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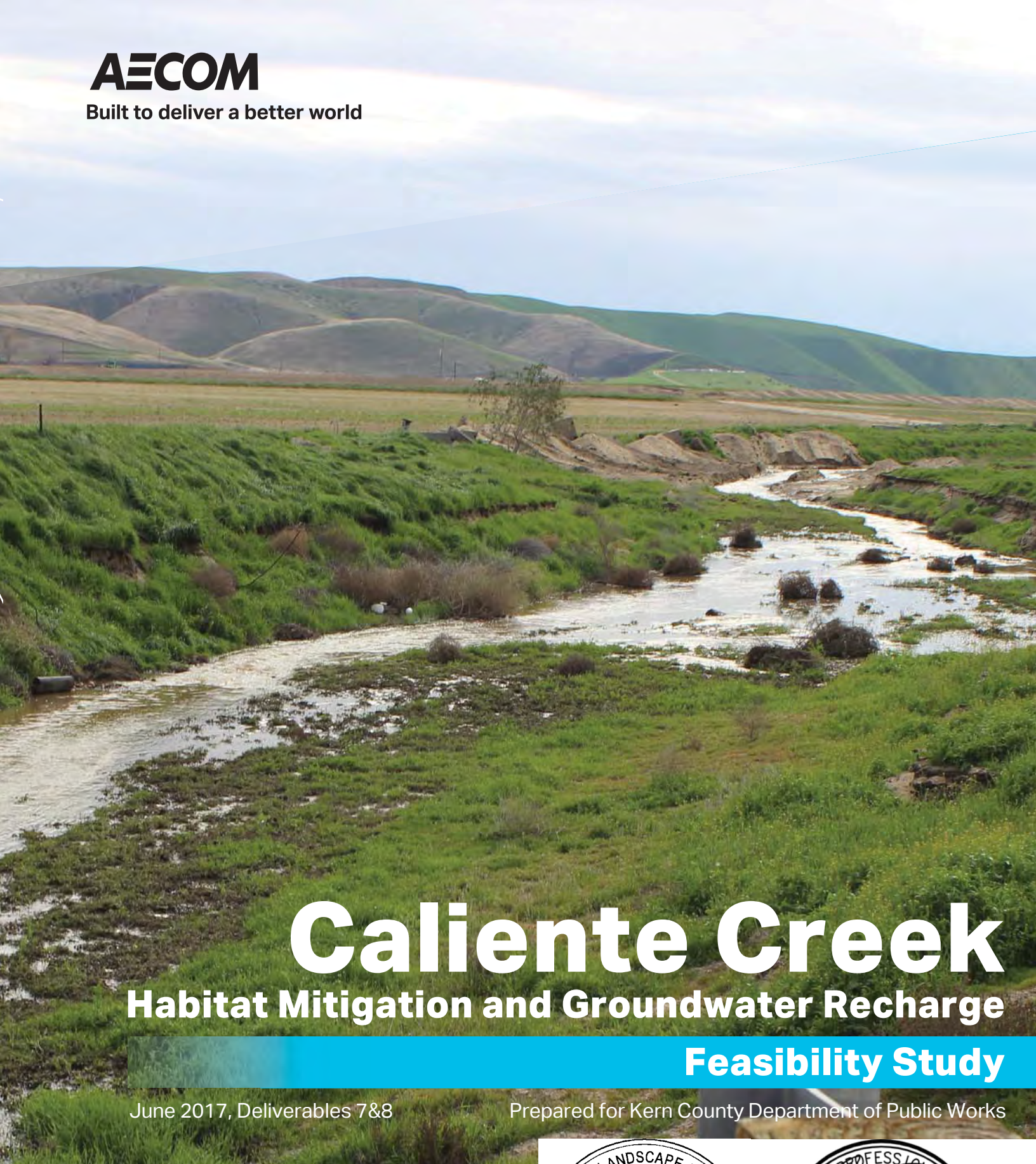

Caliente Creek

Habitat Mitigation and Groundwater Recharge

Feasibility Study

June 2017, Deliverables 7&8

Prepared for Kern County Department of Public Works

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ABBREVIATIONS AND ACRONYMS

Caltrans	California Department of Transportation
CDFW	California Department of Fish and Wildlife
CNDDB	California Natural Diversity Database
CRMP	Kern Lake Coordinated Resource Management and Planning Group
CWA	Clean Water Act
CWC	California Water Code
HEC-HMS	Hydrologic Engineering Center's Hydrologic Modeling System
MUSLE	Modified Universal Soil Loss Equation
RWQCB	Regional Water Quality Control Board
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
VFHCP	Valley Floor Habitat Conservation Plan
WDR	Waste Discharge Requirement

1.0 FOREWORD

Caliente Creek is a significant natural drainage delivering storm water from the Tehachapi Mountains to the San Joaquin Valley. Storm flow from Caliente Creek has presented challenges to Kern County for decades. Flooding, as well as sediment and debris flow, causes frequent damage to private property and public infrastructure in the Lamont and Arvin areas. A study completed by the Kern Lake Coordinated Resource Management and Planning (CRMP) Group in 2000 identified the Caliente Creek alluvial plain as a site with potential to help manage flood-related problems. The purpose of The Caliente Creek Habitat Mitigation and Groundwater Recharge Feasibility Study (feasibility study)is to provide an in-depth analysis of potential solutions and recommend a more refined and detailed proposal for a combined Caliente Creek project. Specifically, the purpose of this feasibility study is to identify solutions that achieve project goals, which include the following: reduce sediment generation from the project area; increase sediment deposition from sediment-laden water entering this reach; increase groundwater recharge; improve the habitat value of the area; and clarify and purify waters crossing the alluvial floodplain. Work completed for the study included:

- Aerial photogrammetric survey;
- Sediment and soil percolation testing;
- Modeling of hydrology, hydraulics, sediment transport, and infiltration for existing and proposed conditions;
- Preparation of conceptual design alternatives and a recommended design; and
- A project implementation plan, including projected costs and economic benefits of project implementation.

A number of design alternatives were considered and are discussed in this report. The full-restoration alternative proposes re-creating, as closely as possible, pre-development natural function to the Caliente Creek alluvial plain. This approach provides the best combination of achieving project goals and meeting feasibility criteria. The objectives of the full-restoration alternative are to spread storm flows over as much of the alluvial fan as possible, and slow the velocity of storm flows as much as possible. These objectives work together to achieve project goals by reducing the water's ability to capture and transport sediment, and allowing the natural porosity of the alluvial fan to infiltrate as much runoff as possible before it exits the project. Using a natural systems restoration approach allows the project to remain flexible and minimizes

the need for maintenance to sustain project performance over time. Modeling of the recommended alternative shows that it achieves the hydrology, groundwater infiltration, and sediment transport goals of the project, and meets feasibility criteria defined by the study.

2.0 BACKGROUND

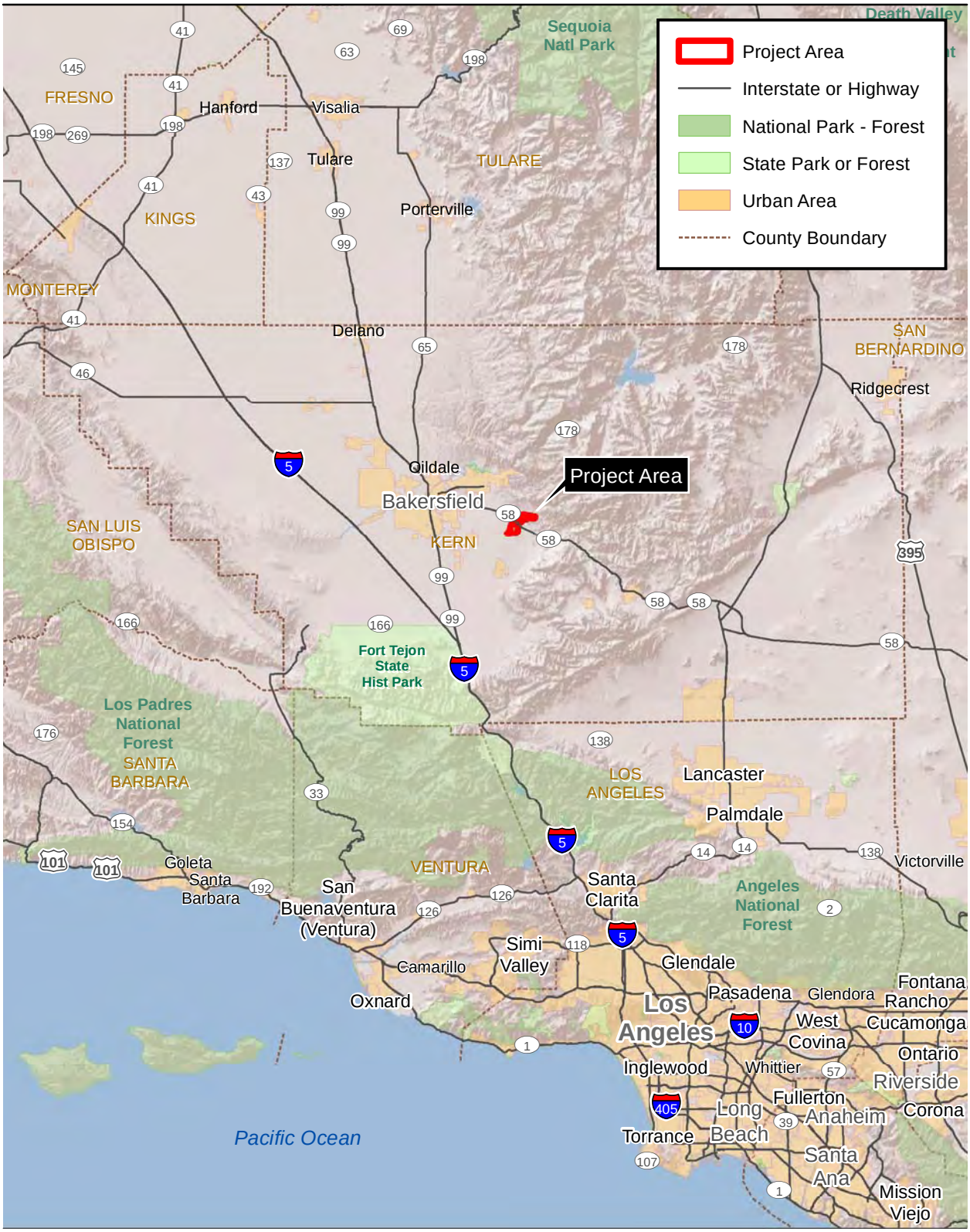
Caliente Creek is a significant natural drainage delivering storm water from the Tehachapi Mountains of the Sierra Nevada to the San Joaquin Valley. Storm flow from Caliente Creek has presented challenges to Kern County for decades. Flooding, as well as sediment and debris flow, causes frequent damage to private property and public infrastructure in the Lamont and Arvin areas. This chapter provides an introduction to the project setting and establishes the purpose and goals of this feasibility study.

2.1 LOCATION AND SETTING

The project area consists of a roughly 3,200-acre portion of Caliente Creek and its associated floodplain in Kern County, California (Figure 1). Kern County is a diverse county, with the western half dominated by the flat agricultural landscape of the San Joaquin Valley, the southeastern portion consisting of the desert landscape of the Antelope Valley, and the Sierra Nevada separating the two. The project is entirely within the San Joaquin Valley, on the alluvial fan created by Caliente Creek as it emerges from the Sierra Nevada and enters the valley. The Caliente Creek project area is approximately 15 miles southeast of the City of Bakersfield and approximately 5 miles northeast of the community of Lamont.

Caliente Creek is an intermittent stream whose headwaters originate in the Sierra Nevada east of the project. As Caliente Creek enters the project area, it has collected flow from Tehachapi Creek and Walker Basin Creek. Caliente Creek ends as a defined drainage feature approximately 3 miles downstream from the project area (Figure 2). During storm events, however, water and sediment flows continue farther into the San Joaquin Valley's agricultural fields and communities.

Photo 1: Overview of project area



Source: Imperial Irrigation District 2009; ESRI; Bing.

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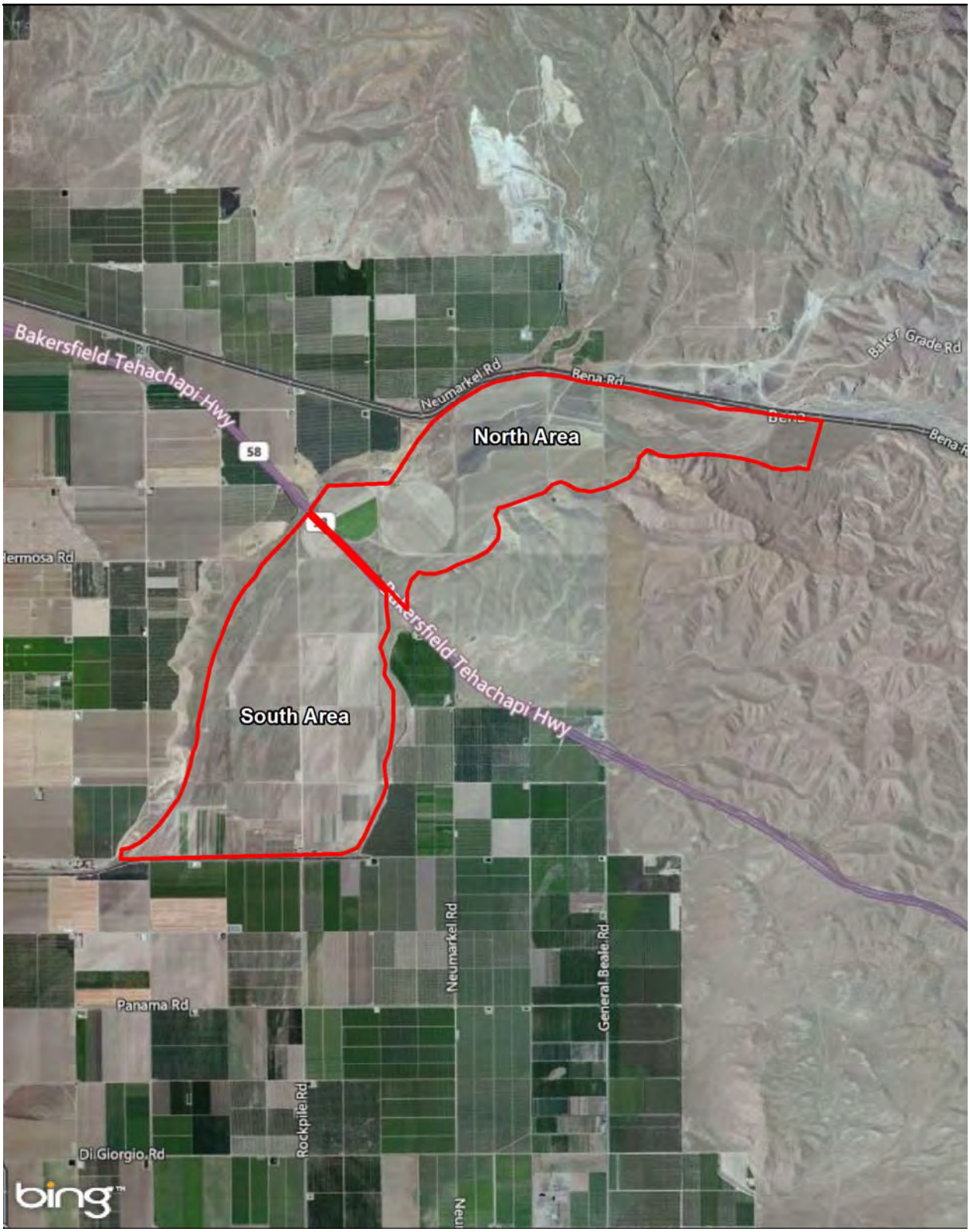
Figure 1
Regional Location



Source: Imperial Irrigation District 2009; ESRI; Bing.

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Figure 2
Project Area

2.2 PURPOSE AND GOALS

A 1990 study prepared by the U.S. Army Corps of Engineers (USACE) characterized this reach of Caliente Creek as a "supply reach" for sediment, meaning that, during storm events, sediment from the project area is picked up by runoff and transported downstream. The resulting flooding and sediment flow create hazards to public safety and damage to property and infrastructure. The most recent prior study of the issue occurred in 2000, when the Kern Lake CRMP prepared a conceptual approach to mitigate flooding problems in Lamont and Arvin. The concept required an integrated approach that mitigates sediment yield, peak flow rate, flow volume, and habitat loss for all watersheds contributing to the Kern Lake bed in the southern San Joaquin Valley. The CRMP identified numerous recommended projects, each of which would require additional study. The Caliente Creek Habitat Mitigation and Groundwater Recharge Projects were identified as high priorities by the CRMP study. The purpose of this current feasibility study is to provide a more in-depth analysis of potential solutions and recommend a more refined and detailed proposal for a combined Caliente Creek project.

The more specific purpose of this feasibility study is to identify solutions that eliminate the "supply" reach conditions and create conditions that achieve project goals, which include:

- Reduce sediment generation from this area;
- Increase sediment deposition from sediment laden water entering this reach;
- Increase groundwater recharge;
- Improve the habitat value of the area; and
- Clarify and purify waters crossing the alluvial floodplain.

Additionally, the inherent goal of the feasibility study is to identify feasible, implementable solutions. To this end, the study seeks a solution that minimizes long-term maintenance and repair costs.

Photo 2: Road damage from 2017 storm event

2.3 LIMITATION OF STUDY

This feasibility study is intended to (1) build on, rather than redo, previous studies, and (2) establish a feasible conceptual solution.

In keeping with the first point, since little or no effectual stream gauge information is available and since USACE has studied the watershed in great detail, this feasibility study was founded on the established USACE Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) for Caliente Creek. Therefore, it was assumed that the established USACE HEC-HMS model adequately described the watershed and its individual components with appropriate assigned variables to establish the relationship between rainfall and runoff. While the model utilizes a uniform 3.5 inches of rain over the entire watershed, which does not reflect the current NOAA Atlas 14 rainfall, the new model was calibrated to USACE's rainfall for peak discharge and volume. The model was then run with current National Oceanic and Atmospheric Administration rainfall data to determine the new 100-year, 10-year, 5-year, and 2-year values.

In keeping with the second point, the level of detail provided in the analysis and recommendations is appropriate to articulate the nature and expected performance of the proposed solutions. Further design will be necessary to refine technical details.

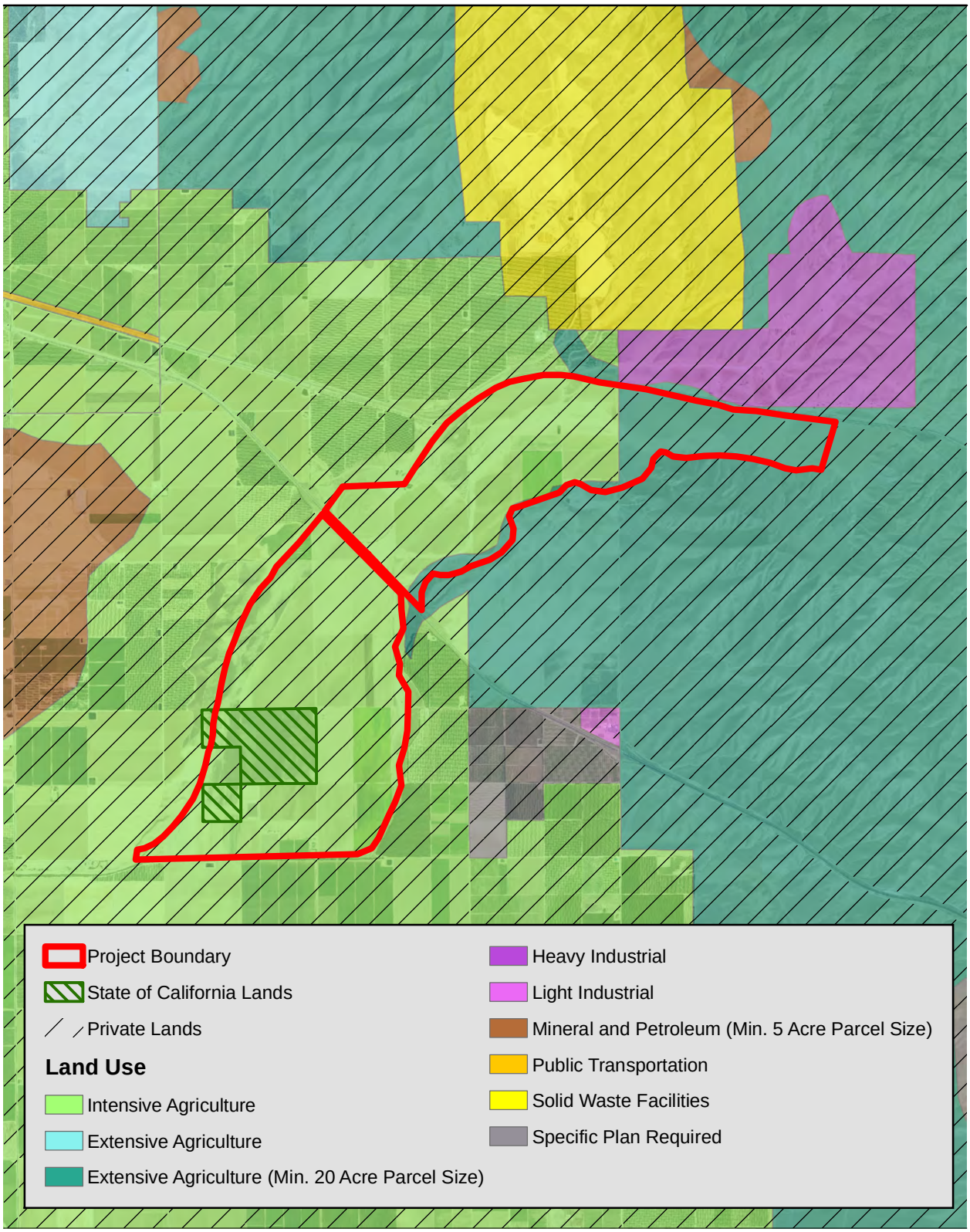
Additionally, it is important to note that the proposed habitat restoration and groundwater recharge project on Caliente Creek is one part of a much larger and broader solution. The proposed project would provide a good start toward a complete solution, but it cannot resolve all of the issues present in the watershed on its own. Other projects will be essential to help reduce sediment loading and slow runoff from the upper reaches of the watershed. Refer to the CRMP for a full list of potential projects considered in that study.

3.0 EXISTING CONDITIONS AND ISSUES

3.1 OWNERSHIP AND LAND USE

The project area primarily consists of privately owned land (Figure 3). Most of the privately owned land is currently used for annual agricultural crop production (Photos 3 and 4). The remainder is fallow and has naturalized to a mixture of nonnative grassland, salt bush scrub, and stream channel habitats. The naturalized areas include the upstream end of the project area, and portions of existing natural and altered stream channel alignments. Publicly owned land is limited to two properties owned by the County of Kern and two properties owned by the State of California. Three of these properties appear to be fallow agricultural land that has naturalized to primarily nonnative grassland habitats. The fourth property, located along Bena Road where Walker Creek enters the project area, is partially naturalized habitats but also contains tilled land in agricultural production. The California Department of Transportation (Caltrans) holds an easement through the project for Highway 58.

Photo 3: Freshly tilled agricultural fields within study area



Source: Imperial Irrigation District 2009; ESRI 2009

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Scale: 1 = 63,360; 1 inch = 1 mile(s)

Figure 3
Ownership and Land Use

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Photo 4: Annual agricultural crops within study area

Four privately owned water wells are located within the project site based on information provided by the Kern County Water Agency. Figure 4 shows the approximate location of these four wells, including wells within proximity to the project site. Groundwater elevation and depth of groundwater data have not been provided for these well sites within the past 10 years. Thus, it is difficult to determine the current conditions of these well sites, including how often they are used. Table 1 lists the well owners.

Table 1
Well Owner and Well Information

Well No.	Owner	Publishing Year of Most Recent Well Completion Report
30S/30E 09Q01	Joseph Casaletto	1998
30S/30E 16A	Marvin Bender	1952
30S/30E 30R	Clarence Rogers	1993
30S/30E 30E	Kern Brothers Trucking	2004

3.2 CIRCULATION AND PUBLIC ACCESS

Public access is limited throughout most of the project area. Highway 58, operated by Caltrans, is a public highway that runs approximately 1.08 miles through the center of the project area (Photo 5). Bena Road and Rockpile Road are operated by the County of Kern and, like Highway 58, are also accessible to the general public (Figure 5). Bena Road borders the upstream portion of the project area and is owned by the County of Kern. This road borders approximately 1.49 miles of the project area. Rockpile Road, also owned by the County of Kern, extends approximately 400 feet into the project area from the southern edge of the project. All other roads within the project area are private and/or are not accessible to the general public.

Photo 5: Highway 58

3.3 TOPOGRAPHY AND GEOMORPHOLOGY

The project area consists of a broad alluvial plain, and is generally flat. Historically, the alluvial plain was highly dynamic in response to storm flows and sediments delivered by those flows. Coarser sediment collected from the upper watershed was deposited as flow entered the flat valley and slowed. Deposition of sediment, along with larger flood events, created an ever-changing pattern of braided stream channels within the alluvial plain. Historic photos from 1937, 1952, 1956, 1975, 1981, 1985, and 1991 (Photos 6 through 12) illustrate the degree of change and general geomorphology of the project area. Generally, the valley slope is approximately 0.99% from the upstream limits to downstream limits of the project area.

Source: AECOM

Figure 4
Well Locations

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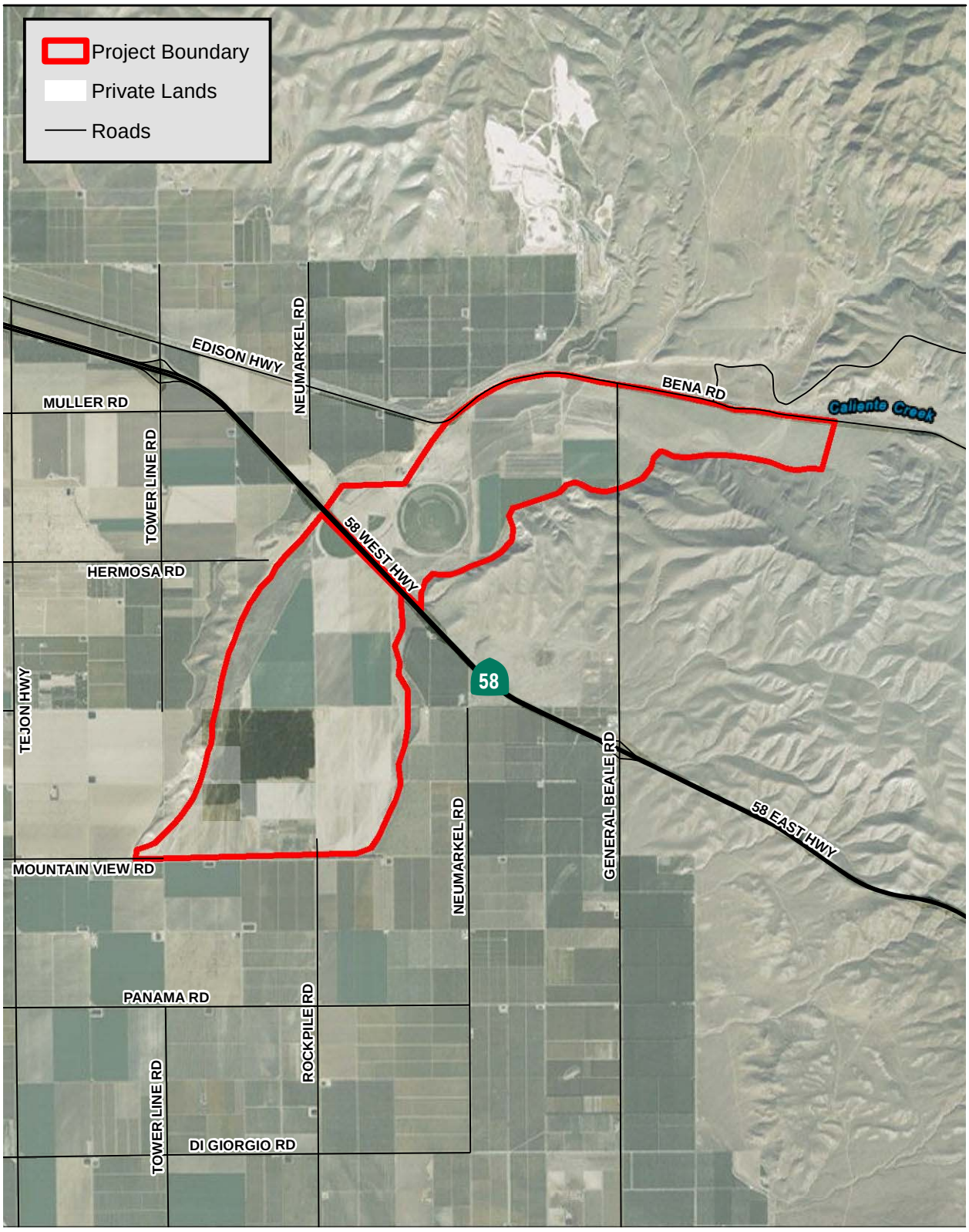

Source: Imperial Irrigation District 2009; ESRI 2009

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Scale: 1 = 63,360; 1 inch = 1 mile(s)

Figure 5
Circulation and Public Access

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Photo 6: 1937 aerial photo of project area

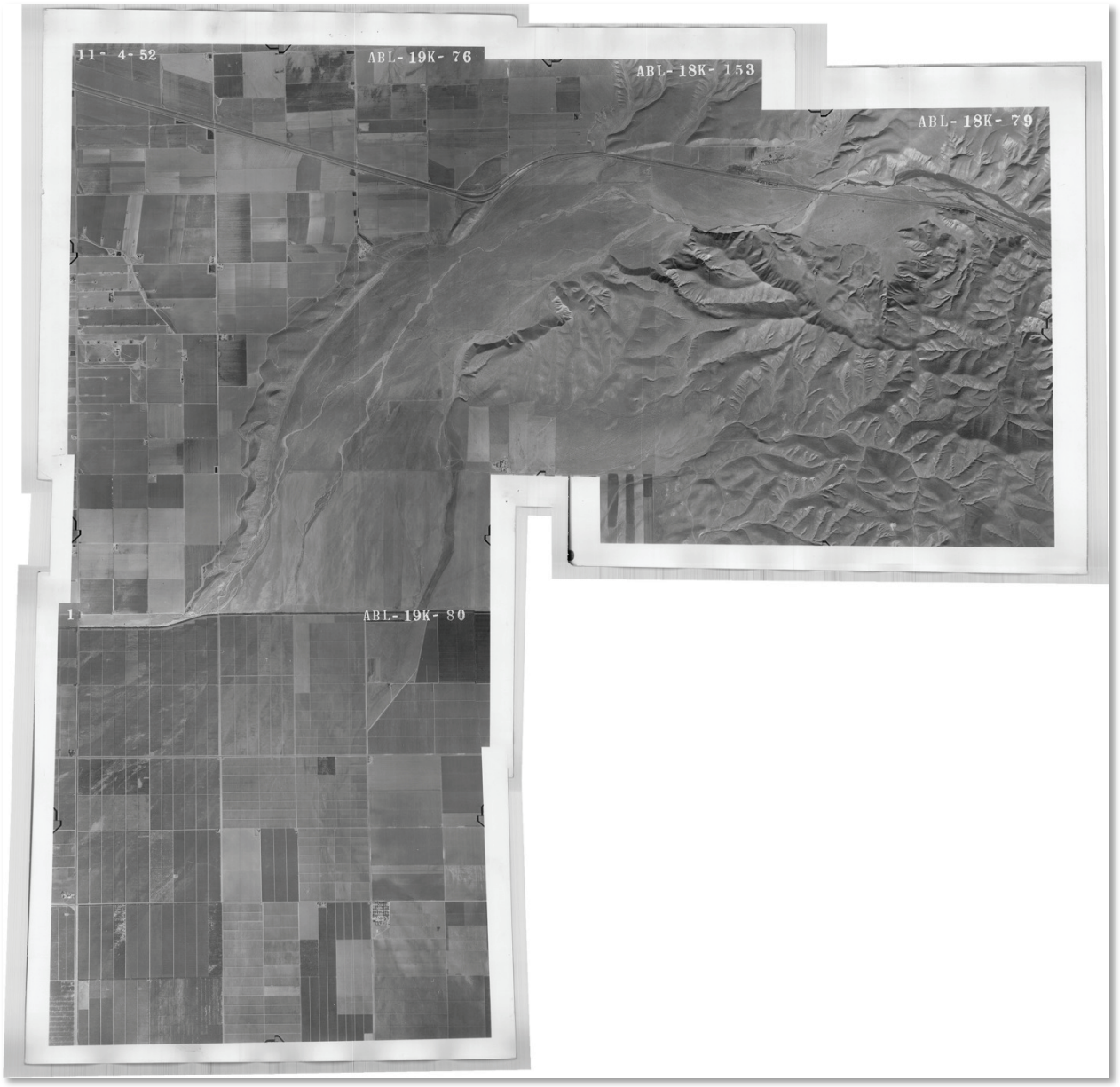


Photo 7: 1952 aerial photo of project area

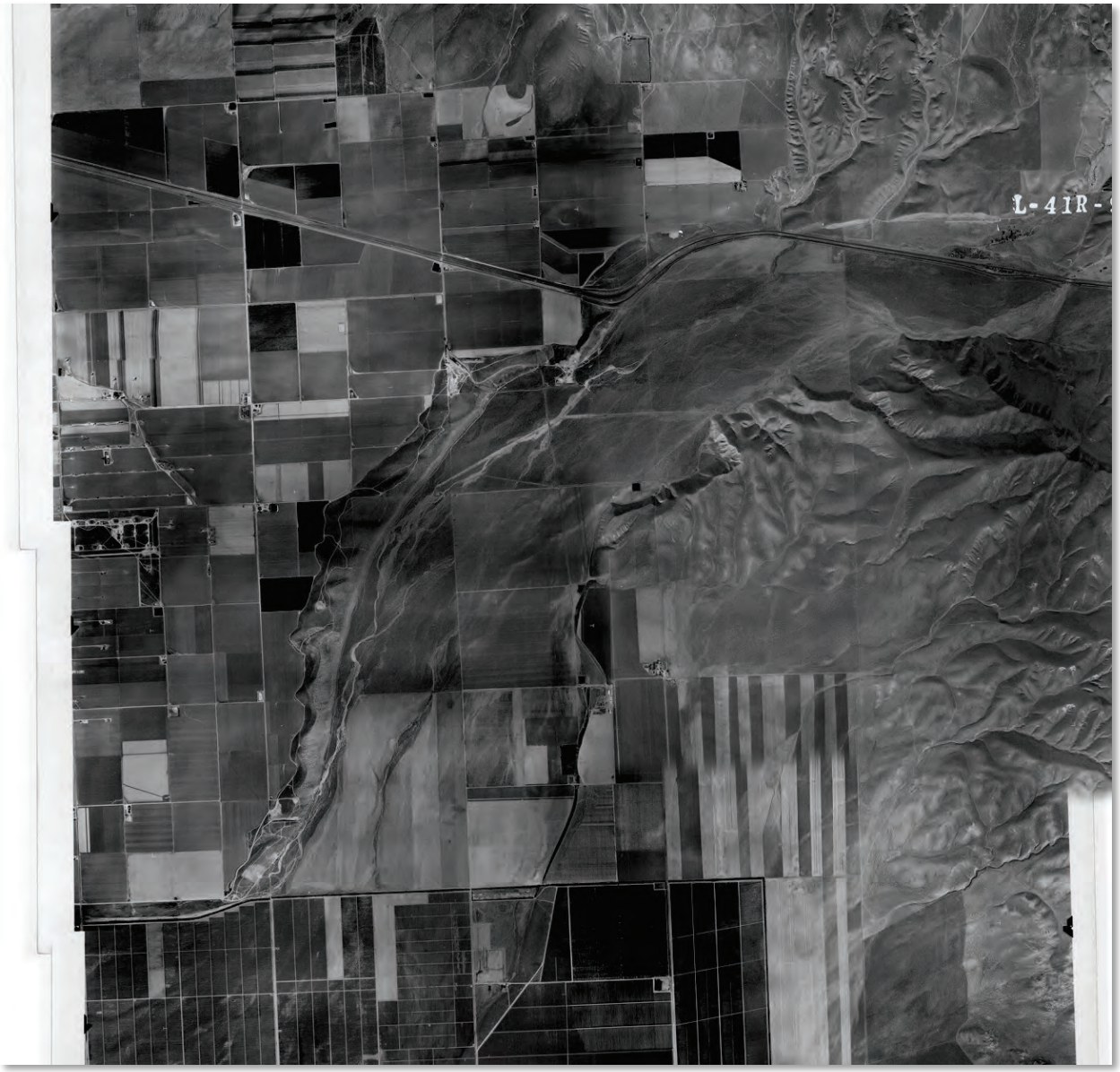


Photo 8: 1956 aerial photo of project area

Photo 9: 1975 aerial photo of project area

Photo 10: 1981 aerial photo of project area

Photo 11: 1985 aerial photo of project area (partial)

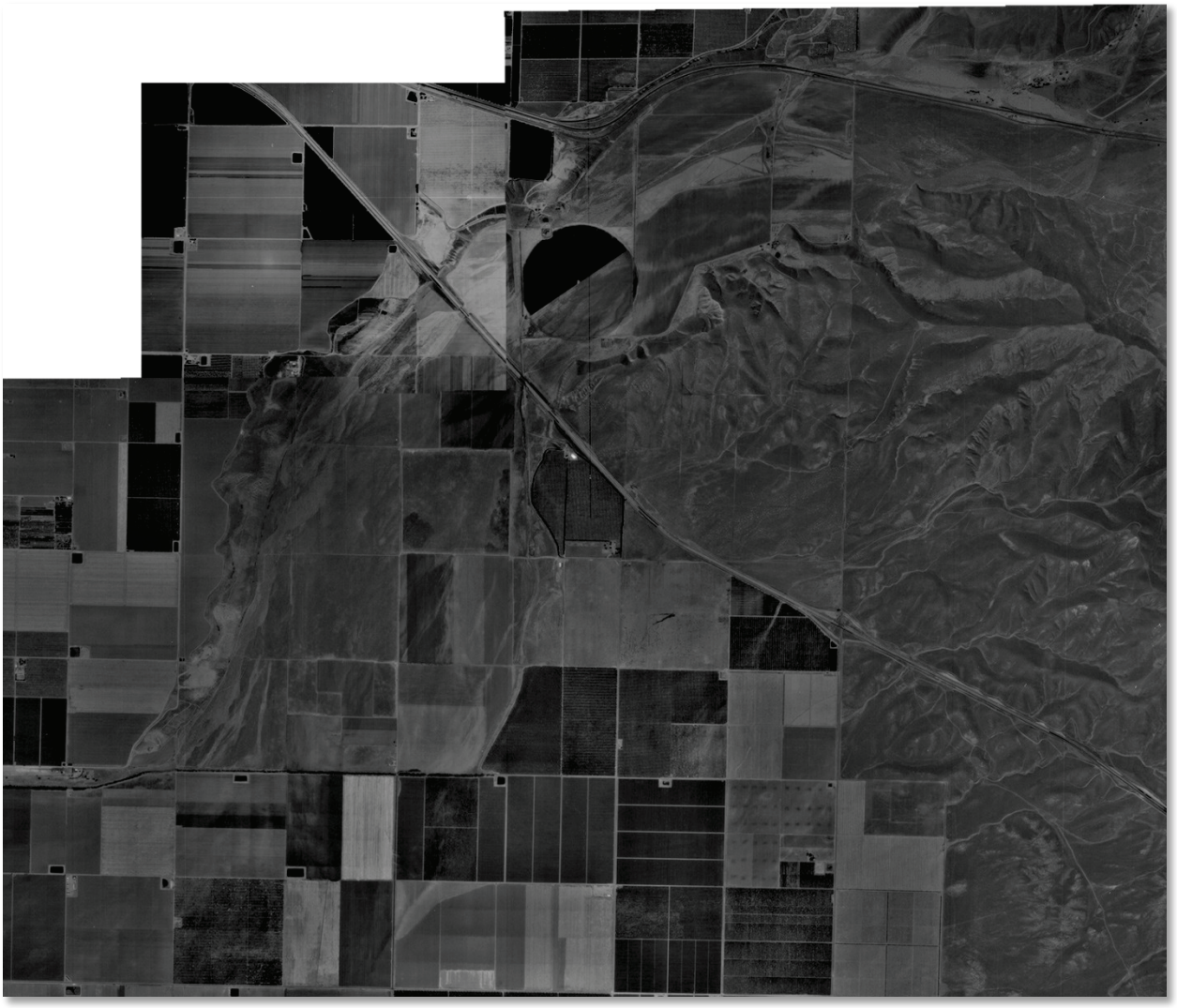


Photo 12: 1991 aerial photo of project area

Agricultural and transportation uses have created important changes in topography to build roads, level fields and divert storm runoff around fields. These modifications have altered the hydraulics and geomorphology of the alluvial plain. The most important modifications are (1) the creation of the Highway 58 road fill, which alters hydraulics and geomorphology by limiting flow through the highway fill to two channel undercrossings (Photos 13 and 14); and (2) the construction of an artificial dike and channel on the east and south edges of the lower half of the project that constrain flow from the eastern bridge channel crossing to a channelized condition (Photos 15 and 16).

Photo 13: Western crossing under Highway 58

Photo 14: Eastern crossing under Highway 58

Photo 15: Major channelization on east edge of project area. Channel left, berm center, ag field right

Photo 16: Grading / Modification in channel near confluence of Caliente Creek and Walker Basin Creek

Existing topography data were created for the project through aerial photogrammetric methods in 2016, with a contour interval of 2 feet. This data set was subsequently used for hydraulic modeling and restoration design.

3.4 HYDROLOGY

The nearly 3,200-acre project area receives runoff from Walker Basin and Caliente Creek Basin. These two basins encompass a watershed that contains approximately 476 square miles. The watershed begins in the Tehachapi Mountains of the Sierra Nevada and drains west starting at the divide to the Mojave Desert. These basins include Walker Basin Creek, Rancheria Creek, Caliente Creek, Weaver Creek, Indian Creek, Tehachapi Creek, Tweedy Creek, and Brite Creek (Figure 6). Elevation varies from just over 8,000 feet to about 615 feet above mean sea level.

Average streambed slopes vary from over 500 feet per mile (9.5%) to just under 100 feet per mile (1.9%). The flows at the project area are ephemeral and have potential to be quick and large. Indeed, whenever significant rainfall occurs, the downstream communities of Arvin and Lamont suffer greatly. Damage is caused not only by floodwaters but also by sedimentation carried by these flows.

A new HEC-HMS hydrology model was constructed and calibrated to the established USACE HEC-HMS model. See Appendix A for full details of the hydrology study completed for the project. Based on results of the study, the recommended hydrographs are detailed in Table 2 below. Figures 7 and 8 show the hydrographs for both the 2-year event and the 5-year event at each location listed in Table 2.

Table 2
2017 Model Results – Project Design Flows

Location	5-Year 24-Hour Event			2-Year 24-Hour Event		
	Peak Flow, CFS	Time of Peak, Hours	Volume of Discharge, Acre-Feet	Peak Flow, CFS	Time of Peak, Hours	Volume of Discharge, Acre-Feet
Walker Basin Creek at Railroad Bridge	1,479	16.50	1,383	721	18.00	729
Caliente Creek at Bena Road Bridge	4,328	17.00	4,449	2,086	18.50	2,267
Confluence of Walker Basin Creek and Caliente Creek	5,639	17.50	5,782	2,712	19.00	2,974
Unimpeded Exit at Project South Boundary	5,516	18.50	5,778	2,671	20.00	2,956

CFS = cubic feet per second

3.5 CHANNEL HYDRAULICS AND SEDIMENT TRANSPORT

No direct measurement of sediment yield from the Caliente Creek watershed is currently available. To estimate watershed sediment yield, a hydraulic and watershed sediment yield analysis was prepared for the study. Analysis was completed using the following methodologies. All FLO-2D analysis was conducted for the 2- and 5-year design events as summarized in Table 3.

- Watershed sediment yield: Modified Universal Soil Loss Equation (MUSLE) and USACE (Tatum) methodologies
- Channel and surface flow hydraulics: FLO-2D computational model
- Groundwater infiltration: FLO-2D computational model
- Two dimensional sediment transport: FLO-2D computational model
- Estimated stream sediment transport potential: SAM numerical model

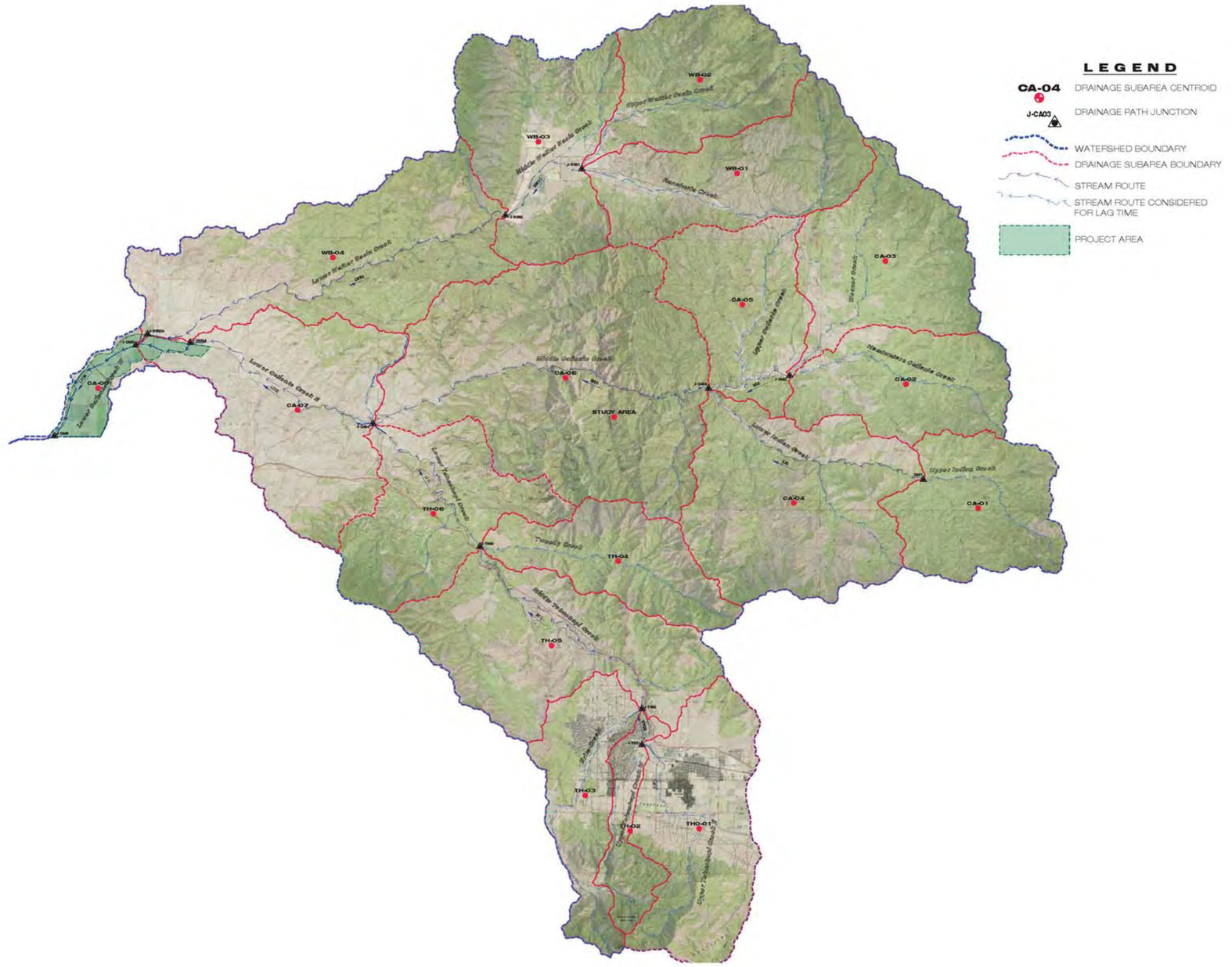
The sediment inflow at the upstream end of the project and the sediment outflow at the downstream end of the project area are summarized in Table 3. Refer to Appendix B for the full details of modeling methods and results.

Table 3
2017 Model Results – Existing Conditions Sediment Yield

Location	2-Year Event (CF)	5-Year Event (CF)
Upstream Limit of Project Area (Sediment Inflow)	298,502	581,128
Downstream Limit of Project Area (Sediment Outflow)	11,575	138,050

CF = cubic feet

The maximum depths and velocities for existing conditions on Caliente Creek's alluvial plain are presented alongside the proposed conditions in Chapter 5 (Figures 15 and 21, respectively, for the 2-year condition, and Figures 17 and 23, respectively, for the existing 5-year condition). The figures show significant overbank (i.e., uncontained) flows during the 2- and 5-year events in the upper half of the project, though these flows have been impacted by agricultural activity. Likewise, results for the lower half of the project indicate that farming practice has largely



Source: Meyer Civil Engineering

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Figure 6
Watershed Map

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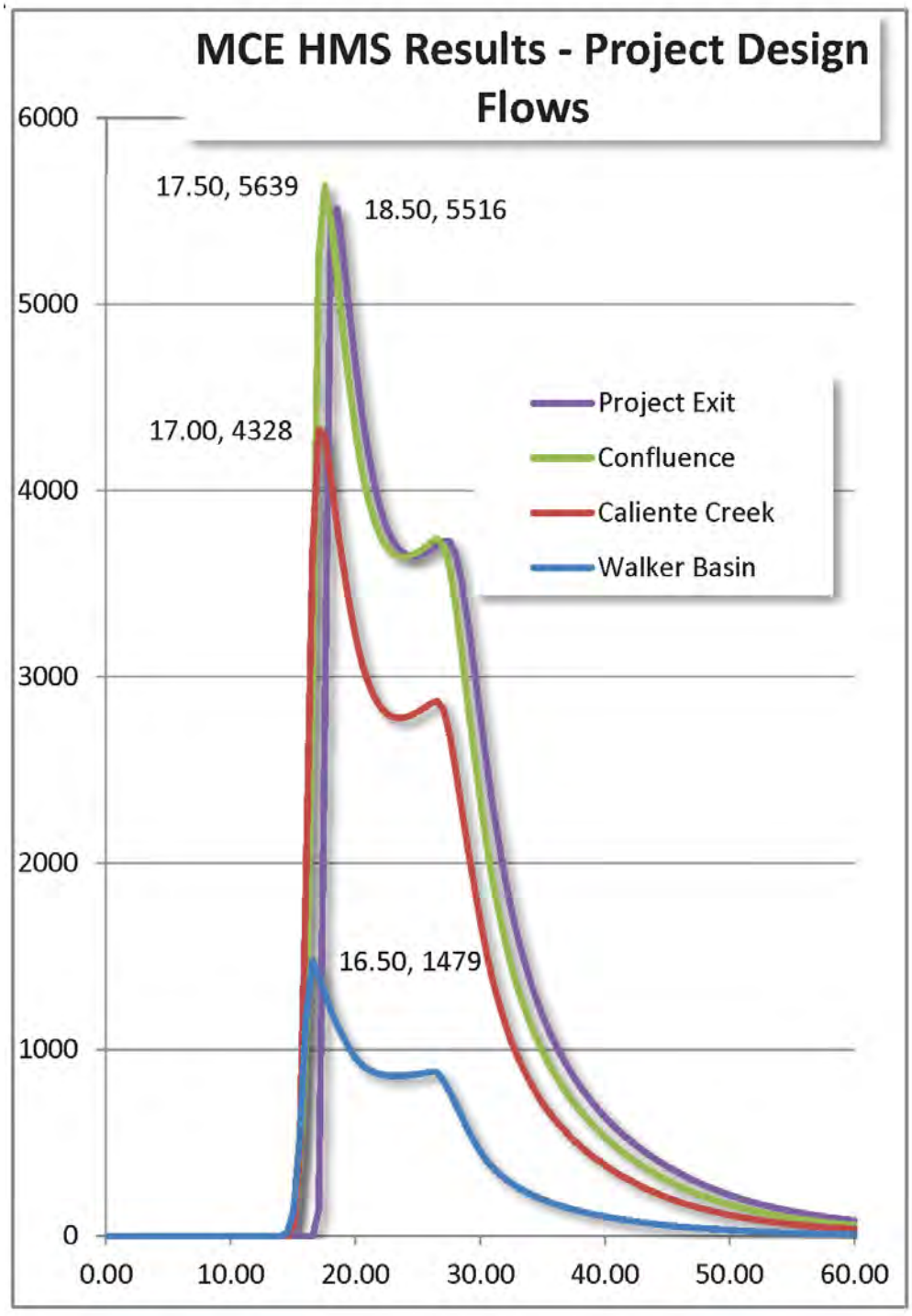
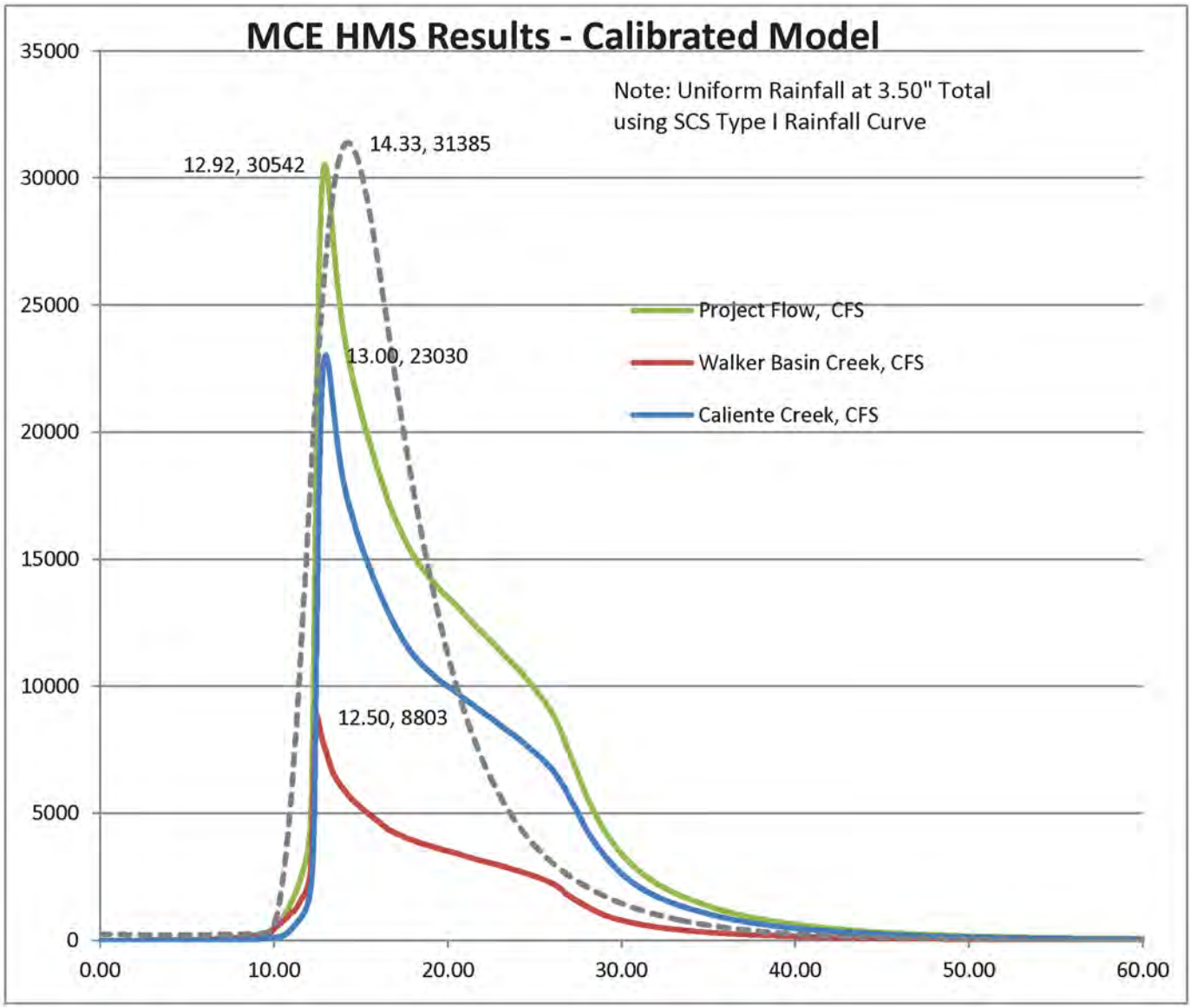


Source: Meyer Civil Engineering

Figure 7
Caliente Creek and Walker Basin Creek 2-year, 24-hour hydrographs at Edison Highway



Source: Meyer Civil Engineering

Figure 8
Caliente Creek and Walker Basin Creek 5-year, 24-hour hydrographs at Edison Highway

eliminated uncontained surface flows. Maximum velocities for both existing conditions design events was approximately 6 feet per second, though typical flow velocities over most of the project area are much lower.

Sediment data used to support the hydraulics and sediment transport analysis were taken from a series of 18 samples taken at six different locations within the project area. Sample depths ranged from 0.5 to 5.5 feet. Sediment data are summarized in Figure 9. A complete description of the sediment data and methodology can be found in Appendix B.

3.6 GROUNDWATER INFILTRATION

Groundwater begins with rain and snow melt that seeps or infiltrates into the ground. The amount of water that seeps into the ground varies widely from place to place according to the type of land surface that is present. In relatively flat areas with porous surface material that water readily seeps through, such as sand or gravel, 40 to 50 percent of the rain and snow melt may seep into the ground. Seepage into less porous surface material may range from 5 to 20 percent. The remainder of the rain and snow melt runs off the land surface into streams or returns to the atmosphere by evaporation. Water fills all of the openings (pores) in the soil or rock is the saturated zone. A zone is usually present between the water table and the land surface where the openings, or pores, in the soil are only partially filled with water; this zone is called the unsaturated or vadose zone.

Groundwater recharge is a hydrologic process where water moves downward from surface water to groundwater. Recharge is the primary method through which water enters an aquifer. This process usually occurs in the vadose zone below plant roots and is often expressed as a flux to the water table surface. Recharge occurs both naturally (through the water cycle) and through anthropogenic processes (i.e., "artificial groundwater recharge"), where rainwater and or reclaimed water is intentionally routed to the subsurface. Groundwater recharge is an important process for sustainable groundwater management, since the volume-rate extracted from an aquifer in the long term should be less than or equal to the volume-rate that is recharged.

Permeability is a measure of how fast water will flow through connected openings in soil or rock. Low permeability refers to soil or rock that restricts the movement of water through it . The specific yield is the actual amount of water that will drain out of saturated soil and rock by gravity flow. It does not drain out completely because some water forms a film that clings to soil and rock because of water’s strong adhesion properties. High permeability is critical for water supply purposes. The capacity of soil or rock to hold water is called porosity. Saturated sand contains about 20% water; gravel, 25%; and clay, 48%. Saturated bedrock with few crevices commonly contains less than 1% water. Clay is not a good water source despite its high water

content, or porosity, because the extremely small size of the openings between microscopic particles creates friction that effectively halts water movement. Saturated clay is virtually impermeable.

