFICIENT = 0.763

MODIFIED CHANNEL ROUTING COEFFICIENT FOR 5-MINUTE
UNIT INTERVALS IS CSTAR = 0.969
```

CONVEX METHOD CHANNEL ROUTING RESULTS:

MODEL TIME (HRS)	INFLOW (STREAM 3) (CFS)	ROUTED FLOW (CFS)	OUTFLOW LESS LOSS (STREAM 3) (CFS)
15.000	32.20	32.13	32.13
15.083	32.41	32.34	32.34
15.167	32.66	32.57	32.57
15.250	32.92	32.83	32.83
15.333	33.22	33.12	33.12
15.417	33.54	33.43	33.43
15.500	33.89	33.77	33.77
15.583	34.24	34.12	34.12
15.667	34.58	34.46	34.46
15.750	34.92	34.80	34.80
15.833	35.26	35.14	35.14
15.917	35.63	35.50	35.50
16.000	36.09	35.93	35.93
16.083	36.81	36.56	36.56
16.167	37.99	37.58	37.58
16.250	39.84	39.20	39.20
16.333	42.42	41.52	41.52
16.417	45.23	44.24	44.24
16.500	47.63	46.78	46.78
16.583	49.39	48.76	48.76
16.667	50.67	50.21	50.21
16.750	51.58	51.26	51.26
16.833	52.22	51.99	51.99
16.917	52.72	52.54	52.54
17.000	53.17	53.01	53.01
17.083	53.57	53.43	53.43
17.167	53.92	53.80	53.80
17.250	54.22	54.12	54.12
17.333	54.47	54.38	54.38
17.417	54.68	54.60	54.60
17.500	54.84	54.78	54.78
17.583	54.97	54.93	54.93
17.667	55.07	55.03	55.03
17.750	55.13	55.11	55.11
17.833	55.16	55.15	55.15
17.917	55.16	55.16	55.16
18.000	55.12	55.13	55.13
18.083	55.06	55.08	55.08
18.167	54.97	55.00	55.00
18.250	54.86	54.90	54.90
18.333	54.74	54.78	54.78
18.417	54.62	54.67	54.67
18.500	54.50	54.55	54.55
18.583	54.38	54.43	54.43
18.667	54.26	54.30	54.30
18.750	54.13	54.17	54.17
18.833	53.99	54.04	54.04

```
          18.917        53.84        53.90        53.90
          19.000        53.69        53.75        53.75
 ==========================================================================
   PROCESS SUMMARY OF STORAGE:
     INFLOW  VOLUME =      76.590 AF
     OUTFLOW VOLUME =      76.590 AF
     LOSS    VOLUME =       0.000 AF


 **************************************************************************
   FLOW PROCESS FROM NODE   4621.00 TO NODE   4637.00 IS CODE =   1
 --------------------------------------------------------------------------
   >>>>>SUBAREA RUNOFF (UNIT-HYDROGRAPH ANALYSIS)<<<<<
 ==========================================================================

       (UNIT-HYDROGRAPH ADDED TO STREAM #4)

          WATERSHED AREA =      192.270 ACRES
          BASEFLOW =    0.000 CFS/SQUARE-MILE
          *USER ENTERED "LAG" TIME =     0.211 HOURS
           CAUTION: LAG TIME IS LESS THAN 0.50 HOURS.
           THE 5-MINUTE PERIOD UH MODEL (USED IN THIS COMPUTER PROGRAM)
           MAY BE TOO LARGE FOR PEAK FLOW ESTIMATES.
          VALLEY(DEVELOPED) S-GRAPH SELECTED
          MAXIMUM WATERSHED LOSS RATE(INCH/HOUR) =  0.439
          LOW LOSS FRACTION = 0.400
          *HYDROGRAPH MODEL #1 SPECIFIED*

          SPECIFIED PEAK  5-MINUTES RAINFALL(INCH)=  0.59
          SPECIFIED PEAK 30-MINUTES RAINFALL(INCH)=  1.02
          SPECIFIED PEAK  1-HOUR RAINFALL(INCH) =  1.25
          SPECIFIED PEAK  3-HOUR RAINFALL(INCH) =  2.03
          SPECIFIED PEAK  6-HOUR RAINFALL(INCH) =  2.77
          SPECIFIED PEAK 24-HOUR RAINFALL(INCH) =  7.50

          *USER SPECIFIED PRECIPITATION DEPTH-AREA REDUCTION FACTORS:
            5-MINUTE FACTOR = 0.967
           30-MINUTE FACTOR = 0.967
            1-HOUR FACTOR = 0.967
            3-HOUR FACTOR = 0.995
            6-HOUR FACTOR = 0.998
           24-HOUR FACTOR = 0.999

          UNIT HYDROGRAPH TIME UNIT =   5.000 MINUTES
          UNIT INTERVAL PERCENTAGE OF LAG-TIME =  39.494


          RUNOFF HYDROGRAPH LISTING LIMITS:
          MODEL TIME(HOURS) FOR BEGINNING OF RESULTS =  15.00
          MODEL TIME(HOURS) FOR END OF RESULTS =  19.00


 ==========================================================================
                        UNIT HYDROGRAPH DETERMINATION

 --------------------------------------------------------------------------
     INTERVAL          "S" GRAPH          UNIT HYDROGRAPH
      NUMBER          MEAN VALUES          ORDINATES(CFS)
 --------------------------------------------------------------------------
         1                2.849                66.241
         2               18.992               375.374
         3               48.040               675.451
         4               76.485               661.418
         5               90.647               329.308
```



```
         6               96.514               136.406
         7               98.407                44.029
         8               99.148                17.218
         9               99.659                11.893
        10               99.915                 5.946
        11              100.000                 1.982


 --------------------------------------------------------------------------
     TOTAL SOIL-LOSS VOLUME(ACRE-FEET) =      44.6403
     TOTAL STORM RUNOFF VOLUME(ACRE-FEET) =      75.3096
 --------------------------------------------------------------------------
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24-HOUR STORM
RUNOFF HYDROGRAPH

HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
(Note: Time indicated is at END of Each Unit Intervals)

TIME(HRS)	VOLUME(AF)	Q(CFS)	0. 125.0 250.0 375.0 500.0
15.000	37.6174	46.32	
15.083	37.9480	48.00	
15.167	38.2917	49.90	
15.250	38.6498	52.00	
15.333	39.0247	54.43	
15.417	39.4136	56.46	
15.500	39.7972	55.70	
15.583	40.1566	52.18	
15.667	40.4974	49.48	
15.750	40.8501	51.21	
15.833	41.2436	57.14	
15.917	41.7082	67.46	
16.000	42.3051	86.67	
16.083	43.3401	150.29	
16.167	45.5794	325.15	
16.250	48.8132	469.54	
16.333	51.8229	437.01	
16.417	53.5451	250.07	
16.500	54.4920	137.48	
16.583	55.0732	84.40	
16.667	55.5419	68.06	
16.750	55.9654	61.49	
16.833	56.3405	54.47	
16.917	56.6758	48.69	
17.000	56.9825	44.54	
17.083	57.2710	41.88	
17.167	57.5428	39.47	
17.250	57.7989	37.19	
17.333	58.0410	35.15	
17.417	58.2718	33.50	
17.500	58.4930	32.12	
17.583	58.7060	30.93	
17.667	58.9116	29.86	
17.750	59.1106	28.89	
17.833	59.3035	28.01	
17.917	59.4909	27.21	
18.000	59.6731	26.46	
18.083	59.8534	26.18	
18.167	60.0453	27.86	
18.250	60.2618	31.44	
18.333	60.5029	35.00	
18.417	60.7547	36.57	
18.500	61.0095	36.99	
18.583	61.2634	36.87	
18.667	61.5155	36.60	
18.750	61.7656	36.32	
18.833	62.0136	36.01	
18.917	62.2595	35.70	
19.000	62.5032	35.39	

FLOW PROCESS FROM NODE 4637.00 TO NODE 4637.00 IS CODE = 7

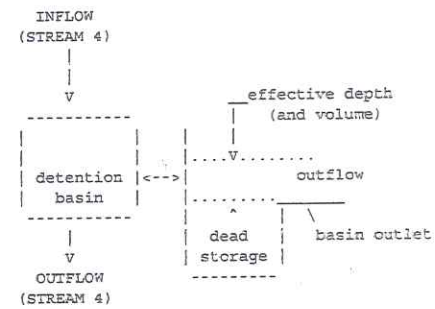
>>>>>STREAM NUMBER 3 ADDED TO STREAM NUMBER 4<<<<<

FLOW PROCESS FROM NODE 4637.00 TO NODE 4637.00 IS CODE = 6

>>>>>STREAM NUMBER 3 CLEARED AND SET TO ZERO<<<<<

FLOW PROCESS FROM NODE 4637.00 TO NODE 4637.00 IS CODE = 3.1

>>>>>FLOW-THROUGH DETENTION BASIN ROUTING MODEL APPLIED TO STREAM #4<<<<<



ROUTE RUNOFF HYDROGRAPH FROM STREAM NUMBER 4
THROUGH A FLOW-THROUGH DETENTION BASIN
SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
DEAD STORAGE(AF) = 0.000
SPECIFIED DEAD STORAGE(AF) FILLED = 0.000
SPECIFIED EFFECTIVE VOLUME(AF) FILLED ABOVE OUTLET = 0.000
DETENTION BASIN CONSTANT LOSS RATE(CFS) = 0.00

BASIN DEPTH VERSUS OUTFLOW AND STORAGE INFORMATION:

INTERVAL NUMBER	DEPTH (FT)	OUTFLOW (CFS)	STORAGE (AF)
1	0.00	0.00	0.000
2	1.00	10.00	4.130
3	2.00	32.00	8.450
4	3.00	56.00	12.950
5	4.00	75.00	17.650
6	5.00	90.00	22.550
7	6.00	103.00	26.910
8	7.00	114.00	30.710

MODIFIED-PULS BASIN ROUTING MODEL RESULTS(5-MINUTE COMPUTATION INTERVALS):
(Note: Computed EFFECTIVE DEPTH and VOLUME are estimated at the clock time;
MEAN OUTFLOW is the average value during the unit interval.)

CLOCK TIME (HRS)	DEAD-STORAGE FILLED(AF)	INFLOW (CFS)	LOSS (CFS)	EFFECTIVE DEPTH(FT)	MEAN OUTFLOW (CFS)	EFFECTIVE VOLUME(AF)
15.083	0.000	80.34	0.00	3.44	64.1	15.005
15.167	0.000	82.47	0.00	3.46	64.6	15.129
15.250	0.000	84.83	0.00	3.49	65.1	15.265
15.333	0.000	87.55	0.00	3.52	65.7	15.415
15.417	0.000	89.89	0.00	3.56	66.3	15.578
15.500	0.000	89.47	0.00	3.59	66.9	15.733
15.583	0.000	86.30	0.00	3.62	67.5	15.863
15.667	0.000	83.95	0.00	3.64	68.0	15.972
15.750	0.000	86.01	0.00	3.67	68.5	16.093
15.833	0.000	92.28	0.00	3.70	69.0	16.253
15.917	0.000	102.95	0.00	3.75	69.8	16.482
16.000	0.000	122.60	0.00	3.83	71.0	16.837
16.083	0.000	186.85	0.00	3.99	73.3	17.619
16.167	0.000	362.73	0.00	4.39	77.9	19.581
16.250	0.000	508.74	0.00	4.99	85.4	22.496
16.333	0.000	478.53	0.00	5.60	93.8	25.146
16.417	0.000	294.31	0.00	5.90	99.7	26.486
16.500	0.000	184.26	0.00	6.04	102.6	27.049
16.583	0.000	133.16	0.00	6.09	103.7	27.252
16.667	0.000	118.27	0.00	6.12	104.1	27.349
16.750	0.000	112.74	0.00	6.13	104.4	27.407
16.833	0.000	106.46	0.00	6.13	104.5	27.421
16.917	0.000	101.23	0.00	6.13	104.4	27.399
17.000	0.000	97.54	0.00	6.12	104.3	27.352
17.083	0.000	95.31	0.00	6.10	104.2	27.291
17.167	0.000	93.27	0.00	6.08	104.0	27.217
17.250	0.000	91.30	0.00	6.06	103.8	27.131
17.333	0.000	89.54	0.00	6.03	103.5	27.035
17.417	0.000	88.11	0.00	6.01	103.2	26.931
17.500	0.000	86.91	0.00	5.98	102.9	26.821
17.583	0.000	85.85	0.00	5.95	102.6	26.705
17.667	0.000	84.89	0.00	5.93	102.2	26.586
17.750	0.000	84.00	0.00	5.90	101.9	26.463
17.833	0.000	83.16	0.00	5.87	101.5	26.337
17.917	0.000	82.36	0.00	5.84	101.1	26.208
18.000	0.000	81.60	0.00	5.81	100.7	26.076
18.083	0.000	81.26	0.00	5.78	100.3	25.945
18.167	0.000	82.86	0.00	5.75	99.9	25.828
18.250	0.000	86.34	0.00	5.73	99.6	25.736
18.333	0.000	89.78	0.00	5.72	99.4	25.670
18.417	0.000	91.24	0.00	5.70	99.2	25.615
18.500	0.000	91.54	0.00	5.69	99.1	25.562
18.583	0.000	91.29	0.00	5.68	98.9	25.510
18.667	0.000	90.90	0.00	5.67	98.7	25.456
18.750	0.000	90.49	0.00	5.65	98.6	25.401
18.833	0.000	90.05	0.00	5.64	98.4	25.343
18.917	0.000	89.59	0.00	5.63	98.2	25.284
19.000	0.000	89.13	0.00	5.61	98.1	25.222

PROCESS SUMMARY OF STORAGE:

INFLOW VOLUME = 151.899 AF
BASIN STORAGE = 0.000 AF (WITH 0.000 AF INITIALLY FILLED)
OUTFLOW VOLUME = 151.899 AF
LOSS VOLUME = 0.000 AF

****
FLOW PROCESS FROM NODE 4637.00 TO NODE 4637.00 IS CODE = 7

>>>>>STREAM NUMBER 4 ADDED TO STREAM NUMBER 5<<<<<

****
FLOW PROCESS FROM NODE 4637.00 TO NODE 4637.00 IS CODE = 6

>>>>>STREAM NUMBER 4 CLEARED AND SET TO ZERO<<<<<

****
FLOW PROCESS FROM NODE 4637.00 TO NODE 4637.00 IS CODE = 11

>>>>>VIEW STREAM NUMBER 5 HYDROGRAPH<<<<<

STREAM HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
(Note: Time indicated is at END of Each Unit Intervals)

TIME(HRS)	VOLUME(AF)	Q(CFS)	0.	50.0	100.0	150.0	200.0
15.000	74.9064	93.91	. V	Q .	.	.	.
15.083	75.5579	94.60	. V	Q .	.	.	.
15.167	76.2146	95.35	. V	Q.	.	.	.
15.250	76.8769	96.17	. V	Q.	.	.	.
15.333	77.5454	97.06	. V	Q.	.	.	.
15.417	78.2204	98.01	. V	Q.	.	.	.
15.500	78.9020	98.97	. V	Q.	.	.	.
15.583	79.5898	99.87	. V	Q.	.	.	.
15.667	80.2831	100.67	. V	Q	.	.	.
15.750	80.9817	101.43	. V	Q	.	.	.
15.833	81.6860	102.27	. V	Q	.	.	.
15.917	82.3977	103.34	. V	Q	.	.	.
16.000	83.1199	104.87	. V	Q	.	.	.
16.083	83.8617	107.70	. V	.Q	.	.	.
16.167	84.6421	113.31	. V	. Q	.	.	.
16.250	85.4871	122.70	. V	. Q	.	.	.
16.333	86.4102	134.03	. V	. Q	.	.	.
16.417	87.3983	143.46	. V	. Q	.	.	.
16.500	88.4286	149.60	. V	. Q.	.	.	.
16.583	89.4843	153.29	. V	. Q	.	.	.
16.667	90.5546	155.40	. V	. .Q	.	.	.
16.750	91.6333	156.63	. V	. .Q	.	.	.
16.833	92.7171	157.36	. V	. .Q	.	.	.
16.917	93.8034	157.73	. V	. .Q	.	.	.
17.000	94.8906	157.86	. V	. .Q	.	.	.
17.083	95.9776	157.84	. V	. .Q	.	.	.
17.167	97.0639	157.72	. V	. .Q	.	.	.
17.250	98.1487	157.52	. V	. .Q	.	.	.
17.333	99.2315	157.23	. V	. .Q	.	.	.
17.417	100.3119	156.87	. V	. .Q	.	.	.
17.500	101.3894	156.45	. V	. .Q	.	.	.
17.583	102.4637	155.99	. V	. .Q	.	.	.
17.667	103.5347	155.50	. V	. .Q	.	.	.
17.750	104.6020	154.97	. V	. Q	.	.	.
17.833	105.6655	154.42	. V	. Q	.	.	.
17.917	106.7250	153.84	. V	. Q	.	.	.
18.000	107.7804	153.24	. V	. Q	.	.	.
18.083	108.8316	152.63	. V	. Q	.	.	.
18.167	109.8786	152.03	. V	. Q	.	.	.
18.250	110.9218	151.48	. V	. Q	.	.	.
18.333	111.9618	151.01	. V	. Q	.	.	.
18.417	112.9990	150.61	. V	. Q	.	.	.

```
 18.500   114.0338   150.25  .        .        V        Q        .
 18.583   115.0662   149.91  .        .        V        Q.       .
 18.667   116.0963   149.57  .        .        V        Q.       .
 18.750   117.1240   149.22  .        .        .V       Q.       .
 18.833   118.1492   148.86  .        .        .V       Q.       .
 18.917   119.1719   148.50  .        .        .V       Q.       .
 19.000   120.1920   148.12  .        .        .V       Q.       .

****************************************************************************
  FLOW PROCESS FROM NODE   4637.00 TO NODE   4821.00 IS CODE = 5.2
----------------------------------------------------------------------------
  >>>>>MODEL CHANNEL ROUTING OF STREAM #5 BY THE CONVEX METHOD<<<<<
============================================================================

        THE MODIFIED C-ROUTING COEFFICIENT IS ESTIMATED IN ORDER
        TO ROUTE THE STREAM 5 INFLOW HYDROGRAPH BY 5-MINUTE
        INTERVALS(Reference: the National Engineering Handbook,
        Hydrology, Chapter 17, page 17-52, August,1972,
        U.S. Department of Commerce).

        ASSUMED REGULAR CHANNEL INFORMATION:
          BASEWIDTH(FT) =   36.00     CHANNEL Z =  1.50
          UPSTREAM ELEVATION(FT) =    2116.00
          DOWNSTREAM ELEVATION(FT) =    2093.80
          CHANNEL LENGTH(FT) =    1367.70     MANNING'S FACTOR = 0.030
          CONSTANT LOSS RATE(CFS) =    0.00

        CHANNEL ROUTING COEFFICIENT ESTIMATED:
          MAXIMUM INFLOW(CFS) =   157.86
          AVERAGE FLOWRATE IN EXCESS OF 50% MAXIMUM INFLOW =   114.42
          CHANNEL NORMAL VELOCITY FOR Q =   114.42 CFS =   4.66 FPS
          ESTIMATED CHANNEL ROUTING COEFFICIENT = 0.733

        MODIFIED CHANNEL ROUTING COEFFICIENT FOR 5-MINUTE
        UNIT INTERVALS IS CSTAR = 0.811

        CONVEX METHOD CHANNEL ROUTING RESULTS:
                                          OUTFLOW LESS
         MODEL        INFLOW      ROUTED      LOSS
          TIME      (STREAM 5)    FLOW     (STREAM 5)
         (HRS)        (CFS)       (CFS)       (CFS)
         15.000       93.91       93.33       93.33
         15.083       94.60       93.96       93.96
         15.167       95.35       94.65       94.65
         15.250       96.17       95.41       95.41
         15.333       97.06       96.23       96.23
         15.417       98.01       97.12       97.12
         15.500       98.97       98.06       98.06
         15.583       99.87       99.00       99.00
         15.667      100.67       99.89       99.89
         15.750      101.43      100.70      100.70
         15.833      102.27      101.48      101.48
         15.917      103.34      102.37      102.37
         16.000      104.87      103.51      103.51
         16.083      107.70      105.26      105.26
         16.167      113.31      108.53      108.53
         16.250      122.70      114.57      114.57
         16.333      134.03      123.77      123.77
         16.417      143.46      134.26      134.26
         16.500      149.60      143.14      143.14
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         16.583      153.29      149.23      149.23
         16.667      155.40      153.01      153.01
         16.750      156.63      155.23      155.23
         16.833      157.36      156.53      156.53
         16.917      157.73      157.29      157.29
         17.000      157.86      157.68      157.68
         17.083      157.84      157.82      157.82
         17.167      157.72      157.81      157.81
         17.250      157.52      157.69      157.69
         17.333      157.23      157.48      157.48
         17.417      156.87      157.19      157.19
         17.500      156.45      156.83      156.83
         17.583      155.99      156.42      156.42
         17.667      155.50      155.96      155.96
         17.750      154.97      155.47      155.47
         17.833      154.42      154.94      154.94
         17.917      153.84      154.39      154.39
         18.000      153.24      153.81      153.81
         18.083      152.63      153.21      153.21
         18.167      152.03      152.60      152.60
         18.250      151.48      152.01      152.01
         18.333      151.01      151.47      151.47
         18.417      150.61      151.00      151.00
         18.500      150.25      150.60      150.60
         18.583      149.91      150.24      150.24
         18.667      149.57      149.89      149.89
         18.750      149.22      149.55      149.55
         18.833      148.86      149.20      149.20
         18.917      148.50      148.84      148.84
         19.000      148.12      148.48      148.48
============================================================================
  PROCESS SUMMARY OF STORAGE:
    INFLOW  VOLUME =    221.846 AF
    OUTFLOW VOLUME =    221.846 AF
    LOSS    VOLUME =      0.000 AF

****************************************************************************
  FLOW PROCESS FROM NODE   4821.00 TO NODE   4821.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>SUBAREA RUNOFF (UNIT-HYDROGRAPH ANALYSIS)<<<<<
============================================================================

      (UNIT-HYDROGRAPH ADDED TO STREAM #1)

        WATERSHED AREA =     158.540 ACRES
        BASEFLOW =   0.000 CFS/SQUARE-MILE
        *USER ENTERED "LAG" TIME =    0.294 HOURS
         CAUTION: LAG TIME IS LESS THAN 0.50 HOURS.
         THE 5-MINUTE PERIOD UH MODEL (USED IN THIS COMPUTER PROGRAM)
         MAY BE TOO LARGE FOR PEAK FLOW ESTIMATES.
        VALLEY(UNDEVELOPED)/DESERT S-GRAPH SELECTED
        MAXIMUM WATERSHED LOSS RATE(INCH/HOUR) =  0.426
        LOW LOSS FRACTION = 0.389
        *HYDROGRAPH MODEL #1 SPECIFIED*

        SPECIFIED PEAK  5-MINUTES RAINFALL(INCH)=  0.59
        SPECIFIED PEAK 30-MINUTES RAINFALL(INCH)=  1.02
        SPECIFIED PEAK  1-HOUR RAINFALL(INCH) =  1.25
        SPECIFIED PEAK  3-HOUR RAINFALL(INCH) =  2.03
        SPECIFIED PEAK  6-HOUR RAINFALL(INCH) =  2.75
        SPECIFIED PEAK 24-HOUR RAINFALL(INCH) =  7.50

        *USER SPECIFIED PRECIPITATION DEPTH-AREA REDUCTION FACTORS:
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5-MINUTE FACTOR = 0.967
30-MINUTE FACTOR = 0.967
1-HOUR FACTOR = 0.967
3-HOUR FACTOR = 0.995
6-HOUR FACTOR = 0.998
24-HOUR FACTOR = 0.999

UNIT HYDROGRAPH TIME UNIT = 5.000 MINUTES
UNIT INTERVAL PERCENTAGE OF LAG-TIME = 28.297

RUNOFF HYDROGRAPH LISTING LIMITS:
MODEL TIME(HOURS) FOR BEGINNING OF RESULTS = 0.00
MODEL TIME(HOURS) FOR END OF RESULTS = 24.00

UNIT HYDROGRAPH DETERMINATION

INTERVAL NUMBER	"S" GRAPH MEAN VALUES	UNIT HYDROGRAPH ORDINATES(CFS)
1	2.650	50.815
2	11.856	176.501
3	28.837	325.580
4	48.862	383.956
5	62.426	260.072
6	70.333	151.605
7	75.625	101.463
8	79.554	75.331
9	82.649	59.341
10	85.192	48.757
11	87.259	39.626
12	88.965	32.724
13	90.495	29.338
14	91.797	24.954
15	92.900	21.151
16	93.926	19.674
17	94.791	16.582
18	95.623	15.950
19	96.301	12.999
20	96.850	10.534
21	97.400	10.534
22	97.920	9.984
23	98.184	5.061
24	98.387	3.893
25	98.591	3.896
26	98.794	3.891
27	98.997	3.896
28	99.200	3.891
29	99.403	3.891
30	99.606	3.891
31	99.808	3.891
32	100.000	3.673

TOTAL SOIL-LOSS VOLUME(ACRE-FEET) = 35.7937
TOTAL STORM RUNOFF VOLUME(ACRE-FEET) = 63.1127

24-HOUR STORM
RUNOFF HYDROGRAPH

HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
(Note: Time indicated is at END of Each Unit Intervals)

TIME(HRS)	VOLUME(AF)	Q(CFS)	0. 75.0 150.0 225.0 300.0
0.083	0.0040	0.59	Q . . . .
0.167	0.0221	2.62	Q . . . .
0.250	0.0659	6.37	Q . . . .
0.333	0.1403	10.80	VQ . . . .
0.417	0.2354	13.81	VQ . . . .
0.500	0.3427	15.57	V Q . . . .
0.583	0.4581	16.77	V Q . . . .
0.667	0.5798	17.66	V Q . . . .
0.750	0.7062	18.37	V Q . . . .
0.833	0.8368	18.95	V Q . . . .
0.917	0.9707	19.44	V Q . . . .
1.000	1.1073	19.84	V Q . . . .
1.083	1.2465	20.21	V Q . . . .
1.167	1.3879	20.53	V Q . . . .
1.250	1.5312	20.80	V Q . . . .
1.333	1.6763	21.06	.VQ . . . .
1.417	1.8229	21.29	.VQ . . . .
1.500	1.9709	21.50	.VQ . . . .
1.583	2.1203	21.68	.VQ . . . .
1.667	2.2707	21.84	.VQ . . . .
1.750	2.4222	21.99	.VQ . . . .
1.833	2.5747	22.14	.VQ . . . .
1.917	2.7278	22.24	.VQ . . . .
2.000	2.8815	22.32	.VQ . . . .
2.083	3.0358	22.40	.VQ . . . .
2.167	3.1906	22.48	. Q . . . .
2.250	3.3460	22.56	. VQ . . . .
2.333	3.5019	22.64	. VQ . . . .
2.417	3.6584	22.72	. VQ . . . .
2.500	3.8154	22.80	. VQ . . . .
2.583	3.9731	22.89	. VQ . . . .
2.667	4.1313	22.97	. VQ . . . .
2.750	4.2897	23.01	. VQ . . . .
2.833	4.4484	23.04	. VQ . . . .
2.917	4.6074	23.08	. VQ . . . .
3.000	4.7666	23.12	. Q . . . .
3.083	4.9261	23.16	. Q . . . .
3.167	5.0859	23.20	. Q . . . .
3.250	5.2460	23.24	. Q . . . .
3.333	5.4063	23.28	. Q . . . .
3.417	5.5670	23.32	. Q . . . .
3.500	5.7279	23.36	. Q . . . .
3.583	5.8891	23.41	. Q . . . .
3.667	6.0505	23.45	. Q . . . .
3.750	6.2123	23.49	. Q . . . .
3.833	6.3744	23.53	. QV . . . .
3.917	6.5367	23.57	. QV . . . .
4.000	6.6994	23.62	. QV . . . .
4.083	6.8623	23.66	. QV . . . .
4.167	7.0256	23.71	. QV . . . .
4.250	7.1892	23.75	. QV . . . .
4.333	7.3530	23.79	. QV . . . .

4.417	7.5172	23.84	.	QV	.	.	.	.
4.500	7.6817	23.89	.	QV	.	.	.	.
4.583	7.8465	23.93	.	QV	.	.	.	.
4.667	8.0117	23.98	.	Q V	.	.	.	.
4.750	8.1771	24.02	.	Q V	.	.	.	.
4.833	8.3429	24.07	.	Q V	.	.	.	.
4.917	8.5090	24.12	.	Q V	.	.	.	.
5.000	8.6754	24.17	.	Q V	.	.	.	.
5.083	8.8422	24.22	.	Q V	.	.	.	.
5.167	9.0093	24.26	.	Q V	.	.	.	.
5.250	9.1768	24.31	.	Q V	.	.	.	.
5.333	9.3446	24.36	.	Q V	.	.	.	.
5.417	9.5127	24.41	.	Q V	.	.	.	.
5.500	9.6812	24.46	.	Q V	.	.	.	.
5.583	9.8500	24.52	.	Q V	.	.	.	.
5.667	10.0192	24.57	.	Q V	.	.	.	.
5.750	10.1888	24.62	.	Q V	.	.	.	.
5.833	10.3587	24.67	.	Q V	.	.	.	.
5.917	10.5290	24.73	.	Q V	.	.	.	.
6.000	10.6997	24.78	.	Q V	.	.	.	.
6.083	10.8707	24.83	.	Q V	.	.	.	.
6.167	11.0421	24.89	.	Q V	.	.	.	.
6.250	11.2139	24.95	.	Q V	.	.	.	.
6.333	11.3861	25.00	.	Q V	.	.	.	.
6.417	11.5587	25.06	.	Q V	.	.	.	.
6.500	11.7317	25.12	.	Q V	.	.	.	.
6.583	11.9050	25.17	.	Q V	.	.	.	.
6.667	12.0788	25.23	.	Q V	.	.	.	.
6.750	12.2530	25.29	.	Q V	.	.	.	.
6.833	12.4276	25.35	.	Q V	.	.	.	.
6.917	12.6026	25.41	.	Q V	.	.	.	.
7.000	12.7780	25.47	.	Q V	.	.	.	.
7.083	12.9539	25.54	.	Q V	.	.	.	.
7.167	13.1302	25.60	.	Q V	.	.	.	.
7.250	13.3069	25.66	.	Q V	.	.	.	.
7.333	13.4841	25.73	.	Q V	.	.	.	.
7.417	13.6617	25.79	.	Q V	.	.	.	.
7.500	13.8398	25.86	.	Q V	.	.	.	.
7.583	14.0183	25.92	.	Q V	.	.	.	.
7.667	14.1973	25.99	.	Q V	.	.	.	.
7.750	14.3768	26.06	.	Q V.	.	.	.	.
7.833	14.5567	26.13	.	Q V.	.	.	.	.
7.917	14.7371	26.20	.	Q V.	.	.	.	.
8.000	14.9180	26.27	.	Q V.	.	.	.	.
8.083	15.0994	26.34	.	Q V.	.	.	.	.
8.167	15.2813	26.41	.	Q V.	.	.	.	.
8.250	15.4637	26.48	.	Q V.	.	.	.	.
8.333	15.6466	26.56	.	Q V.	.	.	.	.
8.417	15.8300	26.63	.	Q V	.	.	.	.
8.500	16.0140	26.71	.	Q V	.	.	.	.
8.583	16.1985	26.79	.	Q V	.	.	.	.
8.667	16.3835	26.87	.	Q V	.	.	.	.
8.750	16.5691	26.94	.	Q V	.	.	.	.
8.833	16.7552	27.03	.	Q V	.	.	.	.
8.917	16.9419	27.11	.	Q V	.	.	.	.
9.000	17.1291	27.19	.	Q V	.	.	.	.
9.083	17.3169	27.27	.	Q V	.	.	.	.
9.167	17.5054	27.36	.	Q .V	.	.	.	.
9.250	17.6944	27.44	.	Q .V	.	.	.	.
9.333	17.8840	27.53	.	Q .V	.	.	.	.
9.417	18.0742	27.62	.	Q .V	.	.	.	.
9.500	18.2651	27.71	.	Q .V	.	.	.	.
9.583	18.4566	27.80	.	Q .V	.	.	.	.
9.667	18.6487	27.90	.	Q .V	.	.	.	.

9.750	18.8415	27.99	.	Q	.V	.	.	.
9.833	19.0349	28.09	.	Q	. V	.	.	.
9.917	19.2291	28.19	.	Q	. V	.	.	.
10.000	19.4239	28.29	.	Q	. V	.	.	.
10.083	19.6194	28.39	.	Q	. V	.	.	.
10.167	19.8156	28.49	.	Q	. V	.	.	.
10.250	20.0125	28.59	.	Q	. V	.	.	.
10.333	20.2101	28.70	.	Q	. V	.	.	.
10.417	20.4085	28.81	.	Q	. V	.	.	.
10.500	20.6077	28.92	.	Q	. V	.	.	.
10.583	20.8076	29.03	.	Q	. V	.	.	.
10.667	21.0083	29.14	.	Q	. V	.	.	.
10.750	21.2098	29.26	.	Q	. V	.	.	.
10.833	21.4122	29.38	.	Q	. V	.	.	.
10.917	21.6153	29.50	.	Q	. V	.	.	.
11.000	21.8193	29.62	.	Q	. V	.	.	.
11.083	22.0242	29.75	.	Q	. V	.	.	.
11.167	22.2300	29.87	.	Q	. V	.	.	.
11.250	22.4366	30.00	.	Q	. V	.	.	.
11.333	22.6442	30.14	.	Q	. V	.	.	.
11.417	22.8527	30.27	.	Q	. V	.	.	.
11.500	23.0621	30.41	.	Q	. V	.	.	.
11.583	23.2726	30.55	.	Q	. V	.	.	.
11.667	23.4840	30.70	.	Q	. V	.	.	.
11.750	23.6964	30.85	.	Q	. V	.	.	.
11.833	23.9099	31.00	.	Q	. V	.	.	.
11.917	24.1245	31.15	.	Q	. V	.	.	.
12.000	24.3402	31.31	.	Q	. V	.	.	.
12.083	24.5546	31.14	.	Q	. V	.	.	.
12.167	24.7623	30.15	.	Q	. V	.	.	.
12.250	24.9564	28.18	.	Q	. V	.	.	.
12.333	25.1344	25.84	.	Q	. V	.	.	.
12.417	25.3020	24.34	.	Q	. V	.	.	.
12.500	25.4642	23.55	.	Q	. V	.	.	.
12.583	25.6233	23.11	.	Q	. V	.	.	.
12.667	25.7807	22.85	.	Q	. V	.	.	.
12.750	25.9371	22.71	.	Q	. V	.	.	.
12.833	26.0931	22.64	.	Q	. V	.	.	.
12.917	26.2490	22.65	.	Q	. V	.	.	.
13.000	26.4054	22.71	.	Q	. V	.	.	.
13.083	26.5625	22.81	.	Q	. V	.	.	.
13.167	26.7205	22.94	.	Q	. V	.	.	.
13.250	26.8797	23.12	.	Q	. V	.	.	.
13.333	27.0403	23.32	.	Q	. V	.	.	.
13.417	27.2025	23.55	.	Q	. V	.	.	.
13.500	27.3664	23.80	.	Q	. V	.	.	.
13.583	27.5323	24.09	.	Q	. V	.	.	.
13.667	27.7004	24.41	.	Q	. V	.	.	.
13.750	27.8709	24.75	.	Q	. V	.	.	.
13.833	28.0439	25.12	.	Q	. V	.	.	.
13.917	28.2198	25.54	.	Q	. V	.	.	.
14.000	28.3988	26.00	.	Q	. V	.	.	.
14.083	28.5815	26.52	.	Q	. V	.	.	.
14.167	28.7687	27.19	.	Q	. V	.	.	.
14.250	28.9617	28.02	.	Q	. V	.	.	.
14.333	29.1610	28.94	.	Q	. V	.	.	.
14.417	29.3662	29.80	.	Q	. V	.	.	.
14.500	29.5770	30.60	.	Q	. V	.	.	.
14.583	29.7932	31.40	.	Q	. V	.	.	.
14.667	30.0153	32.24	.	Q	. V.	.	.	.
14.750	30.2435	33.15	.	Q	. V.	.	.	.
14.833	30.4785	34.12	.	Q	. V.	.	.	.
14.917	30.7207	35.16	.	Q	. V.	.	.	.
15.000	30.9707	36.30	.	Q	. V.	.	.	.

```
15.083    31.2291    37.53  .   Q    .        V.         .         .
15.167    31.4970    38.90  .   Q    .        V.         .         .
15.250    31.7753    40.41  .   Q    .         V         .         .
15.333    32.0653    42.11  .   Q    .         V         .         .
15.417    32.3647    43.48  .   Q    .         V         .         .
15.500    32.6663    43.78  .   Q    .         V         .         .
15.583    32.9609    42.78  .   Q    .         V         .         .
15.667    33.2470    41.55  .   Q    .        .V         .         .
15.750    33.5383    42.29  .   Q    .        .V         .         .
15.833    33.8505    45.33  .    Q   .        .V         .         .
15.917    34.2019    51.03  .    Q   .        .V         .         .
16.000    34.6289    61.99  .      Q .        .V         .         .
16.083    35.3335   102.31  .        . Q      . V         .         .
16.167    36.5614   178.29  .        .         . Q        .         .
16.250    38.3229   255.77  .        .         .  V       .   Q     .
16.333    40.2192   275.35  .        .         .   V      .     Q   .
16.417    41.6208   203.52  .        .         .    VQ    .         .
16.500    42.5925   141.08  .        .       Q .    V     .         .
16.583    43.3546   110.65  .        .    Q    .     V    .         .
16.667    44.0063    94.63  .        . Q      .     V    .         .
16.750    44.5824    83.65  .        .Q       .      V   .         .
16.833    45.0994    75.07  .        Q        .      V   .         .
16.917    45.5643    67.50  .      Q .        .      V   .         .
17.000    45.9873    61.42  .      Q .        .       V.           .
17.083    46.3813    57.21  .     Q  .        .       V.           .
17.167    46.7442    52.70  .     Q  .        .       V.           .
17.250    47.0791    48.63  .    Q   .        .       V.           .
17.333    47.3943    45.75  .    Q   .        .        V           .
17.417    47.6866    42.45  .   Q    .        .        V           .
17.500    47.9651    40.43  .   Q    .        .        V           .
17.583    48.2231    37.47  .  Q     .        .        V           .
17.667    48.4640    34.97  .  Q     .        .        V           .
17.750    48.6959    33.68  .  Q     .        .        V           .
17.833    48.9167    32.05  .  Q     .        .        .V          .
17.917    49.1134    28.56  . Q      .        .        .V          .
18.000    49.2995    27.03  . Q      .        .        .V          .
18.083    49.4827    26.59  . Q      .        .        .V          .
18.167    49.6692    27.08  . Q      .        .        .V          .
18.250    49.8659    28.56  . Q      .        .        .V          .
18.333    50.0758    30.48  .  Q     .        .        .V          .
18.417    50.2935    31.61  .  Q     .        .        .V          .
18.500    50.5143    32.06  .  Q     .        .        . V         .
18.583    50.7356    32.13  .  Q     .        .        . V         .
18.667    50.9546    31.81  .  Q     .        .        . V         .
18.750    51.1606    29.91  . Q      .        .        . V         .
18.833    51.3657    29.77  . Q      .        .        . V         .
18.917    51.5700    29.66  . Q      .        .        . V         .
19.000    51.7734    29.54  . Q      .        .        . V         .
19.083    51.9758    29.39  . Q      .        .        . V         .
19.167    52.1772    29.23  . Q      .        .        .  V        .
19.250    52.3774    29.07  . Q      .        .        .  V        .
19.333    52.5766    28.92  . Q      .        .        .  V        .
19.417    52.7747    28.76  . Q      .        .        .  V        .
19.500    52.9717    28.61  . Q      .        .        .  V        .
19.583    53.1677    28.45  . Q      .        .        .  V        .
19.667    53.3625    28.29  . Q      .        .        .  V        .
19.750    53.5563    28.14  . Q      .        .        .  V        .
19.833    53.7491    28.00  . Q      .        .        .   V       .
19.917    53.9408    27.83  . Q      .        .        .   V       .
20.000    54.1312    27.66  . Q      .        .        .   V       .
20.083    54.3206    27.49  . Q      .        .        .   V       .
20.167    54.5089    27.34  . Q      .        .        .   V       .
20.250    54.6961    27.19  . Q      .        .        .   V       .
20.333    54.8823    27.04  . Q      .        .        .   V       .
```



```
20.417    55.0676    26.90  . Q      .        .        .  V      .
20.500    55.2519    26.76  . Q      .        .        .   V     .
20.583    55.4353    26.63  . Q      .        .        .   V     .
20.667    55.6179    26.51  . Q      .        .        .   V     .
20.750    55.7994    26.36  . Q      .        .        .   V     .
20.833    55.9800    26.21  . Q      .        .        .   V     .
20.917    56.1595    26.07  . Q      .        .        .   V     .
21.000    56.3382    25.94  . Q      .        .        .   V     .
21.083    56.5159    25.80  . Q      .        .        .   V     .
21.167    56.6927    25.67  . Q      .        .        .   V     .
21.250    56.8686    25.55  . Q      .        .        .    V    .
21.333    57.0437    25.42  . Q      .        .        .    V    .
21.417    57.2180    25.30  . Q      .        .        .    V    .
21.500    57.3914    25.18  . Q      .        .        .    V    .
21.583    57.5641    25.07  . Q      .        .        .    V    .
21.667    57.7359    24.95  . Q      .        .        .    V    .
21.750    57.9070    24.84  . Q      .        .        .    V    .
21.833    58.0773    24.73  . Q      .        .        .    V    .
21.917    58.2469    24.62  . Q      .        .        .    V    .
22.000    58.4158    24.52  . Q      .        .        .     V   .
22.083    58.5839    24.42  . Q      .        .        .     V   .
22.167    58.7514    24.32  . Q      .        .        .     V   .
22.250    58.9182    24.22  . Q      .        .        .     V   .
22.333    59.0843    24.12  . Q      .        .        .     V   .
22.417    59.2498    24.03  . Q      .        .        .     V   .
22.500    59.4146    23.93  . Q      .        .        .     V   .
22.583    59.5788    23.84  . Q      .        .        .     V   .
22.667    59.7424    23.75  . Q      .        .        .     V   .
22.750    59.9053    23.66  . Q      .        .        .     V   .
22.833    60.0677    23.57  . Q      .        .        .      V  .
22.917    60.2294    23.49  . Q      .        .        .      V  .
23.000    60.3906    23.40  . Q      .        .        .      V  .
23.083    60.5513    23.32  . Q      .        .        .      V  .
23.167    60.7113    23.24  . Q      .        .        .      V  .
23.250    60.8708    23.16  . Q      .        .        .      V  .
23.333    61.0298    23.08  . Q      .        .        .      V  .
23.417    61.1882    23.00  . Q      .        .        .      V  .
23.500    61.3461    22.93  . Q      .        .        .      V  .
23.583    61.5035    22.85  . Q      .        .        .      V  .
23.667    61.6604    22.78  . Q      .        .        .       V.
23.750    61.8167    22.71  . Q      .        .        .       V.
23.833    61.9726    22.63  . Q      .        .        .       V.
23.917    62.1280    22.56  . Q      .        .        .       V.
24.000    62.2829    22.49  .Q       .        .        .       V.
```

```
*****************************************************************************
  FLOW PROCESS FROM NODE   4821.00 TO NODE   4821.00 IS CODE = 3.1
-----------------------------------------------------------------------------
  >>>>>FLOW-THROUGH DETENTION BASIN ROUTING MODEL APPLIED TO STREAM #1<<<<<
=============================================================================

                    INFLOW
                  (STREAM 1)
                       |
                       |
                       V                 __effective depth
                 -----------             |   (and volume)
                |           |   |   |    |
                |           |   |   |....V........
                | detention |<--->|            outflow
                |   basin   |   |.........._______
                 -----------    |     ^    |  \
                       |        |  dead    |   basin outlet
```

```
                    V          | storage |
                 OUTFLOW        ---------
               (STREAM 1)


ROUTE RUNOFF HYDROGRAPH FROM STREAM NUMBER 1
THROUGH A FLOW-THROUGH DETENTION BASIN
SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
  DEAD STORAGE(AF) =       0.000
  SPECIFIED DEAD STORAGE(AF) FILLED =       0.000
  SPECIFIED EFFECTIVE VOLUME(AF) FILLED ABOVE OUTLET =       0.000
  DETENTION BASIN CONSTANT LOSS RATE(CFS) =     0.00


BASIN DEPTH VERSUS OUTFLOW AND STORAGE INFORMATION:

 INTERVAL    DEPTH      OUTFLOW     STORAGE
 NUMBER      (FT)       (CFS)       (AF)
    1        0.00        0.00       0.000
    2        1.00       14.70       1.050
    3        2.00       48.00       2.120
    4        3.00       83.70       3.220
    5        4.00      112.50       4.340
    6        5.00      135.00       5.490
    7        6.00      154.50       6.660
    8        7.00      170.40       7.850


==========================================================================
MODIFIED-PULS BASIN ROUTING MODEL RESULTS(5-MINUTE COMPUTATION INTERVALS):
(Note: Computed EFFECTIVE DEPTH and VOLUME are estimated at the clock time;
       MEAN OUTFLOW is the average value during the unit interval.)

   CLOCK                                                MEAN
   TIME   DEAD-STORAGE  INFLOW   LOSS   EFFECTIVE OUTFLOW  EFFECTIVE
   (HRS)   FILLED(AF)   (CFS)   (CFS)   DEPTH(FT)  (CFS)   VOLUME(AF)
--------------------------------------------------------------------------
  15.083       0.000    37.53    0.00      1.56     33.0      1.654
  15.167       0.000    38.90    0.00      1.60     34.0      1.688
  15.250       0.000    40.41    0.00      1.63     35.1      1.724
  15.333       0.000    42.11    0.00      1.67     36.3      1.764
  15.417       0.000    43.48    0.00      1.71     37.6      1.805
  15.500       0.000    43.78    0.00      1.74     38.7      1.840
  15.583       0.000    42.78    0.00      1.76     39.6      1.862
  15.667       0.000    41.55    0.00      1.77     40.1      1.871
  15.750       0.000    42.29    0.00      1.78     40.5      1.884
  15.833       0.000    45.33    0.00      1.81     41.1      1.913
  15.917       0.000    51.03    0.00      1.86     42.5      1.972
  16.000       0.000    61.99    0.00      1.97     45.2      2.088
  16.083       0.000   102.31    0.00      2.28     52.5      2.431
  16.167       0.000   178.29    0.00      2.96     70.2      3.175
  16.250       0.000   255.77    0.00      3.94     96.5      4.272
  16.333       0.000   275.35    0.00      4.86    121.3      5.333
  16.417       0.000   203.52    0.00      5.26    136.0      5.798
  16.500       0.000   141.08    0.00      5.27    140.2      5.804
  16.583       0.000   110.65    0.00      5.10    138.6      5.611
  16.667       0.000    94.63    0.00      4.87    134.5      5.337
  16.750       0.000    83.65    0.00      4.60    128.9      5.025
  16.833       0.000    75.07    0.00      4.31    122.7      4.697
  16.917       0.000    67.50    0.00      4.02    116.2      4.361
  17.000       0.000    61.42    0.00      3.73    108.8      4.035
  17.083       0.000    57.21    0.00      3.46    100.8      3.735
  17.167       0.000    52.70    0.00      3.21     93.3      3.455
```



```
  17.250       0.000    48.63    0.00      2.98     86.3      3.195
  17.333       0.000    45.75    0.00      2.77     79.2      2.965
  17.417       0.000    42.45    0.00      2.58     72.1      2.761
  17.500       0.000    40.43    0.00      2.42     65.9      2.585
  17.583       0.000    37.47    0.00      2.28     60.5      2.426
  17.667       0.000    34.97    0.00      2.15     55.6      2.284
  17.750       0.000    33.68    0.00      2.04     51.4      2.162
  17.833       0.000    32.05    0.00      1.94     47.7      2.055
  17.917       0.000    28.56    0.00      1.84     44.3      1.947
  18.000       0.000    27.03    0.00      1.75     41.1      1.850
  18.083       0.000    26.59    0.00      1.67     38.3      1.769
  18.167       0.000    27.08    0.00      1.61     36.1      1.707
  18.250       0.000    28.56    0.00      1.58     34.5      1.666
  18.333       0.000    30.48    0.00      1.56     33.5      1.645
  18.417       0.000    31.61    0.00      1.55     33.1      1.635
  18.500       0.000    32.06    0.00      1.54     32.8      1.630
  18.583       0.000    32.13    0.00      1.54     32.7      1.626
  18.667       0.000    31.81    0.00      1.53     32.5      1.621
  18.750       0.000    29.91    0.00      1.52     32.2      1.605
  18.833       0.000    29.77    0.00      1.51     31.8      1.591
  18.917       0.000    29.66    0.00      1.49     31.4      1.580
  19.000       0.000    29.54    0.00      1.49     31.0      1.569
--------------------------------------------------------------------------
 PROCESS SUMMARY OF STORAGE:
   INFLOW  VOLUME =      63.113 AF
   BASIN  STORAGE =       0.000 AF (WITH       0.000 AF INITIALLY FILLED)
   OUTFLOW VOLUME =      63.113 AF
   LOSS    VOLUME =       0.000 AF


**************************************************************************
 FLOW PROCESS FROM NODE   4821.00 TO NODE   4821.00 IS CODE =   7
--------------------------------------------------------------------------
 >>>>>STREAM NUMBER 1 ADDED TO STREAM NUMBER 5<<<<<
==========================================================================


**************************************************************************
 FLOW PROCESS FROM NODE   4821.00 TO NODE   4821.00 IS CODE =  11
--------------------------------------------------------------------------
 >>>>>VIEW STREAM NUMBER 5 HYDROGRAPH<<<<<
==========================================================================

          STREAM HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
       (Note: Time indicated is at END of Each Unit Intervals)
--------------------------------------------------------------------------
 TIME(HRS) VOLUME(AF)   Q(CFS) 0.        75.0      150.0     225.0     300.0
--------------------------------------------------------------------------
   0.083     0.0002      0.03  Q         .         .         .         .
   0.167     0.0015      0.19  Q         .         .         .         .
   0.250     0.0061      0.66  Q         .         .         .         .
   0.333     0.0170      1.59  Q         .         .         .         .
   0.417     0.0372      2.94  Q         .         .         .         .
   0.500     0.0685      4.55  Q         .         .         .         .
   0.583     0.1119      6.29  Q         .         .         .         .
   0.667     0.1676      8.09  VQ        .         .         .         .
   0.750     0.2357      9.69  VQ        .         .         .         .
   0.833     0.3161     11.67  VQ        .         .         .         .
   0.917     0.4084     13.41  VQ        .         .         .         .
   1.000     0.5124     15.10  V Q       .         .         .         .
   1.083     0.6277     16.74  V Q       .         .         .         .
   1.167     0.7539     18.32  V Q       .         .         .         .
   1.250     0.8905     19.85  V Q       .         .         .         .
   1.333     1.0374     21.32  V Q       .         .         .         .
```

1.417	1.1940	22.74	V	Q	.	.	.	.
1.500	1.3615	24.33	V	Q	.	.	.	.
1.583	1.5418	26.17	V	Q	.	.	.	.
1.667	1.7345	27.98	V	Q	.	.	.	.
1.750	1.9390	29.69	V	Q	.	.	.	.
1.833	2.1549	31.36	V	Q	.	.	.	.
1.917	2.3818	32.95	V	Q	.	.	.	.
2.000	2.6190	34.44	V	Q	.	.	.	.
2.083	2.8659	35.84	V	Q	.	.	.	.
2.167	3.1217	37.15	V	Q	.	.	.	.
2.250	3.3861	38.39	V	Q	.	.	.	.
2.333	3.6589	39.60	V	Q	.	.	.	.
2.417	3.9404	40.88	V	Q	.	.	.	.
2.500	4.2317	42.29	V	Q	.	.	.	.
2.583	4.5330	43.75	V	Q	.	.	.	.
2.667	4.8442	45.19	V	Q	.	.	.	.
2.750	5.1650	46.58	V	Q	.	.	.	.
2.833	5.4952	47.94	V	Q	.	.	.	.
2.917	5.8344	49.25	V	Q	.	.	.	.
3.000	6.1824	50.54	V	Q	.	.	.	.
3.083	6.5391	51.79	V	Q	.	.	.	.
3.167	6.9042	53.01	V	Q	.	.	.	.
3.250	7.2775	54.20	.V	Q	.	.	.	.
3.333	7.6588	55.37	.V	Q	.	.	.	.
3.417	8.0480	56.51	.V	Q	.	.	.	.
3.500	8.4450	57.63	.V	Q	.	.	.	.
3.583	8.8494	58.73	.V	Q	.	.	.	.
3.667	9.2613	59.80	.V	Q	.	.	.	.
3.750	9.6804	60.86	.V	Q	.	.	.	.
3.833	10.1067	61.89	.V	Q	.	.	.	.
3.917	10.5399	62.91	.V	Q	.	.	.	.
4.000	10.9801	63.91	.V	Q	.	.	.	.
4.083	11.4269	64.89	.V	Q	.	.	.	.
4.167	11.8804	65.85	.V	Q	.	.	.	.
4.250	12.3405	66.80	.V	Q	.	.	.	.
4.333	12.8069	67.73	.V	Q	.	.	.	.
4.417	13.2797	68.65	.V	Q	.	.	.	.
4.500	13.7587	69.55	.V	Q	.	.	.	.
4.583	14.2438	70.43	.V	Q	.	.	.	.
4.667	14.7349	71.31	. V	Q	.	.	.	.
4.750	15.2319	72.17	. V	Q	.	.	.	.
4.833	15.7347	73.01	. V	Q	.	.	.	.
4.917	16.2433	73.85	. V	Q	.	.	.	.
5.000	16.7575	74.67	. V	Q	.	.	.	.
5.083	17.2774	75.49	. V	Q	.	.	.	.
5.167	17.8029	76.30	. V	Q	.	.	.	.
5.250	18.3339	77.11	. V	Q	.	.	.	.
5.333	18.8705	77.90	. V	Q	.	.	.	.
5.417	19.4123	78.68	. V	Q	.	.	.	.
5.500	19.9595	79.45	. V	Q	.	.	.	.
5.583	20.5119	80.21	. V	Q	.	.	.	.
5.667	21.0695	80.96	. V	Q	.	.	.	.
5.750	21.6321	81.69	. V	Q	.	.	.	.
5.833	22.1997	82.41	. V	Q	.	.	.	.
5.917	22.7722	83.13	. V	.Q	.	.	.	.
6.000	23.3495	83.83	. V	.Q	.	.	.	.
6.083	23.9316	84.52	. V	.Q	.	.	.	.
6.167	24.5184	85.20	. V	.Q	.	.	.	.
6.250	25.1099	85.88	. V	.Q	.	.	.	.
6.333	25.7059	86.54	. V	.Q	.	.	.	.
6.417	26.3064	87.19	. V	.Q	.	.	.	.
6.500	26.9114	87.84	. V	.Q	.	.	.	.
6.583	27.5207	88.48	. V	.Q	.	.	.	.
6.667	28.1344	89.11	. V	.Q	.	.	.	.

6.750	28.7523	89.73	.	V	.Q	.	.	.
6.833	29.3745	90.34	.	V	. Q	.	.	.
6.917	30.0009	90.95	.	V	. Q	.	.	.
7.000	30.6314	91.55	.	V	. Q	.	.	.
7.083	31.2659	92.14	.	V	. Q	.	.	.
7.167	31.9045	92.72	.	V	. Q	.	.	.
7.250	32.5471	93.30	.	V	. Q	.	.	.
7.333	33.1936	93.87	.	V	. Q	.	.	.
7.417	33.8440	94.44	.	V	. Q	.	.	.
7.500	34.4982	95.00	.	V	. Q	.	.	.
7.583	35.1563	95.55	.	V	. Q	.	.	.
7.667	35.8181	96.10	.	V	. Q	.	.	.
7.750	36.4837	96.64	.	V	. Q	.	.	.
7.833	37.1530	97.17	.	V	. Q	.	.	.
7.917	37.8257	97.69	.	V	. Q	.	.	.
8.000	38.5020	98.19	.	V	. Q	.	.	.
8.083	39.1816	98.68	.	V	. Q	.	.	.
8.167	39.8646	99.17	.	V	. Q	.	.	.
8.250	40.5509	99.66	.	V	. Q	.	.	.
8.333	41.2406	100.14	.	V	. Q	.	.	.
8.417	41.9336	100.62	.	V	. Q	.	.	.
8.500	42.6299	101.10	.	V	. Q	.	.	.
8.583	43.3295	101.58	.	V	. Q	.	.	.
8.667	44.0324	102.06	.	V	. Q	.	.	.
8.750	44.7385	102.53	.	V	. Q	.	.	.
8.833	45.4479	103.00	.	V	. Q	.	.	.
8.917	46.1605	103.47	.	V	. Q	.	.	.
9.000	46.8763	103.94	.	V	. Q	.	.	.
9.083	47.5953	104.40	.	V	. Q	.	.	.
9.167	48.3176	104.87	.	V	. Q	.	.	.
9.250	49.0430	105.33	.	V	. Q	.	.	.
9.333	49.7716	105.80	.	V	. Q	.	.	.
9.417	50.5034	106.26	.	V	. Q	.	.	.
9.500	51.2384	106.72	.	V	. Q	.	.	.
9.583	51.9766	107.18	.	V	. Q	.	.	.
9.667	52.7179	107.64	.	V	. Q	.	.	.
9.750	53.4623	108.10	.	V	. Q	.	.	.
9.833	54.2099	108.55	.	V	. Q	.	.	.
9.917	54.9607	109.01	.	V	. Q	.	.	.
10.000	55.7146	109.47	.	V	. Q	.	.	.
10.083	56.4717	109.92	.	V	. Q	.	.	.
10.167	57.2319	110.38	.	V	. Q	.	.	.
10.250	57.9951	110.82	.	V	. Q	.	.	.
10.333	58.7612	111.24	.	V	. Q	.	.	.
10.417	59.5301	111.64	.	V	. Q	.	.	.
10.500	60.3018	112.04	.	V	. Q	.	.	.
10.583	61.0762	112.45	.	V	. Q	.	.	.
10.667	61.8535	112.86	.	V	. Q	.	.	.
10.750	62.6336	113.27	.	V	. Q	.	.	.
10.833	63.4166	113.69	.	V	. Q	.	.	.
10.917	64.2024	114.11	.	V.	Q	.	.	.
11.000	64.9912	114.53	.	V.	Q	.	.	.
11.083	65.7830	114.96	.	V.	Q	.	.	.
11.167	66.5777	115.40	.	V.	Q	.	.	.
11.250	67.3755	115.84	.	V.	Q	.	.	.
11.333	68.1763	116.28	.	V.	Q	.	.	.
11.417	68.9802	116.73	.	V.	Q	.	.	.
11.500	69.7873	117.18	.	V.	Q	.	.	.
11.583	70.5975	117.64	.	V.	Q	.	.	.
11.667	71.4109	118.11	.	V	Q	.	.	.
11.750	72.2276	118.58	.	V	Q	.	.	.
11.833	73.0475	119.06	.	V	Q	.	.	.
11.917	73.8708	119.54	.	V	Q	.	.	.
12.000	74.6975	120.04	.	V	Q	.	.	.

12.083	75.5275	120.50	V Q
12.167	76.3596	120.82	V Q
12.250	77.1917	120.82	V Q
12.333	78.0206	120.36	V Q
12.417	78.8438	119.53	.V Q
12.500	79.6602	118.55	.V Q
12.583	80.4700	117.57	.V Q
12.667	81.2733	116.65	.V Q
12.750	82.0711	115.83	.V Q
12.833	82.8639	115.11	.V Q
12.917	83.6525	114.50	.V Q
13.000	84.4376	114.00	.V Q
13.083	85.2199	113.60	.V Q
13.167	86.0001	113.28	. V Q
13.250	86.7787	113.05	. V Q
13.333	87.5562	112.90	. V Q
13.417	88.3332	112.82	. V Q
13.500	89.1102	112.81	. V Q
13.583	89.8875	112.86	. V Q
13.667	90.6656	112.98	. V Q
13.750	91.4449	113.16	. V Q
13.833	92.2259	113.40	. V Q
13.917	93.0090	113.70	. V Q
14.000	93.7945	114.06	. V Q
14.083	94.5830	114.49	. V Q
14.167	95.3749	114.99	. V Q
14.250	96.1711	115.61	. V Q
14.333	96.9724	116.35	. V Q
14.417	97.7796	117.20	. V Q
14.500	98.5932	118.14	. V Q
14.583	99.4138	119.15	. V Q
14.667	100.2418	120.24	. V Q
14.750	101.0779	121.40	. V Q
14.833	101.9226	122.65	. V Q
14.917	102.7765	123.99	. V Q
15.000	103.6403	125.43	. V Q
15.083	104.5149	126.99	. V Q
15.167	105.4011	128.68	. V Q
15.250	106.3001	130.53	. V Q
15.333	107.2129	132.54	. V Q
15.417	108.1405	134.69	. V Q
15.500	109.0826	136.80	. V Q
15.583	110.0373	138.82	. V Q
15.667	111.0015	140.00	. V Q
15.750	111.9736	141.16	. V Q
15.833	112.9557	142.59	. V Q.
15.917	113.9532	144.85	. V Q.
16.000	114.9774	148.70	. V Q.
16.083	116.0641	157.80	. V .Q
16.167	117.2948	178.69	. V . Q
16.250	118.7484	211.07	. V . Q .
16.333	120.4365	245.11	. V . . Q
16.417	122.2979	270.29	. V . . Q
16.500	124.2491	283.31	. V . . Q
16.583	126.2316	287.85	. V . . Q
16.667	128.2118	287.52	. V . . Q
16.750	130.1689	284.18	. V . . Q
16.833	132.0919	279.22	. V . . Q
16.917	133.9754	273.49	. V . . Q
17.000	135.8106	266.46	. V. . Q
17.083	137.5917	258.62	. V. . Q
17.167	139.3214	251.15	. V. . Q
17.250	141.0019	244.01	. V. . Q
17.333	142.6317	236.65	. V .Q

17.417	144.2110	229.31	V Q
17.500	145.7453	222.78	V Q.
17.583	147.2394	216.94	V Q .
17.667	148.6967	211.60	V Q .
17.750	150.1211	206.82	.V Q .
17.833	151.5165	202.61	.V Q .
17.917	152.8847	198.67	.V Q .
18.000	154.2270	194.90	.V Q .
18.083	155.5462	191.54	.V Q .
18.167	156.8458	188.71	. V Q .
18.250	158.1303	186.51	. V Q .
18.333	159.4044	185.01	. V Q .
18.417	160.6720	184.06	. V Q .
18.500	161.9352	183.42	. V Q .
18.583	163.1950	182.91	. V Q .
18.667	164.4514	182.43	. VQ .
18.750	165.7032	181.76	. VQ .
18.833	166.9494	180.95	. VQ .
18.917	168.1905	180.20	. VQ .
19.000	169.4267	179.50	. Q .
19.083	170.6583	178.82	. Q .
19.167	171.8853	178.16	. QV .
19.250	173.1079	177.52	. QV .
19.333	174.3261	176.88	. QV .
19.417	175.5400	176.26	. QV .
19.500	176.7496	175.64	. QV .
19.583	177.9551	175.03	. QV .
19.667	179.1563	174.42	. Q V .
19.750	180.3534	173.81	. Q V .
19.833	181.5462	173.20	. Q V .
19.917	182.7349	172.60	. Q V .
20.000	183.9194	171.99	. Q V .
20.083	185.0997	171.38	. Q V .
20.167	186.2758	170.76	. Q V .
20.250	187.4476	170.15	. Q V .
20.333	188.6152	169.53	. Q V .
20.417	189.7785	168.92	. Q V .
20.500	190.9375	168.29	. Q V .
20.583	192.0922	167.66	. Q V .
20.667	193.2425	167.03	. Q V .
20.750	194.3884	166.39	. Q V .
20.833	195.5300	165.76	. Q V .
20.917	196.6672	165.12	. Q V .
21.000	197.8000	164.48	.Q V .
21.083	198.9284	163.84	.Q V .
21.167	200.0524	163.21	.Q V .
21.250	201.1721	162.57	.Q V .
21.333	202.2874	161.94	.Q V .
21.417	203.3983	161.30	.Q V .
21.500	204.5048	160.67	.Q V .
21.583	205.6071	160.04	.Q V .
21.667	206.7050	159.42	.Q V.
21.750	207.7986	158.79	.Q V.
21.833	208.8879	158.16	.Q V.
21.917	209.9728	157.54	.Q V.
22.000	211.0535	156.91	Q V.
22.083	212.1298	156.28	Q V.
22.167	213.2017	155.64	Q V.
22.250	214.2692	155.00	Q V
22.333	215.3322	154.35	Q V
22.417	216.3908	153.71	Q V
22.500	217.4450	153.07	Q V
22.583	218.4949	152.44	Q V
22.667	219.5403	151.80	Q V

```
 22.750    220.5815    151.17  .         .         Q         V         .
 22.833    221.6183    150.54  .         .         Q         .V        .
 22.917    222.6508    149.92  .         .        Q.         .V        .
 23.000    223.6790    149.30  .         .        Q.         .V        .
 23.083    224.7030    148.68  .         .        Q.         .V        .
 23.167    225.7227    148.06  .         .        Q.         .V        .
 23.250    226.7382    147.45  .         .        Q.         .V        .
 23.333    227.7495    146.84  .         .        Q.         .V        .
 23.417    228.7566    146.23  .         .        Q.         . V       .
 23.500    229.7596    145.63  .         .        Q.         . V       .
 23.583    230.7584    145.03  .         .        Q.         . V       .
 23.667    231.7531    144.43  .         .        Q.         . V       .
 23.750    232.7437    143.83  .         .        Q.         . V       .
 23.833    233.7302    143.24  .         .        Q.         . V       .
 23.917    234.7126    142.65  .         .        Q.         . V       .
 24.000    235.6909    142.05  .         .       Q .         .  V      .
==============================================================================

 END OF FLOODSCx ROUTING ANALYSIS
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            F L O O D   R O U T I N G   A N A L Y S I S
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                     Analysis prepared by:

                        RBF Consulting
                      14725 Alton Parkway
                   Irvine, California  92618


 ************************* DESCRIPTION OF STUDY *************************
* CITY OF YUCAIPA                                                        *
* MASTER PLAN OF DRAINAGE UPDATE- Depth Area = 878.58 ac.                *
* UH BASIN MODEL - NODE 4821 MC - ALT 5                                  *
 ************************************************************************

  FILE NAME: D5-4821.DAT
  TIME/DATE OF STUDY: 11:43 05/23/2011


****************************************************************************
  FLOW PROCESS FROM NODE   4711.00 TO NODE   4811.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>SUBAREA RUNOFF (UNIT-HYDROGRAPH ANALYSIS)<<<<<
============================================================================

      (UNIT-HYDROGRAPH ADDED TO STREAM #5)

         WATERSHED AREA =     196.500 ACRES
         BASEFLOW =    0.000 CFS/SQUARE-MILE
         *USER ENTERED "LAG" TIME =     0.320 HOURS
          CAUTION: LAG TIME IS LESS THAN 0.50 HOURS.
          THE 5-MINUTE PERIOD UH MODEL (USED IN THIS COMPUTER PROGRAM)
          MAY BE TOO LARGE FOR PEAK FLOW ESTIMATES.
         VALLEY(DEVELOPED):
                 "S"-CURVE PERCENTAGE(DECIMAL NOTATION) =  0.530
         FOOTHILL "S"-CURVE PERCENTAGE(DECIMAL NOTATION) =  0.000
         MOUNTAIN "S"-CURVE PERCENTAGE(DECIMAL NOTATION) =  0.000
         VALLEY(UNDEVELOPED)/DESERT:
                 "S"-CURVE PERCENTAGE(DECIMAL NOTATION) =  0.470
         DESERT(UNDEVELOPED) "S"-CURVE PERCENTAGE(DECIMAL NOTATION) =  0.000
         MAXIMUM WATERSHED LOSS RATE(INCH/HOUR) =  0.526
         LOW LOSS FRACTION = 0.461
         *HYDROGRAPH MODEL #1 SPECIFIED*

         SPECIFIED PEAK  5-MINUTES RAINFALL(INCH)=  0.59
         SPECIFIED PEAK 30-MINUTES RAINFALL(INCH)=  1.02
         SPECIFIED PEAK  1-HOUR RAINFALL(INCH) =  1.25
         SPECIFIED PEAK  3-HOUR RAINFALL(INCH) =  2.07
         SPECIFIED PEAK  6-HOUR RAINFALL(INCH) =  2.85
         SPECIFIED PEAK 24-HOUR RAINFALL(INCH) =  7.50

         *USER SPECIFIED PRECIPITATION DEPTH-AREA REDUCTION FACTORS:
           5-MINUTE FACTOR = 0.961
          30-MINUTE FACTOR = 0.961
           1-HOUR FACTOR = 0.961
           3-HOUR FACTOR = 0.994
           6-HOUR FACTOR = 0.997
          24-HOUR FACTOR = 0.998
```



```
         UNIT HYDROGRAPH TIME UNIT =   5.000 MINUTES
         UNIT INTERVAL PERCENTAGE OF LAG-TIME =  26.042


         RUNOFF HYDROGRAPH LISTING LIMITS:
         MODEL TIME(HOURS) FOR BEGINNING OF RESULTS =  15.00
         MODEL TIME(HOURS) FOR END OF RESULTS =  19.00
```

UNIT HYDROGRAPH DETERMINATION

INTERVAL NUMBER	"S" GRAPH MEAN VALUES	UNIT HYDROGRAPH ORDINATES(CFS)
1	1.954	46.424
2	9.120	170.311
3	23.597	344.019
4	42.579	451.094
5	61.023	438.305
6	73.701	301.286
7	81.423	183.503
8	86.178	113.010
9	89.277	73.635
10	91.220	46.173
11	92.533	31.205
12	93.666	26.938
13	94.649	23.357
14	95.443	18.868
15	96.055	14.533
16	96.547	11.706
17	97.000	10.760
18	97.397	9.446
19	97.757	8.555
20	98.103	8.201
21	98.356	6.025
22	98.594	5.646
23	98.831	5.649
24	99.047	5.132
25	99.151	2.468
26	99.239	2.091
27	99.327	2.084
28	99.415	2.089
29	99.503	2.086
30	99.590	2.088
31	99.678	2.087
32	99.766	2.088
33	99.854	2.087
34	99.942	2.088
35	100.000	1.383
36	100.000	0.000
37	100.000	0.000
38	100.000	0.000
39	100.000	0.000
40	100.000	0.000
41	100.000	0.000
42	100.000	0.000
43	100.000	0.000
44	100.000	0.000
45	100.000	0.000
46	100.000	0.000
47	100.000	0.000

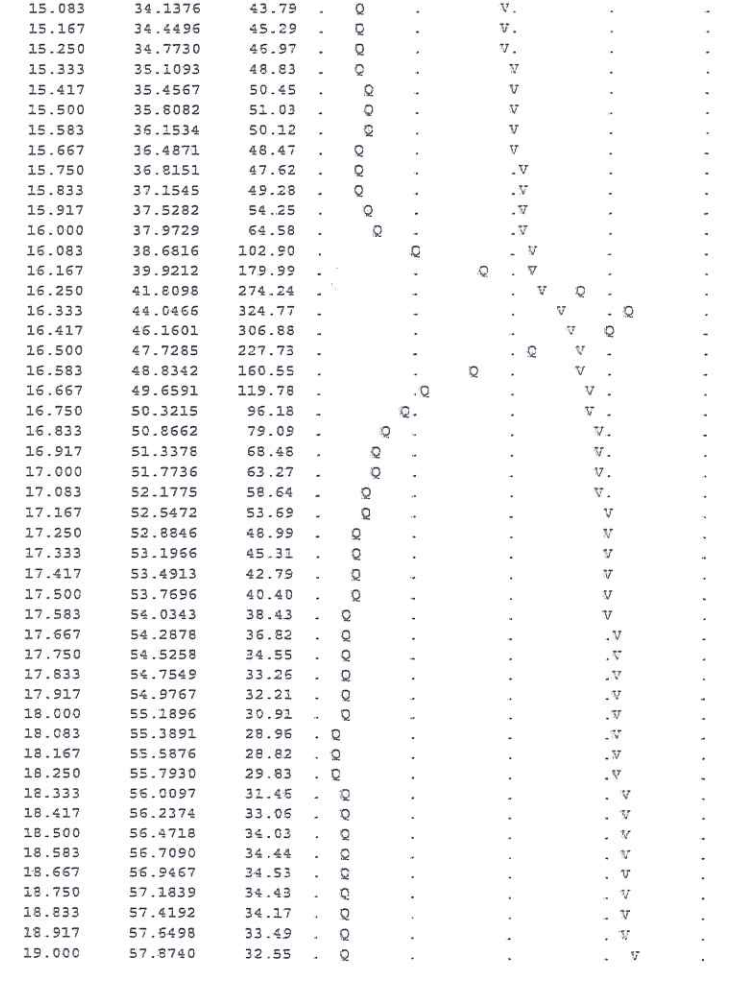
48	100.000	0.000
49	100.000	0.000
50	100.000	0.000
51	100.000	0.000
52	100.000	0.000
53	100.000	0.000
54	100.000	0.000
55	100.000	0.000
56	100.000	0.000

TOTAL SOIL-LOSS VOLUME(ACRE-FEET) = 52.6629
TOTAL STORM RUNOFF VOLUME(ACRE-FEET) = 69.8968

24 - H O U R S T O R M
R U N O F F H Y D R O G R A P H

HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
(Note: Time indicated is at END of Each Unit Intervals)

TIME(HRS)	VOLUME(AF)	Q(CFS)
15.000	33.8361	42.41
15.083	34.1376	43.79
15.167	34.4496	45.29
15.250	34.7730	46.97
15.333	35.1093	48.83
15.417	35.4567	50.45
15.500	35.8082	51.03
15.583	36.1534	50.12
15.667	36.4871	48.47
15.750	36.8151	47.62
15.833	37.1545	49.28
15.917	37.5282	54.25
16.000	37.9729	64.58
16.083	38.6816	102.90
16.167	39.9212	179.99
16.250	41.8098	274.24
16.333	44.0466	324.77
16.417	46.1601	306.88
16.500	47.7285	227.73
16.583	48.8342	160.55
16.667	49.6591	119.78
16.750	50.3215	96.18
16.833	50.8662	79.09
16.917	51.3378	68.48
17.000	51.7736	63.27
17.083	52.1775	58.64
17.167	52.5472	53.69
17.250	52.8846	48.99
17.333	53.1966	45.31
17.417	53.4913	42.79
17.500	53.7696	40.40
17.583	54.0343	38.43
17.667	54.2878	36.82
17.750	54.5258	34.55
17.833	54.7549	33.26
17.917	54.9767	32.21
18.000	55.1896	30.91
18.083	55.3891	28.96
18.167	55.5876	28.82
18.250	55.7930	29.83
18.333	56.0097	31.46
18.417	56.2374	33.06
18.500	56.4718	34.03
18.583	56.7090	34.44
18.667	56.9467	34.53
18.750	57.1839	34.43
18.833	57.4192	34.17
18.917	57.5498	33.49
19.000	57.8740	32.55



FLOW PROCESS FROM NODE 4811.00 TO NODE 4811.00 IS CODE = 3.1

>>>>>FLOW-THROUGH DETENTION BASIN ROUTING MODEL APPLIED TO STREAM #5<<<<<

```
                 INFLOW
               (STREAM 5)
                   |
                   |
                   V                 __effective depth
                -----------          |   (and volume)
               |           |    |    |
               |           |    |....V........
               | detention |<--->|           outflow
               |   basin   |    |.........______
                -----------     |     ^     |  \
                   |            |  dead     |   basin outlet
                   V            | storage   |
                 OUTFLOW         ---------
               (STREAM 5)
```

ROUTE RUNOFF HYDROGRAPH FROM STREAM NUMBER 5
THROUGH A FLOW-THROUGH DETENTION BASIN
SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
DEAD STORAGE(AF) = 0.000
SPECIFIED DEAD STORAGE(AF) FILLED = 0.000
SPECIFIED EFFECTIVE VOLUME(AF) FILLED ABOVE OUTLET = 0.000
DETENTION BASIN CONSTANT LOSS RATE(CFS) = 0.00

BASIN DEPTH VERSUS OUTFLOW AND STORAGE INFORMATION:

INTERVAL NUMBER	DEPTH (FT)	OUTFLOW (CFS)	STORAGE (AF)
1	0.00	0.00	0.000
2	1.00	4.55	1.997
3	2.00	14.40	4.050
4	3.00	24.35	6.158
5	4.00	31.45	8.323
6	5.00	37.25	10.545
7	6.00	42.25	12.825
8	7.00	46.70	15.162
9	8.00	50.80	17.559
10	9.00	54.55	20.015

MODIFIED-PULS BASIN ROUTING MODEL RESULTS(5-MINUTE COMPUTATION INTERVALS):
(Note: Computed EFFECTIVE DEPTH and VOLUME are estimated at the clock time; MEAN OUTFLOW is the average value during the unit interval.)

CLOCK TIME (HRS)	DEAD-STORAGE FILLED(AF)	INFLOW (CFS)	LOSS (CFS)	EFFECTIVE DEPTH(FT)	MEAN OUTFLOW (CFS)	EFFECTIVE VOLUME(AF)
15.083	0.000	43.79	0.00	3.93	30.8	8.180
15.167	0.000	45.29	0.00	3.98	31.1	8.277
15.250	0.000	46.97	0.00	4.03	31.5	8.384
15.333	0.000	48.83	0.00	4.08	31.8	8.502
15.417	0.000	50.45	0.00	4.14	32.1	8.628
15.500	0.000	51.03	0.00	4.20	32.4	8.756
15.583	0.000	50.12	0.00	4.25	32.7	8.876

15.667	0.000	48.47	0.00	4.30	33.0	8.982
15.750	0.000	47.62	0.00	4.34	33.3	9.081
15.833	0.000	49.28	0.00	4.39	33.6	9.189
15.917	0.000	54.25	0.00	4.45	33.9	9.329
16.000	0.000	64.58	0.00	4.55	34.3	9.538
16.083	0.000	102.90	0.00	4.76	35.2	10.004
16.167	0.000	179.99	0.00	5.19	37.0	10.988
16.250	0.000	274.24	0.00	5.90	40.0	12.601
16.333	0.000	324.77	0.00	6.73	43.6	14.538
16.417	0.000	306.88	0.00	7.49	47.1	16.327
16.500	0.000	227.73	0.00	8.00	49.7	17.553
16.583	0.000	160.55	0.00	8.30	51.4	18.305
16.667	0.000	119.78	0.00	8.49	52.3	18.769
16.750	0.000	96.18	0.00	8.61	52.9	19.068
16.833	0.000	79.09	0.00	8.69	53.2	19.246
16.917	0.000	68.48	0.00	8.73	53.5	19.349
17.000	0.000	63.27	0.00	8.76	53.6	19.416
17.083	0.000	58.64	0.00	8.77	53.7	19.450
17.167	0.000	53.69	0.00	8.77	53.7	19.450
17.250	0.000	48.99	0.00	8.76	53.7	19.418
17.333	0.000	45.31	0.00	8.73	53.6	19.361
17.417	0.000	42.79	0.00	8.70	53.5	19.287
17.500	0.000	40.40	0.00	8.67	53.4	19.198
17.583	0.000	38.43	0.00	8.63	53.2	19.096
17.667	0.000	36.82	0.00	8.58	53.1	18.984
17.750	0.000	34.55	0.00	8.53	52.9	18.858
17.833	0.000	33.26	0.00	8.47	52.7	18.724
17.917	0.000	32.21	0.00	8.42	52.5	18.585
18.000	0.000	30.91	0.00	8.36	52.3	18.438
18.083	0.000	28.96	0.00	8.29	52.0	18.279
18.167	0.000	28.82	0.00	8.23	51.8	18.121
18.250	0.000	29.83	0.00	8.17	51.5	17.971
18.333	0.000	31.46	0.00	8.11	51.3	17.834
18.417	0.000	33.06	0.00	8.06	51.1	17.710
18.500	0.000	34.03	0.00	8.01	50.9	17.594
18.583	0.000	34.44	0.00	7.97	50.8	17.481
18.667	0.000	34.53	0.00	7.92	50.6	17.371
18.750	0.000	34.43	0.00	7.88	50.4	17.261
18.833	0.000	34.17	0.00	7.83	50.2	17.150
18.917	0.000	33.49	0.00	7.78	50.0	17.037
19.000	0.000	32.55	0.00	7.73	49.8	16.918

PROCESS SUMMARY OF STORAGE:
INFLOW VOLUME = 69.897 AF
BASIN STORAGE = 0.000 AF (WITH 0.000 AF INITIALLY FILLED)
OUTFLOW VOLUME = 69.897 AF
LOSS VOLUME = 0.000 AF

FLOW PROCESS FROM NODE 4811.00 TO NODE 4637.00 IS CODE = 5.2

>>>>>MODEL CHANNEL ROUTING OF STREAM #5 BY THE CONVEX METHOD<<<<<

THE MODIFIED C-ROUTING COEFFICIENT IS ESTIMATED IN ORDER TO ROUTE THE STREAM 5 INFLOW HYDROGRAPH BY 5-MINUTE INTERVALS(Reference: the National Engineering Handbook, Hydrology, Chapter 17, page 17-52, August,1972, U.S. Department of Commerce).

ASSUMED REGULAR CHANNEL INFORMATION:
BASEWIDTH(FT) = 36.00 CHANNEL Z = 1.50

UPSTREAM ELEVATION(FT) = 2219.90
DOWNSTREAM ELEVATION(FT) = 2139.05
CHANNEL LENGTH(FT) = 1349.00 MANNING'S FACTOR = 0.030
CONSTANT LOSS RATE(CFS) = 0.00

CHANNEL ROUTING COEFFICIENT ESTIMATED:
MAXIMUM INFLOW(CFS) = 53.69
AVERAGE FLOWRATE IN EXCESS OF 50% MAXIMUM INFLOW = 38.25
CHANNEL NORMAL VELOCITY FOR Q = 38.25 CFS = 4.45 FPS
ESTIMATED CHANNEL ROUTING COEFFICIENT = 0.724

MODIFIED CHANNEL ROUTING COEFFICIENT FOR 5-MINUTE
UNIT INTERVALS IS CSTAR = 0.798

CONVEX METHOD CHANNEL ROUTING RESULTS:

MODEL TIME (HRS)	INFLOW (STREAM 5) (CFS)	ROUTED FLOW (CFS)	OUTFLOW LESS LOSS (STREAM 5) (CFS)
15.000	30.55	30.31	30.31
15.083	30.83	30.56	30.56
15.167	31.14	30.85	30.85
15.250	31.45	31.15	31.15
15.333	31.76	31.46	31.46
15.417	32.08	31.77	31.77
15.500	32.41	32.09	32.09
15.583	32.74	32.42	32.42
15.667	33.03	32.74	32.74
15.750	33.30	33.03	33.03
15.833	33.57	33.30	33.30
15.917	33.89	33.59	33.59
16.000	34.35	33.93	33.93
16.083	35.23	34.45	34.45
16.167	37.03	35.46	35.46
16.250	39.99	37.35	37.35
16.333	43.64	40.24	40.24
16.417	47.10	43.69	43.69
16.500	49.74	46.98	46.98
16.583	51.36	49.53	49.53
16.667	52.29	51.19	51.19
16.750	52.88	52.20	52.20
16.833	53.24	52.82	52.82
16.917	53.45	53.20	53.20
17.000	53.58	53.43	53.43
17.083	53.66	53.57	53.57
17.167	53.69	53.65	53.65
17.250	53.66	53.67	53.67
17.333	53.59	53.65	53.65
17.417	53.49	53.58	53.58
17.500	53.37	53.49	53.49
17.583	53.22	53.36	53.36
17.667	53.06	53.22	53.22
17.750	52.88	53.05	53.05
17.833	52.68	52.87	52.87
17.917	52.47	52.67	52.67
18.000	52.25	52.47	52.47
18.083	52.02	52.25	52.25
18.167	51.78	52.01	52.01
18.250	51.54	51.78	51.78
18.333	51.32	51.54	51.54
18.417	51.13	51.33	51.33
18.500	50.94	51.13	51.13

18.583	50.76	50.94	50.94
18.667	50.57	50.76	50.76
18.750	50.38	50.57	50.57
18.833	50.20	50.38	50.38
18.917	50.00	50.19	50.19
19.000	49.80	50.00	50.00

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PROCESS SUMMARY OF STORAGE:
INFLOW VOLUME = 69.897 AF
OUTFLOW VOLUME = 69.897 AF
LOSS VOLUME = 0.000 AF

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FLOW PROCESS FROM NODE 4611.00 TO NODE 4616.00 IS CODE = 1

>>>>>SUBAREA RUNOFF (UNIT-HYDROGRAPH ANALYSIS)<<<<<
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(UNIT-HYDROGRAPH ADDED TO STREAM #3)

WATERSHED AREA = 95.840 ACRES
BASEFLOW = 0.000 CFS/SQUARE-MILE
*USER ENTERED "LAG" TIME = 0.165 HOURS
CAUTION: LAG TIME IS LESS THAN 0.50 HOURS.
THE 5-MINUTE PERIOD UH MODEL (USED IN THIS COMPUTER PROGRAM)
MAY BE TOO LARGE FOR PEAK FLOW ESTIMATES.
VALLEY(DEVELOPED):
"S"-CURVE PERCENTAGE(DECIMAL NOTATION) = 0.990
FOOTHILL "S"-CURVE PERCENTAGE(DECIMAL NOTATION) = 0.000
MOUNTAIN "S"-CURVE PERCENTAGE(DECIMAL NOTATION) = 0.000
VALLEY(UNDEVELOPED)/DESERT:
"S"-CURVE PERCENTAGE(DECIMAL NOTATION) = 0.010
DESERT(UNDEVELOPED) "S"-CURVE PERCENTAGE(DECIMAL NOTATION) = 0.000
MAXIMUM WATERSHED LOSS RATE(INCH/HOUR) = 0.451
LOW LOSS FRACTION = 0.410
HYDROGRAPH MODEL #1 SPECIFIED

SPECIFIED PEAK 5-MINUTES RAINFALL(INCH)= 0.59
SPECIFIED PEAK 30-MINUTES RAINFALL(INCH)= 1.02
SPECIFIED PEAK 1-HOUR RAINFALL(INCH) = 1.25
SPECIFIED PEAK 3-HOUR RAINFALL(INCH) = 2.03
SPECIFIED PEAK 6-HOUR RAINFALL(INCH) = 2.76
SPECIFIED PEAK 24-HOUR RAINFALL(INCH) = 7.50

*USER SPECIFIED PRECIPITATION DEPTH-AREA REDUCTION FACTORS:
5-MINUTE FACTOR = 0.961
30-MINUTE FACTOR = 0.961
1-HOUR FACTOR = 0.961
3-HOUR FACTOR = 0.994
6-HOUR FACTOR = 0.997
24-HOUR FACTOR = 0.998

UNIT HYDROGRAPH TIME UNIT = 5.000 MINUTES
UNIT INTERVAL PERCENTAGE OF LAG-TIME = 50.505

RUNOFF HYDROGRAPH LISTING LIMITS:
MODEL TIME(HOURS) FOR BEGINNING OF RESULTS = 15.00
MODEL TIME(HOURS) FOR END OF RESULTS = 19.00

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UNIT HYDROGRAPH DETERMINATION

INTERVAL NUMBER	"S" GRAPH MEAN VALUES	UNIT HYDROGRAPH ORDINATES(CFS)
1	4.553	52.776
2	30.270	298.069
3	68.792	446.494
4	90.067	246.597
5	97.026	80.658
6	98.673	19.086
7	99.381	8.206
8	99.712	3.843
9	99.885	2.002
10	99.952	0.775
11	99.964	0.146
12	99.974	0.114
13	99.981	0.085
14	99.985	0.042
15	99.989	0.042
16	99.992	0.042
17	99.996	0.042
18	100.000	0.042
19	100.000	0.005

TOTAL SOIL-LOSS VOLUME(ACRE-FEET) = 22.8194
TOTAL STORM RUNOFF VOLUME(ACRE-FEET) = 36.9558

24-HOUR STORM
RUNOFF HYDROGRAPH

HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
(Note: Time indicated is at END of Each Unit Intervals)

TIME(HRS)	VOLUME(AF)	Q(CFS)	0. 75.0 150.0 225.0 300.0
15.000	18.5400	23.30	. Q . V . .
15.083	18.7065	24.18	. Q . V . .
15.167	18.8798	25.16	. Q . V . .
15.250	19.0607	26.27	. Q . V . .
15.333	19.2502	27.52	. Q . V . .
15.417	19.4459	28.42	. Q . .V . .
15.500	19.6313	26.92	. Q . .V . .
15.583	19.7974	24.11	. Q . .V . .
15.667	19.9608	23.73	. Q . .V . .
15.750	20.1381	25.75	. Q . .V . .
15.833	20.3430	29.76	. Q . . V . .
15.917	20.5913	36.06	. Q . . V . .
16.000	20.9212	47.90	. Q . . V . .
16.083	21.5635	93.26	. . Q . V . .
16.167	23.0811	220.35	. . . V Q. .
16.250	25.0080	279.79	. . . V . Q .
16.333	26.1654	168.05	. . . Q V . .
16.417	26.6838	75.27	. Q . V . .
16.500	26.9580	39.82	. Q . . V. .
16.583	27.1888	33.51	. Q . . V. .
16.667	27.3962	30.11	. Q . . V. .
16.750	27.5834	27.18	. Q . . V. .
16.833	27.7526	24.57	. Q . . V .
16.917	27.9084	22.62	. Q . . V .
17.000	28.0546	21.23	. Q . . V .
17.083	28.1924	20.01	. Q . . V .
17.167	28.3216	18.75	. Q . . V .
17.250	28.4422	17.52	. Q . . V .
17.333	28.5563	16.56	. Q . . V .
17.417	28.6653	15.83	. Q . . .V .
17.500	28.7701	15.22	. Q . . .V .
17.583	28.8711	14.66	.Q . . .V .
17.667	28.9686	14.16	.Q . . .V .
17.750	29.0631	13.72	.Q . . .V .
17.833	29.1548	13.31	.Q . . .V .
17.917	29.2439	12.94	.Q . . .V .
18.000	29.3306	12.59	.Q . . .V .
18.083	29.4174	12.60	.Q . . .V .
18.167	29.5149	14.15	.Q . . .V .
18.250	29.6295	16.65	. Q . . . V .
18.333	29.7532	17.95	. Q . . . V .
18.417	29.8788	18.24	. Q . . . V .
18.500	30.0039	18.17	. Q . . . V .
18.583	30.1281	18.03	. Q . . . V .
18.667	30.2512	17.88	. Q . . . V .
18.750	30.3733	17.72	. Q . . . V .
18.833	30.4943	17.57	. Q . . . V .
18.917	30.6142	17.41	. Q . . . V .
19.000	30.7331	17.27	. Q . . . V .

FLOW PROCESS FROM NODE 4616.00 TO NODE 4616.00 IS CODE = 3.1

>>>>>FLOW-THROUGH DETENTION BASIN ROUTING MODEL APPLIED TO STREAM #3<<<<<