Theoretically, water that falls as rain will entirely percolate into the soil as long as the allowable saturated percolation rate is higher than the rate of precipitation. However, there are many variables in nature that affect percolation rates. These variables include (1) the uniform application rate, (2) available area for infiltration, and (3) change in soil properties. Application rates are affected by change in grades, precipitation rates, or can be hydraulically influenced by shallow vadose zones, high phreatic surface or mounding. The available area can be influenced by bedrock or clay lenses which reduce the available pores for water to flow. Soil properties can have variability in the amount of fines, silts and clay content of the unit soil area.

Percolation tests were conducted at the six sediment sampling locations within the project area (under dry conditions). Percolation ranged from 120-150 inches per hour in those tests. It is important to note that percolation rates under saturated soil conditions will behave differently than under dry conditions. It is extremely difficult to determine the actual percolation rate under saturated soil conditions. Under very high rainfall events, the location of the phreatic surface (i.e. the water table) could be relatively shallow and impede the percolation rate directly or indirectly through groundwater mounding. Because the saturated soil percolation rate could not be verified, a more conservative approach was selected. The Natural Resource Conservation Service (NRCS) soil survey for the study area lusts saturated hydraulic conductivity values of 4.0-12.7 inches per hour, with a weighted average for the study area of 10.9 inches per hour. The CRMP study found that the study area has an infiltration rate of approximately 2.0 inches per hour. Numerical modeling for the feasibility study uses the 2.0 inches per hour value since it is more conservative.

Table 4 summarizes the inflow, infiltration, and outflow of design flows under existing conditions, as shown by the FLO-2D model prepared for the project. Both design storms result in substantial flow exiting the downstream limit of the project, indicating that infiltration is unable to absorb the full volume of water created by the design storms. It is these flows that continue downstream and cause infrastructure and property damage. Refer to Appendix B for the full details of modeling methods and results.

Table 4
2017 Model Results – Existing Conditions Groundwater Infiltration

Hydrology Event	Water Inflow (Acre-Feet)	Infiltration (Acre-Feet)	Water Outflow (Acre-Feet)	Inundated Area (Acres)
2-Year Event	3,010	2,744	159	1,018
5-Year Event	5,860	4,748	1,110	1,629

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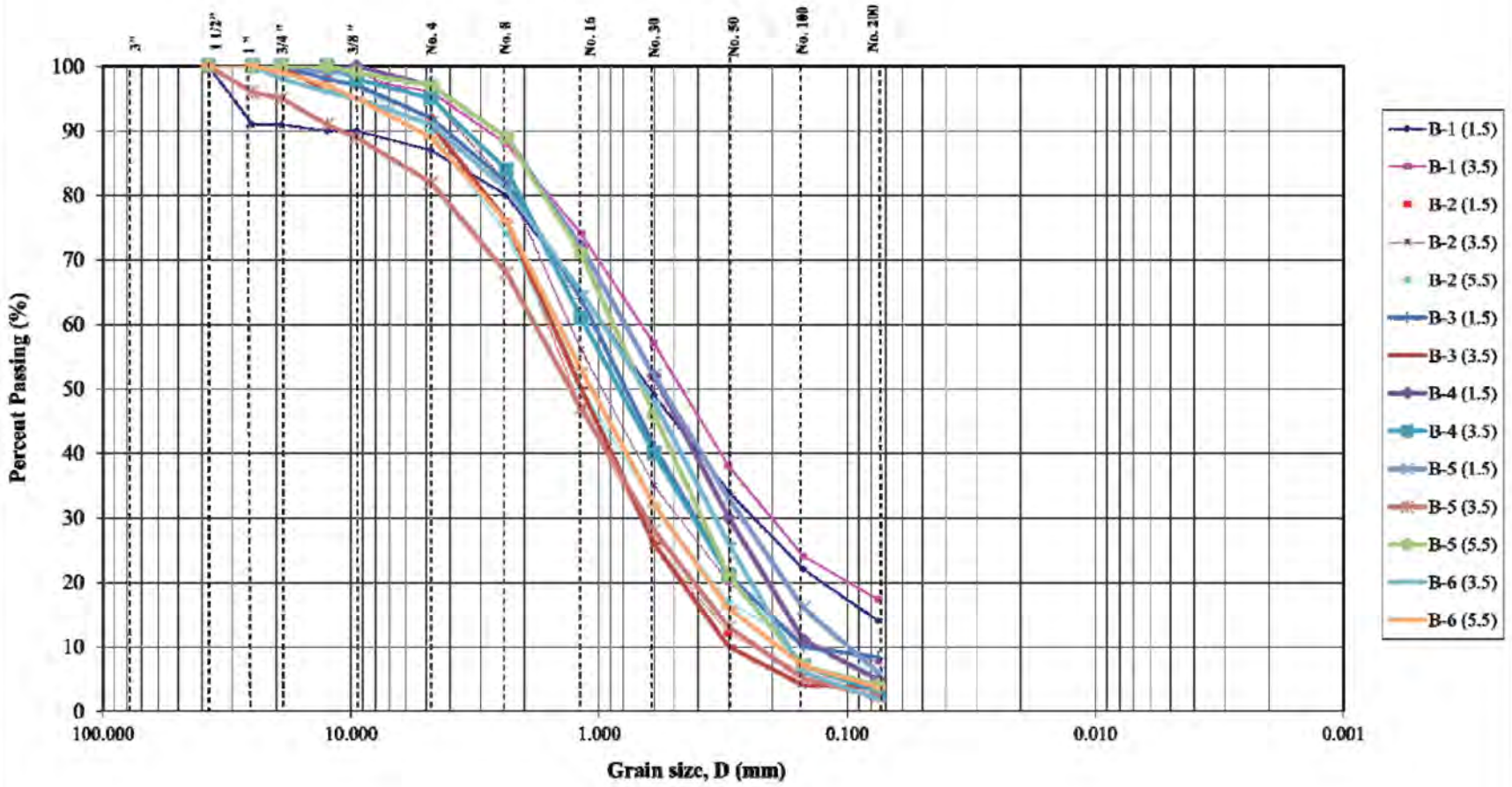

Figure 9
Grain size distribution, by location

3.7 WATER QUALITY

Water quality studies were conducted in Caliente Creek in the 1980s. These studies investigated the quality of water in Caliente Creek and Walker Basin Creek in regard to inorganic chemicals, nutrients, toxic metals, oil and grease, pesticides, and polychlorinated biphenyls. Turbidity, particle size distribution, and radioactivity levels were also measured. The results of these studies indicated that all parameters except hardness, salinity, sulfate, and oil and grease pose no threat to human health, although they may not be acceptable to all consumers. The Caliente and Walker Basin Creeks exceeded U.S. Environmental Protection Agency criteria for mercury and zinc (Appendix D).

Although the water quality studies in the CRMP indicated that water quality was not impaired for parameters excluding hardness, salinity, sulfate, and oil and grease, the sample locations for these studies is not indicated in the report. The Caliente Creek headwaters and upstream portion of the creek are relatively undeveloped; therefore, flows may not come into contact with many urban or agricultural pollutants. However, within and downstream of the project area, agricultural fields are vast and may contribute to the impairment of water quality. As Caliente Creek poses a significant flood risk to the area, flooding of the agricultural fields and developed area would exacerbate water pollution. As the proposed project would alleviate flooding within the project area and surrounding area, it would reduce the flooding of nearby agricultural fields and improve water quality.

Sediment and turbidity are substantial water quality concerns within the Caliente Creek watershed, the project study area, and areas downstream. The majority of the project area is currently used to grow annual crops, and the soil is kept in a loose tilled condition year-round. Rainfall and flooding events that fall on tilled agricultural soils are prone to heavy erosion. Eroded soils are carried by Caliente Creek downstream until they are deposited.

3.8 BIOLOGY AND WETLANDS

A desktop investigation for the project area was performed to research the existing natural resources, presence/absence of special-status species, and presence/absence of regulated waters. A full description of existing environmental conditions can be found in Appendix C.

3.8.1 Vegetation Communities

As seen on recent aerial photographs, a large portion of the project area has been transformed into agricultural fields. However, the Valley Floor Habitat Conservation Plan (VFHCP) provides some information on the historical ecological conditions of the area. The original vegetation communities in the project vicinity included native grasslands and saltbush scrub. San Joaquin Valley grassland communities were originally dominated by purple needlegrass (*Stipa pulchra*), with a variety of perennial broad-leaved herbaceous plants and annual species. Saltbush scrub communities were originally dominated by a mix of mid-size perennial woody shrubs, including common saltbush (*Atriplex polycarpa*), arrowscale saltbush (*A. phullostegia*), spiny saltbush (*A. spinifera*), alkali heath (*Frankenia grandifolia*), cheesebush (*Hymenoclea salsola*), and Bakersfield cactus (*Opuntia basilaris* var. *treleasei*) (Kern County 2006). Introduction and spread of nonnative grassland species began during Mexican colonization of the San Joaquin Valley and accelerated after 1850. This is closely associated with the decline of native vegetation communities and native grassland species (Kern County 2006).

Riparian vegetation on Caliente Creek was likely historically sparse, given its intermittent flow. Currently, scattered cottonwood (*Populus fremontii*) trees can be seen along less-disturbed sections of Caliente Creek within and upstream from the project area. A lower ground plane layer of vegetation in riparian areas is expected to be dominated by nonnative grassland species. The remainder of the nonagricultural crop vegetation present on-site is dominated by nonnative grassland species. Bladderpod (*Peritoma arborea),* are other saltbush scrub shrub species are present in modest numbers within grassland areas.

3.8.2 Special-Status Species

Caliente Creek and its surroundings could potentially provide habitat for special-status species. A California Natural Diversity Database (CNDDB) search for special-status species occurrences in a 1-mile vicinity of the project area produced the plant and animal special-status species listed in Table 5. Table 5 describes the special-status species, status, and habitats.

Photo 17: Existing nonnative grassland and saltbush scrub present on areas not currently in ag production

Photo 18: Cottonwood trees on Caliente Creek, immediately upstream of project area

Table 5
Special-Status Species in Project Vicinity

Species Name	Status	Habitat
Plants		
Comanche Point layia *Layia leucopappa*	1B.1	Annual herb, native and endemic to California. Blooms March–April. Habitat includes chenopod scrub, and valley and foothill grassland.
San Joaquin woollythreads *Monolopia congdonii*	FE 1B.2	Annual herb, native and endemic to California. Blooms February–May. Habitat includes chenopod scrub, and valley and foothill grassland.
California jewelflower *Caulanthus californicus*	FE SE 1B.1	Annual herb, native and endemic to California. Blooms February–May. Habitat includes chenopod scrub, pinyon and juniper woodland, and valley and foothill grassland.
Bakersfield cactus *Opuntia basilaris* var. *treleasei*	FE SE 1B.1	Perennial stem succulent, native and endemic to California. Blooms April–May. Habitat includes chenopod scrub, cismontane woodland, and valley and foothill grassland.
Vasek's clarkia *Clarkia tembloriensis* ssp. *Calientensis*	1B.1	Annual herb, native and endemic to California. Blooms April. Habitat includes valley and foothill grassland.
Animals		
burrowing owl *Athene cunicularia*	CDFW SSC	Habitats include open spaces with sparse vegetation such as prairie, pastures, desert, or shrub-steppe. Uses nest burrows that can be several yards long, less than 3 feet deep.
pallid bat *Antrozous pallidus*	CDFW SSC	Habitats include rocky mountainous areas, usually near water, and open, sparsely vegetated grasslands. Prefers to forage in the open. Roosts in warm, horizontal openings.
blunt-nosed leopard lizard *Gambelia sila*	FE SE CDFW FP	Habitats include semi-arid grasslands, alkali flats, low foothills, canyon floors, large washes, and arroyos, usually on sandy, gravelly, or loamy substrate.
Tulare grasshopper mouse *Onychomys torridus tularensis*	CDFW SSC	Habitats include hot, arid grassland and shrubland communities, alkali sink, mesquite associations on the valley floor, upper Sonoran shrub associations, and grassland associations.
western spadefoot *Spea hammondii*	CDFW SSC	Uses temporary ponds, vernal pools, and backwaters of slow-flowing creeks for breeding and upland habitats such as grasslands and coastal sage scrub for aestivation.

CNPS: California Native Plant Society's California Rare Plant Rank:

1B: Considered rare, threatened, or endangered in California and elsewhere
2: Plants rare, threatened, or endangered in California, but more common elsewhere
3: Plants for which we need more information – review list
4: Plants of limited distribution a watch list

Decimal notations: .1 – Seriously endangered in California, .2 – Fairly endangered in California, .3 – Not very endangered in California

The following codes indicate whether a species has been included on a federal or state (California) list as endangered, threatened, rare, candidate, etc.: **CDFW SSC:** listed as California Department of Fish and Wildlife Species of Special Concern; (**FP**) listed as Fully Protected. **State listed wildlife:** (**SE**) state listed, endangered; (**ST**) state listed, threatened. **Federal candidate and listed wildlife:** (**FE**) federally listed, endangered; (**FT**) federally listed, threatened.

Of the species described in Table 5, Bakersfield cactus (*Opuntia basilaris* var. *treleasei)* was reported within the project area by the CNDDB. This species is a federally and state endangered species, and the presence of the species in the project area would need to be confirmed and mitigated, if the project were to impact the species. In addition, the VFHCP reports that extant populations of Comanche Point layia (*Layia leucopappa*), a nonlisted special-status species, are primarily located in the Caliente Creek drainage, and at the bases of the Tejon and Comanche Hills (Kern County 2006).

USFWS designates critical habitat for certain special-status species. A review of available data indicates no critical habitat designations in the vicinity of the project.

3.8.3 Wetlands and Jurisdictional Waters

The project area includes a creek bed that the project would enhance/restore. Waters and wetlands are regulated by resource agencies charged with carrying out the federal Clean Water Act (CWA), and the state Streambed Alteration Program.

3.8.3.1 Clean Water Act, Section 404

Section 404 of the CWA requires that project proponents obtain a permit from USACE before performing any activity that involves any discharge of dredged or fill material into "waters of the U.S.," including wetlands.

A recent jurisdictional delineation along Caliente Creek, Tehachapi Creek, and their unnamed headwaters was performed, and a determination was released by USACE (SPK-2014-00236). In this determination, USACE concluded that no CWA jurisdictional waters were present along the length of the creek, primarily because the creek is considered isolated waters and does not contain a significant nexus with traditional navigable waters. Caliente Creek ends at Malaga Road. The roadway does not contain any culverts, and there are no other indications of a hydrologic connection to traditional navigable waters.

Because USACE concluded no CWA jurisdictional waters are present on the site, no further investigations or permitting for USACE will be necessary to move forward with the project.

3.8.3.2 Clean Water Act, Section 401

Because it was determined that actions within Caliente Creek would not require a permit pursuant to Section 404 of the CWA, a certification pursuant to Section 401 of the CWA would also not be required. However, a certification from the Regional Water Quality Control Board

(RWQCB) may still be necessary for the discharge of waste or fill material into isolated waters under the Porter-Cologne Water Quality Control Act, as described below.

3.8.3.3 Porter-Cologne Water Quality Control Act

Pursuant to Section 13000 et seq. of the California Water Code (CWC) (Porter-Cologne), the RWQCB is authorized to regulate any activity that would result in discharges of waste or fill material into waters of the state, including "isolated" waters and/or wetlands (e.g., vernal pools and seeps), saline waters, and groundwater within the boundaries of the state (CWC Section 13050[e]). Porter-Cologne authorizes the State Water Resources Control Board to adopt, review, and revise policies for all waters of the state, and directs the RWQCB to develop and implement regional Basin Plans that recognize and are designed to maintain the unique characteristics of each region with regard to natural water quality, actual and potential beneficial uses, and addressing water quality problems of that region (CWC Section 13050[j]). Parties proposing to discharge waste that could affect state waters may need to file a Report of Waste Discharge, and the RWQCB may respond by issuing Waste Discharge Requirements (WDRs), or waiving the WDRs.

3.8.3.4 Lake and Streambed Alteration Program

Pursuant to Section 1600 et seq. of the California Fish and Game Code, the California Department of Fish and Wildlife (CDFW is authorized to regulate any activity that would alter the flow, bed, channel, or bank of all streams and lakes. Jurisdictional waters of the state, as defined by Section 1600 regulations, include the "bed, channel, or bank of any river, stream, or lake designated by [CDFW] in which there is at any time an existing fish or wildlife resource or from which these resources derive benefit." In practice, CDFW usually extends its jurisdictional limit to the top of the bank of a stream or lake, or to the continuous outer edge of its riparian extent, whichever is wider.

Given the periodic flows and flooding of Caliente Creek, and the extent to which CDFW takes jurisdiction of episodic streams, it is likely that CDFW would take jurisdiction of at least some channels in the upper and lower portions of the stream where there is a more well-defined channel bed and bank. A delineation study could help identify the reach of CDFW jurisdiction, where channels may be relict, and the current extent of the creek bed and bank.

3.8.4 California Natural Communities Conservation Planning Act

The California Natural Communities Conservation Planning Act of 1991 was enacted to help local government collaborate with wildlife agencies to conserve ecosystems and threatened and

endangered species and habitats. Many local governments have wildlife-agency-approved plans, which allow them to issue Incidental Take Permits for covered species on behalf of the wildlife agencies.

The project area is within the boundaries of the VFHCP (Kern County 2006). The VFHCP has mapped the area covered by the plan into a hierarchy of zones. The Red Zones, of highest importance, include habitat for VFHCP covered species. Green Zones contain habitat of moderate importance for conservation purposes. Some Green Zone lands are/will be targeted for acquisition for preserves. White Zones are of lower conservation importance due primarily to existing intensive agricultural and other uses. The project area is partially labelled in the VFHCP as a Green Zone, and partially labelled as a White Zone. The White Zone part of the project area is mapped as agricultural land, while the Green Zone portion is mapped as nonnative grassland area. Given the project's goals of establishing habitats and restoring more natural ecosystem functions, the project is expected to be compatible with VFHCP policies and goals.

4.0 PLANNING PROCESS

Work began with review of existing data and relevant previous planning studies, followed by preparation of baseline existing conditions data for use on the project, as summarized in previous chapters of this study. This chapter summarizes the planning framework and design parameters that establish the basis for determining feasibility and selecting a preferred project design.

4.1 PROJECT UNDERSTANDING AND APPROACH

4.1.1 Definition of Feasibility

There are a wide range of potential solutions that address the project purpose and goals discussed in Section 2.2. However, the solution that is most feasible will provide the most opportunity to address the issues surrounding Caliente Creek. A feasible solution is buildable, functional, approvable, and affordable.

- A buildable solution is one that can be practically carried out. Issues considered in determining if a solution is buildable include realistic structural and geotechnical considerations, utility and infrastructure constraints, overall landform and slope conditions, and material disposal/placement options for excavated material.
- A functional solution is one that operates as designed, and achieves the goals of the project while in operation. A functional solution must also be in balance with natural processes to work as designed and avoid maintenance and repair issues.
- An approvable solution is one that local, federal, and state agencies would recognize the benefits of, and would issue permits and approvals for.
- An affordable solution is one that considers both the one-time construction costs and the ongoing annual maintenance and repair costs of the proposed project. An affordable and sustainable solution would provide long-term cost savings that outweigh the long-term costs.

These elements of feasibility were used to evaluate potential design alternatives.

4.1.2 Basis of Design

Project goals, as summarized in Section 2.2, seek a reduction of downstream flooding and sediment impacts through a combination of slowing, filtering, and infiltrating storm water on

Caliente Creek's alluvial plain. Selecting a set of alternatives to consider from a virtually unlimited set of possibilities requires establishing a few primary design targets. Based on review of existing conditions and collaboration with County staff, the following targets were established as the basis of design for the project.

- Hydrology: The primary design target is the selection of an appropriate design storm event. Whereas most flood-related studies are most concerned with identifying and analyzing the 100-year storm event, this project instead focuses on the smaller but more frequent 5-year and 2-year events. Protecting against damage from the 100-year event is beyond the capacity of this site to address. Furthermore, the flood damage that instigated the CRMP and this feasibility study is generated by the frequent small storms. The original intent of the feasibility study was to analyze the 5-year and 10-year events. After reviewing the results of the 5-year event with Kern County, however, County staff determined that analysis of the 2-year event would be of greater value and more reflecting of the chronic problems that Kern County faces during more frequent smaller storm events.

- Sediment Transport: No specific targets for capture of sediment were identified for the study. Through initial investigations and discussions with County staff, it was determined that solutions that re-create or mimic the historic geomorphology and natural function of the alluvial plain are preferred. While it may be possible to maximize project performance through use of carefully engineered water control structures, several feasibility factors work against such solutions and instead favor solutions that mimic natural systems. The purpose of the study is to quantify the degree of sediment reduction possible and determine the feasibility of the project.

- Groundwater Infiltration: No specific groundwater infiltration target was identified for the study. The purpose of the study is to quantify the degree of infiltration possible, determine the feasibility of the project, and identify additional studies if needed.

- Habitat Restoration: Habitat mitigation projects typically have aggressive expectations for the quality of the new habitat, as measured by native cover, lack of weed cover, species diversity, and similar measures. The proposed habitat restoration targets a more modest expectation for two important reasons. First, both the site and/or the surrounding foothills are dominated by nonnative grassland species that spread quickly and aggressively. The level of effort to successfully establish native habitats with low weed cover would be extremely high, with continuing high weed management costs annually through time to defend against invasion from seed sources washed in by stream flows or blown in from surrounding areas. Second, Kern County funding is limited and cannot support such a high ongoing management cost. Furthermore, the project is not proposed

as mitigation for impacts to habitat or as a focused special-status species conservation effort.

4.1.2.1 Other Design Criteria

Other pragmatic issues were considered as part of the design targets. From a land use perspective, the primary design target is to eliminate conventional till agriculture from the project area given its role in currently making the project area function as a sediment source. Possibilities may exist for certain agricultural activities to continue within the project area as uses subordinate to the primary project goals. Existing roadways are similarly considered detrimental to achieving project goals due to the effect raised road prisms and borrow ditches have on hydraulics, sediment transport, and geomorphology. With the elimination of agriculture and support facilities from the project area, formal access roads are no longer needed. Therefore, the design targets the elimination of all roads interior to the project footprint.

4.2 PRELIMINARY CONCEPTUAL ALTERNATIVES CONSIDERED BUT NOT SELECTED

Based upon initial investigations and a workshop held with Kern County staff, four conceptual alternative approaches to the project were identified. The recommended alternative/proposed project (full-restoration) is described in detail in Chapter 5. The remaining alternatives are briefly described below, along with the anticipated benefits and problems as compared to the recommended alternative. Detailed modeling and quantified results were prepared for the recommended alternative only.

4.2.1 Alternative 1: Passive Restoration

Under this alternative, all agricultural uses would cease, but no grading or active restoration efforts would be implemented. The project area would be allowed to revegetate passively.

Benefits:

- Lowest cost to implement and maintain.
- Would likely sharply reduce the amount of sediment loss from the project area by eliminating tilled soils.
- Allows for incremental future actions to improve project function after observing results of the basic initial project implementation.

Problems:

- A major key to achieving project goals is simply spreading flow over as much area as possible. While many of the minor grading alterations that control and channelize flows would be erased by flood flows over time, the largest alteration (on the east and south edges of the downstream half of the project) would persist indefinitely. The persistence of this channelized section would prevent flood flows from accessing a large portion of the alluvial fan, reducing infiltration, filtering, and other project benefits accordingly.
- Vegetation communities that would colonize the project would likely have a relatively low shrub component. Benefits of densely branched and rigid shrubs on slowing flow velocities and filtering sediment would be reduced.

4.2.2 Alternative 2: Retain Partial Agricultural Production

This alternative is the same as the full-restoration alternative (recommended alternative, discussed in Chapter 5), but would identify portions of the site that could remain in agricultural production if the results of project modeling suggest it's feasible to do so and still achieve project goals. Areas that would be considered eligible to remain in agricultural production would be those not subject to flood flow. Further enhancement of this alternative could include converting agricultural production from annual crops or those that require annual tillage to perennial crops or those that do not require regular soil tillage.

Benefits:

- Reduces the effect of the project on agriculture in the area.
- Areas remaining in agriculture would be better aligned with project goals.
- Would likely achieve performance benefits similar to the recommended alternative for high frequency storm events.
- If the County acquired all land within the project area and issued leases for areas to remain in agricultural production, the leases could be a potential source of revenue to help fund ongoing maintenance costs, and they would provide the County with more control over land management.

Problems:

- Modeling shows that few areas within the project would remain available for agriculture.

- Larger, low frequency storms would flood the entire alluvial plain, including retained farming areas.
- Though leases could provide revenue, the County would need to allocate funding to management of the leases. It is uncertain at this time whether such a program would be revenue positive.

4.2.3 Alternative 3: Engineered Structures and Basins

This alternative focuses on developing a more uniform application rate by spreading storm flows over a larger area using engineered structures, weirs, basins, etc. to maximize water retention, sediment trapping, and groundwater infiltration. There are many different ways to approach this with different objectives in mind, but essentially these solutions can be designed around two objectives

1. Slow the flow down and spread the water out for a more uniform application rate. This could be accomplished by constructing a series of short dams capable of holding 100 acre-feet or more, creating spreading basins that maximize groundwater infiltration (similar to the conceptual solution proposed in the CRMP).
2. Preserve high infiltration rates with a series of retention basins upstream of spread basins to capture and remove sediment before it enters and clogs the pores of the downstream spreading basins. These facilities are typical of recharge facilities downstream of dams where sediment is problematic and large sustained flows provide a revenue stream to offset the implementation and maintenance costs.

For this project, there isn't evidence that fine sediments that would affect infiltration are a large problem, and flows are low duration, thus there would be little initial value added by using retention basins. However, over many years of service, clogging of pores by fines could reduce infiltration. The decision on whether there is a long-term need for retention basins is, therefore, a complex and difficult one. This alternative assumes that retention basins to manage silt would be necessary to ensure continued function of the solution.

<u>Benefits</u>:

- Engineered systems could potentially greatly increase the capacity of the project to increase groundwater recharge and reduce downstream flooding and sediment impacts.

Problems:

- Engineered solutions would be much more costly to design, construct, operate, and maintain. Ongoing maintenance costs could be extremely high if large quantities of sediment are captured by settling and infiltration basins. Removal and disposal of sediment is very costly, and finding disposal sites for the material may be challenging.
- Controlling the flows over the vast expanse within the study limits to develop a more uniform application would result in large structures and significant areas of regrading incurring significant costs and potential environmental impacts.
- Though initial infiltration from holding basins would be very high, settling of fine materials could reduce infiltration over time unless additional settling basins are incorporated to capture the fines. Though such designs have been implemented by others, they add substantial additional construction and maintenance costs.
- Engineered solutions are prone to catastrophic failure from large, low-frequency storms if earthen structures are used. Concrete structures designed to withstand such high flows would be prohibitively expensive. Failures could result in substantial downstream risks and high repair costs.
- The habitat value of the project may not be as high as other alternatives.

4.2.4 Alternative 4: Full-Restoration

The Full Restoration alternative is the recommended solution for the project. See Section 5.0 for a detailed description of this alternative.

4.2.5 Alternatives Comparison

Table 6 below summarizes the anticipated performance of each alternative against project goals and feasibility criteria. Evaluations are qualitative and provided to illustrate the general differences between alternatives considered and the reason why Alternative 4 (described in Chapter 5) was selected for more detailed analysis and modeling.

Table 6
Project Goals and Feasibility Criteria

Alternative	Project Goals					Feasibility Criteria			
	Reduce sediment source	Increase sediment capture	Increase recharge	Improve habitat value	Clarify and purify water	Buildable	Functional	Approvable	Affordable
Alt 1: Passive Restoration	M	L	L	M	L	H	L	H	H
Alt 2: Retain Partial Ag	H	M	M	H	M	H	H	H	M
Alt 3: Engineered Structures	H	H	H	L	H	L	H	L	L
Alt 4: Full-Restoration	H	M	M	H	M	H	H	H	M

Key: H = High, M = Moderate, L = Low

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5.0 RECOMMENDED ALTERNATIVE – FULL-RESTORATION

The CRMP identifies two distinctly different projects within the project limits for this study. The portion upstream of Highway 58 proposed restoration of natural landforms and native habitats, while the downstream portion proposed a series of water control structures that would target maximum infiltration. Because feasibility of solutions is a critical consideration, and because there are potentially large concerns with regulatory and economic feasibility of implementing the water control structures proposed in the CRMP, this study proposes applying a restoration-oriented solution to the entire project area.

The full-restoration alternative (Figure 10) proposes re-creating, as closely as possible, pre-development natural function to the Caliente Creek alluvial plain. Though it may not meet groundwater infiltration and sediment capture goals as well as Alternative 3, it provides the best combination of achieving project goals and meeting feasibility criteria. The objectives of the full-restoration alternative are to spread storm flows over as much of the alluvial fan as possible, and slow the velocity of storm flows as much as possible. These objectives work together to achieve project goals by reducing the water's ability to capture and transport sediment, and allowing the natural porosity of the alluvial fan to infiltrate as much runoff as possible before it exits the project. Using a natural systems restoration approach allows the project to remain flexible and severely reduces the need for maintenance to maintain project performance over time (e.g., removing sediment captured in basins).

5.1 LAND USE CHANGES

The proposed project converts all agricultural land uses within the project boundary to open space habitat. Doing so will maximize project benefits; however, it may be possible to maintain some level of agricultural use of the property if needed or desired. Possible agricultural uses that could be compatible with project goals include perennial/no-till crops, cutting hay, or carefully managed grazing.

5.2 GRADING/LANDFORM

Agricultural uses within the project area have, over time, created a series of water diversion ditches, poorly constructed dikes and levees, and road grades that have substantially altered how water moves through the site. The landform modifications all tend to limit the spatial extent of flood flows, which in turn limits infiltration, increases runoff velocity and volume, and increases transport of sediment and flood flows downstream. Proposed grading seeks to eliminate the

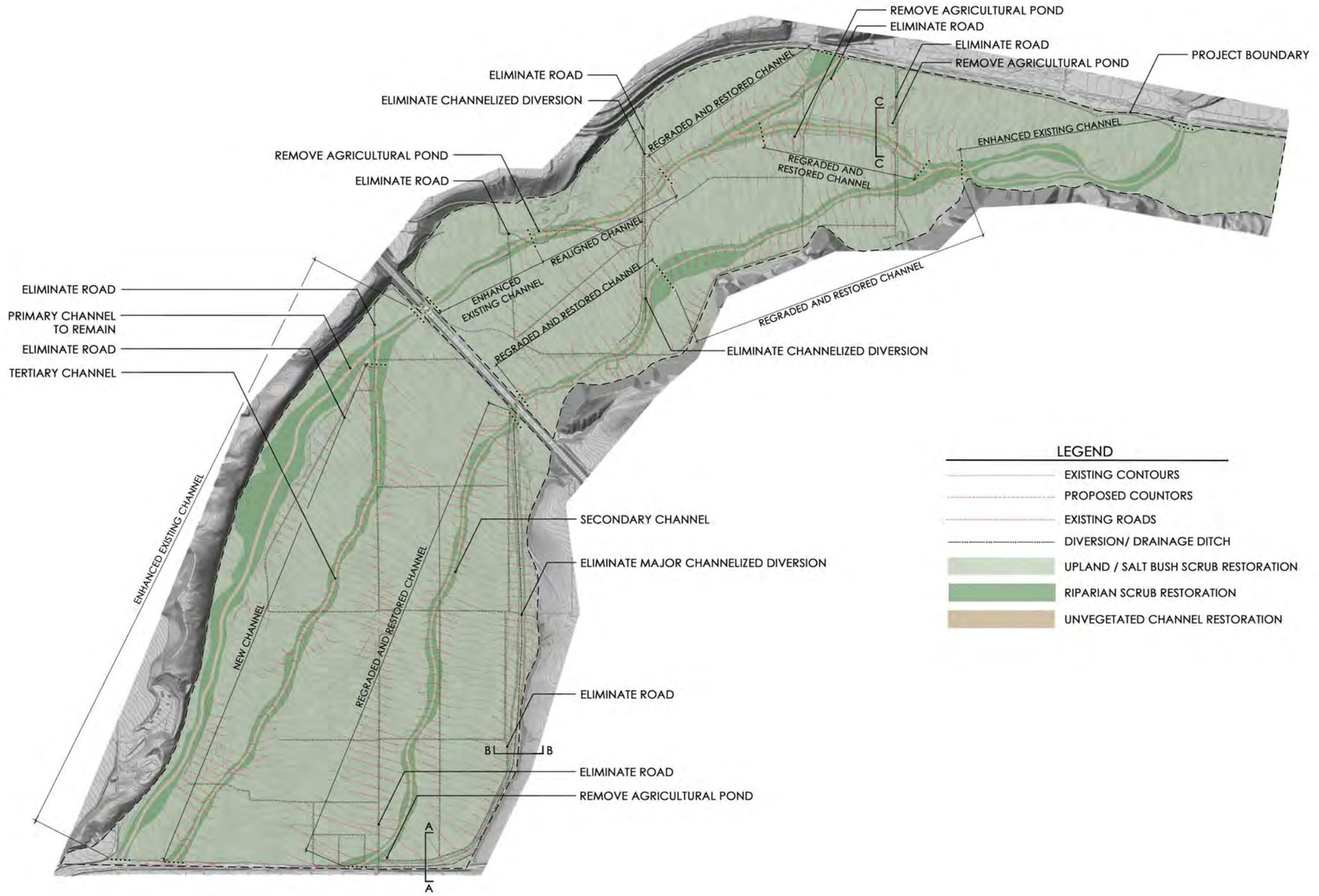
human landform alterations and reestablish a highly natural geomorphological function within this portion of Caliente Creek's alluvial plain.

A review of historical aerial photographs over time helped to illustrate the original flow and channel patterns within the project area. Alluvial plains are very geomorphically active, with major changes in channel configuration occurring in response to larger storms over time. The proposed grading plan is based upon patterns identified on those historical aerials. Some portions of existing channels will remain as-is, while others that have been heavily impacted by agriculture will be realigned or restored. New channels are proposed where they have been completely eliminated by agricultural modifications. Following implementation of the project, the natural dynamics of the alluvial plain will resume, with changes in channel patterns occurring over time. Figure 10 illustrates the work proposed to restore channels, and Figures 11 through 13 provide graphic sections illustrating the most critical grading changes. Implementation of the recommended grading plan would require approximately 800,000 cubic yards of earthwork.

The most important components of the proposed grading are the elimination of the artificial dike and channel on the east and south edges of the lower half of the project, and the north-south diversion ditch in the upper half of the project. Minor features such as road grades and ditches would also be eliminated. These modifications allow storm flow to spread over a much larger portion of the site, which is key to achieving project goals.

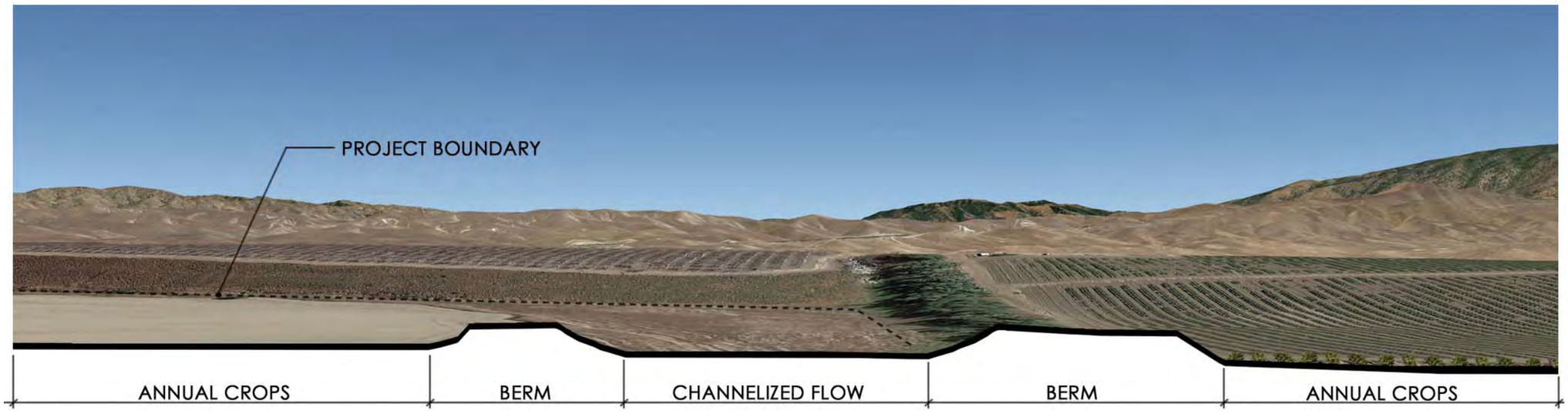
5.3 PLANTING

The proposed solution targets restoration of natural landforms, geomorphology, and habitats within the project limits, including the restoration of saltbush scrub habitat throughout the project extent. Habitats within the drainage channels, while maintaining many of the same saltbush scrub species, would include other species common to riparian zones and are shown in the project plan as riparian scrub to reinforce that subtle distinction. Drainage channels are not expected to support a consistent riparian forest, though scattered Freemont cottonwood (*Populus fremontii*) are expected to establish successfully.

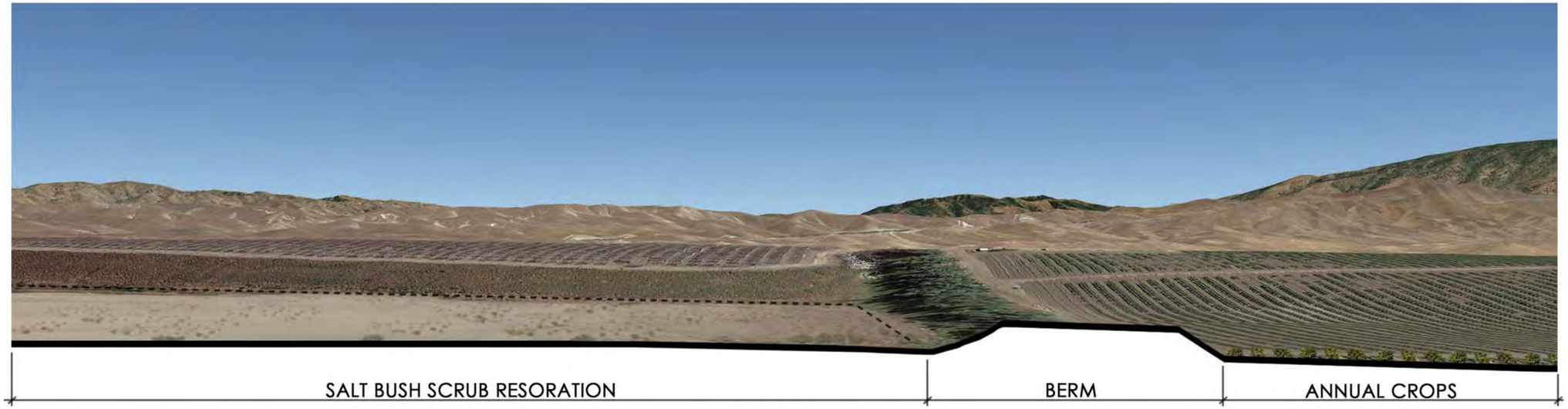


Source: Meyer Civil Engineering

Figure 10
Proposed Project Design



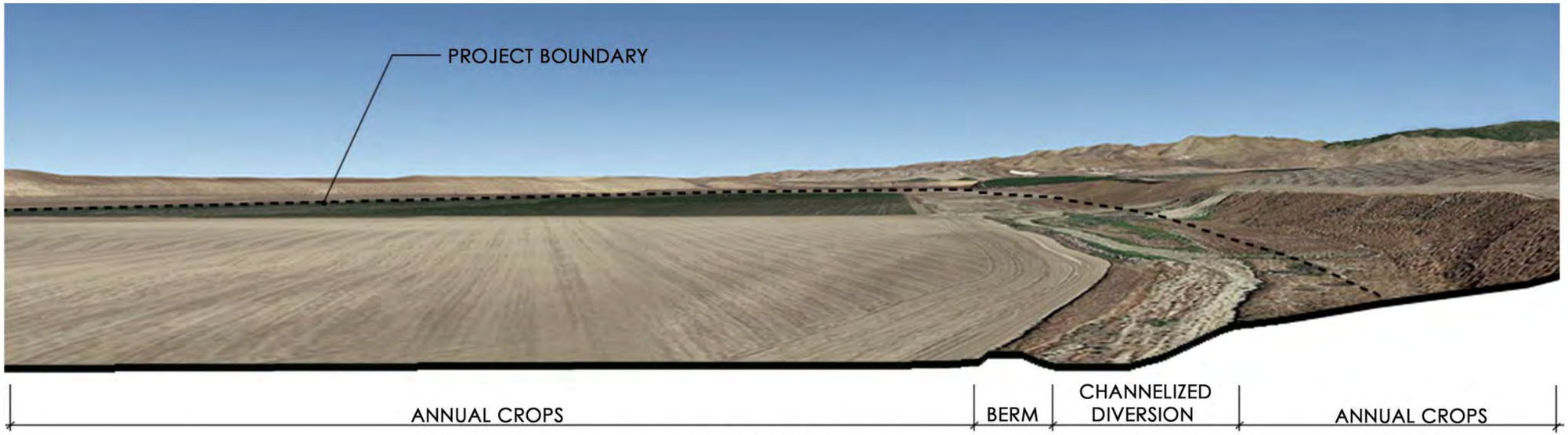
SECTION A-A
EXISTING CONDITIONS LOOKING EAST



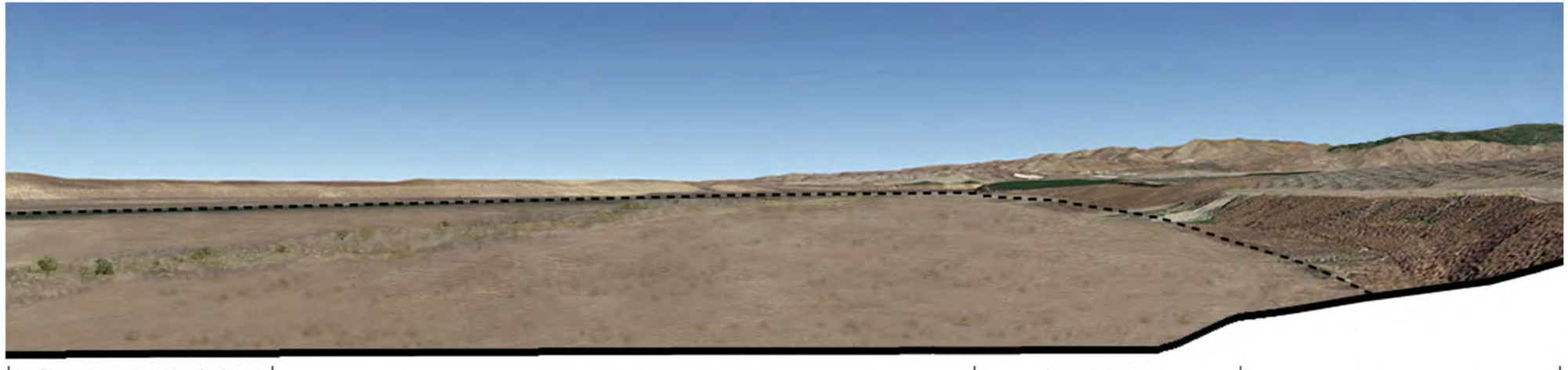
SECTION A-A
PROPOSED HABITAT RESTORATION LOOKING EAST

Source: Meyer Civil Engineering

Figure 11
Section A-A



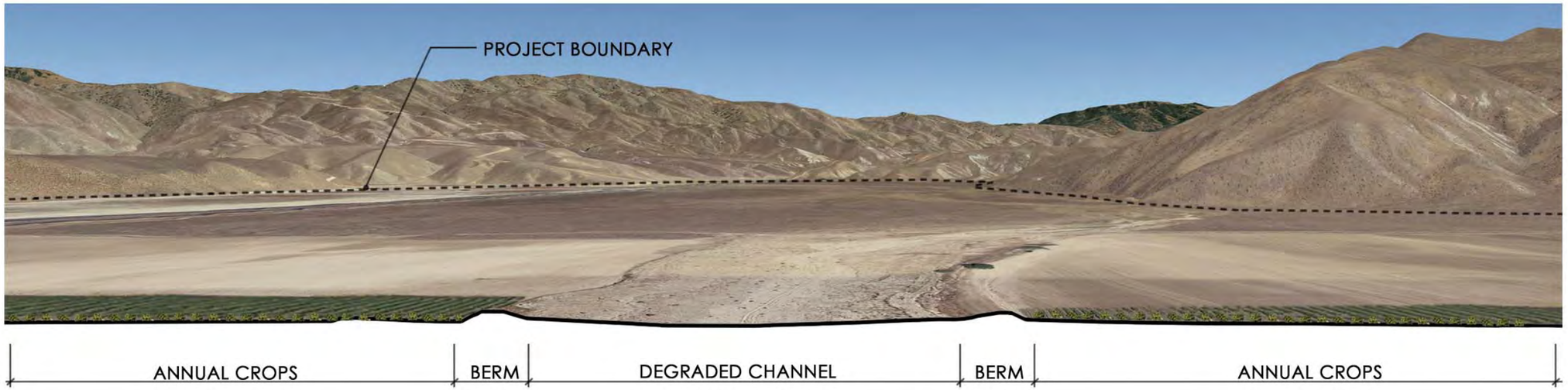
SECTION B-B
EXISTING CONDITIONS LOOKING NORTH



SECTION B-B
PROPOSED HABITAT RESTORATION LOOKING NORTH

Source: Meyer Civil Engineering

Figure 12
Section B-B



SECTION C-C
EXISTING CONDITIONS LOOKING NORTH

SECTION C-C
PROPOSED HABITAT RESTORATION LOOKING NORTH

Source: Meyer Civil Engineering

Figure 13
Section C-C

Photo 19: Proposed saltbush scrub species are 4-5' tall, with dense, stiff branching habitats

All portions of the project area will be enhanced through planting and seeding. Areas that are bare soil due to agricultural production or project grading work will be seeded with a native seed mix to stabilize the soils and establish new habitat. Areas that will not be graded, and are already in a natural or naturalized state, will be enhanced through selective weeding and seeding. Soil amendments are not anticipated to be necessary given the history of successful agricultural production on the site; however, soil tests should be conducted throughout the site to verify conditions are suitable for seeding.

It is recommended that seeding be completed using imprinting methods. Imprinting uses specialized tractor-mounted equipment with a heavy roller studded with metal nobs (Photo 20). After the implement applies seed to the soil surface, the roller slightly compacts the soil, while the nobs create numerous small basins (Photo 21). The equipment allows for large areas to be seeded quickly, promotes soil stabilization, reduces runoff, and aids in plant establishment. Areas that currently support substantial shrub growth and will not be graded may not be suitable for imprinting methods and should instead be seeded via hydroseeding. For each phase of the project, seeding should occur following the completion of grading or earthwork. The ideal time period for seeding is approximately October, which would ensure seeding is complete prior to the start of the rainy season.

Photo 20: Imprinting equipment

Photo 21: Effect of imprinting on soil surface

Table 7 includes conceptual seed mixes that would apply to habitat zone within the project area. These planting specifications are based on the historic plant communities of the project area, as described in the CRMP and VFHCP.

Table 7
Conceptual Seed Mixes

Planting Zone	Common Name	*Scientific Name*
Upland / Saltbush Scrub		
	cheesebush	*Ambrosia Salsola*
	common salt bush	*Atriplex polycarpa*
	spiny salt bush	*Atriplex spinifera*
	common tarweed	*Centromadia pungens* ssp. *Laevis*
	California poppy	*Eschscholzia californica*
	alkali heath	*Frankenia salina*
	alkali goldenbush	*Isocoma acradenia*
	arroyo lupine	*Lupinus succulentus*
	bladderpod	*Peritoma arborea*
	purple needlegrass	*Stipa pulchra*
	fescue	*Vulpia microstachys*
Riparian Scrub: Includes all of the above species PLUS the following		
	iodine bush	*Allenrolfea occidentalis*
	big salt bush	*Atriplex lentiformis*
	mulefat	*Baccharis salicifolia*
	Fremont's cottonwood	*Populus fremontii*

5.4 IRRIGATION

Given the scale of the project, irrigation is not recommended. Rather, seed application should be timed to take advantage of natural winter rainfall (see Section 5.3). In addition, it should be assumed that seeding may need to be repeated in portions of the project area to ensure that adequate germination is achieved. Typically, habitat restoration projects require temporary irrigation for 2 to 3 years to assist in initial establishment and survival of planted and seeded species. For this project, irrigation may be considered as a remedial or contingency measure if the desired vegetative cover is not observed after initial seeding plus two growing years. In such a case, particularly if the low amounts of cover are likely due to insufficient precipitation, irrigation could be used to supplement specific portions of the project area. Several existing wells support agricultural irrigation within the project area. If irrigation is needed as a contingency measure, these wells should be repurposed to serve that need, then closed or abandoned when no longer needed.

5.5 PROJECT PHASING

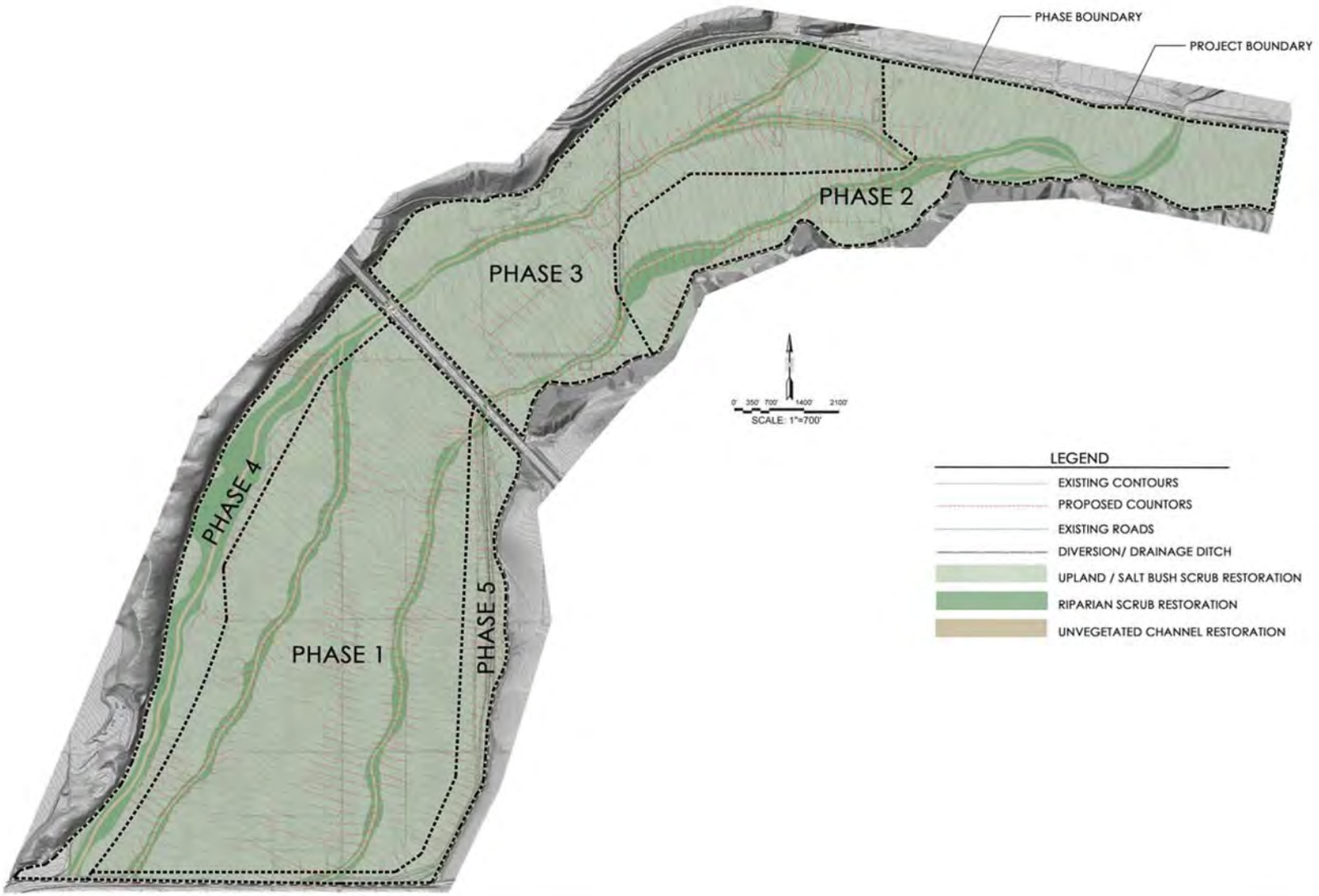
A phased implementation of the project is likely to be necessary, given its scale. Phasing of earthwork would reduce the potential for temporary erosion impacts from construction and allow for subsequent phases to adjust to observed changes resulting from early phases. Phasing could be accomplished in a variety of ways and should be given extensive consideration during final design; however, a preliminary phasing concept is presented in Figure 14. The goal of the phasing concept is to regrade and revegetate as much of the project as possible prior to eliminating the main channelized features. Doing so will give those areas to which flow will be redirected opportunity to revegetate and stabilize before being subjected to potentially damaging storm flow.

5.6 POST-CONSTRUCTION MAINTENANCE AND MONITORING

Habitat restoration projects typically include a 5-year (on average) post-construction establishment period following implementation, during which maintenance, monitoring, and reporting occur on a regular basis and site conditions are assessed against established performance criteria or success standards. While this project may not be required by regulatory agencies to implement a 5-year program, it is advisable to plan for a 5-year establishment period to ensure the project has adequate opportunity to successfully establish and become ready to support project goals. This period would begin following the end of implementation for each phase, including all initial grading, earthwork, seeding, and planting. Maintenance, monitoring, and reporting would occur on a more frequent basis during this initial management period. Basic success standards should be established to ensure that each phase of the project is on track to develop the desired conditions and to provide information to guide adaptive management, if needed. Because the project is not being undertaken as mitigation for impacts to sensitive resources, the standards provided below can be considered as somewhat flexible guidelines to evaluate project performance in relation to the project's goals.

The conceptual success standards listed below could be used to establish more formal success standards once the project is in the detailed designing phase.

- Minimum of 25–30% native cover.
- Minimum of 25% cover from shrubs at 3 feet or taller.
- Minimum of 60% cover at ground level (inclusive of nonnative grass and herbaceous species).



Source: Meyer Civil Engineering

Figure 14
Phasing

- During each year of the post-construction establishment period, nonnative species cover within the project area should not exceed 50% absolute cover, and percent cover of noxious or invasive weed species[1] should not exceed 10% absolute cover.

The post-construction establishment period would include both habitat monitoring and erosion and sediment transport monitoring. It is recommended that habitat monitoring be conducted on at least a semiannual basis, with visits in the late winter/early spring (February/March) and late spring/early summer (May/June). During habitat monitoring surveys, the following conditions should be assessed:

- Native germination and percent cover.
- Percent weed cover and presence of noxious or invasive species.
- Need for additional seeding, weeding, or other maintenance activities.

It is recommended that erosion and sediment transport monitoring be conducted on at least a semiannual basis as well, with visits in the late fall/early winter (November/December), following the first winter storm events, and late winter/early spring (February/March), following the rainiest months of the year. In addition, erosion and sediment transport monitoring should be conducted after the occurrence of any 5-year or higher storm events, to evaluate whether project implementation has succeeded in mitigating flooding and sediment transport from these storm events and whether remedial grading may be needed to address undesirable erosion or sediment transport issues.

Erosion and sediment transport monitoring should focus on key locations of each phase of the project where substantial topographic changes have been made (e.g., removal of human landform alterations) or where significant flooding, sedimentation, or erosion problems have been observed in the past (such as the area immediately downstream from the project boundary). The purpose of conducting monitoring at these locations would be to verify that the implemented grading and landform changes are functioning as intended to reduce flooding, sedimentation, and erosion issues within and downstream of the project area.

The results of habitat monitoring should be used to inform the need for maintenance, which may include supplementary seeding for targeted portions of the project area with low native cover, control of specific populations of invasive or noxious weed species, select treatment of

[1] For the purposes of this project, noxious or invasive weeds are defined as those species recognized by the California Invasive Plant Council (Cal-IPC 2006) as “high” and “moderate” threats to California wildlands or by the U.S. Department of Agriculture (USDA 2012) as noxious weeds. However, nonnative grass and forb species that are ubiquitous in the surrounding areas should not be considered noxious or invasive, as it is infeasible to prevent these species from colonizing the project area.

ubiquitous or naturalized weed species to reduce competition with germinating native species, or additional planting of the created channels. These are the primary maintenance activities that may be needed during the post-construction establishment period. One to two maintenance visits per year should be anticipated during this period. Supplementary seeding should be conducted using the same methods and specifications as described in Section 5.3, although seeding rates could be reduced, if appropriate. Weed control should be conducted using aquatic-approved herbicides, by personnel trained in the application of herbicide and identification of the target species, under the supervision of an individual with a Qualified Applicators License.

The results of erosion and sediment transport monitoring should be used to determine whether remedial grading or earthwork is needed to meet the goals of the project with regard to flooding, sedimentation, and erosion. The need for minor remedial grading should be anticipated.

Basic maintenance and monitoring reports should be prepared on an annual basis during the post-construction establishment period to document monitoring results, maintenance activities, and performance for each phase of the project. Annual reports may also be a requirement of any permits that the project is required to obtain. At a minimum, annual reports should contain the following information for each active phase of the project:

- A summary of habitat and erosion and sediment transfer monitoring results, including dates and locations of monitoring visits;
- A summary of habitat and erosion and sediment transfer maintenance activities;
- A discussion of project performance in relation to any established success standards as well as to the larger goals of the project;
- Recommendations for future maintenance activities or remedial measures; and
- Any additional information required by the project's permits.

Annual reports should be prepared by the contractors conducting the grading and restoration activities and would be submitted to the County Public Works Department and any permitting agencies with reporting requirements satisfied by these reports.

5.7 LONG-TERM MANAGEMENT PLAN

Following the post-construction establishment period, the project would enter a long-term management period, which is expected to last in perpetuity or until the project area is turned over to a different management agency, at which time new management guidelines could be established by that agency. It is possible that, in the future, portions of the project area may be

dedicated to different land uses, such as low-intensity grazing or alternative agricultural uses (see Section 5.1). In such a case, revised management guidelines would be created for the portions of the project area subject to those alternative uses.

The ultimate goal of the long-term management plan is to ensure that the project area continues to function as designed with regard to flood, sediment, and erosion control. Secondary goals may include maintaining or improving the condition of the project area with regard to biological resources. It is anticipated that funding for long-term maintenance would be limited; therefore, long-term management should focus on maintaining the functions of the project in preventing flooding and sedimentation of downstream areas.

To that end, it is recommended that erosion and sediment transport monitoring continue during long-term management, though with reduced frequency. This type of monitoring should continue to focus on large precipitation events and target locations within the project area with the potential for flooding or sedimentation. The project is designed to accommodate flows from high frequency storm events, and larger storm events will likely lead to changes in the existing and proposed channels. Although this is a natural process, if these changes prove problematic (i.e., lead to increased flooding or sedimentation in downstream areas), then additional grading or other hydraulic modifications may be needed to correct these issues. However, as long as topographic changes within the project area do not lead to such problems, the topography of the site should be allowed to develop naturally.

Habitat monitoring may also be continued during the long-term management period, if desired. This type of monitoring could focus on maintaining the conditions established during the post-construction establishment period or on improving these conditions for the benefit of native plant and wildlife species. The primary method for fulfilling either of these goals would be the control of nonnative plant species. As described previously in Section 5.6, the highest priority weed species would be noxious or invasive species that are not already naturalized to the project area. Due to the nature of the surrounding areas and the project area's long history of disturbance, it would be infeasible to establish pristine native habitat on-site. However, weed management could focus on select invasive species or portions of the project area that are of highest priority for improvement. Therefore, habitat maintenance during the long-term management period is anticipated to consist primarily of weed control.

5.8 PROJECT PERFORMANCE

The full-restoration design alternative was prepared and modeled using methods consistent with existing conditions modeling. Results of the modeling, and a discussion of how they relate to

project goals, are summarized below. Full details of the modeling process and results can be found in Appendix B.

Due to the vast area analyzed, the FLO-2D model was divided into two parts; upstream of Highway 58 (North Model) and downstream of Highway 58 (South Model). Tables 8 and 9 summarize the results of the proposed full-restoration alternative under both 2-year and 5-year design events.

Table 8
Results for Proposed Full-Restoration Alternative, 2-year event

1 Model	2 Water Inflow (Acre-Feet)	3 Water Infiltration (Acre-Feet)	**Water Infiltration Improvement**	4 Water Left on Floodplain (Acre-Feet)	5 Water Outflow (Acre-Feet)	**Water Outflow Improvement**	6 Inundated Area (Acres)	**Inundated Area Improvement**	7 Sediment Inflow (Cubic Feet)	9 Sediment Leaving (Cubic Feet)	**Sediment Flow Improvement**
Existing Condition	3010	2744		106	160		1018		298502	11575	
Proposed Condition without Riprap	3010	2899	**6%**	111	0	**100%**	1095	**8%**	298502	0	**100%**
Proposed Condition with Riprap	3010	2899	**6%**	111	0	**100%**	1092	**7%**	298501	0	**100%**

Table 9
Results for Proposed Full-Restoration Alternative, 5-year event

1 Model	2 Water Inflow (Acre-Feet)	3 Water Infiltration (Acre-Feet)	**Water Infiltration Improvement**	4 Water Left on Floodplain (Acre-Feet)	5 Water Outflow (Acre-Feet)	**Water Outflow Improvement**	6 Inundated Area (Acres)	**Inundated Area Improvement**	7 Sediment Inflow (Cubic Feet)	9 Sediment Leaving (Cubic Feet)	**Sediment Flow Improvement**
Existing Condition	5860	4748		5	1107		1649		581128	138050	
Proposed Condition without Riprap	5860	5316	**12%**	3	541	**51%**	1836	**11%**	581128	71942	**48%**
Proposed Condition with Riprap	5860	5257	**11%**	3	600	**46%**	1817	**10%**	581143	2727	**98%**

Results for the full-restoration alternative show the project design is very effective at achieving project goals. Key results include:

- Flow currently contained within channelized sections is effectively uncontained by the proposed grading plan, allowing for a much greater degree of spreading of flow over the alluvial plain;
- Increase in water infiltration of 10%;
- A 51% decrease in quantity of water exiting the project under 5-year event conditions, and a 100% decrease in water exiting the project under 2-year event conditions; and
- A 48% and 100% decrease in sediment exiting the project under 5-year and 2-year events, respectively.

Upon review of initial modeling for the full-restoration alternative, several high-velocity areas near bridges, culverts, and certain channel banks were identified. An additional model run was prepared for each design event that evaluated the effect of placing rock protection (riprap) on these high-velocity areas. While the full-restoration design without riprap was shown to be highly effective, the riprap modification was shown to further improve results for sediment transport (98% reduction in sediment exiting the project under 5-year event conditions), though it was not quite as effective at reducing flow of water or increasing the area of inundation.

Figures 15 through 42 present the results of modeling for flow depth, flow velocity, and sediment scour/deposition under existing conditions, proposed conditions under the full-restoration alternative, and proposed conditions for the riprap modification of the full-restoration alternative.

5.8.1 Habitats

As discussed in Section 4.1.2, the proposed project targets the restoration of saltbush scrub habitat throughout the project extent. Habitats within the drainage channels, while maintaining many of the same saltbush scrub species, would include other species common to riparian zones. Drainage channels are not expected to support a consistent riparian forest, though scattered Freemont cottonwood (*Populus fremontii*) are expected to establish successfully.

Undisturbed open space is increasingly rare as a result of expansive urban and agricultural development and is largely restricted to the sloping margins of the valley in Kern County. More than 90% of native habitats of the valley floor have been converted to human uses. The VFHCP estimates that approximately 10% of the area managed by that plan supports endangered species or their habitats. The restoration of the project area to natural habitats presents a unique opportunity to provide habitat for rare species such as western spadefoot, San Joaquin kit fox, blunt-nosed leopard lizard, and Tipton kangaroo rat. In addition to suitable habitat, the proposed project also provides an opportunity to preserve and restore uninterrupted large open spaces, where species can move between habitats without the risk of encountering human-caused threats (e.g., vehicles, pets, etc.).

Aside from habitat loss, a major threat to wildlife species is habitat fragmentation. Habitat fragmentation is caused by the bisecting of wilderness areas into smaller and smaller areas, which restricts species movement. This can affect species' ability to utilize their range at specific life stages, and ultimately affect the populations' gene pool. The project area's proximity to other large open spaces such as Sequoia National Forest, Bright Star Wilderness, and Tehachapi Mountain Park would work towards creating wildlife movement corridors that allow wildlife species to move within their habitat ranges.

5.8.2 Water Quality

The proposed project is expected to provide improvements to water quality, both within the project area and downstream. As discussed in Section 4.1.2, the project is designed to increase infiltration and relieve flooding of the surrounding area. The project area is currently largely agricultural, which can cause nutrient loading of nearby water bodies and runoff of pesticides. The proposed project would contribute to improved water quality downstream by eliminating agricultural activities within the alluvial plain. The proposed project would also improve groundwater quality by increasing infiltration and establishing natural vegetation. As water infiltrates naturally vegetated areas, plants help nutrient uptake, while the increased pervious area increases the amount of water percolating through the ground. No quantification of these benefits aside from sediment transport analysis was conducted as part of the feasibility study.

5.9 PROJECT IMPLEMENTATION

The previous sections describe the purpose and details of the proposed project. However, before project implementation, the following steps would need to be completed:

- The project area would need to be acquired by Kern County, either in fee title or through the dedication of easements that would allow the proposed project to be completed and protect the project area from undesired uses.
- Detailed design and construction documents would need to be prepared and approved by Kern County Public Works Department, including final grading plan and planting/seeding specifications. Further improvements to project performance are likely to be gained through a more detailed evaluation of grading options.
- Environmental documents, including California Environmental Quality Act and National Environmental Policy Act (if federal funding, property, or permitting decisions are required for the project) reviews, would need to be prepared and approved, and any applicable permits, such as a CDFW Section 1600 Streambed Alteration Agreement and RWQCB Report of Waste Discharge, would need to be obtained.
- Once the proposed grading plan was finalized, a detailed construction phasing plan should be prepared. The construction phasing plan would identify the different phases of the project, the order in which grading would occur, strategies to protect newly graded areas from erosive storm flows, and construction cost estimates.

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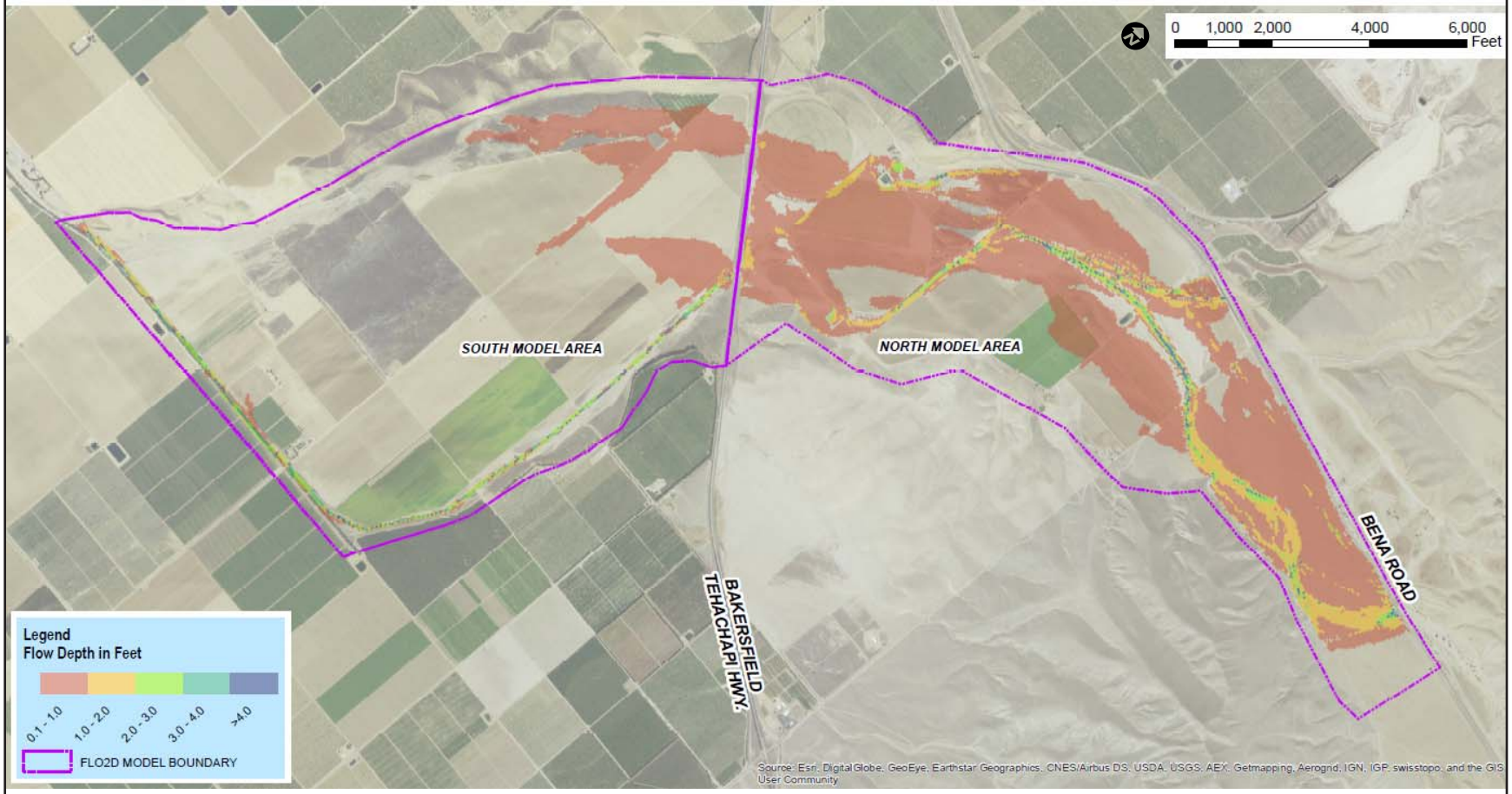

Source: Meyer Civil Engineering

Figure 15
2-year Event Hydrology (Flow Depth) Existing Conditions

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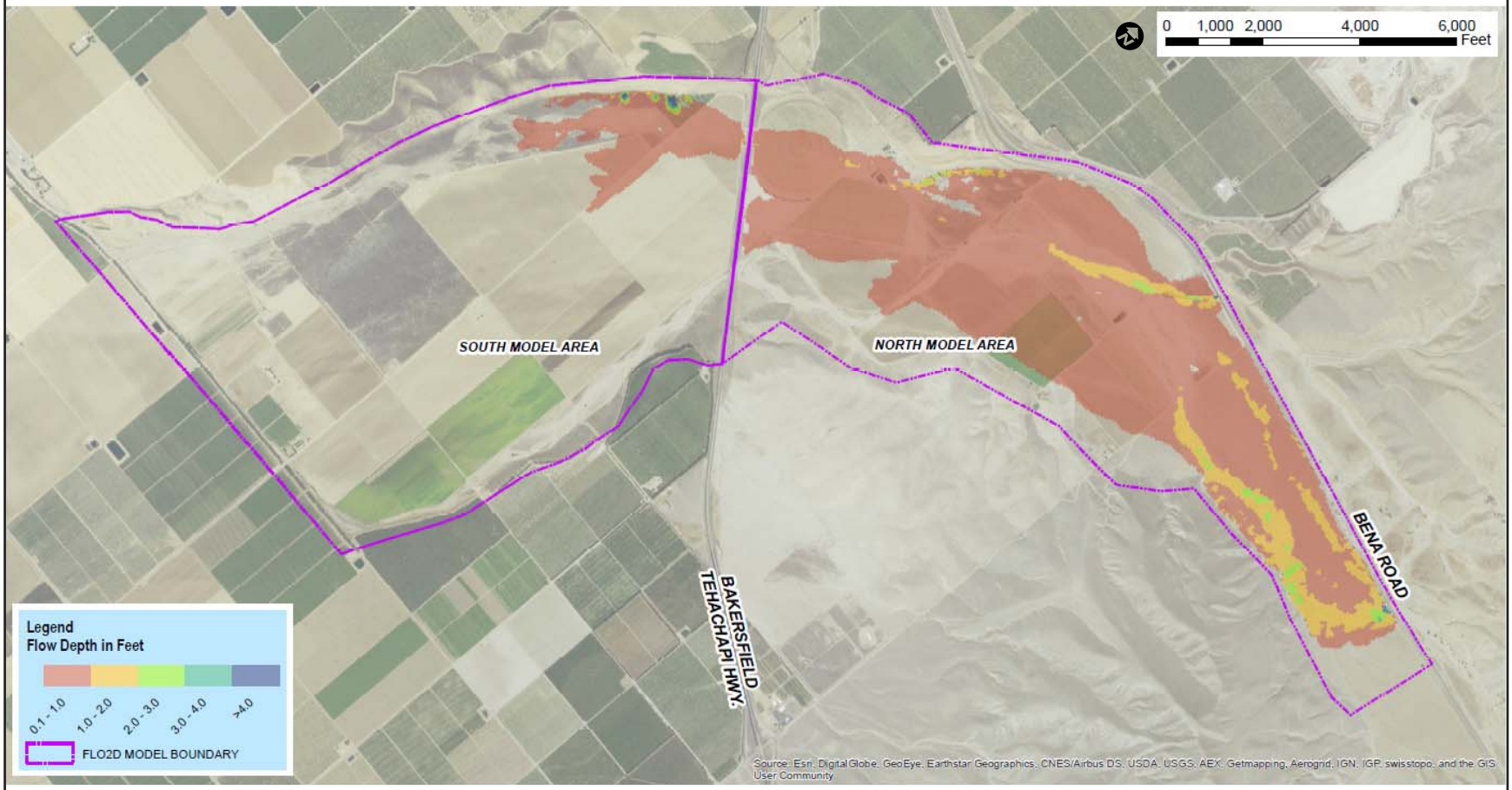

Source: Meyer Civil Engineering

Figure 16
2-year Event Hydrology (Flow Depth) Proposed Conditions

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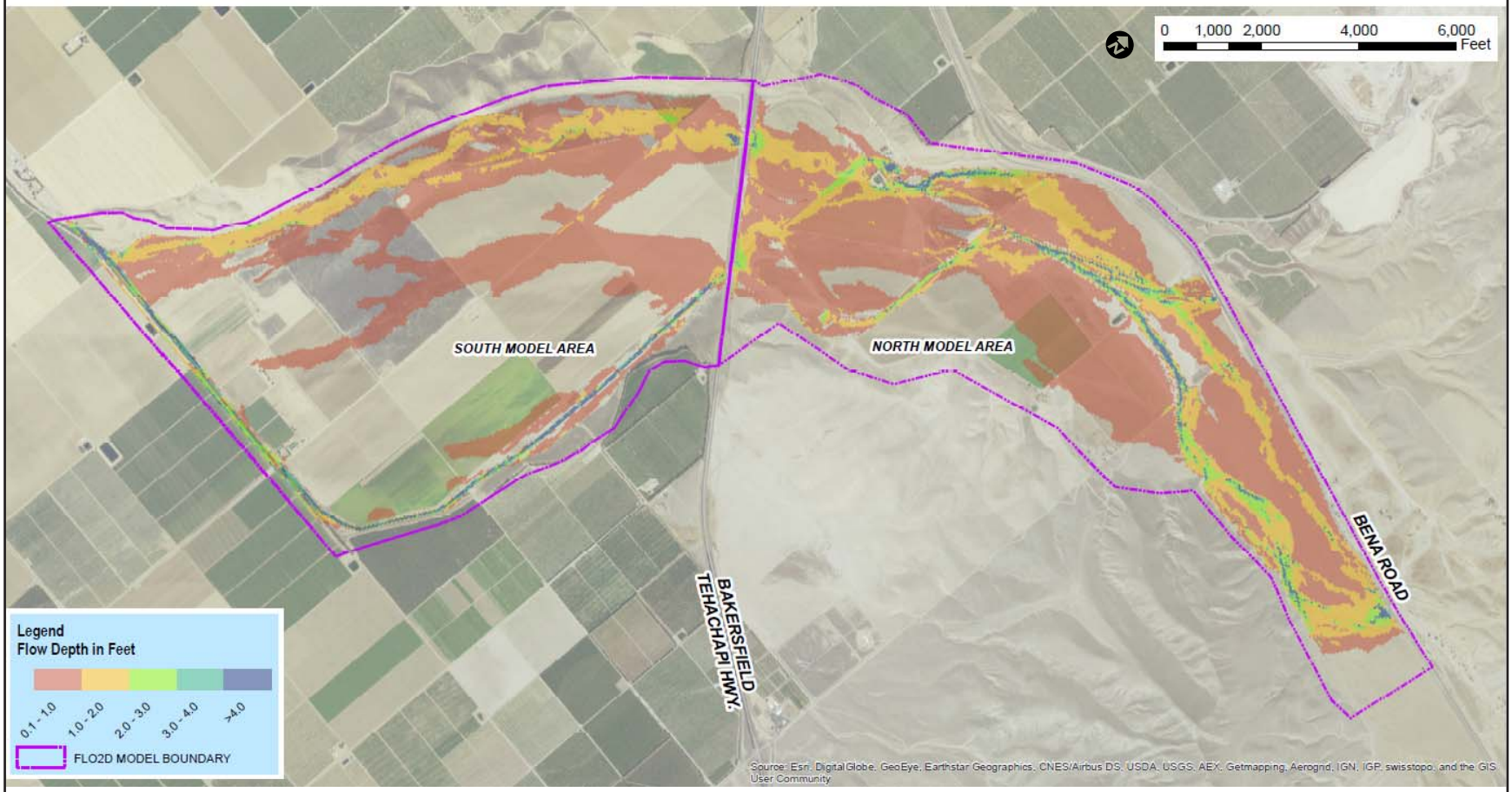

Source: Meyer Civil Engineering

Figure 17
5-year Event Hydrology (Flow Depth) Existing Conditions

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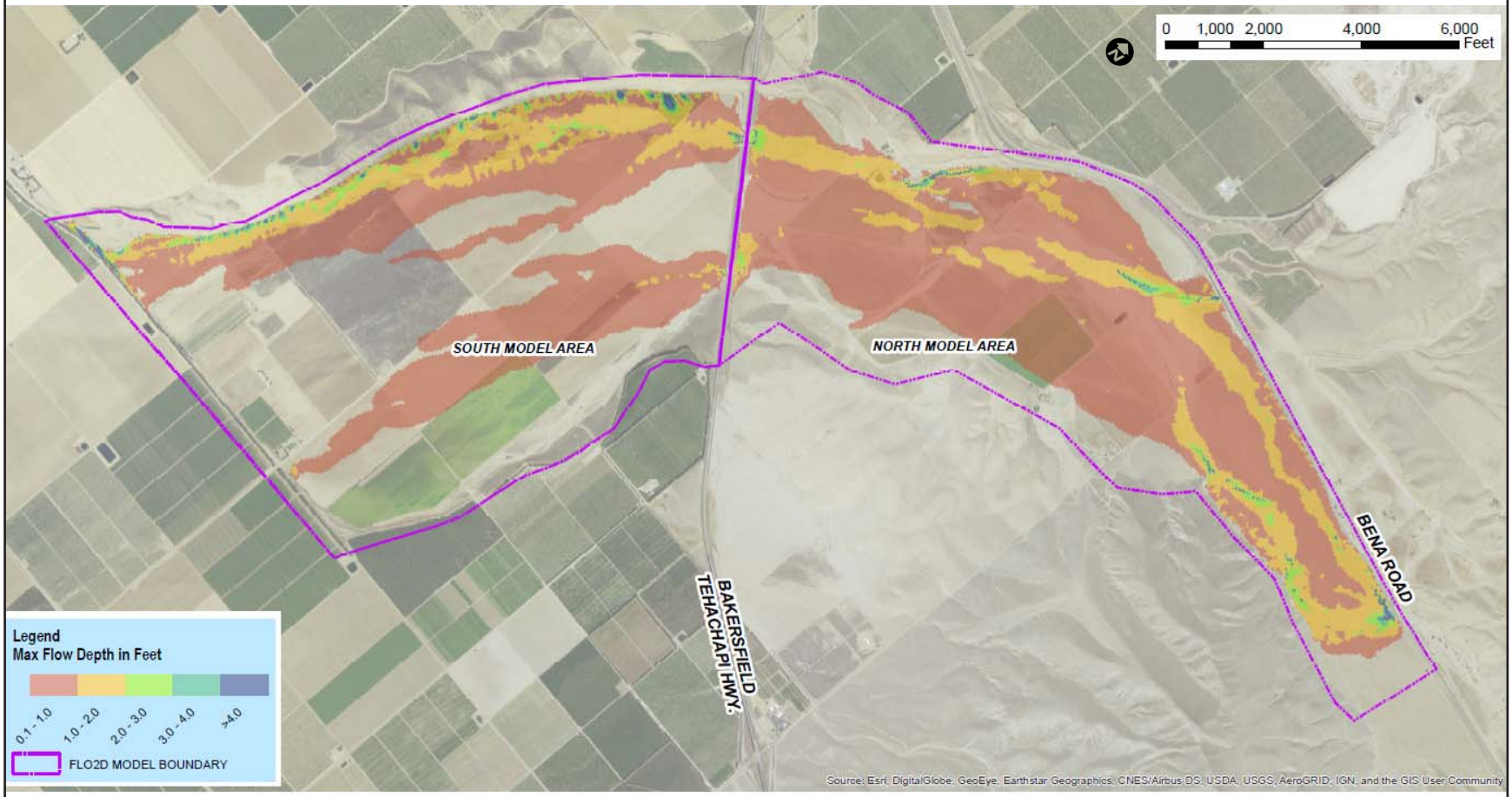
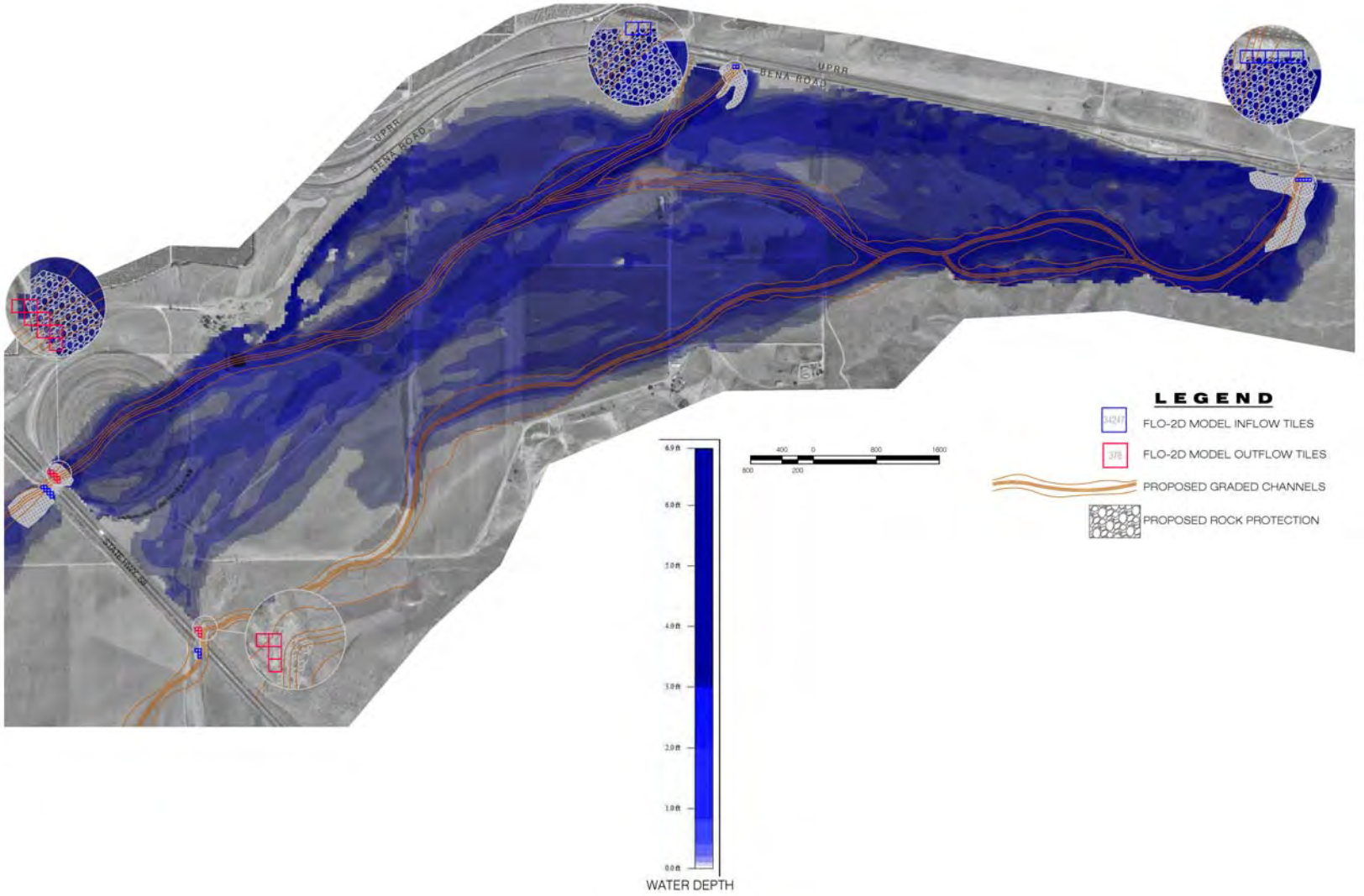


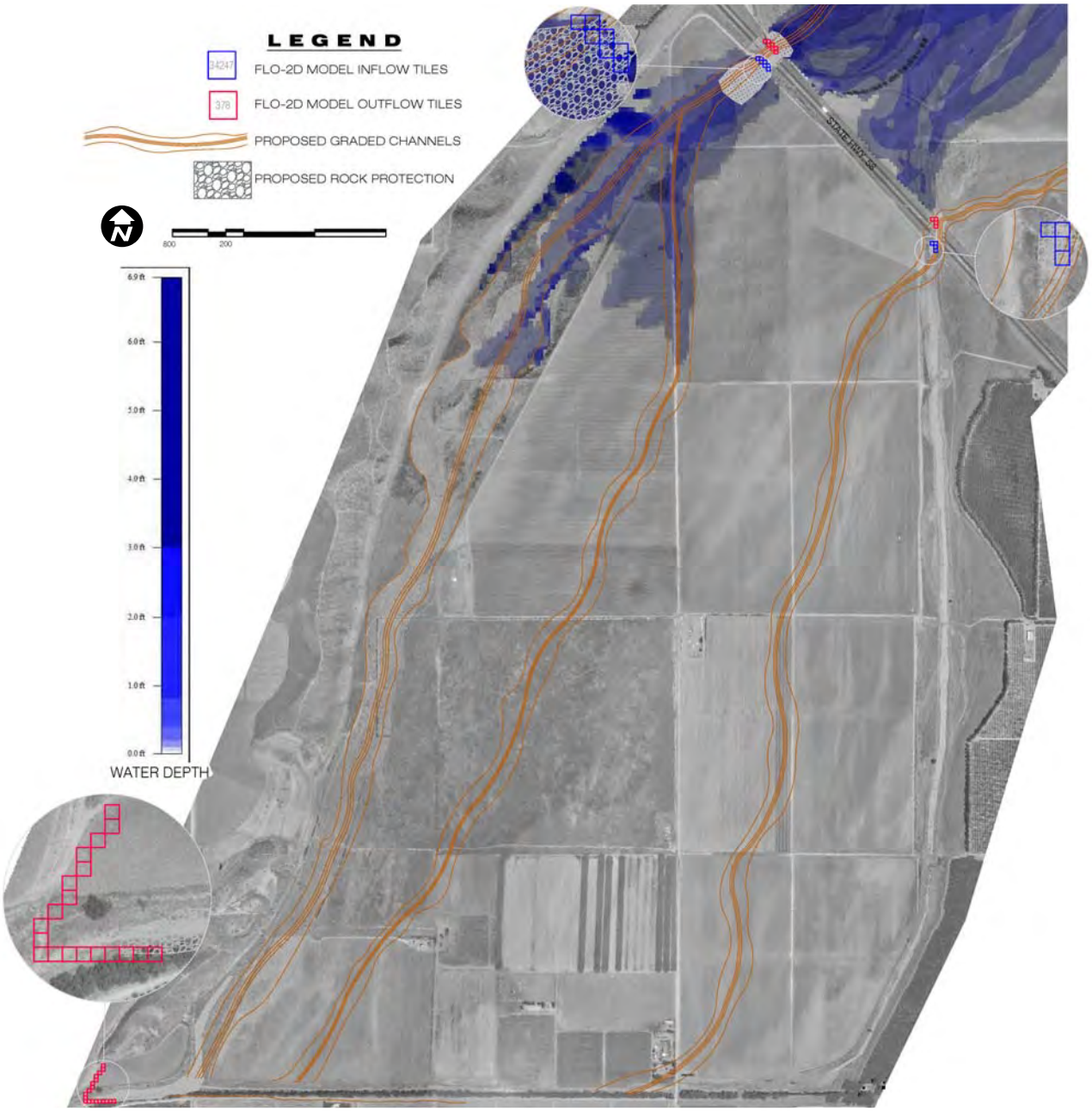
Source: Meyer Civil Engineering

Figure 18
5-year Event Hydrology (Flow Depth) Proposed Conditions



Source: Meyer Civil Engineering

Figure 19
2-year Event Hydrology (Flow Depth) Proposed Conditions with Riprap, North



Source: Meyer Civil Engineering

Figure 20
2-year Event Hydrology (Flow Depth) Proposed Conditions with Riprap, South

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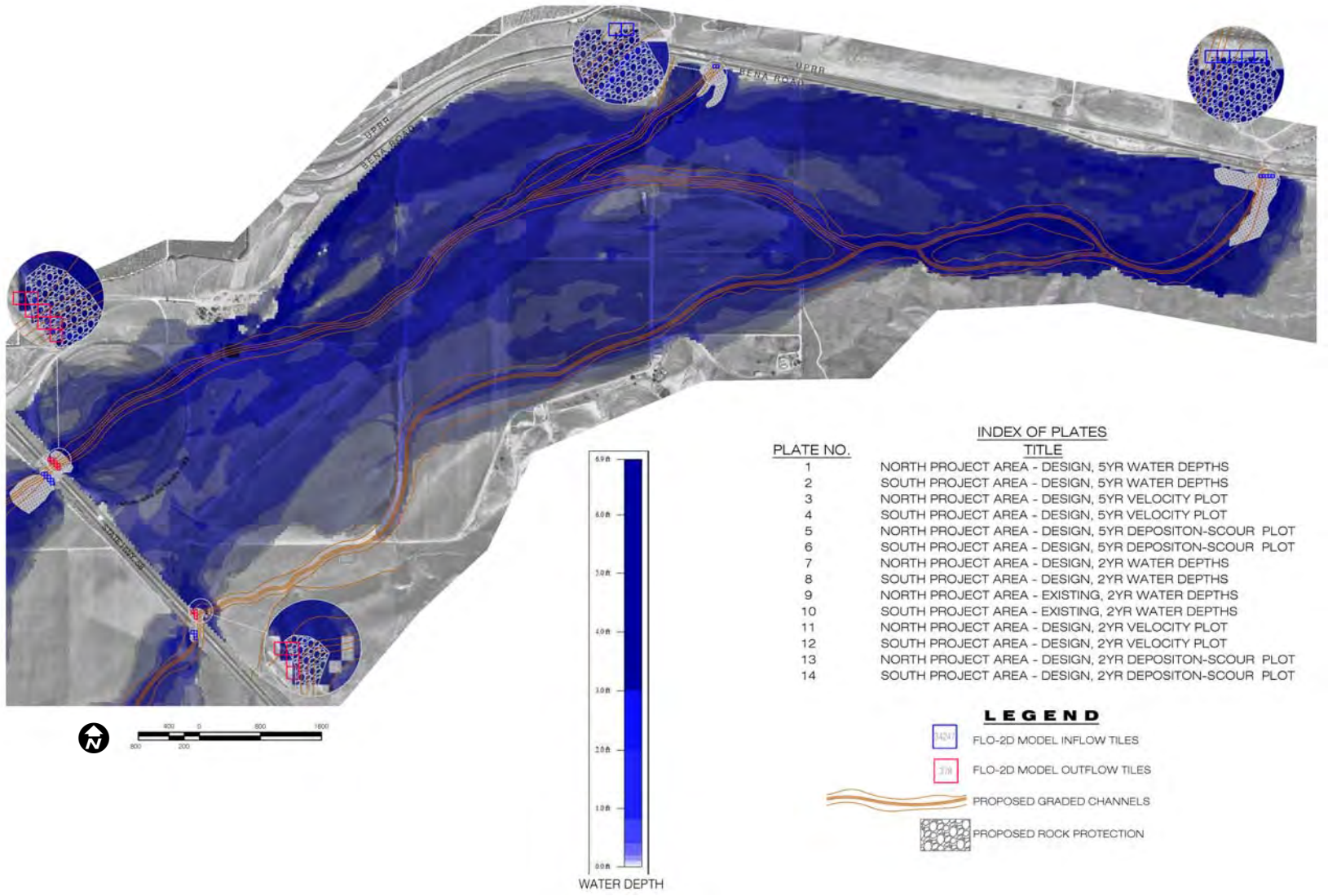
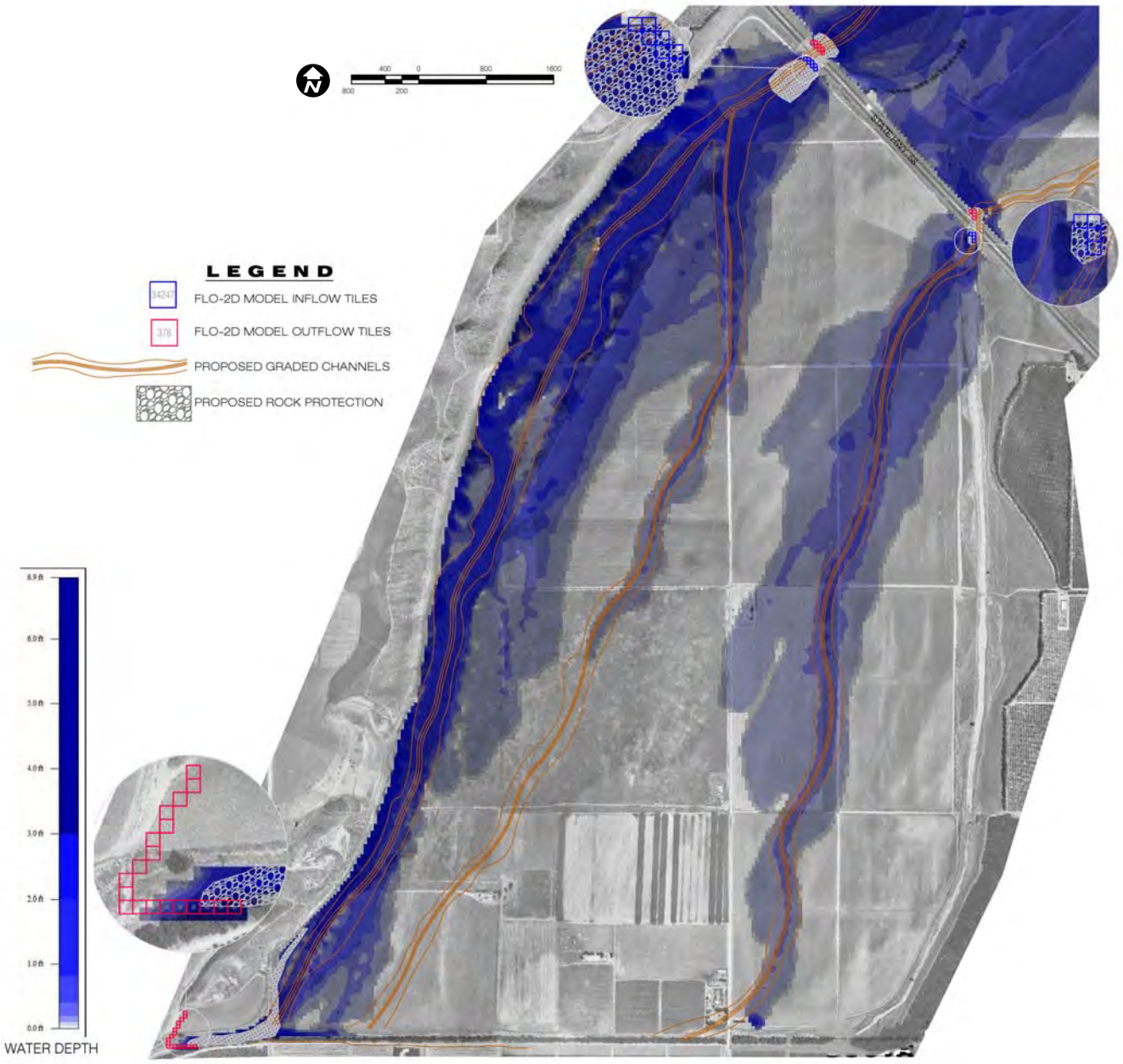


Source: Meyer Civil Engineering Inc.

Figure 21
5-year Event Hydrology (Flow Depth) Proposed Conditions with Riprap, North



Source: Meyer Civil Engineering Inc.

Figure 22
5-year Event Hydrology (Flow Depth) Proposed Conditions with Riprap, South

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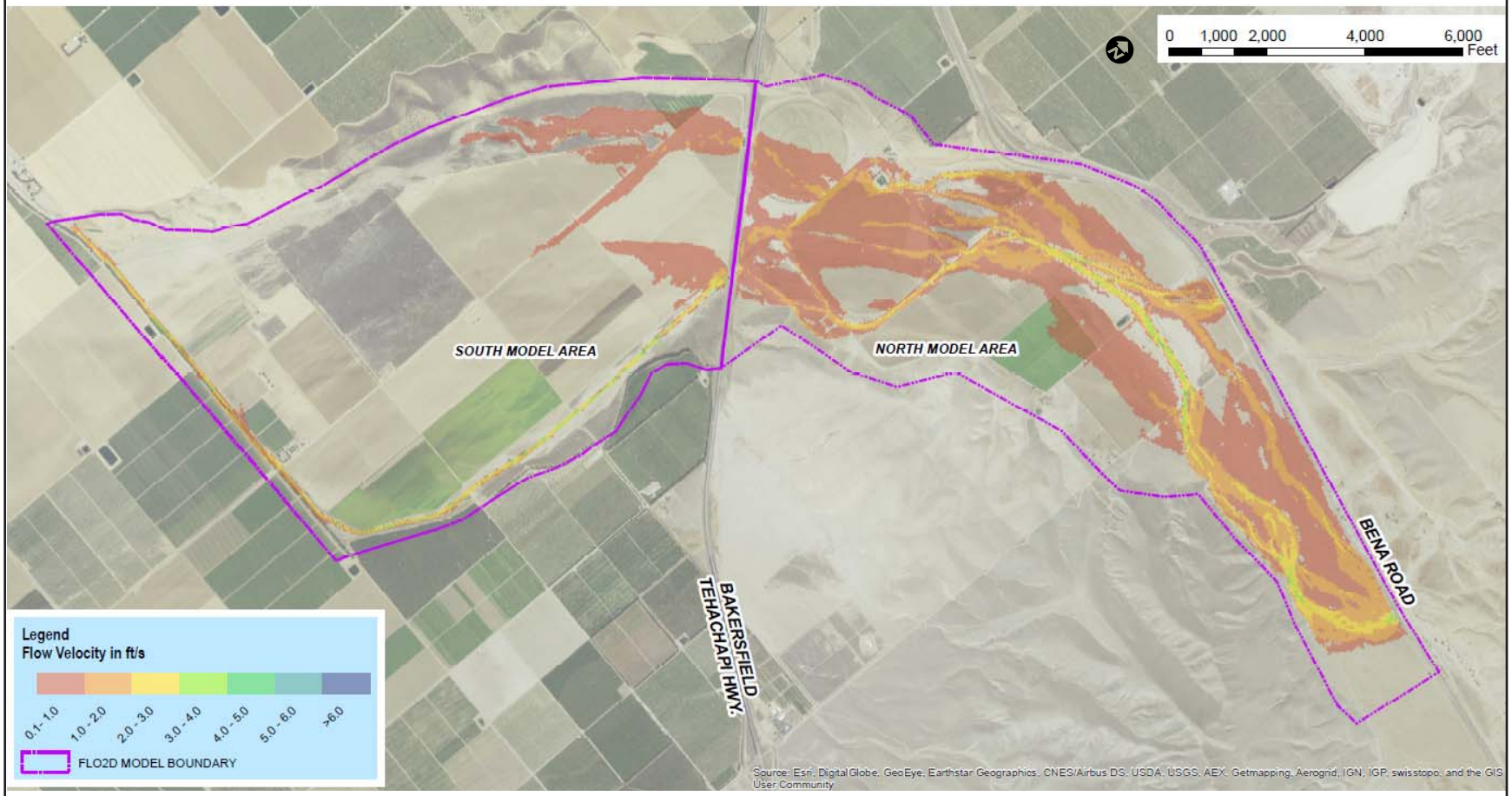

Source: Psomas 2017

Figure 23
2-year Event Hydrology (Velocity) Existing Conditions

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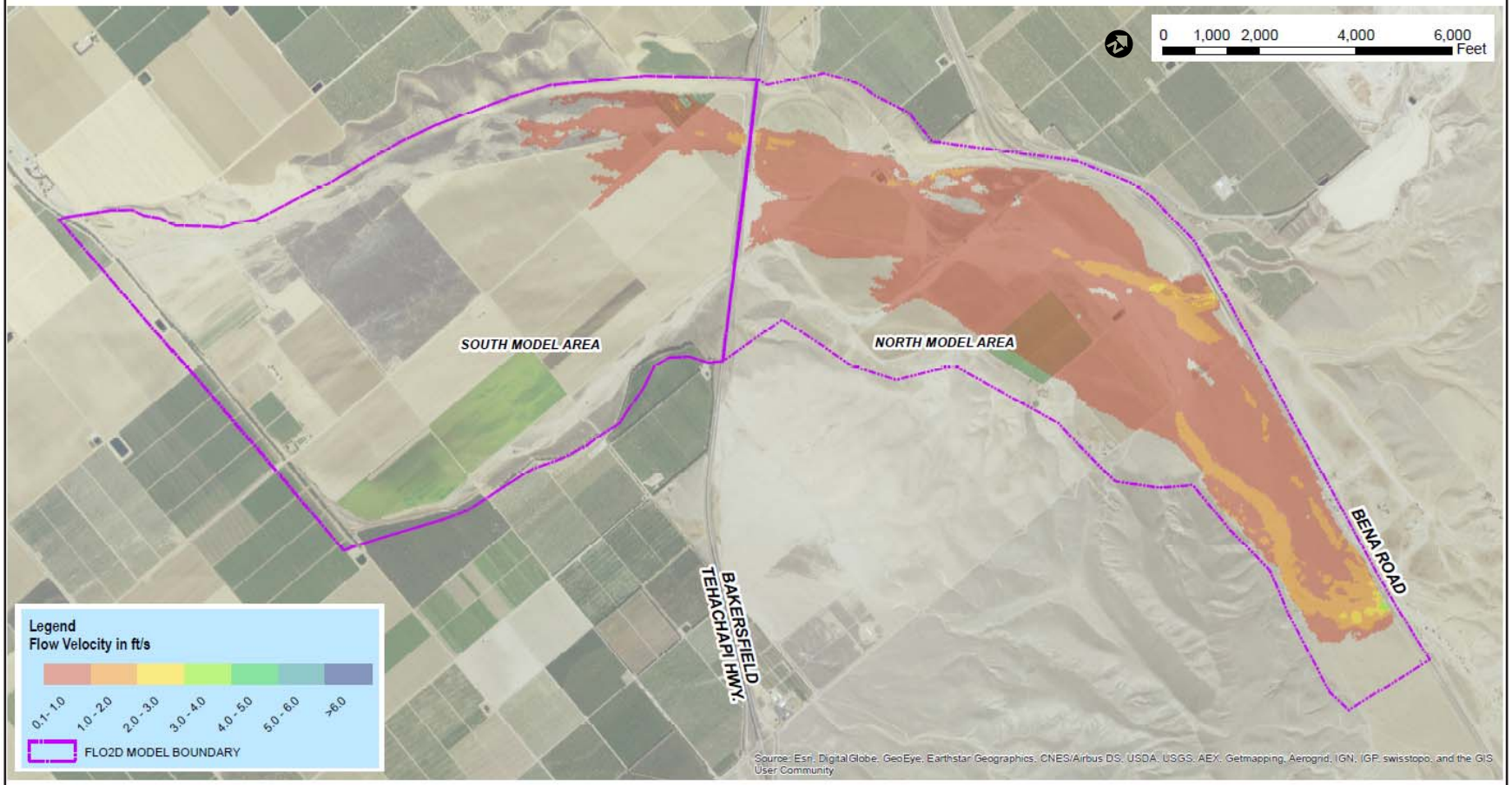

Source: Psomas 2017

Figure 24
2-year Event Hydrology (Velocity) Proposed Conditions

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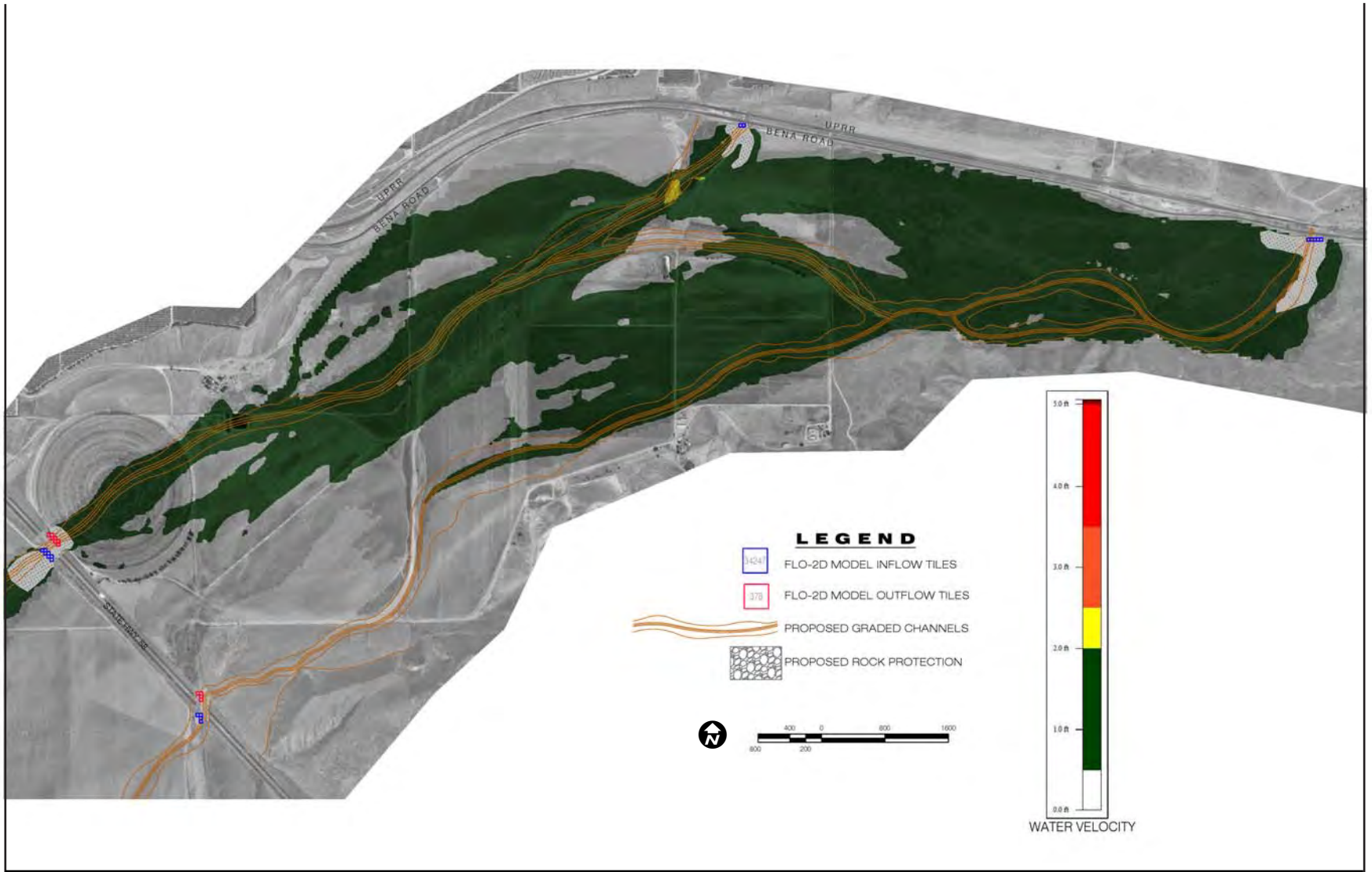
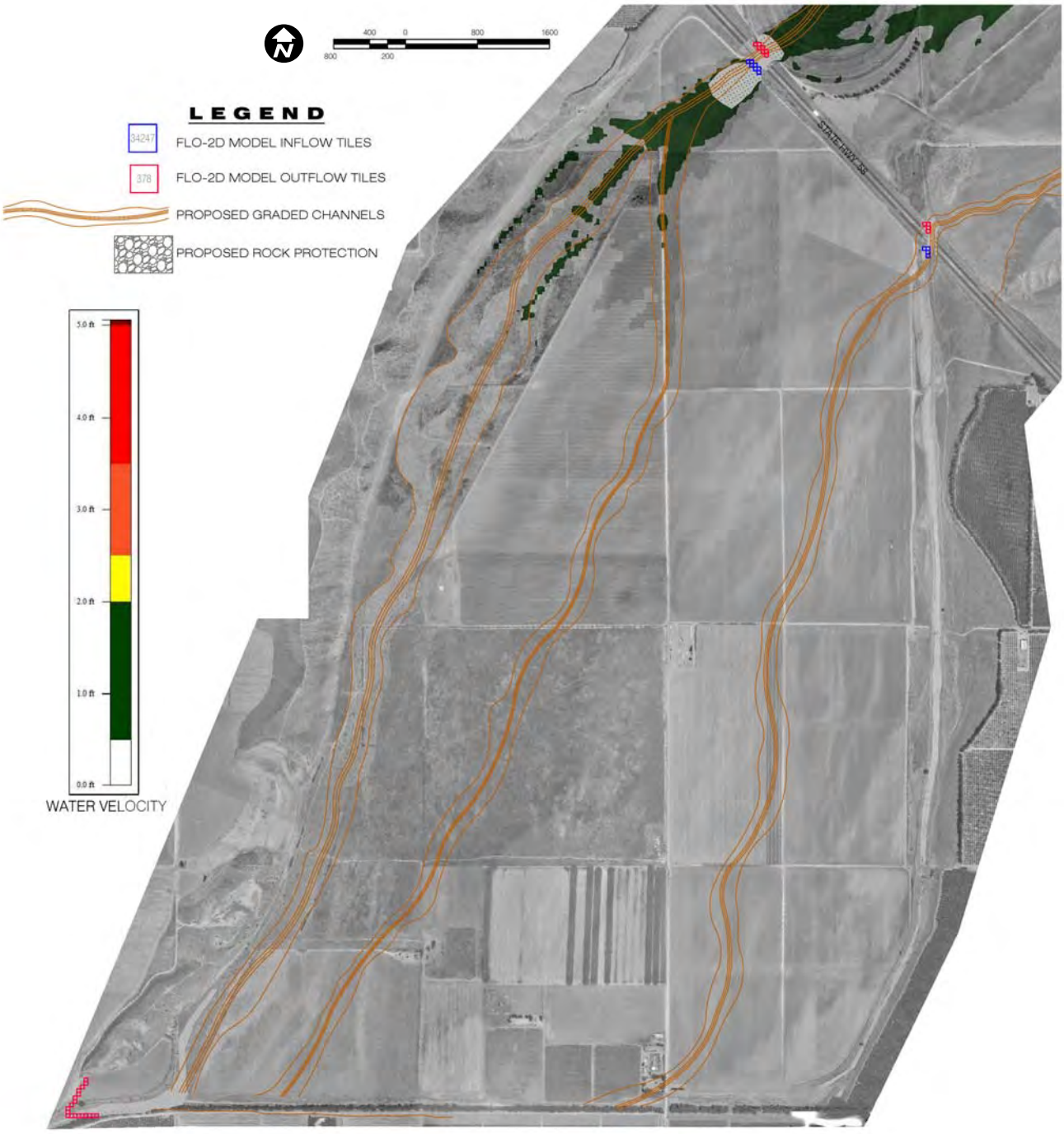


Source: Meyer Civil Engineering Inc.

Figure 25
2-year Event Hydrology (Velocity) Proposed Conditions with Riprap, North



Source: Meyer Civil Engineering Inc.