```
                INFLOW
              (STREAM 3)
                  |
                  |
                  V                 __effective depth
             -----------            |   (and volume)
            |           |    |      |
            |           |    |      |
            |           |    |....V........
            | detention |<-->|           outflow
            |   basin   |    |.........______
             -----------     |     ^    |  \
                  |          |  dead    |   basin outlet
                  V          | storage  |
              OUTFLOW         ---------
              (STREAM 3)
```

ROUTE RUNOFF HYDROGRAPH FROM STREAM NUMBER 3
THROUGH A FLOW-THROUGH DETENTION BASIN
SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
DEAD STORAGE(AF) = 0.000
SPECIFIED DEAD STORAGE(AF) FILLED = 0.000
SPECIFIED EFFECTIVE VOLUME(AF) FILLED ABOVE OUTLET = 0.000
DETENTION BASIN CONSTANT LOSS RATE(CFS) = 0.00

BASIN DEPTH VERSUS OUTFLOW AND STORAGE INFORMATION:

INTERVAL NUMBER	DEPTH (FT)	OUTFLOW (CFS)	STORAGE (AF)
1	0.00	0.00	0.000
2	1.00	6.00	0.120
3	2.00	21.50	0.570
4	3.00	41.40	1.650
5	4.00	61.80	3.490
6	5.00	78.60	5.910
7	6.00	92.20	8.720
8	7.00	104.10	11.830
9	8.00	114.70	15.190

MODIFIED-PULS BASIN ROUTING MODEL RESULTS(5-MINUTE COMPUTATION INTERVALS):
(Note: Computed EFFECTIVE DEPTH and VOLUME are estimated at the clock time; MEAN OUTFLOW is the average value during the unit interval.)

CLOCK TIME (HRS)	DEAD-STORAGE FILLED(AF)	INFLOW (CFS)	LOSS (CFS)	EFFECTIVE DEPTH(FT)	MEAN OUTFLOW (CFS)	EFFECTIVE VOLUME(AF)
15.083	0.000	24.18	0.00	2.00	21.3	0.574
15.167	0.000	25.16	0.00	2.03	21.8	0.598
15.250	0.000	26.27	0.00	2.05	22.3	0.626
15.333	0.000	27.52	0.00	2.08	22.8	0.656
15.417	0.000	28.42	0.00	2.11	23.4	0.692
15.500	0.000	26.92	0.00	2.13	23.9	0.712
15.583	0.000	24.11	0.00	2.13	24.1	0.712
15.667	0.000	23.73	0.00	2.13	24.1	0.710

15.750	0.000	25.75	0.00	2.14	24.2	0.721
15.833	0.000	29.76	0.00	2.17	24.6	0.756
15.917	0.000	36.06	0.00	2.24	25.6	0.828
16.000	0.000	47.90	0.00	2.37	27.5	0.968
16.083	0.000	93.26	0.00	2.76	32.7	1.386
16.167	0.000	220.35	0.00	3.52	44.2	2.599
16.250	0.000	279.79	0.00	4.26	59.0	4.119
16.333	0.000	168.05	0.00	4.54	68.5	4.804
16.417	0.000	75.27	0.00	4.56	71.0	4.833
16.500	0.000	39.82	0.00	4.47	70.4	4.623
16.583	0.000	33.51	0.00	4.37	68.8	4.380
16.667	0.000	30.11	0.00	4.26	67.1	4.125
16.750	0.000	27.18	0.00	4.15	65.3	3.862
16.833	0.000	24.57	0.00	4.04	63.5	3.595
16.917	0.000	22.62	0.00	3.91	61.3	3.328
17.000	0.000	21.23	0.00	3.77	58.6	3.071
17.083	0.000	20.01	0.00	3.64	55.8	2.825
17.167	0.000	18.75	0.00	3.51	53.1	2.588
17.250	0.000	17.52	0.00	3.39	50.5	2.361
17.333	0.000	16.56	0.00	3.27	48.1	2.144
17.417	0.000	15.83	0.00	3.16	45.7	1.938
17.500	0.000	15.22	0.00	3.05	43.5	1.743
17.583	0.000	14.66	0.00	2.92	41.1	1.561
17.667	0.000	14.16	0.00	2.76	38.2	1.395
17.750	0.000	13.72	0.00	2.63	35.3	1.246
17.833	0.000	13.31	0.00	2.50	32.7	1.113
17.917	0.000	12.94	0.00	2.39	30.4	0.992
18.000	0.000	12.59	0.00	2.29	28.3	0.884
18.083	0.000	12.60	0.00	2.20	26.4	0.789
18.167	0.000	14.15	0.00	2.13	24.9	0.715
18.250	0.000	16.65	0.00	2.09	23.7	0.667
18.333	0.000	17.95	0.00	2.06	23.0	0.632
18.417	0.000	18.24	0.00	2.03	22.4	0.604
18.500	0.000	18.17	0.00	2.01	21.9	0.578
18.583	0.000	18.03	0.00	1.97	21.3	0.555
18.667	0.000	17.88	0.00	1.92	20.7	0.536
18.750	0.000	17.72	0.00	1.89	20.1	0.520
18.833	0.000	17.57	0.00	1.86	19.5	0.506
18.917	0.000	17.41	0.00	1.83	19.1	0.495
19.000	0.000	17.27	0.00	1.81	18.7	0.485

PROCESS SUMMARY OF STORAGE:
INFLOW VOLUME = 36.956 AF
BASIN STORAGE = 0.000 AF (WITH 0.000 AF INITIALLY FILLED)
OUTFLOW VOLUME = 36.956 AF
LOSS VOLUME = 0.000 AF

FLOW PROCESS FROM NODE 4616.00 TO NODE 4635.50 IS CODE = 5.2

>>>>>MODEL CHANNEL ROUTING OF STREAM #3 BY THE CONVEX METHOD<<<<<

THE MODIFIED C-ROUTING COEFFICIENT IS ESTIMATED IN ORDER TO ROUTE THE STREAM 3 INFLOW HYDROGRAPH BY 5-MINUTE INTERVALS(Reference: the National Engineering Handbook, Hydrology, Chapter 17, page 17-52, August,1972, U.S. Department of Commerce).

ASSUMED REGULAR CHANNEL INFORMATION:
BASEWIDTH(FT) = 5.00 CHANNEL Z = 1.00
UPSTREAM ELEVATION(FT) = 2140.00

DOWNSTREAM ELEVATION(FT) = 2139.05
CHANNEL LENGTH(FT) = 1650.00 MANNING'S FACTOR = 0.035
CONSTANT LOSS RATE(CFS) = 0.00

CHANNEL ROUTING COEFFICIENT ESTIMATED:
MAXIMUM INFLOW(CFS) = 71.02
AVERAGE FLOWRATE IN EXCESS OF 50% MAXIMUM INFLOW = 56.52
CHANNEL NORMAL VELOCITY FOR Q = 56.52 CFS = 1.69 FPS
ESTIMATED CHANNEL ROUTING COEFFICIENT = 0.498

MODIFIED CHANNEL ROUTING COEFFICIENT FOR 5-MINUTE
UNIT INTERVALS IS CSTAR = 0.401

CONVEX METHOD CHANNEL ROUTING RESULTS:

MODEL TIME (HRS)	INFLOW (STREAM 3) (CFS)	ROUTED FLOW (CFS)	OUTFLOW LESS LOSS (STREAM 3) (CFS)
15.000	20.64	18.90	18.90
15.083	21.27	19.45	19.45
15.167	21.79	20.02	20.02
15.250	22.26	20.60	20.60
15.333	22.81	21.15	21.15
15.417	23.43	21.68	21.68
15.500	23.93	22.23	22.23
15.583	24.12	22.78	22.78
15.667	24.10	23.27	23.27
15.750	24.18	23.61	23.61
15.833	24.60	23.82	23.82
15.917	25.59	24.03	24.03
16.000	27.55	24.41	24.41
16.083	32.68	25.18	25.18
16.167	44.22	26.90	26.90
16.250	59.04	30.96	30.96
16.333	68.54	38.50	38.50
16.417	71.02	48.17	48.17
16.500	70.40	56.71	56.71
16.583	68.82	62.35	62.35
16.667	67.09	65.34	65.34
16.750	65.30	66.48	66.48
16.833	63.46	66.45	66.45
16.917	61.27	65.71	65.71
17.000	58.58	64.48	64.48
17.083	55.79	62.79	62.79
17.167	53.11	60.68	60.68
17.250	50.54	58.32	58.32
17.333	48.08	55.84	55.84
17.417	45.73	53.35	53.35
17.500	43.51	50.88	50.88
17.583	41.09	48.48	48.48
17.667	38.23	46.13	46.13
17.750	35.33	43.68	43.68
17.833	32.73	41.06	41.06
17.917	30.39	38.37	38.37
18.000	28.29	35.76	35.76
18.083	26.41	33.29	33.29
18.167	24.86	31.00	31.00
18.250	23.73	28.93	28.93
18.333	22.96	27.13	27.13
18.417	22.38	25.65	25.65
18.500	21.88	24.48	24.48
18.583	21.32	23.57	23.57

18.667	20.67	22.81	22.81
18.750	20.06	22.11	22.11
18.833	19.55	21.44	21.44
18.917	19.11	20.81	20.81
19.000	18.74	20.24	20.24

PROCESS SUMMARY OF STORAGE:
INFLOW VOLUME = 36.956 AF
OUTFLOW VOLUME = 36.989 AF
LOSS VOLUME = 0.000 AF

FLOW PROCESS FROM NODE 4636.50 TO NODE 4636.50 IS CODE = 1

>>>>>SUBAREA RUNOFF (UNIT-HYDROGRAPH ANALYSIS)<<<<<

(UNIT-HYDROGRAPH ADDED TO STREAM #3)

WATERSHED AREA = 102.490 ACRES
BASEFLOW = 0.000 CFS/SQUARE-MILE
*USER ENTERED "LAG" TIME = 0.316 HOURS
CAUTION: LAG TIME IS LESS THAN 0.50 HOURS.
THE 5-MINUTE PERIOD UH MODEL (USED IN THIS COMPUTER PROGRAM)
MAY BE TOO LARGE FOR PEAK FLOW ESTIMATES.
VALLEY(DEVELOPED) S-GRAPH SELECTED
MAXIMUM WATERSHED LOSS RATE(INCH/HOUR) = 0.449
LOW LOSS FRACTION = 0.409
HYDROGRAPH MODEL #1 SPECIFIED

SPECIFIED PEAK 5-MINUTES RAINFALL(INCH)= 0.59
SPECIFIED PEAK 30-MINUTES RAINFALL(INCH)= 1.02
SPECIFIED PEAK 1-HOUR RAINFALL(INCH) = 1.25
SPECIFIED PEAK 3-HOUR RAINFALL(INCH) = 2.03
SPECIFIED PEAK 6-HOUR RAINFALL(INCH) = 2.76
SPECIFIED PEAK 24-HOUR RAINFALL(INCH) = 7.50

*USER SPECIFIED PRECIPITATION DEPTH-AREA REDUCTION FACTORS:
5-MINUTE FACTOR = 0.961
30-MINUTE FACTOR = 0.961
1-HOUR FACTOR = 0.961
3-HOUR FACTOR = 0.994
6-HOUR FACTOR = 0.997
24-HOUR FACTOR = 0.998

UNIT HYDROGRAPH TIME UNIT = 5.000 MINUTES
UNIT INTERVAL PERCENTAGE OF LAG-TIME = 26.371

RUNOFF HYDROGRAPH LISTING LIMITS:
MODEL TIME(HOURS) FOR BEGINNING OF RESULTS = 15.00
MODEL TIME(HOURS) FOR END OF RESULTS = 19.00

UNIT HYDROGRAPH DETERMINATION

INTERVAL NUMBER	"S" GRAPH MEAN VALUES	UNIT HYDROGRAPH ORDINATES(CFS)
1	1.596	19.781
2	8.284	82.896

3	22.979	182.147
4	42.645	243.750
5	64.322	268.693
6	80.190	196.678
7	89.326	113.243
8	94.410	63.008
9	97.143	33.884
10	98.291	14.227
11	98.786	6.129
12	99.280	6.123
13	99.712	5.358
14	99.928	2.679
15	100.000	0.893

TOTAL SOIL-LOSS VOLUME(ACRE-FEET) = 24.3414
TOTAL STORM RUNOFF VOLUME(ACRE-FEET) = 39.5614

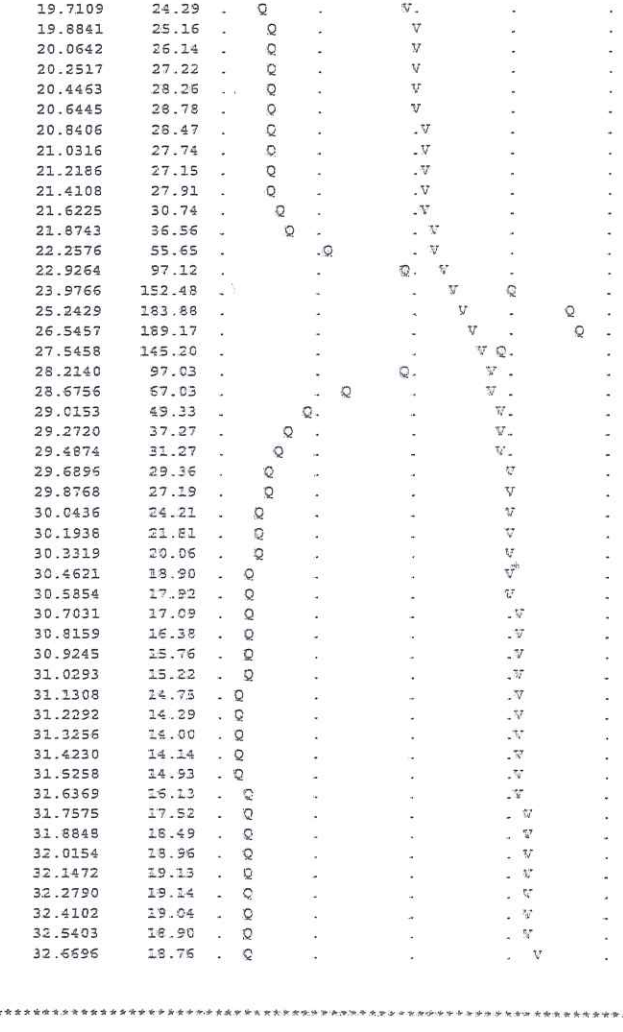
==========

24-HOUR STORM
RUNOFF HYDROGRAPH

==========

HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
(Note: Time indicated is at END of Each Unit Intervals)

TIME(HRS)	VOLUME(AF)	Q(CFS)
15.000	19.5435	23.50
15.083	19.7109	24.29
15.167	19.8841	25.16
15.250	20.0642	26.14
15.333	20.2517	27.22
15.417	20.4463	28.26
15.500	20.6445	28.78
15.583	20.8406	26.47
15.667	21.0316	27.74
15.750	21.2186	27.15
15.833	21.4108	27.91
15.917	21.6225	30.74
16.000	21.8743	36.56
16.083	22.2576	55.65
16.167	22.9264	97.12
16.250	23.9766	152.48
16.333	25.2429	183.88
16.417	26.5457	189.17
16.500	27.5458	145.20
16.583	28.2140	97.03
16.667	28.6756	67.03
16.750	29.0153	49.33
16.833	29.2720	37.27
16.917	29.4874	31.27
17.000	29.6896	29.36
17.083	29.8768	27.19
17.167	30.0436	24.21
17.250	30.1936	21.81
17.333	30.3319	20.06
17.417	30.4621	18.90
17.500	30.5854	17.92
17.583	30.7031	17.09
17.667	30.8159	16.38
17.750	30.9245	15.76
17.833	31.0293	15.22
17.917	31.1308	14.73
18.000	31.2292	14.29
18.083	31.3256	14.00
18.167	31.4230	14.14
18.250	31.5258	14.93
18.333	31.6369	16.13
18.417	31.7575	17.52
18.500	31.8848	18.49
18.583	32.0154	18.96
18.667	32.1472	19.13
18.750	32.2790	19.14
18.833	32.4102	19.04
18.917	32.5403	18.90
19.000	32.6696	18.76



****

```
  FLOW PROCESS FROM NODE   4636.50 TO NODE   4636.50 IS CODE = 3.1
---------------------------------------------------------------------------
  >>>>>FLOW-THROUGH DETENTION BASIN ROUTING MODEL APPLIED TO STREAM #3<<<<<
===========================================================================

                 INFLOW
               (STREAM 3)
                    |
                    |
                    v                 __effective depth
                -----------           |   (and volume)
               |           |    |    |
               |           |    |....v........
               | detention |<-->|           outflow
               |   basin   |    |.........______
                -----------     |     ^     |  \
                    |           |  dead     |   basin outlet
                    v           | storage |
                 OUTFLOW         ---------
               (STREAM 3)


        ROUTE RUNOFF HYDROGRAPH FROM STREAM NUMBER 3
        THROUGH A FLOW-THROUGH DETENTION BASIN
        SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
          DEAD STORAGE(AF) =        0.000
          SPECIFIED DEAD STORAGE(AF) FILLED =       0.000
          SPECIFIED EFFECTIVE VOLUME(AF) FILLED ABOVE OUTLET =       0.000
          DETENTION BASIN CONSTANT LOSS RATE(CFS) =     0.00
```

BASIN DEPTH VERSUS OUTFLOW AND STORAGE INFORMATION:

INTERVAL NUMBER	DEPTH (FT)	OUTFLOW (CFS)	STORAGE (AF)
1	0.00	0.00	0.000
2	1.00	4.90	2.880
3	2.00	16.00	5.850
4	3.00	27.90	8.920
5	4.00	37.50	12.090
6	5.00	45.00	15.360
7	6.00	51.50	18.740
8	7.00	56.80	22.230

```
===========================================================================
 MODIFIED-PULS BASIN ROUTING MODEL RESULTS(5-MINUTE COMPUTATION INTERVALS):
 (Note: Computed EFFECTIVE DEPTH and VOLUME are estimated at the clock time;
        MEAN OUTFLOW is the average value during the unit interval.)
```

CLOCK TIME (HRS)	DEAD-STORAGE FILLED(AF)	INFLOW (CFS)	LOSS (CFS)	EFFECTIVE DEPTH(FT)	MEAN OUTFLOW (CFS)	EFFECTIVE VOLUME(AF)
15.083	0.000	43.74	0.00	3.49	32.5	10.465
15.167	0.000	45.18	0.00	3.51	32.7	10.551
15.250	0.000	46.74	0.00	3.54	33.0	10.645
15.333	0.000	48.37	0.00	3.58	33.3	10.749
15.417	0.000	49.94	0.00	3.61	33.6	10.862
15.500	0.000	51.01	0.00	3.65	34.0	10.979
15.583	0.000	51.26	0.00	3.69	34.3	11.096
15.667	0.000	51.02	0.00	3.72	34.7	11.209
15.750	0.000	50.76	0.00	3.76	35.0	11.317

15.833	0.000	51.72	0.00	3.79	35.3	11.430
15.917	0.000	54.76	0.00	3.83	35.7	11.561
16.000	0.000	60.97	0.00	3.89	36.2	11.732
16.083	0.000	80.83	0.00	3.98	36.9	12.035
16.167	0.000	124.02	0.00	4.16	38.0	12.627
16.250	0.000	183.43	0.00	4.47	39.9	13.616
16.333	0.000	222.38	0.00	4.85	42.4	14.855
16.417	0.000	237.33	0.00	5.24	45.2	16.178
16.500	0.000	201.92	0.00	5.56	47.6	17.241
16.583	0.000	159.38	0.00	5.78	49.3	17.999
16.667	0.000	132.37	0.00	5.95	50.6	18.562
16.750	0.000	115.80	0.00	6.08	51.5	19.005
16.833	0.000	103.72	0.00	6.18	52.2	19.360
16.917	0.000	96.98	0.00	6.27	52.7	19.665
17.000	0.000	93.83	0.00	6.35	53.1	19.945
17.083	0.000	89.97	0.00	6.42	53.5	20.196
17.167	0.000	84.89	0.00	6.48	53.9	20.410
17.250	0.000	80.12	0.00	6.53	54.2	20.589
17.333	0.000	75.90	0.00	6.57	54.4	20.737
17.417	0.000	72.25	0.00	6.61	54.6	20.858
17.500	0.000	68.80	0.00	6.63	54.8	20.955
17.583	0.000	65.57	0.00	6.66	54.9	21.028
17.667	0.000	62.50	0.00	6.67	55.0	21.080
17.750	0.000	59.44	0.00	6.68	55.1	21.110
17.833	0.000	56.28	0.00	6.68	55.1	21.118
17.917	0.000	53.10	0.00	6.68	55.1	21.104
18.000	0.000	50.04	0.00	6.67	55.1	21.069
18.083	0.000	47.29	0.00	6.65	55.0	21.016
18.167	0.000	45.14	0.00	6.63	54.9	20.949
18.250	0.000	43.86	0.00	6.61	54.8	20.874
18.333	0.000	43.26	0.00	6.59	54.7	20.795
18.417	0.000	43.17	0.00	6.57	54.6	20.716
18.500	0.000	42.97	0.00	6.54	54.4	20.637
18.583	0.000	42.52	0.00	6.52	54.3	20.556
18.667	0.000	41.94	0.00	6.50	54.2	20.472
18.750	0.000	41.26	0.00	6.47	54.1	20.384
18.833	0.000	40.48	0.00	6.44	53.9	20.291
18.917	0.000	39.71	0.00	6.42	53.8	20.194
19.000	0.000	39.00	0.00	6.39	53.6	20.093

```
---------------------------------------------------------------------------
  FROCESS SUMMARY OF STORAGE:
    INFLOW  VOLUME =      76.537 AF
    BASIN  STORAGE =       0.000 AF (WITH       0.000 AF INITIALLY FILLED)
    OUTFLOW VOLUME =      76.541 AF
    LOSS    VOLUME =       0.000 AF


***************************************************************************
  FLOW PROCESS FROM NODE   4636.50 TO NODE   4636.50 IS CODE =  11
---------------------------------------------------------------------------
  >>>>>VIEW STREAM NUMBER 3 HYDROGRAPH<<<<<
===========================================================================

            STREAM HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
        (Note: Time indicated is at END of Each Unit Intervals)
---------------------------------------------------------------------------
 TIME(HRS) VOLUME(AF)   Q(CFS) 0.       15.0      30.0      45.0      60.0
---------------------------------------------------------------------------
  15.000     26.7193     32.24  .         .  V      .Q        .         .
  15.083     26.9428     32.46  .         .  V      .Q        .         .
  15.167     27.1681     32.71  .         .  V      .Q        .         .
  15.250     27.3952     32.98  .         .  V      .Q        .         .
  15.333     27.6245     33.28  .         .  V      . Q       .         .
  15.417     27.8559     33.61  .         .  V      . Q       .         .
```

```
15.500    28.0898    33.96  .        .  V     . Q       .         .
15.583    28.3261    34.31  .        .  V     . Q       .         .
15.667    28.5648    34.66  .        .  V     .  Q      .         .
15.750    28.8058    35.00  .        .   V    .  Q      .         .
15.833    29.0492    35.33  .        .   V    .  Q      .         .
15.917    29.2950    35.70  .        .   V    .  Q      .         .
16.000    29.5441    36.16  .        .   V    .   Q     .         .
16.083    29.7980    36.87  .        .   V    .   Q     .         .
16.167    30.0599    38.03  .        .   V    .    Q    .         .
16.250    30.3345    39.87  .        .   V    .     Q   .         .
16.333    30.6267    42.42  .        .   V    .      Q  .         .
16.417    30.9380    45.21  .        .    V   .        Q         .
16.500    31.2658    47.60  .        .    V   .        .Q        .
16.583    31.6057    49.35  .        .    V   .        . Q       .
16.667    31.9543    50.62  .        .    V   .        .  Q      .
16.750    32.3091    51.53  .        .    V   .        .   Q     .
16.833    32.6684    52.17  .        .     V  .        .   Q     .
16.917    33.0312    52.67  .        .     V  .        .    Q    .
17.000    33.3970    53.12  .        .     V  .        .    Q    .
17.083    33.7656    53.52  .        .     V  .        .    Q    .
17.167    34.1367    53.87  .        .     V  .        .    Q    .
17.250    34.5098    54.17  .        .      V .        .     Q   .
17.333    34.8846    54.42  .        .      V .        .     Q   .
17.417    35.2608    54.62  .        .      V .        .     Q   .
17.500    35.6381    54.79  .        .      V .        .     Q   .
17.583    36.0163    54.92  .        .      V .        .     Q   .
17.667    36.3952    55.01  .        .       V.        .     Q   .
17.750    36.7745    55.08  .        .       V.        .     Q   .
17.833    37.1540    55.10  .        .       V.        .     Q   .
17.917    37.5335    55.10  .        .       V.        .     Q   .
18.000    37.9127    55.06  .        .       V.        .     Q   .
18.083    38.2915    55.00  .        .       V.        .     Q   .
18.167    38.6696    54.91  .        .        V        .     Q   .
18.250    39.0470    54.80  .        .        V        .     Q   .
18.333    39.4236    54.68  .        .        V        .     Q   .
18.417    39.7994    54.56  .        .        V        .     Q   .
18.500    40.1743    54.44  .        .        V        .     Q   .
18.583    40.5484    54.32  .        .        .V       .     Q   .
18.667    40.9217    54.19  .        .        .V       .     Q   .
18.750    41.2940    54.06  .        .        .V       .     Q   .
18.833    41.6654    53.93  .        .        .V       .    Q    .
18.917    42.0358    53.78  .        .        .V       .    Q    .
19.000    42.4052    53.63  .        .        . V      .    Q    .

****************************************************************************
  FLOW PROCESS FROM NODE   4636.50 TO NODE   4637.00 IS CODE = 5.2
----------------------------------------------------------------------------
  >>>>>MODEL CHANNEL ROUTING OF STREAM #3 BY THE CONVEX METHOD<<<<<
============================================================================

        THE MODIFIED C-ROUTING COEFFICIENT IS ESTIMATED IN ORDER
        TO ROUTE THE STREAM 3 INFLOW HYDROGRAPH BY 5-MINUTE
        INTERVALS(Reference: the National Engineering Handbook,
        Hydrology, Chapter 17, page 17-52, August,1972,
        U.S. Department of Commerce).

        ASSUMED REGULAR CHANNEL INFORMATION:
          BASEWIDTH(FT) =     5.00      CHANNEL Z =  1.00
          UPSTREAM ELEVATION(FT) =      100.00
          DOWNSTREAM ELEVATION(FT) =      90.00
          CHANNEL LENGTH(FT) =      687.00      MANNING'S FACTOR = 0.030
          CONSTANT LOSS RATE(CFS) =     0.00
```



```
CHANNEL ROUTING COEFFICIENT ESTIMATED:
  MAXIMUM INFLOW(CFS) =     55.10
  AVERAGE FLOWRATE IN EXCESS OF 50% MAXIMUM INFLOW =     39.88
  CHANNEL NORMAL VELOCITY FOR Q =     39.88 CFS =    5.45 FPS
  ESTIMATED CHANNEL ROUTING COEFFICIENT = 0.762

MODIFIED CHANNEL ROUTING COEFFICIENT FOR 5-MINUTE
UNIT INTERVALS IS CSTAR = 0.969
```

CONVEX METHOD CHANNEL ROUTING RESULTS:

MODEL TIME (HRS)	INFLOW (STREAM 3) (CFS)	ROUTED FLOW (CFS)	OUTFLOW LESS LOSS (STREAM 3) (CFS)
15.000	32.24	32.17	32.17
15.083	32.46	32.38	32.38
15.167	32.71	32.62	32.62
15.250	32.98	32.89	32.89
15.333	33.28	33.18	33.18
15.417	33.61	33.50	33.50
15.500	33.96	33.84	33.84
15.583	34.31	34.19	34.19
15.667	34.66	34.54	34.54
15.750	35.00	34.88	34.88
15.833	35.33	35.21	35.21
15.917	35.70	35.57	35.57
16.000	36.16	36.00	36.00
16.083	36.87	36.63	36.63
16.167	38.03	37.63	37.63
16.250	39.87	39.23	39.23
16.333	42.42	41.53	41.53
16.417	45.21	44.23	44.23
16.500	47.60	46.75	46.75
16.583	49.35	48.72	48.72
16.667	50.62	50.16	50.16
16.750	51.53	51.20	51.20
16.833	52.17	51.94	51.94
16.917	52.67	52.49	52.49
17.000	53.12	52.96	52.96
17.083	53.52	53.38	53.38
17.167	53.87	53.75	53.75
17.250	54.17	54.07	54.07
17.333	54.42	54.33	54.33
17.417	54.62	54.55	54.55
17.500	54.79	54.73	54.73
17.583	54.92	54.87	54.87
17.667	55.01	54.98	54.98
17.750	55.08	55.05	55.05
17.833	55.10	55.09	55.09
17.917	55.10	55.10	55.10
18.000	55.06	55.08	55.08
18.083	55.00	55.02	55.02
18.167	54.91	54.94	54.94
18.250	54.80	54.84	54.84
18.333	54.68	54.72	54.72
18.417	54.56	54.60	54.60
18.500	54.44	54.48	54.48
18.583	54.32	54.36	54.36
18.667	54.19	54.24	54.24
18.750	54.06	54.11	54.11
18.833	53.93	53.97	53.97

```
        18.917        53.78        53.83        53.83
        19.000        53.63        53.68        53.68
==============================================================================
  PROCESS SUMMARY OF STORAGE:
    INFLOW  VOLUME =      76.599 AF
    OUTFLOW VOLUME =      76.599 AF
    LOSS    VOLUME =       0.000 AF


******************************************************************************
  FLOW PROCESS FROM NODE   4621.00 TO NODE   4637.00 IS CODE =   1
------------------------------------------------------------------------------
  >>>>>SUBAREA RUNOFF (UNIT-HYDROGRAPH ANALYSIS)<<<<<
==============================================================================

      (UNIT-HYDROGRAPH ADDED TO STREAM #4)

        WATERSHED AREA =      192.270 ACRES
        BASEFLOW =    0.000 CFS/SQUARE-MILE
        *USER ENTERED "LAG" TIME =     0.211 HOURS
         CAUTION: LAG TIME IS LESS THAN 0.50 HOURS.
         THE 5-MINUTE PERIOD UH MODEL (USED IN THIS COMPUTER PROGRAM)
         MAY BE TOO LARGE FOR PEAK FLOW ESTIMATES.
        VALLEY(DEVELOPED) S-GRAPH SELECTED
        MAXIMUM WATERSHED LOSS RATE(INCH/HOUR) =  0.439
        LOW LOSS FRACTION = 0.400
        *HYDROGRAPH MODEL #1 SPECIFIED*

        SPECIFIED PEAK  5-MINUTES RAINFALL(INCH)=  0.59
        SPECIFIED PEAK 30-MINUTES RAINFALL(INCH)=  1.02
        SPECIFIED PEAK  1-HOUR RAINFALL(INCH) =  1.25
        SPECIFIED PEAK  3-HOUR RAINFALL(INCH) =  2.03
        SPECIFIED PEAK  6-HOUR RAINFALL(INCH) =  2.77
        SPECIFIED PEAK 24-HOUR RAINFALL(INCH) =  7.50

        *USER SPECIFIED PRECIPITATION DEPTH-AREA REDUCTION FACTORS:
          5-MINUTE FACTOR = 0.961
         30-MINUTE FACTOR = 0.961
          1-HOUR FACTOR = 0.961
          3-HOUR FACTOR = 0.994
          6-HOUR FACTOR = 0.997
         24-HOUR FACTOR = 0.998

        UNIT HYDROGRAPH TIME UNIT =   5.000 MINUTES
        UNIT INTERVAL PERCENTAGE OF LAG-TIME =  39.494


        RUNOFF HYDROGRAPH LISTING LIMITS:
        MODEL TIME(HOURS) FOR BEGINNING OF RESULTS =  15.00
        MODEL TIME(HOURS) FOR END OF RESULTS =  19.00


==============================================================================
                      UNIT HYDROGRAPH DETERMINATION

------------------------------------------------------------------------------
    INTERVAL          "S" GRAPH          UNIT HYDROGRAPH
     NUMBER          MEAN VALUES          ORDINATES(CFS)
------------------------------------------------------------------------------
        1                2.849                66.241
        2               18.992               375.374
        3               48.040               675.451
        4               76.485               661.418
        5               90.647               329.308
```



```
        6               96.514               136.406
        7               98.407                44.029
        8               99.148                17.218
        9               99.659                11.893
       10               99.915                 5.946
       11              100.000                 1.982


------------------------------------------------------------------------------
    TOTAL SOIL-LOSS VOLUME(ACRE-FEET) =      44.6588
    TOTAL STORM RUNOFF VOLUME(ACRE-FEET) =      75.2591
------------------------------------------------------------------------------
```

24-HOUR STORM
RUNOFF HYDROGRAPH

HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
(Note: Time indicated is at END of Each Unit Intervals)

TIME(HRS)	VOLUME(AF)	Q(CFS)
15.000	37.6379	46.65
15.083	37.9707	48.33
15.167	38.3166	50.23
15.250	38.6770	52.32
15.333	39.0540	54.74
15.417	39.4448	56.75
15.500	39.8298	55.89
15.583	40.1893	52.21
15.667	40.5291	49.34
15.750	40.8800	50.96
15.833	41.2713	56.81
15.917	41.7330	67.04
16.000	42.3256	86.05
16.083	43.3526	149.12
16.167	45.5756	322.77
16.250	48.7869	466.29
16.333	51.7765	434.08
16.417	53.4875	248.45
16.500	54.4291	136.72
16.583	55.0089	84.18
16.667	55.4781	68.13
16.750	55.9030	61.69
16.833	56.2800	54.74
16.917	56.6175	49.00
17.000	56.9264	44.86
17.083	57.2171	42.21
17.167	57.4908	39.74
17.250	57.7482	37.37
17.333	57.9910	35.25
17.417	58.2221	33.55
17.500	58.4435	32.15
17.583	58.6567	30.95
17.667	58.8625	29.88
17.750	59.0617	28.92
17.833	59.2547	28.03
17.917	59.4423	27.23
18.000	59.6247	26.49
18.083	59.8051	26.20
18.167	59.9971	27.87
18.250	60.2137	31.45
18.333	60.4547	35.00
18.417	60.7065	36.56
18.500	60.9612	36.98
18.583	61.2151	36.86
18.667	61.4671	36.59
18.750	61.7171	36.31
18.833	61.9651	36.00
18.917	62.2109	35.69
19.000	62.4546	35.38

FLOW PROCESS FROM NODE 4637.00 TO NODE 4637.00 IS CODE = 7

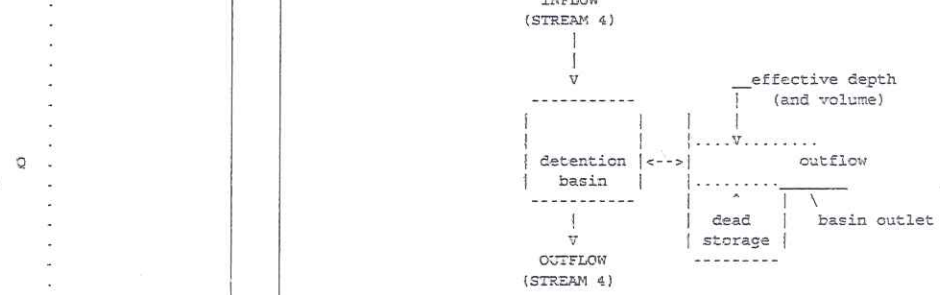
>>>>>STREAM NUMBER 3 ADDED TO STREAM NUMBER 4<<<<<

FLOW PROCESS FROM NODE 4637.00 TO NODE 4637.00 IS CODE = 6

>>>>>STREAM NUMBER 3 CLEARED AND SET TO ZERO<<<<<

FLOW PROCESS FROM NODE 4637.00 TO NODE 4637.00 IS CODE = 3.1

>>>>>FLOW-THROUGH DETENTION BASIN ROUTING MODEL APPLIED TO STREAM #4<<<<<



ROUTE RUNOFF HYDROGRAPH FROM STREAM NUMBER 4
THROUGH A FLOW-THROUGH DETENTION BASIN
SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
DEAD STORAGE(AF) = 0.000
SPECIFIED DEAD STORAGE(AF) FILLED = 0.000
SPECIFIED EFFECTIVE VOLUME(AF) FILLED ABOVE OUTLET = 0.000
DETENTION BASIN CONSTANT LOSS RATE(CFS) = 0.00

BASIN DEPTH VERSUS OUTFLOW AND STORAGE INFORMATION:

INTERVAL NUMBER	DEPTH (FT)	OUTFLOW (CFS)	STORAGE (AF)
1	0.00	0.00	0.000
2	1.00	10.00	4.130
3	2.00	32.00	6.450
4	3.00	56.00	12.950
5	4.00	75.00	17.650
6	5.00	90.00	22.550
7	6.00	103.00	26.910
8	7.00	114.00	30.710

MODIFIED-PULS BASIN ROUTING MODEL RESULTS(5-MINUTE COMPUTATION INTERVALS):
(Note: Computed EFFECTIVE DEPTH and VOLUME are estimated at the clock time;
MEAN OUTFLOW is the average value during the unit interval.)

CLOCK TIME (HRS)	DEAD-STORAGE FILLED(AF)	INFLOW (CFS)	LOSS (CFS)	EFFECTIVE DEPTH(FT)	MEAN OUTFLOW (CFS)	EFFECTIVE VOLUME(AF)
15.083	0.000	80.71	0.00	3.44	64.2	15.028
15.167	0.000	82.85	0.00	3.47	64.7	15.154
15.250	0.000	85.21	0.00	3.50	65.2	15.292
15.333	0.000	87.92	0.00	3.53	65.8	15.444
15.417	0.000	90.24	0.00	3.57	66.4	15.608
15.500	0.000	89.73	0.00	3.60	67.1	15.764
15.583	0.000	86.39	0.00	3.63	67.6	15.894
15.667	0.000	83.87	0.00	3.65	68.1	16.002
15.750	0.000	85.83	0.00	3.67	68.6	16.121
15.833	0.000	92.02	0.00	3.71	69.1	16.278
15.917	0.000	102.61	0.00	3.76	69.9	16.504
16.000	0.000	122.05	0.00	3.83	71.1	16.855
16.083	0.000	185.75	0.00	4.00	73.3	17.629
16.167	0.000	360.40	0.00	4.39	77.9	19.574
16.250	0.000	505.52	0.00	4.98	85.3	22.468
16.333	0.000	475.61	0.00	5.58	93.7	25.099
16.417	0.000	292.68	0.00	5.89	99.6	26.429
16.500	0.000	183.47	0.00	6.02	102.4	26.987
16.583	0.000	132.90	0.00	6.07	103.5	27.189
16.667	0.000	118.30	0.00	6.10	104.0	27.288
16.750	0.000	112.89	0.00	6.12	104.2	27.348
16.833	0.000	106.68	0.00	6.12	104.3	27.365
16.917	0.000	101.49	0.00	6.11	104.3	27.345
17.000	0.000	97.82	0.00	6.10	104.2	27.301
17.083	0.000	95.59	0.00	6.09	104.0	27.243
17.167	0.000	93.49	0.00	6.07	103.9	27.172
17.250	0.000	91.44	0.00	6.05	103.6	27.088
17.333	0.000	89.58	0.00	6.02	103.4	26.993
17.417	0.000	88.11	0.00	6.00	103.1	26.890
17.500	0.000	86.88	0.00	5.97	102.8	26.780
17.583	0.000	85.83	0.00	5.94	102.4	26.666
17.667	0.000	84.86	0.00	5.92	102.1	26.547
17.750	0.000	83.97	0.00	5.89	101.7	26.425
17.833	0.000	83.13	0.00	5.86	101.4	26.299
17.917	0.000	82.33	0.00	5.83	101.0	26.171
18.000	0.000	81.56	0.00	5.80	100.6	26.039
18.083	0.000	81.22	0.00	5.77	100.2	25.909
18.167	0.000	82.81	0.00	5.74	99.8	25.791
18.250	0.000	86.28	0.00	5.72	99.5	25.700
18.333	0.000	89.72	0.00	5.71	99.3	25.634
18.417	0.000	91.17	0.00	5.69	99.1	25.580
18.500	0.000	91.47	0.00	5.68	99.0	25.528
18.583	0.000	91.22	0.00	5.67	98.8	25.476
18.667	0.000	90.83	0.00	5.66	98.6	25.422
18.750	0.000	90.42	0.00	5.65	98.5	25.366
18.833	0.000	89.98	0.00	5.63	98.3	25.309
18.917	0.000	89.52	0.00	5.62	98.1	25.250
19.000	0.000	89.06	0.00	5.61	98.0	25.188

PROCESS SUMMARY OF STORAGE:
INFLOW VOLUME = 151.799 AF
BASIN STORAGE = 0.000 AF (WITH 0.000 AF INITIALLY FILLED)
OUTFLOW VOLUME = 151.799 AF
LOSS VOLUME = 0.000 AF

****
FLOW PROCESS FROM NODE 4637.00 TO NODE 4637.00 IS CODE = 7

>>>>>STREAM NUMBER 4 ADDED TO STREAM NUMBER 5<<<<<

****
FLOW PROCESS FROM NODE 4637.00 TO NODE 4637.00 IS CODE = 6

>>>>>STREAM NUMBER 4 CLEARED AND SET TO ZERO<<<<<

****
FLOW PROCESS FROM NODE 4637.00 TO NODE 4637.00 IS CODE = 11

>>>>>VIEW STREAM NUMBER 5 HYDROGRAPH<<<<<

STREAM HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
(Note: Time indicated is at END of Each Unit Intervals)

TIME(HRS)	VOLUME(AF)	Q(CFS)	0. 50.0 100.0 150.0 200.0
15.000	74.9032	94.04	. . V Q . . .
15.083	75.5556	94.74	. . V Q . . .
15.167	76.2134	95.50	. . V Q. . .
15.250	76.8768	96.34	. . V Q. . .
15.333	77.5465	97.23	. . V Q. . .
15.417	78.2227	98.18	. . V Q. . .
15.500	78.9055	99.15	. . V Q. . .
15.583	79.5946	100.06	. . V Q . .
15.667	80.2892	100.85	. . V Q . .
15.750	80.9890	101.61	. . V Q . .
15.833	81.6945	102.44	. . V Q . .
15.917	82.4073	103.50	. . V Q . .
16.000	83.1305	105.00	. . V .Q . .
16.083	83.8729	107.80	. . V .Q . .
16.167	84.6536	113.36	. . V . Q . .
16.250	85.4985	122.67	. . V . Q . .
16.333	86.4207	133.91	. . V . Q . .
16.417	87.4075	143.28	. . V . Q . .
16.500	88.4362	149.37	. . V . Q. .
16.583	89.4903	153.05	. . V . Q .
16.667	90.5588	155.15	. . V . .Q .
16.750	91.6357	156.38	. . V . .Q .
16.833	92.7178	157.11	. . V . .Q .
16.917	93.8024	157.49	. . V . .Q .
17.000	94.8880	157.63	. . V . .Q .
17.083	95.9735	157.62	. . V . .Q .
17.167	97.0583	157.51	. . V . .Q .
17.250	98.1417	157.31	. . V . .Q .
17.333	99.2231	157.03	. . V . .Q .
17.417	100.3022	156.67	. . V . .Q .
17.500	101.3784	156.26	. . V . .Q .
17.583	102.4514	155.80	. . V . .Q .
17.667	103.5210	155.31	. . V . .Q .
17.750	104.5871	154.79	. . V . Q .
17.833	105.6493	154.24	. . V. Q .
17.917	106.7076	153.66	. . V. Q .
18.000	107.7618	153.07	. . V. Q .
18.083	108.8118	152.46	. . V. Q .
18.167	109.8576	151.85	. . V. Q .
18.250	110.8996	151.30	. . V Q .
18.333	111.9384	150.84	. . V Q .
18.417	112.9745	150.44	. . V Q .

```
18.500    114.0082    150.08  .          .          V          Q          .
18.583    115.0394    149.74  .          .          V          Q.         .
18.667    116.0684    149.40  .          .          V          Q.         .
18.750    117.0949    149.05  .          .          .V         Q.         .
18.833    118.1189    148.69  .          .          .V         Q.         .
18.917    119.1405    148.33  .          .          .V         Q.         .
19.000    120.1595    147.96  .          .          .V         Q.         .

****************************************************************************
  FLOW PROCESS FROM NODE   4637.00 TO NODE   4821.00 IS CODE = 5.2
----------------------------------------------------------------------------
  >>>>>MODEL CHANNEL ROUTING OF STREAM #5 BY THE CONVEX METHOD<<<<<
============================================================================

        THE MODIFIED C-ROUTING COEFFICIENT IS ESTIMATED IN ORDER
        TO ROUTE THE STREAM 5 INFLOW HYDROGRAPH BY 5-MINUTE
        INTERVALS(Reference: the National Engineering Handbook,
        Hydrology, Chapter 17, page 17-52, August,1972,
        U.S. Department of Commerce).