Figure 26
2-year Event Hydrology (Velocity) Proposed Conditions with Riprap, South

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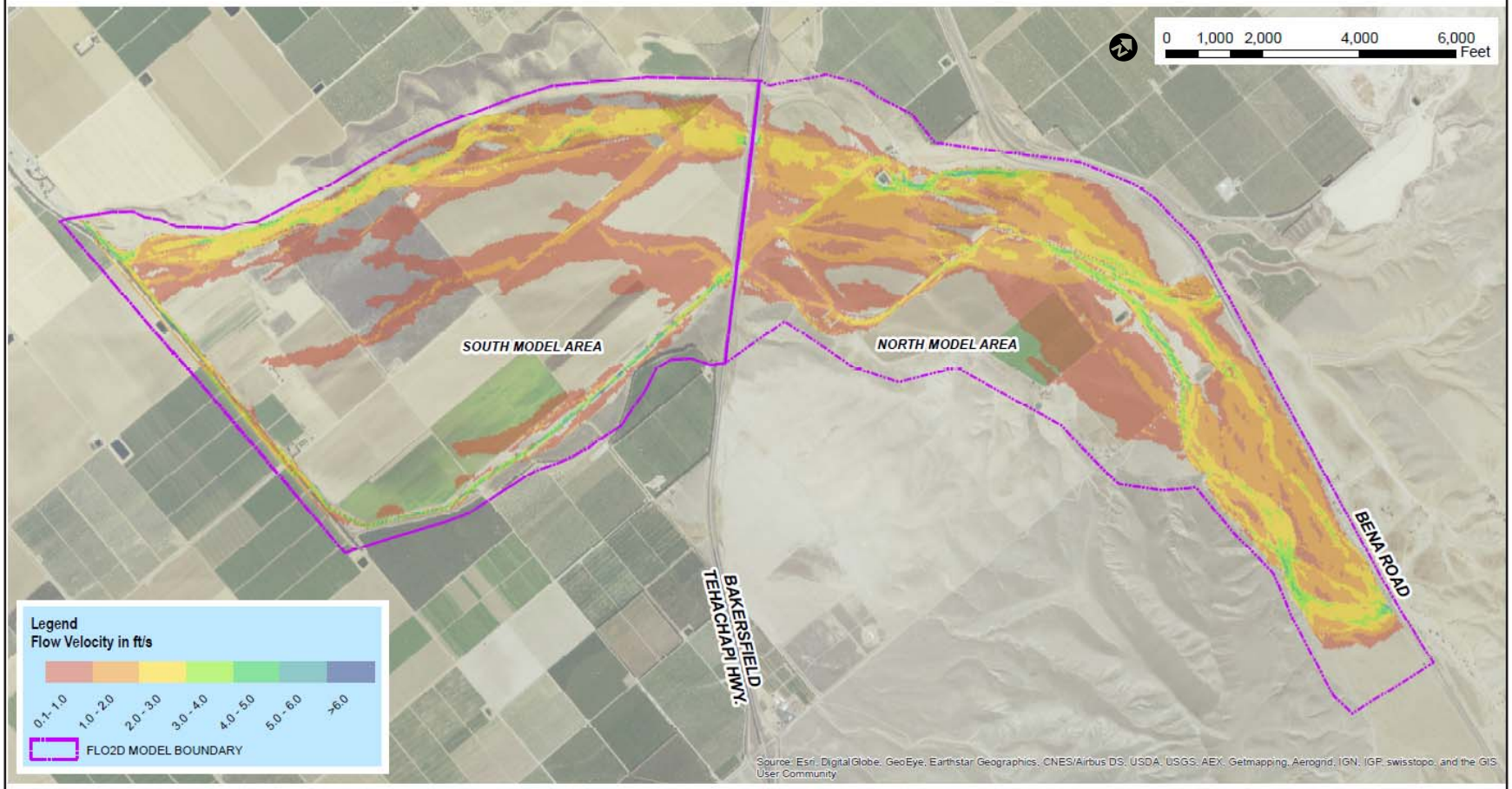

Source: Psomas 2017

Figure 27
5-year Event Hydrology (Velocity) Existing Conditions

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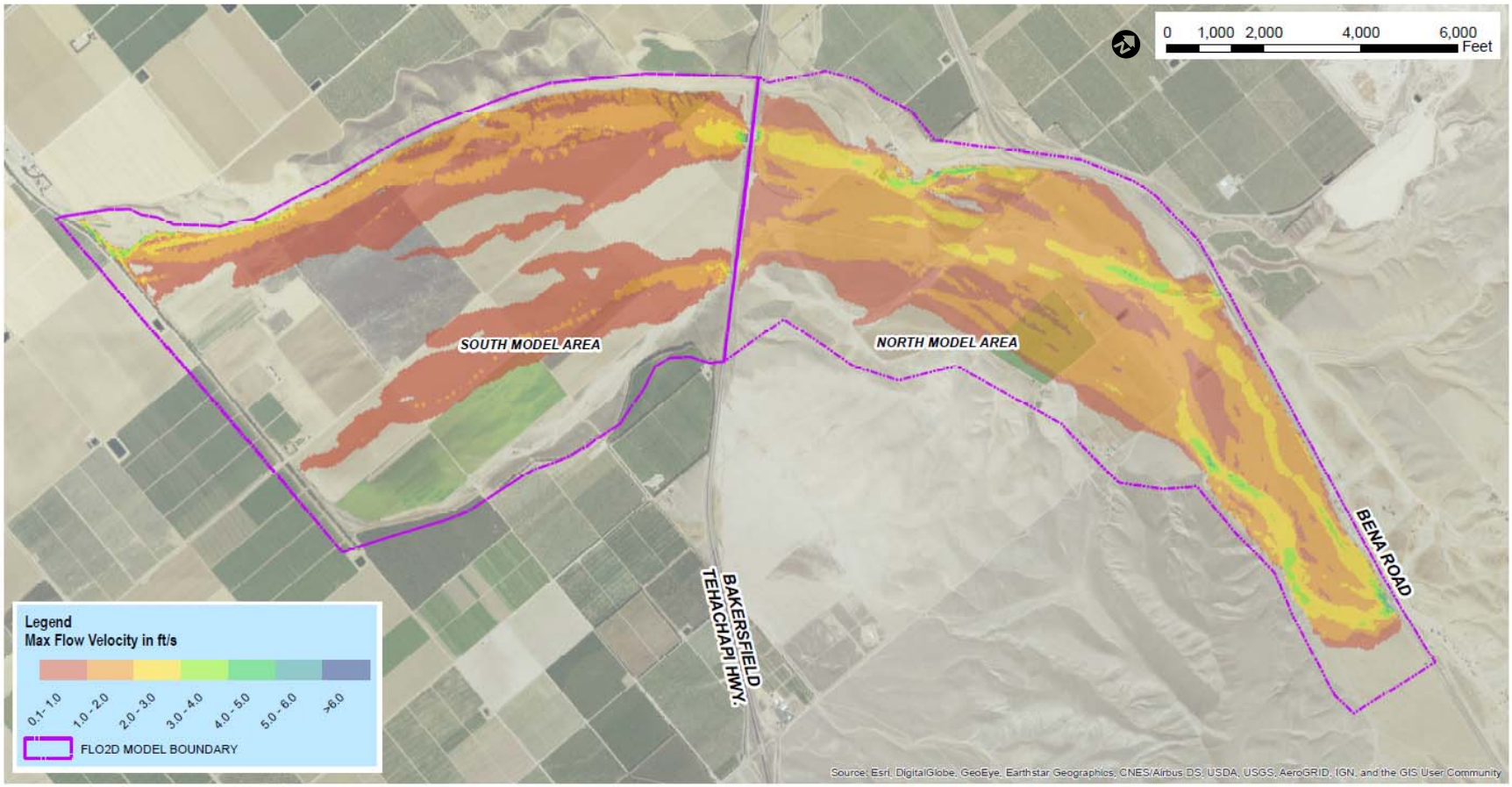

Source: Psomas 2017

Figure 28
5-year Event Hydrology (Velocity) Proposed Conditions

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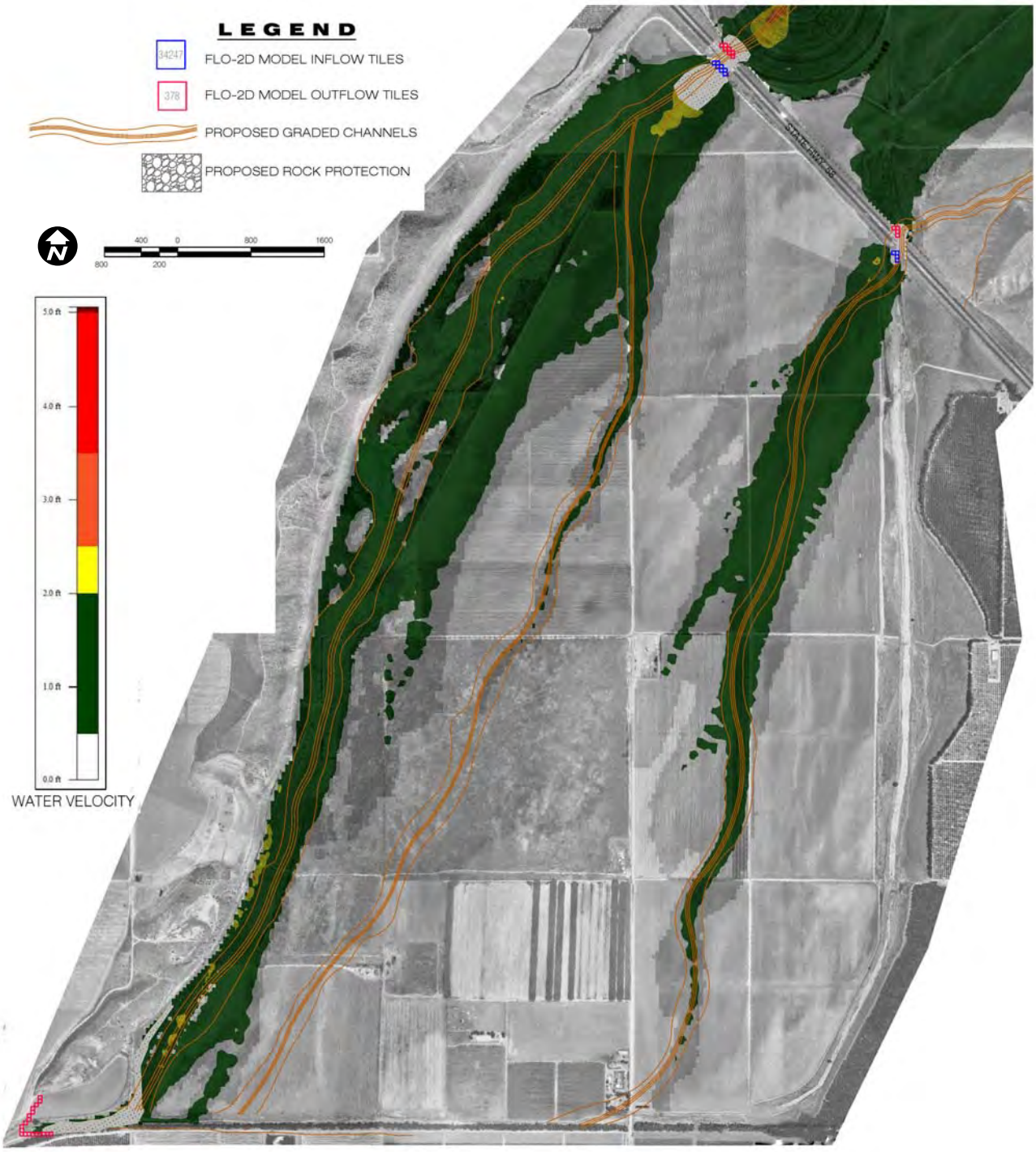
Source: Meyer Civil Engineering Inc.

Figure 29
5-year Event Hydrology (Velocity) Proposed Conditions with Riprap, North



Source: Meyer Civil Engineering Inc.

Figure 30
5-year Event Hydrology (Velocity) Proposed Conditions with Riprap, South

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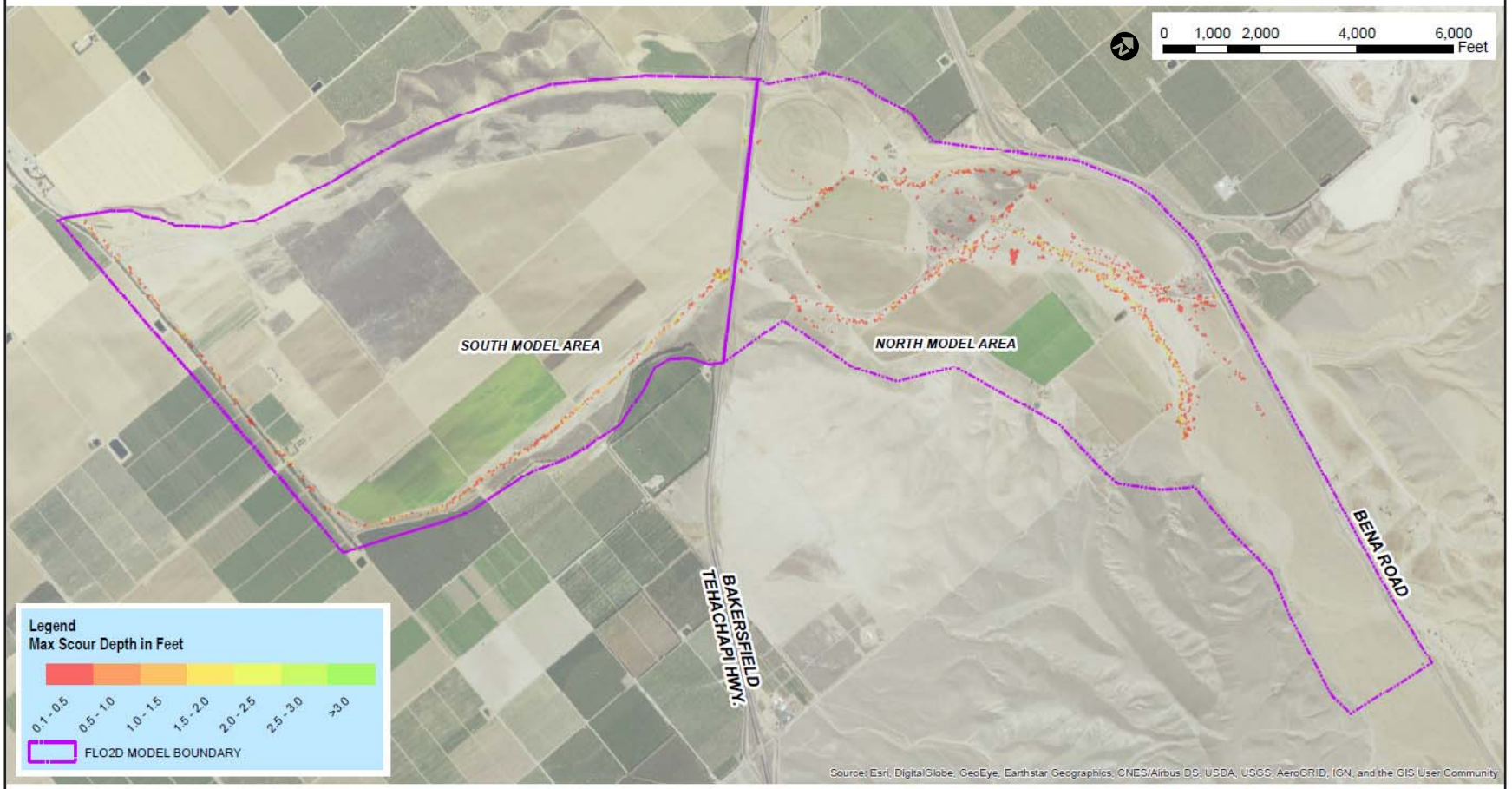

Source: Psomas 2017

Figure 31
2-year Event Scour Existing Conditions

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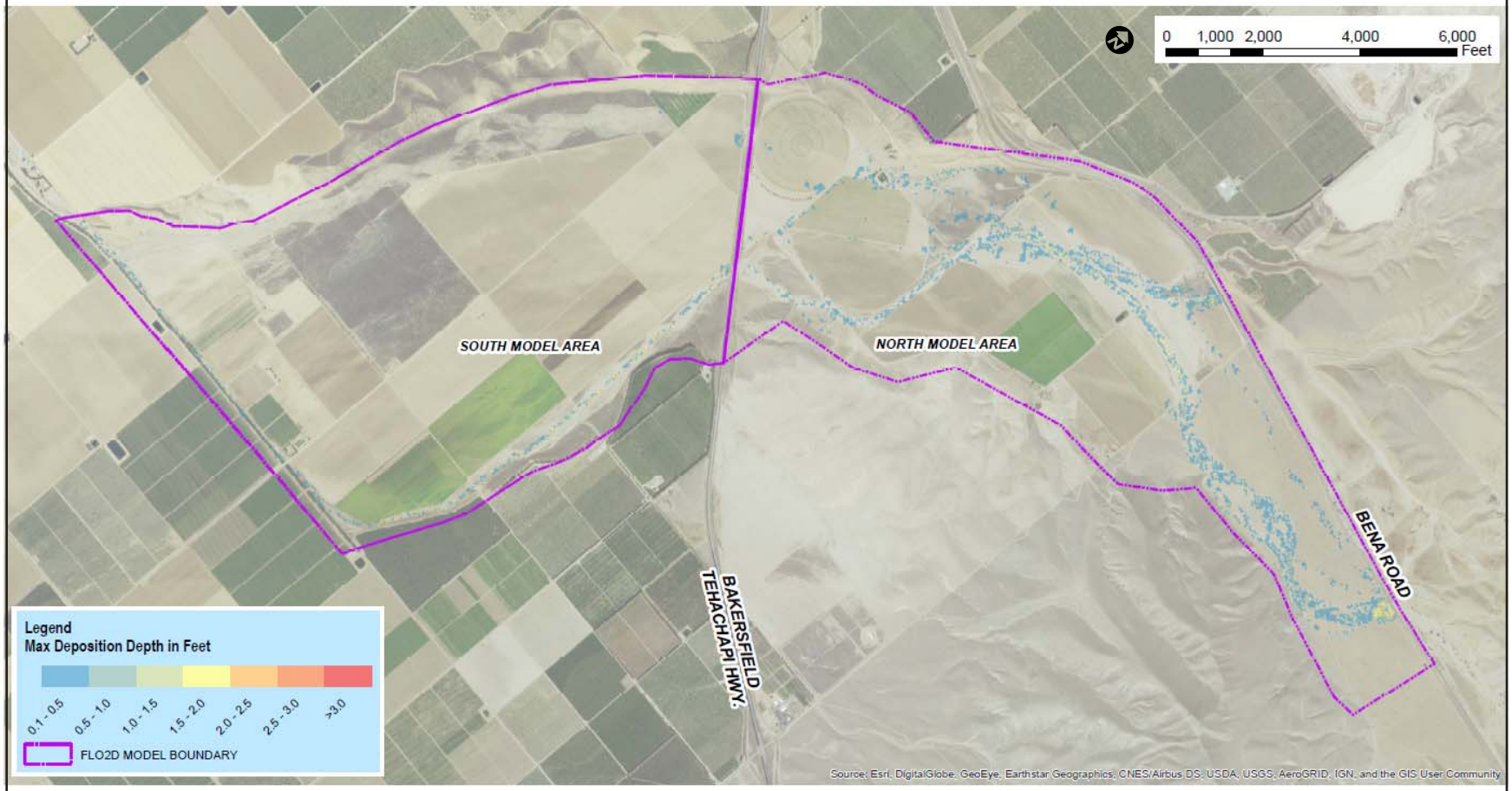

Source: Meyer Civil Engineering

Figure 32
2-year Event Deposition Existing Conditions

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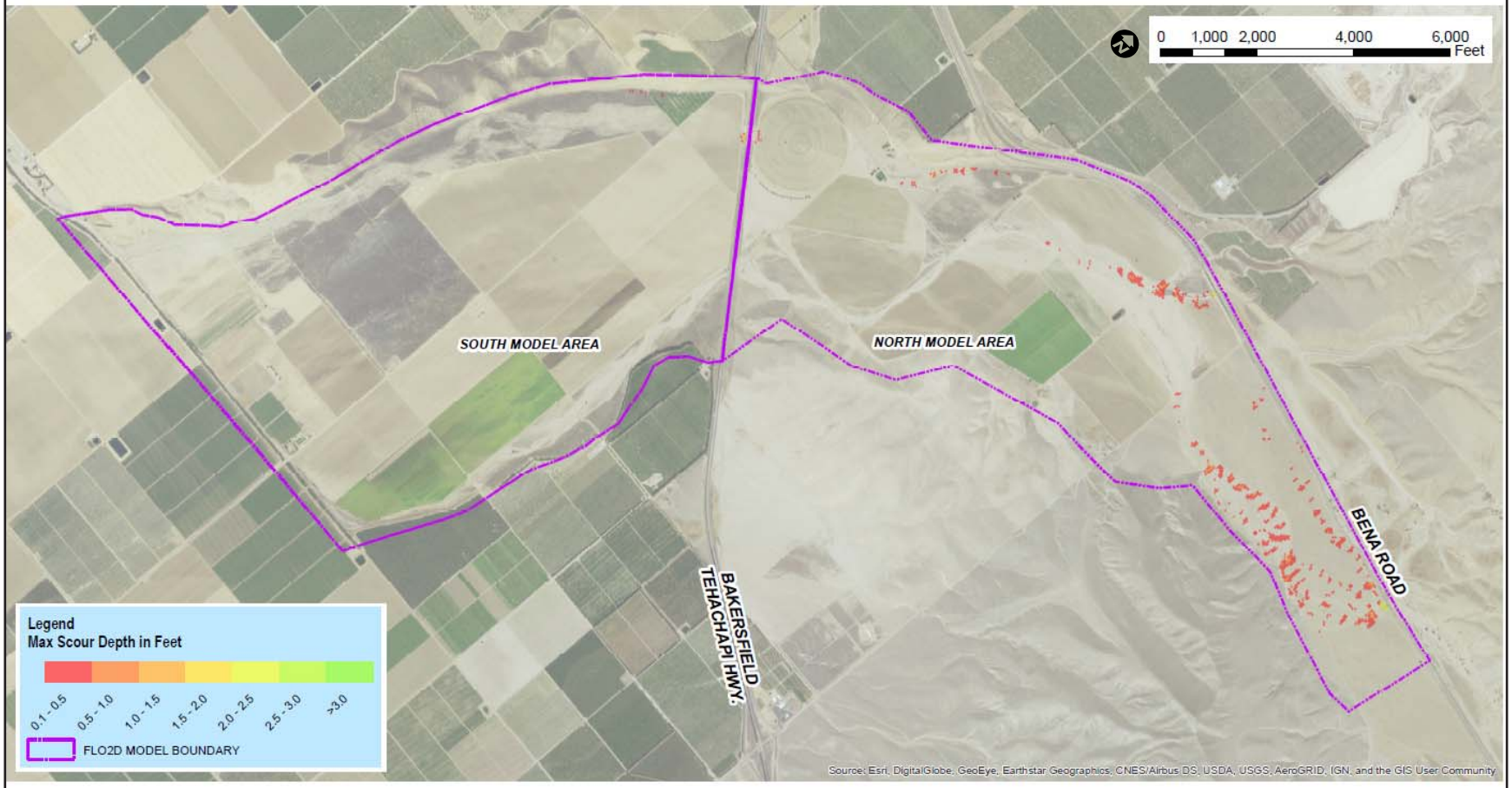

Source: Psomas 2017

Figure 33
2-year Event Scour Proposed Conditions

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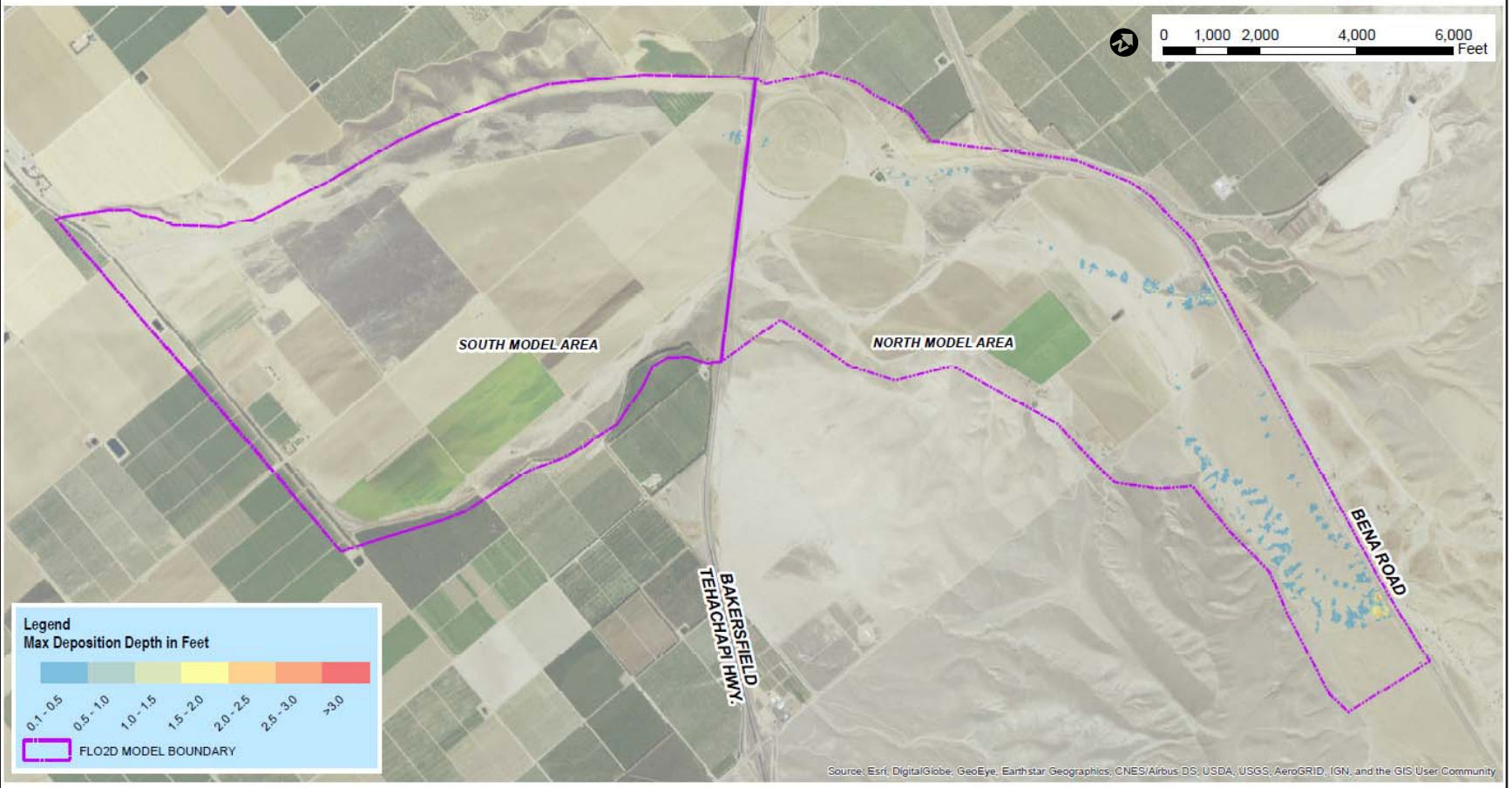

Source: Psomas 2017

Figure 34
2-year Event Deposition Proposed Conditions

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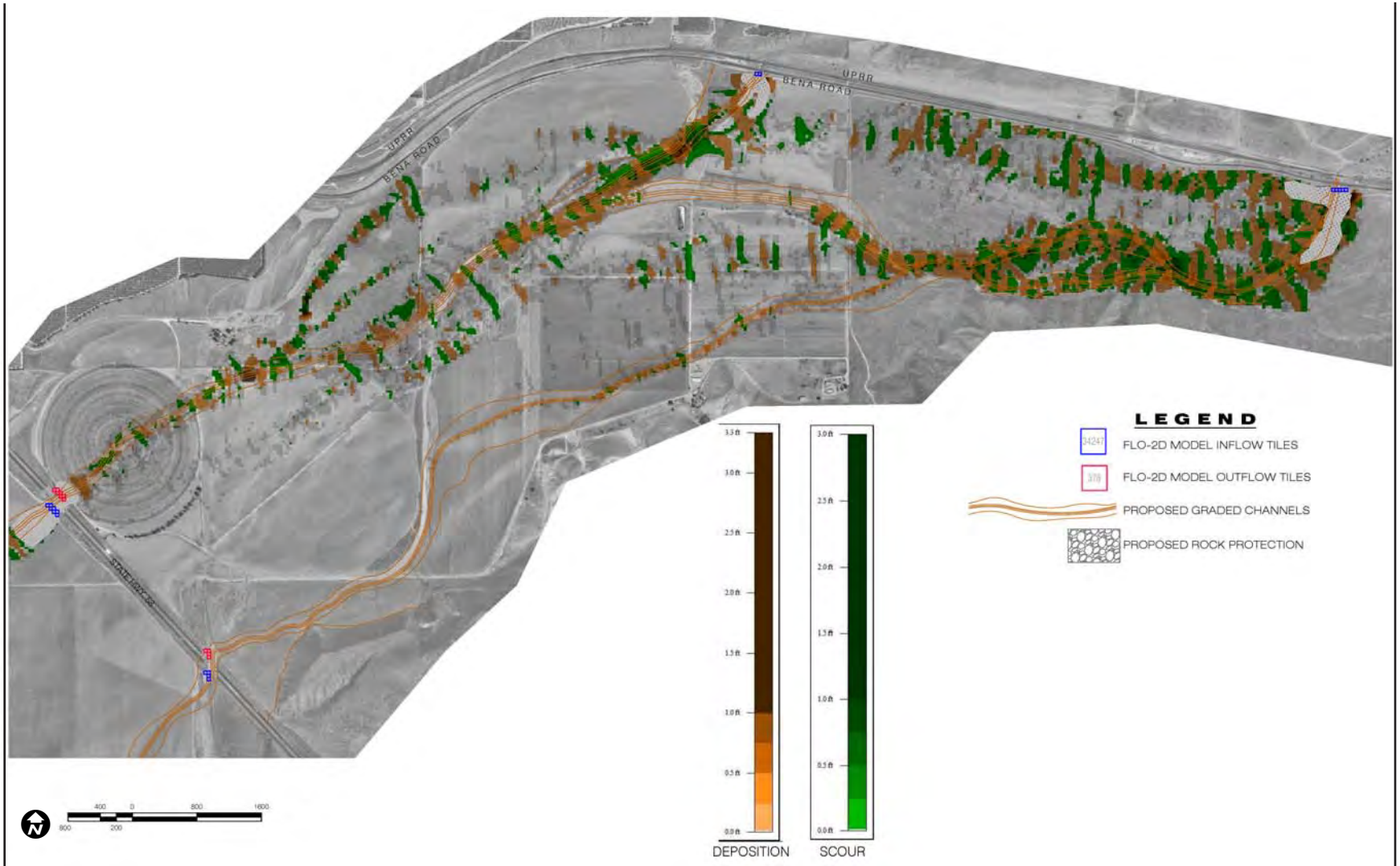
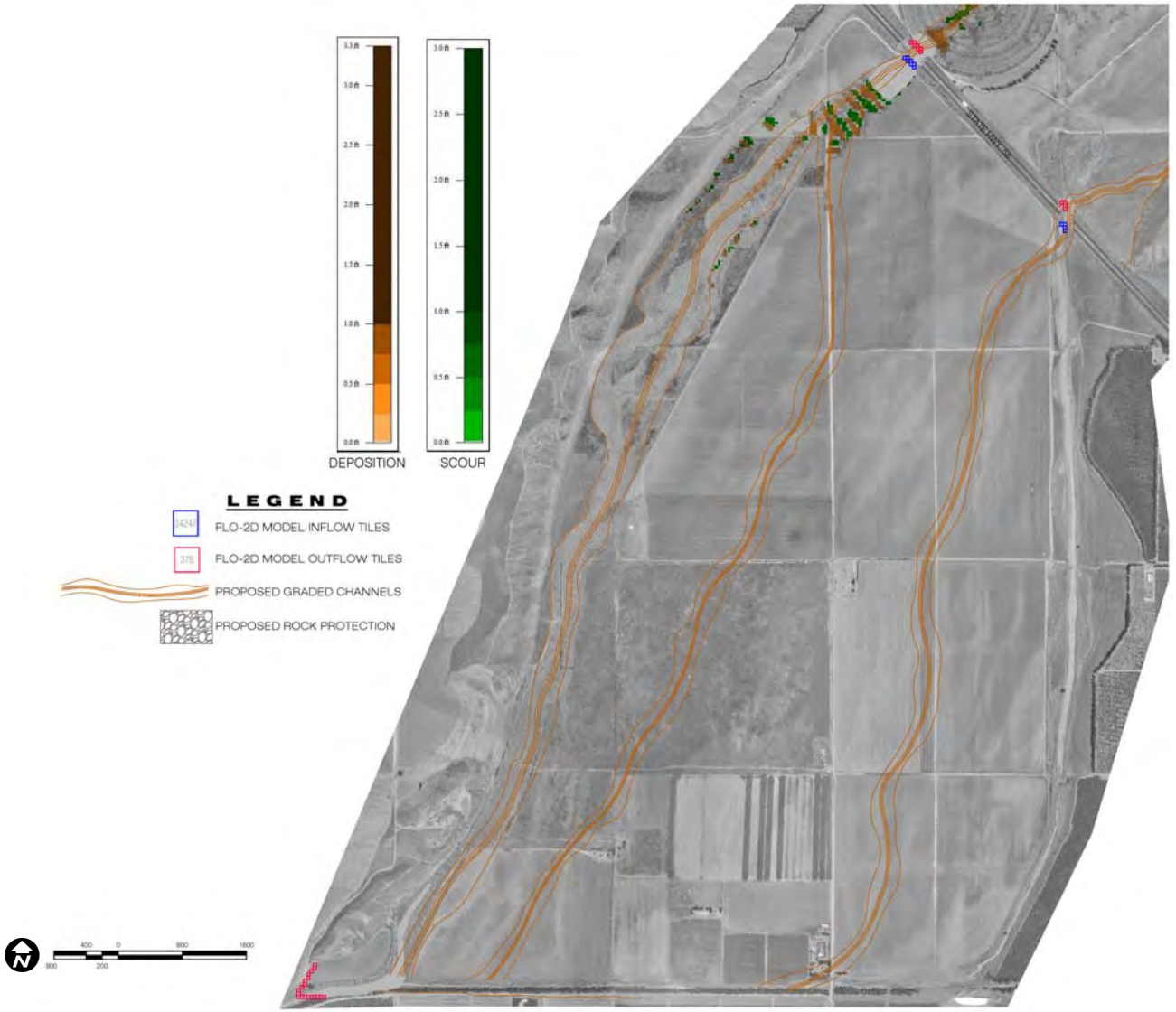


Source: Meyer Civil Engineering Inc.

Figure 35
2-year Event Scour and Deposition Proposed Conditions with Riprap, North



Source: Meyer Civil Engineering Inc.

Figure 36
2-year Event Scour and Deposition Proposed Conditions with Riprap, South

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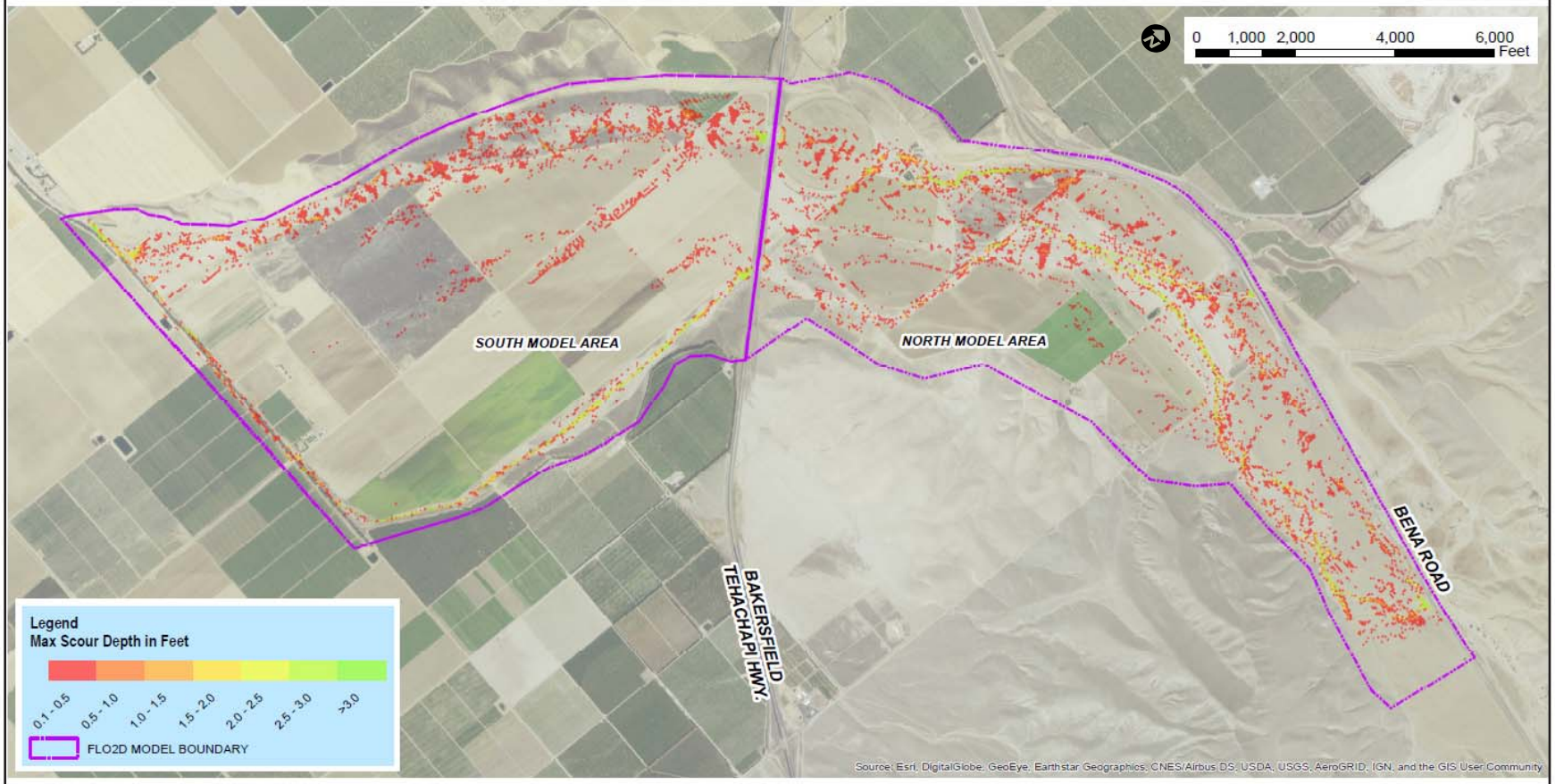

Source: Psomas 2017

Figure 37
5-year Event Scour Existing Conditions

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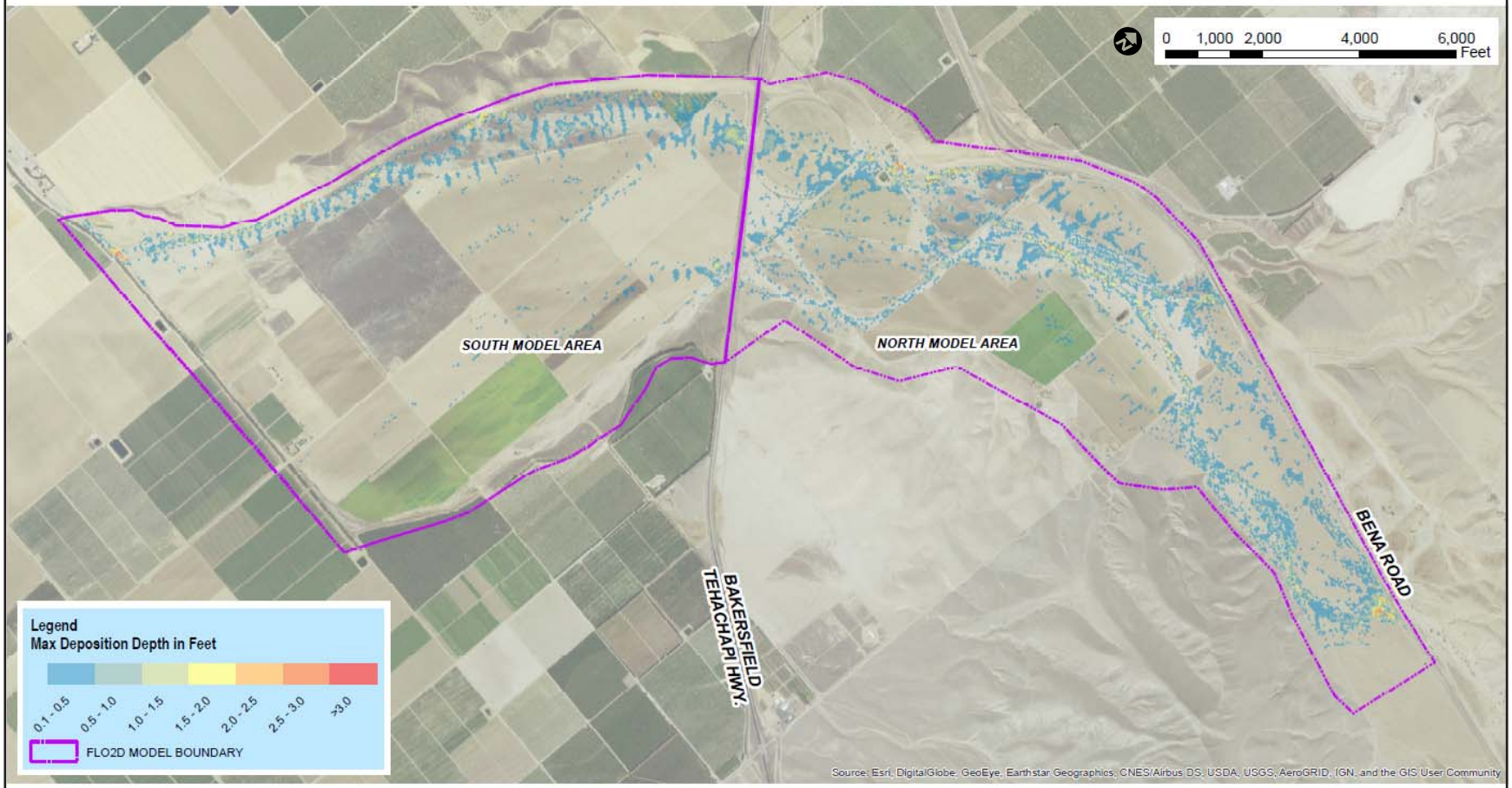

Source: Psomas 2017

Figure 38
5-year Event Deposition Existing Conditions

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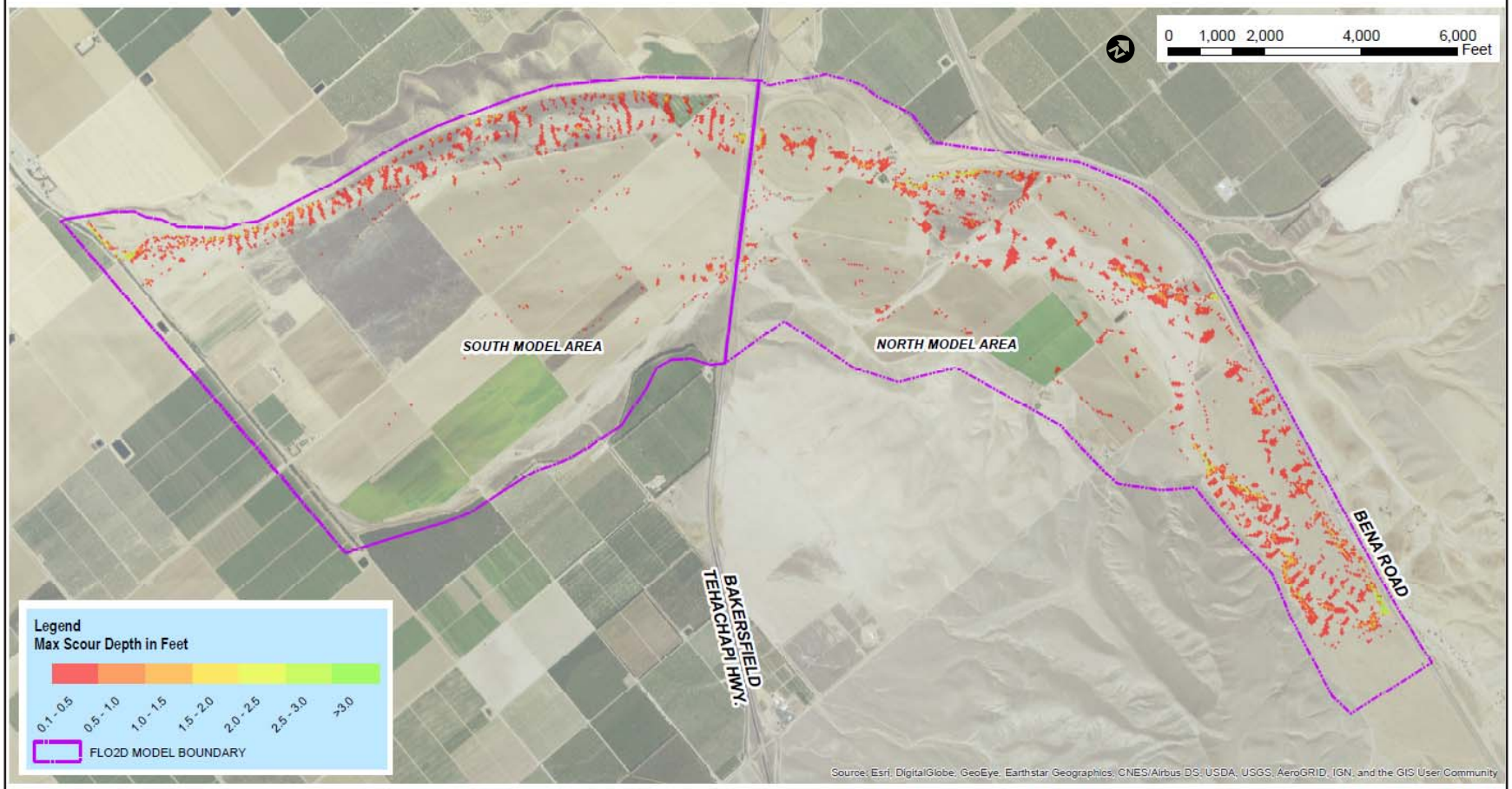

Source: Psomas 2017

Figure 39
5-year Event Scour Proposed Conditions

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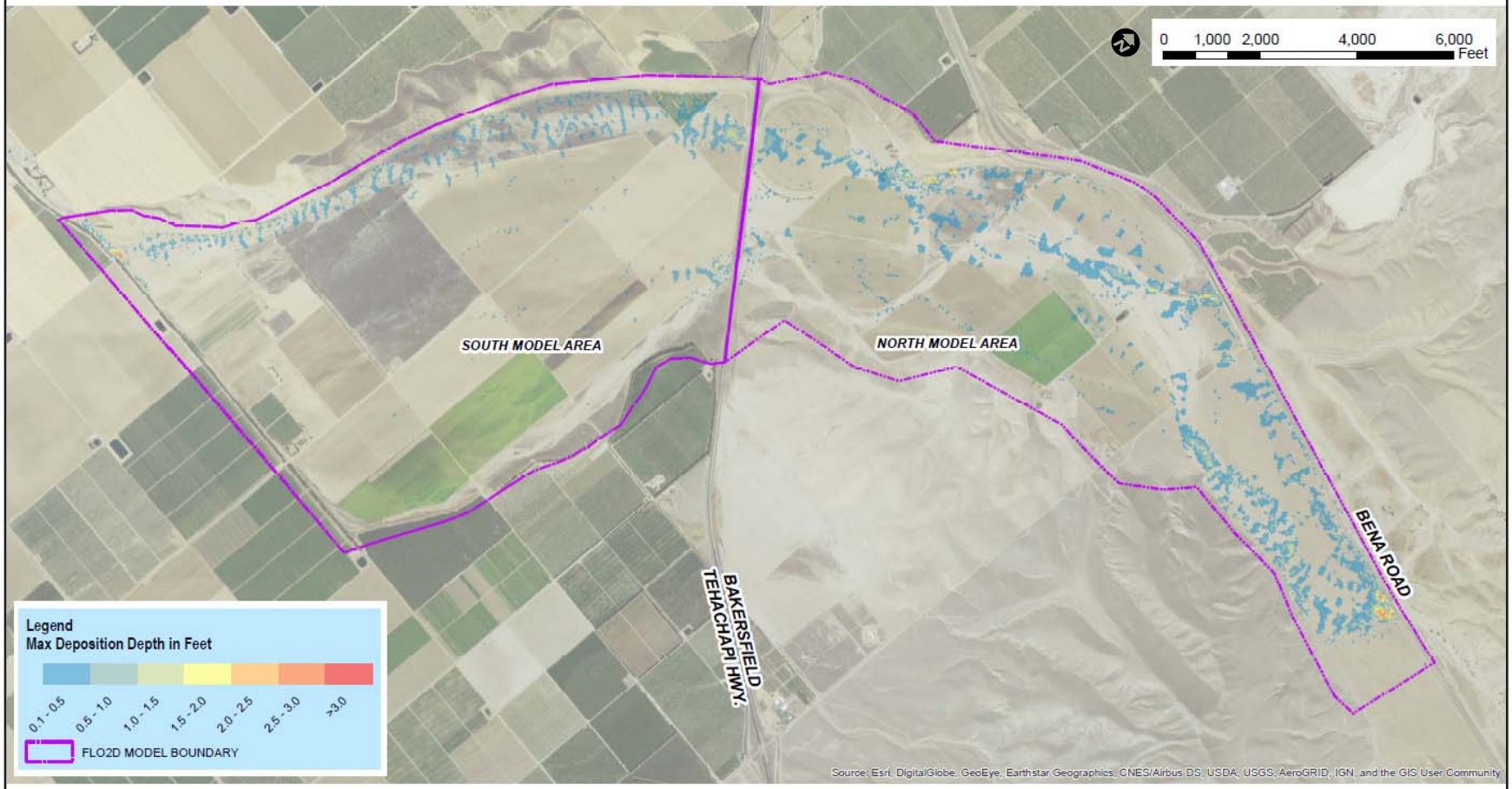
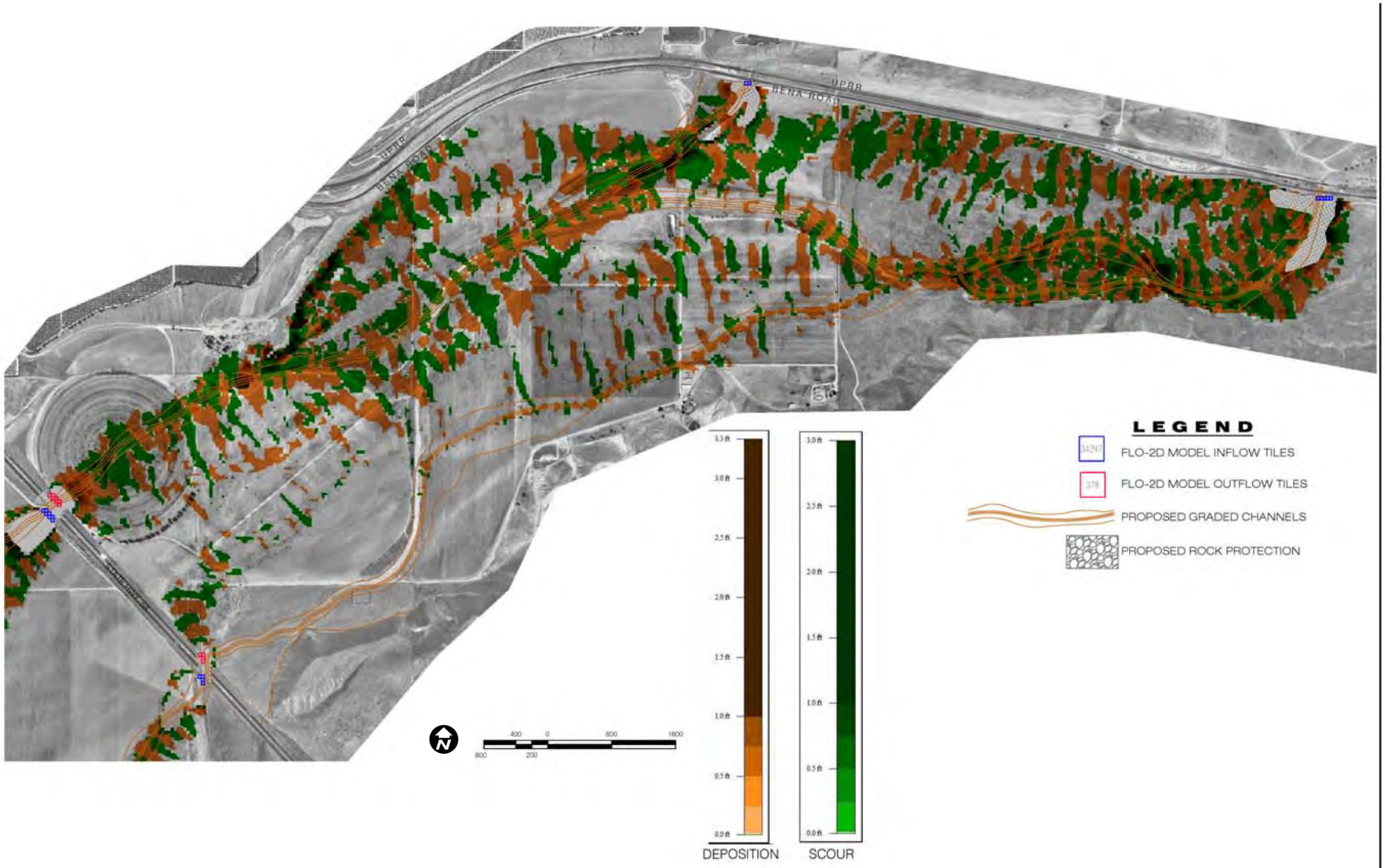


Source: Psomas 2017

Figure 40
5-year Event Deposition Proposed Conditions



Source: Meyer Civil Engineering Inc.

Figure 41
5-year Event Scour and Deposition Proposed Conditions with Riprap, North

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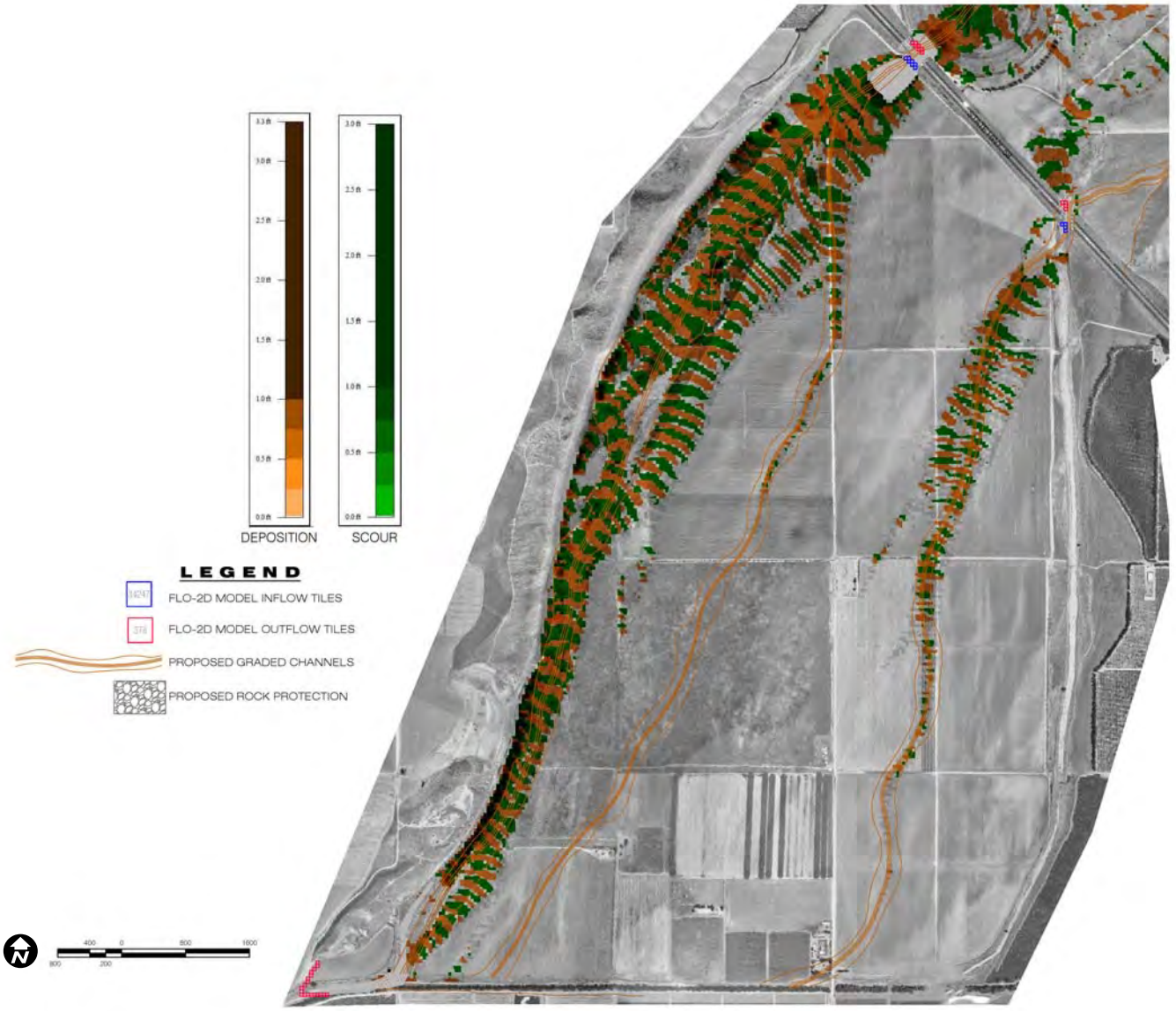


Source: Meyer Civil Engineering Inc.

Figure 42
5-year Event Scour and Deposition Proposed Conditions with Riprap, South

6.0 COST/BENEFIT ANALYSIS

The Kern County Floodplain Management Ordinance recognizes the benefits of natural conveyance of creeks and flood waters. One purpose of this ordinance is to promote public health, safety, and general welfare, and minimize public and private losses from floods. While it is difficult to translate these benefits into dollar amounts, this ordinance recognizes that the alteration of floodplains causes public and private losses from floods. This ordinance includes the following measures to prevent public and private losses due to flooding: controlling the alteration of natural floodplains, stream channels, and natural protective barriers, which helps accommodate or channel flood waters; controlling filling, grading, dredging, and other development that may increase flood damage; and preventing or regulating the construction of flood barriers that will unnaturally divert flood waters or that may increase flood hazards in other areas. The proposed project essentially reverses these three conditions, which have exacerbated flooding issues in the project area, the extent of which are illustrated in Figure 43.

Costs to implement the project and economic benefits of implementing the project are provided in the following sections. All cost projections are based upon available information and should be used for general planning purposes only. Future costs are not escalated for inflation.

6.1 COSTS OF PROJECT IMPLEMENTATION

Estimated project design and construction costs are described in Table 10. These costs include the final planning, construction, and post-construction maintenance and monitoring stages of the project.

Total cost to design and construct the project, including an initial 3-year establishment period, is $39,595,375 for the base project, and $47,914,125 when including riprap enhancements. Annual maintenance and monitoring beyond the initial establishment period is projected to cost approximately $20,000 per year. To establish a baseline for comparison against economic benefits of the project, a 35-year projected cost of $40,312,875 ($48,631,625 with riprap) was calculated, consisting of all implementation costs plus 35 years of post-construction maintenance.

Table 10
Project Costs

Phase	Project Feature	Unit	Quantity	Rate	Total Cost (Total with Optional Riprap)
Planning	Final Design				$1,250,000
	Environmental Review				$500,000
	Permitting				$20,000
	Planning Total				**$1,770,000**
Implementation	Land Acquisition	Acre	2,800	$5,000 – $8,000*	$22,400,000
	Earthwork/Grading	CY	800,000	$6.50**	$5,200,000
	Riprap – 18% (optional)	CY	53,240	$125***	($6,655,000)
	Planting (see line items below)				
	Seed mix	Acre	4,200	$500	$2,100,000
	Imprint/Hydromulch labor and equipment	Day	56	$1,050	$58,800
	Construction Total				**$7,358,800 ($14,013,800)**
3-Year Establishment Period	Monitoring - habitat and hydrology	Day	20	$900	$18,000
	Maintenance	Day	40	$2,600	$104,000
	Reporting	Each	3	$8,500	$25,500
	Establishment Period Total				**$147,500**
Implementation Summary				**Project Subtotal**	**$31,676,300 ($38,331,300)**
				Misc. Costs and Contingency (25%)	**$7,919,075 ($9,582,825)**
				Total Project Implementation Cost	**$39,595,375 ($47,914,125)**
Long-Term Maintenance	Annual Maintenance and Monitoring	Year	35	20,500	$717,500
				35-YEAR PROJECTED COSTS	**$48,631,625 ($40,312,875)**

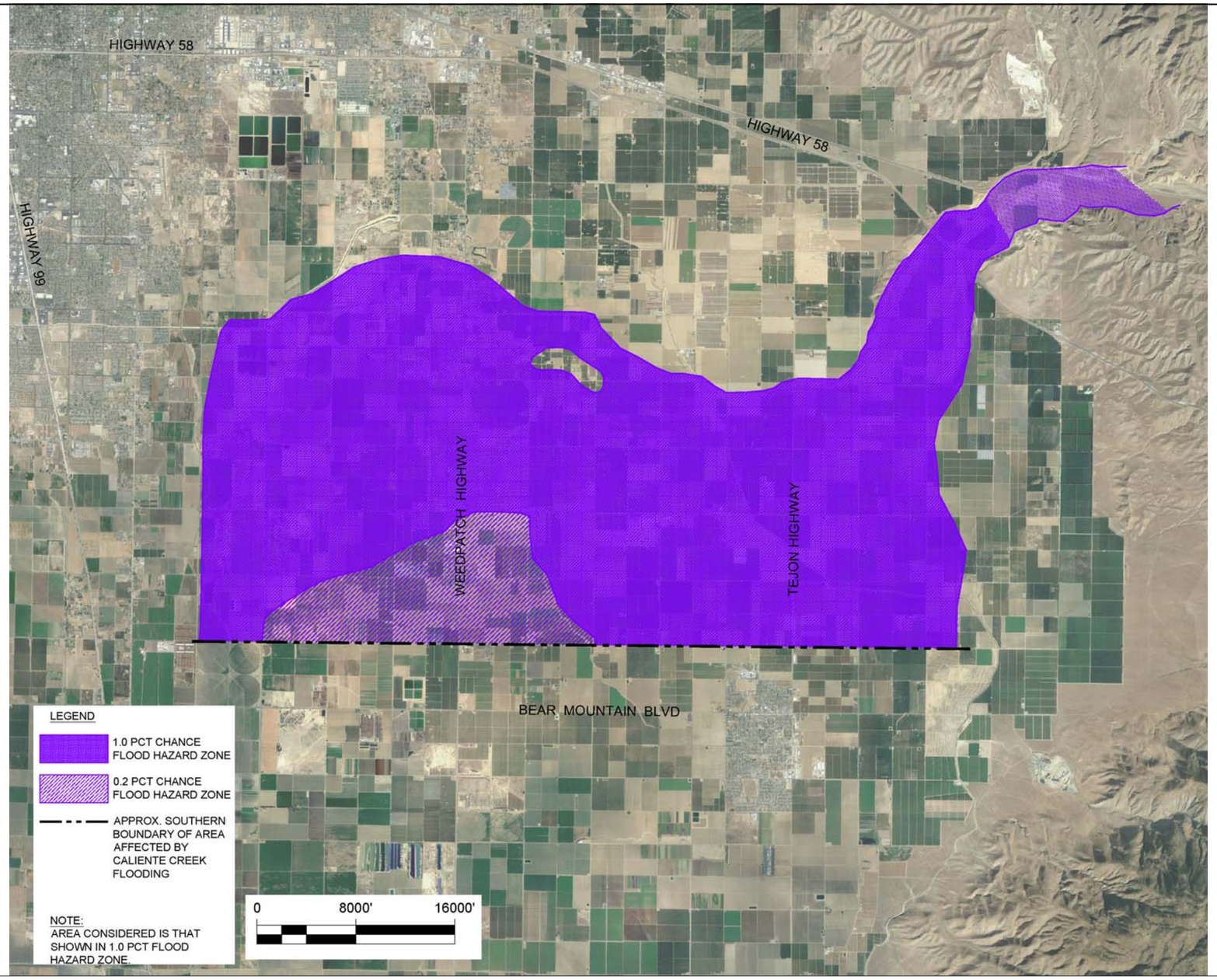
CY = cubic yards

* Source: Kern County Assessor for the $8,000 figure which was used for the report cost opinion. Subsequently an appraisal for a parcel of farm land in the study area was for $5,000 per acre.