        ASSUMED REGULAR CHANNEL INFORMATION:
          BASEWIDTH(FT) =   36.00     CHANNEL Z =  1.50
          UPSTREAM ELEVATION(FT) =    2116.00
          DOWNSTREAM ELEVATION(FT) =    2093.80
          CHANNEL LENGTH(FT) =    1367.70     MANNING'S FACTOR = 0.030
          CONSTANT LOSS RATE(CFS) =    0.00


        CHANNEL ROUTING COEFFICIENT ESTIMATED:
          MAXIMUM INFLOW(CFS) =   157.63
          AVERAGE FLOWRATE IN EXCESS OF 50% MAXIMUM INFLOW =   114.35
          CHANNEL NORMAL VELOCITY FOR Q =   114.35 CFS =   4.66 FPS
          ESTIMATED CHANNEL ROUTING COEFFICIENT = 0.733

        MODIFIED CHANNEL ROUTING COEFFICIENT FOR 5-MINUTE
        UNIT INTERVALS IS CSTAR = 0.811


        CONVEX METHOD CHANNEL ROUTING RESULTS:
                                          OUTFLOW LESS
         MODEL        INFLOW      ROUTED      LOSS
          TIME      (STREAM 5)    FLOW     (STREAM 5)
         (HRS)        (CFS)       (CFS)       (CFS)
         15.000       94.04       93.44       93.44
         15.083       94.74       94.09       94.09
         15.167       95.50       94.79       94.79
         15.250       96.34       95.56       95.56
         15.333       97.23       96.39       96.39
         15.417       98.18       97.29       97.29
         15.500       99.15       98.24       98.24
         15.583      100.06       99.19       99.19
         15.667      100.85      100.07      100.07
         15.750      101.61      100.88      100.88
         15.833      102.44      101.66      101.66
         15.917      103.50      102.54      102.54
         16.000      105.00      103.66      103.66
         16.083      107.80      105.39      105.39
         16.167      113.36      108.62      108.62
         16.250      122.67      114.60      114.60
         16.333      133.91      123.72      123.72
         16.417      143.28      134.13      134.13
         16.500      149.37      142.95      142.95
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         16.583      153.05      149.00      149.00
         16.667      155.15      152.76      152.76
         16.750      156.38      154.98      154.98
         16.833      157.11      156.28      156.28
         16.917      157.49      157.04      157.04
         17.000      157.63      157.44      157.44
         17.083      157.62      157.59      157.59
         17.167      157.51      157.59      157.59
         17.250      157.31      157.48      157.48
         17.333      157.03      157.28      157.28
         17.417      156.67      156.99      156.99
         17.500      156.26      156.64      156.64
         17.583      155.80      156.23      156.23
         17.667      155.31      155.77      155.77
         17.750      154.79      155.28      155.28
         17.833      154.24      154.76      154.76
         17.917      153.66      154.20      154.20
         18.000      153.07      153.63      153.63
         18.083      152.46      153.03      153.03
         18.167      151.85      152.43      152.43
         18.250      151.30      151.84      151.84
         18.333      150.84      151.30      151.30
         18.417      150.44      150.83      150.83
         18.500      150.08      150.43      150.43
         18.583      149.74      150.07      150.07
         18.667      149.40      149.73      149.73
         18.750      149.05      149.38      149.38
         18.833      148.69      149.03      149.03
         18.917      148.33      148.67      148.67
         19.000      147.96      148.31      148.31
============================================================================
  PROCESS SUMMARY OF STORAGE:
    INFLOW  VOLUME =    221.696 AF
    OUTFLOW VOLUME =    221.696 AF
    LOSS    VOLUME =      0.000 AF


****************************************************************************
  FLOW PROCESS FROM NODE   4821.00 TO NODE   4821.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>SUBAREA RUNOFF (UNIT-HYDROGRAPH ANALYSIS)<<<<<
============================================================================

      (UNIT-HYDROGRAPH ADDED TO STREAM #1)

        WATERSHED AREA =      158.540 ACRES
        BASEFLOW =   0.000 CFS/SQUARE-MILE
        *USER ENTERED "LAG" TIME =    0.294 HOURS
         CAUTION: LAG TIME IS LESS THAN 0.50 HOURS.
         THE 5-MINUTE PERIOD UH MODEL (USED IN THIS COMPUTER PROGRAM)
         MAY BE TOO LARGE FOR PEAK FLOW ESTIMATES.
        VALLEY(UNDEVELOPED)/DESERT S-GRAPH SELECTED
        MAXIMUM WATERSHED LOSS RATE(INCH/HOUR) =  0.426
        LOW LOSS FRACTION = 0.389
        *HYDROGRAPH MODEL #1 SPECIFIED*

        SPECIFIED PEAK  5-MINUTES RAINFALL(INCH)=  0.59
        SPECIFIED PEAK 30-MINUTES RAINFALL(INCH)=  1.02
        SPECIFIED PEAK  1-HOUR RAINFALL(INCH) =  1.25
        SPECIFIED PEAK  3-HOUR RAINFALL(INCH) =  2.03
        SPECIFIED PEAK  6-HOUR RAINFALL(INCH) =  2.75
        SPECIFIED PEAK 24-HOUR RAINFALL(INCH) =  7.50

        *USER SPECIFIED PRECIPITATION DEPTH-AREA REDUCTION FACTORS:
```

5-MINUTE FACTOR = 0.961
30-MINUTE FACTOR = 0.961
1-HOUR FACTOR = 0.961
3-HOUR FACTOR = 0.994
6-HOUR FACTOR = 0.997
24-HOUR FACTOR = 0.998

UNIT HYDROGRAPH TIME UNIT = 5.000 MINUTES
UNIT INTERVAL PERCENTAGE OF LAG-TIME = 28.297

RUNOFF HYDROGRAPH LISTING LIMITS:
MODEL TIME(HOURS) FOR BEGINNING OF RESULTS = 0.00
MODEL TIME(HOURS) FOR END OF RESULTS = 24.00

UNIT HYDROGRAPH DETERMINATION

INTERVAL NUMBER	"S" GRAPH MEAN VALUES	UNIT HYDROGRAPH ORDINATES(CFS)
1	2.650	50.815
2	11.856	176.501
3	28.837	325.580
4	48.862	383.956
5	62.426	260.072
6	70.333	151.605
7	75.625	101.463
8	79.554	75.331
9	82.649	59.341
10	85.192	48.757
11	87.259	39.626
12	88.965	32.724
13	90.495	29.338
14	91.797	24.954
15	92.900	21.151
16	93.926	19.674
17	94.791	16.582
18	95.623	15.950
19	96.301	12.999
20	96.850	10.534
21	97.400	10.534
22	97.920	9.984
23	98.184	5.061
24	98.387	3.893
25	98.591	3.896
26	98.794	3.891
27	98.997	3.896
28	99.200	3.891
29	99.403	3.891
30	99.606	3.891
31	99.808	3.891
32	100.000	3.673

TOTAL SOIL-LOSS VOLUME(ACRE-FEET) = 35.8085
TOTAL STORM RUNOFF VOLUME(ACRE-FEET) = 63.0715

24-HOUR STORM
RUNOFF HYDROGRAPH

HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
(Note: Time indicated is at END of Each Unit Intervals)

TIME(HRS)	VOLUME(AF)	Q(CFS)	0. 75.0 150.0 225.0 300.0
0.083	0.0040	0.59	Q
0.167	0.0221	2.62	Q
0.250	0.0659	6.37	Q
0.333	0.1403	10.80	VQ
0.417	0.2354	13.81	VQ
0.500	0.3427	15.57	V Q
0.583	0.4581	16.76	V Q
0.667	0.5797	17.66	V Q
0.750	0.7062	18.36	V Q
0.833	0.8367	18.95	V Q
0.917	0.9706	19.44	V Q
1.000	1.1072	19.84	V Q
1.083	1.2464	20.21	V Q
1.167	1.3878	20.53	V Q
1.250	1.5311	20.80	V Q
1.333	1.6761	21.06	.VQ
1.417	1.8227	21.28	.VQ
1.500	1.9708	21.50	.VQ
1.583	2.1201	21.68	.VQ
1.667	2.2705	21.84	.VQ
1.750	2.4219	21.99	.VQ
1.833	2.5744	22.14	.VQ
1.917	2.7276	22.24	.VQ
2.000	2.8813	22.32	.VQ
2.083	3.0355	22.40	.VQ
2.167	3.1903	22.48	. Q
2.250	3.3457	22.56	. VQ
2.333	3.5016	22.64	. VQ
2.417	3.6580	22.72	. VQ
2.500	3.8151	22.80	. VQ
2.583	3.9727	22.88	. VQ
2.667	4.1308	22.96	. VQ
2.750	4.2893	23.00	. VQ
2.833	4.4480	23.04	. VQ
2.917	4.6069	23.08	. VQ
3.000	4.7661	23.12	. Q
3.083	4.9256	23.16	. Q
3.167	5.0854	23.20	. Q
3.250	5.2455	23.24	. Q
3.333	5.4058	23.28	. Q
3.417	5.5664	23.32	. Q
3.500	5.7273	23.36	. Q
3.583	5.8885	23.40	. Q
3.667	6.0499	23.44	. Q
3.750	6.2117	23.49	. Q
3.833	6.3737	23.53	. QV
3.917	6.5361	23.57	. QV
4.000	6.6987	23.61	. QV
4.083	6.8616	23.66	. QV
4.167	7.0249	23.70	. QV
4.250	7.1884	23.75	. QV
4.333	7.3523	23.79	. QV

4.417	7.5164	23.84	QV	.	.	.	.	.
4.500	7.6809	23.88	QV	.	.	.	.	.
4.583	7.8457	23.93	QV	.	.	.	.	.
4.667	8.0108	23.97	Q V	.	.	.	.	.
4.750	8.1762	24.02	Q V	.	.	.	.	.
4.833	8.3420	24.07	Q V	.	.	.	.	.
4.917	8.5081	24.12	Q V	.	.	.	.	.
5.000	8.6745	24.16	Q V	.	.	.	.	.
5.083	8.8412	24.21	Q V	.	.	.	.	.
5.167	9.0083	24.26	Q V	.	.	.	.	.
5.250	9.1758	24.31	Q V	.	.	.	.	.
5.333	9.3435	24.36	Q V	.	.	.	.	.
5.417	9.5116	24.41	Q V	.	.	.	.	.
5.500	9.6801	24.46	Q V	.	.	.	.	.
5.583	9.8489	24.51	Q V	.	.	.	.	.
5.667	10.0181	24.56	Q V	.	.	.	.	.
5.750	10.1876	24.62	Q V	.	.	.	.	.
5.833	10.3575	24.67	Q V	.	.	.	.	.
5.917	10.5278	24.72	Q V	.	.	.	.	.
6.000	10.6984	24.78	Q V	.	.	.	.	.
6.083	10.8695	24.83	Q V	.	.	.	.	.
6.167	11.0408	24.89	Q V	.	.	.	.	.
6.250	11.2126	24.94	Q V	.	.	.	.	.
6.333	11.3848	25.00	Q V	.	.	.	.	.
6.417	11.5573	25.05	Q V	.	.	.	.	.
6.500	11.7303	25.11	Q V	.	.	.	.	.
6.583	11.9036	25.17	Q V	.	.	.	.	.
6.667	12.0774	25.23	Q V	.	.	.	.	.
6.750	12.2515	25.29	Q V	.	.	.	.	.
6.833	12.4261	25.35	Q V	.	.	.	.	.
6.917	12.6011	25.41	Q V	.	.	.	.	.
7.000	12.7765	25.47	Q V	.	.	.	.	.
7.083	12.9523	25.52	Q V	.	.	.	.	.
7.167	13.1286	25.59	Q V	.	.	.	.	.
7.250	13.3053	25.66	Q V	.	.	.	.	.
7.333	13.4825	25.72	Q V	.	.	.	.	.
7.417	13.6600	25.79	Q V	.	.	.	.	.
7.500	13.8381	25.85	Q V	.	.	.	.	.
7.583	14.0166	25.92	Q V	.	.	.	.	.
7.667	14.1955	25.99	Q V.	.	.	.	.	.
7.750	14.3750	26.05	Q V.	.	.	.	.	.
7.833	14.5549	26.12	Q V.	.	.	.	.	.
7.917	14.7353	26.19	Q V.	.	.	.	.	.
8.000	14.9161	26.26	Q V.	.	.	.	.	.
8.083	15.0975	26.33	Q V.	.	.	.	.	.
8.167	15.2794	26.41	Q V.	.	.	.	.	.
8.250	15.4617	26.48	Q V.	.	.	.	.	.
8.333	15.6446	26.55	Q V.	.	.	.	.	.
8.417	15.8280	26.63	Q V	.	.	.	.	.
8.500	16.0119	26.71	Q V	.	.	.	.	.
8.583	16.1964	26.78	Q V	.	.	.	.	.
8.667	16.3813	26.86	Q V	.	.	.	.	.
8.750	16.5669	26.94	Q V	.	.	.	.	.
8.833	16.7530	27.02	Q V	.	.	.	.	.
8.917	16.9396	27.10	Q V	.	.	.	.	.
9.000	17.1268	27.18	Q V	.	.	.	.	.
9.083	17.3146	27.27	Q V	.	.	.	.	.
9.167	17.5030	27.35	Q V	.	.	.	.	.
9.250	17.6920	27.44	Q V	.	.	.	.	.
9.333	17.8816	27.53	Q V	.	.	.	.	.
9.417	18.0718	27.62	Q V	.	.	.	.	.
9.500	18.2626	27.71	Q V	.	.	.	.	.
9.583	18.4540	27.80	Q V	.	.	.	.	.
9.667	18.6461	27.89	Q V	.	.	.	.	.

9.750	18.8389	27.99	Q	V	.	.	.	.
9.833	19.0323	28.08	Q	V	.	.	.	.
9.917	19.2264	28.18	Q	V	.	.	.	.
10.000	19.4211	28.28	Q	V	.	.	.	.
10.083	19.6166	28.38	Q	V	.	.	.	.
10.167	19.8127	28.48	Q	V	.	.	.	.
10.250	20.0096	28.59	Q	V	.	.	.	.
10.333	20.2072	28.69	Q	V	.	.	.	.
10.417	20.4056	28.80	Q	V	.	.	.	.
10.500	20.6047	28.91	Q	V	.	.	.	.
10.583	20.8046	29.02	Q	V	.	.	.	.
10.667	21.0053	29.14	Q	V	.	.	.	.
10.750	21.2067	29.25	Q	V	.	.	.	.
10.833	21.4090	29.37	Q	V	.	.	.	.
10.917	21.6121	29.49	Q	V	.	.	.	.
11.000	21.8161	29.62	Q	V	.	.	.	.
11.083	22.0209	29.74	Q	V	.	.	.	.
11.167	22.2266	29.87	Q	V	.	.	.	.
11.250	22.4332	30.00	Q	V	.	.	.	.
11.333	22.6407	30.13	Q	V	.	.	.	.
11.417	22.8492	30.27	Q	V	.	.	.	.
11.500	23.0586	30.41	Q	V	.	.	.	.
11.583	23.2690	30.55	Q	V	.	.	.	.
11.667	23.4803	30.69	Q	V	.	.	.	.
11.750	23.6927	30.84	Q	V	.	.	.	.
11.833	23.9062	30.99	Q	V	.	.	.	.
11.917	24.1207	31.15	Q	V	.	.	.	.
12.000	24.3363	31.31	Q	V	.	.	.	.
12.083	24.5507	31.13	Q	V	.	.	.	.
12.167	24.7583	30.14	Q	V	.	.	.	.
12.250	24.9524	28.18	Q	V	.	.	.	.
12.333	25.1305	25.85	Q	V	.	.	.	.
12.417	25.2981	24.34	Q	V	.	.	.	.
12.500	25.4604	23.57	Q	V	.	.	.	.
12.583	25.6197	23.12	Q	V	.	.	.	.
12.667	25.7772	22.87	Q	V	.	.	.	.
12.750	25.9336	22.72	Q	V	.	.	.	.
12.833	26.0897	22.66	Q	V	.	.	.	.
12.917	26.2458	22.66	Q	V	.	.	.	.
13.000	26.4023	22.73	Q	V	.	.	.	.
13.083	26.5595	22.82	Q	V	.	.	.	.
13.167	26.7176	22.96	Q	V	.	.	.	.
13.250	26.8770	23.13	Q	V	.	.	.	.
13.333	27.0377	23.33	Q	V	.	.	.	.
13.417	27.2000	23.57	Q	V	.	.	.	.
13.500	27.3640	23.82	Q	V	.	.	.	.
13.583	27.5300	24.11	Q	V	.	.	.	.
13.667	27.6983	24.43	Q	V	.	.	.	.
13.750	27.8689	24.77	Q	V	.	.	.	.
13.833	28.0420	25.14	Q	V	.	.	.	.
13.917	28.2180	25.56	Q	V	.	.	.	.
14.000	28.3972	26.01	Q	V	.	.	.	.
14.083	28.5800	26.54	Q	V	.	.	.	.
14.167	28.7676	27.24	Q	V	.	.	.	.
14.250	28.9612	28.12	Q	V	.	.	.	.
14.333	29.1616	29.09	Q	V	.	.	.	.
14.417	29.3680	29.98	Q	V	.	.	.	.
14.500	29.5802	30.60	Q	V	.	.	.	.
14.583	29.7980	31.62	Q	V	.	.	.	.
14.667	30.0216	32.47	Q	V.	.	.	.	.
14.750	30.2515	33.39	Q	V.	.	.	.	.
14.833	30.4882	34.37	Q	V.	.	.	.	.
14.917	30.7321	35.41	Q	V.	.	.	.	.
15.000	30.9838	36.55	Q	V.	.	.	.	.

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15.083   31.2440   37.78 .   Q   .       V.        .        .
15.167   31.5136   39.15 .   Q   .       V.        .        .
15.250   31.7936   40.66 .   Q   .        V        .        .
15.333   32.0854   42.36 .   Q   .        V        .        .
15.417   32.3865   43.72 .   Q   .        V        .        .
15.500   32.6893   43.97 .   Q   .        V        .        .
15.583   32.9846   42.88 .   Q   .        V        .        .
15.667   33.2708   41.56 .   Q   .       .V        .        .
15.750   33.5616   42.22 .   Q   .       .V        .        .
15.833   33.8730   45.21 .    Q  .       .V        .        .
15.917   34.2230   50.83 .    Q  .       .V        .        .
16.000   34.6477   61.66 .     Q .      .V         .        .
16.083   35.3478  101.65 .       . Q    .. V       .        .
16.167   36.5674  177.08 .       .      .  Q       .        .
16.250   38.3171  254.05 .       .      .   V      . Q      .
16.333   40.2010  273.55 .       .      .    V     .    Q   .
16.417   41.5937  202.22 .       .      .     Q    .        .
16.500   42.5597  140.26 .       .    Q .     V    .        .
16.583   43.3181  110.12 .       . Q    .      V   .        .
16.667   43.9676   94.31 .       . Q    .      V   .        .
16.750   44.5424   83.47 .       .Q     .       V  .        .
16.833   45.0589   74.99 .      Q.      .       V  .        .
16.917   45.5236   67.48 .     Q .      .       V  .        .
17.000   45.9468   61.46 .     Q .      .        V.        .
17.083   46.3413   57.27 .    Q  .      .        V.        .
17.167   46.7046   52.76 .    Q  .      .        V.        .
17.250   47.0399   48.68 .   Q   .      .        V.        .
17.333   47.3551   45.76 .   Q   .      .         V        .
17.417   47.6474   42.45 .  Q    .      .         V        .
17.500   47.9257   40.42 .  Q    .      .         V        .
17.583   48.1837   37.46 . Q     .      .         V        .
17.667   48.4245   34.96 . Q     .      .         V        .
17.750   48.6564   33.67 . Q     .      .         V        .
17.833   48.8771   32.05 . Q     .      .         V        .
17.917   49.0739   28.57 . Q     .      .        .V        .
18.000   49.2601   27.05 . Q     .      .        .V        .
18.083   49.4434   26.61 . Q     .      .        .V        .
18.167   49.6299   27.09 . Q     .      .        .V        .
18.250   49.8266   28.56 . Q     .      .        .V        .
18.333   50.0365   30.47 .  Q    .      .        .V        .
18.417   50.2541   31.60 .  Q    .      .        .V        .
18.500   50.4748   32.04 .  Q    .      .        . V       .
18.583   50.6960   32.11 .  Q    .      .        . V       .
18.667   50.9150   31.80 .  Q    .      .        . V       .
18.750   51.1210   29.91 . Q     .      .        . V       .
18.833   51.3260   29.77 . Q     .      .        . V       .
18.917   51.5303   29.66 . Q     .      .        . V       .
19.000   51.7338   29.54 . Q     .      .        . V       .
19.083   51.9362   29.39 . Q     .      .        . V       .
19.167   52.1375   29.23 . Q     .      .        .  V      .
19.250   52.3377   29.07 . Q     .      .        .  V      .
19.333   52.5369   28.92 . Q     .      .        .  V      .
19.417   52.7349   28.76 . Q     .      .        .  V      .
19.500   52.9319   28.61 . Q     .      .        .  V      .
19.583   53.1279   28.45 . Q     .      .        .  V      .
19.667   53.3227   28.29 . Q     .      .        .  V      .
19.750   53.5164   28.14 . Q     .      .        .  V      .
19.833   53.7092   27.99 . Q     .      .        .   V     .
19.917   53.9008   27.82 . Q     .      .        .   V     .
20.000   54.0913   27.65 . Q     .      .        .   V     .
20.083   54.2806   27.49 . Q     .      .        .   V     .
20.167   54.4688   27.33 . Q     .      .        .   V     .
20.250   54.6560   27.18 . Q     .      .        .   V     .
20.333   54.8422   27.04 . Q     .      .        .   V     .
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20.417   55.0274   26.90 . Q     .      .        .  V     .
20.500   55.2117   26.76 . Q     .      .        .   V    .
20.583   55.3951   26.63 . Q     .      .        .   V    .
20.667   55.5776   26.50 . Q     .      .        .   V    .
20.750   55.7591   26.35 . Q     .      .        .   V    .
20.833   55.9396   26.21 . Q     .      .        .   V    .
20.917   56.1192   26.07 . Q     .      .        .   V    .
21.000   56.2978   25.93 . Q     .      .        .   V    .
21.083   56.4755   25.80 . Q     .      .        .   V    .
21.167   56.6523   25.67 . Q     .      .        .   V    .
21.250   56.8282   25.54 . Q     .      .        .    V   .
21.333   57.0033   25.42 . Q     .      .        .    V   .
21.417   57.1775   25.30 . Q     .      .        .    V   .
21.500   57.3509   25.18 . Q     .      .        .    V   .
21.583   57.5235   25.06 . Q     .      .        .    V   .
21.667   57.6953   24.95 . Q     .      .        .    V   .
21.750   57.8664   24.84 . Q     .      .        .    V   .
21.833   58.0367   24.73 . Q     .      .        .    V   .
21.917   58.2062   24.62 . Q     .      .        .    V   .
22.000   58.3751   24.52 . Q     .      .        .     V  .
22.083   58.5432   24.41 . Q     .      .        .     V  .
22.167   58.7107   24.31 . Q     .      .        .     V  .
22.250   58.8774   24.21 . Q     .      .        .     V  .
22.333   59.0435   24.12 . Q     .      .        .     V  .
22.417   59.2090   24.02 . Q     .      .        .     V  .
22.500   59.3738   23.93 . Q     .      .        .     V  .
22.583   59.5380   23.84 . Q     .      .        .     V  .
22.667   59.7015   23.75 . Q     .      .        .     V  .
22.750   59.8644   23.66 . Q     .      .        .     V  .
22.833   60.0268   23.57 . Q     .      .        .      V .
22.917   60.1885   23.49 . Q     .      .        .      V .
23.000   60.3497   23.40 . Q     .      .        .      V .
23.083   60.5103   23.32 . Q     .      .        .      V .
23.167   60.6703   23.24 . Q     .      .        .      V .
23.250   60.8298   23.16 . Q     .      .        .      V .
23.333   60.9888   23.08 . Q     .      .        .      V .
23.417   61.1472   23.00 . Q     .      .        .      V .
23.500   61.3051   22.92 . Q     .      .        .      V .
23.583   61.4624   22.85 . Q     .      .        .      V .
23.667   61.6193   22.78 . Q     .      .        .       V.
23.750   61.7757   22.70 . Q     .      .        .       V.
23.833   61.9315   22.63 . Q     .      .        .       V.
23.917   62.0869   22.56 . Q     .      .        .       V.
24.000   62.2418   22.49 . Q     .      .        .       V.

*****************************************************************************
  FLOW PROCESS FROM NODE    4821.00 TO NODE    4821.00 IS CODE = 3.1
-----------------------------------------------------------------------------
  >>>>>FLOW-THROUGH DETENTION BASIN ROUTING MODEL APPLIED TO STREAM #1<<<<<
=============================================================================

                    INFLOW
                  (STREAM 1)
                      |
                      |
                      v                 __effective depth
                 -----------            |   (and volume)
                |           |    |    |
                |           |    |....v........
                | detention |<-->|           outflow
                |   basin   |    |.........______
                 -----------     |     ^    |  \
                      |          |  dead    |   basin outlet
```

```
                    V            | storage |
                 OUTFLOW          ---------
               (STREAM 1)


        ROUTE RUNOFF HYDROGRAPH FROM STREAM NUMBER 1
        THROUGH A FLOW-THROUGH DETENTION BASIN
        SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
          DEAD STORAGE(AF) =       0.000
          SPECIFIED DEAD STORAGE(AF) FILLED =       0.000
          SPECIFIED EFFECTIVE VOLUME(AF) FILLED ABOVE OUTLET =       0.000
          DETENTION BASIN CONSTANT LOSS RATE(CFS) =     0.00


        BASIN DEPTH VERSUS OUTFLOW AND STORAGE INFORMATION:

         INTERVAL    DEPTH      OUTFLOW     STORAGE
          NUMBER      (FT)       (CFS)       (AF)
             1        0.00        0.00       0.000
             2        1.00       14.70       1.050
             3        2.00       48.00       2.120
             4        3.00       83.70       3.220
             5        4.00      112.50       4.340
             6        5.00      135.00       5.490
             7        6.00      154.50       6.660
             8        7.00      170.40       7.850


=============================================================================
 MODIFIED-PULS BASIN ROUTING MODEL RESULTS(5-MINUTE COMPUTATION INTERVALS):
 (Note: Computed EFFECTIVE DEPTH and VOLUME are estimated at the clock time;
        MEAN OUTFLOW is the average value during the unit interval.)

          CLOCK                                          MEAN
           TIME  DEAD-STORAGE  INFLOW    LOSS   EFFECTIVE OUTFLOW  EFFECTIVE
          (HRS)   FILLED(AF)   (CFS)    (CFS)  DEPTH(FT)  (CFS)   VOLUME(AF)
-----------------------------------------------------------------------------
         15.083       0.000    37.78     0.00      1.57     33.2      1.661
         15.167       0.000    39.15     0.00      1.60     34.3      1.695
         15.250       0.000    40.66     0.00      1.64     35.3      1.732
         15.333       0.000    42.36     0.00      1.67     36.5      1.772
         15.417       0.000    43.72     0.00      1.71     37.8      1.813
         15.500       0.000    43.97     0.00      1.74     39.0      1.847
         15.583       0.000    42.88     0.00      1.76     39.8      1.868
         15.667       0.000    41.56     0.00      1.77     40.3      1.877
         15.750       0.000    42.22     0.00      1.78     40.6      1.888
         15.833       0.000    45.21     0.00      1.81     41.2      1.915
         15.917       0.000    50.83     0.00      1.86     42.5      1.973
         16.000       0.000    61.66     0.00      1.97     45.2      2.086
         16.083       0.000   101.65     0.00      2.28     52.4      2.425
         16.167       0.000   177.08     0.00      2.95     69.9      3.163
         16.250       0.000   254.05     0.00      3.92     96.0      4.252
         16.333       0.000   273.55     0.00      4.84    120.8      5.304
         16.417       0.000   202.22     0.00      5.23    135.5      5.764
         16.500       0.000   140.26     0.00      5.24    139.6      5.768
         16.583       0.000   110.12     0.00      5.07    138.0      5.576
         16.667       0.000    94.31     0.00      4.84    133.9      5.303
         16.750       0.000    83.47     0.00      4.57    128.3      4.994
         16.833       0.000    74.99     0.00      4.29    122.1      4.670
         16.917       0.000    67.48     0.00      4.00    115.7      4.338
         17.000       0.000    61.46     0.00      3.71    108.3      4.015
         17.083       0.000    57.27     0.00      3.45    100.3      3.718
         17.167       0.000    52.76     0.00      3.20     93.0      3.442
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         17.250       0.000    48.68     0.00      2.97     86.0      3.185
         17.333       0.000    45.76     0.00      2.76     78.9      2.957
         17.417       0.000    42.45     0.00      2.58     71.9      2.754
         17.500       0.000    40.42     0.00      2.42     65.8      2.580
         17.583       0.000    37.46     0.00      2.27     60.4      2.422
         17.667       0.000    34.96     0.00      2.15     55.5      2.281
         17.750       0.000    33.67     0.00      2.04     51.2      2.159
         17.833       0.000    32.05     0.00      1.94     47.6      2.052
         17.917       0.000    28.57     0.00      1.84     44.2      1.945
         18.000       0.000    27.05     0.00      1.75     41.0      1.848
         18.083       0.000    26.61     0.00      1.67     38.3      1.768
         18.167       0.000    27.09     0.00      1.61     36.1      1.706
         18.250       0.000    28.56     0.00      1.57     34.5      1.665
         18.333       0.000    30.47     0.00      1.56     33.5      1.644
         18.417       0.000    31.60     0.00      1.55     33.0      1.634
         18.500       0.000    32.04     0.00      1.54     32.8      1.629
         18.583       0.000    32.11     0.00      1.54     32.7      1.625
         18.667       0.000    31.80     0.00      1.53     32.5      1.620
         18.750       0.000    29.91     0.00      1.52     32.2      1.604
         18.833       0.000    29.77     0.00      1.51     31.7      1.591
         18.917       0.000    29.66     0.00      1.49     31.4      1.579
         19.000       0.000    29.54     0.00      1.49     31.0      1.569
-----------------------------------------------------------------------------
  PROCESS SUMMARY OF STORAGE:
    INFLOW  VOLUME =      63.072 AF
    BASIN  STORAGE =       0.000 AF (WITH       0.000 AF INITIALLY FILLED)
    OUTFLOW VOLUME =      63.072 AF
    LOSS    VOLUME =       0.000 AF


****************************************************************************
  FLOW PROCESS FROM NODE   4821.00 TO NODE   4821.00 IS CODE =   7
----------------------------------------------------------------------------
  >>>>>STREAM NUMBER 1 ADDED TO STREAM NUMBER 5<<<<<
============================================================================


****************************************************************************
  FLOW PROCESS FROM NODE   4821.00 TO NODE   4821.00 IS CODE =  11
----------------------------------------------------------------------------
  >>>>>VIEW STREAM NUMBER 5 HYDROGRAPH<<<<<
============================================================================

          STREAM HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
       (Note: Time indicated is at END of Each Unit Intervals)
----------------------------------------------------------------------------
 TIME(HRS) VOLUME(AF)   Q(CFS) 0.        75.0     150.0     225.0     300.0
----------------------------------------------------------------------------
   0.083      0.0002      0.03  Q         .         .         .         .
   0.167      0.0015      0.19  Q         .         .         .         .
   0.250      0.0061      0.66  Q         .         .         .         .
   0.333      0.0170      1.59  Q         .         .         .         .
   0.417      0.0372      2.94  Q         .         .         .         .
   0.500      0.0685      4.55  Q         .         .         .         .
   0.583      0.1119      6.29  Q         .         .         .         .
   0.667      0.1676      8.09  VQ        .         .         .         .
   0.750      0.2357      9.89  VQ        .         .         .         .
   0.833      0.3160     11.67  VQ        .         .         .         .
   0.917      0.4084     13.41  VQ        .         .         .         .
   1.000      0.5124     15.10  V Q       .         .         .         .
   1.083      0.6276     16.73  V Q       .         .         .         .
   1.167      0.7537     18.32  V Q       .         .         .         .
   1.250      0.8904     19.84  V Q       .         .         .         .
   1.333      1.0372     21.32  V Q       .         .         .         .
```

1.417	1.1938	22.74	V	Q	.	.	.	.
1.500	1.3614	24.33	V	Q	.	.	.	.
1.583	1.5415	26.16	V	Q	.	.	.	.
1.667	1.7342	27.98	V	Q	.	.	.	.
1.750	1.9387	29.69	V	Q	.	.	.	.
1.833	2.1546	31.35	V	Q	.	.	.	.
1.917	2.3815	32.94	V	Q	.	.	.	.
2.000	2.6187	34.44	V	Q	.	.	.	.
2.083	2.8654	35.83	V	Q	.	.	.	.
2.167	3.1212	37.14	V	Q	.	.	.	.
2.250	3.3856	38.39	V	Q	.	.	.	.
2.333	3.6583	39.60	V	Q	.	.	.	.
2.417	3.9398	40.88	V	Q	.	.	.	.
2.500	4.2311	42.29	V	Q	.	.	.	.
2.583	4.5323	43.74	V	Q	.	.	.	.
2.667	4.8435	45.18	V	Q	.	.	.	.
2.750	5.1643	46.58	V	Q	.	.	.	.
2.833	5.4944	47.93	V	Q	.	.	.	.
2.917	5.8335	49.25	V	Q	.	.	.	.
3.000	6.1815	50.53	V	Q	.	.	.	.
3.083	6.5381	51.78	V	Q	.	.	.	.
3.167	6.9032	53.00	V	Q	.	.	.	.
3.250	7.2764	54.20	.V	Q	.	.	.	.
3.333	7.6577	55.36	.V	Q	.	.	.	.
3.417	8.0469	56.51	.V	Q	.	.	.	.
3.500	8.4438	57.63	.V	Q	.	.	.	.
3.583	8.8482	58.72	.V	Q	.	.	.	.
3.667	9.2600	59.80	.V	Q	.	.	.	.
3.750	9.6791	60.85	.V	Q	.	.	.	.
3.833	10.1053	61.88	.V	Q	.	.	.	.
3.917	10.5385	62.90	.V	Q	.	.	.	.
4.000	10.9785	63.90	.V	Q	.	.	.	.
4.083	11.4253	64.88	.V	Q	.	.	.	.
4.167	11.8788	65.84	.V	Q	.	.	.	.
4.250	12.3388	66.79	.V	Q	.	.	.	.
4.333	12.8052	67.72	.V	Q	.	.	.	.
4.417	13.2779	68.64	.V	Q	.	.	.	.
4.500	13.7568	69.54	.V	Q	.	.	.	.
4.583	14.2418	70.43	. V	Q	.	.	.	.
4.667	14.7328	71.30	. V	Q	.	.	.	.
4.750	15.2298	72.16	. V	Q	.	.	.	.
4.833	15.7326	73.00	. V	Q	.	.	.	.
4.917	16.2411	73.84	. V	Q	.	.	.	.
5.000	16.7553	74.66	. V	Q	.	.	.	.
5.083	17.2751	75.48	. V	Q	.	.	.	.
5.167	17.8005	76.29	. V	Q	.	.	.	.
5.250	18.3315	77.10	. V	Q	.	.	.	.
5.333	18.8679	77.89	. V	Q	.	.	.	.
5.417	19.4097	78.67	. V	Q	.	.	.	.
5.500	19.9569	79.44	. V	Q	.	.	.	.
5.583	20.5092	80.20	. V	Q	.	.	.	.
5.667	21.0667	80.95	. V	Q	.	.	.	.
5.750	21.6292	81.68	. V	Q	.	.	.	.
5.833	22.1967	82.40	. V	Q	.	.	.	.
5.917	22.7691	83.12	. V	.Q	.	.	.	.
6.000	23.3464	83.82	. V	.Q	.	.	.	.
6.083	23.9284	84.51	. V	.Q	.	.	.	.
6.167	24.5152	85.19	. V	.Q	.	.	.	.
6.250	25.1065	85.87	. V	.Q	.	.	.	.
6.333	25.7024	86.53	. V	.Q	.	.	.	.
6.417	26.3029	87.18	. V	.Q	.	.	.	.
6.500	26.9078	87.83	. V	.Q	.	.	.	.
6.583	27.5170	88.47	. V	.Q	.	.	.	.
6.667	28.1306	89.09	. V	.Q	.	.	.	.

6.750	28.7485	89.72	.	V	.Q	.	.	.
6.833	29.3706	90.33	.	V	. Q	.	.	.
6.917	29.9969	90.93	.	V	. Q	.	.	.
7.000	30.6273	91.53	.	V	. Q	.	.	.
7.083	31.2617	92.12	.	V	. Q	.	.	.
7.167	31.9002	92.71	.	V	. Q	.	.	.
7.250	32.5427	93.29	.	V	. Q	.	.	.
7.333	33.1891	93.86	.	V	. Q	.	.	.
7.417	33.8394	94.42	.	V	. Q	.	.	.
7.500	34.4936	94.98	.	V	. Q	.	.	.
7.583	35.1516	95.54	.	V	. Q	.	.	.
7.667	35.8133	96.09	.	V	. Q	.	.	.
7.750	36.4788	96.63	.	V	. Q	.	.	.
7.833	37.1479	97.16	.	V	. Q	.	.	.
7.917	37.8206	97.67	.	V	. Q	.	.	.
8.000	38.4968	98.17	.	V	. Q	.	.	.
8.083	39.1763	98.67	.	V	. Q	.	.	.
8.167	39.8592	99.16	.	V	. Q	.	.	.
8.250	40.5455	99.64	.	V	. Q	.	.	.
8.333	41.2350	100.13	.	V	. Q	.	.	.
8.417	41.9279	100.61	.	V	. Q	.	.	.
8.500	42.6242	101.09	.	V	. Q	.	.	.
8.583	43.3236	101.57	.	V	. Q	.	.	.
8.667	44.0264	102.04	.	V	. Q	.	.	.
8.750	44.7324	102.51	.	V	. Q	.	.	.
8.833	45.4417	102.98	.	V	. Q	.	.	.
8.917	46.1542	103.45	.	V	. Q	.	.	.
9.000	46.8699	103.92	.	V	. Q	.	.	.
9.083	47.5888	104.39	.	V	. Q	.	.	.
9.167	48.3109	104.85	.	V	. Q	.	.	.
9.250	49.0363	105.32	.	V	. Q	.	.	.
9.333	49.7648	105.78	.	V	. Q	.	.	.
9.417	50.4965	106.24	.	V	. Q	.	.	.
9.500	51.2313	106.70	.	V	. Q	.	.	.
9.583	51.9694	107.16	.	V	. Q	.	.	.
9.667	52.7106	107.62	.	V	. Q	.	.	.
9.750	53.4549	108.08	.	V	. Q	.	.	.
9.833	54.2024	108.53	.	V	. Q	.	.	.
9.917	54.9530	108.99	.	V	. Q	.	.	.
10.000	55.7066	109.45	.	V	. Q	.	.	.
10.083	56.4637	109.91	.	V	. Q	.	.	.
10.167	57.2238	110.36	.	V	. Q	.	.	.
10.250	57.9869	110.81	.	V	. Q	.	.	.
10.333	58.7529	111.22	.	V	. Q	.	.	.
10.417	59.5217	111.63	.	V	. Q	.	.	.
10.500	60.2932	112.03	.	V	. Q	.	.	.
10.583	61.0676	112.43	.	V	. Q	.	.	.
10.667	61.8447	112.84	.	V	. Q	.	.	.
10.750	62.6247	113.25	.	V	. Q	.	.	.
10.833	63.4075	113.67	.	V	. Q	.	.	.
10.917	64.1933	114.09	.	V.	Q	.	.	.
11.000	64.9819	114.51	.	V.	Q	.	.	.
11.083	65.7736	114.94	.	V.	Q	.	.	.
11.167	66.5682	115.38	.	V.	Q	.	.	.
11.250	67.3658	115.82	.	V.	Q	.	.	.
11.333	68.1665	116.26	.	V.	Q	.	.	.
11.417	68.9703	116.71	.	V.	Q	.	.	.
11.500	69.7772	117.16	.	V.	Q	.	.	.
11.583	70.5872	117.62	.	V.	Q	.	.	.
11.667	71.4005	118.09	.	V	Q	.	.	.
11.750	72.2170	118.56	.	V	Q	.	.	.
11.833	73.0369	119.04	.	V	Q	.	.	.
11.917	73.8600	119.52	.	V	Q	.	.	.
12.000	74.6866	120.01	.	V	Q	.	.	.

12.083	75.5163	120.48	. V Q . . .
12.167	76.3483	120.60	. V Q . . .
12.250	77.1802	120.80	. V Q . . .
12.333	78.0090	120.34	. V Q . . .
12.417	78.8321	119.51	. .V Q . . .
12.500	79.6485	118.54	. .V Q . . .
12.583	80.4581	117.56	. .V Q . . .
12.667	81.2615	116.65	. .V Q . . .
12.750	82.0592	115.83	. .V Q . . .
12.833	82.8519	115.11	. .V Q . . .
12.917	83.6405	114.51	. .V Q . . .
13.000	84.4257	114.01	. .V Q . . .
13.083	85.2081	113.60	. .V Q . . .
13.167	85.9883	113.29	. . V Q . . .
13.250	86.7670	113.06	. . V Q . . .
13.333	87.5446	112.91	. . V Q . . .
13.417	88.3217	112.83	. . V Q . . .
13.500	89.0988	112.83	. . V Q . . .
13.583	89.8762	112.88	. . V Q . . .
13.667	90.6544	113.00	. . V Q . . .
13.750	91.4339	113.18	. . V Q . . .
13.833	92.2150	113.42	. . V Q . . .
13.917	92.9982	113.72	. . V Q . . .
14.000	93.7839	114.08	. . V Q . . .
14.083	94.5726	114.51	. . V Q . . .
14.167	95.3647	115.02	. . V Q . . .
14.250	96.1612	115.65	. . V Q . . .
14.333	96.9630	116.41	. . V Q . . .
14.417	97.7707	117.29	. . V Q . . .
14.500	98.5852	118.26	. . V Q . . .
14.583	99.4069	119.31	. . V Q . . .
14.667	100.2364	120.43	. . V Q . . .
14.750	101.0740	121.63	. . V Q . . .
14.833	101.9204	122.90	. . V Q . . .
14.917	102.7763	124.27	. . V Q . . .
15.000	103.6423	125.74	. . V Q . . .
15.083	104.5192	127.33	. . V Q . . .
15.167	105.4079	129.04	. . V Q . . .
15.250	106.3095	130.90	. . V Q . . .
15.333	107.2250	132.93	. . V Q . . .
15.417	108.1554	135.09	. . V Q . . .
15.500	109.1003	137.21	. . V Q . . .
15.583	110.0577	139.02	. . V Q . . .
15.667	111.0244	140.37	. . V Q . . .
15.750	111.9988	141.48	. . V Q . . .
15.833	112.9828	142.87	. . V Q. . . .
15.917	113.9818	145.06	. . V Q. . . .
16.000	115.0069	148.84	. . V Q. . . .
16.083	116.0938	157.82	. . V .Q . . .
16.167	117.3232	178.51	. . V . Q . . .
16.250	118.7739	210.65	. . V . Q . . .
16.333	120.4579	244.51	. . V . . Q . .
16.417	122.3146	269.59	. . V . . Q . .
16.500	124.2604	282.54	. . V . . Q . .
16.583	126.2372	287.03	. . V . . Q . .
16.667	128.2114	286.65	. . V . . Q . .
16.750	130.1625	283.80	. . V . . Q . .
16.833	132.0799	278.41	. . V . . Q . .
16.917	133.9583	272.73	. . V . . Q . .
17.000	135.7883	265.73	. . V. . Q . .
17.083	137.5647	257.92	. . V. . Q . .
17.167	139.2902	250.55	. . V. . Q . .
17.250	140.9669	243.46	. . V. . Q . .
17.333	142.5931	236.13	. . V .Q . .

17.417	144.1693	228.86	. . V Q .
17.500	145.7010	222.39	. . V Q. .
17.583	147.1926	216.59	. . V Q . .
17.667	148.6477	211.28	. . V Q . .
17.750	150.0700	206.52	. . .V Q . .
17.833	151.4636	202.34	. . .V Q . .
17.917	152.8301	198.42	. . .V Q . .
18.000	154.1708	194.67	. . .V Q . .
18.083	155.4885	191.32	. . .V Q . .
18.167	156.7867	188.50	. . . V Q . .
18.250	158.0699	186.31	. . . V Q . .
18.333	159.3427	184.82	. . . V Q . .
18.417	160.6090	183.87	. . . V Q . .
18.500	161.8710	183.24	. . . V Q . .
18.583	163.1295	182.73	. . . V Q . .
18.667	164.3847	182.25	. . . VQ . .
18.750	165.6352	181.58	. . . VQ . .
18.833	166.8802	180.78	. . . VQ . .
18.917	168.1201	180.03	. . . VQ . .
19.000	169.3551	179.32	. . . Q . .
19.083	170.5855	178.65	. . . Q . .
19.167	171.8113	177.99	. . . QV . .
19.250	173.0327	177.35	. . . QV . .
19.333	174.2498	176.72	. . . QV . .
19.417	175.4626	176.10	. . . QV . .
19.500	176.6711	175.48	. . . QV . .
19.583	177.8755	174.87	. . . QV . .
19.667	179.0756	174.26	. . . Q V . .
19.750	180.2715	173.65	. . . Q V . .
19.833	181.4633	173.05	. . . Q V . .
19.917	182.6509	172.44	. . . Q V . .
20.000	183.8343	171.83	. . . Q V . .
20.083	185.0135	171.22	. . . Q V . .
20.167	186.1886	170.61	. . . Q V . .
20.250	187.3593	170.00	. . . Q V . .
20.333	188.5259	169.38	. . . Q V . .
20.417	189.6881	168.76	. . . Q V . .
20.500	190.8461	168.13	. . . Q V . .
20.583	191.9997	167.50	. . . Q V . .
20.667	193.1489	166.87	. . . Q V . .
20.750	194.2938	166.24	. . . Q V . .
20.833	195.4343	165.60	. . . Q V . .
20.917	196.5705	164.97	. . .Q V . .
21.000	197.7022	164.33	. . .Q V . .
21.083	198.8296	163.70	. . .Q V . .
21.167	199.9526	163.06	. . .Q V . .
21.250	201.0713	162.43	. . .Q V . .
21.333	202.1855	161.79	. . .Q V . .
21.417	203.2955	161.16	. . .Q V . .
21.500	204.4010	160.53	. . .Q V . .
21.583	205.5023	159.90	. . .Q V . .
21.667	206.5992	159.28	. . .Q V. .
21.750	207.5919	158.65	. . .Q V. .
21.833	208.7802	158.02	. . .Q V. .
21.917	209.8642	157.40	. . Q V. .
22.000	210.9439	156.77	. . Q V. .
22.083	212.0192	156.14	. . Q V. .
22.167	213.0902	155.50	. . Q V. .
22.250	214.1567	154.86	. . Q V .
22.333	215.2187	154.21	. . Q V .
22.417	216.2764	153.57	. . Q V .
22.500	217.3295	152.93	. . Q V .
22.583	218.3785	152.30	. . Q V .
22.667	219.4231	151.67	. . Q V .

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 22.750   220.4633   151.04  .        .        Q        V        .
 22.833   221.4992   150.41  .        .        Q        .V       .
 22.917   222.5308   149.79  .        .       Q.        .V       .
 23.000   223.5581   149.17  .        .       Q.        .V       .
 23.083   224.5812   148.55  .        .       Q.        .V       .
 23.167   225.6000   147.94  .        .       Q.        .V       .
 23.250   226.6146   147.32  .        .       Q.        .V       .
 23.333   227.6251   146.71  .        .       Q.        .V       .
 23.417   228.6313   146.11  .        .       Q.        . V      .
 23.500   229.6334   145.51  .        .       Q.        . V      .
 23.583   230.6314   144.90  .        .       Q.        . V      .
 23.667   231.6252   144.31  .        .       Q.        . V      .
 23.750   232.6150   143.71  .        .       Q.        . V      .
 23.833   233.6007   143.12  .        .       Q.        . V      .
 23.917   234.5823   142.53  .        .       Q.        . V      .
 24.000   235.5597   141.93  .        .      Q .        .  V     .

****************************************************************************
  FLOW PROCESS FROM NODE   4931.00 TO NODE   4821.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>SUBAREA RUNOFF (UNIT-HYDROGRAPH ANALYSIS)<<<<<
============================================================================

     (UNIT-HYDROGRAPH ADDED TO STREAM #4)

        WATERSHED AREA =     132.940 ACRES
        BASEFLOW =    0.000 CFS/SQUARE-MILE
        *USER ENTERED "LAG" TIME =    0.211 HOURS
         CAUTION: LAG TIME IS LESS THAN 0.50 HOURS.
         THE 5-MINUTE PERIOD UH MODEL (USED IN THIS COMPUTER PROGRAM)
         MAY BE TOO LARGE FOR PEAK FLOW ESTIMATES.
        VALLEY(DEVELOPED) S-GRAPH SELECTED
        MAXIMUM WATERSHED LOSS RATE(INCH/HOUR) =  0.347
        LOW LOSS FRACTION = 0.324
        *HYDROGRAPH MODEL #1 SPECIFIED*

        SPECIFIED PEAK  5-MINUTES RAINFALL(INCH)=  0.59
        SPECIFIED PEAK 30-MINUTES RAINFALL(INCH)=  1.02
        SPECIFIED PEAK  1-HOUR RAINFALL(INCH) =  1.25
        SPECIFIED PEAK  3-HOUR RAINFALL(INCH) =  2.03
        SPECIFIED PEAK  6-HOUR RAINFALL(INCH) =  2.75
        SPECIFIED PEAK 24-HOUR RAINFALL(INCH) =  7.50

        *USER SPECIFIED PRECIPITATION DEPTH-AREA REDUCTION FACTORS:
          5-MINUTE FACTOR = 0.961
         30-MINUTE FACTOR = 0.961
          1-HOUR FACTOR = 0.961
          3-HOUR FACTOR = 0.994
          6-HOUR FACTOR = 0.997
         24-HOUR FACTOR = 0.998

        UNIT HYDROGRAPH TIME UNIT =   5.000 MINUTES
        UNIT INTERVAL PERCENTAGE OF LAG-TIME =  39.513


        RUNOFF HYDROGRAPH LISTING LIMITS:
        MODEL TIME(HOURS) FOR BEGINNING OF RESULTS =  15.00
        MODEL TIME(HOURS) FOR END OF RESULTS =  19.00


============================================================================
                      UNIT HYDROGRAPH DETERMINATION
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INTERVAL NUMBER	"S" GRAPH MEAN VALUES	UNIT HYDROGRAPH ORDINATES(CFS)
1	2.851	45.638
2	19.009	259.781
3	48.080	467.382
4	76.519	457.233
5	90.666	227.436
6	96.523	94.165
7	98.409	30.333
8	99.150	11.908
9	99.660	8.198
10	99.915	4.099
11	100.000	1.366

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TOTAL SOIL-LOSS VOLUME(ACRE-FEET) =      24.9875
TOTAL STORM RUNOFF VOLUME(ACRE-FEET) =      57.9235
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24-HOUR STORM
RUNOFF HYDROGRAPH

HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
(Note: Time indicated is at END of Each Unit Intervals)

TIME(HRS)	VOLUME(AF)	Q(CFS)	0. 100.0 200.0 300.0 400.0
15.000	29.3209	36.34	
15.083	29.5802	37.65	
15.167	29.8496	39.13	
15.250	30.1304	40.76	
15.333	30.4241	42.65	
15.417	30.7286	44.21	
15.500	31.0284	43.54	
15.583	31.3085	40.66	
15.667	31.5732	38.43	
15.750	31.8466	39.70	
15.833	32.1514	44.26	
15.917	32.5113	52.26	
16.000	32.9727	66.99	
16.083	33.7479	112.56	
16.167	35.3612	234.25	
16.250	37.6589	333.63	
16.333	39.7931	309.87	
16.417	41.0288	179.43	
16.500	41.7221	100.67	
16.583	42.1605	63.66	
16.667	42.5209	52.33	
16.750	42.8483	47.53	
16.833	43.1401	42.38	
16.917	43.4024	38.08	
17.000	43.6431	34.95	
17.083	43.8694	32.86	
17.167	44.0818	30.84	
17.250	44.2802	28.81	
17.333	44.4660	26.97	
17.417	44.6420	25.57	
17.500	44.8104	24.45	
17.583	44.9723	23.50	
17.667	45.1284	22.67	
17.750	45.2794	21.92	
17.833	45.4257	21.24	
17.917	45.5677	20.62	
18.000	45.7057	20.04	
18.083	45.8424	19.85	
18.167	45.9888	21.25	
18.250	46.1554	24.20	
18.333	46.3423	27.14	
18.417	46.5382	28.44	
18.500	46.7366	28.80	
18.583	46.9344	28.72	
18.667	47.1309	28.53	
18.750	47.3259	28.31	
18.833	47.5193	28.08	
18.917	47.7110	27.84	
19.000	47.9011	27.60	

FLOW PROCESS FROM NODE 4821.00 TO NODE 4821.00 IS CODE = 7

>>>>>STREAM NUMBER 4 ADDED TO STREAM NUMBER 5<<<<<

FLOW PROCESS FROM NODE 4821.00 TO NODE 4821.00 IS CODE = 11

>>>>>VIEW STREAM NUMBER 5 HYDROGRAPH<<<<<

STREAM HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
(Note: Time indicated is at END of Each Unit Intervals)

TIME(HRS)	VOLUME(AF)	Q(CFS)	0. 150.0 300.0 450.0 600.0
0.083	0.0042	0.61	
0.167	0.0323	4.08	
0.250	0.1047	10.51	
0.333	0.2237	17.28	
0.417	0.3721	21.54	
0.500	0.5400	24.38	
0.583	0.7228	26.54	
0.667	0.9193	28.52	
0.750	1.1290	30.46	
0.833	1.3516	32.32	
0.917	1.5865	34.10	
1.000	1.6332	35.83	
1.083	2.0914	37.49	
1.167	2.3607	39.11	
1.250	2.6408	40.67	
1.333	2.9312	42.17	
1.417	3.2317	43.63	
1.500	3.5433	45.24	
1.583	3.8677	47.11	
1.667	4.2049	48.96	
1.750	4.5542	50.71	
1.833	4.9151	52.40	
1.917	5.2871	54.03	
2.000	5.6697	55.55	
2.083	6.0622	56.98	
2.167	6.4639	58.33	
2.250	6.8744	59.61	
2.333	7.2935	60.85	
2.417	7.7217	62.17	
2.500	8.1598	63.61	
2.583	8.6082	65.11	
2.667	9.0667	66.58	
2.750	9.5351	68.01	
2.833	10.0131	69.40	
2.917	10.5003	70.75	
3.000	10.9967	72.07	
3.083	11.5020	73.36	
3.167	12.0159	74.62	
3.250	12.5383	75.85	
3.333	13.0690	77.06	
3.417	13.6078	78.24	
3.500	14.1547	79.40	
3.583	14.7093	80.53	
3.667	15.2716	81.65	
3.750	15.8414	82.74	
3.833	16.4187	83.82	
3.917	17.0032	84.87	

4.000	17.5949	85.91	.	V	Q	.	.	.	.
4.083	18.1936	86.93	.	V	Q	.	.	.	.
4.167	18.7992	87.94	.	V	Q	.	.	.	.
4.250	19.4116	88.93	.	V	Q	.	.	.	.
4.333	20.0308	89.90	.	V	Q	.	.	.	.
4.417	20.6566	90.86	.	V	Q	.	.	.	.
4.500	21.2888	91.80	.	V	Q	.	.	.	.
4.583	21.9275	92.74	.	V	Q	.	.	.	.
4.667	22.5725	93.65	.	V	Q	.	.	.	.
4.750	23.2237	94.56	.	V	Q	.	.	.	.
4.833	23.8810	95.45	.	V	Q	.	.	.	.
4.917	24.5444	96.32	.	V	Q	.	.	.	.
5.000	25.2138	97.19	.	V	Q	.	.	.	.
5.083	25.8891	98.06	.	V	Q	.	.	.	.
5.167	26.5704	98.92	.	V	Q	.	.	.	.
5.250	27.2575	99.77	.	V	Q	.	.	.	.
5.333	27.9504	100.61	.	V	Q	.	.	.	.
5.417	28.6490	101.44	.	V	Q	.	.	.	.
5.500	29.3533	102.26	.	V	Q	.	.	.	.
5.583	30.0631	103.06	.	V	Q	.	.	.	.
5.667	30.7784	103.86	.	V	Q	.	.	.	.
5.750	31.4991	104.64	.	V	Q	.	.	.	.
5.833	32.2251	105.42	.	V	Q	.	.	.	.
5.917	32.9564	106.18	.	V	Q	.	.	.	.
6.000	33.6928	106.93	.	V	Q	.	.	.	.
6.083	34.4344	107.68	.	V	Q	.	.	.	.
6.167	35.1811	108.41	.	V	Q	.	.	.	.
6.250	35.9327	109.14	.	V	Q	.	.	.	.
6.333	36.6893	109.86	.	V	Q	.	.	.	.
6.417	37.4507	110.56	.	V	Q	.	.	.	.
6.500	38.2170	111.26	.	V	Q	.	.	.	.
6.583	38.9881	111.96	.	V	Q	.	.	.	.
6.667	39.7638	112.64	.	V	Q	.	.	.	.
6.750	40.5443	113.32	.	V	Q	.	.	.	.
6.833	41.3293	113.99	.	V	Q	.	.	.	.
6.917	42.1189	114.65	.	V	Q	.	.	.	.
7.000	42.9131	115.31	.	V	Q	.	.	.	.
7.083	43.7117	115.96	.	V	Q	.	.	.	.
7.167	44.5148	116.60	.	V	Q	.	.	.	.
7.250	45.3222	117.24	.	V	Q	.	.	.	.
7.333	46.1340	117.88	.	V	Q	.	.	.	.
7.417	46.9502	118.50	.	V	Q	.	.	.	.
7.500	47.7706	119.13	.	V	Q	.	.	.	.
7.583	48.5953	119.74	.	V	Q	.	.	.	.
7.667	49.4242	120.36	.	V	Q	.	.	.	.
7.750	50.2572	120.96	.	V	Q	.	.	.	.
7.833	51.0944	121.56	.	V	Q	.	.	.	.
7.917	51.9356	122.14	.	V	Q	.	.	.	.
8.000	52.7807	122.71	.	V	Q	.	.	.	.
8.083	53.6297	123.27	.	V	Q	.	.	.	.
8.167	54.4825	123.83	.	V	Q	.	.	.	.
8.250	55.3391	124.39	.	V	Q	.	.	.	.
8.333	56.1996	124.94	.	V	Q	.	.	.	.
8.417	57.0639	125.49	.	V	Q	.	.	.	.
8.500	57.9320	126.05	.	V	Q	.	.	.	.
8.583	58.8039	126.60	.	V	Q	.	.	.	.
8.667	59.6795	127.15	.	V	Q	.	.	.	.
8.750	60.5590	127.70	.		VQ	.	.	.	.
8.833	61.4422	128.24	.		VQ	.	.	.	.
8.917	62.3292	128.79	.		VQ	.	.	.	.
9.000	63.2200	129.34	.		VQ	.	.	.	.
9.083	64.1145	129.89	.		VQ	.	.	.	.
9.167	65.0128	130.43	.		VQ	.	.	.	.
9.250	65.9149	130.98	.		VQ	.	.	.	.

9.333	66.8207	131.53	.		VQ	.	.	.	.
9.417	67.7303	132.07	.		VQ	.	.	.	.
9.500	68.6437	132.62	.		Q	.	.	.	.
9.583	69.5609	133.17	.		Q	.	.	.	.
9.667	70.4818	133.72	.		Q	.	.	.	.
9.750	71.4065	134.27	.		Q	.	.	.	.
9.833	72.3350	134.82	.		Q	.	.	.	.
9.917	73.2673	135.37	.		VQ	.	.	.	.
10.000	74.2033	135.92	.		VQ	.	.	.	.
10.083	75.1433	136.48	.		VQ	.	.	.	.
10.167	76.0870	137.03	.		VQ	.	.	.	.
10.250	77.0345	137.57	.		VQ	.	.	.	.
10.333	77.9855	138.10	.		Q	.	.	.	.
10.417	78.9401	138.60	.		Q	.	.	.	.
10.500	79.8982	139.11	.		Q	.	.	.	.
10.583	80.8598	139.62	.		Q	.	.	.	.
10.667	81.8249	140.14	.		Q	.	.	.	.
10.750	82.7937	140.67	.		Q	.	.	.	.
10.833	83.7662	141.20	.		Q	.	.	.	.
10.917	84.7423	141.73	.		Q	.	.	.	.
11.000	85.7222	142.28	.		QV	.	.	.	.
11.083	86.7058	142.83	.		QV	.	.	.	.
11.167	87.6934	143.39	.		QV	.	.	.	.
11.250	88.6848	143.95	.		QV	.	.	.	.
11.333	89.6801	144.53	.		QV	.	.	.	.
11.417	90.6795	145.11	.		QV	.	.	.	.
11.500	91.6829	145.70	.		QV	.	.	.	.
11.583	92.6904	146.29	.		QV	.	.	.	.
11.667	93.7022	146.90	.		QV	.	.	.	.
11.750	94.7181	147.52	.		Q	V	.	.	.
11.833	95.7384	148.15	.		Q	V	.	.	.
11.917	96.7631	148.78	.		Q	V	.	.	.
12.000	97.7922	149.43	.		Q	V	.	.	.
12.083	98.8233	149.72	.		Q	V	.	.	.
12.167	99.8448	148.32	.		Q	V	.	.	.
12.250	100.8441	145.09	.		Q	V	.	.	.
12.333	101.8187	141.51	.		Q	V	.	.	.
12.417	102.7776	139.24	.		Q	V	.	.	.
12.500	103.7267	137.81	.		Q.	V	.	.	.
12.583	104.6692	136.84	.		Q.	V	.	.	.
12.667	105.6064	136.08	.		Q.	V	.	.	.
12.750	106.5393	135.46	.		Q.	V	.	.	.
12.833	107.4689	134.98	.		Q	. V	.	.	.
12.917	108.3961	134.63	.		Q	. V	.	.	.
13.000	109.3218	134.42	.		Q	. V	.	.	.
13.083	110.2468	134.30	.		Q	. V	.	.	.
13.167	111.1717	134.30	.		Q	. V	.	.	.
13.250	112.0973	134.39	.		Q	. V	.	.	.
13.333	113.0241	134.58	.		Q	. V	.	.	.
13.417	113.9528	134.84	.		Q	. V	.	.	.
13.500	114.8839	135.20	.		Q.	V	.	.	.
13.583	115.8181	135.64	.		Q.	V	.	.	.
13.667	116.7558	136.16	.		Q.	V	.	.	.
13.750	117.6977	136.75	.		Q.	V	.	.	.
13.833	118.6443	137.45	.		Q.	V	.	.	.
13.917	119.5962	138.21	.		Q.	V	.	.	.
14.000	120.5540	139.07	.		Q.	V	.	.	.
14.083	121.5187	140.07	.		Q.	V	.	.	.
14.167	122.4928	141.44	.		Q.	V	.	.	.
14.250	123.4790	143.19	.		Q.	V	.	.	.
14.333	124.4784	145.11	.		Q.	V	.	.	.
14.417	125.4902	146.92	.		Q.	V	.	.	.
14.500	126.5146	148.74	.		Q.	V	.	.	.
14.583	127.5518	150.50	.		Q	V	.	.	.

14.667	128.6026	152.58	. Q V . . .
14.750	129.6679	154.69	. Q V . . .
14.833	130.7490	156.97	. Q V . . .
14.917	131.8469	159.41	. Q V . . .
15.000	132.9632	162.09	. Q V . . .
15.083	134.0994	164.97	. Q V . . .
15.167	135.2576	168.17	. .Q V . . .
15.250	136.4398	171.66	. .Q V . . .
15.333	137.6491	175.58	. .Q V . . .
15.417	138.8839	179.30	. .Q V . . .
15.500	140.1288	180.75	. . Q V . . .
15.583	141.3662	179.68	. .Q V . . .
15.667	142.5976	178.80	. .Q V . . .
15.750	143.8454	181.18	. . Q V . . .
15.833	145.1342	187.13	. . Q V . . .
15.917	146.4931	197.32	. . Q V . . .
16.000	147.9796	215.83	. . Q V . . .
16.083	149.8418	270.38	. . VQ . . .
16.167	152.6844	412.75	. . V . Q . .
16.250	156.4329	544.28	. . V . . Q .
16.333	160.2510	554.39	. . V . . Q .
16.417	163.3434	449.02	. . V. Q. .
16.500	165.9826	383.21	. . V. Q . .
16.583	168.3978	350.69	. . V. Q . .
16.667	170.7324	338.98	. . V. Q . .
16.750	173.0108	330.83	. . V Q . .
16.833	175.2201	320.79	. . VQ . .
16.917	177.3607	310.82	. . Q . .
17.000	179.4315	300.67	. . Q . .
17.083	181.4341	290.78	. . Q.V . .
17.167	183.3720	281.38	. . Q .V . .
17.250	185.2471	272.26	. . Q .V . .
17.333	187.0591	263.11	. . Q .V . .
17.417	188.8114	254.43	. . Q . V . .
17.500	190.5114	246.84	. . Q . V . .
17.583	192.1649	240.09	. . Q . V . .
17.667	193.7762	233.95	. . Q . V . .
17.750	195.3495	228.45	. . Q . V . .
17.833	196.8893	223.58	. . Q . V . .
17.917	198.3979	219.04	. . Q . V . .
18.000	199.8766	214.71	. . Q . V . .
18.083	201.3310	211.17	. . Q . V . .
18.167	202.7755	209.75	. . Q . V . .
18.250	204.2254	210.52	. . Q . V . .
18.333	205.6851	211.95	. . Q . V . .
18.417	207.1473	212.31	. . Q . V . .
18.500	208.6076	212.04	. . Q . V . .
18.583	210.0639	211.46	. . Q . V . .
18.667	211.5156	210.78	. . Q . V . .
18.750	212.9611	209.89	. . Q . V . .
18.833	214.3995	208.86	. . Q . V . .
18.917	215.8311	207.87	. . Q . V . .
19.000	217.2562	206.93	. . Q . V . .
19.083	218.6751	206.02	. . Q . V . .
19.167	220.0880	205.14	. . Q . V . .
19.250	221.4949	204.29	. . Q . V . .
19.333	222.8961	203.45	. . Q . V . .
19.417	224.2916	202.63	. . Q . V . .
19.500	225.6815	201.82	. . Q . V . .
19.583	227.0660	201.02	. . Q . V . .
19.667	228.4450	200.23	. . Q . V . .
19.750	229.8187	199.45	. . Q . V . .
19.833	231.1870	198.68	. . Q . V . .
19.917	232.5500	197.91	. . Q . V . .

20.000	233.9077	197.14	. . Q . V . .
20.083	235.2601	196.38	. . Q . V . .
20.167	236.6073	195.61	. . Q . V . .
20.250	237.9493	194.85	. . Q . V . .
20.333	239.2861	194.10	. . Q . V . .
20.417	240.6176	193.34	. . Q . V . .
20.500	241.9438	192.57	. . Q . V . .
20.583	243.2648	191.81	. . Q . V . .
20.667	244.5806	191.05	. . Q . V . .
20.750	245.8912	190.29	. . Q . V . .
20.833	247.1965	189.54	. . Q . V . .
20.917	248.4967	188.78	. . Q . V. .
21.000	249.7916	188.03	. . Q . V. .
21.083	251.0814	187.28	. . Q . V. .
21.167	252.3660	186.53	. . Q . V. .
21.250	253.6456	185.79	. . Q . V. .
21.333	254.9200	185.04	. . Q . V. .
21.417	256.1893	184.31	. . Q . V. .
21.500	257.4536	183.58	. . Q . V .
21.583	258.7129	182.85	. . Q . V .
21.667	259.9671	182.12	. . Q . V .
21.750	261.2164	181.40	. . Q . V .
21.833	262.4608	180.68	. . Q . V .
21.917	263.7002	179.96	.Q . V .
22.000	264.9346	179.24	.Q . V .
22.083	266.1641	178.52	.Q . .V .
22.167	267.3885	177.79	.Q . .V .
22.250	268.6079	177.06	.Q . .V .
22.333	269.8224	176.33	.Q . .V .
22.417	271.0318	175.61	.Q . .V .
22.500	272.2362	174.89	.Q . .V .
22.583	273.4358	174.17	.Q . .V .
22.667	274.6304	173.46	.Q . . V .
22.750	275.8202	172.76	.Q . . V .
22.833	277.0052	172.05	.Q . . V .
22.917	278.1853	171.35	.Q . . V .
23.000	279.3606	170.66	.Q . . V .
23.083	280.5312	169.97	.Q . . V .
23.167	281.6971	169.28	.Q . . V .
23.250	282.8582	168.60	.Q . . V .
23.333	284.0147	167.92	.Q . . V .
23.417	285.1665	167.25	.Q . . V .
23.500	286.3138	166.58	.Q . . V .
23.583	287.4564	165.91	.Q . . V .
23.667	288.5944	165.25	.Q . . V .
23.750	289.7279	164.59	Q . . V .
23.833	290.8569	163.93	Q . . V .
23.917	291.9814	163.28	Q . . V .
24.000	293.1013	162.61	Q . . V .

END OF FLOODSCx ROUTING ANALYSIS

Dunlap Channel - Hydraulics

WATER SURFACE PROFILE - TITLE CARD LISTING

H G LINE NO 1 IS -

CITY OF YUCAIPA

HEADING LINE NO 2 IS -

CAPACITY ANALYSIS - YUCAIPA BLVD

HEADING LINE NO 3 IS -

DATE: 6/ 9/2011
TIME: 16:19

F0515P

WATER SURFACE PROFILE - CHANNEL DEFINITION LISTING

CARD CODE	SECT NO	CHN TYPE	NO OF PIERS	AVE PIER WIDTH	HEIGHT 1 DIAMETER	BASE WIDTH	ZL	ZR	INV DROP	Y(1)	Y(2)	Y(3)	Y(4)	Y(5)	Y(6)	Y(7)	Y(8)	Y(9)	Y(10)
CD	54	4			4.50														
CD	48	4			4.00														
CD	36	4			3.00														
CD	18	4			1.50														

WATER SURFACE PROFILE - ELEMENT CARD LISTING

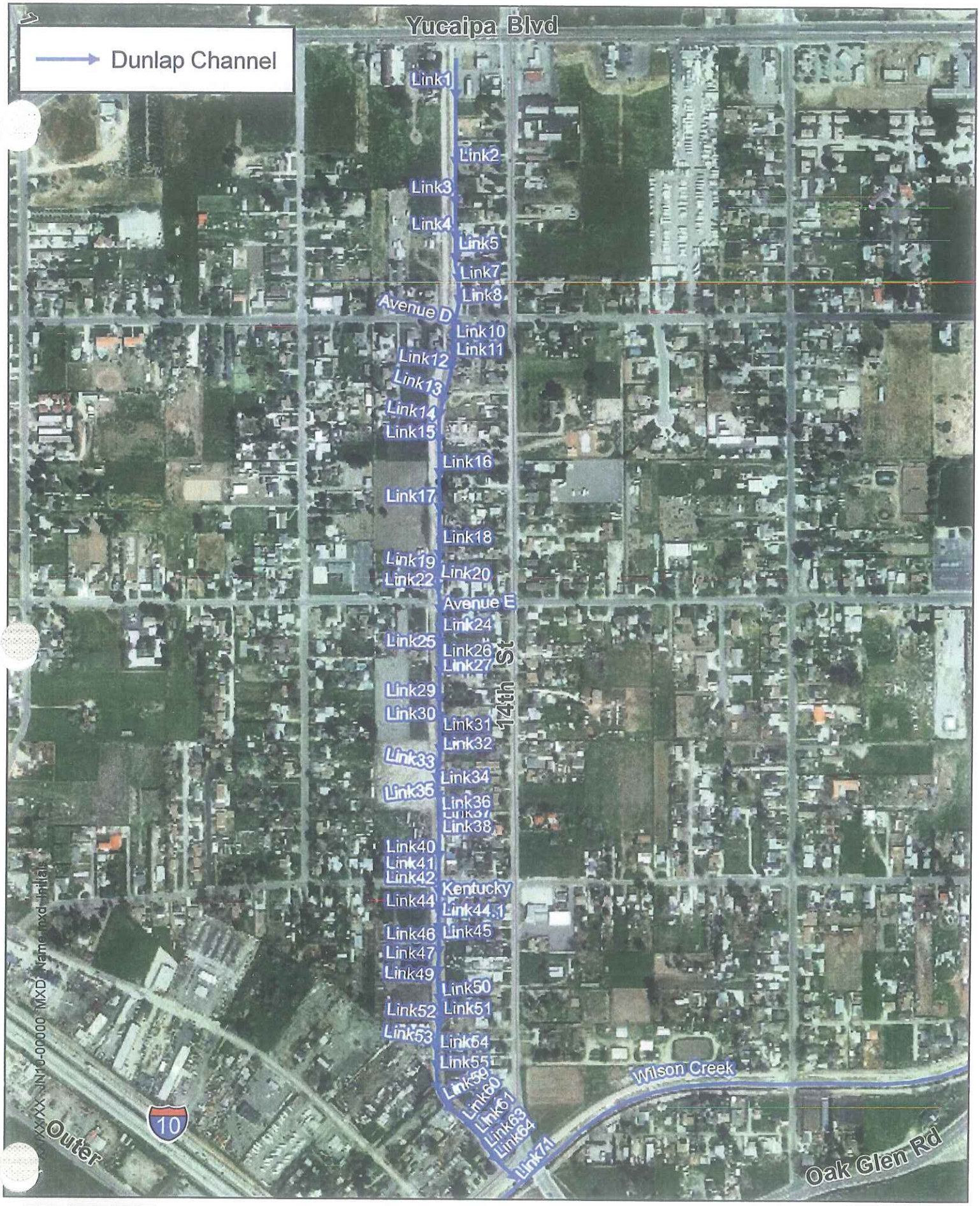
```
 NT NO   1 IS A SYSTEM OUTLET      *         *     *
                U/S DATA   STATION    INVERT  SECT                                  W S ELEV
                            1118.45 2089.00   54                                        0.00

ELEMENT NO   2 IS A REACH            *         *     *
                U/S DATA   STATION    INVERT  SECT              N                              RADIUS  ANGLE  ANG PT  MAN H
                            1198.00 2089.81   54             0.013                                0.00   0.00    0.00     0

ELEMENT NO   3 IS A JUNCTION         *         *     *     *                *                *              *
                U/S DATA   STATION    INVERT  SECT LAT-1 LAT-2   N      Q3       Q4    INVERT-3 INVERT-4  PHI 3   PHI 4
                            1203.50 2089.90   48    18     0  0.014     60.0      0.0  2089.91     0.00  45.00    0.00

ELEMENT NO   4 IS A REACH            *         *     *
                U/S DATA   STATION    INVERT  SECT              N                              RADIUS  ANGLE  ANG PT  MAN H
                            1570.05 2098.96   48             0.013                                0.00   0.00    0.00     0

ELEMENT NO   5 IS A JUNCTION         *         *     *     *                *                *              *
                U/S DATA   STATION    INVERT  SECT LAT-1 LAT-2   N      Q3       Q4    INVERT-3 INVERT-4  PHI 3   PHI 4
                            1579.05 2099.12   36    18     0  0.014    165.0      0.0  2099.13     0.00  45.00    0.00

ELEMENT NO   6 IS A REACH            *         *     *
                U/S DATA   STATION    INVERT  SECT              N                              RADIUS  ANGLE  ANG PT  MAN H
                            2848.70 2111.81   36             0.013                                0.00   0.00    0.00     4

ELEMENT NO   7 IS A REACH            *         *     *
                U/S DATA   STATION    INVERT  SECT              N                              RADIUS  ANGLE  ANG PT  MAN H
                            2923.83 2117.72   36             0.013                                0.00   0.00    0.00     0

ELEMENT NO   8 IS A SYSTEM HEADWORKS                 *                    *
                U/S DATA   STATION    INVERT  SECT                                  W S ELEV
                            2923.83 2117.72   36                                        0.00
NO EDIT ERRORS ENCOUNTERED-COMPUTATION IS NOW BEGINNING
** WARNING NO. 2 ** - WATER SURFACE ELEVATION GIVEN IS LESS THAN OR EQUALS INVERT ELEVATION IN HDWKDS, W.S.ELEV = INV + DC
```

WATER SURFACE PROFILE LISTING

CITY OF YUCAIPA

CAPACITY ANALYSIS - YUCAIPA BLVD

STATION	INVERT ELEV	DEPTH OF FLOW	W.S. ELEV	Q	VEL	VEL HEAD	ENERGY GRD.EL.	SUPER ELEV	CRITICAL DEPTH		HGT/ DIA	BASE/ ID NO.	ZL	NO PIER	AVBPR
L/ELEM	SO					SF AVE	HF			NORM DEPTH			ZR		
1118.45	2089.00	4.394	2093.394	305.0	19.30	5.781	2099.175	0.00	4.394		4.50	0.00	0.00	0	0.00
2.89	0.01018					.022572	0.07			4.500			0.00		
1121.34	2089.03	4.500	2093.529	305.0	19.18	5.711	2099.240	0.00	4.394		4.50	0.00	0.00	0	0.00
76.66	0.01018					.023904	1.83			4.500			0.00		
1198.00	2089.81	5.564	2095.374	305.0	19.18	5.711	2101.085	0.00	4.394		4.50	0.00	0.00	0	0.00
JUNCT STR	0.01636					.030819	0.17						0.00		
1203.50	2089.90	5.451	2095.351	245.0	19.50	5.903	2101.254	0.00	3.930		4.00	0.00	0.00	0	0.00
366.55	0.02472					.029091	10.66			4.000			0.00		
1570.05	2098.96	7.055	2106.015	245.0	19.50	5.903	2111.918	0.00	3.930		4.00	0.00	0.00	0	0.00
JUNCT STR	0.01778												0.00		
1579.05	2099.12	2.770	2101.890	80.0	11.73	2.137	2104.027	0.00	2.770		3.00	0.00	0.00	0	0.00
24.75	0.01000					.013317	0.33			3.000			0.00		
1603.80	2099.37	3.000	2102.367	80.0	11.32	1.989	2104.356	0.00	2.770		3.00	0.00	0.00	0	0.00
1244.90	0.01000					.014275	17.77			3.000			0.00		
2848.70	2111.81	8.857	2120.667	80.0	11.32	1.989	2122.656	0.00	2.770		3.00	0.00	0.00	0	0.00
75.13	0.07866					.014386	1.08			1.370			0.00		
2923.83	2117.72	4.028	2121.748	80.0	11.32	1.989	2123.737	0.00	2.770		3.00	0.00	0.00	0	0.00



RBF CONSULTING

NOT TO SCALE

0 150300 600 900 1,200 Feet

City of Yucaipa

XP-SWMM Cross-Sections

Source:

Exhibit 1

XP-SWMM Analysis Results Dunlap Channel													
Conduit Name	Conduit Type	Channel Length (ft)	Maximum Flow (cfs)	Maximum Velocity (ft/s)	Maximum Volume (ft^3)	Normal Depth (ft)	Critical Depth (ft)	Upstream Invert Elevation (ft)	Upstream WSE (ft)	Upstream Depth (ft)	Downstream Invert Elevation (ft)	Downstream WSE (ft)	Downstream Depth (ft)
Link1	Natural	192.32	470.9	7.1	15578.0	4.9	3.8	2089.2	2094.2	5.0	2088.3	2093.4	5.1
Link2	Natural	312.63	470.9	6.0	30664.1	4.5	3.3	2088.3	2093.4	5.1	2086.7	2092.6	5.9
Link3	Natural	181.8	470.9	5.9	22687.0	4.4	3.4	2086.7	2092.6	5.9	2085.8	2092.4	6.6
Link4	Natural	159.9	470.9	6.3	22939.2	4.6	3.5	2085.8	2092.4	6.6	2085.0	2092.3	7.3
Link5	Natural	105.33	470.9	7.3	17770.7	4.5	3.5	2085.0	2092.3	7.3	2084.5	2092.2	7.8
Link6	Natural	40.81	470.9	8.1	9695.4	3.7	2.7	2084.5	2092.2	7.8	2084.3	2092.2	8.0
Link7	Natural	58.77	470.9	4.6	27232.7	2.0	1.5	2084.3	2092.2	8.0	2084.0	2092.2	8.3
Link8	Natural	100.26	470.9	2.9	53926.4	1.9	1.4	2084.0	2092.2	8.3	2083.5	2092.2	8.8
	2-54" RCP		215.2*	13.4	2862.8	2.6	4.1	2083.5	2092.2	8.8	2081.0	2086.5	5.5
Ave D	Weir		40.4										
Link10	Natural	50.47	637.4	6.6	4897.1	6.5	4.4	2081.0	2086.5	5.5	2080.9	2086.1	5.3
Link11	Natural	65.35	637.4	7.0	5965.4	6.5	4.3	2080.9	2086.1	5.3	2080.7	2085.6	4.9
Link12	Natural	69.86	637.4	7.7	5804.8	5.1	4.2	2080.7	2085.6	4.9	2080.3	2084.9	4.6
Link13	Natural	166.37	637.4	8.1	13165.2	4.7	4.2	2080.2	2084.9	4.7	2078.8	2083.1	4.3
Link14	Natural	67.74	637.4	8.9	4867.5	4.6	4.1	2078.8	2083.1	4.3	2078.2	2082.0	3.8
Link15	Natural	118.11	637.4	7.8	9621.7	3.8	3.4	2078.2	2082.0	3.8	2077.2	2080.7	3.5
Link16	Natural	157.12	637.4	7.7	12989.9	3.6	3.1	2077.2	2080.7	3.5	2075.8	2078.9	3.1
Link17	Natural	160.4	637.4	7.2	14115.7	3.1	2.7	2075.8	2078.9	3.1	2074.4	2077.4	3.0
Link18	Natural	219.93	637.4	6.8	22375.6	2.7	2.5	2074.4	2077.4	3.0	2072.6	2076.7	4.2
Link19	Natural	28.23	637.4	5.8	4099.8	2.6	2.4	2072.6	2076.7	4.2	2072.3	2076.7	4.4
Link20	Natural	57.61	637.4	6.5	7653.7	2.9	2.8	2072.3	2076.7	4.4	2071.8	2076.7	4.9
Link22	Natural	70.33	637.4	8.1	8381.9	3.6	3.4	2071.8	2076.7	4.9	2071.2	2076.6	5.3
Avenue E	2-60" RCP	89.75	318.7*	19.6	2993.4	2.3	4.7	2071.2	2076.6	5.3	2063.0	2072.0	9.0
Link24	Natural	63.69	709.3	4.5	23663.6	3.9	3.1	2063.0	2072.0	9.0	2062.6	2072.0	9.5
Link25	Natural	28.29	709.3	5.2	16667.7	4.8	4.0	2062.6	2072.0	9.5	2062.2	2072.0	9.8
Link26	Natural	106.61	709.3	4.6	7987.1	4.7	3.9	2062.2	2072.0	9.8	2062.1	2072.0	9.9
Link27	Natural	134.56	709.3	5.1	29411.0	5.3	4.4	2062.1	2072.0	9.9	2061.6	2072.0	10.4
Link29	Natural	81.31	709.3	3.8	41927.4	5.8	4.9	2061.6	2072.0	10.4	2060.9	2072.0	11.1
Link30	Natural	47.72	709.3	3.1	27448.3	5.3	4.4	2060.9	2072.0	11.1	2060.5	2072.0	11.5
Link31	Natural	77.22	709.3	2.8	15473.1	5.8	4.9	2060.5	2072.0	11.5	2060.2	2072.0	11.7
Grade	Natural		445.2	4.3	10937.3	4.0	2.3	2069.0	2072.0	3.0	2069.0	2071.3	2.3
Control	Circular	18-in	28.8	15.9	194.3	1.5	2.7	2060.3	2072.0	11.7	2059.4	2067.2	7.9
Link33	Natural	55.59	465.7	3.2	14290.0	4.3	3.3	2059.4	2067.2	7.9	2059.0	2067.2	8.2
Link34	Natural	84.28	465.7	2.7	12582.8	4.3	3.6	2059.0	2067.2	8.2	2058.7	2067.2	8.5
Link35	Natural	47.72	465.7	1.8	22715.0	3.7	3.0	2058.7	2067.2	8.5	2058.3	2067.2	8.9
Link36	Natural	29.73	465.7	1.5	14692.3	3.5	2.8	2058.3	2067.2	8.9	2058.0	2067.2	9.2
Grade	Natural		441.4	4.7	4406.3	2.8	1.8	2065.0	2067.2	2.2	2065.0	2066.8	1.8
Control	Circular	18-in	28.6	15.9	85.9	1.5	2.7	2058.0	2067.2	9.2	2057.5	2063.4	6.0
Link38	Natural	20.68	709.3	7.4	2832.8	6.6	5.4	2057.5	2063.4	6.0	2057.3	2063.1	5.8

XP-SWMM Analysis Results Dunlap Channel													
Conduit Name	Conduit Type	Channel Length (ft)	Maximum Flow (cfs)	Maximum Velocity (ft/s)	Maximum Volume (ft^3)	Normal Depth (ft)	Critical Depth (ft)	Upstream Invert Elevation (ft)	Upstream WSE (ft)	Upstream Depth (ft)	Downstream Invert Elevation (ft)	Downstream WSE (ft)	Downstream Depth (ft)
Link39	Natural	135.3	709.3	8.1	1816.8	6.6	5.5	2057.3	2063.1	5.8	2057.2	2062.7	5.6
Link40	Natural	38.81	709.3	8.2	11693.4	6.2	5.1	2057.2	2062.7	5.6	2056.5	2059.8	3.3
Link41	Natural	19.12	709.3	8.1	3405.5	3.7	3.1	2056.5	2059.8	3.3	2056.2	2059.2	3.0
Link42	Natural	29.61	709.3	7.5	1811.6	3.6	2.7	2056.2	2059.2	3.0	2056.1	2059.0	2.9
Kentucky	2-72" RCP	78.34	354.6	23.8	2336.6	2.0	5.1	2056.1	2059.0	2.9	2043.0	2049.7	6.7
Link44	Natural	48.42	1090.0	8.4	3829.7	7.1	5.6	2043.0	2049.7	6.7	2042.9	2049.5	6.7
Link44.1	Natural	47.07	1090.0	7.9	8146.0	6.8	5.4	2042.9	2049.5	6.7	2042.6	2049.2	6.6
Link45	Natural	61.67	1090.0	8.0	10708.0	6.9	5.5	2042.6	2049.2	6.6	2042.2	2048.6	6.4
Link46	Natural	66.33	1090.0	9.5	5597.1	7.7	5.9	2042.2	2048.6	6.4	2041.9	2047.9	6.0
Link47	Natural	126.66	1090.0	8.4	8248.4	7.0	5.1	2041.9	2047.9	6.0	2041.6	2047.3	5.6
Grade	Circular	18-in	29.5	17.8	63.8	0.9	2.8	2041.6	2047.3	5.6	2036.8	2043.0	6.2
Control	Natural		1037.5	7.0	4050.7	4.1	3.1	2043.9	2047.3	3.4	2043.9	2046.9	3.1
Link49	Natural	38.66	1090.0	8.7	8316.8	6.8	5.4	2036.8	2043.0	6.2	2036.5	2042.3	5.8
Link50	Natural	82.9	1090.0	8.3	16583.8	6.3	5.0	2036.5	2042.3	5.8	2035.8	2041.0	5.2
Link51	Natural	47.83	1090.0	8.5	5196.9	5.6	4.4	2035.8	2041.0	5.2	2035.7	2040.6	5.0
Link52	Natural	64.83	1090.0	8.2	12133.3	5.0	4.1	2035.7	2040.6	5.0	2035.2	2039.5	4.2
Link53	Natural	77.17	1090.0	9.1	7139.1	4.4	4.2	2035.2	2039.5	4.2	2035.0	2038.5	3.5
Link54	Natural	23.42	1090.0	6.7	10660.7	3.4	2.7	2035.0	2038.5	3.5	2034.7	2038.2	3.5
Link55	Natural	16.16	1090.0	6.8	12670.5	3.7	2.7	2034.7	2038.2	3.5	2034.3	2037.6	3.3
Link56	Natural	60.83	1090.0	6.5	4305.4	3.3	2.7	2034.3	2037.6	3.3	2034.2	2037.5	3.4
Link57	Natural	122.74	1090.0	7.6	2308.6	3.6	3.1	2034.2	2037.5	3.4	2034.1	2037.4	3.3
Link58	Natural	121.33	1090.0	6.2	9598.8	3.3	2.7	2034.1	2037.4	3.3	2033.8	2037.1	3.3
Link59	Natural	36.73	1090.0	6.2	21512.6	3.4	2.7	2033.8	2037.1	3.3	2033.2	2036.8	3.6
Link60	Natural	47.84	1090.0	5.6	24205.5	3.1	2.5	2033.2	2036.8	3.6	2032.6	2036.5	3.9
Link61	Natural	47.76	1090.0	6.7	5835.0	4.0	3.5	2032.6	2036.5	3.9	2032.4	2036.3	3.9
Link62	Natural	53.5	1090.0	7.7	7854.4	4.0	3.4	2032.4	2036.3	3.9	2032.1	2036.0	3.9
Link63	Natural	12.24	1090.0	4.7	13156.5	2.8	2.2	2032.1	2036.0	3.9	2031.9	2036.0	4.1
Link64	Natural	58.78	1090.0	4.4	13262.0	3.1	2.7	2031.9	2036.0	4.1	2031.5	2035.9	4.4
Link65	Natural	105.32	545.0	1.8	3.8	3.5	2.6	2031.5	2035.9	4.4	2031.5	2035.9	4.4
Link71	Dbl 6x6 RCB	150	545.0	14.5	2124.9	1.9	4.8	2031.5	2035.9	4.4	2024.0	2025.9	1.9

TECHNICAL MEMORANDUM
Chicken Springs Study
June 20, 2011

RBF has analyzed the Chicken Springs Watershed to design ultimate facilities along the channel. Chicken Springs was extended upstream from 7th Street to 200' downstream of 2nd Street.

Detention Basin
City of Yucaipa proposed a potential detention basin location upstream of 7th street. This location was analyzed with different basins geometry and sizes. Due to the existing discharges and limited basin area along Chicken Springs Wash the basin will require extensive improvements along the South edge of the parking lot to avoid flooding the adjacent properties.

Hydrology
The discharges along Chicken Springs were extrapolated from the approved MPD hydrology prepared by Boyle Rational Method. However, the Unit Hydrograph method was analyzed for Node 3833 (Upstream of Wilson Creek Confluence) and approved in the 2008 MPD Update. Additional UH was analyzed for Node 4316 (at 7th Street) since the drainage area is larger than 1 sq. mile. The average cfs/acre for these 2 concentration points were used to determine the flows along the channel. The discharges were found to be the following:

Chicken Springs Wastershed					
Location	Node	Area (ac.)	Q, Boyle RM	Q, UH	Q, extrapolated
2nd Street	4144	781.71	1789	-	1234
3rd Street	4154	842.18	1858	-	1330
4th Street	4231	881.98	1858	-	1392
5th Street	4232	928.66	1887	-	1466
6th Street	4246	1148.57	2222	-	1813
7th Street	4316	1234.54	2336	2163	
Wilson Crk	3833	1771.65		2490	

Note: Qmax = 311 cfs from 54" RCP

The upstream flowrate from the 54" along Yucaipa Blvd was found to be 311 cfs based on the plans provided by the City. Additional flow will be conveyed via a 7.5' (W) x 7.5' (H) RCB along 3rd Street. This RCB is assumed to have a slope of 1.2%. No bulking factors were used for the sizing of the Chicken Springs facilities, since the tributary drainage areas are within developed areas and the proposed Chicken Springs channel improvements will be designed to reduce scour.

Hydraulics
The USACE HEC-RAS software was used to run the hydraulics for the main channel of Chicken Spring Wash. Cross-sections were identified using existing topography, obtained from the City of Yucaipa. WSPG, FHWA Nomographs and HECRAS was used to size the ultimate crossings along 5th Street, 6th Street and 7th Street. The ultimate

crossings were designed to convey only the 10-yr flows and higher discharges would weir over the street. Based on the results of the analysis Chicken Wash will need to be lined with loose rip-rap to avoid scour.

Chicken Springs Wastershed		
Location	**Existing Facility**	**Ultimate Facility***
3rd Street	2 - 60" CMP	
Poplar Street	2 - 60" CMP	
4th Street	2 - 60" CMP	
5th Street	60" CMP	4 - 7' x 6' RCB
6th Street	11' x 5' RCB	2 - 10' x 5' RCB
7th Street	48" CMP & 60" CMP	2 - 10' x 5' RCB

Ultimate Facility proposed by RBF

The drainage cost for chicken spring wash from the confluence with Wilson Creek to 3rd Street is $19,098,674.