** Source: Recent construction bids for large-scale restoration projects

*** Source: Kern County Development Standards

Implementation costs are subject to variation in the real estate and labor markets. Land acquisition accounts for roughly half of project costs. Agricultural land values in Kern County have increased in value by approximately a factor of 10 since 2003, but have begun an expected decrease in 2017. The value of properties within the project area is much lower than similar irrigated cropland nearby that is not subject to damage from storm flows; however, trends in land



Source: Psomas 2017

Figure 43
Flood Zone Map

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value have a large impact on the overall cost efficiency of the project. If property purchases are made when prices are low, it's possible the overall costs of project implementation could be substantially reduced. Conversely, if land values see another steep increase, project implementation costs will rise accordingly.

6.2 ECONOMIC BENEFITS OF PROJECT IMPLEMENTATION

Flooding in the Caliente Creek area results in damages to infrastructure and private property, and poses significant public safety hazards. Those hazards result in costs to the County and community in a variety of ways.

Approximately 106 miles of Kern County roads and Caltrans highways occur within the area flooded by Caliente Creek. Flooding is estimated to reduce the lifetime of a roadway by approximately 20 per cent.

Table 11 summarizes the total increase in costs to roads for flood mitigation and loss of service life. Caltrans and Kern County spend approximately $5.3 million for flood mitigation every 6 years, which averages $881,000 on a yearly basis . The cost for maintenance, repair, and reconstruction of roads within the area influenced by Caliente Creek's discharge over a usual estimated useful life of 35 years is $66,709,843 ($67 million). Since the flooding reduces the useful life of roads by at least 20% according to Kern County, the added cost is $16,667,641 ($17 million). The additional cost annually is therefore approximately $477,000. The annual increase in costs to roads for flood mitigation and loss of service life on an annual basis is approximately $1,357,149, and the total increase in costs to roads for flood mitigation and loss of service life over the full 35-year useful life of a roadway is $47,500,213. Nearly 95% of those costs are born by Kern County.

Using these estimated storm damage costs and project implementation costs, the project would break even with road maintenance costs events in approximately 30 years for the base project, and 36 years with riprap enhancements. Each subsequent year would represent an annual maintenance savings of approximately $1,337,000. Because the project design would establish more natural self-sustaining geomorphic processes, it is likely the project could continue functioning indefinitely without the need for major redesign, reconstruction or repair.

In practice, the economic benefits of project implementation would likely be much greater, as the storm damage costs discussed herein do not account for or other damage resulting from regular Caliente Creek flooding. Cost data for other damage was not readily available, but such costs include:

Table 11
Road Maintenance Costs

Cost Description		Kern County	Caltrans	Combined
Flood Mitigation Expenses	Estimated total costs of flood mitigation expenses based on a 6-year period:	$5,000,000	$283,900	$5,283,900
	Estimated annual costs (based on a 6-year period)	$833,333	$47,317	$880,650
	Estimated total costs of flood mitigation expenses based on a 35-year road life cycle	$29,166,667	$1,656,086	$30,822,753
Road Repair Expenses	Annual costs to repair roads based on road life of 35 years:	$1,803,588	$102,408	$1,905,996
	Total costs to repair roads based on road life of 35 years:	$63,125,568	$3,584,275	$66,709,843
	Increase in annual maintenance repair based on 20% decline in road life over a 35-year period:	$450,897	$25,602	$476,499
	Increase in total maintenance repair based on 20% decline in road life over a 35-year period:	$15,781,392	$896,069	$16,677,461
Total Road Expenses from Flooding	Total cost of flooding maintenance and road repair on annual basis:	$1,284,230	$72,919	$1,357,149
	Total cost of flooding maintenance and road repair for 35-year road life cycle	**$44,948,059**	**$2,552,155**	**$47,500,213**

Based on costs for area affected by flows from the project area, which includes 106 miles of Kern County and Caltrans roadways. Area included is limited to 1PCT Flood Hazard Zone, North of Sunset Boulevard.

- Loss to personal property;
- Delay of emergency vehicles;
- Rerouting of traffic during road repairs. During the winter of 2016–2017, which represents a typical wet year, Caltrans had to close Highway 184 from Highway 58 to Lamont. The communities of Arvin and Lamont incurred major expenses to repair their own streets and provided assistance to residents, schools, and businesses, which is not captured in the damage costs described above.
- Costs to protect public facilities. For example, schools recorded 30 inches of water that needed to be contained with sandbags and pumped, as a result of Caliente Creek flooding.

Additional economic value could potentially be realized from project implementation in a variety of ways.

- Value of increases to groundwater supply: Quantification of the overall increase would require study of a much larger area, however, modeling results suggest that groundwater yield would be increased by the project. An increase in available groundwater accessible by wells represents a cost savings by avoiding the high cost imported water and the

infrastructure necessary to deliver it. Infiltration increases shown in modeling results (see Tables 8 and 9) range from 159 acre-feet per event for a 2-year storm to up to 570 acre-feet per event for a 5 year storm. The number of events that occur each year is highly variable, but if one assumed six events occur in a year that capture an average of 300 acre-feet more infiltration, then approximately 1,800 acre-feet per year of additional groundwater yield would result.

- Value of decreased groundwater use: The project would result in the elimination of approximately 2400 acres of irrigated farming. If the annual irrigation demand is at least two acre-feet per acre per year, demand on groundwater for agricultural irrigation would be reduced by at least 4800 acre-feet per year. It is important to note that if the current agricultural uses were relocated to nearby land not currently in production, this savings would be reduced or eliminated.

- Value of Biological Mitigation Credits: As noted earlier, the project as proposed is not designed as a mitigation site intended to meet regulatory standards for biological mitigation. However; the site offers potential economic value as a mitigation bank for Kern County. The banked acreage could be used to satisfy internal County mitigation needs or sold to other parties. Additional study, regulatory approvals, and potentially an increase in proposed biological performance standards would be required to prepare the project for use as a mitigation bank and to determine the market value of the habitat. The value of upland mitigation credits could range from as little as $5,000 to more than $25,000 per acre. Wetland credit values vary greatly, but could be between $10,000 per acre to well over $100,000 per acre. It is possible the project could more than pay for itself through establishing a mitigation bank; however, using the project as mitigation would likely make it ineligible for most grant funding programs which would represent a major difference in the funding program for the County. A large advantage of grant funding is that it is secured prior to the County expending money on project implementation, whereas the income from mitigation banks is obtained only after the project is built, thus requiring a large initial funding investment well in advance of the return on that investment.

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7.0 SUMMARY AND CONCLUSIONS

The purpose of this current feasibility study is to provide a more in-depth analysis of potential solutions and recommend a more refined and detailed proposal for a combined Caliente Creek project. Chapter 5 describes the recommended alternative (full-restoration), which reduces flooding, increases groundwater infiltration, reduces sediment transport, and restores natural habitats.

Results of the study indicate the proposed solution would be very effective at reducing, or eliminating, downstream flooding and sediment damage from small, high-frequency storm events by achieving project goals of reducing sediment generation, increasing sediment capture, increasing groundwater recharge, and improving the habitat value on the alluvial plain. Furthermore, the modeling shows that the selective addition of riprap to high-velocity areas enhances the results for hydrology, groundwater infiltration, and sediment transport. Further improvements to performance are likely possible through minor changes in the grading plan during final design. The study also indicates the project meets feasibility criteria well:

- It is buildable, given that it consists of relatively straightforward grading and planting solutions and it does not require major modifications to existing infrastructure or development.
- It is functional, as measured by modeled performance against project goals.
- It is approvable, given that the full-restoration approach should be generally desirable to regulatory agencies.
- It is affordable, as indicated by the project's annualized costs being less than or roughly equal to annual road maintenance costs.

Potential challenges for project implementation include (1) securing funding, and (2) land acquisition and potential opposition to the elimination of agricultural land uses in the area.

Based on the results of this study, the project is effective, feasible, and worthwhile to advance to the next phase of planning and design.

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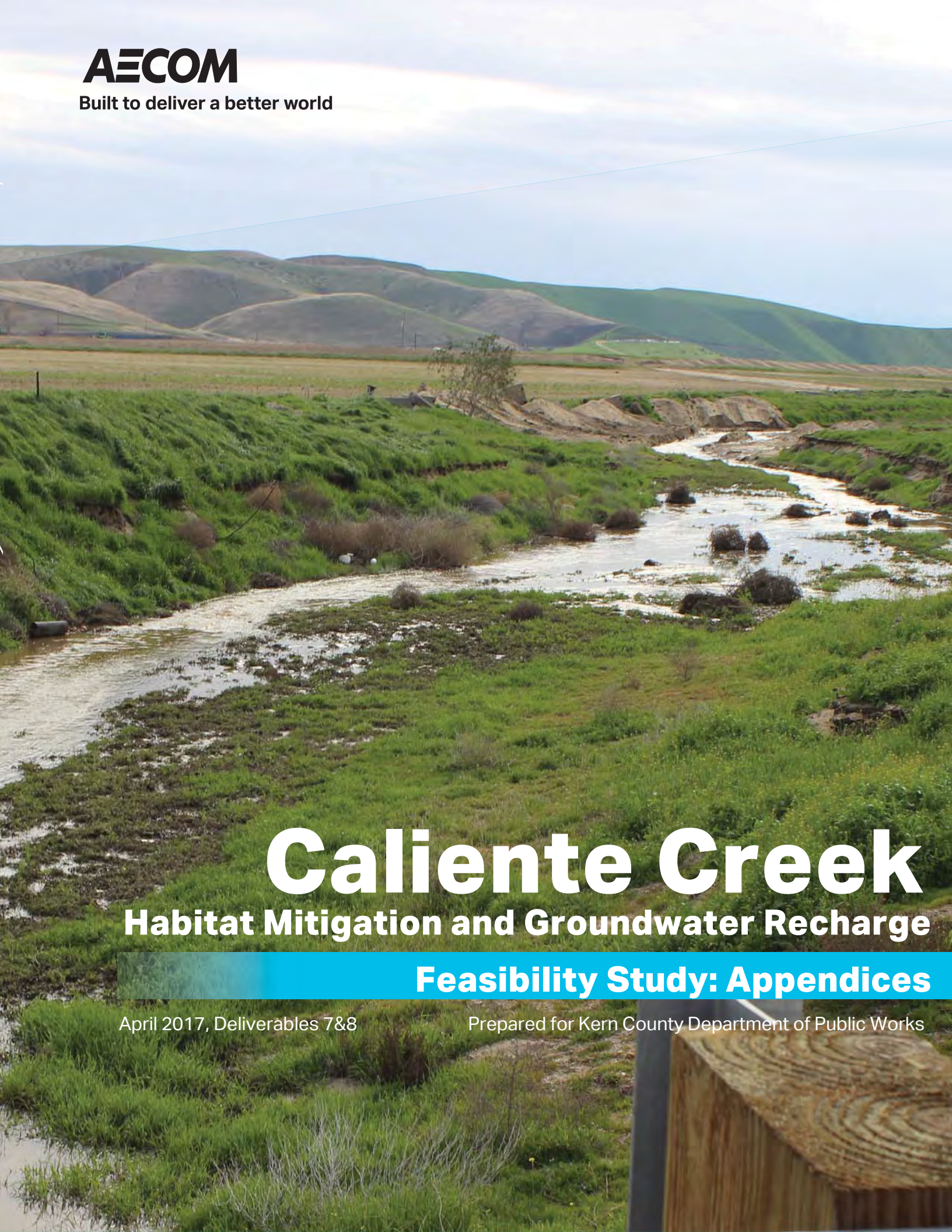

Caliente Creek

Habitat Mitigation and Groundwater Recharge

Feasibility Study: Appendices

April 2017, Deliverables 7&8

Prepared for Kern County Department of Public Works

APPENDIX A

HYDROLOGY
TECHNICAL MEMO

TECHNICAL MEMORANDUM

TO: Mr. Bill Black, PE, Principal Engineer, AECOM

FROM: Richard Meyer, PE, Meyer Civil Engineering, Inc.

DATE: September 16, 2016

SUBJECT: **Hydrology Study for the Caliente Creek Habitat Mitigation and Groundwater Recharge Projects**

General: The nearly 3200 acre project area receives runoff from Walker Basin and Caliente Creek Basin. These two basins encompass a watershed that contains approximately 476 square miles. The watershed begins in the Tehachapi Mountains of the Sierra Nevada and drains west starting at the divide to the Mojave Desert. These basins include Walker Basin Creek, Rancheria Creek, Caliente Creek, Weaver Creek, Indian Creek, Tehachapi Creek, Tweedy Creek and Brite Creek. Elevation varies from just over 8,000 feet to about 615 feet mean above sea level. Average streambed slopes vary from over 500 feet per mile to just under 100 feet per mile. The flows at the project area are ephemeral and have potential to be quick and large. Indeed, whenever significant rainfall occurs, the downstream communities of Arvin and Lamont suffer greatly. Damage is caused not only by floodwaters but also by sedimentation which these flows carry. Typically engineers are concerned about the one percent chance or 100 year event, but history indicates that flood damage to these two communities has been caused by much more frequent events. Thus the charge of Kern County staff to the project team is to design the project to mitigate these more frequent events. Also, the project as defined within its concept and magnitude will not be able to significantly mitigate larger events. These larger events will need to be routed through the project area with sustained damage.

Study Objective: Develop the 5 and 10 year, 24 hour event hydrographs for the project area and recommend the design event.

Assumption: Since little or no effectual stream gauge information is available and since the Army Corps of Engineers (ACOE) has studied the watershed in great detail, this new study was founded on the established ACOE Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) for Caliente Creek. Therefore it was assumed that the established ACOE HEC-HMS model adequately describes the watershed and its individual components with appropriate assigned variables to establish the relationship between rainfall and runoff. While the model utilizes a uniform 3.5" of rain over the entire watershed, which does not reflect the current Atlas rainfall, the new model was calibrated to the ACOE's rainfall for peak discharge and volume. The model was then run with current National Oceanic and Atmospheric Administration (NOAA) rainfall data to determine new 100 year, 10 year and 5 year values.

Approach: A new HEC-HMS hydrology model was constructed and calibrated to the established ACOE HEC-HMS model. The calibrated flow and volume was matched closely to the ACOE

Meteorological model run named "100 yr". This run utilized "CalGS.dat" which specified the Soil Conservation Service (SCS) Type I rainfall pattern with a 3.50" volume. The following procedure was utilized.

1. Constructed a new hydrology model in HEC-HMS:
    a. Verified or reestablished boundaries of watershed and interior drainage sub-basins based on USGS mapping.
    b. Verified or reestablished drainage paths and confluence locations.
    c. Verified or reestablished watershed characteristics, such as surface roughness (Manning's "n" values) and soils absorption.
2. The Kern County Hydrology Manual (KCHM) was followed as much as was practicable to the purpose of calibrating the new model to the ACOE values.
    a. Determination of lag times was in accordance with Section E.12.I.B.2 of the KCHM, where: Lag (hours) = $24n*[(L*Lca)/S^{\wedge 0.5}]^m$. Manning's n was varied to obtain similar routing times as the ACOE model.
    b. Infiltration was determined in accordance with SCS soil and cover Cn values. However, infiltration was not bounded by an upper limit. This was due to how the ACOE model was constructed which was with a constant infiltration rate of 0.25 inches per hour. For this reason, an antecedent moisture condition of dry was utilized (AMC I). Percent impervious was set to 1%, except for inhabited areas in which additional imperviousness was included.
    c. Hydrographs were patterned based on the KCHM S-Graphs for the "Mountains", "Foot Hills" and "Valley–Undeveloped".
3. Rainfall was studied as follows:
    a. Rainfall pattern for the calibrated model was in accordance with SCS Type I rainfall. Total rainfall was 3.50" matching the ACOE model.
    b. After calibration, rainfalls more representative of modern data were investigated:
        i. KCHM rainfall patterns paired with both Atlas 2 and Atlas 14 rainfall were investigated (Scenarios 1 & 2).
        ii. A special derived "balanced" hyetograph was developed and paired with Atlas 14 rainfall (Scenarios 3 & 4). The balanced rainfall curve is centered on 12 hours within a 24 hour duration. Intensity for the 5 minute, 30 minute, 1 hour, 12 hour and 24 hour durations is plotted symmetrically about the 12 hour centerline. Therefore each of these defined intensities was built into the curve. A 3 hour duration curve was also formulated in a similar way. The 3 hour curve was utilized in the fourth scenario listed in Table B below. The 3 hour curve was applied only to five of the lower elevation sub-basins (Scenario 4).
    c. Area Reduction Factors (ARF's) were applied to the Atlas values. The study area is approximately 476 square miles. Area Reduction Factors were taken from NOAA Atlas 2 Volume 11 for Atlas 2 rainfall and from NOAA Hydrometeorological Report No. 59 (HMR59) for Atlas 14 rainfall.

4. Routing of flows was accomplished with Kinematic Wave methodology. This was primarily due to the lack of detailed topography information for the stream cross-sections. Applied Manning's "n" values varied from 0.050 for upper reaches to 0.030 for lower reaches.
5. Calibration of the HEC-HMS model:
    a. The calibration point on the ACOE model is named "13+9 WAL". This is the confluence of Walker Basin Creek with Caliente Creek inside the project area and just downstream of the Walker Basin Creek railroad bridge and the Caliente Creek Bena Road bridge. The corresponding label on the new model is "J-CA05".
    b. Rainfall was held constant matching ACOE values for the "100yr" analysis.
    c. Cn values were adjusted to approximate total discharge volume.
    d. Manning's "n" values were adjusted to increase or decrease discharge peaks.

Results: The various model runs resulting in the following:

6. Calibration of the model resulted in the following:

TABLE A - Calibration of New Model to ACOE – 3.50" Rainfall						
Location	New Model			ACOE Model		
	Peak Flow, CFS	Time, Hrs	Volume, Inches	Peak Flow, CFS	Time, Hrs	Volume, Inches
Confluence of Walker Basin and Caliente Creeks	30,542	12.92	0.87	31,385	14.33	0.84
Caliente Creek from Bena Road Bridge	23,030	13.00	0.87	23,448	14.50	0.84
Walker Basin Flows from Railroad Bridge	8,803	12.50	0.90	8,858	13.17	0.84

7. Different rainfall curves paired with both Atlas 2 and Atlas 14 rainfall values were then studied. These are summarized as follows:

TABLE B - New Model Results of Studied Rainfall Curve and Values							
Modeled Rainfall Scenario		100 yr 24 hr Event		10 yr 24 hr Event		5 yr 24 hr Event	
		Peak Flow, CFS	Volume, Inches	Peak Flow, CFS	Volume, Inches	Peak Flow, CFS	Volume, Inches
1.	KCHM(1) with Atlas 2	47,887	1.57	23,206	0.78	16,256	0.56
2.	KCHM(1) with Atlas 14	55,287	1.37	18,985	0.52	12,464	0.35
3.	Balanced Storm with Atlas 14(2)	50,754	1.36	13,550	0.52	8,746	0.35
4.	24 hour Event on Higher Elevs. and 3 hour Event on Lower Elevs. with Balanced Storms using Atlas 14	32,062	0.97	8,891	0.37	5,639	0.23

(1) Hyetograph per Kern County Hydrology Manual.

(2) Equal amount of water is placed on rising limb as falling limb of the balanced synthetic hyetograph. 5min, 30min, 1hr, 12hr & 24hr intensities are centered on 12 hours' time.

8. When results were reviewed for the first three scenarios, concerns still existed for significantly higher resultant values of flow when compared to established 100 year flow values. For these reasons a fourth scenario was developed as shown in Table B above. Development of this scenario was based on the reasoning that; a) it is highly unlikely that the 476 square mile watershed will be affected by the 24 hour storm at once; b) the storm will be moving into the mountains from the valley and so rainfall will occur in the lower part of the basin first; and c) the storm will be more intensified in the mountains as it is affected by orographic lift. Therefore this fourth scenario utilized the 100 year 3 hour storm in the lower five sub-basins.

Conclusions: The following conclusions are offered.

9. The resultant flows due to the application of modern Atlas rainfall values revealed a significant difference from the ACOE model "100 yr" value. The area average rainfall for the 100 year 24 hour event, areal adjusted, is significantly greater than the 3.50" applied in the ACOE model:

TABLE C - 24 Hour Event Rainfall Comparison(1)			
Source	100yr Volume, inches	10yr Volume, inches	5yr Volume, inches
Atlas 2 Volume 11	4.46	2.88	2.41
Atlas 14 Volume 6	4.69	2.72	2.21
ACOE HMS Model	3.50	-	-

(1) Comparison based on centroid of entire watershed.

It is noted that Kern County has adopted the Atlas 14 values for hydrologic study; therefore, Atlas 14 is the much preferred rainfall data.

10. The KCHM hyetograph design was primarily developed for the purpose of smaller watersheds under development. Therefore the KCHM curve is purposely designed to derive larger peak flows in these smaller applications. This is evidenced by the fact that the centroid of the shorter duration intensities is set at 16 hours in the 24 hour graph. This causes a long duration saturation of the watershed and then application of high intensity rainfall. Considering the largeness of the Caliente Creek watershed, it is not likely that these intensities will occur over the whole area during the same 24 hour period. For this reason, the balanced curve was studied. It is noted that the balanced hyetograph does contain the entire duration intensities specific to the study area. The balanced hyetograph produced smaller peak discharges than the KCHM curve while producing the same volume.
11. Scenario 4 (combination of 24 hour rainfall with 3 hour rainfall) helped to compensate for the significant volumetric differences. Peak flows were also significantly reduced and brought more into line with established ACOE and FEMA values.

Recommendations: These recommendations are based on detailed modeling and this engineer's experience in hydrologic study.

12. Based on the foregoing, it is recommended that values from the Balanced Storm with Atlas 14 rainfall be considered applicable to the design of the project.
13. It is also recommended that the 5 year 24 hour combined with 3 hour rainfall events be considered as the project design event. Mitigation of the peak flow and volume contained in this more frequent event hydrograph is more feasible to attain with the proposed project.

Application: This information is summarized to assist the designers of the project.

14. The recommended study hydrographs that enter and exit the project area are detailed in the following table.

TABLE D – Project Design Flows (5 Year 24 Hour Event)

Location	Peak Flow, CFS	Time of Peak, Hours	Volume of Discharge, Acre-Feet
Walker Basin Creek at Railroad Bridge, Model Point J-WB02A	1,479	16.50	1,383
Caliente Creek at Bena Road Bridge, Model Point J-CA04A	4,328	17.00	4,449
Confluence of Walker Basin Creek and Caliente Creek, Model Point J-CA05	5,639	17.50	5,782
Unimpeded Exit at Project South Boundary, Model Point J-CA06	5,516	18.50	5,778

15. The following pages in Appendix A illustrate the plotted hydrographs along with the corresponding coordinates.

Respectfully Submitted,

Richard Meyer, CE 28104
Meyer Civil Engineering, Inc.

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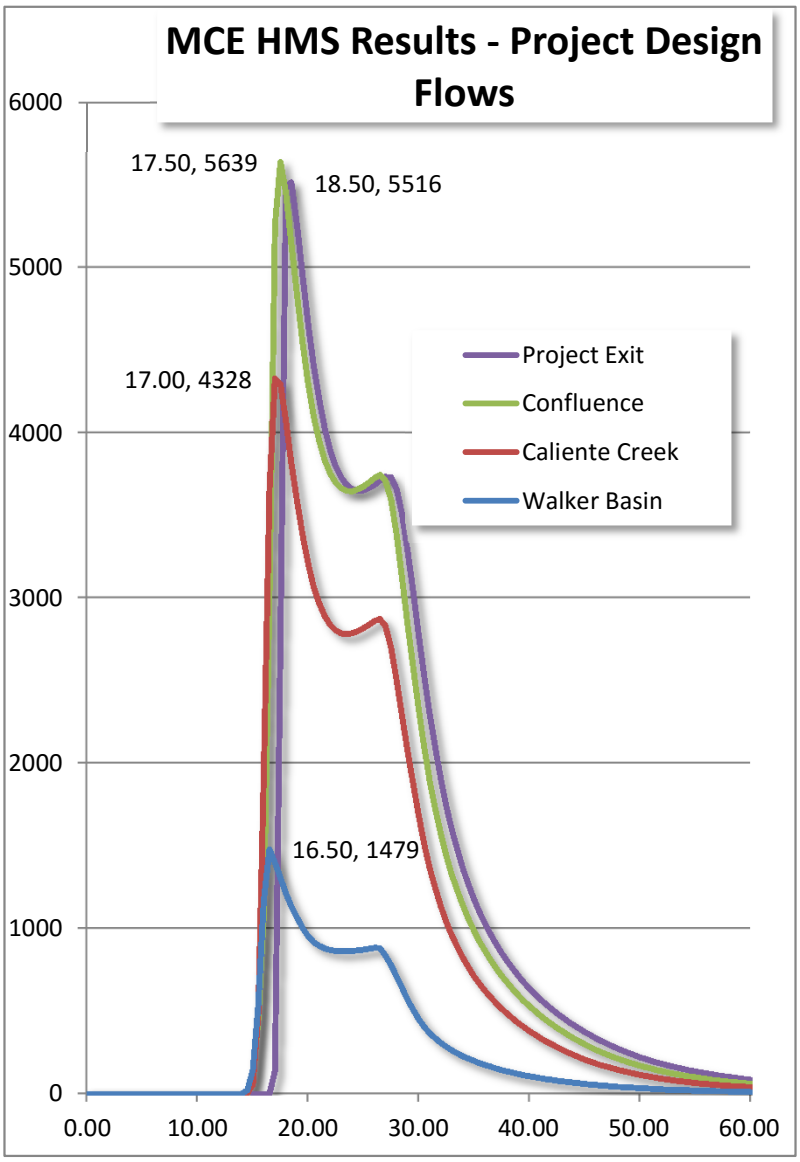
MCE HMS Results - Project Design Flows

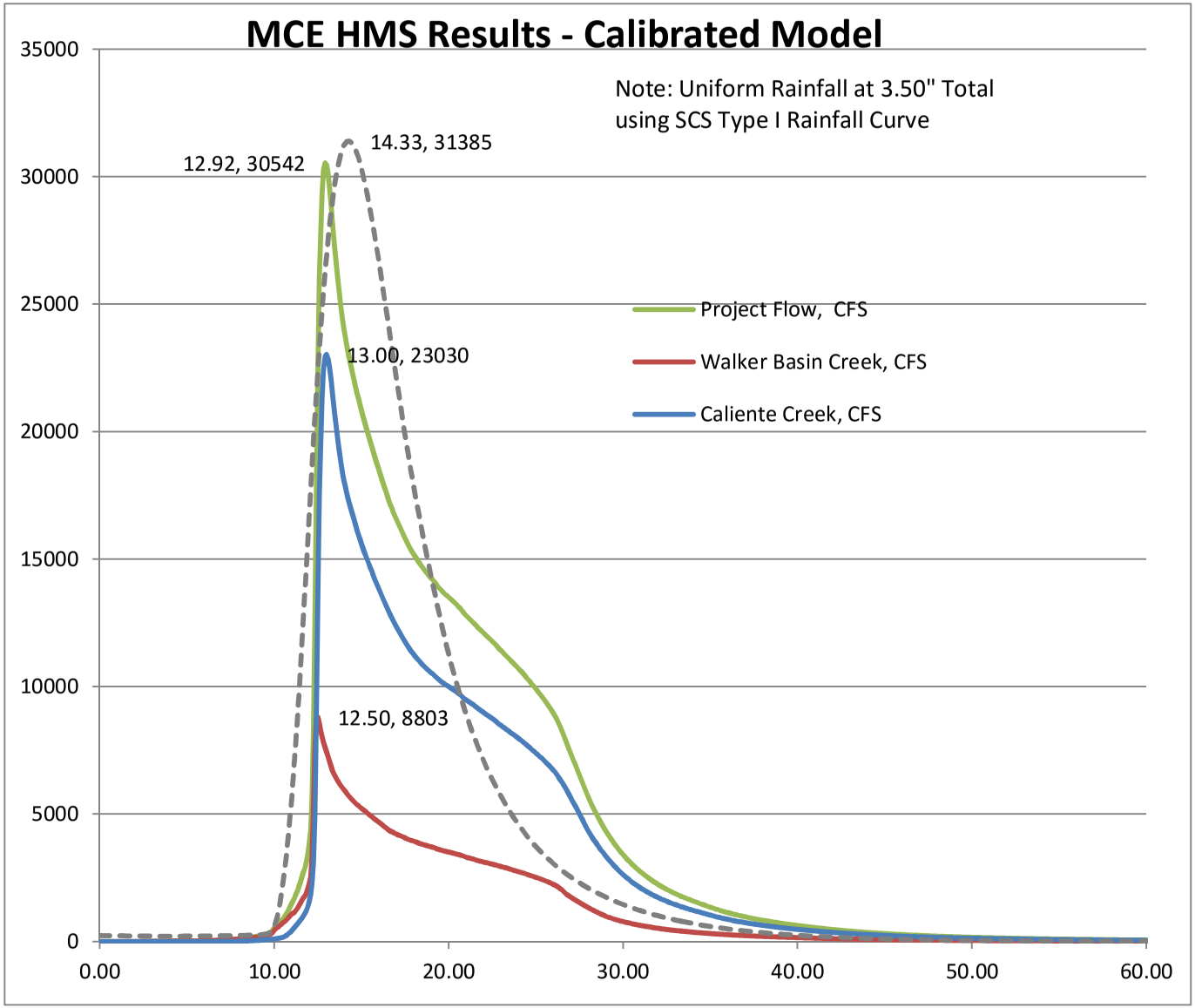
	1479 CFS	4328 CFS	5639 CFS	5516 CFS
	1383 AF	4449 AF	5782 AF	5778 AF
Time, Hrs	Walker Basin	Caliente Creek	Confluence	Project Exit
0.00	0	0	0	0
0.50	0	0	0	0
1.00	0	0	0	0
1.50	0	0	0	0
2.00	0	0	0	0
2.50	1	1	0	0
3.00	1	1	0	0
3.50	1	1	0	0
4.00	2	1	0	0
4.50	2	1	1	0
5.00	2	1	2	0
5.50	1	1	2	0
6.00	1	0	2	0
6.50	1	0	1	0
7.00	1	0	1	0
7.50	0	0	1	0
8.00	0	0	1	0
8.50	0	0	1	0
9.00	0	0	1	0
9.50	0	0	0	0
10.00	0	0	0	0
10.50	0	0	0	0
11.00	0	0	0	0
11.50	0	0	0	0
12.00	0	0	0	0
12.50	0	0	0	0
13.00	0	0	0	0
13.50	0	0	0	0
14.00	3	0	0	0
14.50	23	3	1	0
15.00	144	56	88	0
15.50	539	484	451	0
16.00	1170	1924	1081	0
16.50	1479	3661	3022	1
17.00	1398	4328	5253	139
17.50	1309	4295	5639	2727
18.00	1214	4071	5453	5480
18.50	1135	3818	5142	5516
19.00	1067	3585	4830	5253
19.50	1005	3383	4546	4951
20.00	955	3212	4303	4666
20.50	919	3073	4104	4414
21.00	895	2967	3949	4201
21.50	880	2891	3834	4028
22.00	871	2838	3752	3895



Time, Hrs	Walker Basin	Caliente Creek	Confluence	Project Exit
22.50	865	2804	3698	3797
23.00	863	2786	3664	3729
23.50	863	2781	3648	3683
24.00	865	2787	3647	3658
24.50	869	2800	3657	3648
25.00	873	2818	3675	3651
25.50	878	2839	3699	3665
26.00	884	2862	3726	3686
26.50	881	2874	3746	3711
27.00	838	2831	3711	3735
27.50	777	2698	3593	3730
28.00	710	2502	3385	3661
28.50	642	2288	3124	3509
29.00	570	2075	2846	3289
29.50	507	1872	2577	3035
30.00	452	1683	2326	2777
30.50	405	1513	2097	2530
31.00	369	1367	1896	2299
31.50	336	1243	1722	2089
32.00	308	1134	1572	1904
32.50	285	1039	1441	1740
33.00	263	960	1325	1599
33.50	245	887	1227	1474
34.00	227	822	1138	1362
34.50	213	766	1059	1266
35.00	199	712	988	1179
35.50	187	667	923	1100
36.00	175	623	864	1030
36.50	164	585	810	966
37.00	154	548	760	907
37.50	144	515	715	853
38.00	136	484	672	803
38.50	128	456	633	758
39.00	120	429	597	715
39.50	113	404	563	676
40.00	107	380	531	639
40.50	101	359	502	604
41.00	95	338	474	572
41.50	90	319	448	542
42.00	85	300	423	514
42.50	80	283	400	487
43.00	76	266	378	462
43.50	72	250	356	439
44.00	67	236	337	416
44.50	64	222	317	395
45.00	60	208	300	375
45.50	57	197	283	356
46.00	54	185	267	337

Time, Hrs	Walker Basin	Caliente Creek	Confluence	Project Exit
46.50	51	174	252	320
47.00	48	164	238	304
47.50	45	155	225	288
48.00	43	145	212	273
48.50	40	137	201	259
49.00	38	130	190	246
49.50	36	122	179	234
50.00	34	115	170	222
50.50	32	109	161	211
51.00	31	103	152	201
51.50	29	97	144	191
52.00	28	92	137	181
52.50	26	87	130	173
53.00	25	82	123	165
53.50	23	78	117	156
54.00	22	74	111	149
54.50	21	70	105	142
55.00	20	66	100	136
55.50	19	63	95	129
56.00	18	59	91	123
56.50	17	57	86	118
57.00	17	54	82	112
57.50	16	51	78	107
58.00	15	48	74	103
58.50	14	46	71	98
59.00	13	44	68	94
59.50	13	42	64	90
60.00	12	40	61	86

	23030 CFS	8803 CFS	30542 CFS
	0.87 IN	0.90 IN	0.87 IN
Time, Hrs	Caliente Creek, CFS	Walker Basin Creek, CFS	Project Flow, CFS
0.00	0	0	0
0.50	0	0	0
1.00	0	0	0
1.50	0	0	0
2.00	0	0	0
2.50	0	2	2
3.00	0	5	5
3.50	0	10	10
4.00	0	11	11
4.50	0	13	13
5.00	0	16	16
5.50	0	20	20
6.00	0	27	27
6.50	1	39	39
7.00	2	53	55
7.50	5	72	76
8.00	11	93	104
8.50	23	121	143
9.00	40	163	203
9.50	64	228	293
10.00	98	430	528
10.50	159	724	883
11.00	421	1080	1501
11.50	823	1503	2326
13.00	23030	7433	30463
13.50	20502	6479	26981
14.00	18081	5955	24036
14.50	16718	5528	22245
15.00	15600	5225	20826
15.50	14686	4943	19629



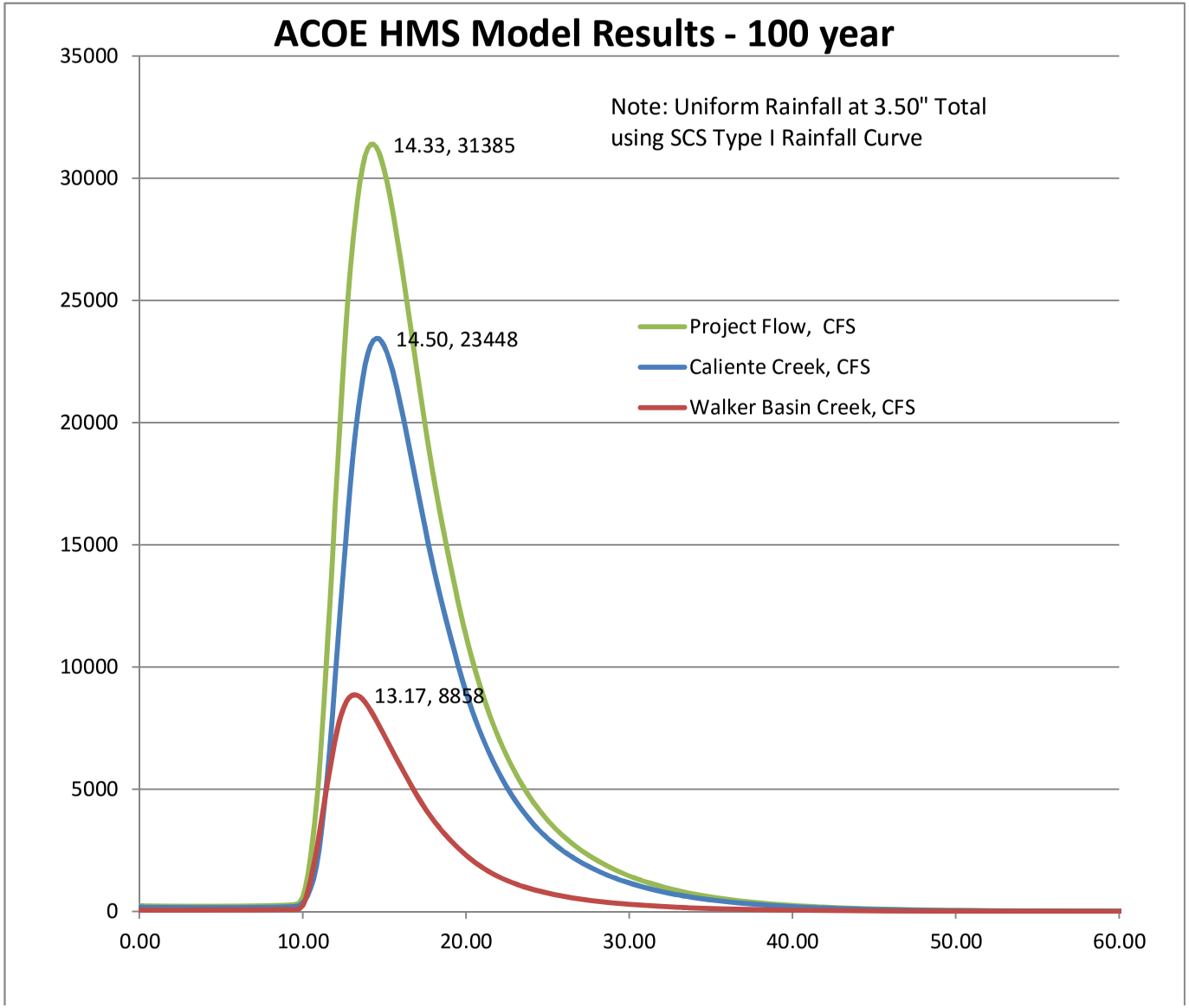
Time, Hrs	Caliente Creek, CFS	Walker Basin Creek, CFS	Project Flow, CFS
16.00	13828	4674	18502
16.50	13040	4401	17441
17.00	12355	4211	16566
17.50	11754	4064	15818
18.00	11253	3934	15187
18.50	10859	3809	14668
19.00	10535	3712	14247
19.50	10236	3594	13830
20.00	9998	3507	13505
20.50	9764	3417	13182
21.00	9477	3307	12784
21.50	9234	3210	12445
22.00	8980	3116	12096
22.50	8744	3031	11775
23.00	8473	2940	11413
23.50	8219	2841	11060
24.00	7971	2738	10710
24.50	7689	2631	10320
25.00	7390	2515	9906
25.50	7080	2388	9467
26.00	6722	2242	8964
26.50	6241	2017	8258
27.00	5639	1739	7378
27.50	5003	1526	6529
28.00	4343	1332	5675
28.50	3811	1150	4962
29.00	3357	995	4352
29.50	2963	874	3837
30.00	2624	779	3403
30.50	2340	700	3040
31.00	2099	633	2732
31.50	1897	571	2467
32.00	1725	516	2240

Time, Hrs	Caliente Creek, CFS	Walker Basin Creek, CFS	Project Flow, CFS
32.50	1576	469	2045
33.00	1445	430	1875
33.50	1328	395	1723
34.00	1225	365	1589
34.50	1129	337	1466
35.00	1034	311	1345
35.50	945	286	1231
36.00	867	265	1132
36.50	798	245	1044
37.00	737	228	965
37.50	683	213	895
38.00	633	199	832
38.50	588	185	773
39.00	547	173	720
39.50	509	161	670
40.00	473	151	624
40.50	441	140	581
41.00	411	131	542
41.50	383	121	504
42.00	358	111	469
42.50	334	103	436
43.00	312	95	406
43.50	291	88	379
44.00	271	82	353
44.50	253	76	330
45.00	237	71	308
45.50	221	66	288
46.00	207	62	269
46.50	194	58	252
47.00	182	54	236
47.50	171	51	222
48.00	161	47	208
48.50	152	44	196

Time, Hrs	Caliente Creek, CFS	Walker Basin Creek, CFS	Project Flow, CFS
49.00	143	42	185
49.50	135	39	174
50.00	127	37	164
50.50	120	35	155
51.00	113	33	146
51.50	107	31	138
52.00	101	29	131
52.50	96	28	124
53.00	91	26	117
53.50	86	25	111
54.00	81	24	105
54.50	77	22	99
55.00	73	21	94
55.50	69	20	89
56.00	65	19	85
56.50	62	18	80
57.00	59	17	76
57.50	56	16	72
58.00	53	16	69
58.50	51	15	65
59.00	48	14	62
59.50	46	13	59
60.00	44	13	57

ACOE HMS Model Results - 100 year

	23448 CFS	8858 CFS	31385 CFS
			0.84 IN
Time, Hrs	Caliente Creek, CFS	Walker Basin Creek, CFS	Project Flow, CFS
0.00	173	58	231
1.00	169	55	224
2.00	161	54	215
3.00	154	55	209
4.00	151	56	207
5.00	152	58	210
6.00	156	60	216
7.00	162	62	224
8.00	170	66	236
9.00	182	70	252
10.00	343	234	577
11.00	2516	3098	5615
12.00	9589	7036	16625
13.00	18050	8825	26875
14.00	22828	8397	31225
14.50	23448	7825	31273
15.00	23127	7201	30328
15.17	22858	6990	29848
15.33	22525	6778	29303
15.50	22137	6566	28703
15.67	21702	6354	28056
15.83	21229	6144	27373
16.00	20725	5940	26665
17.00	17373	4745	22117
18.00	14095	3738	17833
19.00	11370	2949	14319
20.00	8978	2303	11281
21.00	7128	1797	8925
22.00	5688	1419	7106
23.00	4559	1135	5694

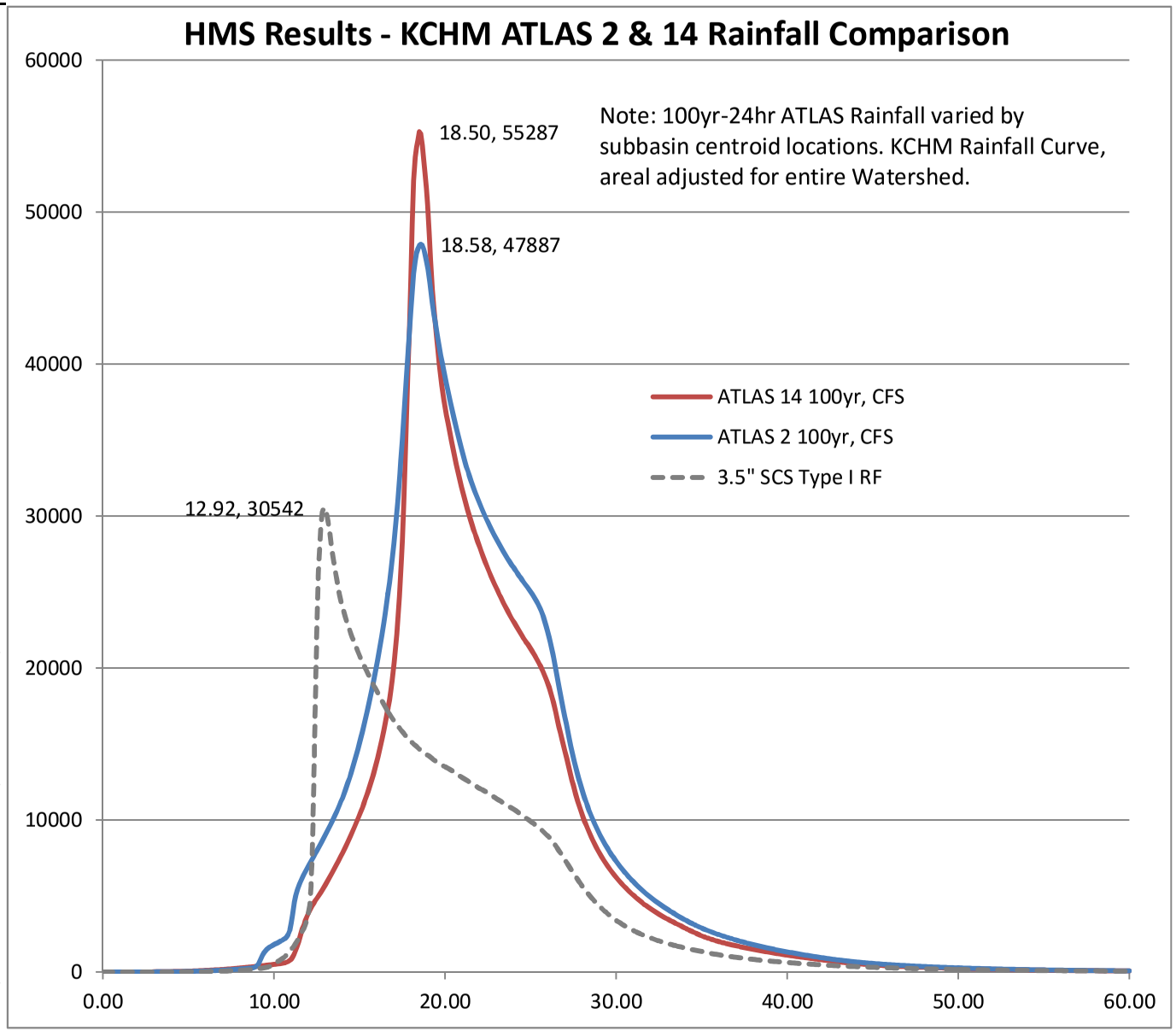


Time, Hrs	Caliente Creek, CFS	Walker Basin Creek, CFS	Project Flow, CFS
24.00	3675	915	4590
25.00	2985	744	3729
26.00	2450	611	3061
27.00	2023	504	2527
28.00	1678	418	2096
29.00	1395	347	1742
30.00	1161	290	1450
31.00	967	242	1209
32.00	807	202	1009
33.00	674	169	842
34.00	562	141	703
35.00	469	118	587
36.00	392	99	491
37.00	328	83	411
38.00	275	70	345
39.00	230	59	288
40.00	193	49	242
41.00	162	42	205
42.00	136	35	171
43.00	114	29	143
44.00	95	24	119
45.00	79	20	99
46.00	66	17	83
47.00	55	14	69
48.00	46	12	58
49.00	38	10	48
50.00	32	8	40
51.00	26	7	33
52.00	22	6	28
53.00	18	5	23
54.00	15	4	19
55.00	13	3	16
56.00	11	3	13

Time, Hrs	Caliente Creek, CFS	Walker Basin Creek, CFS	Project Flow, CFS
57.00	9	2	11
58.00	7	2	9
59.00	6	2	8
60.00	5	1	6
61.00	4	1	5
62.00	4	1	5
63.00	3	1	4
64.00	3	1	3
65.00	2	1	3
66.00	2	0	2
67.00	1	0	2
68.00	1	0	2
69.00	1	0	1
70.00	1	0	1
71.00	1	0	1
72.00	1	0	1
73.00	1	0	1
74.00	0	0	1
75.00	0	0	0
76.00	0	0	0
77.00	0	0	0
78.00	0	0	0
79.00	0	0	0
80.00	0	0	0
81.00	0	0	0
82.00	0	0	0
83.00	0	0	0
84.00	0	0	0
85.00	0	0	0
86.00	0	0	0
87.00	0	0	0
88.00	0	0	0
89.00	0	0	0

HMS Results - KCHM ATLAS 2 & 14 Rainfall Comparison

	47887 CFS	55287 CFS
	1.57 IN	1.31 IN
Time, Hrs	ATLAS 2 100yr, CFS	ATLAS 14 100yr, CFS
0.00	0	0
0.50	0	0
1.00	0	0
1.50	0	0
2.00	0	1
2.50	4	5
3.00	10	12
3.50	16	20
4.00	20	27
4.50	26	37
5.00	36	53
5.50	51	76
6.00	71	102
6.50	93	132
7.00	120	166
7.50	154	207
8.00	195	256
8.50	242	312
9.00	396	371
9.50	1395	434
10.00	1799	499
10.50	2095	576
11.00	3198	836
11.50	5810	2224
12.00	6947	3842
12.50	7952	4832
13.00	9007	5713
13.50	10144	6743
14.00	11449	7820
14.50	13060	9004
15.00	15071	10338



KCHM ATLAS 2 & 14 RF 100yr

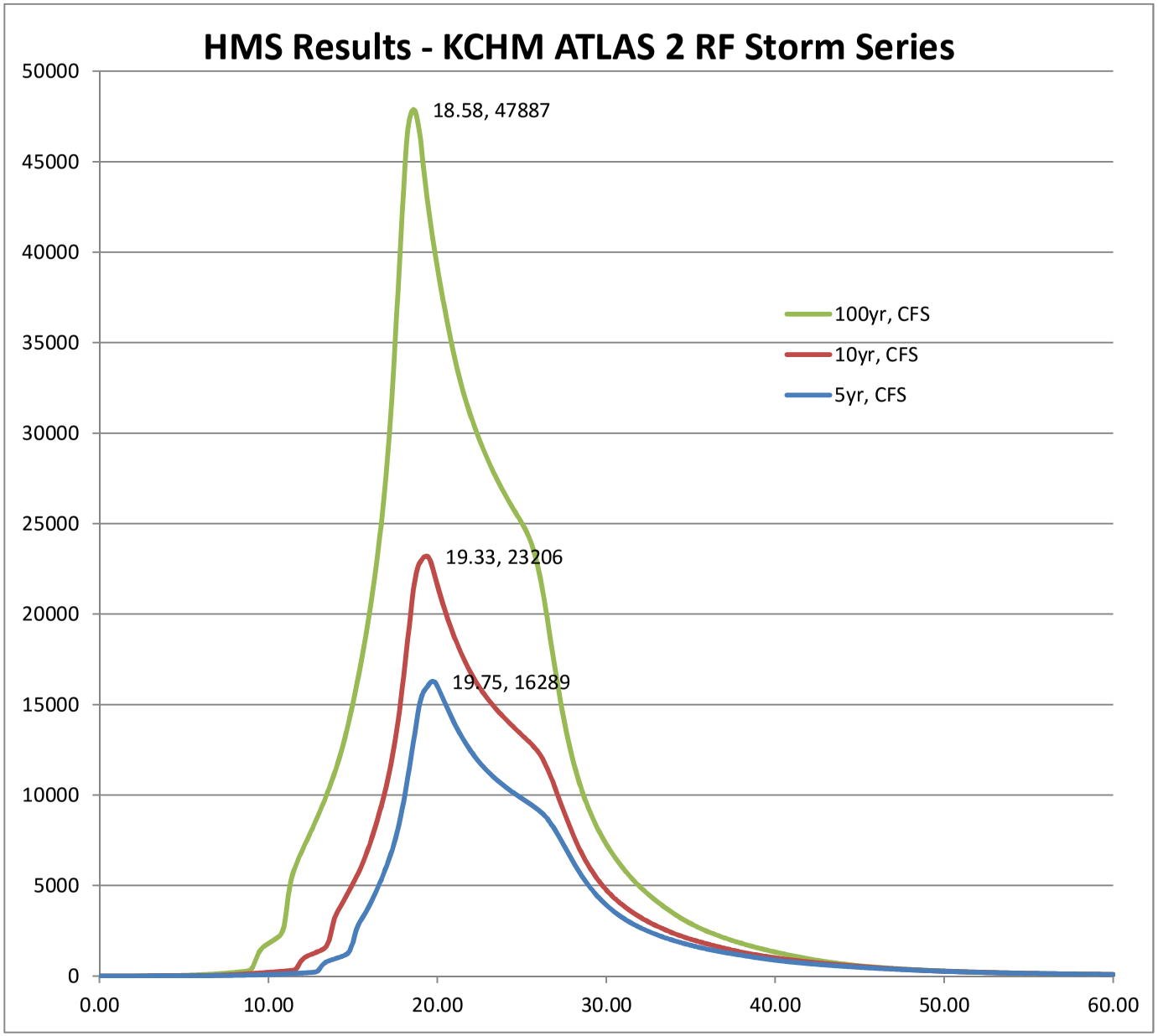
Time, Hrs	ATLAS 2 100yr, CFS	ATLAS 14 100yr, CFS
15.50	17422	11879
16.00	20164	13765
16.50	23572	16350
17.00	28104	20113
17.50	35059	28374
18.00	43512	45657
18.50	47809	55287
19.00	46227	50100
19.50	42206	41792
20.00	39157	37176
20.50	36541	34258
21.00	34257	31723
21.50	32377	29719
22.00	30880	28043
22.50	29608	26548
23.00	28489	25275
23.50	27496	24108
24.00	26616	23056
24.50	25798	22116
25.00	25035	21281
25.50	24075	20284
26.00	22388	19016
26.50	19779	16938
27.00	16792	14547
27.50	14099	12265
28.00	12013	10408
28.50	10400	8994
29.00	9144	7880
29.50	8124	6969
30.00	7284	6226
30.50	6572	5600
31.00	5948	5065
31.50	5401	4580
32.00	4923	4169

Time, Hrs	ATLAS 2 100yr, CFS	ATLAS 14 100yr, CFS
32.50	4498	3805
33.00	4120	3483
33.50	3768	3193
34.00	3444	2906
34.50	3156	2633
35.00	2894	2380
35.50	2663	2177
36.00	2458	2005
36.50	2274	1856
37.00	2105	1726
37.50	1948	1608
38.00	1804	1498
38.50	1670	1392
39.00	1545	1293
39.50	1430	1199
40.00	1322	1112
40.50	1221	1031
41.00	1124	955
41.50	1031	880
42.00	943	804
42.50	863	731
43.00	790	665
43.50	724	608
44.00	665	557
44.50	611	512
45.00	563	471
45.50	521	435
46.00	483	403
46.50	448	375
47.00	417	349
47.50	387	326
48.00	360	304
48.50	334	285
49.00	311	266

Time, Hrs	ATLAS 2 100yr, CFS	ATLAS 14 100yr, CFS
49.50	290	249
50.00	270	232
50.50	253	217
51.00	236	203
51.50	221	190
52.00	206	178
52.50	193	166
53.00	180	156
53.50	169	146
54.00	158	137
54.50	147	129
55.00	138	121
55.50	129	114
56.00	121	107
56.50	114	101
57.00	107	95
57.50	101	90
58.00	95	85
58.50	90	81
59.00	85	76
59.50	80	72
60.00	76	69

HMS Results - KCHM ATLAS 2 RF Storm Series

	16289 CFS	23206 CFS	47887 CFS
	0.56 IN	0.78 IN	1.57 IN
Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
0.00	0	0	0
0.50	0	0	0
1.00	0	0	0
1.50	0	0	0
2.00	0	0	0
2.50	0	1	4
3.00	2	3	10
3.50	5	7	16
4.00	8	10	20
4.50	9	12	26
5.00	11	14	36
5.50	12	16	51
6.00	14	20	71
6.50	16	27	93
7.00	20	38	120
7.50	27	54	154
8.00	34	76	195
8.50	44	104	242
9.00	54	135	396
9.50	67	168	1395
10.00	82	201	1799
10.50	99	236	2095
11.00	118	274	3198
11.50	140	328	5810
12.00	164	902	6947
12.50	191	1181	7952
13.00	363	1373	9007
13.50	812	1775	10144
14.00	971	3382	11449
14.50	1141	4224	13060
15.00	1853	5105	15071
15.50	3128	6062	17422