Chicken Springs Wash - Hydrology

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              F L O O D   R O U T I N G   A N A L Y S I S
         USING COUNTY HYDROLOGY MANUAL OF SAN BERNARDINO(1986)
        (c) Copyright 1989-2004 Advanced Engineering Software (aes)
            Ver. 10.0  Release Date: 01/01/2004  License ID 1264

                         Analysis prepared by:

                            RBF Consulting
                          14725 Alton Parkway
                       Irvine, California  92618


 ************************* DESCRIPTION OF STUDY *************************
* CITY OF YUCAIPA - DIF and TIF ASSESSMENT                               *
* MASTER PLAN OF DRAINAGE UPDATE- Depth Area =  1235 ac.                 *
* CHICKEN SPRINGS @ 7TH AVE - NODE 4316  MC AUG 2009                     *
 ************************************************************************

  FILE NAME: YC-4316.DAT
  TIME/DATE OF STUDY: 11:30 08/24/2009


****************************************************************************
  FLOW PROCESS FROM NODE   3911.00 TO NODE   4316.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>SUBAREA RUNOFF (UNIT-HYDROGRAPH ANALYSIS)<<<<<
============================================================================

      (UNIT-HYDROGRAPH ADDED TO STREAM #3)

        WATERSHED AREA =    1234.500 ACRES
        BASEFLOW =   0.000 CFS/SQUARE-MILE
        *USER ENTERED "LAG" TIME =    0.353 HOURS
         CAUTION: LAG TIME IS LESS THAN 0.50 HOURS.
         THE 5-MINUTE PERIOD UH MODEL (USED IN THIS COMPUTER PROGRAM)
         MAY BE TOO LARGE FOR PEAK FLOW ESTIMATES.
        VALLEY(DEVELOPED):
                 "S"-CURVE PERCENTAGE(DECIMAL NOTATION) =  0.567
        FOOTHILL "S"-CURVE PERCENTAGE(DECIMAL NOTATION) =  0.000
        MOUNTAIN "S"-CURVE PERCENTAGE(DECIMAL NOTATION) =  0.000
        VALLEY(UNDEVELOPED)/DESERT:
                 "S"-CURVE PERCENTAGE(DECIMAL NOTATION) =  0.433
        DESERT(UNDEVELOPED) "S"-CURVE PERCENTAGE(DECIMAL NOTATION) =  0.000
        MAXIMUM WATERSHED LOSS RATE(INCH/HOUR) =  0.332
        LOW LOSS FRACTION = 0.305
        *HYDROGRAPH MODEL #1 SPECIFIED*

        SPECIFIED PEAK  5-MINUTES RAINFALL(INCH)=  0.62
        SPECIFIED PEAK 30-MINUTES RAINFALL(INCH)=  1.06
        SPECIFIED PEAK  1-HOUR RAINFALL(INCH) =  1.30
        SPECIFIED PEAK  3-HOUR RAINFALL(INCH) =  2.26
        SPECIFIED PEAK  6-HOUR RAINFALL(INCH) =  3.20
        SPECIFIED PEAK 24-HOUR RAINFALL(INCH) =  7.73

        *USER SPECIFIED PRECIPITATION DEPTH-AREA REDUCTION FACTORS:
          5-MINUTE FACTOR = 0.945
         30-MINUTE FACTOR = 0.945
          1-HOUR FACTOR = 0.945
          3-HOUR FACTOR = 0.992
          6-HOUR FACTOR = 0.996
         24-HOUR FACTOR = 0.998
```



```
        UNIT HYDROGRAPH TIME UNIT =   5.000 MINUTES
        UNIT INTERVAL PERCENTAGE OF LAG-TIME =  23.607


        RUNOFF HYDROGRAPH LISTING LIMITS:
        MODEL TIME(HOURS) FOR BEGINNING OF RESULTS =  15.00
        MODEL TIME(HOURS) FOR END OF RESULTS =  19.00
```

UNIT HYDROGRAPH DETERMINATION

INTERVAL NUMBER	"S" GRAPH MEAN VALUES	UNIT HYDROGRAPH ORDINATES(CFS)
1	1.708	255.041
2	7.516	867.046
3	19.624	1807.797
4	35.785	2412.703
5	53.993	2718.469
6	68.357	2144.493
7	77.727	1398.893
8	83.678	888.517
9	87.574	581.540
10	90.152	384.984
11	91.796	245.383
12	92.934	169.976
13	93.934	149.188
14	94.607	130.386
15	95.638	124.136
16	96.131	73.616
17	96.586	67.936
18	96.971	57.415
19	97.345	55.763
20	97.661	47.258
21	97.962	44.884
22	98.250	43.108
23	98.463	31.695
24	98.661	29.630
25	98.860	29.630
26	99.057	29.523
27	99.179	18.207
28	99.253	10.943
29	99.326	10.964
30	99.399	10.943
31	99.473	10.964
32	99.546	10.943
33	99.619	10.953
34	99.693	10.943
35	99.766	10.943
36	99.839	10.943
37	99.913	10.943
38	99.986	10.943
39	100.000	2.095

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----------------------------------------------------------------------------
    TOTAL SOIL-LOSS VOLUME(ACRE-FEET) =      224.9413
    TOTAL STORM RUNOFF VOLUME(ACRE-FEET) =     568.0163
----------------------------------------------------------------------------
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24-HOUR STORM
RUNOFF HYDROGRAPH

==========

HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
(Note: Time indicated is at END of Each Unit Intervals)

TIME(HRS)	VOLUME(AF)	Q(CFS)	0.	550.0	1100.0	1650.0	2200.0
15.000	278.0303	405.16	.	Q .	V.	.	.
15.083	280.8998	416.66	.	Q .	V.	.	.
15.167	283.8548	429.06	.	Q .	V.	.	.
15.250	286.9053	442.94	.	Q .	V	.	.
15.333	290.0602	458.09	.	Q .	V	.	.
15.417	293.3020	470.70	.	Q .	V	.	.
15.500	296.5680	474.22	.	Q .	V	.	.
15.583	299.7613	463.68	.	Q .	.V	.	.
15.667	302.8268	445.12	.	Q .	.V	.	.
15.750	305.7617	426.14	.	Q .	.V	.	.
15.833	308.6844	424.38	.	Q .	.V	.	.
15.917	311.7876	450.57	.	Q .	.V	.	.
16.000	315.3390	515.66	.	Q.	. V	.	.
16.083	320.4885	747.72	.	. Q	. V	.	.
16.167	328.5826	1175.26	.	.	.Q V	.	.
16.250	340.5262	1734.22	.	.	. V	.Q	.
16.333	354.7564	2066.23	.	.	. V	.	Q .
16.417	369.6545	2163.20	.	.	. V	.	Q.
16.500	381.9724	1788.57	.	.	. V	. Q	.
16.583	391.1853	1337.71	.	.	. Q V	.	.
16.667	398.2644	1027.88	.	. Q	. V	.	.
16.750	404.0660	842.39	.	. Q	. V	.	.
16.833	409.0065	717.36	.	. Q	. V	.	.
16.917	413.2885	621.74	.	.Q	. V.	.	.
17.000	417.1484	560.47	.	Q	. V.	.	.
17.083	420.7836	527.83	.	Q.	. V.	.	.
17.167	424.2029	496.48	.	Q.	. V.	.	.
17.250	427.4341	469.17	.	Q .	. V	.	.
17.333	430.3415	422.16	.	Q .	. V	.	.
17.417	433.0882	398.82	.	Q .	. V	.	.
17.500	435.6807	376.43	.	Q .	. V	.	.
17.583	438.1682	361.19	.	Q .	. V	.	.
17.667	440.5391	344.26	.	Q .	. .V	.	.
17.750	442.8239	331.76	.	Q .	. .V	.	.
17.833	445.0298	320.29	.	Q .	. .V	.	.
17.917	447.1334	305.45	.	Q .	. .V	.	.
18.000	449.1722	296.04	.	Q .	. .V	.	.
18.083	451.1638	289.18	.	Q .	. .V	.	.
18.167	453.1247	284.71	.	Q .	. .V	.	.
18.250	455.0459	278.96	.	Q .	. . V	.	.
18.333	456.9647	278.60	.	Q .	. . V	.	.
18.417	458.9191	283.78	.	Q .	. . V	.	.
18.500	460.8974	287.25	.	Q .	. . V	.	.
18.583	462.8817	288.11	.	Q .	. . V	.	.
18.667	464.8594	287.17	.	Q .	. . V	.	.
18.750	466.8240	285.26	.	Q .	. . V	.	.
18.833	468.7715	282.78	.	Q .	. . V	.	.
18.917	470.6992	279.90	.	Q .	. . V	.	.
19.000	472.6059	276.85	.	Q .	. . V	.	.

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FLOW PROCESS FROM NODE 3911.00 TO NODE 4316.00 IS CODE = 11

>>>>>VIEW STREAM NUMBER 3 HYDROGRAPH<<<<<

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STREAM HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
(Note: Time indicated is at END of Each Unit Intervals)

TIME(HRS)	VOLUME(AF)	Q(CFS)	0.	550.0	1100.0	1650.0	2200.0
15.000	278.0303	405.16	.	Q .	V.	.	.
15.083	280.8998	416.66	.	Q .	V.	.	.
15.167	283.8548	429.06	.	Q .	V.	.	.
15.250	286.9053	442.94	.	Q .	V	.	.
15.333	290.0602	458.09	.	Q .	V	.	.
15.417	293.3020	470.70	.	Q .	V	.	.
15.500	296.5680	474.22	.	Q .	V	.	.
15.583	299.7613	463.68	.	Q .	.V	.	.
15.667	302.8268	445.12	.	Q .	.V	.	.
15.750	305.7617	426.14	.	Q .	.V	.	.
15.833	308.6844	424.38	.	Q .	.V	.	.
15.917	311.7876	450.57	.	Q .	.V	.	.
16.000	315.3390	515.66	.	Q.	. V	.	.
16.083	320.4885	747.72	.	. Q	. V	.	.
16.167	328.5826	1175.26	.	.	.Q V	.	.
16.250	340.5262	1734.22	.	.	. V	.Q	.
16.333	354.7564	2066.23	.	.	. V	.	Q .
16.417	369.6545	2163.20	.	.	. V	.	Q.
16.500	381.9724	1788.57	.	.	. V	. Q	.
16.583	391.1853	1337.71	.	.	. Q V	.	.
16.667	398.2644	1027.88	.	.	Q . V	.	.
16.750	404.0660	842.39	.	. Q	. V	.	.
16.833	409.0065	717.36	.	. Q	. V	.	.
16.917	413.2885	621.74	.	.Q	. V.	.	.
17.000	417.1484	560.47	.	Q	. V.	.	.
17.083	420.7836	527.83	.	Q.	. V.	.	.
17.167	424.2029	496.48	.	Q.	. V.	.	.
17.250	427.4341	469.17	.	Q .	. V	.	.
17.333	430.3415	422.16	.	Q .	. V	.	.
17.417	433.0882	398.82	.	Q .	. V	.	.
17.500	435.6807	376.43	.	Q .	. V	.	.
17.583	438.1682	361.19	.	Q .	. V	.	.
17.667	440.5391	344.26	.	Q .	. .V	.	.
17.750	442.8239	331.76	.	Q .	. .V	.	.
17.833	445.0298	320.29	.	Q .	. .V	.	.
17.917	447.1334	305.45	.	Q .	. .V	.	.
18.000	449.1722	296.04	.	Q .	. .V	.	.
18.083	451.1638	289.18	.	Q .	. .V	.	.
18.167	453.1247	284.71	.	Q .	. .V	.	.
18.250	455.0459	278.96	.	Q .	. . V	.	.
18.333	456.9647	278.60	.	Q .	. . V	.	.
18.417	458.9191	283.78	.	Q .	. . V	.	.
18.500	460.8974	287.25	.	Q .	. . V	.	.
18.583	462.8817	288.11	.	Q .	. . V	.	.
18.667	464.8594	287.17	.	Q .	. . V	.	.
18.750	466.8240	285.26	.	Q .	. . V	.	.
18.833	468.7715	282.78	.	Q .	. . V	.	.
18.917	470.6992	279.90	.	Q .	. . V	.	.
19.000	472.6059	276.85	.	Q .	. . V	.	.

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END OF FLOODSCx ROUTING ANALYSIS

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            F L O O D   R O U T I N G   A N A L Y S I S
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                     Analysis prepared by:

                        RBF Consulting
                      14725 Alton Parkway
                    Irvine, California  92618


 ************************* DESCRIPTION OF STUDY **************************
* CITY OF YUCAIPA                                                        *
* MASTER PLAN OF DRAINAGE UPDATE- Depth Area = 1771.7 ac.                *
* UNIT HYDROGRAPH BASIN MODEL - NODE 3833B JULY 2008                     *
 ************************************************************************

  FILE NAME: YC-3833A.DAT
  TIME/DATE OF STUDY: 18:44 07/08/2008


****************************************************************************
  FLOW PROCESS FROM NODE   3911.00 TO NODE   3833.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>SUBAREA RUNOFF (UNIT-HYDROGRAPH ANALYSIS)<<<<<
============================================================================

      (UNIT-HYDROGRAPH ADDED TO STREAM #4)

         WATERSHED AREA =    1771.650 ACRES
         BASEFLOW =    0.000 CFS/SQUARE-MILE
         *USER ENTERED "LAG" TIME =    0.494 HOURS
          CAUTION: LAG TIME IS LESS THAN 0.50 HOURS.
          THE 5-MINUTE PERIOD UH MODEL (USED IN THIS COMPUTER PROGRAM)
          MAY BE TOO LARGE FOR PEAK FLOW ESTIMATES.
         VALLEY(DEVELOPED):
                  "S"-CURVE PERCENTAGE(DECIMAL NOTATION) =  0.970
         FOOTHILL "S"-CURVE PERCENTAGE(DECIMAL NOTATION) =  0.000
         MOUNTAIN "S"-CURVE PERCENTAGE(DECIMAL NOTATION) =  0.000
         VALLEY(UNDEVELOPED)/DESERT:
                  "S"-CURVE PERCENTAGE(DECIMAL NOTATION) =  0.030
         DESERT(UNDEVELOPED) "S"-CURVE PERCENTAGE(DECIMAL NOTATION) =  0.000
         MAXIMUM WATERSHED LOSS RATE(INCH/HOUR) =  0.355
         LOW LOSS FRACTION = 0.330
         *HYDROGRAPH MODEL #1 SPECIFIED*

         SPECIFIED PEAK  5-MINUTES RAINFALL(INCH)=  0.61
         SPECIFIED PEAK 30-MINUTES RAINFALL(INCH)=  1.05
         SPECIFIED PEAK  1-HOUR RAINFALL(INCH) =  1.28
         SPECIFIED PEAK  3-HOUR RAINFALL(INCH) =  2.18
         SPECIFIED PEAK  6-HOUR RAINFALL(INCH) =  3.05
         SPECIFIED PEAK 24-HOUR RAINFALL(INCH) =  7.55

         *USER SPECIFIED PRECIPITATION DEPTH-AREA REDUCTION FACTORS:
           5-MINUTE FACTOR = 0.921
          30-MINUTE FACTOR = 0.921
           1-HOUR FACTOR = 0.921
           3-HOUR FACTOR = 0.988
           6-HOUR FACTOR = 0.994
          24-HOUR FACTOR = 0.996
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         UNIT HYDROGRAPH TIME UNIT =   5.000 MINUTES
         UNIT INTERVAL PERCENTAGE OF LAG-TIME =  16.869


         RUNOFF HYDROGRAPH LISTING LIMITS:
         MODEL TIME(HOURS) FOR BEGINNING OF RESULTS =  15.00
         MODEL TIME(HOURS) FOR END OF RESULTS =  19.00
```

UNIT HYDROGRAPH DETERMINATION

INTERVAL NUMBER	"S" GRAPH MEAN VALUES	UNIT HYDROGRAPH ORDINATES(CFS)
1	0.978	209.547
2	3.510	542.417
3	9.316	1244.171
4	18.687	2007.711
5	29.666	2352.379
6	42.947	2845.655
7	57.257	3065.836
8	69.984	2727.055
9	79.171	1968.229
10	85.881	1437.749
11	90.205	926.537
12	93.402	684.905
13	95.537	457.427
14	96.945	301.800
15	97.726	167.179
16	98.080	75.831
17	98.426	74.327
18	98.770	73.531
19	99.107	72.375
20	99.444	72.102
21	99.704	55.621
22	99.727	5.117
23	99.751	5.035
24	99.772	4.417
25	99.790	4.016
26	99.809	4.015
27	99.826	3.670
28	99.841	3.191
29	99.856	3.189
30	99.871	3.189
31	99.884	2.764
32	99.894	2.112
33	99.903	2.105
34	99.913	2.105
35	99.923	2.105
36	99.933	2.104
37	99.941	1.702
38	99.945	0.811
39	99.948	0.780
40	99.952	0.776
41	99.956	0.781
42	99.959	0.776
43	99.963	0.776
44	99.966	0.780
45	99.970	0.778
46	99.974	0.780
47	99.977	0.778

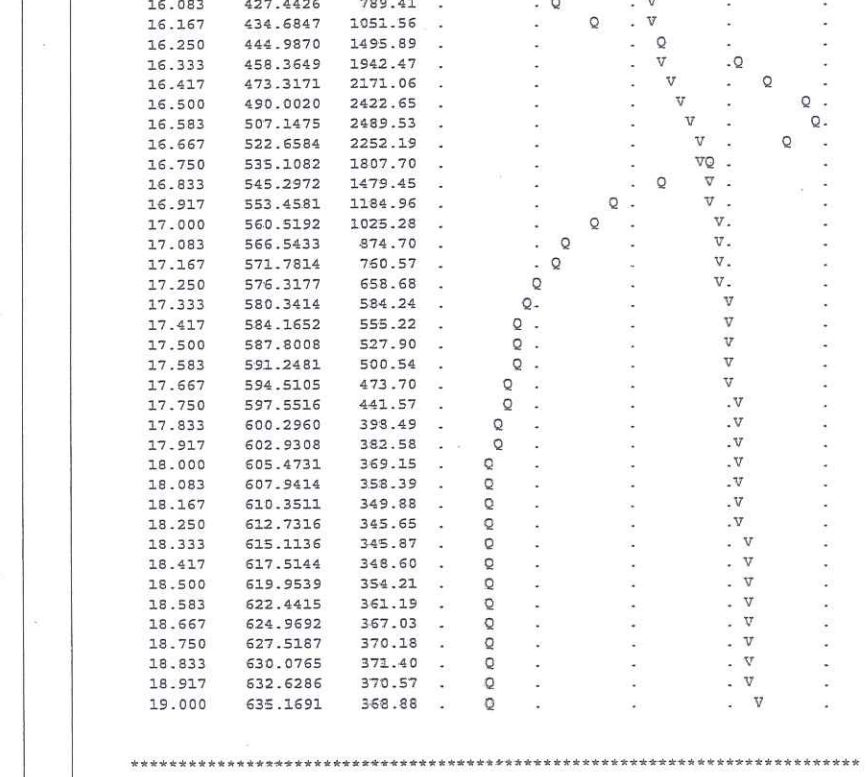
48	99.981	0.778
49	99.985	0.778
50	99.988	0.780
51	99.992	0.778
52	99.996	0.778
53	99.999	0.778
54	100.000	0.185

TOTAL SOIL-LOSS VOLUME(ACRE-FEET) = 341.4474
TOTAL STORM RUNOFF VOLUME(ACRE-FEET) = 768.8508

24-HOUR STORM RUNOFF HYDROGRAPH

HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
(Note: Time indicated is at END of Each Unit Intervals)

TIME(HRS)	VOLUME(AF)	Q(CFS)
15.000	372.9897	523.11
15.083	376.6916	537.52
15.167	380.4990	552.84
15.250	384.4191	569.20
15.333	388.4623	587.07
15.417	392.6167	603.22
15.500	396.8589	615.97
15.583	401.1238	619.26
15.667	405.3437	612.73
15.750	409.5102	604.98
15.833	413.6114	595.48
15.917	417.7069	594.68
16.000	422.0059	624.20
16.083	427.4426	789.41
16.167	434.6847	1051.56
16.250	444.9870	1495.89
16.333	458.3649	1942.47
16.417	473.3171	2171.06
16.500	490.0020	2422.65
16.583	507.1475	2489.53
16.667	522.6584	2252.19
16.750	535.1082	1807.70
16.833	545.2972	1479.45
16.917	553.4581	1184.96
17.000	560.5192	1025.28
17.083	566.5433	874.70
17.167	571.7814	760.57
17.250	576.3177	658.68
17.333	580.3414	584.24
17.417	584.1652	555.22
17.500	587.8008	527.90
17.583	591.2481	500.54
17.667	594.5105	473.70
17.750	597.5516	441.57
17.833	600.2960	398.49
17.917	602.9308	382.58
18.000	605.4731	369.15
18.083	607.9414	358.39
18.167	610.3511	349.88
18.250	612.7316	345.65
18.333	615.1136	345.87
18.417	617.5144	348.60
18.500	619.9539	354.21
18.583	622.4415	361.19
18.667	624.9692	367.03
18.750	627.5187	370.18
18.833	630.0765	371.40
18.917	632.6286	370.57
19.000	635.1691	368.88



FLOW PROCESS FROM NODE 3833.00 TO NODE 3833.00 IS CODE = 11

>>>>>VIEW STREAM NUMBER 4 HYDROGRAPH<<<<<

STREAM HYDROGRAPH IN FIVE-MINUTE UNIT INTERVALS(CFS)
(Note: Time indicated is at END of Each Unit Intervals)

TIME(HRS)	VOLUME(AF)	Q(CFS)	0. 625.0 1250.0 1875.0 2500.0
15.000	372.9897	523.11	. Q . V. . .
15.083	376.6916	537.52	. Q . V. . .
15.167	380.4990	552.84	. Q . V. . .
15.250	384.4191	569.20	. Q. V. . .
15.333	388.4623	587.07	. Q. V . .
15.417	392.6167	603.22	. Q. V . .
15.500	396.8589	615.97	. Q. V . .
15.583	401.1238	619.26	. Q. V . .
15.667	405.3437	612.73	. Q. .V . .
15.750	409.5102	604.98	. Q. .V . .
15.833	413.6114	595.48	. Q. .V . .
15.917	417.7069	594.68	. Q. .V . .
16.000	422.0059	624.20	. Q. .V . .
16.083	427.4426	789.41	. . Q . V . .
16.167	434.6847	1051.56	. . Q . V . .
16.250	444.9870	1495.89	. . . Q . .
16.333	458.3649	1942.47	. . . V .Q .
16.417	473.3171	2171.06	. . . V . Q .
16.500	490.0020	2422.65	. . . V . Q .
16.583	507.1475	2489.53	. . . V . Q.
16.667	522.6584	2252.19	. . . V . Q .
16.750	535.1082	1807.70	. . . VQ . .
16.833	545.2972	1479.45	. . . Q V . .
16.917	553.4581	1184.96	. . Q . V . .
17.000	560.5192	1025.28	. . Q . V. .
17.083	566.5433	874.70	. . Q . V. .
17.167	571.7814	760.57	. . Q . V. .
17.250	576.3177	658.68	. Q . V. .
17.333	580.3414	584.24	. Q. . V .
17.417	584.1652	555.22	. Q . . V .
17.500	587.8008	527.90	. Q . . V .
17.583	591.2481	500.54	. Q . . V .
17.667	594.5105	473.70	. Q . . V .
17.750	597.5516	441.57	. Q . . .V .
17.833	600.2960	398.49	. Q . . .V .
17.917	602.9308	382.58	. Q . . .V .
18.000	605.4731	369.15	. Q . . .V .
18.083	607.9414	358.39	. Q . . .V .
18.167	610.3511	349.88	. Q . . .V .
18.250	612.7316	345.65	. Q . . .V .
18.333	615.1136	345.87	. Q . . . V .
18.417	617.5144	348.60	. Q . . . V .
18.500	619.9539	354.21	. Q . . . V .
18.583	622.4415	361.19	. Q . . . V .
18.667	624.9692	367.03	. Q . . . V .
18.750	627.5187	370.18	. Q . . . V .
18.833	630.0765	371.40	. Q . . . V .
18.917	632.6286	370.57	. Q . . . V .
19.000	635.1691	368.88	. Q . . . V .

END OF FLOODSCx ROUTING ANALYSIS

Chicken Springs Wash - Hydraulics

CHICKEN SPRINGS WASH.

HEC-RAS Plan: 03 River: Chicken Springs Reach: Reach 1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	7240.742	MPD – 100 yr	1234.00	2598.00	2604.91	2604.91	2606.38	0.010225	9.86	132.58	55.66	0.89
Reach 1	7240.742	Yucaipa - Prop	311.00	2598.00	2601.74	2601.74	2602.74	0.015747	8.02	38.77	19.42	1.00
Reach 1	7240.742	PF 3 – 10 yr	311.00	2598.00	2601.74	2601.74	2602.74	0.015747	8.02	38.77	19.42	1.00
Reach 1	7125.303	MPD	1234.00	2594.00	2600.50	2600.50	2602.13	0.010067	10.30	125.01	47.65	0.88
Reach 1	7125.303	Yucaipa - Prop	311.00	2594.00	2597.19	2597.04	2598.08	0.012900	7.60	40.91	19.06	0.91
Reach 1	7125.303	PF 3	311.00	2594.00	2597.19	2597.04	2598.08	0.012900	7.60	40.91	19.06	0.91
Reach 1	7018.258	MPD	1234.00	2592.00	2597.68	2597.68	2598.54	0.008363	8.60	177.24	91.86	0.79
Reach 1	7018.258	Yucaipa - Prop	311.00	2592.00	2595.43	2595.43	2596.53	0.015959	8.42	36.92	17.08	1.01
Reach 1	7018.258	PF 3	311.00	2592.00	2595.43	2595.43	2596.53	0.015959	8.42	36.92	17.08	1.01
Reach 1	6952.561	MPD	1234.00	2588.00	2595.40	2595.40	2596.33	0.006982	8.49	179.09	91.27	0.73
Reach 1	6952.561	Yucaipa - Prop	311.00	2588.00	2592.00	2592.00	2593.14	0.016350	8.58	36.24	16.17	1.01
Reach 1	6952.561	PF 3	311.00	2588.00	2592.00	2592.00	2593.14	0.016350	8.58	36.24	16.17	1.01
Reach 1	6847.059	MPD	1234.00	2586.00	2594.44	2592.14	2594.67	0.001155	3.58	325.04	77.05	0.29
Reach 1	6847.059	Yucaipa - Prop	311.00	2586.00	2592.31	2590.94	2592.37	0.000650	1.96	164.41	74.28	0.20
Reach 1	6847.059	PF 3	311.00	2586.00	2592.31	2590.94	2592.37	0.000650	1.96	164.41	74.28	0.20
Reach 1	6845		Culvert	True Value Hardware								
Reach 1	6659.734	MPD	1234.00	2580.00	2583.70	2583.70	2584.57	0.010069	8.27	170.83	91.74	0.87
Reach 1	6659.734	Yucaipa - Prop	311.00	2580.00	2582.46	2582.46	2582.94	0.008760	5.69	61.74	74.02	0.76
Reach 1	6659.734	PF 3	311.00	2580.00	2582.46	2582.46	2582.94	0.008760	5.69	61.74	74.02	0.76
Reach 1	6546.732	MPD	1234.00	2576.00	2580.75	2580.75	2581.69	0.008469	8.74	170.29	88.16	0.83
Reach 1	6546.732	Yucaipa - Prop	311.00	2576.00	2578.86	2578.86	2579.62	0.012989	7.09	45.73	32.57	0.92
Reach 1	6546.732	PF 3	311.00	2576.00	2578.86	2578.86	2579.62	0.012989	7.09	45.73	32.57	0.92
Reach 1	6418.787	MPD	1234.00	2568.19	2575.05	2575.05	2576.08	0.008595	8.97	162.57	74.38	0.81
Reach 1	6418.787	Yucaipa - Prop	311.00	2568.19	2572.28	2572.28	2573.38	0.016237	8.40	37.02	17.21	1.01
Reach 1	6418.787	PF 3	311.00	2568.19	2572.28	2572.28	2573.38	0.016237	8.40	37.02	17.21	1.01
Reach 1	6341.041	MPD	1234.00	2566.00	2573.86	2572.50	2574.14	0.001723	4.51	306.38	98.86	0.37
Reach 1	6341.041	Yucaipa - Prop	311.00	2566.00	2571.94	2568.74	2572.05	0.001171	2.65	123.30	73.26	0.28
Reach 1	6341.041	PF 3	311.00	2566.00	2571.94	2568.74	2572.05	0.001171	2.65	123.30	73.26	0.28
Reach 1	6340		Culvert	3rd Street (2- 60" RCP) CMP								

HEC-RAS Plan: 03 River: Chicken Springs Reach: Reach 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	6243.487	MPD	1330.00	2562.00	2568.27	2568.27	2569.91	0.013249	10.28	129.41	40.22	1.01
Reach 1	6243.487	Yucaipa - Prop	1330.00	2562.00	2568.27	2568.27	2569.91	0.013249	10.28	129.41	40.22	1.01
Reach 1	6243.487	PF 3	532.00	2562.00	2566.39	2566.39	2567.48	0.014780	8.36	63.61	29.34	1.00
Reach 1	6089.832	MPD	1330.00	2556.00	2563.23	2563.23	2565.05	0.013216	10.83	122.83	33.99	1.00
Reach 1	6089.832	Yucaipa - Prop	1330.00	2556.00	2563.23	2563.23	2565.05	0.013216	10.83	122.83	33.99	1.00
Reach 1	6089.832	PF 3	532.00	2556.00	2560.94	2560.94	2562.24	0.014811	9.12	58.32	22.59	1.00
Reach 1	5961.347	MPD	1330.00	2554.00	2560.29	2560.29	2561.42	0.009778	8.61	162.04	87.63	0.87
Reach 1	5961.347	Yucaipa - Prop	1330.00	2554.00	2560.29	2560.29	2561.42	0.009778	8.61	162.04	87.63	0.87
Reach 1	5961.347	PF 3	532.00	2554.00	2558.05	2558.05	2559.18	0.014743	8.53	62.36	27.95	1.01
Reach 1	5853.383	MPD	1330.00	2548.00	2554.35	2554.35	2556.11	0.013140	10.64	125.01	35.59	1.00
Reach 1	5853.383	Yucaipa - Prop	1330.00	2548.00	2554.35	2554.35	2556.11	0.013140	10.64	125.01	35.59	1.00
Reach 1	5853.383	PF 3	532.00	2548.00	2551.99	2551.99	2553.29	0.014786	9.13	58.28	22.73	1.00
Reach 1	5724.524	MPD	1330.00	2542.00	2548.88	2548.88	2550.82	0.013266	11.17	119.05	31.17	1.01
Reach 1	5724.524	Yucaipa - Prop	1330.00	2542.00	2548.88	2548.88	2550.82	0.013266	11.17	119.05	31.17	1.01
Reach 1	5724.524	PF 3	532.00	2542.00	2546.55	2546.55	2547.88	0.014840	9.25	57.51	21.99	1.01
Reach 1	5551.322	MPD	1330.00	2540.00	2545.22	2545.22	2546.70	0.010834	9.84	140.58	52.64	0.94
Reach 1	5551.322	Yucaipa - Prop	1330.00	2540.00	2545.22	2545.22	2546.70	0.010834	9.84	140.58	52.64	0.94
Reach 1	5551.322	PF 3	532.00	2540.00	2543.43	2543.43	2544.43	0.014643	8.04	66.19	32.99	1.00
Reach 1	5443.262	MPD	1330.00	2536.00	2541.51	2541.51	2542.87	0.013372	9.33	142.47	52.89	1.00
Reach 1	5443.262	Yucaipa - Prop	1330.00	2536.00	2541.51	2541.51	2542.87	0.013372	9.33	142.47	52.89	1.00
Reach 1	5443.262	PF 3	532.00	2536.00	2539.83	2539.83	2540.78	0.015050	7.81	68.08	35.99	1.00
Reach 1	5286.171	MPD	1330.00	2530.12	2538.37	2535.43	2538.67	0.001229	4.63	326.15	101.82	0.33
Reach 1	5286.171	Yucaipa - Prop	1330.00	2530.12	2538.37	2535.43	2538.67	0.001229	4.63	326.15	101.82	0.33
Reach 1	5286.171	PF 3	532.00	2530.12	2536.85	2533.55	2536.98	0.000660	2.89	200.60	76.18	0.24
Reach 1	5285		Culvert	Poplar Street (2-60" CMP)								
Reach 1	5170.472	MPD	1330.00	2526.00	2531.94	2531.94	2533.73	0.010802	10.87	129.09	42.41	0.92
Reach 1	5170.472	Yucaipa - Prop	1330.00	2526.00	2531.94	2531.94	2533.73	0.010802	10.87	129.09	42.41	0.92
Reach 1	5170.472	PF 3	532.00	2526.00	2529.37	2529.37	2530.77	0.015175	9.52	55.87	20.06	1.01

HEC-RAS Plan: 03 River: Chicken Springs Reach: Reach 1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	5053.620	MPD	1330.00	2522.45	2527.90	2527.90	2528.69	0.008878	8.38	196.64	111.18	0.82
Reach 1	5053.620	Yucaipa - Prop	1330.00	2522.45	2527.90	2527.90	2528.69	0.008878	8.38	196.64	111.18	0.82
Reach 1	5053.620	PF 3	532.00	2522.45	2527.00	2527.00	2527.59	0.008149	6.92	99.85	92.33	0.76
Reach 1	4928.594	MPD	1330.00	2516.00	2523.32	2523.32	2524.55	0.008427	9.29	159.52	63.90	0.82
Reach 1	4928.594	Yucaipa - Prop	1330.00	2516.00	2523.32	2523.32	2524.55	0.008427	9.29	159.52	63.90	0.82
Reach 1	4928.594	PF 3	532.00	2516.00	2520.91	2520.91	2522.18	0.014974	9.05	58.78	23.59	1.01
Reach 1	4641.989	MPD	1330.00	2508.03	2515.11	2515.11	2517.02	0.013234	11.10	119.78	31.84	1.01
Reach 1	4641.989	Yucaipa - Prop	1330.00	2508.03	2515.11	2515.11	2517.02	0.013234	11.10	119.78	31.84	1.01
Reach 1	4641.989	PF 3	532.00	2508.03	2512.93	2512.93	2514.20	0.014718	9.03	58.92	23.38	1.00
Reach 1	4441.567	MPD	1330.00	2506.00	2513.85	2511.30	2514.04	0.000792	3.89	427.38	147.28	0.27
Reach 1	4441.567	Yucaipa - Prop	1330.00	2506.00	2513.85	2511.30	2514.04	0.000792	3.89	427.38	147.28	0.27
Reach 1	4441.567	PF 3	532.00	2506.00	2512.71	2508.90	2512.79	0.000371	2.34	269.23	114.56	0.18
Reach 1	4440		Culvert		4th Street (2-60" CMP)							
Reach 1	4325.308	MPD	1393.00	2494.47	2500.24	2500.24	2501.88	0.012765	10.27	135.63	41.45	1.00
Reach 1	4325.308	Yucaipa - Prop	1393.00	2494.47	2500.24	2500.24	2501.88	0.012765	10.27	135.63	41.45	1.00
Reach 1	4325.308	PF 3	557.20	2494.47	2498.44	2498.44	2499.48	0.014628	8.19	68.06	32.77	1.00
Reach 1	4242.031	MPD	1393.00	2490.82	2498.06	2498.06	2500.17	0.013481	11.66	119.44	28.68	1.01
Reach 1	4242.031	Yucaipa - Prop	1393.00	2490.82	2498.06	2498.06	2500.17	0.013481	11.66	119.44	28.68	1.01
Reach 1	4242.031	PF 3	557.20	2490.82	2495.44	2495.44	2496.91	0.014934	9.73	57.26	19.70	1.01
Reach 1	3696.665	MPD	1393.00	2472.00	2478.52	2478.52	2480.46	0.012926	11.18	124.64	32.23	1.00
Reach 1	3696.665	Yucaipa - Prop	1393.00	2472.00	2478.52	2478.52	2480.46	0.012926	11.18	124.64	32.23	1.00
Reach 1	3696.665	PF 3	557.20	2472.00	2476.17	2476.17	2477.52	0.014669	9.30	59.90	22.61	1.01
Reach 1	3480.638	MPD	1466.00	2466.00	2472.09	2472.09	2474.15	0.013080	11.53	127.18	31.31	1.01
Reach 1	3480.638	Yucaipa - Prop	1466.00	2466.00	2472.09	2472.09	2474.15	0.013080	11.53	127.18	31.31	1.01
Reach 1	3480.638	PF 3	586.40	2466.00	2469.66	2469.66	2471.05	0.014567	9.46	61.98	22.57	1.01
Reach 1	3006.343	MPD	1466.00	2458.95	2467.37	2465.41	2467.69	0.001286	5.03	362.52	121.60	0.35
Reach 1	3006.343	Yucaipa - Prop	1466.00	2458.95	2467.37	2465.41	2467.69	0.001286	5.03	362.52	121.60	0.35
Reach 1	3006.343	PF 3	586.40	2458.95	2465.32	2462.88	2465.55	0.001356	3.99	163.34	69.78	0.34
Reach 1	3005		Culvert		5th Street (2-7'X6' RCB)							

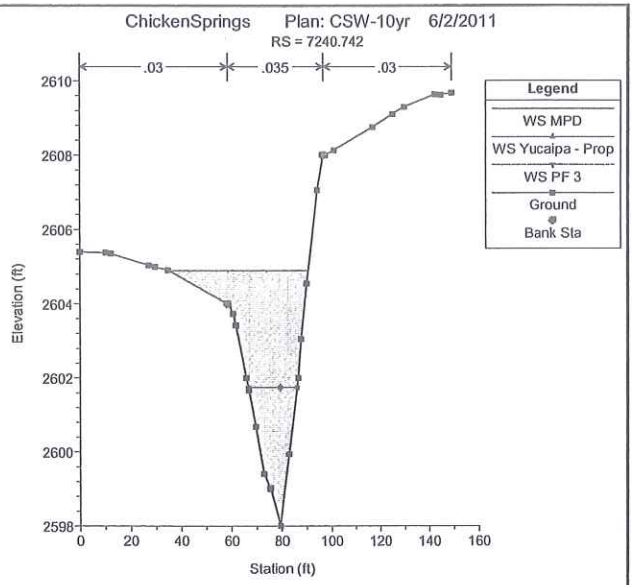
HEC-RAS Plan: 03 River: Chicken Springs Reach: Reach 1 (Continued)

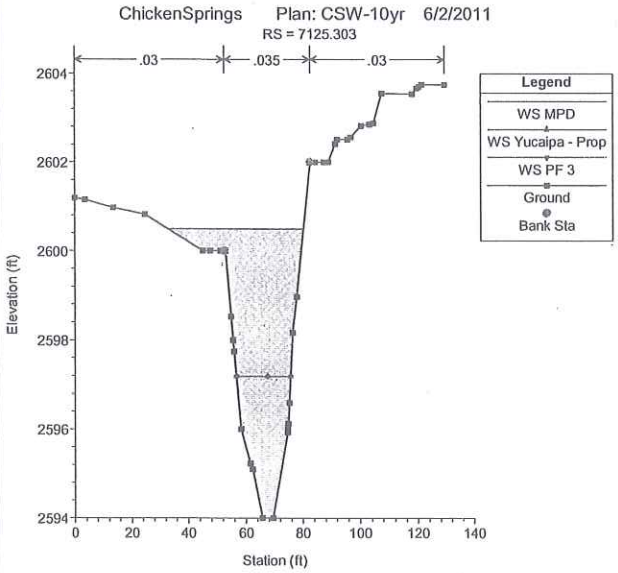
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	2881.291	MPD	1466.00	2443.12	2449.82	2449.82	2451.88	0.012933	11.53	127.12	31.22	1.01
Reach 1	2881.291	Yucaipa - Prop	1466.00	2443.12	2449.82	2449.82	2451.88	0.012933	11.53	127.12	31.22	1.01
Reach 1	2881.291	PF 3	586.40	2443.12	2447.56	2447.56	2448.87	0.014304	9.16	64.00	24.58	1.00
Reach 1	2392.580	MPD	1466.00	2428.00	2434.05	2434.05	2436.29	0.013235	12.00	122.16	27.65	1.01
Reach 1	2392.580	Yucaipa - Prop	1466.00	2428.00	2434.05	2434.05	2436.29	0.013235	12.00	122.16	27.65	1.01
Reach 1	2392.580	PF 3	586.40	2428.00	2431.60	2431.60	2433.01	0.014588	9.55	61.41	21.92	1.01
Reach 1	2197.704	MPD	1466.00	2424.00	2428.61	2428.61	2430.21	0.012753	10.16	144.30	45.19	1.00
Reach 1	2197.704	Yucaipa - Prop	1466.00	2424.00	2428.61	2428.61	2430.21	0.012753	10.16	144.30	45.19	1.00
Reach 1	2197.704	PF 3	586.40	2424.00	2427.20		2427.93	0.009282	6.88	85.27	38.11	0.81
Reach 1	1861.186	MPD	1813.00	2420.00	2425.08	2425.08	2426.12	0.008574	8.87	238.96	115.62	0.84
Reach 1	1861.186	Yucaipa - Prop	1813.00	2420.00	2425.08	2425.08	2426.12	0.008574	8.87	238.96	115.62	0.84
Reach 1	1861.186	PF 3	725.20	2420.00	2423.54	2423.54	2424.46	0.011139	7.75	96.51	64.71	0.90
Reach 1	1597.134	MPD	1813.00	2412.00	2420.09	2417.53	2420.27	0.000679	3.74	556.25	126.20	0.26
Reach 1	1597.134	Yucaipa - Prop	1813.00	2412.00	2420.09	2417.53	2420.27	0.000679	3.74	556.25	126.20	0.26
Reach 1	1597.134	PF 3	725.20	2412.00	2417.89	2416.36	2418.02	0.000843	3.18	278.61	126.20	0.27
Reach 1	1597		Culvert		6th Street (2-10 x 5 RCB)							
Reach 1	1513.128	MPD	1813.00	2406.42	2412.05	2412.05	2413.25	0.007836	9.20	222.40	90.05	0.81
Reach 1	1513.128	Yucaipa - Prop	1813.00	2406.42	2412.05	2412.05	2413.25	0.007836	9.20	222.40	90.05	0.81
Reach 1	1513.128	PF 3	725.20	2406.42	2409.72	2409.72	2410.93	0.014089	8.86	81.89	33.98	1.01
Reach 1	1175.808	MPD	1813.00	2394.00	2400.00	2400.00	2400.87	0.005732	8.00	278.13	157.59	0.70
Reach 1	1175.808	Yucaipa - Prop	1813.00	2394.00	2400.00	2400.00	2400.87	0.005732	8.00	278.13	157.59	0.70
Reach 1	1175.808	PF 3	725.20	2394.00	2397.32	2397.32	2398.54	0.014105	8.87	81.75	33.83	1.01
Reach 1	1087.927	MPD	1813.00	2392.00	2396.86		2397.15	0.003056	4.88	421.94	203.83	0.49
Reach 1	1087.927	Yucaipa - Prop	1813.00	2392.00	2396.86		2397.15	0.003056	4.88	421.94	203.83	0.49
Reach 1	1087.927	PF 3	725.20	2392.00	2395.90		2396.06	0.002194	3.98	239.71	161.00	0.41
Reach 1	957.5858	MPD	1813.00	2392.00	2395.87	2395.87	2396.49	0.007389	7.10	316.74	221.25	0.76
Reach 1	957.5858	Yucaipa - Prop	1813.00	2392.00	2395.87	2395.87	2396.49	0.007389	7.10	316.74	221.25	0.76
Reach 1	957.5858	PF 3	725.20	2392.00	2394.50	2394.50	2395.36	0.015477	7.42	97.67	212.39	1.01

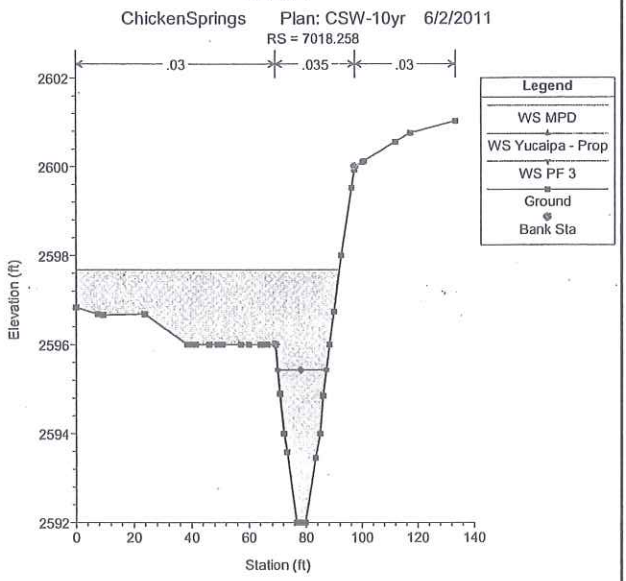
HEC-RAS Plan: 03 River: Chicken Springs Reach: Reach 1 (Continued)