Series KCHM ATLAS 2

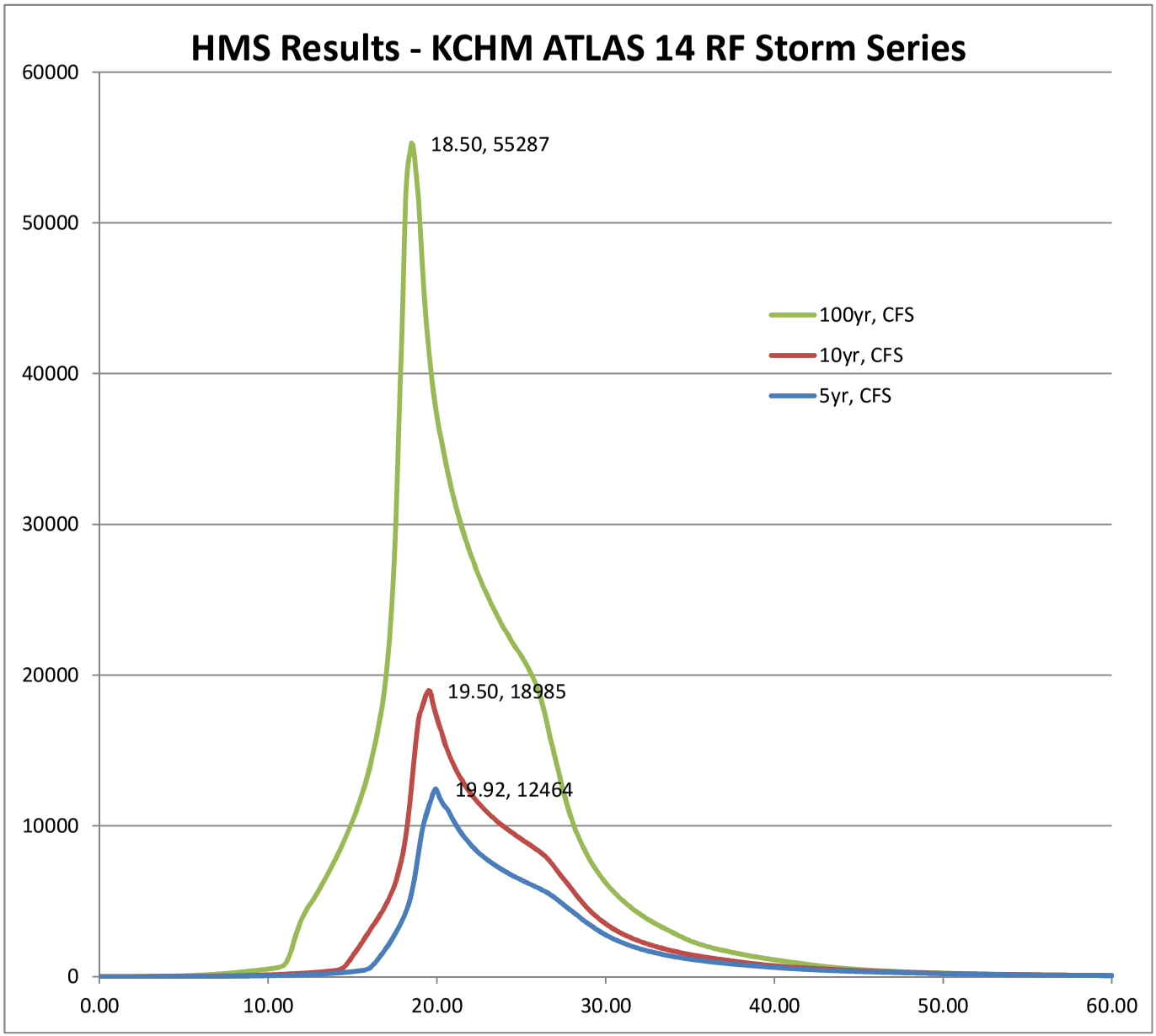
Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
16.00	3942	7278	20164
16.50	4942	8798	23572
17.00	6089	10590	28104
17.50	7520	13029	35059
18.00	9629	16562	43512
18.50	12457	20739	47809
19.00	15239	22905	46227
19.50	16120	23107	42206
20.00	16019	21587	39157
20.50	14982	20058	36541
21.00	13974	18750	34257
21.50	13130	17657	32377
22.00	12401	16706	30880
22.50	11791	15934	29608
23.00	11283	15290	28489
23.50	10851	14725	27496
24.00	10471	14234	26616
24.50	10130	13766	25798
25.00	9811	13318	25035
25.50	9501	12880	24075
26.00	9158	12341	22388
26.50	8704	11472	19779
27.00	8024	10311	16792
27.50	7204	9065	14099
28.00	6374	7886	12013
28.50	5595	6855	10400
29.00	4944	6016	9144
29.50	4389	5327	8124
30.00	3922	4756	7284
30.50	3526	4285	6572
31.00	3195	3892	5948
31.50	2914	3550	5401
32.00	2673	3251	4923
32.50	2464	2988	4498
33.00	2274	2757	4120

Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
33.50	2106	2548	3768
34.00	1957	2356	3444
34.50	1822	2184	3156
35.00	1697	2032	2894
35.50	1584	1894	2663
36.00	1482	1766	2458
36.50	1389	1647	2274
37.00	1303	1532	2105
37.50	1223	1421	1948
38.00	1148	1319	1804
38.50	1073	1228	1670
39.00	1000	1147	1545
39.50	934	1073	1430
40.00	874	1005	1322
40.50	820	942	1221
41.00	770	882	1124
41.50	724	826	1031
42.00	682	775	943
42.50	642	728	863
43.00	605	684	790
43.50	570	642	724
44.00	538	602	665
44.50	507	564	611
45.00	479	529	563
45.50	452	494	521
46.00	426	462	483
46.50	401	430	448
47.00	378	400	417
47.50	356	372	387
48.00	335	346	360
48.50	315	323	334
49.00	295	302	311
49.50	276	283	290
50.00	258	266	270
50.50	242	250	253

Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
51.00	228	235	236
51.50	215	222	221
52.00	203	209	206
52.50	191	197	193
53.00	181	185	180
53.50	171	175	169
54.00	162	165	158
54.50	153	155	147
55.00	145	146	138
55.50	138	138	129
56.00	130	130	121
56.50	124	123	114
57.00	117	116	107
57.50	111	110	101
58.00	105	104	95
58.50	100	99	90
59.00	95	93	85
59.50	90	88	80
60.00	85	83.606	76

HMS Results - KCHM ATLAS 14 RF Storm Series

	12464 CFS	18985 CFS	55287 CFS
	0.34 IN	0.50 IN	1.37 IN
Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
0.00	0	0	0
0.50	0	0	0
1.00	0	0	0
1.50	0	0	0
2.00	0	0	1
2.50	0	1	5
3.00	2	3	12
3.50	4	7	20
4.00	7	10	27
4.50	8	11	37
5.00	9	13	53
5.50	10	16	76
6.00	12	19	102
6.50	14	24	132
7.00	16	32	166
7.50	20	42	207
8.00	26	53	256
8.50	33	66	312
9.00	41	81	371
9.50	51	98	434
10.00	61	117	499
10.50	73	139	576
11.00	87	163	836
11.50	102	191	2224
12.00	120	222	3842
12.50	141	257	4832
13.00	166	297	5713
13.50	196	344	6743
14.00	231	404	7820
14.50	273	631	9004
15.00	327	1360	10338
15.50	398	2156	11879



Series KCHM ATLAS 14

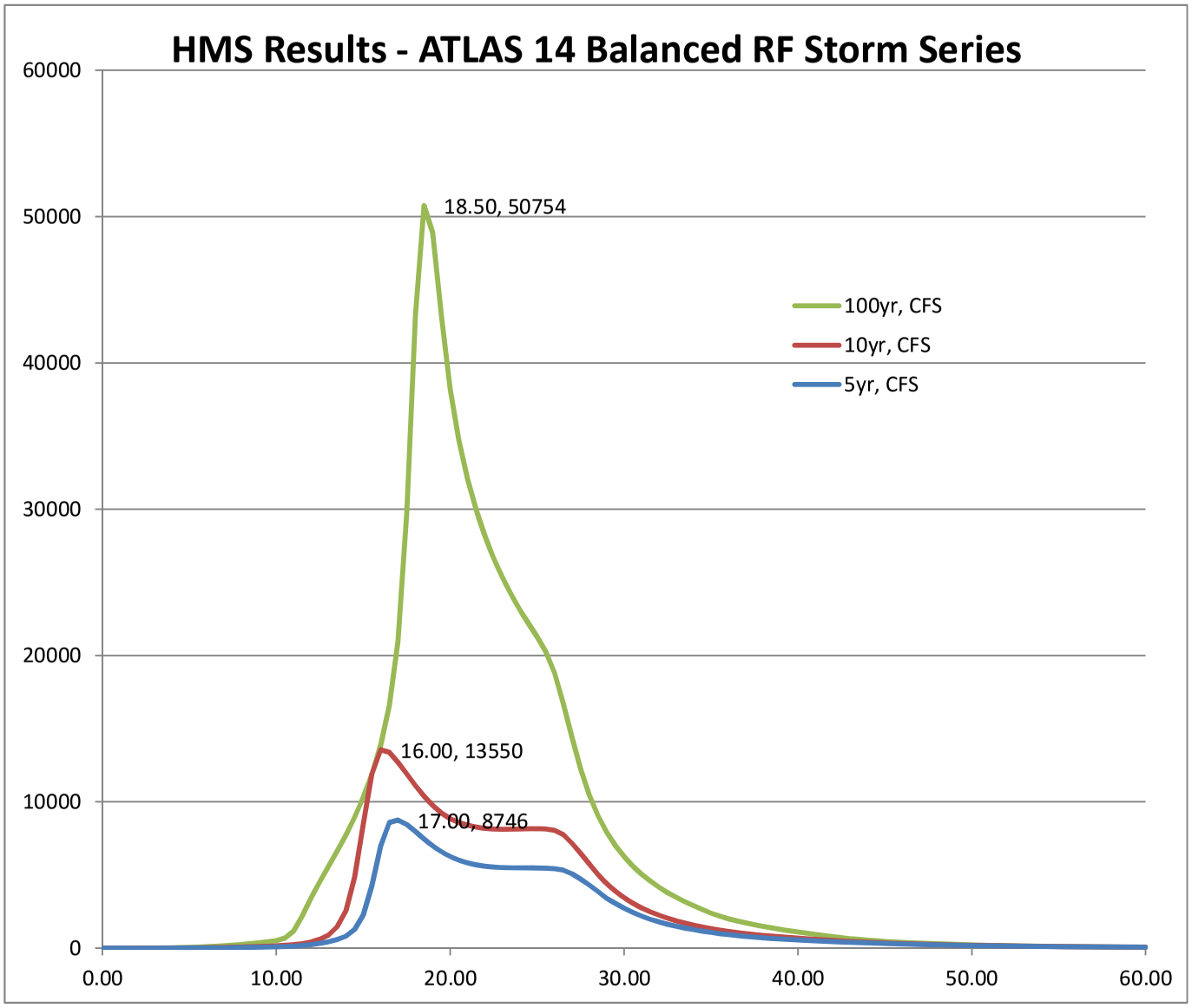
Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
16.00	555	3015	13765
16.50	1145	3853	16350
17.00	1904	4817	20113
17.50	2782	6066	28374
18.00	3856	8263	45657
18.50	5540	12744	55287
19.00	8811	17471	50100
19.50	11246	18985	41792
20.00	12347	17174	37176
20.50	11255	15393	34258
21.00	10316	14028	31723
21.50	9441	13004	29719
22.00	8760	12149	28043
22.50	8193	11474	26548
23.00	7738	10884	25275
23.50	7348	10368	24108
24.00	7002	9915	23056
24.50	6688	9516	22116
25.00	6414	9124	21281
25.50	6144	8749	20284
26.00	5880	8357	19016
26.50	5591	7890	16938
27.00	5224	7213	14547
27.50	4777	6497	12265
28.00	4339	5792	10408
28.50	3900	5081	8994
29.00	3481	4450	7880
29.50	3105	3938	6969
30.00	2769	3509	6226
30.50	2487	3140	5600
31.00	2244	2835	5065
31.50	2034	2579	4580
32.00	1854	2356	4169
32.50	1700	2160	3805
33.00	1567	1985	3483

Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
33.50	1447	1833	3193
34.00	1341	1697	2906
34.50	1244	1573	2633
35.00	1158	1463	2380
35.50	1082	1364	2177
36.00	1012	1274	2005
36.50	948	1190	1856
37.00	890	1114	1726
37.50	836	1038	1608
38.00	787	959	1498
38.50	741	888	1392
39.00	695	826	1293
39.50	650	771	1199
40.00	607	720	1112
40.50	569	674	1031
41.00	533	633	955
41.50	500	596	880
42.00	469	562	804
42.50	441	530	731
43.00	416	501	665
43.50	393	473	608
44.00	372	446	557
44.50	353	420	512
45.00	335	396	471
45.50	318	373	435
46.00	302	351	403
46.50	286	331	375
47.00	271	312	349
47.50	257	292	326
48.00	244	273	304
48.50	231	255	285
49.00	220	239	266
49.50	208	223	249
50.00	197	210	232
50.50	186	197	217

Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
51.00	175	185	203
51.50	165	174	190
52.00	156	164	178
52.50	148	155	166
53.00	140	147	156
53.50	132	139	146
54.00	125	131	137
54.50	119	125	129
55.00	113	118	121
55.50	107	112	114
56.00	102	107	107
56.50	97	101	101
57.00	92	96	95
57.50	88	91	90
58.00	84	87	85
58.50	80	82	81
59.00	76	78	76
59.50	73	74	72
60.00	69.386	71	69

HMS Results - ATLAS 14 Balanced RF Storm Series

	8746 CFS	13550 CFS	50754 CFS
	0.35 IN	0.52 IN	1.36 IN
Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
0.00	0	0	0
0.50	0	0	0
1.00	0	0	0
1.50	0	0	0
2.00	0	0	1
2.50	1	2	5
3.00	3	5	12
3.50	6	10	20
4.00	9	14	27
4.50	11	16	38
5.00	13	20	54
5.50	15	25	77
6.00	17	33	103
6.50	21	43	132
7.00	27	55	167
7.50	34	67	208
8.00	42	81	257
8.50	51	97	312
9.00	60	114	372
9.50	72	136	438
10.00	88	163	522
10.50	107	195	691
11.00	132	237	1180
11.50	166	296	2210
12.00	234	421	3425
12.50	336	609	4560
13.00	445	888	5588
13.50	597	1467	6623
14.00	821	2574	7735
14.50	1270	4845	8963
15.00	2259	8449	10327
15.50	4250	11897	11889



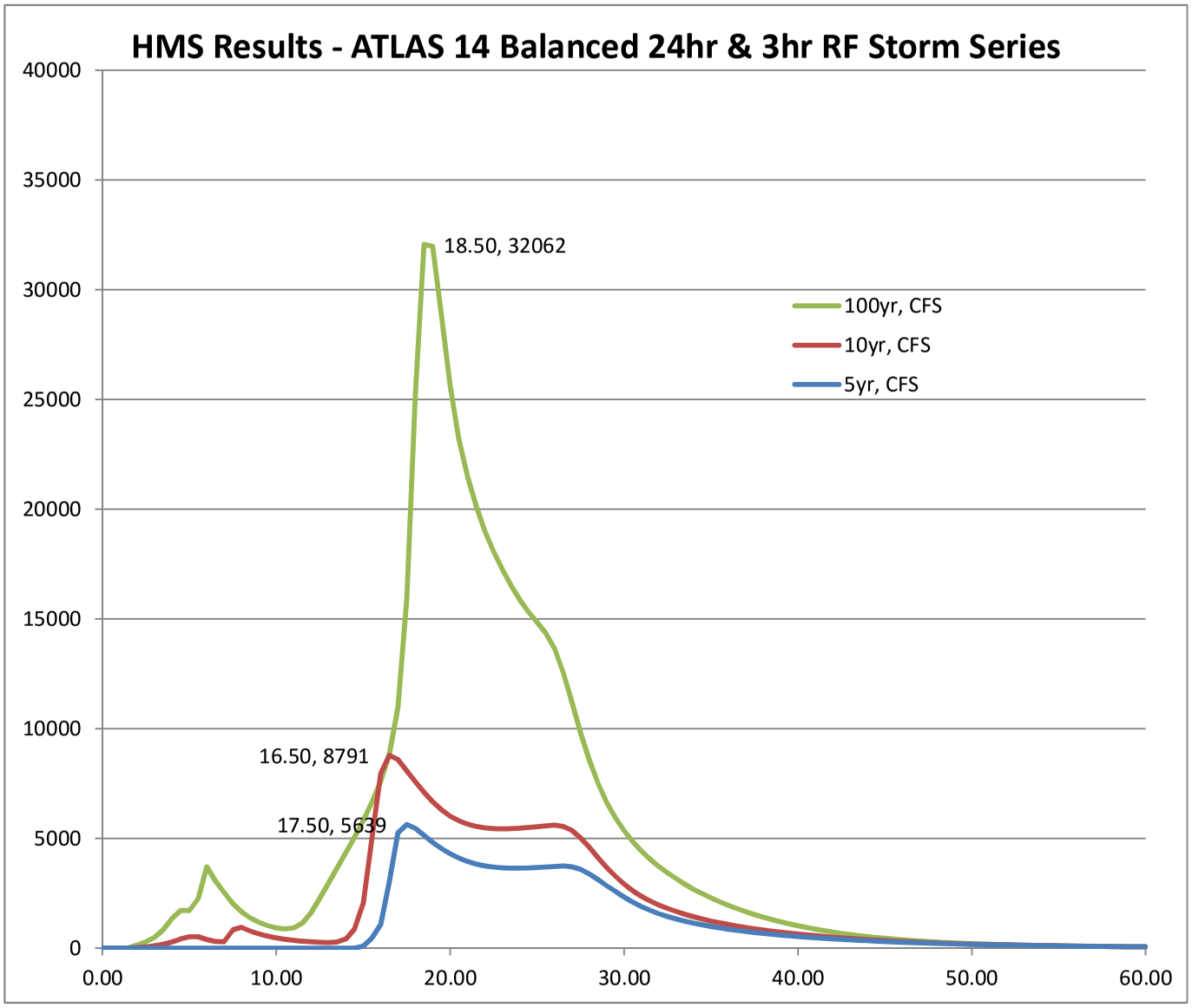
Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
16.00	6995	13550	13874
16.50	8581	13386	16582
17.00	8746	12703	20949
17.50	8451	11916	29822
18.00	7976	11101	43254
18.50	7466	10383	50754
19.00	7006	9752	48905
19.50	6597	9237	43140
20.00	6261	8853	38231
20.50	6013	8589	34725
21.00	5830	8404	32043
21.50	5696	8275	29940
22.00	5602	8191	28188
22.50	5540	8143	26675
23.00	5502	8121	25349
23.50	5483	8129	24185
24.00	5484	8156	23149
24.50	5489	8164	22197
25.00	5488	8159	21283
25.50	5476	8138	20257
26.00	5441	8049	18791
26.50	5342	7758	16730
27.00	5091	7182	14445
27.50	4734	6496	12295
28.00	4313	5757	10480
28.50	3871	5047	9056
29.00	3428	4416	7935
29.50	3055	3899	7013
30.00	2732	3455	6258
30.50	2444	3078	5617
31.00	2199	2759	5068
31.50	1985	2488	4592
32.00	1798	2254	4173
32.50	1638	2051	3808
33.00	1500	1870	3479

Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
33.50	1377	1708	3177
34.00	1265	1561	2897
34.50	1166	1437	2634
35.00	1074	1328	2390
35.50	994	1229	2180
36.00	922	1142	2008
36.50	857	1063	1856
37.00	799	993	1722
37.50	746	931	1599
38.00	700	873	1487
38.50	658	821	1382
39.00	619	773	1283
39.50	585	728	1190
40.00	553	686	1101
40.50	524	645	1019
41.00	496	606	940
41.50	470	568	863
42.00	445	532	789
42.50	421	497	719
43.00	398	465	656
43.50	376	435	600
44.00	355	407	549
44.50	334	380	505
45.00	315	356	465
45.50	296	333	431
46.00	278	312	399
46.50	262	293	370
47.00	247	275	345
47.50	232	258	321
48.00	219	243	299
48.50	207	228	279
49.00	194	214	260
49.50	183	202	243
50.00	174	191	227
50.50	164	180	211

Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
51.00	155	170	197
51.50	147	161	185
52.00	140	152	173
52.50	133	144	161
53.00	126	137	151
53.50	120	130	142
54.00	114	123	133
54.50	109	117	125
55.00	103	111	117
55.50	99	106	110
56.00	94	101	103
56.50	90	96	97
57.00	86	91	92
57.50	82	86	87
58.00	78	82	82
58.50	74	78	78
59.00	71	74	73
59.50	68	71	70
60.00	65	67	66

HMS Results - ATLAS 14 Balanced 24hr & 3hr RF Storm Series

	5639 CFS	8791 CFS	32062 CFS
	0.23 IN	0.37 IN	0.97 IN
Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
0.00	0	0	0
0.50	0	0	0
1.00	0	0	0
1.50	0	0	14
2.00	0	22	145
2.50	0	66	298
3.00	0	119	498
3.50	0	179	839
4.00	0	281	1352
4.50	1	421	1725
5.00	2	515	1714
5.50	2	520	2255
6.00	2	398	3707
6.50	1	302	3059
7.00	1	291	2546
7.50	1	836	2028
8.00	1	952	1660
8.50	1	783	1384
9.00	1	651	1175
9.50	0	551	1024
10.00	0	473	922
10.50	0	412	871
11.00	0	360	922
11.50	0	321	1142
12.00	0	287	1610
12.50	0	264	2273
13.00	0	256	2964
13.50	0	281	3643
14.00	0	425	4338
14.50	1	878	5064
15.00	88	2032	5822
15.50	451	4966	6646



Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
16.00	1081	7958	7595
16.50	3022	8791	8838
17.00	5253	8596	10966
17.50	5639	8079	15936
18.00	5453	7568	25305
18.50	5142	7098	32062
19.00	4830	6674	31983
19.50	4546	6310	28799
20.00	4303	6018	25619
20.50	4104	5805	23208
21.00	3949	5654	21465
21.50	3834	5549	20123
22.00	3752	5482	19017
22.50	3698	5449	18075
23.00	3664	5439	17259
23.50	3648	5448	16530
24.00	3647	5470	15882
24.50	3657	5500	15323
25.00	3675	5536	14845
25.50	3699	5575	14359
26.00	3726	5609	13641
26.50	3746	5552	12560
27.00	3711	5369	11220
27.50	3593	5031	9829
28.00	3385	4591	8573
28.50	3124	4128	7521
29.00	2846	3681	6645
29.50	2577	3281	5938
30.00	2326	2929	5353
30.50	2097	2625	4854
31.00	1896	2368	4426
31.50	1722	2149	4055
32.00	1572	1965	3725
32.50	1441	1806	3429
33.00	1325	1666	3159

Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
33.50	1227	1539	2911
34.00	1138	1427	2687
34.50	1059	1327	2480
35.00	988	1235	2291
35.50	923	1152	2115
36.00	864	1076	1952
36.50	810	1006	1800
37.00	760	942	1661
37.50	715	883	1533
38.00	672	829	1415
38.50	633	779	1303
39.00	597	731	1202
39.50	563	687	1108
40.00	531	646	1020
40.50	502	607	940
41.00	474	570	865
41.50	448	535	795
42.00	423	502	731
42.50	400	471	670
43.00	378	441	616
43.50	356	415	566
44.00	337	389	521
44.50	317	365	479
45.00	300	343	442
45.50	283	322	408
46.00	267	303	376
46.50	252	285	348
47.00	238	267	322
47.50	225	252	299
48.00	212	237	278
48.50	201	223	257
49.00	190	210	239
49.50	179	198	223
50.00	170	187	207
50.50	161	176	192

Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
51.00	152	166	180
51.50	144	157	168
52.00	137	148	157
52.50	130	140	147
53.00	123	132	137
53.50	117	125	128
54.00	111	118	120
54.50	105	112	113
55.00	100	106	107
55.50	95	100	100
56.00	91	95	94
56.50	86	90	88
57.00	82	86	84
57.50	78	81	79
58.00	74	77	75
58.50	71	73	71
59.00	68	69	67
59.50	64	66	63
60.00	61	63	60

NOAA Atlas 2

Subarea	Area, SM
CA-01	20.76
CA-02	20.48
CA-03	25.55
CA-04	37.35
CA-05	20.87
CA-06	62.5
CA-07	34.21
CA-08	4.92
TH-01	27.7
TH-02	7.61
TH-03	16.49
TH-04	18.06
TH-05	34.01
TH-06	24.68
WB-01	26.67
WB-02	22.43
WB-03	29.06
WB-04	42.31
TOTAL:	475.66

Aerial Adjustment Factors:

476 SM

Duration	%
5-min	21
30-min	43.5
60-min	52.5
3-hr	66
6-hr	74.5
24-hr	91

CA-01 Coordinates: 35.2510069 -118.28675

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.232"	0.267"	0.384"	0.049"	0.056"	0.081"
30min	0.520"	0.599"	0.861"	0.226"	0.261"	0.374"
60min	0.711"	0.818"	1.176"	0.373"	0.430"	0.617"
180min	1.242"	1.438"	2.088"	0.820"	0.949"	1.378"
360min	1.767"	2.052"	3.000"	1.316"	1.529"	2.235"
1440min	3.279"	3.906"	5.990"	2.984"	3.555"	5.451"

3.251007 =X5

Event		Point Rainfall	
2yr	6hr	1.390"	=X1
100yr	6hr	3.000"	=X3
2yr	24hr	2.450"	=X2
100yr	24hr	5.990"	=X4
2yr	1hr	0.568"	Y2
100yr	1hr	1.176"	Y100
		1.177"	Y100

CA-02 Coordinates: 35.3083785 -118.32769

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.234"	0.267"	0.380"	0.049"	0.056"	0.080"
30min	0.523"	0.599"	0.850"	0.228"	0.260"	0.370"
60min	0.714"	0.818"	1.162"	0.375"	0.429"	0.610"
180min	1.235"	1.420"	2.036"	0.815"	0.937"	1.344"
360min	1.744"	2.011"	2.900"	1.299"	1.498"	2.161"
1440min	3.196"	3.799"	5.800"	2.909"	3.457"	5.278"

3.308378 =X5

Event		Point Rainfall	
2yr	6hr	1.390"	=X1
100yr	6hr	2.900"	=X3
2yr	24hr	2.400"	=X2
100yr	24hr	5.800"	=X4
2yr	1hr	0.578"	Y2
100yr	1hr	1.162"	Y100
		1.163"	Y100

CA-03 Coordinates: 35.3653537 -118.33955

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.232"	0.269"	0.392"	0.049"	0.057"	0.082"
30min	0.521"	0.603"	0.877"	0.226"	0.262"	0.382"
60min	0.711"	0.824"	1.198"	0.373"	0.433"	0.629"
180min	1.256"	1.462"	2.146"	0.829"	0.965"	1.416"
360min	1.798"	2.099"	3.100"	1.340"	1.564"	2.310"
1440min	3.335"	3.952"	6.000"	3.035"	3.596"	5.460"

3.365354 =X5

Event		Point Rainfall	
2yr	6hr	1.400"	=X1
100yr	6hr	3.100"	=X3
2yr	24hr	2.520"	=X2
100yr	24hr	6.000"	=X4
2yr	1hr	0.562"	Y2
100yr	1hr	1.198"	Y100
		1.199"	Y100

CA-04 Coordinates: 35.2531672 -118.39081

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.236"	0.272"	0.392"	0.049"	0.057"	0.082"
30min	0.528"	0.609"	0.879"	0.230"	0.265"	0.382"
60min	0.721"	0.832"	1.201"	0.378"	0.437"	0.630"
180min	1.242"	1.442"	2.105"	0.820"	0.952"	1.389"
360min	1.752"	2.041"	3.000"	1.305"	1.520"	2.235"
1440min	3.158"	3.769"	5.800"	2.874"	3.430"	5.278"

3.253167 =X5

Event		Point Rainfall	
2yr	6hr	1.370"	=X1
100yr	6hr	3.000"	=X3
2yr	24hr	2.350"	=X2
100yr	24hr	5.800"	=X4
2yr	1hr	0.574"	Y2
100yr	1hr	1.201"	Y100
		1.202"	Y100

CA-05 Coordinates: 35.3449832 -118.42028

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5.000"	10.000"	100.000"
5min	0.224"	0.258"	0.370"	0.047"	0.054"	0.078"
30min	0.502"	0.577"	0.829"	0.218"	0.251"	0.361"
60min	0.685"	0.789"	1.132"	0.360"	0.414"	0.594"
180min	1.199"	1.385"	2.003"	0.791"	0.914"	1.322"
360min	1.706"	1.975"	2.870"	1.271"	1.472"	2.138"
1440min	3.174"	3.745"	5.640"	2.889"	3.408"	5.132"

3.344983 =X5

Event		Point Rainfall	
2yr	6hr	1.350"	=X1
100yr	6hr	2.870"	=X3
2yr	24hr	2.420"	=X2
100yr	24hr	5.640"	=X4
2yr	1hr	0.548"	Y2
100yr	1hr	1.132"	Y100
		1.133"	Y100

CA-06 Coordinates: 35.3106528 -118.51999

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.222"	0.256"	0.369"	0.047"	0.054"	0.078"
30min	0.497"	0.573"	0.827"	0.216"	0.249"	0.360"
60min	0.678"	0.783"	1.130"	0.356"	0.411"	0.593"
180min	1.115"	1.292"	1.879"	0.736"	0.853"	1.240"
360min	1.526"	1.772"	2.590"	1.137"	1.320"	1.930"
1440min	2.522"	2.954"	4.390"	2.295"	2.688"	3.995"

3.310653 =X5

Event		Point Rainfall	
2yr	6hr	1.200"	=X1
100yr	6hr	2.590"	=X3
2yr	24hr	1.950"	=X2
100yr	24hr	4.390"	=X4
2yr	1hr	0.540"	Y2
100yr	1hr	1.130"	Y100
		1.131"	Y100

CA-07 Coordinates: 35.2949692 -118.67116

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.198"	0.231"	0.342"	0.042"	0.049"	0.072"
30min	0.443"	0.518"	0.765"	0.193"	0.225"	0.333"
60min	0.605"	0.707"	1.046"	0.318"	0.371"	0.549"
180min	0.988"	1.157"	1.718"	0.652"	0.764"	1.134"
360min	1.347"	1.579"	2.350"	1.003"	1.176"	1.751"
1440min	2.264"	2.645"	3.910"	2.060"	2.407"	3.558"

3.294969 =X5

Event		Point Rainfall	
2yr	6hr	1.040"	=X1
100yr	6hr	2.350"	=X3
2yr	24hr	1.760"	=X2
100yr	24hr	3.910"	=X4
2yr	1hr	0.471"	Y2
100yr	1hr	1.046"	Y100
		1.046"	Y100

CA-08 Coordinates: 35.3044524 -118.78384

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.196"	0.227"	0.331"	0.041"	0.048"	0.069"
30min	0.439"	0.509"	0.741"	0.191"	0.221"	0.322"
60min	0.599"	0.695"	1.012"	0.314"	0.365"	0.531"
180min	0.903"	1.049"	1.532"	0.596"	0.692"	1.011"
360min	1.171"	1.360"	1.990"	0.872"	1.013"	1.483"
1440min	1.728"	1.999"	2.900"	1.573"	1.820"	2.639"

3.304452 =X5

Event		Point Rainfall	
2yr	6hr	0.920"	=X1
100yr	6hr	1.990"	=X3
2yr	24hr	1.370"	=X2
100yr	24hr	2.900"	=X4
2yr	1hr	0.473"	Y2
100yr	1hr	1.012"	Y100
		1.013"	Y100

TH-01 Coordinates: 35.1020786 -118.44337

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.208"	0.244"	0.364"	0.044"	0.051"	0.076"
30min	0.465"	0.546"	0.815"	0.202"	0.238"	0.355"
60min	0.636"	0.746"	1.113"	0.334"	0.392"	0.584"
180min	1.026"	1.211"	1.824"	0.677"	0.799"	1.204"
360min	1.387"	1.642"	2.490"	1.034"	1.224"	1.855"
1440min	2.372"	2.881"	4.570"	2.159"	2.621"	4.159"

3.102079 =X5

Event		Point Rainfall	
2yr	6hr	1.050"	=X1
100yr	6hr	2.490"	=X3
2yr	24hr	1.700"	=X2
100yr	24hr	4.570"	=X4
2yr	1hr	0.490"	Y2
100yr	1hr	1.113"	Y100
		1.114"	Y100

TH-02 Coordinates: 35.1009362 -118.48221

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.219"	0.252"	0.360"	0.046"	0.053"	0.076"
30min	0.491"	0.564"	0.806"	0.214"	0.245"	0.351"
60min	0.671"	0.770"	1.101"	0.352"	0.404"	0.578"
180min	1.089"	1.257"	1.816"	0.719"	0.830"	1.199"
360min	1.479"	1.713"	2.490"	1.102"	1.276"	1.855"
1440min	2.544"	3.061"	4.780"	2.315"	2.786"	4.350"

3.100936 =X5

Event		Point Rainfall	
2yr	6hr	1.170"	=X1
100yr	6hr	2.490"	=X3
2yr	24hr	1.860"	=X2
100yr	24hr	4.780"	=X4
2yr	1hr	0.539"	Y2
100yr	1hr	1.101"	Y100
		1.102"	Y100

TH-03 Coordinates: 35.1172588 -118.50767

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.201"	0.232"	0.335"	0.042"	0.049"	0.070"
30min	0.451"	0.520"	0.749"	0.196"	0.226"	0.326"
60min	0.616"	0.711"	1.024"	0.324"	0.373"	0.537"
180min	1.055"	1.221"	1.770"	0.696"	0.806"	1.168"
360min	1.482"	1.717"	2.500"	1.104"	1.279"	1.863"
1440min	2.756"	3.252"	4.900"	2.508"	2.959"	4.459"

3.117259 =X5

Event		Point Rainfall	
2yr	6hr	1.170"	=X1
100yr	6hr	2.500"	=X3
2yr	24hr	2.100"	=X2
100yr	24hr	4.900"	=X4
2yr	1hr	0.492"	Y2
100yr	1hr	1.024"	Y100
		1.024"	Y100

TH-04 Coordinates: 35.2258768 -118.4897

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.224"	0.257"	0.370"	0.047"	0.054"	0.078"
30min	0.501"	0.577"	0.828"	0.218"	0.251"	0.360"
60min	0.684"	0.788"	1.131"	0.359"	0.413"	0.594"
180min	1.212"	1.401"	2.032"	0.800"	0.925"	1.341"
360min	1.738"	2.016"	2.940"	1.295"	1.502"	2.190"
1440min	3.163"	3.664"	5.330"	2.878"	3.334"	4.850"

3.225877 =X5

Event		Point Rainfall	
2yr	6hr	1.370"	=X1
100yr	6hr	2.940"	=X3
2yr	24hr	2.500"	=X2
100yr	24hr	5.330"	=X4
2yr	1hr	0.547"	Y2
100yr	1hr	1.131"	Y100
		1.132"	Y100

TH-05 Coordinates: 35.1865462 -118.52706

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.216"	0.248"	0.355"	0.045"	0.052"	0.074"
30min	0.483"	0.555"	0.794"	0.210"	0.242"	0.345"
60min	0.660"	0.759"	1.085"	0.347"	0.398"	0.569"
180min	1.086"	1.253"	1.805"	0.717"	0.827"	1.192"
360min	1.487"	1.719"	2.490"	1.108"	1.281"	1.855"
1440min	2.523"	2.971"	4.460"	2.296"	2.703"	4.059"

3.186546 =X5

Event		Point Rainfall	
2yr	6hr	1.180"	=X1
100yr	6hr	2.490"	=X3
2yr	24hr	1.930"	=X2
100yr	24hr	4.460"	=X4
2yr	1hr	0.531"	Y2
100yr	1hr	1.085"	Y100
		1.085"	Y100

TH-06 Coordinates: 35.247331 -118.59416

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.208"	0.243"	0.356"	0.044"	0.051"	0.075"
30min	0.467"	0.543"	0.797"	0.203"	0.236"	0.347"
60min	0.638"	0.742"	1.089"	0.335"	0.390"	0.572"
180min	1.048"	1.224"	1.808"	0.692"	0.808"	1.193"
360min	1.433"	1.678"	2.490"	1.068"	1.250"	1.855"
1440min	2.431"	2.870"	4.330"	2.212"	2.612"	3.940"

3.247331 =X5

Event		Point Rainfall	
2yr	6hr	1.110"	=X1
100yr	6hr	2.490"	=X3
2yr	24hr	1.850"	=X2
100yr	24hr	4.330"	=X4
2yr	1hr	0.500"	Y2
100yr	1hr	1.089"	Y100
		1.090"	Y100

WB-01 Coordinates: 35.4056835 -118.42352

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.244"	0.283"	0.412"	0.051"	0.059"	0.086"
30min	0.546"	0.633"	0.922"	0.238"	0.275"	0.401"
60min	0.746"	0.865"	1.259"	0.392"	0.454"	0.661"
180min	1.349"	1.573"	2.315"	0.890"	1.038"	1.528"
360min	1.960"	2.293"	3.400"	1.460"	1.709"	2.533"
1440min	3.749"	4.466"	6.850"	3.411"	4.064"	6.234"

3.405683 =X5

Event		Point Rainfall	
2yr	6hr	1.520"	=X1
100yr	6hr	3.400"	=X3
2yr	24hr	2.800"	=X2
100yr	24hr	6.850"	=X4
2yr	1hr	0.589"	Y2
100yr	1hr	1.259"	Y100
		1.260"	Y100

WB-02 Coordinates: 35.4489987 -118.44473

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.251"	0.291"	0.424"	0.053"	0.061"	0.089"
30min	0.561"	0.651"	0.950"	0.244"	0.283"	0.413"
60min	0.767"	0.890"	1.298"	0.403"	0.467"	0.681"
180min	1.409"	1.644"	2.426"	0.930"	1.085"	1.601"
360min	2.068"	2.423"	3.600"	1.541"	1.805"	2.682"
1440min	4.101"	4.934"	7.700"	3.732"	4.490"	7.007"

3.448999 =X5

Event		Point Rainfall	
2yr	6hr	1.600"	=X1
100yr	6hr	3.600"	=X3
2yr	24hr	3.000"	=X2
100yr	24hr	7.700"	=X4
2yr	1hr	0.605"	Y2
100yr	1hr	1.298"	Y100
		1.298"	Y100

WB-03 Coordinates: 35.419868 -118.53598

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.218"	0.251"	0.358"	0.046"	0.053"	0.075"
30min	0.489"	0.562"	0.803"	0.213"	0.244"	0.349"
60min	0.668"	0.767"	1.096"	0.351"	0.403"	0.576"
180min	1.218"	1.401"	2.012"	0.804"	0.925"	1.328"
360min	1.778"	2.049"	2.950"	1.325"	1.527"	2.198"
1440min	3.507"	4.079"	5.980"	3.191"	3.712"	5.442"

3.419868 =X5

Event		Point Rainfall	
2yr	6hr	1.420"	=X1
100yr	6hr	2.950"	=X3
2yr	24hr	2.750"	=X2
100yr	24hr	5.980"	=X4
2yr	1hr	0.537"	Y2
100yr	1hr	1.096"	Y100
		1.097"	Y100

WB-04 Coordinates: 35.3657467 -118.65171

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.212"	0.250"	0.379"	0.04	0.05	0.08
30min	0.474"	0.561"	0.848"	0.21	0.24	0.37
60min	0.648"	0.766"	1.158"	0.34	0.40	0.61
180min	1.129"	1.340"	2.042"	0.75	0.88	1.35
360min	1.603"	1.908"	2.920"	1.19	1.42	2.18
1440min	2.805"	3.255"	4.750"	2.55	2.96	4.32

3.365747 =X5

Event		Point Rainfall	
2yr	6hr	1.200"	=X1
100yr	6hr	2.920"	=X3
2yr	24hr	2.210"	=X2
100yr	24hr	4.750"	=X4
2yr	1hr	0.492"	Y2
100yr	1hr	1.158"	Y100
		1.159"	Y100

STUDY AREA Coordinates: 35.2925815 -118.49236

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.223"	0.261"	0.385"	0.047"	0.055"	0.081"
30min	0.500"	0.584"	0.863"	0.218"	0.254"	0.376"
60min	0.683"	0.798"	1.179"	0.359"	0.419"	0.619"
180min	1.131"	1.328"	1.982"	0.747"	0.877"	1.308"
360min	1.555"	1.832"	2.750"	1.159"	1.365"	2.049"
1440min	2.649"	3.170"	4.900"	2.410"	2.884"	4.459"

3.292581 =X5

Event		Point Rainfall	
2yr	6hr	1.190"	=X1
100yr	6hr	2.750"	=X3
2yr	24hr	1.960"	=X2
100yr	24hr	4.900"	=X4
2yr	1hr	0.531"	Y2
100yr	1hr	1.179"	Y100
		1.180"	Y100

RF-01

CA-01, CA-02, & CA-03

Subarea	Area	Proportion
CA-01	20.76	0.311
CA-02	20.48	0.307
CA-03	25.55	0.383
TOTAL:	66.79	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.049"	0.056"	0.081"
30-min	0.227"	0.261"	0.376"
60-min	0.374"	0.431"	0.620"
3-hr	0.822"	0.952"	1.382"
6-hr	1.320"	1.533"	2.241"
24-hr	2.980"	3.541"	5.401"

RF-02

CA-04, CA-05, TH-03 & WB-03

Subarea	Area	Proportion
CA-04	37.35	0.360
CA-05	20.87	0.201
TH-03	16.49	0.159
WB-03	29.06	0.280
TOTAL:	103.77	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.047"	0.054"	0.078"
30-min	0.217"	0.250"	0.360"
60-min	0.358"	0.413"	0.593"
3-hr	0.790"	0.913"	1.323"
6-hr	1.272"	1.474"	2.146"
24-hr	2.907"	3.430"	5.164"

RF-03

TH-01 & TH-02

Subarea	Area	Proportion
TH-01	27.70	0.784
TH-02	7.61	0.216
TOTAL:	35.31	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.044"	0.052"	0.076"
30-min	0.205"	0.239"	0.354"
60-min	0.338"	0.395"	0.583"
3-hr	0.686"	0.806"	1.203"
6-hr	1.048"	1.235"	1.855"
24-hr	2.192"	2.657"	4.200"

RF-04

TH-04 & TH-05

Subarea	Area	Proportion
TH-04	18.06	0.347
TH-05	34.01	0.653
TOTAL:	52.07	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.046"	0.053"	0.076"
30-min	0.213"	0.245"	0.351"
60-min	0.351"	0.404"	0.578"
3-hr	0.746"	0.861"	1.243"
6-hr	1.173"	1.357"	1.971"
24-hr	2.498"	2.922"	4.333"

RF-05

CA-06, TH-06 & WB-04

Subarea	Area	Proportion
CA-06	62.5	0.483
TH-06	24.68	0.191
WB-04	42.31	0.327
TOTAL:	129.49	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.045"	0.053"	0.078"
30-min	0.210"	0.245"	0.360"
60-min	0.347"	0.404"	0.594"
3-hr	0.730"	0.854"	1.266"
6-hr	1.142"	1.340"	1.996"
24-hr	2.363"	2.763"	4.092"

RF-06

CA-07

Subarea	Area	Proportion
CA-07	34.21	1.000
TOTAL:	34.21	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.042"	0.049"	0.072"
30-min	0.193"	0.225"	0.333"
60-min	0.318"	0.371"	0.549"
3-hr	0.652"	0.764"	1.134"
6-hr	1.003"	1.176"	1.751"
24-hr	2.060"	2.407"	3.558"

RF-07

CA-08

Subarea	Area	Proportion
CA-08	4.92	1.000
TOTAL:	4.92	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.041"	0.048"	0.069"
30-min	0.191"	0.221"	0.322"
60-min	0.314"	0.365"	0.531"
3-hr	0.596"	0.692"	1.011"
6-hr	0.872"	1.013"	1.483"
24-hr	1.573"	1.820"	2.639"

RF-08

WB-01 & WB-02

Subarea	Area	Proportion
WB-01	26.67	0.543
WB-02	22.43	0.457
TOTAL:	49.1	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.052"	0.060"	0.088"
30-min	0.241"	0.279"	0.407"
60-min	0.397"	0.460"	0.670"
3-hr	0.908"	1.060"	1.561"
6-hr	1.497"	1.753"	2.601"
24-hr	3.558"	4.259"	6.587"

RF-09

STUDY AREA - WEIGHTED AVERAGE

Subarea	Area	Proportion
CA-01	20.76	0.044
CA-02	20.48	0.043
CA-03	25.55	0.054
CA-04	37.35	0.079
CA-05	20.87	0.044
CA-06	62.5	0.131
CA-07	34.21	0.072
CA-08	4.92	0.010
TH-01	27.7	0.058
TH-02	7.61	0.016
TH-03	16.49	0.035
TH-04	18.06	0.038
TH-05	34.01	0.072
TH-06	24.68	0.052
WB-01	26.67	0.056
WB-02	22.43	0.047
WB-03	29.06	0.061
WB-04	42.31	0.089
TOTAL:	475.66	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.046"	0.054"	0.078"
30-min	0.216"	0.250"	0.363"
60-min	0.356"	0.412"	0.599"
3-hr	0.766"	0.891"	1.306"
6-hr	1.216"	1.418"	2.089"
24-hr	2.664"	3.146"	4.748"

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Subarea	Area, SM
CA-01	20.76
CA-02	20.48
CA-03	25.55
CA-04	37.35
CA-05	20.87
CA-06	62.5
CA-07	34.21
CA-08	4.92
TH-01	27.7
TH-02	7.61
TH-03	16.49
TH-04	18.06
TH-05	34.01
TH-06	24.68
WB-01	26.67
WB-02	22.43
WB-03	29.06
WB-04	42.31
TOTAL:	475.66

Aerial Adjustment Factors:

476 SM

Duration	%
5-min	63.2
30-min	68
60-min	69.7
3-hr	72.4
6-hr	74.2
24-hr	77.2

CA-01 Coordinates: 35.2510069 -118.28675

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5-min	0.170"	0.210"	0.380"	0.107"	0.133"	0.240"
30-min	0.400"	0.490"	0.900"	0.272"	0.333"	0.612"
60-min	0.560"	0.690"	1.260"	0.390"	0.481"	0.878"
3-hr	1.010"	1.220"	2.070"	0.731"	0.883"	1.499"
6-hr	1.430"	1.720"	2.870"	1.061"	1.276"	2.130"
24-hr	2.750"	3.390"	5.760"	2.123"	2.617"	4.447"

CA-02 Coordinates: 35.3083785 -118.32769

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5-min	0.170"	0.200"	0.360"	0.107"	0.126"	0.228"
30-min	0.390"	0.480"	0.840"	0.265"	0.326"	0.571"
60-min	0.550"	0.670"	1.190"	0.383"	0.467"	0.829"
3-hr	1.000"	1.210"	2.050"	0.724"	0.876"	1.484"
6-hr	1.400"	1.690"	2.840"	1.039"	1.254"	2.107"
24-hr	2.660"	3.290"	5.630"	2.054"	2.540"	4.346"

CA-03 Coordinates: 35.3653537 -118.33955

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5-min	0.170"	0.200"	0.360"	0.107"	0.126"	0.228"
30-min	0.390"	0.480"	0.860"	0.265"	0.326"	0.585"
60-min	0.560"	0.680"	1.210"	0.390"	0.474"	0.843"
3-hr	1.010"	1.220"	2.080"	0.731"	0.883"	1.506"
6-hr	1.410"	1.710"	2.880"	1.046"	1.269"	2.137"
24-hr	2.670"	3.300"	5.670"	2.061"	2.548"	4.377"

CA-04 Coordinates: 35.2531672 -118.39081

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5-min	0.170"	0.210"	0.370"	0.107"	0.133"	0.234"
30-min	0.400"	0.490"	0.870"	0.272"	0.333"	0.592"
60-min	0.560"	0.690"	1.220"	0.390"	0.481"	0.850"
3-hr	1.030"	1.250"	2.110"	0.746"	0.905"	1.528"
6-hr	1.450"	1.750"	2.930"	1.076"	1.299"	2.174"
24-hr	2.780"	3.440"	5.880"	2.146"	2.656"	4.539"

CA-05 Coordinates: 35.3449832 -118.42028

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5-min	0.170"	0.200"	0.350"	0.107"	0.126"	0.221"
30-min	0.400"	0.480"	0.830"	0.272"	0.326"	0.564"
60-min	0.560"	0.680"	1.170"	0.390"	0.474"	0.815"
3-hr	1.050"	1.270"	2.150"	0.760"	0.919"	1.557"
6-hr	1.470"	1.780"	3.000"	1.091"	1.321"	2.226"
24-hr	2.780"	3.430"	5.910"	2.146"	2.648"	4.563"

CA-06 Coordinates: 35.3106528 -118.51999

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5-min	0.180"	0.220"	0.380"	0.114"	0.139"	0.240"
30-min	0.420"	0.510"	0.900"	0.286"	0.347"	0.612"
60-min	0.590"	0.720"	1.270"	0.411"	0.502"	0.885"
3-hr	1.090"	1.320"	2.230"	0.789"	0.956"	1.615"
6-hr	1.540"	1.860"	3.130"	1.143"	1.380"	2.322"
24-hr	2.940"	3.620"	6.190"	2.270"	2.795"	4.779"

CA-07 Coordinates: 35.2949692 -118.67116

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5-min	0.150"	0.180"	0.320"	0.095"	0.114"	0.202"
30-min	0.350"	0.430"	0.760"	0.238"	0.292"	0.517"
60-min	0.500"	0.610"	1.080"	0.349"	0.425"	0.753"
3-hr	0.887"	1.070"	1.780"	0.642"	0.775"	1.289"
6-hr	1.240"	1.480"	2.440"	0.920"	1.098"	1.810"
24-hr	2.290"	2.790"	4.660"	1.768"	2.154"	3.598"

CA-08 Coordinates: 35.3044524 -118.78384

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5-min	0.130"	0.160"	0.280"	0.082"	0.101"	0.177"
30-min	0.310"	0.380"	0.660"	0.211"	0.258"	0.449"
60-min	0.440"	0.540"	0.930"	0.307"	0.376"	0.648"
3-hr	0.760"	0.920"	1.510"	0.550"	0.666"	1.093"
6-hr	1.040"	1.240"	2.030"	0.772"	0.920"	1.506"
24-hr	1.830"	2.230"	3.690"	1.413"	1.722"	2.849"

TH-01 Coordinates: 35.1020786 -118.44337

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5-min	0.200"	0.250"	0.490"	0.126"	0.158"	0.310"
30-min	0.460"	0.570"	1.140"	0.313"	0.388"	0.775"
60-min	0.630"	0.790"	1.570"	0.439"	0.551"	1.094"
3-hr	1.070"	1.280"	2.160"	0.775"	0.927"	1.564"
6-hr	1.520"	1.810"	2.930"	1.128"	1.343"	2.174"
24-hr	3.170"	3.920"	6.550"	2.447"	3.026"	5.057"

TH-02 Coordinates: 35.1009362 -118.48221

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5-min	0.190"	0.240"	0.480"	0.120"	0.152"	0.303"
30-min	0.450"	0.570"	1.120"	0.306"	0.388"	0.762"
60-min	0.630"	0.780"	1.550"	0.439"	0.544"	1.080"
3-hr	1.080"	1.290"	2.180"	0.782"	0.934"	1.578"
6-hr	1.550"	1.850"	2.990"	1.150"	1.373"	2.219"
24-hr	3.200"	3.950"	6.600"	2.470"	3.049"	5.095"

TH-03 Coordinates: 35.1172588 -118.50767

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5-min	0.180"	0.230"	0.450"	0.114"	0.145"	0.284"
30-min	0.420"	0.520"	1.030"	0.286"	0.354"	0.700"
60-min	0.570"	0.720"	1.410"	0.397"	0.502"	0.983"
3-hr	0.980"	1.180"	1.980"	0.710"	0.854"	1.434"
6-hr	1.390"	1.660"	2.670"	1.031"	1.232"	1.981"
24-hr	2.850"	3.520"	5.860"	2.200"	2.717"	4.524"

TH-04 Coordinates: 35.2258768 -118.4897

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5-min	0.170"	0.210"	0.390"	0.107"	0.133"	0.246"
30-min	0.400"	0.490"	0.920"	0.272"	0.333"	0.626"
60-min	0.560"	0.690"	1.280"	0.390"	0.481"	0.892"
3-hr	0.990"	1.200"	2.020"	0.717"	0.869"	1.462"
6-hr	1.400"	1.680"	2.770"	1.039"	1.247"	2.055"
24-hr	2.740"	3.380"	5.710"	2.115"	2.609"	4.408"

TH-05 Coordinates: 35.1865462 -118.52706

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5-min	0.170"	0.210"	0.410"	0.107"	0.133"	0.259"
30-min	0.400"	0.490"	0.950"	0.272"	0.333"	0.646"
60-min	0.550"	0.680"	1.310"	0.383"	0.474"	0.913"
3-hr	0.960"	1.150"	1.930"	0.695"	0.833"	1.397"
6-hr	1.350"	1.610"	2.620"	1.002"	1.195"	1.944"
24-hr	2.700"	3.320"	5.540"	2.084"	2.563"	4.277"

TH-06 Coordinates: 35.247331 -118.59416

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5-min	0.170"	0.210"	0.390"	0.107"	0.133"	0.246"
30-min	0.410"	0.500"	0.910"	0.279"	0.340"	0.619"
60-min	0.580"	0.710"	1.290"	0.404"	0.495"	0.899"
3-hr	0.850"	1.020"	1.750"	0.615"	0.738"	1.267"
6-hr	1.520"	1.820"	3.000"	1.128"	1.350"	2.226"
24-hr	2.940"	3.600"	6.030"	2.270"	2.779"	4.655"

WB-01 Coordinates: 35.4056835 -118.42352

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5-min	0.170"	0.200"	0.360"	0.107"	0.126"	0.228"
30-min	0.390"	0.480"	0.850"	0.265"	0.326"	0.578"
60-min	0.550"	0.680"	1.200"	0.383"	0.474"	0.836"
3-hr	0.990"	1.200"	2.040"	0.717"	0.869"	1.477"
6-hr	1.360"	1.650"	2.800"	1.009"	1.224"	2.078"
24-hr	2.550"	3.150"	5.420"	1.969"	2.432"	4.184"

WB-02 Coordinates: 35.4489987 -118.44473

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5-min	0.170"	0.210"	0.380"	0.107"	0.133"	0.240"
30-min	0.400"	0.490"	0.890"	0.272"	0.333"	0.605"
60-min	0.560"	0.700"	1.250"	0.390"	0.488"	0.871"
3-hr	0.990"	1.200"	2.070"	0.717"	0.869"	1.499"
6-hr	1.360"	1.640"	2.800"	1.009"	1.217"	2.078"
24-hr	2.530"	3.120"	5.390"	1.953"	2.409"	4.161"

WB-03 Coordinates: 35.419868 -118.53598

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5-min	0.180"	0.220"	0.390"	0.114"	0.139"	0.246"
30-min	0.420"	0.520"	0.920"	0.286"	0.354"	0.626"
60-min	0.600"	0.740"	1.300"	0.418"	0.516"	0.906"
3-hr	1.070"	1.300"	2.210"	0.775"	0.941"	1.600"
6-hr	1.500"	1.810"	3.070"	1.113"	1.343"	2.278"
24-hr	2.810"	3.460"	5.920"	2.169"	2.671"	4.570"

WB-04 Coordinates: 35.3657467 -118.65171

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5-min	0.190"	0.230"	0.400"	0.120"	0.145"	0.253"
30-min	0.440"	0.540"	0.940"	0.299"	0.367"	0.639"
60-min	0.630"	0.770"	1.340"	0.439"	0.537"	0.934"
3-hr	1.140"	1.370"	2.290"	0.825"	0.992"	1.658"
6-hr	1.630"	1.950"	3.240"	1.209"	1.447"	2.404"
24-hr	3.020"	3.670"	6.140"	2.331"	2.833"	4.740"

STUDY AREA Coordinates: 35.2925815 -118.49236

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5-min	0.170"	0.210"	0.370"	0.107"	0.133"	0.234"
30-min	0.410"	0.490"	0.860"	0.279"	0.333"	0.585"
60-min	0.570"	0.700"	1.220"	0.397"	0.488"	0.850"
3-hr	1.070"	1.290"	2.180"	0.775"	0.934"	1.578"
6-hr	1.510"	1.820"	3.060"	1.120"	1.350"	2.271"
24-hr	2.860"	3.530"	6.070"	2.208"	2.725"	4.686"

RF-01

CA-01, CA-02, & CA-03

Subarea	Area	Proportion
CA-01	20.76	0.311
CA-02	20.48	0.307
CA-03	25.55	0.383
TOTAL:	66.79	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.107"	0.128"	0.231"
30-min	0.267"	0.329"	0.589"
60-min	0.388"	0.474"	0.850"
3-hr	0.729"	0.881"	1.497"
6-hr	1.049"	1.267"	2.126"
24-hr	2.078"	2.567"	4.389"

RF-02

CA-04, CA-05, TH-03 & WB-03

Subarea	Area	Proportion
CA-04	37.35	0.360
CA-05	20.87	0.201
TH-03	16.49	0.159
WB-03	29.06	0.280
TOTAL:	103.77	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.110"	0.135"	0.243"
30-min	0.278"	0.341"	0.613"
60-min	0.399"	0.493"	0.880"
3-hr	0.751"	0.910"	1.539"
6-hr	1.082"	1.305"	2.183"
24-hr	2.161"	2.668"	4.550"

RF-03

TH-01 & TH-02

Subarea	Area	Proportion
TH-01	27.70	0.784
TH-02	7.61	0.216
TOTAL:	35.31	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.125"	0.157"	0.308"
30-min	0.311"	0.388"	0.772"
60-min	0.439"	0.549"	1.091"
3-hr	0.776"	0.928"	1.567"
6-hr	1.133"	1.349"	2.184"
24-hr	2.452"	3.031"	5.065"

RF-04

TH-04 & TH-05

Subarea	Area	Proportion
TH-04	18.06	0.347
TH-05	34.01	0.653
TOTAL:	52.07	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.107"	0.133"	0.255"
30-min	0.272"	0.333"	0.639"
60-min	0.386"	0.476"	0.906"
3-hr	0.703"	0.845"	1.420"
6-hr	1.015"	1.213"	1.983"
24-hr	2.095"	2.579"	4.322"

RF-05

CA-06, TH-06 & WB-04

Subarea	Area	Proportion
CA-06	62.5	0.483
TH-06	24.68	0.191
WB-04	42.31	0.327
TOTAL:	129.49	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.115"	0.140"	0.245"
30-min	0.289"	0.352"	0.622"
60-min	0.419"	0.512"	0.904"
3-hr	0.768"	0.926"	1.562"
6-hr	1.162"	1.396"	2.331"
24-hr	2.290"	2.804"	4.743"

RF-06

CA-07

Subarea	Area	Proportion
CA-07	34.21	1.000
TOTAL:	34.21	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.095"	0.114"	0.202"
30-min	0.238"	0.292"	0.517"
60-min	0.349"	0.425"	0.753"
3-hr	0.642"	0.775"	1.289"
6-hr	0.920"	1.098"	1.810"
24-hr	1.768"	2.154"	3.598"

RF-07

CA-08

Subarea	Area	Proportion
CA-08	4.92	1.000
TOTAL:	4.92	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.082"	0.101"	0.177"
30-min	0.211"	0.258"	0.449"
60-min	0.307"	0.376"	0.648"
3-hr	0.550"	0.666"	1.093"
6-hr	0.772"	0.920"	1.506"
24-hr	1.413"	1.722"	2.849"

RF-08

WB-01 & WB-02

Subarea	Area	Proportion
WB-01	26.67	0.543
WB-02	22.43	0.457
TOTAL:	49.1	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.107"	0.129"	0.233"
30-min	0.268"	0.330"	0.590"
60-min	0.387"	0.480"	0.852"
3-hr	0.717"	0.869"	1.487"
6-hr	1.009"	1.221"	2.078"
24-hr	1.962"	2.421"	4.174"

RF-09

STUDY AREA - WEIGHTED AVERAGE

Subarea	Area	Proportion
CA-01	20.76	0.044
CA-02	20.48	0.043
CA-03	25.55	0.054
CA-04	37.35	0.079
CA-05	20.87	0.044
CA-06	62.5	0.131
CA-07	34.21	0.072
CA-08	4.92	0.010
TH-01	27.7	0.058
TH-02	7.61	0.016
TH-03	16.49	0.035
TH-04	18.06	0.038
TH-05	34.01	0.072
TH-06	24.68	0.052
WB-01	26.67	0.056
WB-02	22.43	0.047
WB-03	29.06	0.061
WB-04	42.31	0.089
TOTAL:	475.66	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.110"	0.134"	0.244"
30-min	0.277"	0.339"	0.616"
60-min	0.399"	0.490"	0.886"
3-hr	0.736"	0.888"	1.500"
6-hr	1.073"	1.290"	2.149"
24-hr	2.142"	2.636"	4.468"

STUDY AREA

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.543750	30	0.0302
630.0	0.716620	60	0.0604
690.0	0.905315	90	0.0906
705.0	0.964560	120	0.1208
717.5	1.050240	150	0.1510
722.5	1.157680	180	0.1813
735.0	1.243360	210	0.2115
750.0	1.302605	240	0.2417
810.0	1.491300	270	0.2719
900.0	1.664170	300	0.3021
1440.0	2.207920	330	0.3323
		360	0.3625
		390	0.3927
		420	0.4229
		450	0.4531
		480	0.4833
		510	0.5135
		540	0.5438
		570	0.6014
		600	0.6590
		630	0.7166
		660	0.8110
		690	0.9053
		720	1.1040
		750	1.3026
		780	1.3970
		810	1.4913
		840	1.5489
		870	1.6065
		900	1.6642
		930	1.6944
		960	1.7246
		990	1.7548
		1020	1.7850
		1050	1.8152
		1080	1.8454
		1110	1.8756
		1140	1.9058
		1170	1.9360
		1200	1.9663
		1230	1.9965
		1260	2.0267
		1290	2.0569
		1320	2.0871
		1350	2.1173
		1380	2.1475
		1410	2.1777
		1440	2.2079

RF-01

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.514756	30	0.0286
630.0	0.674525	60	0.0572
690.0	0.844943	90	0.0858
705.0	0.905378	120	0.1144
717.5	0.985315	150	0.1430
722.5	1.092755	180	0.1716
735.0	1.172691	210	0.2002
750.0	1.233126	240	0.2288
810.0	1.403545	270	0.2574
900.0	1.563313	300	0.2860
1440.0	2.078069	330	0.3146
		360	0.3432
		390	0.3718
		420	0.4004
		450	0.4290
		480	0.4576
		510	0.4862
		540	0.5148
		570	0.5680
		600	0.6213
		630	0.6745
		660	0.7597
		690	0.8449
		720	1.0390
		750	1.2331
		780	1.3183
		810	1.4035
		840	1.4568
		870	1.5101
		900	1.5633
		930	1.5919
		960	1.6205
		990	1.6491
		1020	1.6777
		1050	1.7063
		1080	1.7349
		1110	1.7635
		1140	1.7921
		1170	1.8207
		1200	1.8493
		1230	1.8779
		1260	1.9065
		1290	1.9351
		1320	1.9637
		1350	1.9923
		1380	2.0209
		1410	2.0495
		1440	2.0781

RF-02			
From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.539517	30	0.0300
630.0	0.705122	60	0.0599
690.0	0.880999	90	0.0899
705.0	0.941632	120	0.1199
717.5	1.025510	150	0.1499
722.5	1.135724	180	0.1798
735.0	1.219601	210	0.2098
750.0	1.280234	240	0.2398
810.0	1.456111	270	0.2698
900.0	1.621716	300	0.2997
1440.0	2.161233	330	0.3297
		360	0.3597
		390	0.3897
		420	0.4196
		450	0.4496
		480	0.4796
		510	0.5095
		540	0.5395
		570	0.5947
		600	0.6499
		630	0.7051
		660	0.7931
		690	0.8810
		720	1.0806
		750	1.2802
		780	1.3682
		810	1.4561
		840	1.5113
		870	1.5665
		900	1.6217
		930	1.6517
		960	1.6817
		990	1.7116
		1020	1.7416
		1050	1.7716
		1080	1.8016
		1110	1.8315
		1140	1.8615
		1170	1.8915
		1200	1.9214
		1230	1.9514
		1260	1.9814
		1290	2.0114
		1320	2.0413
		1350	2.0713
		1380	2.1013
		1410	2.1313
		1440	2.1612

RF-03			
From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.659797	30	0.0367
630.0	0.837996	60	0.0733
690.0	1.006561	90	0.1100
705.0	1.070448	120	0.1466
717.5	1.163597	150	0.1833
722.5	1.288635	180	0.2199
735.0	1.381783	210	0.2566
750.0	1.445671	240	0.2932
810.0	1.614236	270	0.3299
900.0	1.792434	300	0.3666
1440.0	2.452231	330	0.4032
		360	0.4399
		390	0.4765
		420	0.5132
		450	0.5498
		480	0.5865
		510	0.6231
		540	0.6598
		570	0.7192
		600	0.7786
		630	0.8380
		660	0.9223
		690	1.0066
		720	1.2261
		750	1.4457
		780	1.5300
		810	1.6142
		840	1.6736
		870	1.7330
		900	1.7924
		930	1.8291
		960	1.8657
		990	1.9024
		1020	1.9391
		1050	1.9757
		1080	2.0124
		1110	2.0490
		1140	2.0857
		1170	2.1223
		1200	2.1590
		1230	2.1956
		1260	2.2323
		1290	2.2690
		1320	2.3056
		1350	2.3423
		1380	2.3789
		1410	2.4156
		1440	2.4522

RF-04

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.540271	30	0.0300
630.0	0.696269	60	0.0600
690.0	0.854671	90	0.0900
705.0	0.911555	120	0.1201
717.5	0.993835	150	0.1501
722.5	1.101275	180	0.1801
735.0	1.183555	210	0.2101
750.0	1.240439	240	0.2401
810.0	1.398842	270	0.2701
900.0	1.554839	300	0.3002
1440.0	2.095110	330	0.3302
		360	0.3602
		390	0.3902
		420	0.4202
		450	0.4502
		480	0.4802
		510	0.5103
		540	0.5403
		570	0.5923
		600	0.6443
		630	0.6963
		660	0.7755
		690	0.8547
		720	1.0476
		750	1.2404
		780	1.3196
		810	1.3988
		840	1.4508
		870	1.5028
		900	1.5548
		930	1.5849
		960	1.6149
		990	1.6449
		1020	1.6749
		1050	1.7049
		1080	1.7349
		1110	1.7649
		1140	1.7950
		1170	1.8250
		1200	1.8550
		1230	1.8850
		1260	1.9150
		1290	1.9450
		1320	1.9751
		1350	2.0051
		1380	2.0351
		1410	2.0651
		1440	2.0951

RF-05

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.564094	30	0.0313
630.0	0.760995	60	0.0627
690.0	0.935424	90	0.0940
705.0	1.000556	120	0.1254
717.5	1.087620	150	0.1567
722.5	1.202240	180	0.1880
735.0	1.289304	210	0.2194
750.0	1.354435	240	0.2507
810.0	1.528865	270	0.2820
900.0	1.725766	300	0.3134
1440.0	2.289860	330	0.3447
		360	0.3761
		390	0.4074
		420	0.4387
		450	0.4701
		480	0.5014
		510	0.5328
		540	0.5641
		570	0.6297
		600	0.6954
		630	0.7610
		660	0.8482
		690	0.9354
		720	1.1449
		750	1.3544
		780	1.4417
		810	1.5289
		840	1.5945
		870	1.6601
		900	1.7258
		930	1.7571
		960	1.7884
		990	1.8198
		1020	1.8511
		1050	1.8825
		1080	1.9138
		1110	1.9451
		1140	1.9765
		1170	2.0078
		1200	2.0392
		1230	2.0705
		1260	2.1018
		1290	2.1332
		1320	2.1645
		1350	2.1958
		1380	2.2272
		1410	2.2585
		1440	2.2899

RF-05 - 3 Hr

From Series		Expanded	
Time	Cummu-lative, Inches	Time, Min	Cummu-lative, Inches
0	0.000000	0	0.0000
60	0.174430	15	0.0436
75	0.239561	30	0.0872
90	0.383935	45	0.1308
105	0.528309	60	0.1744
120	0.593441	75	0.2396
180	0.767871	90	0.3839
		105	0.5283
		120	0.5934
		135	0.6370
		150	0.6807
		165	0.7243
		180	0.7679

RF-06

From Series		Expanded	
Time	Cummu-lative, Inches	Time, Min	Cummu-lative, Inches
0.0	0.000000	0	0.0000
540.0	0.423900	30	0.0236
630.0	0.562846	60	0.0471
690.0	0.709690	90	0.0707
705.0	0.764940	120	0.0942
717.5	0.836540	150	0.1178
722.5	0.931340	180	0.1413
735.0	1.002940	210	0.1649
750.0	1.058190	240	0.1884
810.0	1.205034	270	0.2120
900.0	1.343980	300	0.2355
1440.0	1.767880	330	0.2591
		360	0.2826
		390	0.3062
		420	0.3297
		450	0.3533
		480	0.3768
		510	0.4004
		540	0.4239
		570	0.4702
		600	0.5165
		630	0.5628
		660	0.6363
		690	0.7097
		720	0.8839
		750	1.0582
		780	1.1316
		810	1.2050
		840	1.2513
		870	1.2977
		900	1.3440
		930	1.3675
		960	1.3911
		990	1.4146
		1020	1.4382
		1050	1.4617
		1080	1.4853
		1110	1.5088
		1140	1.5324
		1170	1.5559
		1200	1.5795
		1230	1.6030
		1260	1.6266
		1290	1.6501
		1320	1.6737
		1350	1.6972
		1380	1.7208
		1410	1.7443
		1440	1.7679

RF-06 - 3 Hr

From Series		Expanded	
Time	Cummu-lative, Inches	Time, Min	Cummu-lative, Inches
0	0.000000	0	0.0000
60	0.146844	15	0.0367
75	0.202094	30	0.0734
90	0.321094	45	0.1101
105	0.440094	60	0.1468
120	0.495344	75	0.2021
180	0.642188	90	0.3211
		105	0.4401
		120	0.4953
		135	0.5321
		150	0.5688
		165	0.6055
		180	0.6422

RF-07

From Series		Expanded	
Time	Cummu-lative, Inches	Time, Min	Cummu-lative, Inches
0.0	0.000000	0	0.0000
540.0	0.320540	30	0.0178
630.0	0.431260	60	0.0356
690.0	0.553040	90	0.0534
705.0	0.600980	120	0.0712
717.5	0.665300	150	0.0890
722.5	0.747460	180	0.1068
735.0	0.811780	210	0.1247
750.0	0.859720	240	0.1425
810.0	0.981500	270	0.1603
900.0	1.092220	300	0.1781
1440.0	1.412760	330	0.1959
		360	0.2137
		390	0.2315
		420	0.2493
		450	0.2671
		480	0.2849
		510	0.3027
		540	0.3205
		570	0.3574
		600	0.3944
		630	0.4313
		660	0.4922
		690	0.5530
		720	0.7064
		750	0.8597
		780	0.9206
		810	0.9815
		840	1.0184
		870	1.0553
		900	1.0922
		930	1.1100
		960	1.1278
		990	1.1456
		1020	1.1635
		1050	1.1813
		1080	1.1991
		1110	1.2169
		1140	1.2347
		1170	1.2525
		1200	1.2703
		1230	1.2881
		1260	1.3059
		1290	1.3237
		1320	1.3415
		1350	1.3593
		1380	1.3771
		1410	1.3950
		1440	1.4128

RF-07 - 3 Hr

From Series		Expanded	
Time	Cummu-lative, Inches	Time, Min	Cummu-lative, Inches
0	0.000000	0	0.0000
60	0.121780	15	0.0304
75	0.169720	30	0.0609
90	0.275120	45	0.0913
105	0.380520	60	0.1218
120	0.428460	75	0.1697
180	0.550240	90	0.2751
		105	0.3805
		120	0.4285
		135	0.4589
		150	0.4894
		165	0.5198
		180	0.5502

RF-08

From Series		Expanded	
Time	Cummu-lative, Inches	Time, Min	Cummu-lative, Inches
0.0	0.000000	0	0.0000
540.0	0.476213	30	0.0265
630.0	0.622393	60	0.0529
690.0	0.787506	90	0.0794
705.0	0.846620	120	0.1058
717.5	0.927053	150	0.1323
722.5	1.034493	180	0.1587
735.0	1.114927	210	0.1852
750.0	1.174040	240	0.2117
810.0	1.339153	270	0.2381
900.0	1.485333	300	0.2646
1440.0	1.961547	330	0.2910
		360	0.3175
		390	0.3439
		420	0.3704
		450	0.3968
		480	0.4233
		510	0.4498
		540	0.4762
		570	0.5249
		600	0.5737
		630	0.6224
		660	0.7049
		690	0.7875
		720	0.9808
		750	1.1740
		780	1.2566
		810	1.3392
		840	1.3879
		870	1.4366
		900	1.4853
		930	1.5118
		960	1.5382
		990	1.5647
		1020	1.5912
		1050	1.6176
		1080	1.6441
		1110	1.6705
		1140	1.6970
		1170	1.7234
		1200	1.7499
		1230	1.7764
		1260	1.8028
		1290	1.8293
		1320	1.8557
		1350	1.8822
		1380	1.9086
		1410	1.9351
		1440	1.9615

STUDY AREA

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.687360	30	0.0382
630.0	0.895600	60	0.0764
690.0	1.118630	90	0.1146
705.0	1.195980	120	0.1527
717.5	1.296220	150	0.1909
722.5	1.428940	180	0.2291
735.0	1.529180	210	0.2673
750.0	1.606530	240	0.3055
810.0	1.829560	270	0.3437
900.0	2.037800	300	0.3819
1440.0	2.725160	330	0.4201
		360	0.4582
		390	0.4964
		420	0.5346
		450	0.5728
		480	0.6110
		510	0.6492
		540	0.6874
		570	0.7568
		600	0.8262
		630	0.8956
		660	1.0071
		690	1.1186
		720	1.3626
		750	1.6065
		780	1.7180
		810	1.8296
		840	1.8990
		870	1.9684
		900	2.0378
		930	2.0760
		960	2.1142
		990	2.1524
		1020	2.1905
		1050	2.2287
		1080	2.2669
		1110	2.3051
		1140	2.3433
		1170	2.3815
		1200	2.4197
		1230	2.4579
		1260	2.4960
		1290	2.5342
		1320	2.5724
		1350	2.6106
		1380	2.6488
		1410	2.6870
		1440	2.7252

RF-01

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.650127	30	0.0361
630.0	0.842884	60	0.0722
690.0	1.046420	90	0.1084
705.0	1.119158	120	0.1445
717.5	1.219232	150	0.1806
722.5	1.347597	180	0.2167
735.0	1.447671	210	0.2528
750.0	1.520409	240	0.2889
810.0	1.723944	270	0.3251
900.0	1.916702	300	0.3612
1440.0	2.566829	330	0.3973
		360	0.4334
		390	0.4695
		420	0.5057
		450	0.5418
		480	0.5779
		510	0.6140
		540	0.6501
		570	0.7144
		600	0.7786
		630	0.8429
		660	0.9447
		690	1.0464
		720	1.2834
		750	1.5204
		780	1.6222
		810	1.7239
		840	1.7882
		870	1.8524
		900	1.9167
		930	1.9528
		960	1.9889
		990	2.0251
		1020	2.0612
		1050	2.0973
		1080	2.1334
		1110	2.1695
		1140	2.2056
		1170	2.2418
		1200	2.2779
		1230	2.3140
		1260	2.3501
		1290	2.3862
		1320	2.4224
		1350	2.4585
		1380	2.4946
		1410	2.5307
		1440	2.5668

RF-02

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.681717	30	0.0379
630.0	0.879135	60	0.0757
690.0	1.087827	90	0.1136
705.0	1.163739	120	0.1515
717.5	1.266519	150	0.1894
722.5	1.401746	180	0.2272
735.0	1.504526	210	0.2651
750.0	1.580438	240	0.3030
810.0	1.789131	270	0.3409
900.0	1.986549	300	0.3787
1440.0	2.668265	330	0.4166
		360	0.4545
		390	0.4924
		420	0.5302
		450	0.5681
		480	0.6060
		510	0.6438
		540	0.6817
		570	0.7475
		600	0.8133
		630	0.8791
		660	0.9835
		690	1.0878
		720	1.3341
		750	1.5804
		780	1.6848
		810	1.7891
		840	1.8549
		870	1.9207
		900	1.9865
		930	2.0244
		960	2.0623
		990	2.1002
		1020	2.1380
		1050	2.1759
		1080	2.2138
		1110	2.2517
		1140	2.2895
		1170	2.3274
		1200	2.3653
		1230	2.4032
		1260	2.4410
		1290	2.4789
		1320	2.5168
		1350	2.5546
		1380	2.5925
		1410	2.6304
		1440	2.6683

RF-03

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.840907	30	0.0467
630.0	1.051476	60	0.0934
690.0	1.241052	90	0.1402
705.0	1.321816	120	0.1869
717.5	1.437297	150	0.2336
722.5	1.593935	180	0.2803
735.0	1.709416	210	0.3270
750.0	1.790180	240	0.3737
810.0	1.979756	270	0.4205
900.0	2.190324	300	0.4672
1440.0	3.031231	330	0.5139
		360	0.5606
		390	0.6073
		420	0.6540
		450	0.7008
		480	0.7475
		510	0.7942
		540	0.8409
		570	0.9111
		600	0.9813
		630	1.0515
		660	1.1463
		690	1.2411
		720	1.5156
		750	1.7902
		780	1.8850
		810	1.9798
		840	2.0499
		870	2.1201
		900	2.1903
		930	2.2370
		960	2.2838
		990	2.3305
		1020	2.3772
		1050	2.4239
		1080	2.4706
		1110	2.5173
		1140	2.5641
		1170	2.6108
		1200	2.6575
		1230	2.7042
		1260	2.7509
		1290	2.7976
		1320	2.8444
		1350	2.8911
		1380	2.9378
		1410	2.9845
		1440	3.0312

RF-04

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.683235	30	0.0380
630.0	0.866975	60	0.0759
690.0	1.051364	90	0.1139
705.0	1.122953	120	0.1518
717.5	1.223193	150	0.1898
722.5	1.355913	180	0.2277
735.0	1.456153	210	0.2657
750.0	1.527742	240	0.3037
810.0	1.712131	270	0.3416
900.0	1.895870	300	0.3796
1440.0	2.579106	330	0.4175
		360	0.4555
		390	0.4934
		420	0.5314
		450	0.5694
		480	0.6073
		510	0.6453
		540	0.6832
		570	0.7445
		600	0.8057
		630	0.8670
		660	0.9592
		690	1.0514
		720	1.2896
		750	1.5277
		780	1.6199
		810	1.7121
		840	1.7734
		870	1.8346
		900	1.8959
		930	1.9338
		960	1.9718
		990	2.0097
		1020	2.0477
		1050	2.0857
		1080	2.1236
		1110	2.1616
		1140	2.1995
		1170	2.2375
		1200	2.2754
		1230	2.3134
		1260	2.3514
		1290	2.3893
		1320	2.4273
		1350	2.4652
		1380	2.5032
		1410	2.5411
		1440	2.5791

RF-05

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.704013	30	0.0391
630.0	0.939099	60	0.0782
690.0	1.146205	90	0.1173
705.0	1.226070	120	0.1564
717.5	1.332205	150	0.1956
722.5	1.472105	180	0.2347
735.0	1.578240	210	0.2738
750.0	1.658104	240	0.3129
810.0	1.865210	270	0.3520
900.0	2.100296	300	0.3911
1440.0	2.804310	330	0.4302
		360	0.4693
		390	0.5085
		420	0.5476
		450	0.5867
		480	0.6258
		510	0.6649
		540	0.7040
		570	0.7824
		600	0.8607
		630	0.9391
		660	1.0427
		690	1.1462
		720	1.4022
		750	1.6581
		780	1.7617
		810	1.8652
		840	1.9436
		870	2.0219
		900	2.1003
		930	2.1394
		960	2.1785
		990	2.2176
		1020	2.2567
		1050	2.2959
		1080	2.3350
		1110	2.3741
		1140	2.4132
		1170	2.4523
		1200	2.4914
		1230	2.5305
		1260	2.5696
		1290	2.6088
		1320	2.6479
		1350	2.6870
		1380	2.7261
		1410	2.7652
		1440	2.8043

RF-05 - 3 Hr

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0	0.000000	0	0.0000
60	0.207106	15	0.0518
75	0.286971	30	0.1036
90	0.463056	45	0.1553
105	0.639140	60	0.2071
120	0.719005	75	0.2870
180	0.926111	90	0.4631
		105	0.6391
		120	0.7190
		135	0.7708
		150	0.8226
		165	0.8743
		180	0.9261

RF-06

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.527860	30	0.0293
630.0	0.689600	60	0.0587
690.0	0.864355	90	0.0880
705.0	0.930740	120	0.1173
717.5	1.020060	150	0.1466
722.5	1.133820	180	0.1760
735.0	1.223140	210	0.2053
750.0	1.289525	240	0.2346
810.0	1.464280	270	0.2639
900.0	1.626020	300	0.2933
1440.0	2.153880	330	0.3226
		360	0.3519
		390	0.3812
		420	0.4106
		450	0.4399
		480	0.4692
		510	0.4985
		540	0.5279
		570	0.5818
		600	0.6357
		630	0.6896
		660	0.7770
		690	0.8644
		720	1.0769
		750	1.2895
		780	1.3769
		810	1.4643
		840	1.5182
		870	1.5721
		900	1.6260
		930	1.6553
		960	1.6847
		990	1.7140
		1020	1.7433
		1050	1.7726
		1080	1.8020
		1110	1.8313
		1140	1.8606
		1170	1.8900
		1200	1.9193
		1230	1.9486
		1260	1.9779
		1290	2.0073
		1320	2.0366
		1350	2.0659
		1380	2.0952
		1410	2.1246
		1440	2.1539

RF-06 - 3 Hr

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0	0.000000	0	0.0000
60	0.174755	15	0.0437
75	0.241140	30	0.0874
90	0.387340	45	0.1311
105	0.533540	60	0.1748
120	0.599925	75	0.2411
180	0.774680	90	0.3873
		105	0.5335
		120	0.5999
		135	0.6436
		150	0.6873
		165	0.7310
		180	0.7747

RF-07

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.400740	30	0.0223
630.0	0.527740	60	0.0445
690.0	0.672590	90	0.0668
705.0	0.731580	120	0.0891
717.5	0.810220	150	0.1113
722.5	0.911340	180	0.1336
735.0	0.989980	210	0.1558
750.0	1.048970	240	0.1781
810.0	1.193820	270	0.2004
900.0	1.320820	300	0.2226
1440.0	1.721560	330	0.2449
		360	0.2672
		390	0.2894
		420	0.3117
		450	0.3340
		480	0.3562
		510	0.3785
		540	0.4007
		570	0.4431
		600	0.4854
		630	0.5277
		660	0.6002
		690	0.6726
		720	0.8608
		750	1.0490
		780	1.1214
		810	1.1938
		840	1.2362
		870	1.2785
		900	1.3208
		930	1.3431
		960	1.3653
		990	1.3876
		1020	1.4099
		1050	1.4321
		1080	1.4544
		1110	1.4767
		1140	1.4989
		1170	1.5212
		1200	1.5435
		1230	1.5657
		1260	1.5880
		1290	1.6102
		1320	1.6325
		1350	1.6548
		1380	1.6770
		1410	1.6993
		1440	1.7216

RF-07 - 3 Hr

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0	0.000000	0	0.0000
60	0.144850	15	0.0362
75	0.203840	30	0.0724
90	0.333040	45	0.1086
105	0.462240	60	0.1449
120	0.521230	75	0.2038
180	0.666080	90	0.3330
		105	0.4622
		120	0.5212
		135	0.5574
		150	0.5937
		165	0.6299
		180	0.6661

RF-08

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.600155	30	0.0333
630.0	0.776210	60	0.0667
690.0	0.970446	90	0.1000
705.0	1.045857	120	0.1334
717.5	1.145966	150	0.1667
722.5	1.275254	180	0.2001
735.0	1.375363	210	0.2334
750.0	1.450774	240	0.2667
810.0	1.645010	270	0.3001
900.0	1.821065	300	0.3334
1440.0	2.421220	330	0.3668
		360	0.4001
		390	0.4334
		420	0.4668
		450	0.5001
		480	0.5335
		510	0.5668
		540	0.6002
		570	0.6588
		600	0.7175
		630	0.7762
		660	0.8733
		690	0.9704
		720	1.2106
		750	1.4508
		780	1.5479
		810	1.6450
		840	1.7037
		870	1.7624
		900	1.8211
		930	1.8544
		960	1.8877
		990	1.9211
		1020	1.9544
		1050	1.9878
		1080	2.0211
		1110	2.0545
		1140	2.0878
		1170	2.1211
		1200	2.1545
		1230	2.1878
		1260	2.2212
		1290	2.2545
		1320	2.2879
		1350	2.3212
		1380	2.3545
		1410	2.3879
		1440	2.4212

STUDY AREA

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	1.207760	30	0.0671
630.0	1.553860	60	0.1342
690.0	1.917850	90	0.2013
705.0	2.050620	120	0.2684
717.5	2.226100	150	0.3355
722.5	2.459940	180	0.4026
735.0	2.635420	210	0.4697
750.0	2.768190	240	0.5368
810.0	3.132180	270	0.6039
900.0	3.478280	300	0.6710
1440.0	4.686040	330	0.7381
		360	0.8052
		390	0.8723
		420	0.9394
		450	1.0065
		480	1.0736
		510	1.1407
		540	1.2078
		570	1.3231
		600	1.4385
		630	1.5539
		660	1.7359
		690	1.9179
		720	2.3430
		750	2.7682
		780	2.9502
		810	3.1322
		840	3.2475
		870	3.3629
		900	3.4783
		930	3.5454
		960	3.6125
		990	3.6796
		1020	3.7467
		1050	3.8138
		1080	3.8809
		1110	3.9480
		1140	4.0151
		1170	4.0822
		1200	4.1493
		1230	4.2164
		1260	4.2835
		1290	4.3506
		1320	4.4176
		1350	4.4847
		1380	4.5518
		1410	4.6189
		1440	4.6860

RF-01

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	1.131907	30	0.0629
630.0	1.446179	60	0.1258
690.0	1.769720	90	0.1887
705.0	1.900142	120	0.2515
717.5	2.078959	150	0.3144
722.5	2.310408	180	0.3773
735.0	2.489226	210	0.4402
750.0	2.619648	240	0.5031
810.0	2.943188	270	0.5660
900.0	3.257460	300	0.6288
1440.0	4.389367	330	0.6917
		360	0.7546
		390	0.8175
		420	0.8804
		450	0.9433
		480	1.0061
		510	1.0690
		540	1.1319
		570	1.2367
		600	1.3414
		630	1.4462
		660	1.6079
		690	1.7697
		720	2.1947
		750	2.6196
		780	2.7814
		810	2.9432
		840	3.0479
		870	3.1527
		900	3.2575
		930	3.3203
		960	3.3832
		990	3.4461
		1020	3.5090
		1050	3.5719
		1080	3.6348
		1110	3.6976
		1140	3.7605
		1170	3.8234
		1200	3.8863
		1230	3.9492
		1260	4.0121
		1290	4.0749
		1320	4.1378
		1350	4.2007
		1380	4.2636
		1410	4.3265
		1440	4.3894

RF-02

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	1.183636	30	0.0658
630.0	1.505715	60	0.1315
690.0	1.835111	90	0.1973
705.0	1.968636	120	0.2630
717.5	2.153670	150	0.3288
722.5	2.396542	180	0.3945
735.0	2.581576	210	0.4603
750.0	2.715101	240	0.5261
810.0	3.044497	270	0.5918
900.0	3.366576	300	0.6576
1440.0	4.550212	330	0.7233
		360	0.7891
		390	0.8548
		420	0.9206
		450	0.9864
		480	1.0521
		510	1.1179
		540	1.1836
		570	1.2910
		600	1.3984
		630	1.5057
		660	1.6704
		690	1.8351
		720	2.2751
		750	2.7151
		780	2.8798
		810	3.0445
		840	3.1519
		870	3.2592
		900	3.3666
		930	3.4323
		960	3.4981
		990	3.5638
		1020	3.6296
		1050	3.6954
		1080	3.7611
		1110	3.8269
		1140	3.8926
		1170	3.9584
		1200	4.0242
		1230	4.0899
		1260	4.1557
		1290	4.2214
		1320	4.2872
		1350	4.3529
		1380	4.4187
		1410	4.4845
		1440	4.5502

RF-03

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	1.440632	30	0.0800
630.0	1.748979	60	0.1601
690.0	1.986817	90	0.2401
705.0	2.146325	120	0.3201
717.5	2.378301	150	0.4002
722.5	2.686618	180	0.4802
735.0	2.918594	210	0.5602
750.0	3.078102	240	0.6403
810.0	3.315940	270	0.7203
900.0	3.624287	300	0.8004
1440.0	5.064919	330	0.8804
		360	0.9604
		390	1.0405
		420	1.1205
		450	1.2005
		480	1.2806
		510	1.3606
		540	1.4406
		570	1.5434
		600	1.6462
		630	1.7490
		660	1.8679
		690	1.9868
		720	2.5325
		750	3.0781
		780	3.1970
		810	3.3159
		840	3.4187
		870	3.5215
		900	3.6243
		930	3.7043
		960	3.7844
		990	3.8644
		1020	3.9444
		1050	4.0245
		1080	4.1045
		1110	4.1845
		1140	4.2646
		1170	4.3446
		1200	4.4246
		1230	4.5047
		1260	4.5847
		1290	4.6647
		1320	4.7448
		1350	4.8248
		1380	4.9048
		1410	4.9849
		1440	5.0649

RF-04

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	1.169878	30	0.0650
630.0	1.451240	60	0.1300
690.0	1.708291	90	0.1950
705.0	1.841737	120	0.2600
717.5	2.033832	150	0.3250
722.5	2.288568	180	0.3900
735.0	2.480662	210	0.4550
750.0	2.614108	240	0.5199
810.0	2.871160	270	0.5849
900.0	3.152521	300	0.6499
1440.0	4.322399	330	0.7149
		360	0.7799
		390	0.8449
		420	0.9099
		450	0.9749
		480	1.0399
		510	1.1049
		540	1.1699
		570	1.2637
		600	1.3575
		630	1.4512
		660	1.5798
		690	1.7083
		720	2.1612
		750	2.6141
		780	2.7426
		810	2.8712
		840	2.9649
		870	3.0587
		900	3.1525
		930	3.2175
		960	3.2825
		990	3.3475
		1020	3.4125
		1050	3.4775
		1080	3.5425
		1110	3.6075
		1140	3.6725
		1170	3.7375
		1200	3.8025
		1230	3.8674
		1260	3.9324
		1290	3.9974
		1320	4.0624
		1350	4.1274
		1380	4.1924
		1410	4.2574
		1440	4.3224

RF-05

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	1.205891	30	0.0670
630.0	1.590023	60	0.1340
690.0	1.919368	90	0.2010
705.0	2.060171	120	0.2680
717.5	2.248515	150	0.3350
722.5	2.494010	180	0.4020
735.0	2.682355	210	0.4690
750.0	2.823157	240	0.5360
810.0	3.152502	270	0.6029
900.0	3.536635	300	0.6699
1440.0	4.742526	330	0.7369
		360	0.8039
		390	0.8709
		420	0.9379
		450	1.0049
		480	1.0719
		510	1.1389
		540	1.2059
		570	1.3339
		600	1.4620
		630	1.5900
		660	1.7547
		690	1.9194
		720	2.3713
		750	2.8232
		780	2.9878
		810	3.1525
		840	3.2805
		870	3.4086
		900	3.5366
		930	3.6036
		960	3.6706
		990	3.7376
		1020	3.8046
		1050	3.8716
		1080	3.9386
		1110	4.0056
		1140	4.0726
		1170	4.1396
		1200	4.2066
		1230	4.2736
		1260	4.3406
		1290	4.4076
		1320	4.4745
		1350	4.5415
		1380	4.6085
		1410	4.6755
		1440	4.7425

RF-05 - 3 Hr

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0	0.000000	0	0.0000
60	0.329345	15	0.0823
75	0.470148	30	0.1647
90	0.781239	45	0.2470
105	1.092331	60	0.3293
120	1.233134	75	0.4701
180	1.562479	90	0.7812
		105	1.0923
		120	1.2331
		135	1.3155
		150	1.3978
		165	1.4801
		180	1.5625

RF-06

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.893520	30	0.0496
630.0	1.154400	60	0.0993
690.0	1.422380	90	0.1489
705.0	1.540360	120	0.1986
717.5	1.697640	150	0.2482
722.5	1.899880	180	0.2978
735.0	2.057160	210	0.3475
750.0	2.175140	240	0.3971
810.0	2.443120	270	0.4468
900.0	2.704000	300	0.4964
1440.0	3.597520	330	0.5460
		360	0.5957
		390	0.6453
		420	0.6950
		450	0.7446
		480	0.7942
		510	0.8439
		540	0.8935
		570	0.9805
		600	1.0674
		630	1.1544
		660	1.2884
		690	1.4224
		720	1.7988
		750	2.1751
		780	2.3091
		810	2.4431
		840	2.5301
		870	2.6170
		900	2.7040
		930	2.7536
		960	2.8033
		990	2.8529
		1020	2.9026
		1050	2.9522
		1080	3.0018
		1110	3.0515
		1140	3.1011
		1170	3.1508
		1200	3.2004
		1230	3.2500
		1260	3.2997
		1290	3.3493
		1320	3.3990
		1350	3.4486
		1380	3.4982
		1410	3.5479
		1440	3.5975

RF-06 - 3 Hr

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0	0.000000	0	0.0000
60	0.267980	15	0.0670
75	0.385960	30	0.1340
90	0.644360	45	0.2010
105	0.902760	60	0.2680
120	1.020740	75	0.3860
180	1.288720	90	0.6444
		105	0.9028
		120	1.0207
		135	1.0877
		150	1.1547
		165	1.2217
		180	1.2887

RF-07

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.671210	30	0.0373
630.0	0.877720	60	0.0746
690.0	1.100235	90	0.1119
705.0	1.199940	120	0.1492
717.5	1.335860	150	0.1864
722.5	1.512820	180	0.2237
735.0	1.648740	210	0.2610
750.0	1.748445	240	0.2983
810.0	1.970960	270	0.3356
900.0	2.177470	300	0.3729
1440.0	2.848680	330	0.4102
		360	0.4475
		390	0.4848
		420	0.5221
		450	0.5593
		480	0.5966
		510	0.6339
		540	0.6712
		570	0.7400
		600	0.8089
		630	0.8777
		660	0.9890
		690	1.1002
		720	1.4243
		750	1.7484
		780	1.8597
		810	1.9710
		840	2.0398
		870	2.1086
		900	2.1775
		930	2.2148
		960	2.2520
		990	2.2893
		1020	2.3266
		1050	2.3639
		1080	2.4012
		1110	2.4385
		1140	2.4758
		1170	2.5131
		1200	2.5504
		1230	2.5877
		1260	2.6249
		1290	2.6622
		1320	2.6995
		1350	2.7368
		1380	2.7741
		1410	2.8114
		1440	2.8487

RF-07 - 3 Hr

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0	0.000000	0	0.0000
60	0.222515	15	0.0556
75	0.322220	30	0.1113
90	0.546620	45	0.1669
105	0.771020	60	0.2225
120	0.870725	75	0.3222
180	1.093240	90	0.5466
		105	0.7710
		120	0.8707
		135	0.9264
		150	0.9820
		165	1.0376
		180	1.0932

RF-08

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	1.048030	30	0.0582
630.0	1.343389	60	0.1164
690.0	1.660670	90	0.1747
705.0	1.791617	120	0.2329
717.5	1.970183	150	0.2911
722.5	2.203477	180	0.3493
735.0	2.382043	210	0.4076
750.0	2.512990	240	0.4658
810.0	2.830271	270	0.5240
900.0	3.125630	300	0.5822
1440.0	4.173660	330	0.6405
		360	0.6987
		390	0.7569
		420	0.8151
		450	0.8734
		480	0.9316
		510	0.9898
		540	1.0480
		570	1.1465
		600	1.2449
		630	1.3434
		660	1.5020
		690	1.6607
		720	2.0868
		750	2.5130
		780	2.6716
		810	2.8303
		840	2.9287
		870	3.0272
		900	3.1256
		930	3.1839
		960	3.2421
		990	3.3003
		1020	3.3585
		1050	3.4167
		1080	3.4750
		1110	3.5332
		1140	3.5914
		1170	3.6496
		1200	3.7079
		1230	3.7661
		1260	3.8243
		1290	3.8825
		1320	3.9408
		1350	3.9990
		1380	4.0572
		1410	4.1154
		1440	4.1737

LAG

Tc(T)=Tc(100)*KT

Return Period	KT Value
2	1.32
5	1.20
10	1.14
25	1.07
50	1.03
100	1.00

LAG EQUATION: Lag (hours)=24n[(L*Lca)/s^0.5]^m

Basin	Manning's n	L, miles	Lca, miles	elev1	elev2	H, feet	s, ft per mile	m, constant	100yr Lag, hours	10yr Lag, hours	5yr Lag, hours
CA-01	0.045	6.958	3.430	6000.0	3640.0	2360.0	339.2	0.38	1.192	1.359	1.430
CA-02	0.045	8.628	4.399	5400.0	2865.0	2535.0	293.8	0.38	1.461	1.665	1.753
CA-03	0.045	9.710	5.047	7360.0	2865.0	4495.0	462.9	0.38	1.477	1.683	1.772
CA-04	0.045	9.597	5.490	6400.0	2645.0	3755.0	391.3	0.38	1.567	1.787	1.881
CA-05	0.045	8.071	4.843	4520.0	2645.0	1875.0	232.3	0.38	1.545	1.761	1.854
CA-06	0.045	16.184	7.323	5000.0	1288.0	3712.0	229.4	0.38	2.360	2.691	2.832
CA-07	0.045	12.798	6.656	3360.0	815.0	2545.0	198.9	0.38	2.139	2.439	2.567
CA-08	0.045	4.697	2.178	1060.0	615.0	445.0	94.7	0.38	1.101	1.255	1.321
TH-01	0.045	9.341	4.384	6800.0	3816.0	2984.0	319.5	0.38	1.480	1.687	1.776
TH-02	0.045	8.325	4.664	7200.0	3660.0	3540.0	425.2	0.38	1.374	1.566	1.648
TH-03	0.045	10.103	3.666	7000.0	3660.0	3340.0	330.6	0.38	1.415	1.613	1.698
TH-04	0.045	8.985	4.754	5400.0	2495.0	2905.0	323.3	0.38	1.500	1.710	1.800
TH-05	0.045	11.330	3.950	5140.0	2495.0	2645.0	233.4	0.38	1.625	1.852	1.950
TH-06	0.045	9.473	5.866	5800.0	1288.0	4512.0	476.3	0.38	1.540	1.756	1.849
WB-01	0.050	12.581	5.047	8060.0	3425.0	4635.0	368.4	0.38	1.891	2.155	2.269
WB-02	0.050	8.998	4.986	8040.0	3425.0	4615.0	512.9	0.38	1.556	1.774	1.867
WB-03	0.050	7.895	2.869	5920.0	3160.0	2760.0	349.6	0.38	1.291	1.471	1.549
WB-04	0.050	16.868	8.389	5720.0	815.0	4905.0	290.8	0.38	2.682	3.057	3.218

KINEMATIC WAVE

From Junction	Reach Name	To Junction	Length	Elev 1	Elev 2	Ave Slope	Manning's	Shape	Width	Sideslopes (xV:1H)
CA05	LCCW	CA06	22432	815	615	0.008916	0.040	Rectangle	600	-
CA04	LCCE	CA05	49291	1288	815	0.009596	0.040	Trapeziod	175	0.5
CA03	MCC	CA04	67111	2645	1288	0.02022	0.040	Trapeziod	115	0.5
CA02	UCC	CA03	16398	2865	2645	0.013416	0.040	Rectangle	525	-
CA01	LIC	CA03	44672	3640	2645	0.022273	0.040	Trapeziod	170	0.5
TH03	LTC	CA04	36137	2495	815	0.04649	0.040	Trapeziod	250	0.5
TH02	MTC	TH03	44865	3660	2495	0.025967	0.040	Trapeziod	220	0.5
TH01	UTCW	TH02	6820	3816	3660	0.022874	0.040	Trapeziod	115	0.5
WB02	LWBC	CA05	74910	3160	815	0.031304	0.040	Trapeziod	175	0.5
WB01	MWBC	WB02	21147	3425	3160	0.012531	0.040	Rectangle	200	-

Subarea	Total Area	Developed Area	% Imp.	Remainder Area	Background % Imp.	Imp. Area	Ave. % Imp.
TH-01	17733	2085	25	15647	1	678	4
TH-02	4866	798	25	4067	1	240	5
TH-03	10551	1023	25	9528	1	351	3

Cn Summary

Subarea	Cn, AMC-I
CA-01	57.81
CA-02	53.82
CA-03	54.62
CA-04	55.46
CA-05	56.04
CA-06	53.09
CA-07 & 08	40.60
TH-01	46.57
TH-02	49.60
TH-03	48.82
TH-04	46.52
TH-05	48.15
TH-06	45.20
WB-01	55.64
WB-02	56.56
WB-03	51.29
WB-04	49.56

Soil Group	Cn, AMC-I	Cn, AMC-II
Type_A_Soils	22	39
Type_B_Soils	41	61
Type_C_Soils	56	74
Type_D_Soils	63	80

Subarea CA-01

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
32308	Type_D_Soils	63	2035380	
99529	Type_D_Soils	63	6270335	
119465	Type_C_Soils	56	6690017	
319549	Type_D_Soils	63	20131573	
411245	Type_D_Soils	63	25908457	
547787	Type_D_Soils	63	34510570	
840668	Type_D_Soils	63	52962056	
1194106	Type_B_Soils	41	48958363	
1519385	Type_D_Soils	63	95721265	
1639172	Type_C_Soils	56	91793643	
2179969	Type_D_Soils	63	137338036	
2926704	Type_D_Soils	63	184382382	
3492535	Type_D_Soils	63	220029699	
5654120	Type_B_Soils	41	231818929	
9728878	Type_D_Soils	63	612919312	
14654643	Type_D_Soils	63	923242507	
48952836	Type_D_Soils	63	3084028690	
78480788	Type_D_Soils	63	4944289659	
405663204	Type_C_Soils	56	22717139452	
578456892			33440170325	**57.81**
578666854	DRAINAREA			

Soil Group	Cn, AMC-I
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea CA-02

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
35199	Type_D_Soils	63	2217508	
49433	Type_D_Soils	63	3114302	
87518	Type_D_Soils	63	5513638	
112998	Type_D_Soils	63	7118857	
198753	Type_D_Soils	63	12521453	
212186	Type_D_Soils	63	13367728	
252255	Type_D_Soils	63	15892085	
341292	Type_D_Soils	63	21501375	
1069519	Type_D_Soils	63	67379687	
2327190	Type_B_Soils	41	95414799	
2524157	Type_D_Soils	63	159021907	
2673776	Type_D_Soils	63	168447864	
3017092	Type_D_Soils	63	190076816	
3765662	Type_D_Soils	63	237236702	
5091994	Type_D_Soils	63	320795639	
5816436	Type_D_Soils	63	366435473	
7077554	Type_D_Soils	63	445885891	
7463402	Type_D_Soils	63	470194342	
7764775	Type_B_Soils	41	318355776	
7951302	Type_B_Soils	41	326003366	
10313945	Type_D_Soils	63	649778522	
10598081	Type_D_Soils	63	667679109	
13506193	Type_D_Soils	63	850890143	
17066093	Type_D_Soils	63	1075163867	
17975551	Type_C_Soils	56	1006630880	
18486485	Type_D_Soils	63	1164648578	
19289146	Type_D_Soils	63	1215216220	
32928160	Type_D_Soils	63	2074474051	
33547937	Type_D_Soils	63	2113520043	
33672168	Type_D_Soils	63	2121346589	
36847772	Type_D_Soils	63	2321409619	
43027056	Type_B_Soils	41	1764109310	
54005882	Type_D_Soils	63	3402370535	
171118195	Type_B_Soils	41	7015846003	
570215158			30689578675	**53.82**
570942475	DRAINAREA			

Soil Group	, AMC-I
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea CA-03

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
44983	Type_B_Soils	41	1844284	
92356	Type_B_Soils	41	3786601	
127375	Type_D_Soils	63	8024650	
314864	Type_D_Soils	63	19836451	
457047	Type_C_Soils	56	25594635	
944640	Type_B_Soils	41	38730259	
1289019	Type_B_Soils	41	52849767	
1547767	Type_B_Soils	41	63458446	
1928471	Type_D_Soils	63	121493689	
2275650	Type_B_Soils	41	93301669	
2645319	Type_D_Soils	63	166655078	
2779241	Type_B_Soils	41	113948874	
4003207	Type_D_Soils	63	252202012	
4741152	Type_D_Soils	63	298692584	
5865481	Type_C_Soils	56	328466935	
6092549	Type_B_Soils	41	249794525	
6382731	Type_D_Soils	63	402112067	
7230649	Type_B_Soils	41	296456595	
8510207	Type_B_Soils	41	348918474	
8592575	Type_B_Soils	41	352295585	
8967407	Type_B_Soils	41	367663696	
8991922	Type_B_Soils	41	368668794	
12017691	Type_B_Soils	41	492725311	
12042955	Type_B_Soils	41	493761153	
12057682	Type_B_Soils	41	494364980	
12467294	Type_B_Soils	41	511159040	
12649740	Type_D_Soils	63	796933625	
18924060	Type_B_Soils	41	775886460	
19393494	Type_D_Soils	63	1221790140	
41041594	Type_D_Soils	63	2585620411	
53277795	Type_D_Soils	63	3356501096	
144036509	Type_B_Soils	41	5905496885	
289715615	Type_D_Soils	63	18252083742	
711449042			38861118513	**54.62**
712180876	DRAINAREA			

Soil Group	Cn, AMC-I
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea CA-04

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
78325	Type_D_Soils	63	4934499	
88362	Type_D_Soils	63	5566797	
293648	Type_D_Soils	63	18499802	
336306	Type_C_Soils	56	18833162	
395119	Type_D_Soils	63	24892481	
634043	Type_D_Soils	63	39944688	
1120173	Type_D_Soils	63	70570881	
1402129	Type_B_Soils	41	57487270	
1518449	Type_B_Soils	41	62256394	
1562747	Type_B_Soils	41	64072622	
1626670	Type_B_Soils	41	66693484	
1934530	Type_D_Soils	63	121875421	
2064748	Type_C_Soils	56	115625915	
2389280	Type_B_Soils	41	97960496	
2494734	Type_B_Soils	41	102284109	
2931492	Type_B_Soils	41	120191189	
3042177	Type_B_Soils	41	124729273	
3447231	Type_B_Soils	41	141336465	
3863724	Type_D_Soils	63	243414602	
3863724	Type_B_Soils	41	158412678	
4109406	Type_D_Soils	63	258892606	
4501877	Type_B_Soils	41	184576977	
4661631	Type_D_Soils	63	293682782	
4987430	Type_B_Soils	41	204484611	
5222520	Type_B_Soils	41	214123310	
5303369	Type_D_Soils	63	334112272	
5365887	Type_B_Soils	41	220001354	
5474266	Type_D_Soils	63	344878742	
6191581	Type_C_Soils	56	346728554	
6634380	Type_D_Soils	63	417965964	
7059635	Type_B_Soils	41	289445050	
7091192	Type_D_Soils	63	446745109	
7337720	Type_B_Soils	41	300846502	
7450145	Type_C_Soils	56	417208094	
8371533	Type_B_Soils	41	343232854	
8747902	Type_D_Soils	63	551117824	
8815925	Type_B_Soils	41	361452920	
8983802	Type_B_Soils	41	368335882	
9200277	Type_D_Soils	63	579617453	
9202234	Type_B_Soils	41	377291585	
9581777	Type_B_Soils	41	392852844	
9994900	Type_D_Soils	63	629678729	
9998900	Type_D_Soils	63	629930710	
10354023	Type_D_Soils	63	652303460	
11215199	Type_D_Soils	63	706557509	
11658580	Type_C_Soils	56	652880453	
11679375	Type_B_Soils	41	478854381	
13383340	Type_B_Soils	41	548716951	
16459169	Type_D_Soils	63	1036927647	
17436651	Type_D_Soils	63	1098509028	
18312574	Type_D_Soils	63	1153692138	
20589156	Type_B_Soils	41	844155398	
20696324	Type_C_Soils	56	1158994120	
21393664	Type_D_Soils	63	1347800807	
22138552	Type_B_Soils	41	907680635	
24015706	Type_B_Soils	41	984643931	
24441414	Type_D_Soils	63	1539809101	
27740859	Type_B_Soils	41	1137375220	
28546725	Type_C_Soils	56	1598616611	
30753264	Type_B_Soils	41	1260883843	
41828254	Type_D_Soils	63	2635179985	
42320764	Type_D_Soils	63	2666208155	
44273076	Type_D_Soils	63	2789203803	
44674875	Type_D_Soils	63	2814517127	
58734163	Type_B_Soils	41	2408100664	
64663766	Type_C_Soils	56	3621170914	
217614366	Type_D_Soils	63	13709705062	
1044299741			57919271900	**55.46**

Soil Group	Cn, AMC-I
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

1041326626 DRAINAREA

Subarea CA-05

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
49906	Type_B_Soils	41	2046152	
53319	Type_D_Soils	63	3359073	
83595	Type_D_Soils	63	5266514	
91471	Type_D_Soils	63	5762683	
145582	Type_B_Soils	41	5968871	
157328	Type_D_Soils	63	9911643	
180056	Type_B_Soils	41	7382306	
181905	Type_D_Soils	63	11459990	
1098101	Type_B_Soils	41	45022149	
1144604	Type_D_Soils	63	72110028	
1214734	Type_D_Soils	63	76528235	
1232390	Type_B_Soils	41	50527982	
1699793	Type_B_Soils	41	69691498	
1750343	Type_D_Soils	63	110271586	
1826429	Type_B_Soils	41	74883580	
1873755	Type_D_Soils	63	118046546	
3903723	Type_D_Soils	63	245934559	
4019427	Type_D_Soils	63	253223926	
10601578	Type_B_Soils	41	434664681	
10971515	Type_B_Soils	41	449832125	
11970337	Type_C_Soils	56	670338848	
13286955	Type_D_Soils	63	837078179	
14131167	Type_D_Soils	63	890263533	
14403008	Type_B_Soils	41	590523319	
19829689	Type_B_Soils	41	813017242	
20137070	Type_B_Soils	41	825619861	
27225191	Type_B_Soils	41	1116232814	
32919345	Type_B_Soils	41	1349693130	
37699246	Type_D_Soils	63	2375052496	
42034549	Type_D_Soils	63	2648176587	
53284589	Type_C_Soils	56	2983936975	
65508270	Type_C_Soils	56	3668463112	
82504231	Type_D_Soils	63	5197766568	
104397899	Type_D_Soils	63	6577067640	
581611097			32595124430	**56.04**
581700004	DRAINAREA			

Soil Group	Cn, AMC-I
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea CA-06

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
78947	Type_B_Soils	41	3236807	
119284	Type_D_Soils	63	7514912	
159298	Type_B_Soils	41	6531202	
338579	Type_B_Soils	41	13881747	
556676	Type_D_Soils	63	35070560	
720490	Type_B_Soils	41	29540107	
766301	Type_B_Soils	41	31418336	
1137355	Type_B_Soils	41	46631539	
1443576	Type_B_Soils	41	59186600	
1474460	Type_B_Soils	41	60452866	
1609785	Type_B_Soils	41	66001181	
1961002	Type_C_Soils	56	109816095	
2088954	Type_B_Soils	41	85647122	
2631366	Type_B_Soils	41	107886025	
2770225	Type_D_Soils	63	174524190	
2882043	Type_C_Soils	56	161394416	
2957107	Type_D_Soils	63	186297760	
3044378	Type_D_Soils	63	191795801	
3071478	Type_D_Soils	63	193503135	
3485259	Type_B_Soils	41	142895616	
3559360	Type_C_Soils	56	199324176	
3590449	Type_B_Soils	41	147208399	
3933169	Type_B_Soils	41	161259945	
4052518	Type_C_Soils	56	226941018	
4072605	Type_B_Soils	41	166976819	
4072605	Type_D_Soils	63	256574136	
4142590	Type_B_Soils	41	169846191	
4227625	Type_C_Soils	56	236746979	
4366327	Type_C_Soils	56	244514303	
4486425	Type_D_Soils	63	282644804	
4624977	Type_C_Soils	56	258998714	
4809295	Type_B_Soils	41	197181088	
4886411	Type_B_Soils	41	200342845	
5018093	Type_B_Soils	41	205741799	
6004937	Type_B_Soils	41	246202437	
6026184	Type_D_Soils	63	379649617	
6534532	Type_B_Soils	41	267915823	
6641937	Type_D_Soils	63	418442061	
6730117	Type_D_Soils	63	423997398	
6735159	Type_D_Soils	63	424315041	
6763052	Type_B_Soils	41	277285113	
6829439	Type_C_Soils	56	382448612	
7080914	Type_B_Soils	41	290317470	
7195786	Type_C_Soils	56	402964043	
7629518	Type_B_Soils	41	312810237	
8649458	Type_B_Soils	41	354627775	
8886872	Type_D_Soils	63	559872939	
9415577	Type_B_Soils	41	386038654	
9502241	Type_C_Soils	56	532125511	
9824683	Type_B_Soils	41	402812011	
11005702	Type_D_Soils	63	693359216	
11814873	Type_C_Soils	56	661632897	
12619794	Type_C_Soils	56	706708468	
12834642	Type_B_Soils	41	526220331	
13577174	Type_D_Soils	63	855361950	
14369053	Type_B_Soils	41	589131181	
14598808	Type_B_Soils	41	598551119	
14808371	Type_B_Soils	41	607143211	
14849606	Type_B_Soils	41	608833830	
15671672	Type_C_Soils	56	877613634	
16699251	Type_D_Soils	63	1052052837	
17781765	Type_C_Soils	56	995778854	
19928105	Type_B_Soils	41	817052290	
20311260	Type_D_Soils	63	1279609350	
22608812	Type_B_Soils	41	926961310	
22688305	Type_B_Soils	41	930220492	
22702390	Type_C_Soils	56	1271333856	
27765591	Type_B_Soils	41	1138389242	
36541268	Type_B_Soils	41	1498191985	
36904843	Type_C_Soils	56	2066671209	
37215261	Type_D_Soils	63	2344561424	
37950825	Type_B_Soils	41	1555983815	
38168061	Type_D_Soils	63	2404587867	
45697484	Type_C_Soils	56	2559059130	
50180722	Type_D_Soils	63	3161385505	
50659049	Type_C_Soils	56	2836906735	
50777873	Type_B_Soils	41	2081892808	
54417060	Type_D_Soils	63	3428274803	
66070220	Type_D_Soils	63	4162423858	
66157306	Type_D_Soils	63	4167910266	
101478676	Type_C_Soils	56	5682805871	
114217308	Type_B_Soils	41	4682909645	
120745286	Type_C_Soils	56	6761736019	
133499099	Type_B_Soils	41	5473463049	
214897758	Type_D_Soils	63	13538558769	
1775802696			94272628800	**53.09**

Soil Group	Cn, AMC-I
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

1741527005 DRAINAREA

Subarea CA-07

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
49199	Type_C_Soils	56	2755160	
83074	Type_C_Soils	56	4652142	
91655	Type_D_Soils	63	5774240	
104242	Type_D_Soils	63	6567242	
107079	Type_B_Soils	41	4390228	
113227	Type_B_Soils	41	4642291	
170062	Type_B_Soils	41	6972555	
182499	Type_D_Soils	63	11497425	
183490	Type_B_Soils	41	7523071	
207705	Type_A_Soils	22	4569502	
215284	Type_B_Soils	41	8826657	
233707	Type_B_Soils	41	9581998	
238619	Type_B_Soils	41	9783392	
257441	Type_B_Soils	41	10555091	
296908	Type_A_Soils	22	6531977	
468898	Type_D_Soils	63	29540546	
524278	Type_B_Soils	41	21495391	
576247	Type_D_Soils	63	36303581	
620656	Type_B_Soils	41	25446903	
849118	Type_B_Soils	41	34813850	
864988	Type_A_Soils	22	19029738	
907854	Type_B_Soils	41	37222006	
978449	Type_D_Soils	63	61642299	
1041859	Type_A_Soils	22	22920905	
1045493	Type_C_Soils	56	58547592	
1049219	Type_B_Soils	41	43017993	
1070315	Type_B_Soils	41	43882920	
1104419	Type_D_Soils	63	69578405	
1113783	Type_B_Soils	41	45665118	
1418837	Type_B_Soils	41	58172298	
1421280	Type_B_Soils	41	58272498	
1579630	Type_A_Soils	22	34751861	
1581502	Type_B_Soils	41	64841575	
1608513	Type_B_Soils	41	65949039	
1737373	Type_B_Soils	41	71232279	
1895007	Type_A_Soils	22	41690152	
1957189	Type_B_Soils	41	80244751	
2074062	Type_B_Soils	41	85036544	
2128809	Type_B_Soils	41	87281167	
2349432	Type_B_Soils	41	96326725	
2485133	Type_B_Soils	41	101890470	
2570173	Type_B_Soils	41	105377085	
2611027	Type_B_Soils	41	107052109	
3028157	Type_C_Soils	56	169576805	
3033018	Type_B_Soils	41	124353722	
3038183	Type_B_Soils	41	124565505	
3395724	Type_B_Soils	41	139224703	
3531283	Type_C_Soils	56	197751869	
3574990	Type_C_Soils	56	200199434	
3713292	Type_B_Soils	41	152244972	
3729772	Type_B_Soils	41	152920666	
3892280	Type_B_Soils	41	159583462	
3949375	Type_B_Soils	41	161924385	
4035802	Type_B_Soils	41	165467897	
4300713	Type_B_Soils	41	176329216	
4328962	Type_B_Soils	41	177487442	
4507055	Type_D_Soils	63	283944472	
4775147	Type_C_Soils	56	267408228	
5056715	Type_B_Soils	41	207325330	
5661226	Type_B_Soils	41	232110252	
5847962	Type_B_Soils	41	239766426	
5966168	Type_D_Soils	63	375868597	
6536901	Type_B_Soils	41	268012943	
6571402	Type_A_Soils	22	144570840	
6753027	Type_B_Soils	41	276874097	
7100975	Type_B_Soils	41	291139965	
7507041	Type_B_Soils	41	307788663	
7958938	Type_B_Soils	41	326316443	
7979839	Type_A_Soils	22	175556447	
8200752	Type_B_Soils	41	336230814	
8663731	Type_B_Soils	41	355212988	
8667820	Type_B_Soils	41	355380605	
10382476	Type_A_Soils	22	228414476	
10501325	Type_B_Soils	41	430554341	
11497418	Type_B_Soils	41	471394135	
11648767	Type_A_Soils	22	256272875	
12004715	Type_B_Soils	41	492193326	
12059411	Type_D_Soils	63	759742898	
12642411	Type_A_Soils	22	278133050	
12687112	Type_C_Soils	56	710478281	
14489762	Type_B_Soils	41	594080238	
15980048	Type_C_Soils	56	894882705	
17124504	Type_D_Soils	63	1078843744	
18592770	Type_B_Soils	41	762303566	
18904767	Type_B_Soils	41	775095433	
20324360	Type_A_Soils	22	447135910	
25423845	Type_B_Soils	41	1042377659	
26938901	Type_B_Soils	41	1104494930	
27188889	Type_A_Soils	22	598155554	
32986036	Type_D_Soils	63	2078120272	
35749346	Type_B_Soils	41	1465723173	
37201792	Type_B_Soils	41	1525273485	
37701241	Type_B_Soils	41	1545750871	
43620529	Type_D_Soils	63	2748093299	
47316836	Type_B_Soils	41	1939990273	
52693707	Type_B_Soils	41	2160441991	
60648104	Type_B_Soils	41	2486572280	
66816949	Type_B_Soils	41	2739494926	
99136000	Type_B_Soils	41	4064576014	
99955723	Type_C_Soils	56	5597520482	
1089691728			44238901848	**40.60**