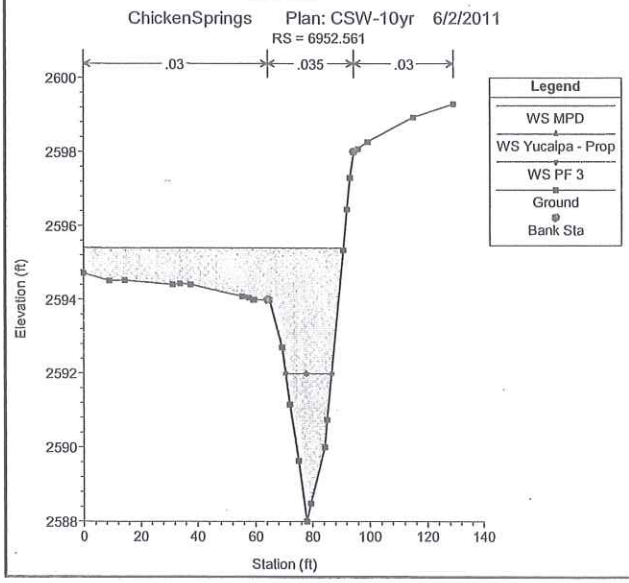
Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach 1	899.6325	MPD	1813.00	2388.00	2390.82	2390.82	2391.59	0.012309	7.44	262.07	166.80	0.93
Reach 1	899.6325	Yucaipa - Prop	1813.00	2388.00	2390.82	2390.82	2391.59	0.012309	7.44	262.07	166.80	0.93
Reach 1	899.6325	PF 3	725.20	2388.00	2390.08	2390.08	2390.54	0.011429	5.63	143.01	155.58	0.84
Reach 1	897.6325	MPD	1813.00	2383.70	2389.38	2389.38	2390.78	0.013552	9.49	190.96	70.02	1.01
Reach 1	897.6325	Yucaipa - Prop	1813.00	2383.70	2389.38	2389.38	2390.78	0.013552	9.49	190.96	70.02	1.01
Reach 1	897.6325	PF 3	725.20	2383.70	2387.00	2387.00	2388.22	0.014230	8.85	81.90	34.05	1.01
Reach 1	867	MPD	1813.00	2382.80	2388.48	2388.48	2389.88	0.013568	9.50	190.86	69.85	1.01
Reach 1	867	Yucaipa - Prop	1813.00	2382.80	2388.48	2388.48	2389.88	0.013568	9.50	190.86	69.85	1.01
Reach 1	867	PF 3	725.20	2382.80	2386.10	2386.10	2387.32	0.014230	8.85	81.90	34.05	1.01
Reach 1	865	MPD	1813.00	2380.20	2385.91	2385.91	2387.28	0.013290	9.42	192.60	72.83	1.00
Reach 1	865	Yucaipa - Prop	1813.00	2380.20	2385.91	2385.91	2387.28	0.013290	9.42	192.60	72.83	1.00
Reach 1	865	PF 3	725.20	2380.20	2383.50	2383.50	2384.72	0.014230	8.85	81.90	34.05	1.01
Reach 1	811.3269	MPD	1813.00	2378.63	2382.65	2382.65	2384.36	0.012617	10.49	172.81	51.06	1.01
Reach 1	811.3269	Yucaipa - Prop	1813.00	2378.63	2382.65	2382.65	2384.36	0.012617	10.49	172.81	51.06	1.01
Reach 1	811.3269	PF 3	725.20	2378.63	2380.89	2380.89	2381.91	0.014716	8.12	89.30	44.04	1.00
Reach 1	617.3793	MPD	1813.00	2373.01	2380.22		2380.40	0.000966	3.55	555.14	190.30	0.33
Reach 1	617.3793	Yucaipa - Prop	1813.00	2373.01	2380.22		2380.40	0.000966	3.55	555.14	190.30	0.33
Reach 1	617.3793	PF 3	725.20	2373.01	2377.98		2378.11	0.000820	2.93	247.89	64.81	0.26
Reach 1	381.3339	MPD	2163.00	2371.22	2379.98	2375.52	2380.21	0.000650	3.98	593.44	272.80	0.26
Reach 1	381.3339	Yucaipa - Prop	2163.00	2371.22	2379.98	2375.52	2380.21	0.000650	3.98	593.44	272.80	0.26
Reach 1	381.3339	PF 3	865.20	2371.22	2377.89	2373.69	2377.98	0.000362	2.37	365.70	211.12	0.18
Reach 1	380		Culvert	7th Street (2-10 x 5 RCB)								
Reach 1	62.18623	MPD	2163.00	2358.00	2365.02	2365.02	2367.33	0.012280	12.20	177.23	38.11	1.00
Reach 1	62.18623	Yucaipa - Prop	2163.00	2358.00	2365.02	2365.02	2367.33	0.012280	12.20	177.23	38.11	1.00
Reach 1	62.18623	PF 3	865.20	2358.00	2362.08	2362.08	2363.68	0.013649	10.13	85.42	26.80	1.00
Reach 1	5.168259	MPD	2163.00	2352.00	2357.29	2357.29	2358.66	0.011764	9.67	230.74	85.79	0.93
Reach 1	5.168259	Yucaipa - Prop	2163.00	2352.00	2357.29	2357.29	2358.66	0.011764	9.67	230.74	85.79	0.93
Reach 1	5.168259	PF 3	865.20	2352.00	2355.66	2355.66	2356.59	0.013122	8.27	112.15	61.07	0.94

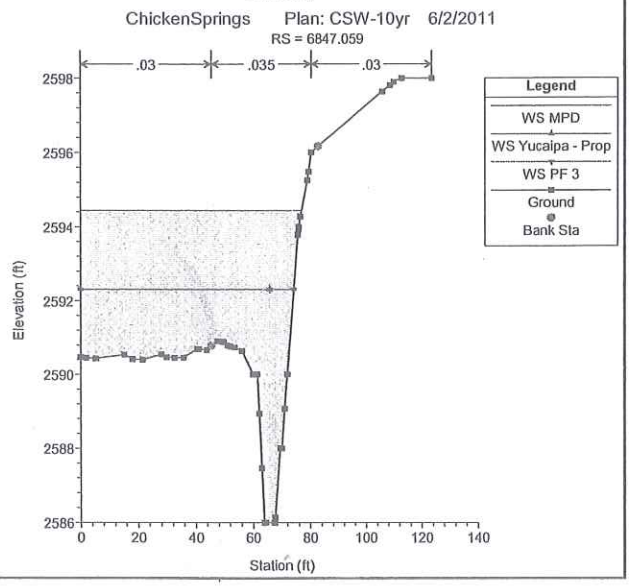
No Data for Plot

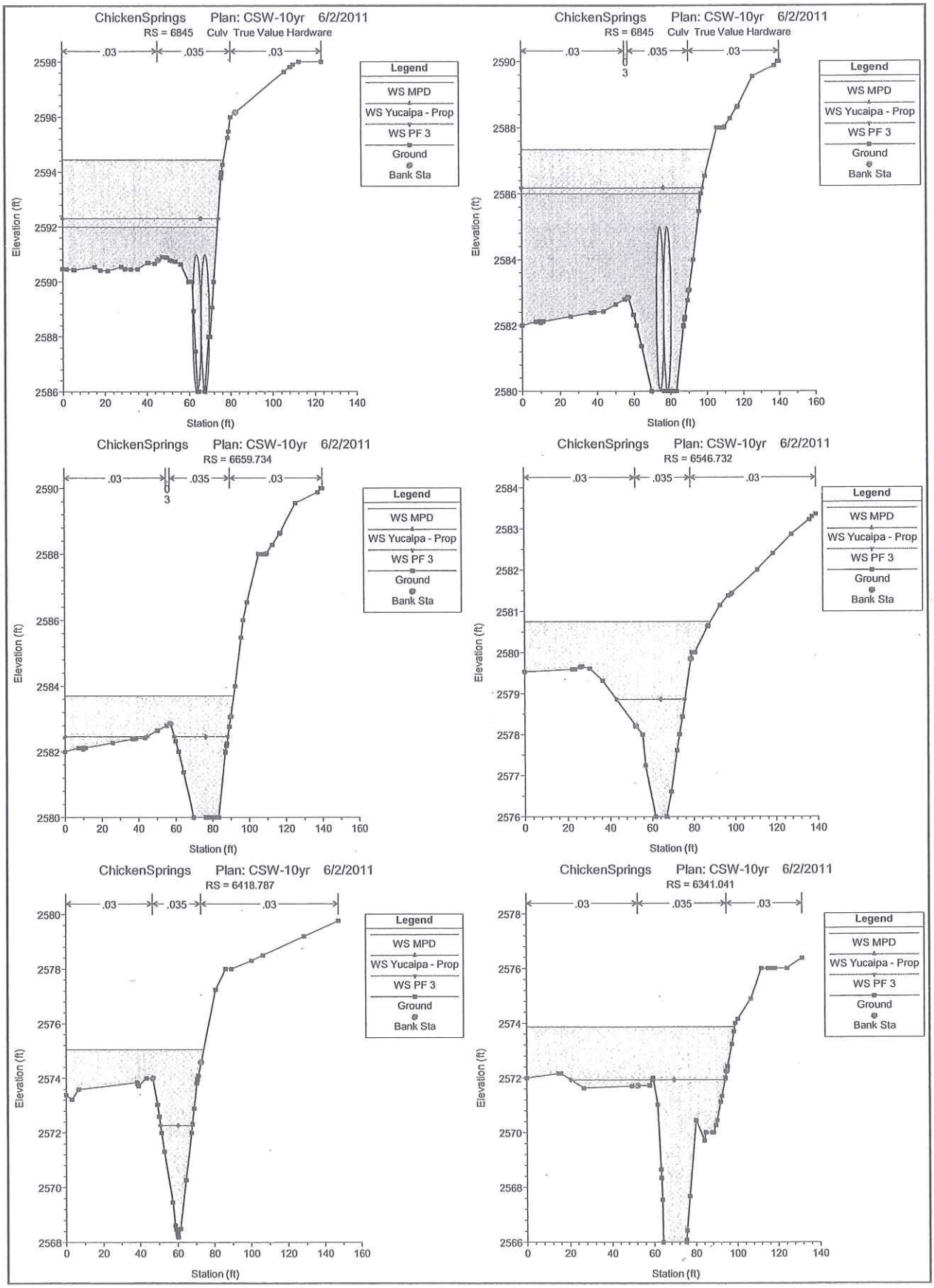








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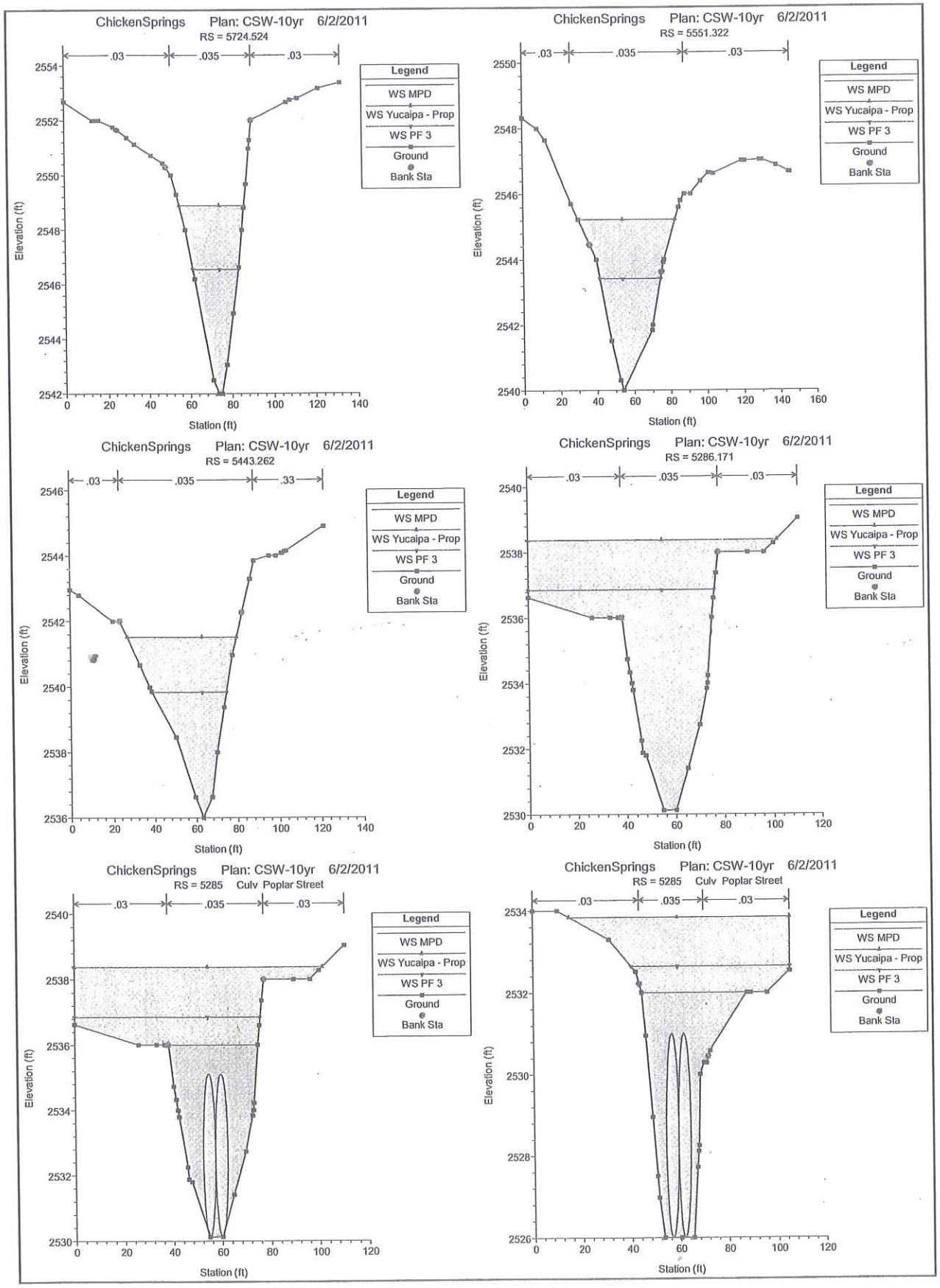
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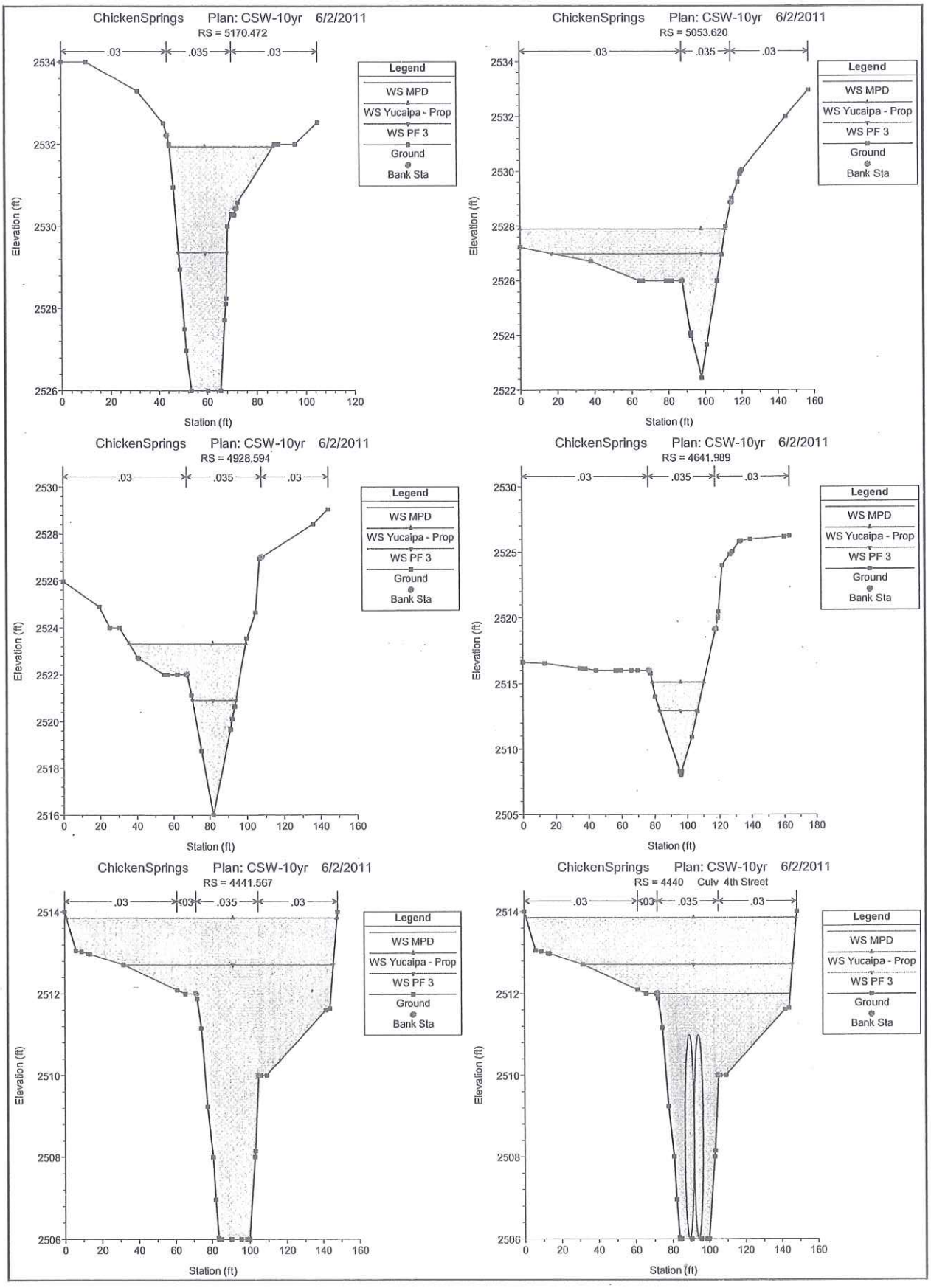
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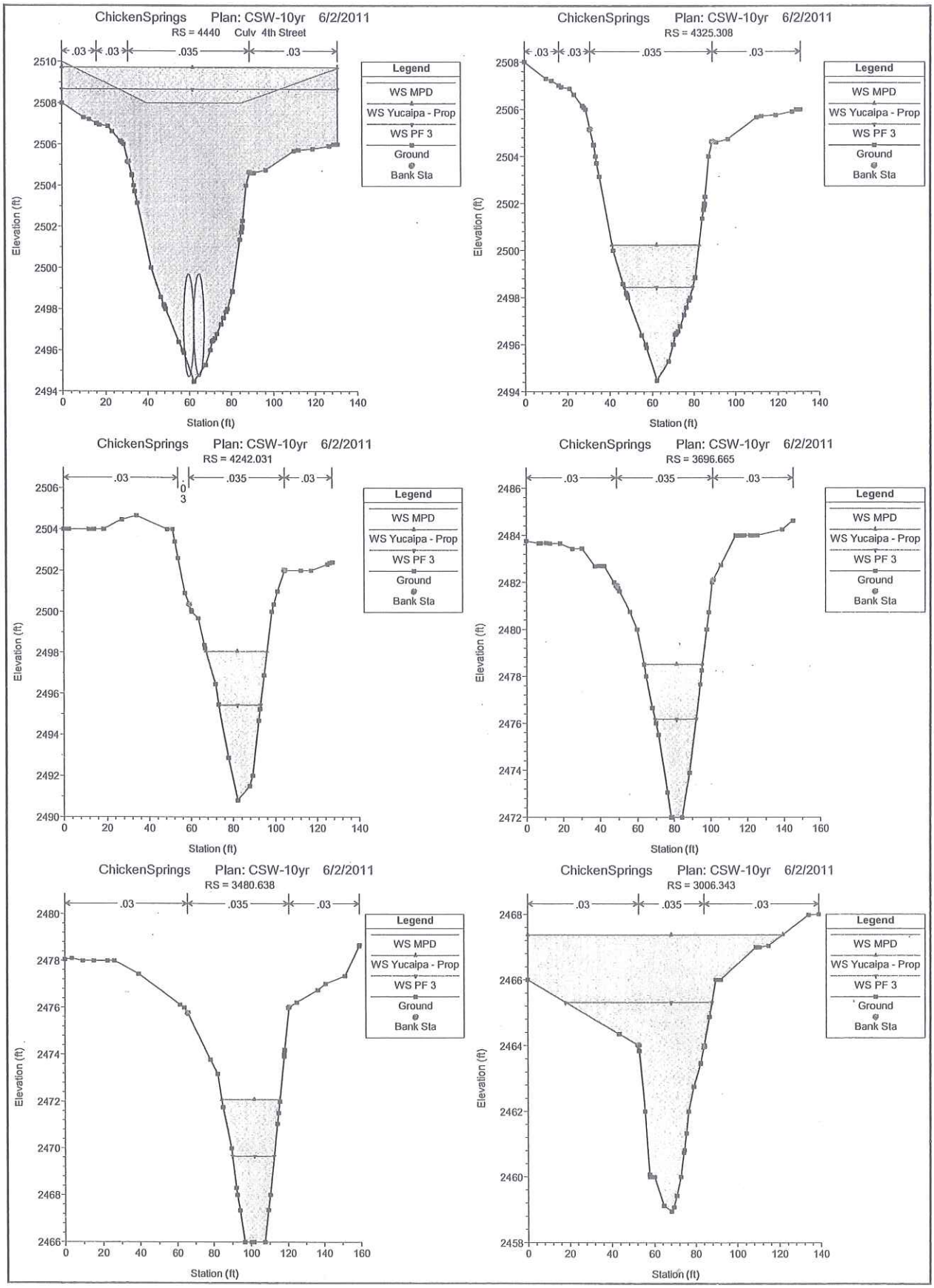
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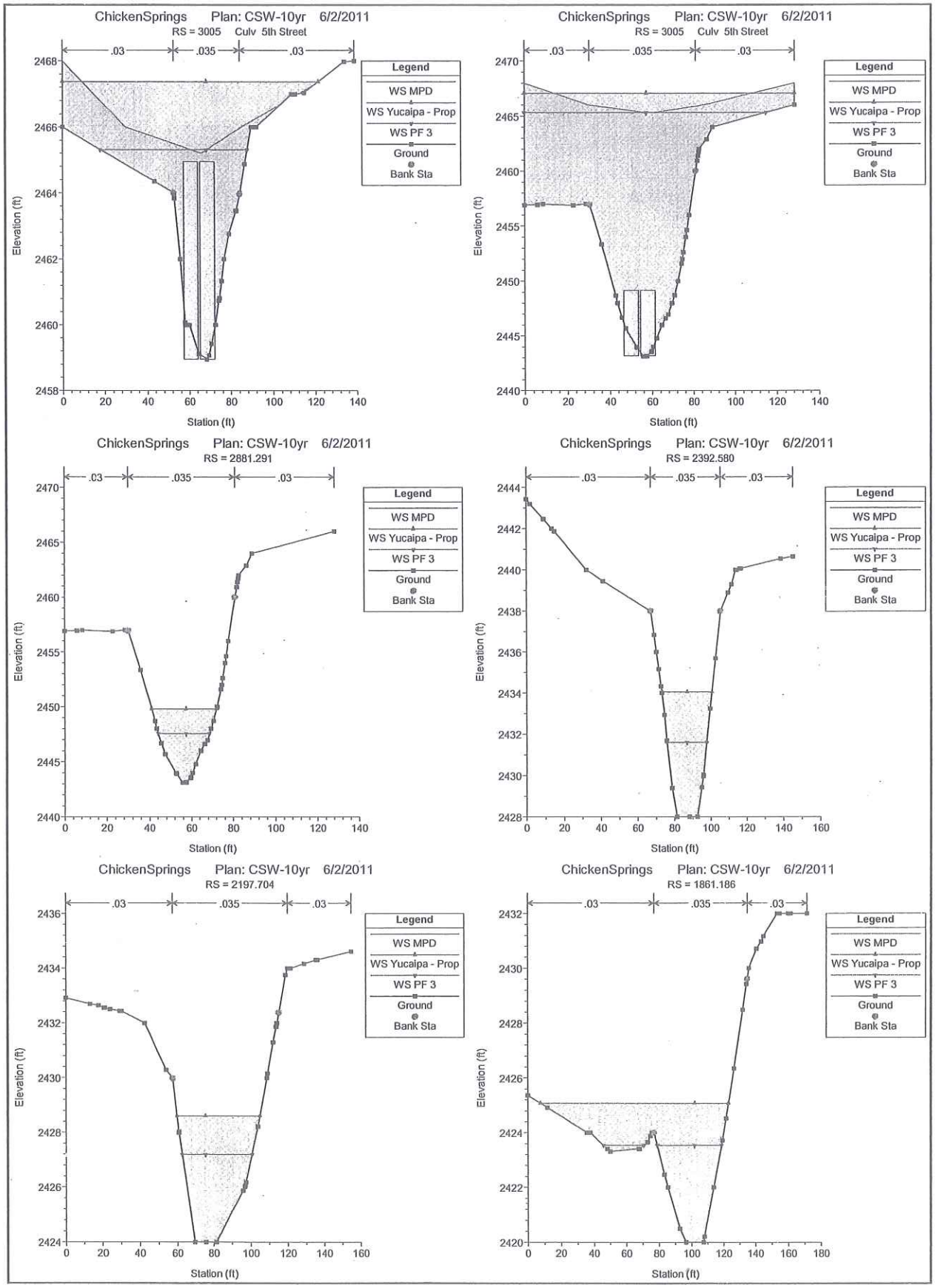
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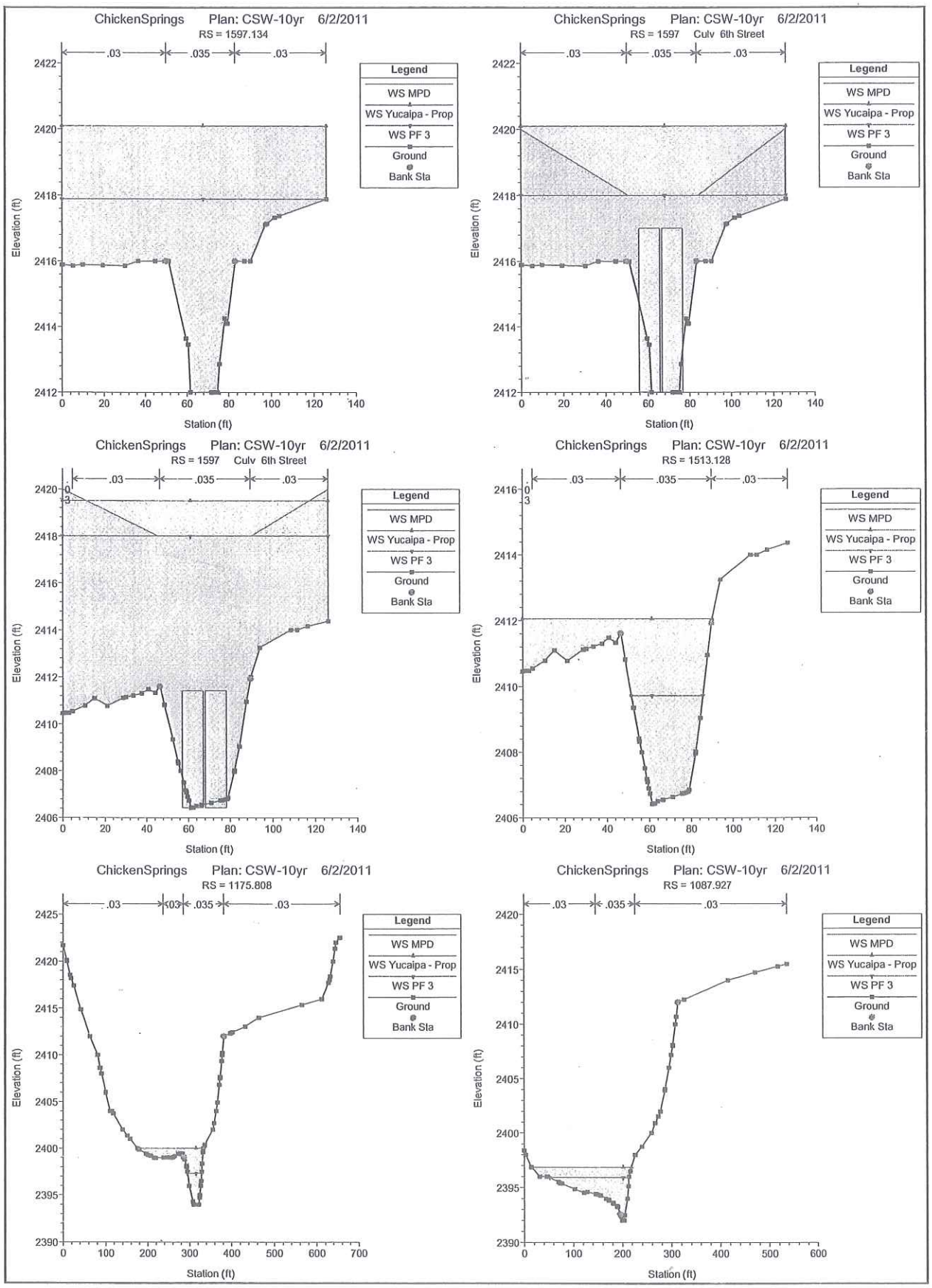
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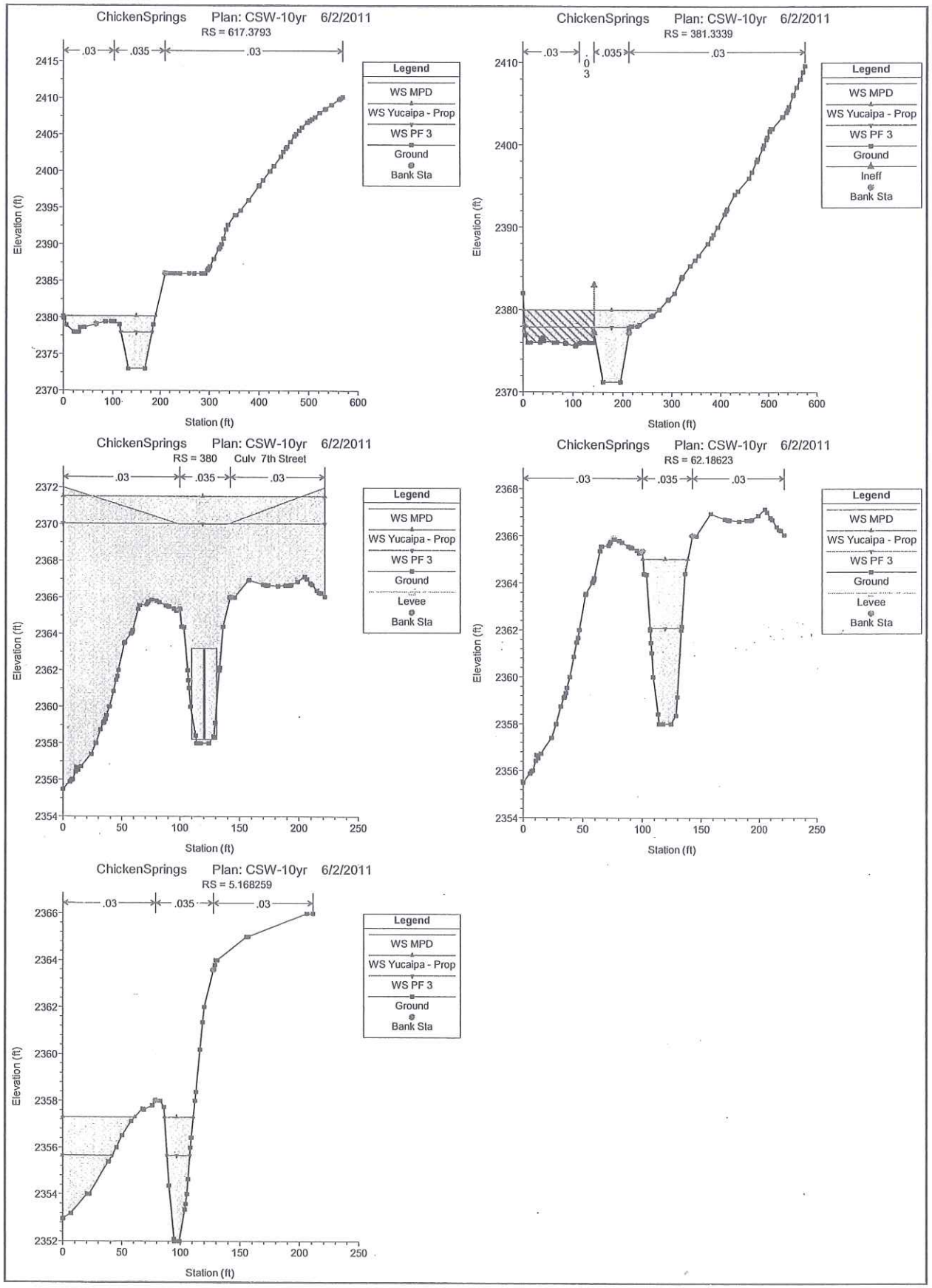
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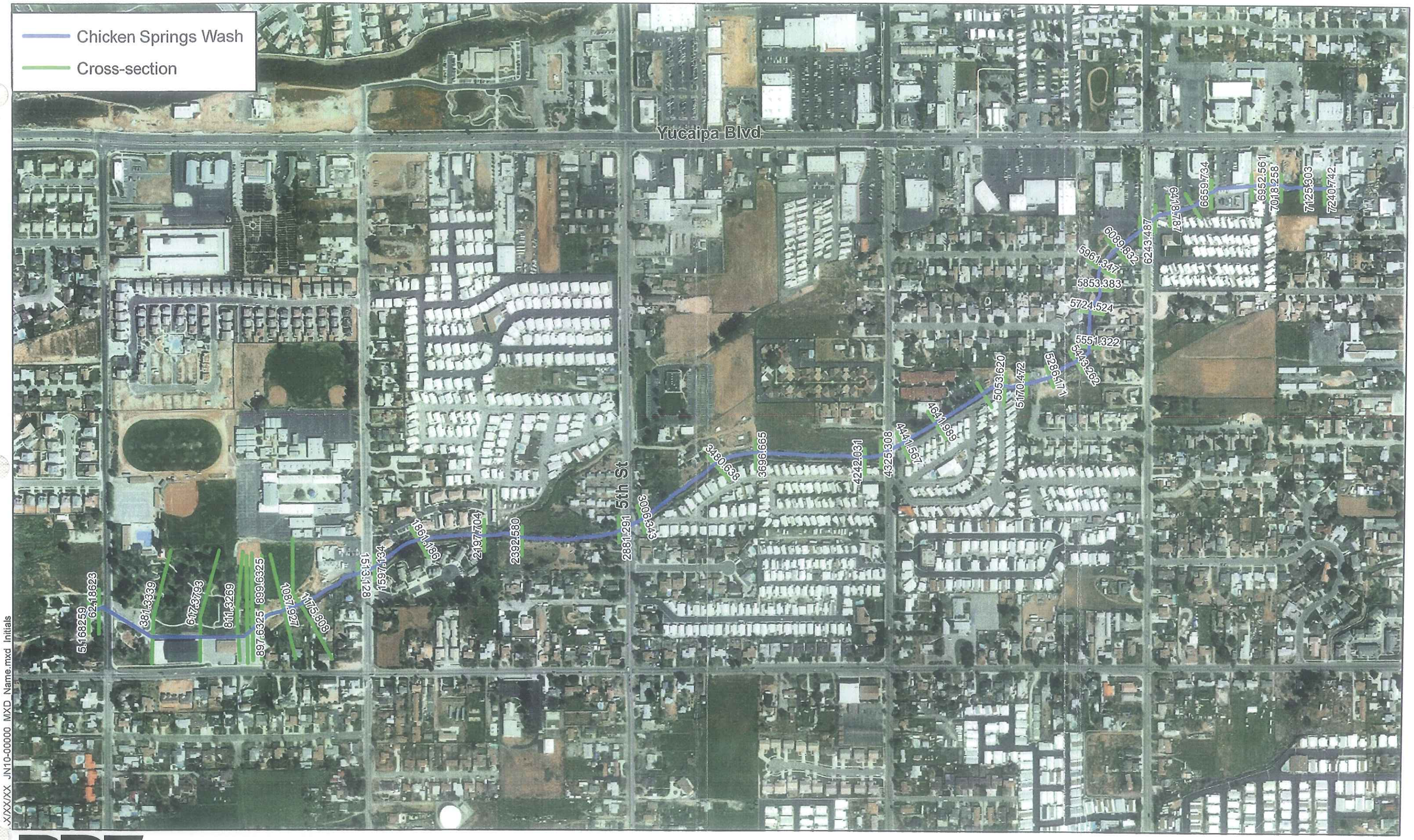

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Source:

CITY OF YUCAIPA

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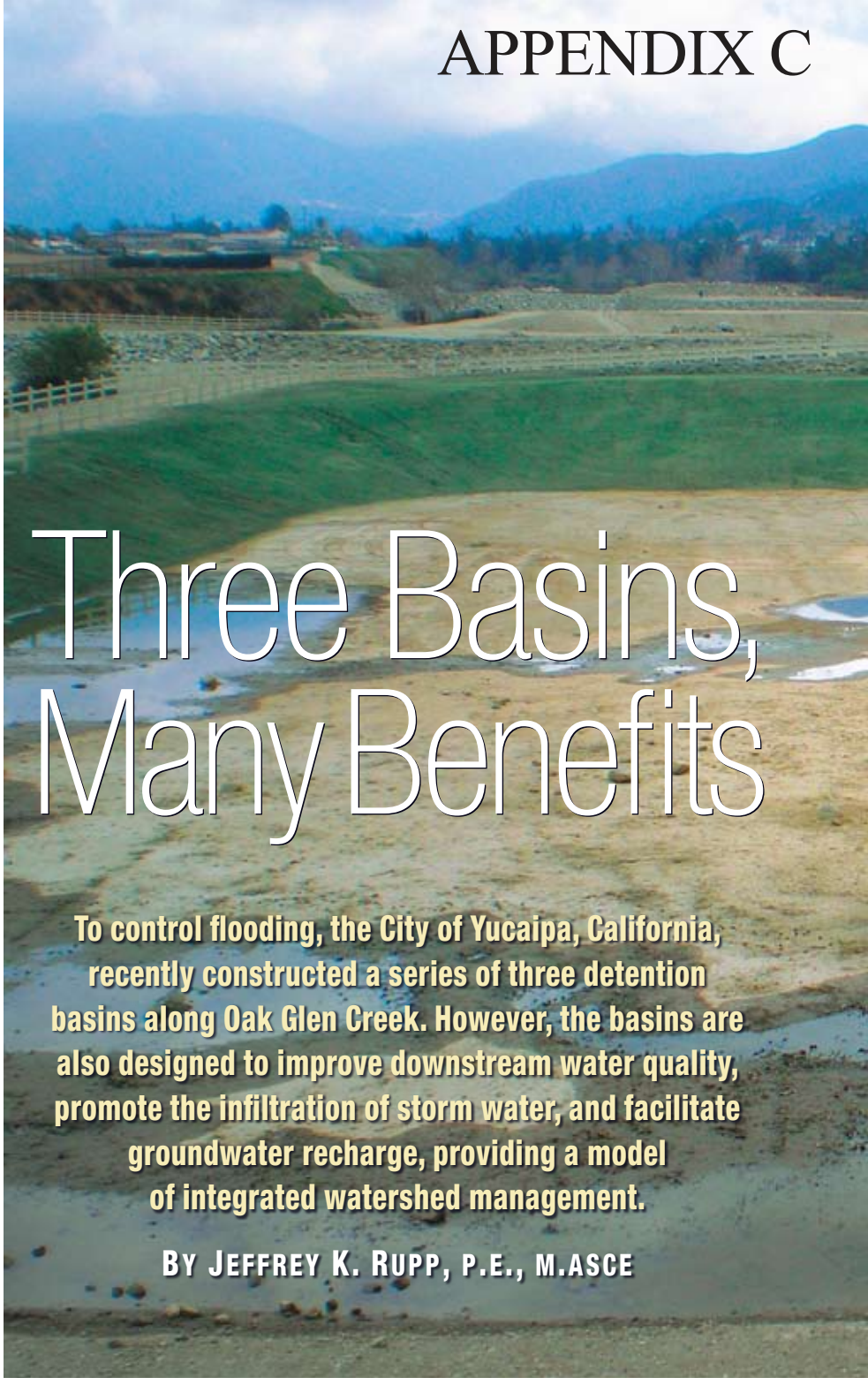


Three Basins, Many Benefits

To control flooding, the City of Yucaipa, California, recently constructed a series of three detention basins along Oak Glen Creek. However, the basins are also designed to improve downstream water quality, promote the infiltration of storm water, and facilitate groundwater recharge, providing a model of integrated watershed management.

BY JEFFREY K. RUPP, P.E., M.ASCE

CALIFORNIA is in the grip of a water crisis. The state, like the rest of the southwestern United States, has had to cope with numerous challenges in recent years, including a nearly decade-long drought on the Colorado River, snowpacks that are below normal, and court-mandated reductions in the amount of water available for delivery by the State Water Project, the massive system of reservoirs, aqueducts, pipelines, and pumping stations that conveys water to 29 water suppliers throughout California. Meanwhile, such factors as climate change, population growth, and the increasing instability of the water supplies in the delta formed by the confluence of the Sacramento and San Joaquin rivers threaten to exacerbate the crisis.

To help address these problems, civil engineers and others involved in the field of water resources must evaluate individual water projects to determine how they might affect the larger watersheds to which they belong. In other words, an integrated approach to watershed management is needed. Placing more concrete and building larger conveyance systems will not solve the problems. Instead, growth and development should be guided by what are referred to as the Ahwahnee principles, a set of guidelines to help foster sustainable and livable communities that was developed in 1991 by a group of architects brought together by the Local Government Commission, a Sacramento-based nonprofit organization that assists local governments in creating healthy, pedestrian-friendly communities that use resources efficiently and judiciously. With respect to water resources, the Ahwahnee principles encourage practices that promote water conservation, groundwater recharge, low-impact development, flood protection, and improvements in water quality.

A project that will soon be completed by the City of Yucaipa, California, was developed with these principles in mind. The undertaking is being carried out in partnership with the San Bernardino County Flood Control District, of San Bernardino, California; the Yucaipa Valley Water District, of Yucaipa; the Inland Empire Resource Conservation District, of Redlands, California; California's State Water Resources Control Board; and the U.S. Environmental Protection Agency. A model of integrated watershed management, the Oak Glen Creek Detention Basins Project aims to control flooding, improve water quality, promote the infiltration of storm water, recharge groundwater supplies, create wildlife habitat, and educate the public about the water cycle and ways to improve the environment. If California is to begin tackling its water crisis, it will need more projects like Yucaipa's.

Yucaipa is nestled in the foothills of the San Bernardino

0885-7024-/09-0005-0074/$25.00 PER ARTICLE

JOHN LAROSE, CONSTRUCTION ENGINEER, CITY OF YUCAIPA

Located just to the east of Bryant Street, the 45 acre-ft (55,500 m³) basin 1 uses the roadway as its levee.

Mountains in Southern California. The valley in which it is located is bounded by the San Bernardino National Forest to the north and east, by low-lying hills to the south, and by the Crafton Hills to the northwest. The valley opens to the west into a canyon leading to the city of Redlands. The foothills that surround the valley range in elevation from about 2,200 ft (670 m) above mean sea level in the west to more than 8,300 ft (2,530 m) above mean sea level in the east.

Yucaipa encompasses approximately 27.75 sq mi (72 km²), or 17,763 acres (7,189 ha), of the valley just south of the San Bernardino Mountains. It is bounded by the city of Calimesa, in Riverside County, to the south, by the city of Redlands to the west, by unincorporated lands to the northwest and east in San Bernardino County, and by the San Bernardino National Forest to the north. According to California's Department of Finance, the population of Yucaipa grew by 27 percent between 1990 and 2000—from 32,400 to 41,207. In 2005 the city's population was estimated to be 49,388.

Yucaipa consists mainly of residential developments, and the city's housing stock comprises 18,290 units. Residential developments include mobile home parks, older single-family homes on narrow lots, multifamily residences, residences on large lots, and new residential tract developments. The city's commercial and industrial establishments are mainly concentrated in strip developments along major roadways.

Once a rural community, Yucaipa has experienced rapid development, and city officials now attach great importance to flood control. In February 1969 Yucaipa saw extensive flooding that caused millions of dollars' worth of property damage. In recent years it has experienced damage to its streets, parks, and private property.

Research has shown that the world is probably experiencing climate change. Average temperatures during the past 30 years have increased by approximately 1°F (0.56°C). This rise in temperature has caused the snowpack in the Sierra Nevada to melt earlier, and this heavier runoff in spring can mean that less surface water and groundwater is available in the summer.

The U.S. Department of Homeland Security's Federal Emergency Management Agency has prepared flood insurance rate maps for most areas within Yucaipa. The maps issued in 1996 indicated that an area of the city encompassing more than 1,450 acres (587 ha) was located within a 100-year floodplain, and since then Yucaipa has grown. Although new development is not allowed within the floodplain unless improvements are made to mitigate flood hazards, older developments along local waterways are exposed to such hazards. Built before the efforts to map floodplains, these developments include residences

Continued growth and development in Yucaipa mean that the expanse of pervious areas is diminishing, increasing the potential for flooding.

on large lots, an elementary school, and scattered commercial establishments.

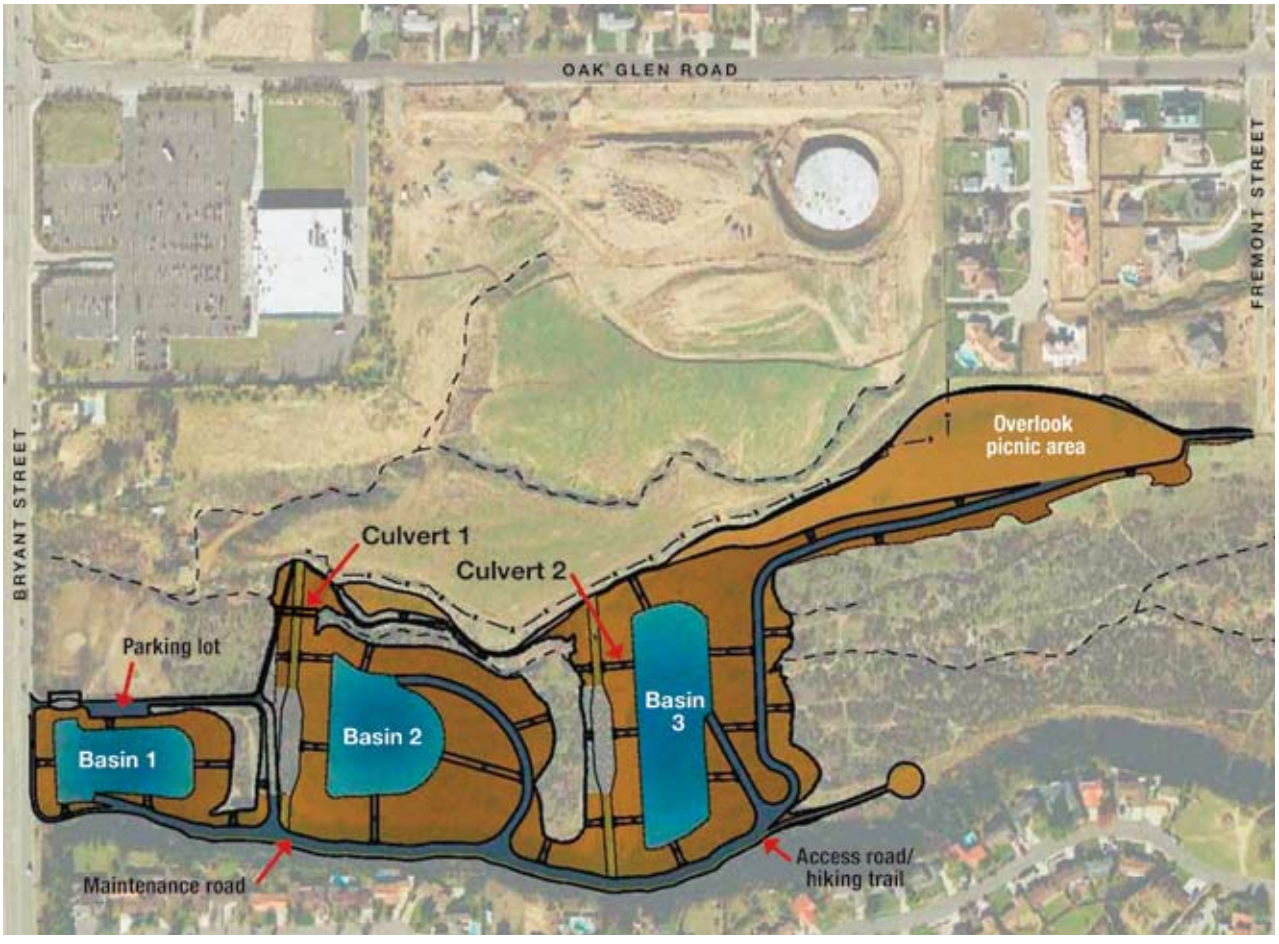
Continued growth and development in Yucaipa mean that the expanse of pervious areas is diminishing, increasing the potential for flooding. Such flooding primarily occurs along Wilson Creek, which runs through the center of town. Yucaipa decided it needed to implement additional measures, in particular, regional drainage facilities, to protect itself from flooding.

A tributary of Wilson Creek, Oak Glen Creek is a natural channel that drains a watershed of approximately 4,450 acres (1,800 ha). It enters Wilson Creek before the latter traverses the center of the city, flowing for the most part from northeast to southwest. The waterway then joins San Timoteo Creek, itself a tributary to the Santa Ana River. The areas along Oak Glen Creek consist primarily of natural foothill terrain with low-lying sagebrush ground cover. Within Yucaipa, Oak Glen Creek passes beneath Bryant Street, a four-lane arterial highway, by means of a 10 by 10 ft (3 by 3 m) reinforced-concrete box culvert. However, Bryant Street acts as a barrier during large storm events, forcing Oak Glen Creek to back up east of the road. During larger storms, the Bryant Street embankment may be overtopped, aggravating downstream flooding.

In 1993 Yucaipa completed and adopted a master drainage plan that specified approximately $90 million worth of improvements to its storm-water facilities. The plan included several spillover detention and desilting basins that would provide short-term and long-term flood protection and remove silt and debris from creeks in the city. The watersheds of Oak Glen Creek and Wilson Creek were viewed as forming a primary system for conveying storm water in Yucaipa to San Timoteo Creek.

In 2003 the city proceeded with the conceptual design phase for the detention and desilting basins for Oak Glen Creek and Wilson Creek. David Evans and Associates, Inc., which has its headquarters in Portland, Oregon, helped Yucaipa develop the concept. In 2006 the city hired the firm to design the basins, conduct environmental planning, obtain the necessary permits, and carry out the landscape architecture for the project. Although the primary purpose of the Oak Glen Creek Detention Basins Project was to control flooding and protect downstream areas of the city, the design team soon realized that many other goals and objectives could be achieved as well.

PLAN VIEW OF PROJECT



DAVID EVANS AND ASSOCIATES, INC.

APPENDIX D -3-

Ultimately, the project was designed to accomplish the following primary goals:

1) Reduce flooding along Oak Glen Creek downstream of Bryant Street;

2) Collect debris and sediment in basins to improve water quality downstream and reduce the potential for flooding caused by clogged storm drains and culverts;

3) Provide groundwater recharge not only by allowing storm water to infiltrate into the ground rather than flow wastefully downstream but also by facilitating active recharge efforts through the infiltration of nonpotable water;

4) Provide open space and habitat for wildlife and native plants;

5) Provide opportunities to educate the public about the water cycle and the importance of water conservation and groundwater recharge.

The 11 by 11 ft (3.4 by 3.4 m) box culvert in basin 3 was designed to return flows to the main channel, helping to reduce high flows and minimize overtopping of levees.

JEFF RUPP

The design team evaluated various concepts and design features for the project, all of which attempted to minimize the disturbance to the natural channel while conferring flood control benefits. As part of this process, some of the initial concepts and configurations, which called for five separate basins, were reevaluated and refined until a layout for the Oak Glen Creek basins was selected. The preferred alternative featured a series of three interconnected basins east of Bryant Street, each having approximately 45 to 49 acre-ft (55,500 to 60,400 m³) of storage capacity. By creating a series of engineered detention basins, the project was designed to detain peak storm flows and reduce the risk of downstream flooding.

In evaluating the various concepts, the project team first prepared a hydrologic analysis to determine the Oak Glen Creek flow hydrographs and peak flows for the 2-, 5-, 10-, 25-, and 100-year storm events. (Known as clear-water hydrographs, the measurements did not include a bulking factor to account for the likelihood of debris entering the runoff as a result of fires in the nearby mountains.) The hydrographs were developed using CivilCadd and CivilDesign, software for respectively site design and hydraulic modeling developed by CivilDesign Corporation, a subsidiary of the civil engineering firm Joseph E. Bonadiman and Associates, Inc., of San Bernardino, California. The accompanying table summarizes the peak discharges for the analyzed storm events (assuming a 24-hour storm duration that results in the highest peaks). The clear-water hydrographs were then used to develop inflow hydrographs that included bulking factors in the unsteady hydraulic model.

A qualitative assessment of sediment yield was performed for the Oak Glen Creek watershed. Of the many methods available to estimate sediment production, some give average annual sediment yield, while others provide estimates of sediment yield for a given storm hydrograph. On the recommendation of the San Bernardino County Flood Control District, the project team decided to use the method for estimating sediment yield developed by the U.S. Army Corps of Engineers' district headquartered in Los Angeles. The Corps developed this approach to estimate unit debris yield values for the design and analysis of debris-catching structures in Southern California watersheds.

The San Bernardino County Flood Control District will operate and maintain the basin facilities once they are completed, while the city will oversee other joint aspects of the site, including multipurpose trails, educational signage, and landscaped areas. During the design process, the district requested that the potential sediment yield for the Oak Glen Creek watershed be estimated for two flooding scenarios: a 100-year flood occurring four years after a fire and a 10-year flood occurring one year after a fire. The second scenario yielded the highest design sediment load, 460 acre-ft (567,400 m³). Unfortunately, the proposed project could not feasibly provide enough basins to capture this design yield. Therefore, a bulking factor needed to be considered in the design. A factor of 1.33 increased the 100-year clear peak of 7,038 cfs (199 m³/s) to a bulked 100-year peak flow of 9,374 cfs (265 m³/s).

The Hydrologic Engineering Center's River Analysis System (HEC-RAS), also developed by the Corps, was used to construct an unsteady hydraulic model for the series of

Peak Discharges for Analyzed Storm Events

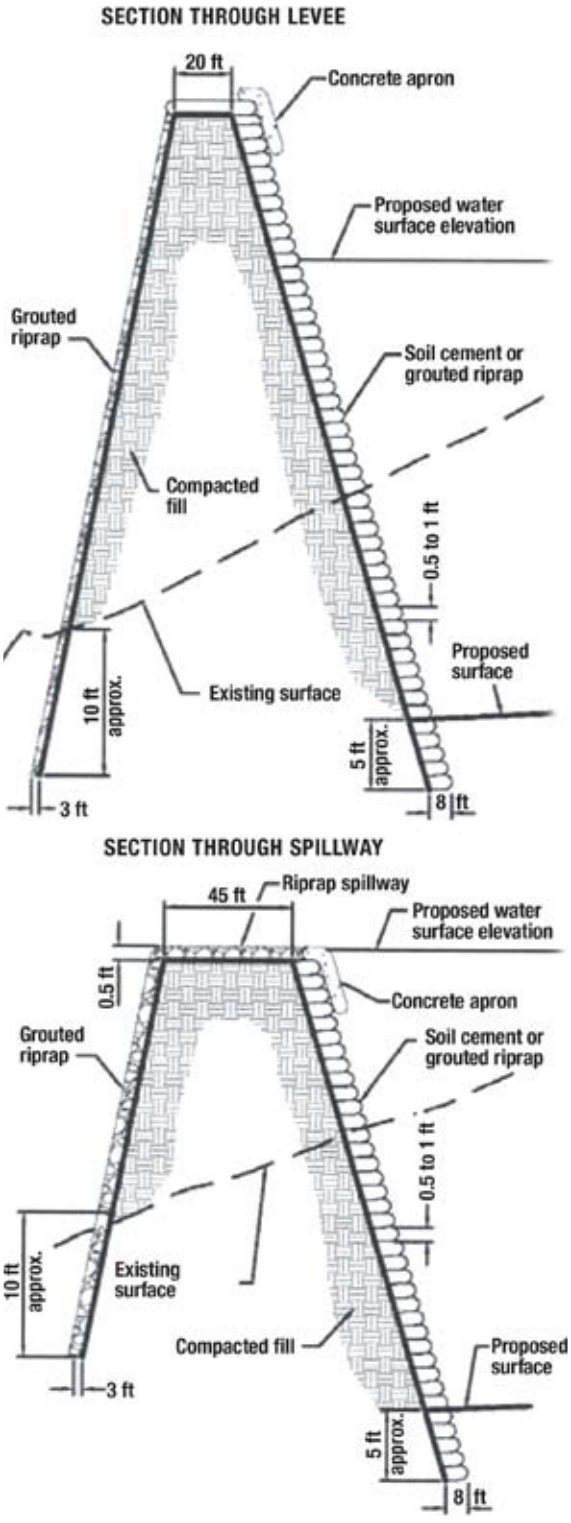
Event	2-year	5-year	10-year	25-year	100-year
Peak flows	2,825 cfs (80 m³/s)	3,817 cfs (108 m³/s)	4,564 cfs (129 m³/s)	5,549 cfs (157 m³/s)	7,038 cfs (199 m³/s)

detention basins along Oak Glen Creek. The study reach extended 3,000 ft (914 m) upstream, or east, of Bryant Street (to Fremont Street) and 300 ft (91 m) downstream of Bryant Street. The hydraulic analysis was performed to optimize the type and size of the culverts to be located in the main channel between the basins. The design intent was to reduce high flows and minimize the overtopping of levees.

Nine alternatives were investigated, and the results were compared and summarized. The selected alternative featured three basins connected by 36 in. (900 mm) diameter storm drains having control valves, along with two 11 by 11 ft (3.4 by 3.4 m) box culverts to convey overflows past the basins and under Bryant Street. This option would provide relatively high flow reduction (19 percent for the 100-year storm and 12 percent for the 25-year storm event), the lowest velocities within culverts 1 and 2 between the basins, minimum water surface elevations in basins 2 and 3, and the least amount of scour downstream of the spillways. (See the figure on page 76.)

An initial study was prepared to define the potential adverse environmental effects from the proposed Oak Glen Creek detention basins. The effort included the following biological studies and surveys: habitat assessment and analysis of environmental factors; delineation of waters subject to the jurisdiction of the Clean Water Act; surveys of the least Bell's vireo, southwestern willow flycatcher, and yellow-billed cuckoo; a trapping survey of the San Bernardino kangaroo rat; and surveys of burrowing owls and other endangered species. Archaeological and paleontological survey reports also were prepared. On the basis of the findings of the initial study, a document referred to as a mitigated negative declaration, which detailed the mitigation and monitoring measures to be implemented as part of the project, was prepared in accordance with the California Environmental Quality Act.

The David Evans and Associates team of civil engineers, environmental planners, and landscape architects designed a series of three basins varying in size from 45 to 50 acre-ft (55,500 to 61,675 m³) to contain peak storm-water flows and reduce flooding downstream within Oak Glen Creek and Wilson Creek. The basins would be created by the construction of levees at two locations along the creek channel, while Bryant Street would be modified to serve as the levee for the third basin. Overlook and rest areas would be provided, and defined hiking trails would be designated to replace existing informal trails. The team designed the project to preserve some existing oak trees at the site, while areas that were graded or otherwise disturbed were subsequently planted with native materials.



Basins 1, 2, and 3 are numbered according to their locations along Oak Glen Creek, which flows westward, basin 1 being farthest downstream, at Bryant Street, and basin 3 being farthest upstream. Basin 3 has been designed to capture storm-water sediment and debris from Oak Glen Creek, improving water quality downstream and decreasing the likelihood of clogging in downstream storm drain pipes and culverts. This desilting basin has the capacity to store approximately 47 acre-ft (57,970 m³) of silt and water. Flows entering the basin will pass over waterfalls constructed at its eastern edge. The waterfalls include decorative boulders and native plantings along the slope. Placed in the path of the original creek, the waterfalls will also recreate the existing creek alignment as flows enter the basin.

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DAVID EVANS AND ASSOCIATES, INC.

APPENDIX D -5-

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Located south of the creek, basin 2 has a storage volume of approximately 45 acre-ft (55,500 m^3). As with the desilting basin, the levee for this detention basin was constructed at the western end and is approximately 24 ft (7.3 m) high, a spillway being located at the southern section of the levee. Spanning the entire basin, the levee is approximately 20 ft (6.1 m) wide, although the spillway is roughly 45 ft (13.7 m) wide and about 5 ft (1.5 m) lower than the top of the levee. As with the first levee, the upstream bank of the second levee is covered with soil-cement and has a concrete anchor at the eastern edge. Concrete was used on the top of the levee and on the upstream bank of the spillway, while riprap was provided on the downstream bank of the levee.

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Bryant Street is approximately 15 to 20 ft (4.6 to 6.1 m) higher than the bottom of basin 1. To prevent erosion of Bryant Street during heavy rains, the eastern edge of the roadway was fortified with a concrete cutoff wall that includes a concrete apron near the top to prevent floodwaters from undermining the asphalt pavement. A smaller spillway located at the northwestern corner of this basin enables high flows to exit the basin and move north toward Oak Glen Creek. A 36 in. (900 mm) diameter pipe installed just west of the spillway directs low flows from the basin north toward the creek.

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Because the flow of runoff can be controlled between the basins by means of the drains equipped with control valves, the basins can also be used for groundwater storage. For example, the drains may be closed during smaller storm events, enabling storm water to collect in the basins and percolate into the ground. As it happens, the Yucaipa Valley Water Distinct, which provides services related to water, wastewater, and reclaimed water to customers in the valley in which Yucaipa is located, recently completed a water filtration plant with water storage tanks just north of the detention basins. This proximity afforded an opportunity for the district to use the basins at certain times to percolate water into the groundwater basin for later use.

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JEFF RUPP

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construction of a 42 in. (1,050 mm) diameter pipeline from the district's facilities to the basin located farthest upstream. In addition to a mix of groundwater and surface water supplies, the district obtains water from a California Department of Water Resources pipeline that connects directly to the filtration plant. During dry periods, the district may choose to purchase low-cost nonpotable water when it is available and store it belowground by means of infiltration through the detention basins. The district would then be able to withdraw the water later from its wells.

For operation and maintenance purposes, access roads are provided around and into all of the basins. The roads extend into the bottoms of each of the basins so that sediment and debris can be removed from the basin bottoms and other maintenance activities can be carried out. Near the spillways, the access road is concrete pavement. Elsewhere, however, it is of natural material compacted to 90 percent. The road, which complies with the requirements of the Americans with Disabilities Act, also serves as a hiking trail that constitutes an important segment of the trail system outlined in the city's master plan, a segment that links a state park to the rest of the community trails. Split-rail-type fencing has been placed around all of the basins, and a 10-space paved parking lot has been provided off Bryant Street for those using the trails.

Also at the site are designated trails from the entry point at Bryant Street that connect to an overlook and rest area. Located on the northeastern portion of the project site, this area is approximately 30 ft (9.1 m) above the creek. Serving as a rest stop for hikers, equestrian enthusiasts, and bicyclists, the area includes trees, shrubs, benches, decorative boulders, and an information kiosk. In the event that debris must be removed from the basins after a storm, maintenance crews will temporarily store the material in the eastern section of this area.

The site includes two other rest areas—one at the southeastern section, the other at the northwestern section. The southeastern rest area includes equestrian hitching posts and informational signs. The northwestern picnic area includes decorative boulders and informational signs. Trees, shrubs, and other native and drought-tolerant plants have been planted at the overlook and rest areas along the northern perimeter of the site and along the eastern slope of the first basin. The slopes of the basins will be revegetated with a mix of native and drought-tolerant plants, the seeds of which will be mixed with water and fertilizer and spread by means of a sprayer. The use of native materials is expected to help minimize maintenance requirements and increase wildlife habitat.

Educational signs are located strategically along the site paths. The signs will convey

Located the farthest upstream of the three basins, basin 3 has been designed to capture stormwater sediment and debris from Oak Glen Creek, improving water quality downstream and decreasing the likelihood of clogging within the downstream storm drain pipes and culverts.

Oak Glen Creek drains a watershed of approximately 4,450 acres (1,800 ha). Though dry condtions make it hard to believe, the creek has contributed to flooding in Yucaipa, California.

JEFF RUPP, BOTH

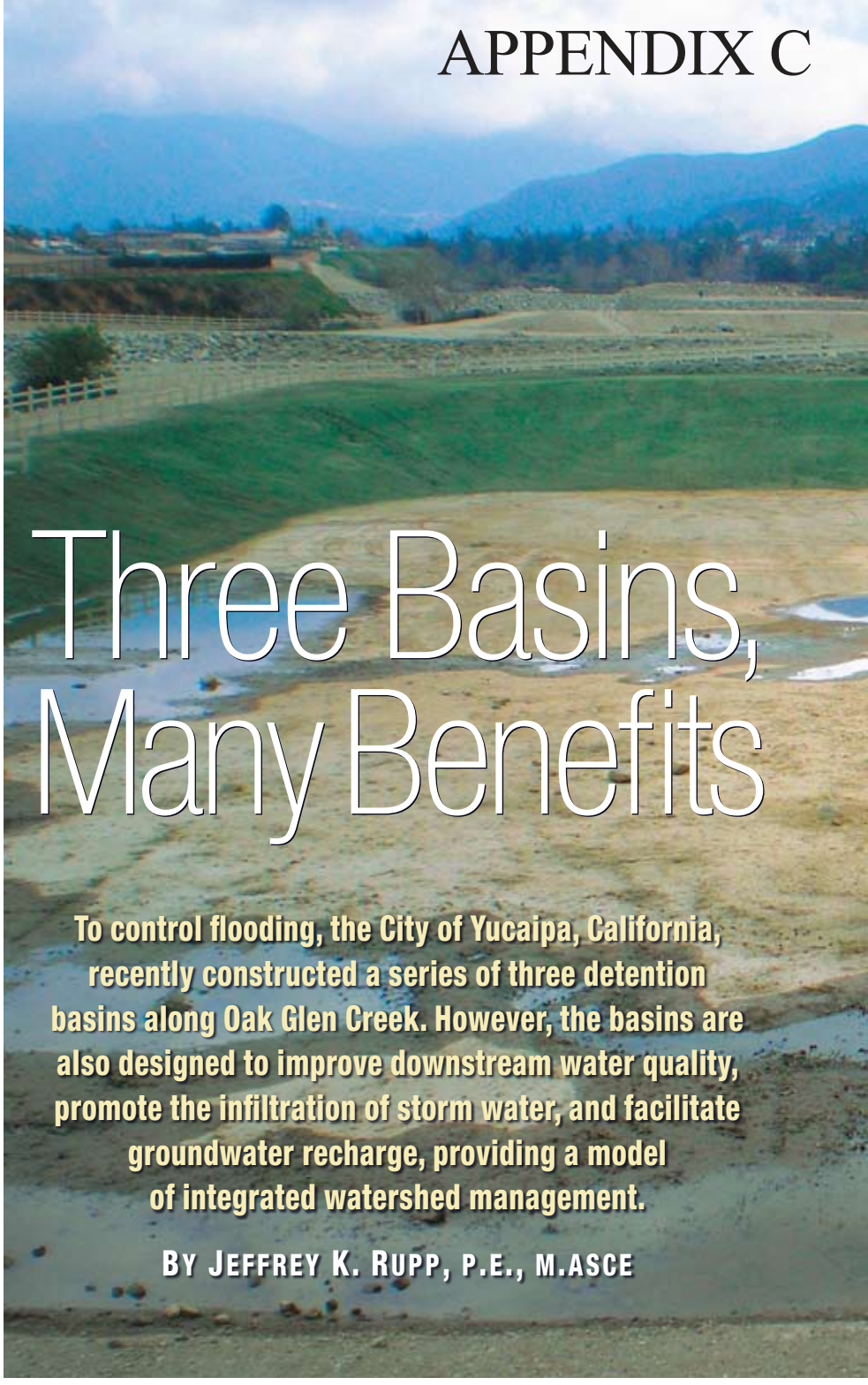
information to the public about aspects of the water cycle within the context of the site itself and in the broader watershed. As people travel along the paths, a story will unfold before them and they will also learn about jurisdictional waters, watersheds, the hydrologic cycle, flooding, natural processes, groundwater recharge, sediment transport, desilting basins, ecosystems, and local flora and fauna. The signs are arranged hierarchically, the primary signs detailing the "Journey of Water" and the secondary ones providing the supporting information. Educational kiosks also provide information on the water cycle, helping people understand the importance of water and how they can conserve and recycle it.

Construction of the $6.1-million project began in June 2008. KEC Engineering, of Corona, California, constructed the basins. Construction proceeded smoothly, and this component of the project was completed in March 2009, as planned. During basin construction, much larger quantities of rock and boulders were encountered than had been anticipated. Fortunately, nearly all of the rock could be incorporated into the project, obviating the need to haul in rock from outside sources. The grading operation involved moving more than 200,000 cu yd (153,000 m^3) of material, including boulders that weighed as much as 50 tons (45 metric tons). The overall project is expected to be completed next month.

The Oak Glen Creek Detention Basins Project embodies an integrated approach to watershed management. By capturing storm water and facilitating groundwater infiltration, it reduces downstream flooding, improves water quality, recharges the groundwater supply, and provides open space for wildlife and plant life. Public access to the facility affords opportunities to educate visitors on the importance of the water cycle and the need to set aside open space for drainage facilities in lieu of more concrete channels. **CE**

Jeffrey K. Rupp, P.E., M.ASCE, is a vice president in the Ontario, California, office of David Evans and Associates, Inc., which has its headquarters in Portland, Oregon. This article is adapted from a paper delivered at the World Environmental and Water Resources Congress 2008, which was sponsored by ASCE and its Environmental and Water Resources Institute and held in Honolulu.

PROJECT CREDITS Owner: City of Yucaipa, California **Designer:** David Evans and Associates, Inc., Portland, Oregon **Contractor:** KEC Engineering, Corona, California **Construction management:** Vali Cooper and Associates, Inc., Richmond, California **Geotechnical engineering:** Converse Consultants, Monrovia, California **Biological assessment:** L and L Environmental, Inc., Corona, California **Sediment transport analysis:** West Consultants, Inc., San Diego **Financial contributors:** San Bernardino County Flood Control District, San Bernardino, California; Yucaipa Valley Water District, Yucaipa, California; Inland Empire Resource Conservation District, Redlands, California; California State Water Resources Control Board; and the U.S. Environmental Protection Agency



Three Basins, Many Benefits

To control flooding, the City of Yucaipa, California, recently constructed a series of three detention basins along Oak Glen Creek. However, the basins are also designed to improve downstream water quality, promote the infiltration of storm water, and facilitate groundwater recharge, providing a model of integrated watershed management.

BY JEFFREY K. RUPP, P.E., M.ASCE

CALIFORNIA is in the grip of a water crisis. The state, like the rest of the southwestern United States, has had to cope with numerous challenges in recent years, including a nearly decade-long drought on the Colorado River, snowpacks that are below normal, and court-mandated reductions in the amount of water available for delivery by the State Water Project, the massive system of reservoirs, aqueducts, pipelines, and pumping stations that conveys water to 29 water suppliers throughout California. Meanwhile, such factors as climate change, population growth, and the increasing instability of the water supplies in the delta formed by the confluence of the Sacramento and San Joaquin rivers threaten to exacerbate the crisis.

To help address these problems, civil engineers and others involved in the field of water resources must evaluate individual water projects to determine how they might affect the larger watersheds to which they belong. In other words, an integrated approach to watershed management is needed. Placing more concrete and building larger conveyance systems will not solve the problems. Instead, growth and development should be guided by what are referred to as the Ahwahnee principles, a set of guidelines to help foster sustainable and livable communities that was developed in 1991 by a group of architects brought together by the Local Government Commission, a Sacramento-based nonprofit organization that assists local governments in creating healthy, pedestrian-friendly communities that use resources efficiently and judiciously. With respect to water resources, the Ahwahnee principles encourage practices that promote water conservation, groundwater recharge, low-impact development, flood protection, and improvements in water quality.

A project that will soon be completed by the City of Yucaipa, California, was developed with these principles in mind. The undertaking is being carried out in partnership with the San Bernardino County Flood Control District, of San Bernardino, California; the Yucaipa Valley Water District, of Yucaipa; the Inland Empire Resource Conservation District, of Redlands, California; California's State Water Resources Control Board; and the U.S. Environmental Protection Agency. A model of integrated watershed management, the Oak Glen Creek Detention Basins Project aims to control flooding, improve water quality, promote the infiltration of storm water, recharge groundwater supplies, create wildlife habitat, and educate the public about the water cycle and ways to improve the environment. If California is to begin tackling its water crisis, it will need more projects like Yucaipa's.

Yucaipa is nestled in the foothills of the San Bernardino

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JOHN LAROSE, CONSTRUCTION ENGINEER, CITY OF YUCAIPA

Located just to the east of Bryant Street, the 45 acre-ft (55,500 m³) basin 1 uses the roadway as its levee.

Mountains in Southern California. The valley in which it is located is bounded by the San Bernardino National Forest to the north and east, by low-lying hills to the south, and by the Crafton Hills to the northwest. The valley opens to the west into a canyon leading to the city of Redlands. The foothills that surround the valley range in elevation from about 2,200 ft (670 m) above mean sea level in the west to more than 8,300 ft (2,530 m) above mean sea level in the east.

Yucaipa encompasses approximately 27.75 sq mi (72 km²), or 17,763 acres (7,189 ha), of the valley just south of the San Bernardino Mountains. It is bounded by the city of Calimesa, in Riverside County, to the south, by the city of Redlands to the west, by unincorporated lands to the northwest and east in San Bernardino County, and by the San Bernardino National Forest to the north. According to California's Department of Finance, the population of Yucaipa grew by 27 percent between 1990 and 2000—from 32,400 to 41,207. In 2005 the city's population was estimated to be 49,388.

Yucaipa consists mainly of residential developments, and the city's housing stock comprises 18,290 units. Residential developments include mobile home parks, older single-family homes on narrow lots, multifamily residences, residences on large lots, and new residential tract developments. The city's commercial and industrial establishments are mainly concentrated in strip developments along major roadways.

Once a rural community, Yucaipa has experienced rapid development, and city officials now attach great importance to flood control. In February 1969 Yucaipa saw extensive flooding that caused millions of dollars' worth of property damage. In recent years it has experienced damage to its streets, parks, and private property.

Research has shown that the world is probably experiencing climate change. Average temperatures during the past 30 years have increased by approximately 1°F (0.56°C). This rise in temperature has caused the snowpack in the Sierra Nevada to melt earlier, and this heavier runoff in spring can mean that less surface water and groundwater is available in the summer.

The U.S. Department of Homeland Security's Federal Emergency Management Agency has prepared flood insurance rate maps for most areas within Yucaipa. The maps issued in 1996 indicated that an area of the city encompassing more than 1,450 acres (587 ha) was located within a 100-year floodplain, and since then Yucaipa has grown. Although new development is not allowed within the floodplain unless improvements are made to mitigate flood hazards, older developments along local waterways are exposed to such hazards. Built before the efforts to map floodplains, these developments include residences

Continued growth and development in Yucaipa mean that the expanse of pervious areas is diminishing, increasing the potential for flooding.

on large lots, an elementary school, and scattered commercial establishments.

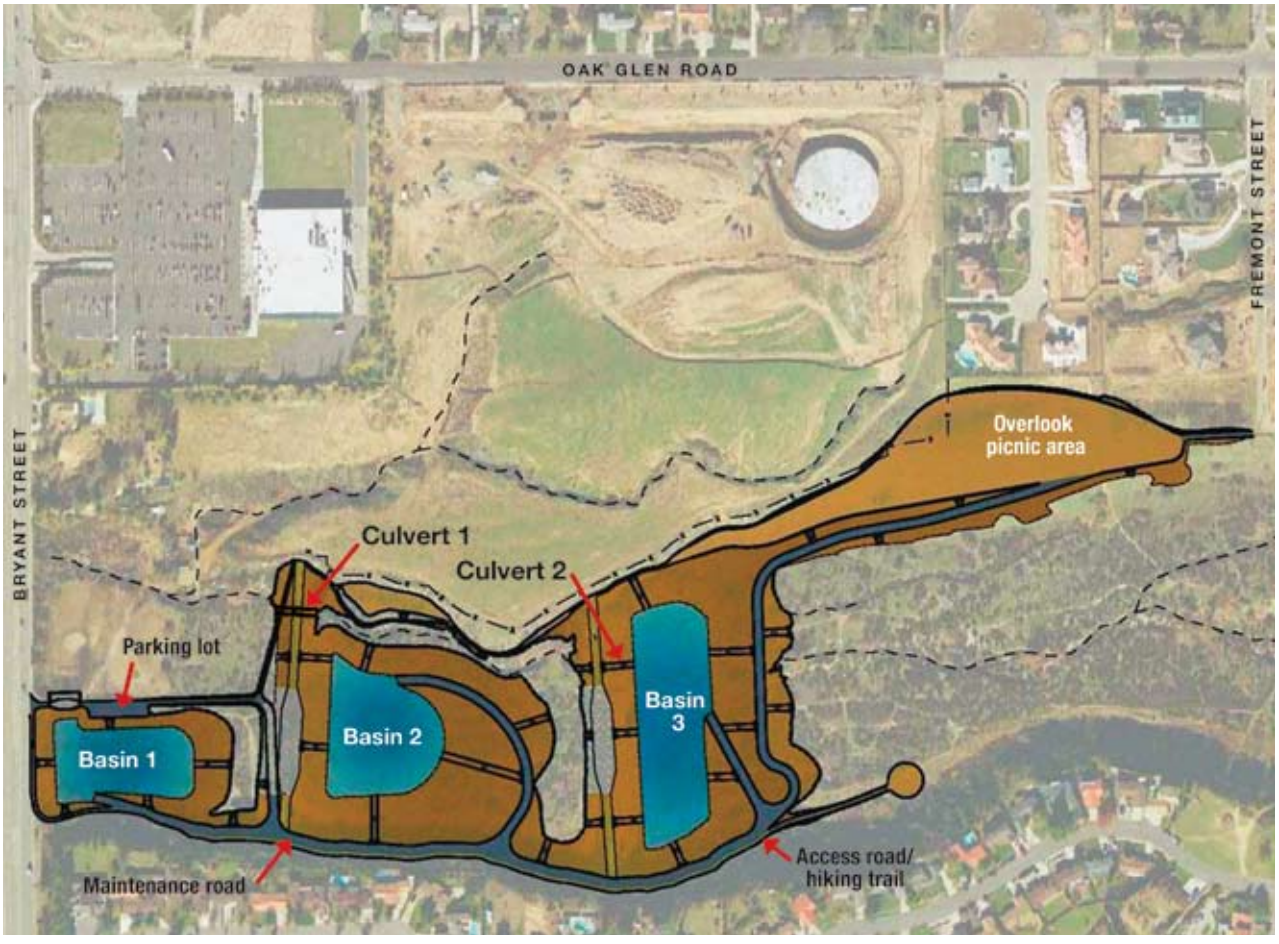
Continued growth and development in Yucaipa mean that the expanse of pervious areas is diminishing, increasing the potential for flooding. Such flooding primarily occurs along Wilson Creek, which runs through the center of town. Yucaipa decided it needed to implement additional measures, in particular, regional drainage facilities, to protect itself from flooding.

A tributary of Wilson Creek, Oak Glen Creek is a natural channel that drains a watershed of approximately 4,450 acres (1,800 ha). It enters Wilson Creek before the latter traverses the center of the city, flowing for the most part from northeast to southwest. The waterway then joins San Timoteo Creek, itself a tributary to the Santa Ana River. The areas along Oak Glen Creek consist primarily of natural foothill terrain with low-lying sagebrush ground cover. Within Yucaipa, Oak Glen Creek passes beneath Bryant Street, a four-lane arterial highway, by means of a 10 by 10 ft (3 by 3 m) reinforced-concrete box culvert. However, Bryant Street acts as a barrier during large storm events, forcing Oak Glen Creek to back up east of the road. During larger storms, the Bryant Street embankment may be overtopped, aggravating downstream flooding.

In 1993 Yucaipa completed and adopted a master drainage plan that specified approximately $90 million worth of improvements to its storm-water facilities. The plan included several spillover detention and desilting basins that would provide short-term and long-term flood protection and remove silt and debris from creeks in the city. The watersheds of Oak Glen Creek and Wilson Creek were viewed as forming a primary system for conveying storm water in Yucaipa to San Timoteo Creek.

In 2003 the city proceeded with the conceptual design phase for the detention and desilting basins for Oak Glen Creek and Wilson Creek. David Evans and Associates, Inc., which has its headquarters in Portland, Oregon, helped Yucaipa develop the concept. In 2006 the city hired the firm to design the basins, conduct environmental planning, obtain the necessary permits, and carry out the landscape architecture for the project. Although the primary purpose of the Oak Glen Creek Detention Basins Project was to control flooding and protect downstream areas of the city, the design team soon realized that many other goals and objectives could be achieved as well.

PLAN VIEW OF PROJECT



DAVID EVANS AND ASSOCIATES, INC.

APPENDIX D -3-

Ultimately, the project was designed to accomplish the following primary goals:

1) Reduce flooding along Oak Glen Creek downstream of Bryant Street;

2) Collect debris and sediment in basins to improve water quality downstream and reduce the potential for flooding caused by clogged storm drains and culverts;

3) Provide groundwater recharge not only by allowing storm water to infiltrate into the ground rather than flow wastefully downstream but also by facilitating active recharge efforts through the infiltration of nonpotable water;

4) Provide open space and habitat for wildlife and native plants;

5) Provide opportunities to educate the public about the water cycle and the importance of water conservation and groundwater recharge.

The 11 by 11 ft (3.4 by 3.4 m) box culvert in basin 3 was designed to return flows to the main channel, helping to reduce high flows and minimize overtopping of levees.

JEFF RUPP

The design team evaluated various concepts and design features for the project, all of which attempted to minimize the disturbance to the natural channel while conferring flood control benefits. As part of this process, some of the initial concepts and configurations, which called for five separate basins, were reevaluated and refined until a layout for the Oak Glen Creek basins was selected. The preferred alternative featured a series of three interconnected basins east of Bryant Street, each having approximately 45 to 49 acre-ft (55,500 to 60,400 m³) of storage capacity. By creating a series of engineered detention basins, the project was designed to detain peak storm flows and reduce the risk of downstream flooding.

In evaluating the various concepts, the project team first prepared a hydrologic analysis to determine the Oak Glen Creek flow hydrographs and peak flows for the 2-, 5-, 10-, 25-, and 100-year storm events. (Known as clear-water hydrographs, the measurements did not include a bulking factor to account for the likelihood of debris entering the runoff as a result of fires in the nearby mountains.) The hydrographs were developed using CivilCadd and CivilDesign, software for respectively site design and hydraulic modeling developed by CivilDesign Corporation, a subsidiary of the civil engineering firm Joseph E. Bonadiman and Associates, Inc., of San Bernardino, California. The accompanying table summarizes the peak discharges for the analyzed storm events (assuming a 24-hour storm duration that results in the highest peaks). The clear-water hydrographs were then used to develop inflow hydrographs that included bulking factors in the unsteady hydraulic model.

A qualitative assessment of sediment yield was performed for the Oak Glen Creek watershed. Of the many methods available to estimate sediment production, some give average annual sediment yield, while others provide estimates of sediment yield for a given storm hydrograph. On the recommendation of the San Bernardino County Flood Control District, the project team decided to use the method for estimating sediment yield developed by the U.S. Army Corps of Engineers' district headquartered in Los Angeles. The Corps developed this approach to estimate unit debris yield values for the design and analysis of debris-catching structures in Southern California watersheds.

The San Bernardino County Flood Control District will operate and maintain the basin facilities once they are completed, while the city will oversee other joint aspects of the site, including multipurpose trails, educational signage, and landscaped areas. During the design process, the district requested that the potential sediment yield for the Oak Glen Creek watershed be estimated for two flooding scenarios: a 100-year flood occurring four years after a fire and a 10-year flood occurring one year after a fire. The second scenario yielded the highest design sediment load, 460 acre-ft (567,400 m³). Unfortunately, the proposed project could not feasibly provide enough basins to capture this design yield. Therefore, a bulking factor needed to be considered in the design. A factor of 1.33 increased the 100-year clear peak of 7,038 cfs (199 m³/s) to a bulked 100-year peak flow of 9,374 cfs (265 m³/s).

The Hydrologic Engineering Center's River Analysis System (HEC-RAS), also developed by the Corps, was used to construct an unsteady hydraulic model for the series of

Peak Discharges for Analyzed Storm Events

Event	2-year	5-year	10-year	25-year	100-year
Peak flows	2,825 cfs (80 m³/s)	3,817 cfs (108 m³/s)	4,564 cfs (129 m³/s)	5,549 cfs (157 m³/s)	7,038 cfs (199 m³/s)

detention basins along Oak Glen Creek. The study reach extended 3,000 ft (914 m) upstream, or east, of Bryant Street (to Fremont Street) and 300 ft (91 m) downstream of Bryant Street. The hydraulic analysis was performed to optimize the type and size of the culverts to be located in the main channel between the basins. The design intent was to reduce high flows and minimize the overtopping of levees.

Nine alternatives were investigated, and the results were compared and summarized. The selected alternative featured three basins connected by 36 in. (900 mm) diameter storm drains having control valves, along with two 11 by 11 ft (3.4 by 3.4 m) box culverts to convey overflows past the basins and under Bryant Street. This option would provide relatively high flow reduction (19 percent for the 100-year storm and 12 percent for the 25-year storm event), the lowest velocities within culverts 1 and 2 between the basins, minimum water surface elevations in basins 2 and 3, and the least amount of scour downstream of the spillways. (See the figure on page 76.)

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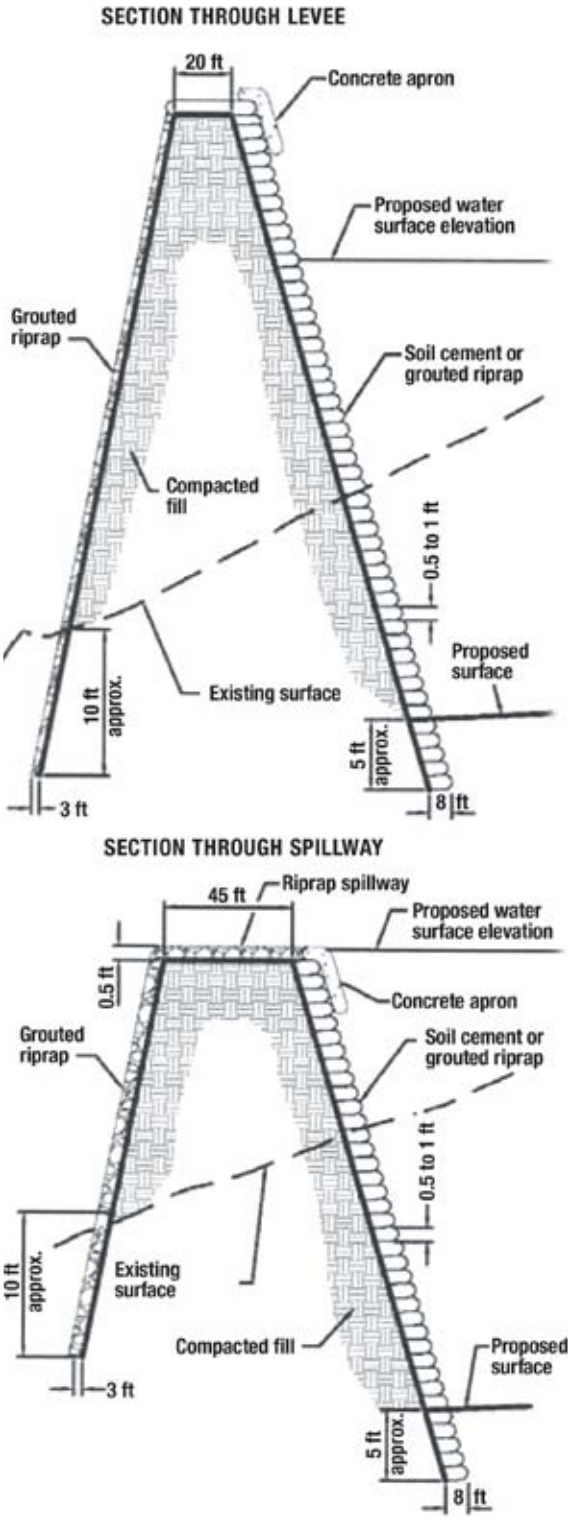

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DAVID EVANS AND ASSOCIATES, INC.

APPENDIX D -5-

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To this end, the project included the

Because outlet gates in the basins will be underwater during storm events, catwalks will provide access to the outlet control gate valves. From the top of such catwalks in basin 2, *below,* the operator can turn a valve to open or close a gate.

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Serving as a rest stop for hikers, equestrian enthusiasts, and bicyclists, the area includes trees, shrubs, benches, decorative boulders, and an information kiosk.

construction of a 42 in. (1,050 mm) diameter pipeline from the district's facilities to the basin located farthest upstream. In addition to a mix of groundwater and surface water supplies, the district obtains water from a California Department of Water Resources pipeline that connects directly to the filtration plant. During dry periods, the district may choose to purchase low-cost nonpotable water when it is available and store it belowground by means of infiltration through the detention basins. The district would then be able to withdraw the water later from its wells.

For operation and maintenance purposes, access roads are provided around and into all of the basins. The roads extend into the bottoms of each of the basins so that sediment and debris can be removed from the basin bottoms and other maintenance activities can be carried out. Near the spillways, the access road is concrete pavement. Elsewhere, however, it is of natural material compacted to 90 percent. The road, which complies with the requirements of the Americans with Disabilities Act, also serves as a hiking trail that constitutes an important segment of the trail system outlined in the city's master plan, a segment that links a state park to the rest of the community trails. Split-rail-type fencing has been placed around all of the basins, and a 10-space paved parking lot has been provided off Bryant Street for those using the trails.

Also at the site are designated trails from the entry point at Bryant Street that connect to an overlook and rest area. Located on the northeastern portion of the project site, this area is approximately 30 ft (9.1 m) above the creek. Serving as a rest stop for hikers, equestrian enthusiasts, and bicyclists, the area includes trees, shrubs, benches, decorative boulders, and an information kiosk. In the event that debris must be removed from the basins after a storm, maintenance crews will temporarily store the material in the eastern section of this area.

The site includes two other rest areas—one at the southeastern section, the other at the northwestern section. The southeastern rest area includes equestrian hitching posts and informational signs. The northwestern picnic area includes decorative boulders and informational signs. Trees, shrubs, and other native and drought-tolerant plants have been planted at the overlook and rest areas along the northern perimeter of the site and along the eastern slope of the first basin. The slopes of the basins will be revegetated with a mix of native and drought-tolerant plants, the seeds of which will be mixed with water and fertilizer and spread by means of a sprayer. The use of native materials is expected to help minimize maintenance requirements and increase wildlife habitat.

Educational signs are located strategically along the site paths. The signs will convey

Located the farthest upstream of the three basins, basin 3 has been designed to capture stormwater sediment and debris from Oak Glen Creek, improving water quality downstream and decreasing the likelihood of clogging within the downstream storm drain pipes and culverts.

Oak Glen Creek drains a watershed of approximately 4,450 acres (1,800 ha). Though dry condtions make it hard to believe, the creek has contributed to flooding in Yucaipa, California.

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information to the public about aspects of the water cycle within the context of the site itself and in the broader watershed. As people travel along the paths, a story will unfold before them and they will also learn about jurisdictional waters, watersheds, the hydrologic cycle, flooding, natural processes, groundwater recharge, sediment transport, desilting basins, ecosystems, and local flora and fauna. The signs are arranged hierarchically, the primary signs detailing the "Journey of Water" and the secondary ones providing the supporting information. Educational kiosks also provide information on the water cycle, helping people understand the importance of water and how they can conserve and recycle it.

Construction of the $6.1-million project began in June 2008. KEC Engineering, of Corona, California, constructed the basins. Construction proceeded smoothly, and this component of the project was completed in March 2009, as planned. During basin construction, much larger quantities of rock and boulders were encountered than had been anticipated. Fortunately, nearly all of the rock could be incorporated into the project, obviating the need to haul in rock from outside sources. The grading operation involved moving more than 200,000 cu yd (153,000 m^3) of material, including boulders that weighed as much as 50 tons (45 metric tons). The overall project is expected to be completed next month.

The Oak Glen Creek Detention Basins Project embodies an integrated approach to watershed management. By capturing storm water and facilitating groundwater infiltration, it reduces downstream flooding, improves water quality, recharges the groundwater supply, and provides open space for wildlife and plant life. Public access to the facility affords opportunities to educate visitors on the importance of the water cycle and the need to set aside open space for drainage facilities in lieu of more concrete channels. **CE**

Jeffrey K. Rupp, P.E., M.ASCE, is a vice president in the Ontario, California, office of David Evans and Associates, Inc., which has its headquarters in Portland, Oregon. This article is adapted from a paper delivered at the World Environmental and Water Resources Congress 2008, which was sponsored by ASCE and its Environmental and Water Resources Institute and held in Honolulu.

PROJECT CREDITS Owner: City of Yucaipa, California **Designer:** David Evans and Associates, Inc., Portland, Oregon **Contractor:** KEC Engineering, Corona, California **Construction management:** Vali Cooper and Associates, Inc., Richmond, California **Geotechnical engineering:** Converse Consultants, Monrovia, California **Biological assessment:** L and L Environmental, Inc., Corona, California **Sediment transport analysis:** West Consultants, Inc., San Diego **Financial contributors:** San Bernardino County Flood Control District, San Bernardino, California; Yucaipa Valley Water District, Yucaipa, California; Inland Empire Resource Conservation District, Redlands, California; California State Water Resources Control Board; and the U.S. Environmental Protection Agency