1090797414 DRAINAREA

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea TH-01

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
27429	Type_C_Soils	56	1536020	
104399	Type_B_Soils	41	4280357	
108477	Type_C_Soils	56	6074691	
215033	Type_C_Soils	56	12041836	
234090	Type_B_Soils	41	9597707	
283840	Type_B_Soils	41	11637447	
329316	Type_C_Soils	56	18441720	
352156	Type_C_Soils	56	19720717	
357504	Type_D_Soils	63	22522783	
368270	Type_B_Soils	41	15099051	
370078	Type_D_Soils	63	23314943	
403101	Type_C_Soils	56	22573649	
438748	Type_B_Soils	41	17988649	
443534	Type_B_Soils	41	18184901	
456036	Type_B_Soils	41	18697464	
468464	Type_C_Soils	56	26233986	
484718	Type_B_Soils	41	19873444	
544139	Type_B_Soils	41	22309714	
633695	Type_B_Soils	41	25981483	
702421	Type_B_Soils	41	28799262	
711213	Type_C_Soils	56	39827950	
722186	Type_C_Soils	56	40442435	
727172	Type_C_Soils	56	40721617	
777267	Type_C_Soils	56	43526936	
796822	Type_C_Soils	56	44622013	
855230	Type_D_Soils	63	53879460	
886223	Type_B_Soils	41	36335160	
897493	Type_C_Soils	56	50259599	
1079603	Type_B_Soils	41	44263708	
1117180	Type_B_Soils	41	45804360	
1212603	Type_C_Soils	56	67905770	
1224758	Type_C_Soils	56	68586439	
1250554	Type_B_Soils	41	51272711	
1316023	Type_A_Soils	22	28952499	
1440357	Type_B_Soils	41	59054644	
1467204	Type_C_Soils	56	82163441	
1534864	Type_B_Soils	41	62929439	
1859446	Type_C_Soils	56	104128982	
1917571	Type_B_Soils	41	78620415	
1931981	Type_B_Soils	41	79211229	
2106350	Type_C_Soils	56	117955620	
2163894	Type_A_Soils	22	47605667	
2332175	Type_B_Soils	41	95619164	
2360699	Type_B_Soils	41	96788647	
2446091	Type_B_Soils	41	100289736	
2463451	Type_B_Soils	41	101001506	
2507212	Type_A_Soils	22	55158670	
2643870	Type_C_Soils	56	148056722	
2671529	Type_C_Soils	56	149605646	
2692702	Type_B_Soils	41	110400791	
2699369	Type_C_Soils	56	151164648	
2809702	Type_B_Soils	41	115197796	
2841823	Type_D_Soils	63	179034865	
2867580	Type_B_Soils	41	117570771	
3049318	Type_A_Soils	22	67085004	
3167078	Type_B_Soils	41	129850206	
3214212	Type_D_Soils	63	202495382	
3301624	Type_B_Soils	41	135366567	
3331867	Type_B_Soils	41	136606552	
3458672	Type_B_Soils	41	141805532	
3794753	Type_B_Soils	41	155584891	
3858305	Type_C_Soils	56	216065061	
3876593	Type_B_Soils	41	158940308	
3941825	Type_B_Soils	41	161614830	
4016883	Type_B_Soils	41	164692191	
4026127	Type_B_Soils	41	165071219	
4166153	Type_C_Soils	56	233304565	
4533275	Type_A_Soils	22	99732049	
4812505	Type_C_Soils	56	269500297	
4831654	Type_B_Soils	41	198097794	
5511156	Type_B_Soils	41	225957415	
5685487	Type_B_Soils	41	233104970	
5716058	Type_B_Soils	41	234358377	
5819082	Type_B_Soils	41	238582380	
5908100	Type_B_Soils	41	242232105	
6029663	Type_B_Soils	41	247216185	
6149875	Type_B_Soils	41	252144885	
6257308	Type_A_Soils	22	137660765	
6324986	Type_B_Soils	41	259324426	
6550866	Type_B_Soils	41	268585524	
6580750	Type_B_Soils	41	269810752	
6760902	Type_B_Soils	41	277196983	
7430030	Type_B_Soils	41	304631228	
7508759	Type_B_Soils	41	307859119	
7590821	Type_B_Soils	41	311223679	
7745905	Type_C_Soils	56	433770676	
8393160	Type_C_Soils	56	470016938	
9041233	Type_C_Soils	56	506309032	
9298244	Type_B_Soils	41	381227989	
9370717	Type_D_Soils	63	590355195	
9806602	Type_B_Soils	41	402070672	
9826727	Type_B_Soils	41	402895795	
10017498	Type_B_Soils	41	410717420	
10086448	Type_B_Soils	41	413544380	
11388496	Type_C_Soils	56	637755799	
13208864	Type_C_Soils	56	739696407	
13927206	Type_B_Soils	41	571015427	
14554439	Type_C_Soils	56	815048586	
14810615	Type_D_Soils	63	933068730	
16134557	Type_C_Soils	56	903535206	
17211448	Type_B_Soils	41	705669376	
17814156	Type_C_Soils	56	997592738	
18015979	Type_B_Soils	41	738655144	
19592718	Type_B_Soils	41	803301438	
21315663	Type_B_Soils	41	873942203	
21364695	Type_C_Soils	56	1196422902	
23503749	Type_C_Soils	56	1316209928	
28522327	Type_B_Soils	41	1169415390	
29986912	Type_B_Soils	41	1229463412	
30437931	Type_D_Soils	63	1917589648	
35640819	Type_B_Soils	41	1461273588	
42421464	Type_C_Soils	56	2375601993	
75201802	Type_B_Soils	41	3083273878	
772502708			35978010008	**46.57**

772145187 DRAINAREA

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea TH-02

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
18684	Type_B_Soils	41	766049	
59543	Type_B_Soils	41	2441265	
146307	Type_C_Soils	56	8193186	
169287	Type_B_Soils	41	6940787	
179510	Type_B_Soils	41	7359891	
179510	Type_C_Soils	56	10052534	
218153	Type_D_Soils	63	13743631	
266096	Type_C_Soils	56	14901349	
323271	Type_B_Soils	41	13254092	
378150	Type_B_Soils	41	15504164	
393938	Type_B_Soils	41	16151442	
543029	Type_B_Soils	41	22264189	
608111	Type_B_Soils	41	24932532	
1041074	Type_B_Soils	41	42684014	
1237157	Type_C_Soils	56	69280769	
1302862	Type_B_Soils	41	53417336	
1342193	Type_B_Soils	41	55029911	
1416660	Type_B_Soils	41	58083064	
1714061	Type_B_Soils	41	70276494	
1994805	Type_A_Soils	22	43885718	
2135329	Type_C_Soils	56	119578445	
2193409	Type_B_Soils	41	89929762	
2242233	Type_C_Soils	56	125565040	
2578361	Type_D_Soils	63	162436732	
2698035	Type_B_Soils	41	110619424	
2770696	Type_A_Soils	22	60955315	
2803214	Type_B_Soils	41	114931767	
2952835	Type_C_Soils	56	165358739	
3384071	Type_B_Soils	41	138746893	
3539813	Type_C_Soils	56	198229504	
4531115	Type_B_Soils	41	185775705	
5020331	Type_C_Soils	56	281138528	
5705109	Type_C_Soils	56	319486118	
6383122	Type_B_Soils	41	261708013	
8830185	Type_C_Soils	56	494490364	
9622070	Type_B_Soils	41	394504889	
9654280	Type_D_Soils	63	608219617	
9682414	Type_B_Soils	41	396978954	
14698777	Type_B_Soils	41	602649840	
15338096	Type_C_Soils	56	858933390	
15444277	Type_B_Soils	41	633215348	
17611945	Type_B_Soils	41	722089733	
21658644	Type_C_Soils	56	1212884082	
27576468	Type_D_Soils	63	1737317454	
212587225			10544906075	**49.60**
212230450	DRAINAREA			

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea TH-03

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
12283	Type_D_Soils	63	773809	
12291	Type_C_Soils	56	688308	
12291	Type_D_Soils	63	774347	
21645	Type_D_Soils	63	1363637	
21645	Type_C_Soils	56	1212122	
25311	Type_D_Soils	63	1594617	
29169	Type_D_Soils	63	1837674	
29625	Type_B_Soils	41	1214614	
29625	Type_D_Soils	63	1866358	
54863	Type_B_Soils	41	2249372	
97472	Type_B_Soils	41	3996363	
159654	Type_D_Soils	63	10058174	
200730	Type_C_Soils	56	11240871	
276661	Type_B_Soils	41	11343106	
360975	Type_B_Soils	41	14799989	
403066	Type_D_Soils	63	25393160	
427900	Type_B_Soils	41	17543907	
436899	Type_B_Soils	41	17912850	
445246	Type_D_Soils	63	28050478	
469577	Type_C_Soils	56	26296294	
519904	Type_C_Soils	56	29114620	
563915	Type_C_Soils	56	31579265	
566463	Type_C_Soils	56	31721945	
592044	Type_B_Soils	41	24273807	
676744	Type_B_Soils	41	27746487	
737046	Type_C_Soils	56	41274563	
774810	Type_D_Soils	63	48813061	
819149	Type_B_Soils	41	33585125	
913009	Type_C_Soils	56	51128491	
913841	Type_B_Soils	41	37467467	
1158615	Type_B_Soils	41	47503221	
1198339	Type_B_Soils	41	49131880	
1333728	Type_B_Soils	41	54682843	
1354047	Type_B_Soils	41	55515917	
1489339	Type_A_Soils	22	32765464	
1614459	Type_C_Soils	56	90409691	
1649710	Type_B_Soils	41	67638100	
1747796	Type_B_Soils	41	71659621	
1846321	Type_B_Soils	41	75699149	
2006846	Type_C_Soils	56	112383387	
2171449	Type_B_Soils	41	89029417	
2477726	Type_B_Soils	41	101586746	
2487432	Type_C_Soils	56	139296182	
2576303	Type_B_Soils	41	105628403	
2664437	Type_B_Soils	41	109241915	
2945770	Type_B_Soils	41	120776575	
2951879	Type_C_Soils	56	165305223	
2972935	Type_B_Soils	41	121890348	
3063300	Type_C_Soils	56	171544817	
3223229	Type_B_Soils	41	132152375	
3562200	Type_A_Soils	22	78368400	
4399717	Type_C_Soils	56	246384136	
4691858	Type_B_Soils	41	192366185	
4924228	Type_C_Soils	56	275756747	
4964847	Type_B_Soils	41	203558732	
5653292	Type_B_Soils	41	231784989	
5825825	Type_B_Soils	41	238858842	
6404580	Type_B_Soils	41	262587763	
6547803	Type_C_Soils	56	366676957	
6825054	Type_B_Soils	41	279827211	
6933417	Type_C_Soils	56	388271367	
7251471	Type_C_Soils	56	406082385	
7360383	Type_B_Soils	41	301775719	
9265425	Type_B_Soils	41	379882440	
9637027	Type_D_Soils	63	607132720	
10235855	Type_B_Soils	41	419670052	
10287872	Type_B_Soils	41	421802746	
11731521	Type_B_Soils	41	480992367	
13547549	Type_B_Soils	41	555449492	
13489954	Type_B_Soils	41	553088106	
13379984	Type_B_Soils	41	548579353	
16634628	Type_C_Soils	56	931539142	
18042506	Type_D_Soils	63	1136677857	
19612678	Type_B_Soils	41	804119798	
30705216	Type_D_Soils	63	1934428602	
45909571	Type_C_Soils	56	2570935956	
48649509	Type_C_Soils	56	2724372531	
59498931	Type_B_Soils	41	2439456165	
459510412			22431182919	**48.82**

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

459599145.5309 DRAINAREA

Subarea TH-04

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
70074	Type_B_Soils	41	2873030	
158469	Type_B_Soils	41	6497237	
167881	Type_B_Soils	41	6883123	
187095	Type_B_Soils	41	7670876	
211563	Type_B_Soils	41	8674079	
250375	Type_D_Soils	63	15773632	
267116	Type_B_Soils	41	10951737	
381787	Type_C_Soils	56	21380064	
492999	Type_B_Soils	41	20212961	
599923	Type_B_Soils	41	24596836	
780559	Type_C_Soils	56	43711297	
787105	Type_C_Soils	56	44077886	
1006606	Type_B_Soils	41	41270832	
1040781	Type_B_Soils	41	42672022	
1177669	Type_D_Soils	63	74193167	
1579958	Type_B_Soils	41	64778280	
1747929	Type_D_Soils	63	110119509	
1894679	Type_C_Soils	56	106102005	
2017841	Type_B_Soils	41	82731501	
2150484	Type_C_Soils	56	120427126	
2344508	Type_D_Soils	63	147703974	
2391254	Type_D_Soils	63	150648990	
2503520	Type_A_Soils	22	55077441	
2875388	Type_D_Soils	63	181149448	
3118541	Type_B_Soils	41	127860164	
3208095	Type_D_Soils	63	202110015	
3589843	Type_D_Soils	63	226160096	
3647974	Type_D_Soils	63	229822368	
3739403	Type_B_Soils	41	153315540	
4063802	Type_B_Soils	41	166615882	
4087051	Type_C_Soils	56	228874836	
4103880	Type_B_Soils	41	168259081	
4601203	Type_B_Soils	41	188649304	
4673200	Type_B_Soils	41	191601201	
4868873	Type_B_Soils	41	199623784	
5002550	Type_B_Soils	41	205104547	
5187516	Type_B_Soils	41	212688159	
5237508	Type_D_Soils	63	329963026	
5254011	Type_C_Soils	56	294224603	
5656624	Type_B_Soils	41	231921568	
7160867	Type_B_Soils	41	293595530	
8018207	Type_B_Soils	41	328746467	
8909208	Type_B_Soils	41	365277524	
8980441	Type_B_Soils	41	368198087	
9658733	Type_B_Soils	41	396008062	
9994273	Type_C_Soils	56	559679310	
10610727	Type_C_Soils	56	594200732	
10996683	Type_D_Soils	63	692791037	
16239693	Type_B_Soils	41	665827408	
16541560	Type_B_Soils	41	678203963	
16784085	Type_B_Soils	41	688147471	
18750351	Type_D_Soils	63	1181272088	
19317054	Type_B_Soils	41	791999205	
22914944	Type_B_Soils	41	939512702	
30648538	Type_B_Soils	41	1256590043	
47491660	Type_D_Soils	63	2991974569	
54286261	Type_B_Soils	41	2225736684	
88298919	Type_B_Soils	41	3620255665	
502727837			23384987774	**46.52**

503473893 DRAINAREA

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea TH-05

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
3709	Type_C_Soils	56	207705	
6311	Type_C_Soils	56	353433	
10096	Type_C_Soils	56	565352	
12140	Type_D_Soils	63	764849	
20217	Type_B_Soils	41	828889	
21515	Type_D_Soils	63	1355437	
28686	Type_B_Soils	41	1176124	
29842	Type_B_Soils	41	1223524	
94228	Type_C_Soils	56	5276761	
127669	Type_D_Soils	63	8043145	
213166	Type_B_Soils	41	8739821	
308049	Type_D_Soils	63	19407085	
389459	Type_C_Soils	56	21809695	
389459	Type_B_Soils	41	15967813	
635586	Type_C_Soils	56	35592838	
897868	Type_C_Soils	56	50280604	
932553	Type_B_Soils	41	38234657	
1046804	Type_B_Soils	41	42918979	
1074735	Type_C_Soils	56	60185133	
1177407	Type_B_Soils	41	48273702	
1287686	Type_B_Soils	41	52795118	
1336762	Type_D_Soils	63	84216017	
1365972	Type_B_Soils	41	56004871	
1437580	Type_B_Soils	41	58940768	
1585564	Type_D_Soils	63	99890556	
1696736	Type_D_Soils	63	106894359	
1799622	Type_B_Soils	41	73784499	
1809168	Type_B_Soils	41	74175886	
1827435	Type_B_Soils	41	74924847	
2067051	Type_D_Soils	63	130224228	
2459954	Type_C_Soils	56	137757408	
2713697	Type_C_Soils	56	151967041	
2806479	Type_D_Soils	63	176808172	
2865285	Type_D_Soils	63	180512936	
3032988	Type_C_Soils	56	169847311	
3178405	Type_B_Soils	41	130314618	
3217445	Type_B_Soils	41	131915249	
3241594	Type_C_Soils	56	181529237	
3356252	Type_A_Soils	22	73837542	
3540247	Type_B_Soils	41	145150108	
3554231	Type_D_Soils	63	223916544	
3964615	Type_B_Soils	41	162549205	
4163826	Type_B_Soils	41	170716882	
4257489	Type_B_Soils	41	174557037	
4345281	Type_B_Soils	41	178156520	
4410826	Type_B_Soils	41	180843882	
4417419	Type_D_Soils	63	278297404	
4427416	Type_B_Soils	41	181524042	
4556397	Type_C_Soils	56	255158229	
4651405	Type_C_Soils	56	260478690	
4980181	Type_D_Soils	63	313751392	
5194121	Type_C_Soils	56	290870803	
5288042	Type_D_Soils	63	333146648	
5796102	Type_D_Soils	63	365154401	
5890597	Type_D_Soils	63	371107626	
6028410	Type_C_Soils	56	337590982	
6037307	Type_D_Soils	63	380350357	
6080604	Type_B_Soils	41	249304758	
6228435	Type_B_Soils	41	255365830	
6286526	Type_B_Soils	41	257747582	
6700544	Type_D_Soils	63	422134256	
6831423	Type_D_Soils	63	430379635	
7752347	Type_C_Soils	56	434131420	
8071941	Type_B_Soils	41	330949575	
8144188	Type_B_Soils	41	333911715	
8330961	Type_B_Soils	41	341569406	
8900507	Type_B_Soils	41	364920789	
9375318	Type_D_Soils	63	590645034	
11022756	Type_B_Soils	41	451932984	
11118291	Type_C_Soils	56	622624289	
11240160	Type_D_Soils	63	708130076	
13703348	Type_B_Soils	41	561837251	
14259530	Type_B_Soils	41	584640745	
14259686	Type_B_Soils	41	584647119	
14588491	Type_C_Soils	56	816955471	
15049667	Type_B_Soils	41	617036355	
15087583	Type_C_Soils	56	844904642	
16043264	Type_D_Soils	63	1010725617	
16228020	Type_B_Soils	41	665348820	
20361909	Type_B_Soils	41	834838258	
21920179	Type_D_Soils	63	1380971253	
23951527	Type_C_Soils	56	1341285509	
27131984	Type_B_Soils	41	1112411336	
27831257	Type_B_Soils	41	1141081555	
28641606	Type_B_Soils	41	1174305853	
29147666	Type_D_Soils	63	1836302935	
29523300	Type_B_Soils	41	1210455309	
36632115	Type_D_Soils	63	2307823268	
46497464	Type_B_Soils	41	1906396006	
51388966	Type_D_Soils	63	3237504846	
68123596	Type_B_Soils	41	2793067424	
166108810	Type_B_Soils	41	6810461196	
948573052			45677615080	**48.15**

948080938 DRAINAREA

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea TH-06

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
13482	Type_B_Soils	41	552775	
85698	Type_B_Soils	41	3513624	
153456	Type_B_Soils	41	6291697	
264528	Type_B_Soils	41	10845642	
278744	Type_B_Soils	41	11428503	
290802	Type_B_Soils	41	11922893	
304551	Type_B_Soils	41	12486595	
393017	Type_B_Soils	41	16113695	
867330	Type_D_Soils	63	54641764	
869668	Type_D_Soils	63	54789065	
1191244	Type_B_Soils	41	48840999	
1552437	Type_B_Soils	41	63649900	
1686188	Type_B_Soils	41	69133709	
1790983	Type_B_Soils	41	73430304	
1861840	Type_B_Soils	41	76335435	
1949507	Type_B_Soils	41	79929785	
2041256	Type_B_Soils	41	83691510	
2074897	Type_B_Soils	41	85070797	
2077486	Type_A_Soils	22	45704685	
2352796	Type_A_Soils	22	51761508	
2578223	Type_B_Soils	41	105707148	
3049736	Type_B_Soils	41	125039190	
3513986	Type_D_Soils	63	221381119	
3541194	Type_B_Soils	41	145188949	
3784222	Type_B_Soils	41	155153087	
3798495	Type_B_Soils	41	155738278	
3852825	Type_D_Soils	63	242727949	
4251050	Type_B_Soils	41	174293038	
4428177	Type_C_Soils	56	247977912	
5512662	Type_D_Soils	63	347297724	
6444055	Type_B_Soils	41	264206266	
6477379	Type_B_Soils	41	265572535	
6560998	Type_C_Soils	56	367415872	
6988384	Type_B_Soils	41	286523758	
7313483	Type_B_Soils	41	299852795	
7632706	Type_B_Soils	41	312940939	
8022024	Type_D_Soils	63	505387522	
8413819	Type_D_Soils	63	530070627	
8740116	Type_B_Soils	41	358344756	
11342844	Type_D_Soils	63	714599181	
11479800	Type_B_Soils	41	470671817	
11636541	Type_B_Soils	41	477098197	
12191662	Type_B_Soils	41	499858150	
13160828	Type_C_Soils	56	737006374	
13233821	Type_B_Soils	41	542586649	
13584254	Type_D_Soils	63	855808016	
14543220	Type_D_Soils	63	916222884	
16101130	Type_B_Soils	41	660146324	
16341717	Type_B_Soils	41	670010397	
16556886	Type_B_Soils	41	678832336	
19140718	Type_B_Soils	41	784769434	
19890008	Type_B_Soils	41	815490327	
20230998	Type_B_Soils	41	829470937	
21589150	Type_C_Soils	56	1208992393	
22890291	Type_B_Soils	41	938501948	
24624688	Type_B_Soils	41	1009612198	
25844170	Type_B_Soils	41	1059610989	
33382084	Type_D_Soils	63	2103071264	
34448795	Type_B_Soils	41	1412400577	
34824624	Type_B_Soils	41	1427809566	
36695922	Type_B_Soils	41	1504532809	
51749578	Type_B_Soils	41	2121732711	
64831396	Type_B_Soils	41	2658087216	
687318569			31067877037	**45.20**

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

688056035 DRAINAREA

Subarea WB-01

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
420056	Type_B_Soils	41	17222298	
501791	Type_B_Soils	41	20573415	
794376	Type_B_Soils	41	32569415	
827454	Type_D_Soils	63	52129632	
1512081	Type_B_Soils	41	61995334	
1991155	Type_D_Soils	63	125442768	
2555521	Type_B_Soils	41	104776343	
3318575	Type_B_Soils	41	136061565	
3695494	Type_A_Soils	22	81300861	
3834162	Type_B_Soils	41	157200636	
3971011	Type_B_Soils	41	162811431	
4437691	Type_B_Soils	41	181945351	
5774693	Type_B_Soils	41	236762409	
6251954	Type_D_Soils	63	393873105	
6667645	Type_D_Soils	63	420061647	
8237822	Type_D_Soils	63	518982765	
8479552	Type_D_Soils	63	534211755	
8900694	Type_B_Soils	41	364928446	
9520379	Type_D_Soils	63	599783886	
14640862	Type_B_Soils	41	600275326	
15526408	Type_B_Soils	41	636582735	
15659397	Type_B_Soils	41	642035268	
16063681	Type_D_Soils	63	1012011928	
17252483	Type_D_Soils	63	1086906448	
19232642	Type_D_Soils	63	1211656418	
23785669	Type_D_Soils	63	1498497171	
24169262	Type_D_Soils	63	1522663501	
24751107	Type_C_Soils	56	1386061999	
25709511	Type_B_Soils	41	1054089940	
27311248	Type_B_Soils	41	1119761185	
29805867	Type_D_Soils	63	1877769625	
30738134	Type_D_Soils	63	1936502454	
34368953	Type_D_Soils	63	2165244022	
35008949	Type_A_Soils	22	770196873	
42217777	Type_C_Soils	56	2364195505	
43429339	Type_D_Soils	63	2736048379	
57026551	Type_D_Soils	63	3592672687	
62988384	Type_C_Soils	56	3527349523	
101009003	Type_D_Soils	63	6363567217	
742387333			41306721267	**55.64**
743572791	DRAINAREA			

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea WB-02

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
38536	Type_B_Soils	41	1579980	
186005	Type_D_Soils	63	11718304	
1083971	Type_B_Soils	41	44442801	
2703393	Type_B_Soils	41	110839108	
3551772	Type_B_Soils	41	145622643	
3649113	Type_D_Soils	63	229894140	
4774636	Type_D_Soils	63	300802088	
5248984	Type_B_Soils	41	215208331	
6109619	Type_D_Soils	63	384905984	
6423204	Type_A_Soils	22	141310483	
17694339	Type_D_Soils	63	1114743349	
21034709	Type_D_Soils	63	1325186648	
21921978	Type_D_Soils	63	1381084610	
25031464	Type_D_Soils	63	1576982206	
33939802	Type_D_Soils	63	2138207517	
44374663	Type_D_Soils	63	2795603764	
56241977	Type_D_Soils	63	3543244580	
63985875	Type_D_Soils	63	4031110122	
64976400	Type_D_Soils	63	4093513172	
66445756	Type_B_Soils	41	2724276003	
83588454	Type_D_Soils	63	5266072589	
91731433	Type_B_Soils	41	3760988735	
624736081			35337337158	**56.56**
625211770	DRAINAREA			

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea WB-03

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
45333	Type_B_Soils	41	1858662	
110657	Type_C_Soils	56	6196777	
126741	Type_C_Soils	56	7097511	
171761	Type_D_Soils	63	10820956	
523648	Type_D_Soils	63	32989811	
524895	Type_B_Soils	41	21520701	
672847	Type_B_Soils	41	27586727	
800350	Type_B_Soils	41	32814337	
2737586	Type_B_Soils	41	112241011	
3894081	Type_B_Soils	41	159657312	
5009045	Type_D_Soils	63	315569838	
5020968	Type_C_Soils	56	281174217	
5902104	Type_B_Soils	41	241986254	
6663314	Type_D_Soils	63	419788770	
6675852	Type_B_Soils	41	273709950	
7711744	Type_D_Soils	63	485839882	
8569321	Type_D_Soils	63	539867208	
10492840	Type_B_Soils	41	430206438	
15110678	Type_D_Soils	63	951972735	
19868710	Type_D_Soils	63	1251728723	
20562714	Type_D_Soils	63	1295450951	
21227816	Type_D_Soils	63	1337352411	
21542481	Type_B_Soils	41	883241720	
22289719	Type_D_Soils	63	1404252297	
27708068	Type_B_Soils	41	1136030800	
32062973	Type_D_Soils	63	2019967328	
33144971	Type_B_Soils	41	1358943825	
34865619	Type_D_Soils	63	2196534023	
37082029	Type_B_Soils	41	1520363199	
41713256	Type_D_Soils	63	2627935106	
89510155	Type_C_Soils	56	5012568695	
93395182	Type_D_Soils	63	5883896481	
100300553	Type_D_Soils	63	6318934842	
134108857	Type_A_Soils	22	2950394849	
810146869			41550494350	**51.29**
810141136	DRAINAREA			

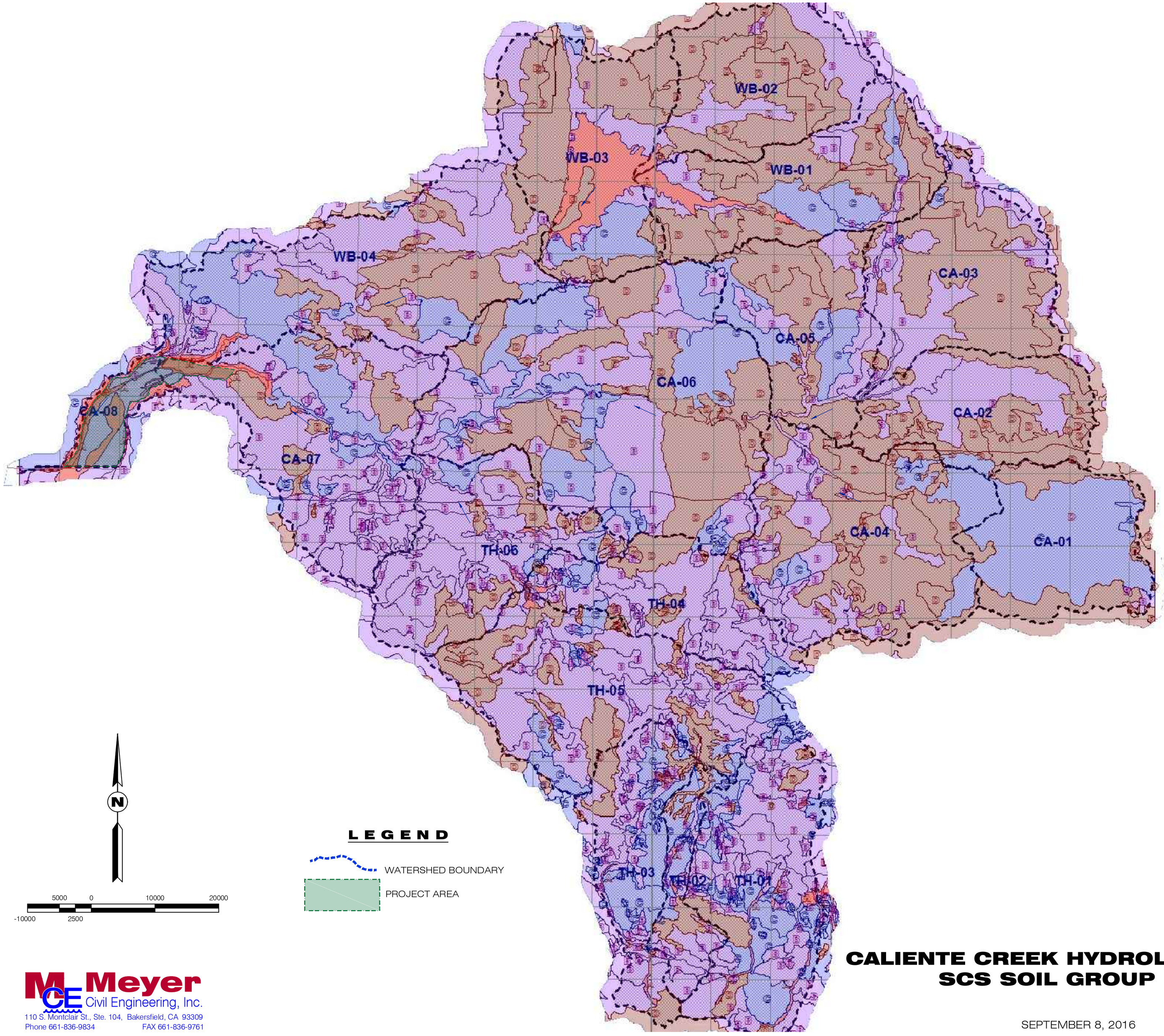
Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea WB-04

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
9794	Type_D_Soils	63	616993	
12396	Type_B_Soils	41	508247	
15248	Type_D_Soils	63	960634	
15347	Type_B_Soils	41	629234	
15446	Type_D_Soils	63	973120	
16464	Type_B_Soils	41	675016	
30040	Type_C_Soils	56	1682246	
38085	Type_B_Soils	41	1561471	
40363	Type_D_Soils	63	2542881	
57420	Type_D_Soils	63	3617469	
68624	Type_D_Soils	63	4323338	
87472	Type_D_Soils	63	5510748	
150714	Type_B_Soils	41	6179254	
179202	Type_D_Soils	63	11289716	
212922	Type_B_Soils	41	8729788	
243698	Type_D_Soils	63	15352988	
255597	Type_B_Soils	41	10479469	
297869	Type_D_Soils	63	18765728	
313460	Type_D_Soils	63	19747955	
339829	Type_B_Soils	41	13932982	
477518	Type_B_Soils	41	19578233	
484936	Type_A_Soils	22	10668581	
629934	Type_B_Soils	41	25827289	
722108	Type_B_Soils	41	29606434	
788527	Type_D_Soils	63	49677170	
790523	Type_B_Soils	41	32411426	
841170	Type_D_Soils	63	52993697	
997660	Type_A_Soils	22	21948526	
1031024	Type_D_Soils	63	64954500	
1121209	Type_D_Soils	63	70636193	
1167439	Type_C_Soils	56	65376574	
1518493	Type_C_Soils	56	85035620	
1548861	Type_C_Soils	56	86736219	
1709863	Type_B_Soils	41	70104366	
2056729	Type_A_Soils	22	45248048	
2345851	Type_B_Soils	41	96179884	
2571320	Type_A_Soils	22	56569033	
2717987	Type_B_Soils	41	111437453	
2918693	Type_B_Soils	41	119666400	
2996624	Type_A_Soils	22	65925722	
3097050	Type_C_Soils	56	173434773	
3164788	Type_B_Soils	41	129756309	
4720222	Type_B_Soils	41	193529083	
4734065	Type_B_Soils	41	194096651	
5555874	Type_B_Soils	41	227790854	
5844458	Type_D_Soils	63	368200859	
6152913	Type_D_Soils	63	387633537	
6288086	Type_D_Soils	63	396149445	
7605688	Type_B_Soils	41	311833211	
8030614	Type_C_Soils	56	449714409	
9235580	Type_A_Soils	22	203182770	
9303481	Type_B_Soils	41	381442737	
9814761	Type_B_Soils	41	402405203	
9929668	Type_D_Soils	63	625569106	
10334652	Type_B_Soils	41	423720718	
11329639	Type_B_Soils	41	464515194	
11609487	Type_B_Soils	41	475988966	
12855981	Type_B_Soils	41	527095229	
13109441	Type_C_Soils	56	734128670	
13385575	Type_B_Soils	41	548808582	
13903106	Type_B_Soils	41	570027352	
14977060	Type_D_Soils	63	943554798	
18287889	Type_C_Soils	56	1024121763	
20339994	Type_D_Soils	63	1281419595	
25021189	Type_D_Soils	63	1576334938	
29790203	Type_B_Soils	41	1221398321	
29989289	Type_B_Soils	41	1229560847	
32716449	Type_B_Soils	41	1341374396	
35151127	Type_D_Soils	63	2214521028	
44927603	Type_C_Soils	56	2515945768	
50523425	Type_B_Soils	41	2071460416	
53922681	Type_D_Soils	63	3397128896	
105100929	Type_B_Soils	41	4309138101	
131427300	Type_D_Soils	63	8279919914	
143468026	Type_C_Soils	56	8034209439	
231549547	Type_B_Soils	41	9493531440	
1179034297			58431303963	49.56

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

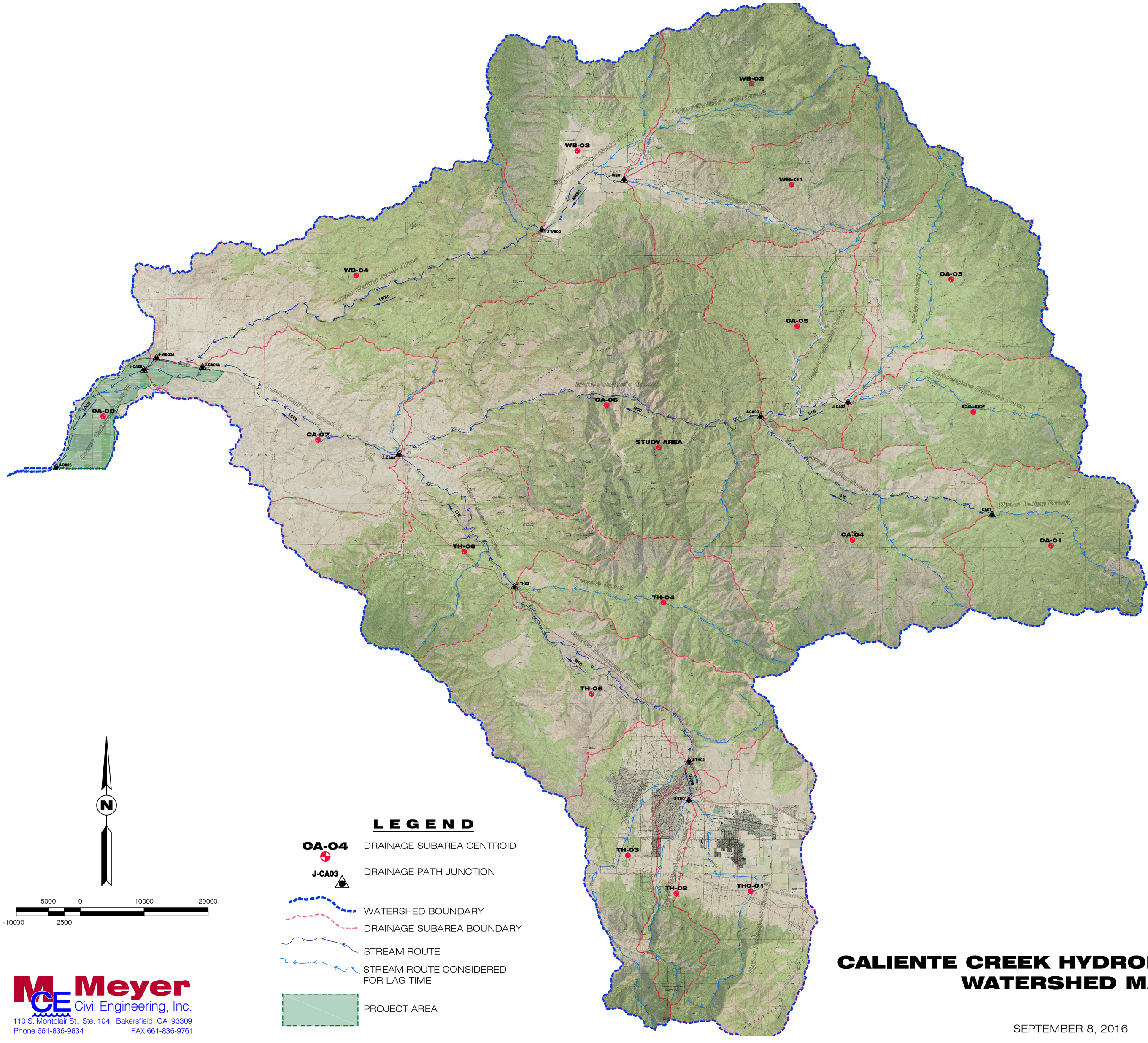
1179551569 DRAINAREA



CALIENTE CREEK HYDROLOGY STUDY
SCS SOIL GROUP MAP

SEPTEMBER 8, 2016

Meyer Civil Engineering, Inc.
110 S. Montclair St., Ste. 104, Bakersfield, CA 93309
Phone 661-836-9834 FAX 661-836-9761



N

5000 0 10000 20000

-10000 2500

LEGEND

CA-04 — DRAINAGE SUBAREA CENTROID

J-CA03 — DRAINAGE PATH JUNCTION

WATERSHED BOUNDARY

DRAINAGE SUBAREA BOUNDARY

STREAM ROUTE

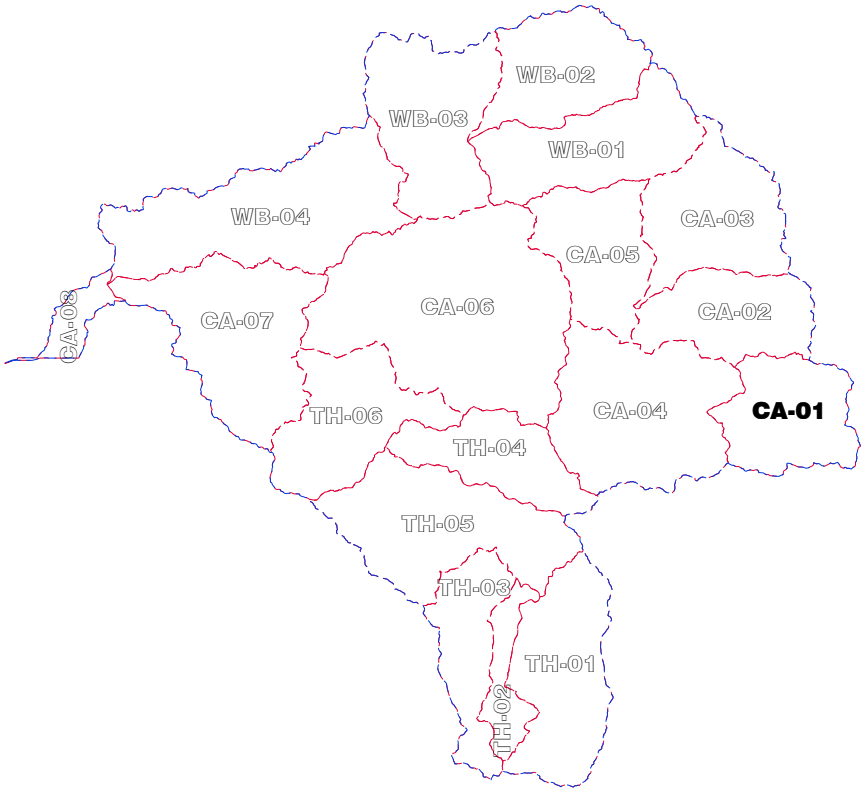
STREAM ROUTE CONSIDERED FOR LAG TIME

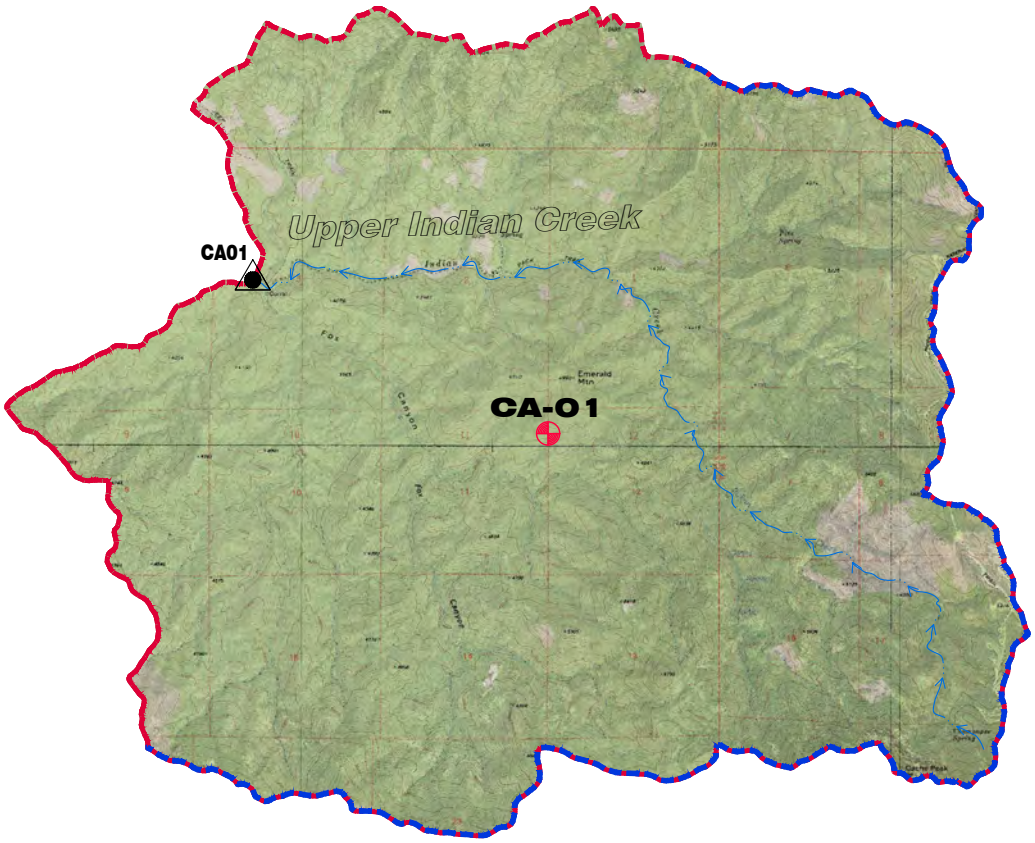
PROJECT AREA

Meyer Civil Engineering, Inc.
110 S. Montclair St., Ste. 104, Bakersfield, CA 93309
Phone 661-836-9834 FAX 661-836-9761

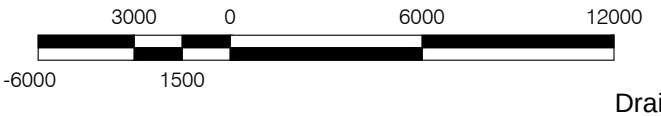
CALIENTE CREEK HYDROLOGY STUDY
WATERSHED MAP

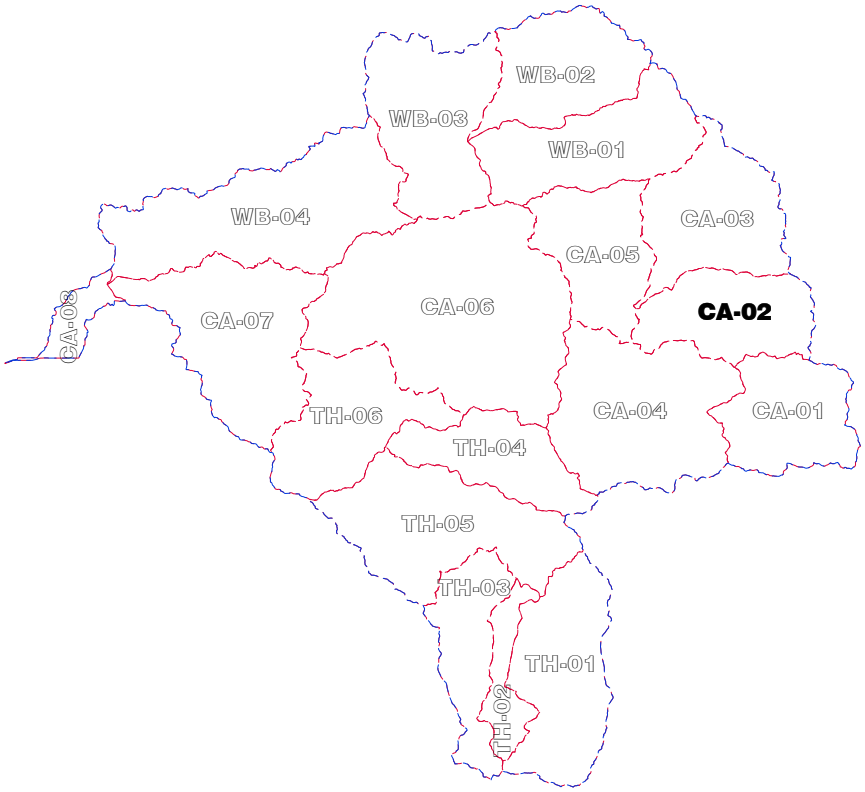
SEPTEMBER 8, 2016





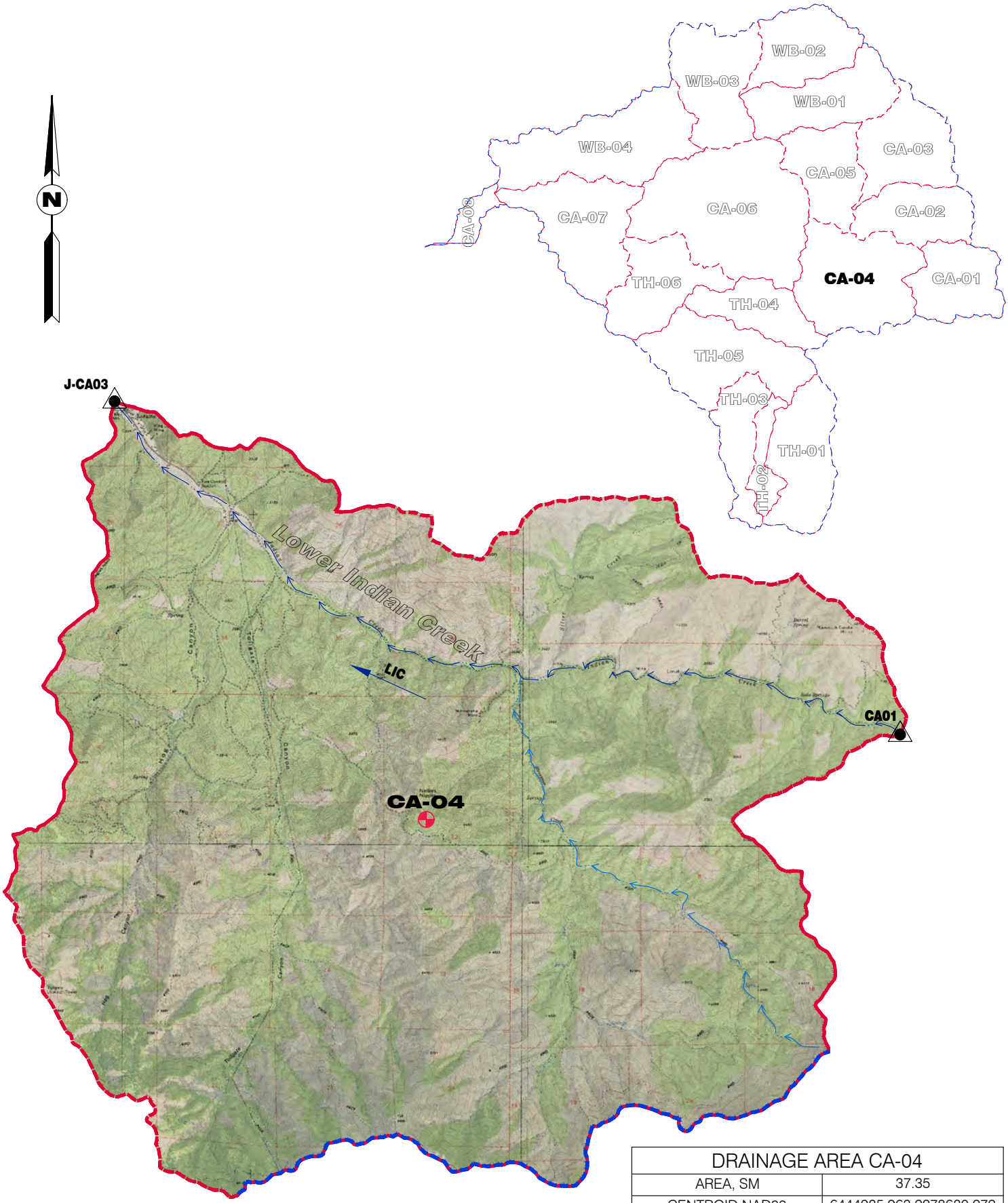
DRAINAGE AREA CA-01	
AREA, SM	20.76
CENTROID NAD83	6476050.441,2277789.285
CENTROID GEODETIC	35.2510069,-118.28675
L, F.L. LENGTH MILES	6.958
La, F.L. BELOW CENTROID	3.430
BEGIN F.L. ELEV.	6000
END F.L. ELEV.	3640
LAG TIME, HRS (100, 10, 5)	1.192, 1.359, 1.430
NRCS Cn	57.81



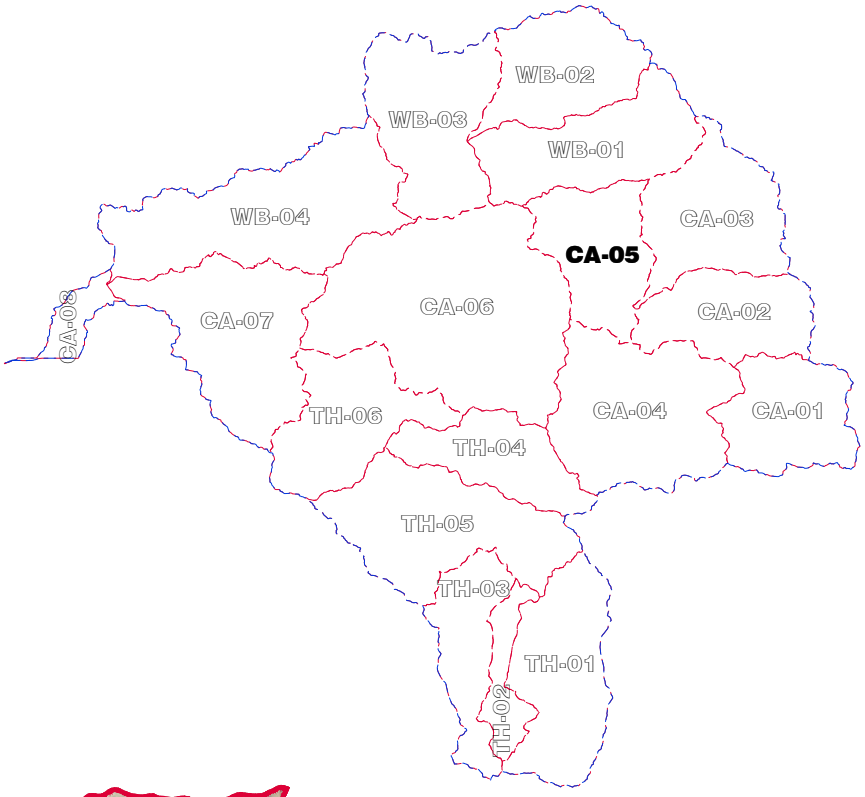


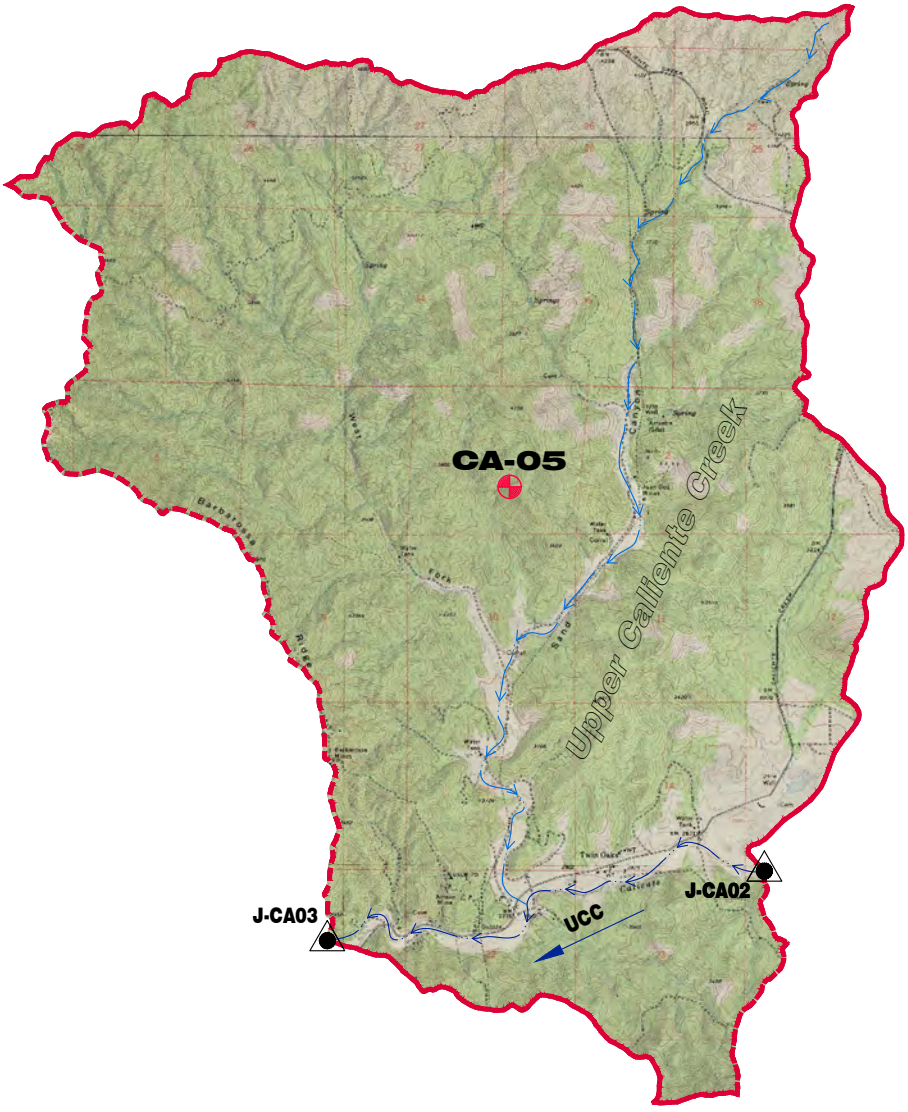
DRAINAGE AREA CA-02	
AREA, SM	20.48
CENTROID NAD83	6463895.964,2298708.723
CENTROID GEODETIC	35.3083785,-118.32769
L, F.L. LENGTH MILES	8.628
La, F.L. BELOW CENTROID	4.399
BEGIN F.L. ELEV.	5400
END F.L. ELEV.	2865
LAG TIME, HRS (100, 10, 5)	1.461, 1.665, 1.753
NRCS Cn	53.82

DRAINAGE AREA CA-03	
AREA, SM	25.55
CENTROID NAD83	6460428.381,2319458.682
CENTROID GEODETIC	35.3653537,-118.33955
L, F.L. LENGTH MILES	9.710
La, F.L. BELOW CENTROID	5.047
BEGIN F.L. ELEV.	7360
END F.L. ELEV.	2865
LAG TIME, HRS (100, 10, 5)	1.477, 1.683, 1.772
NRCS Cn	54.62

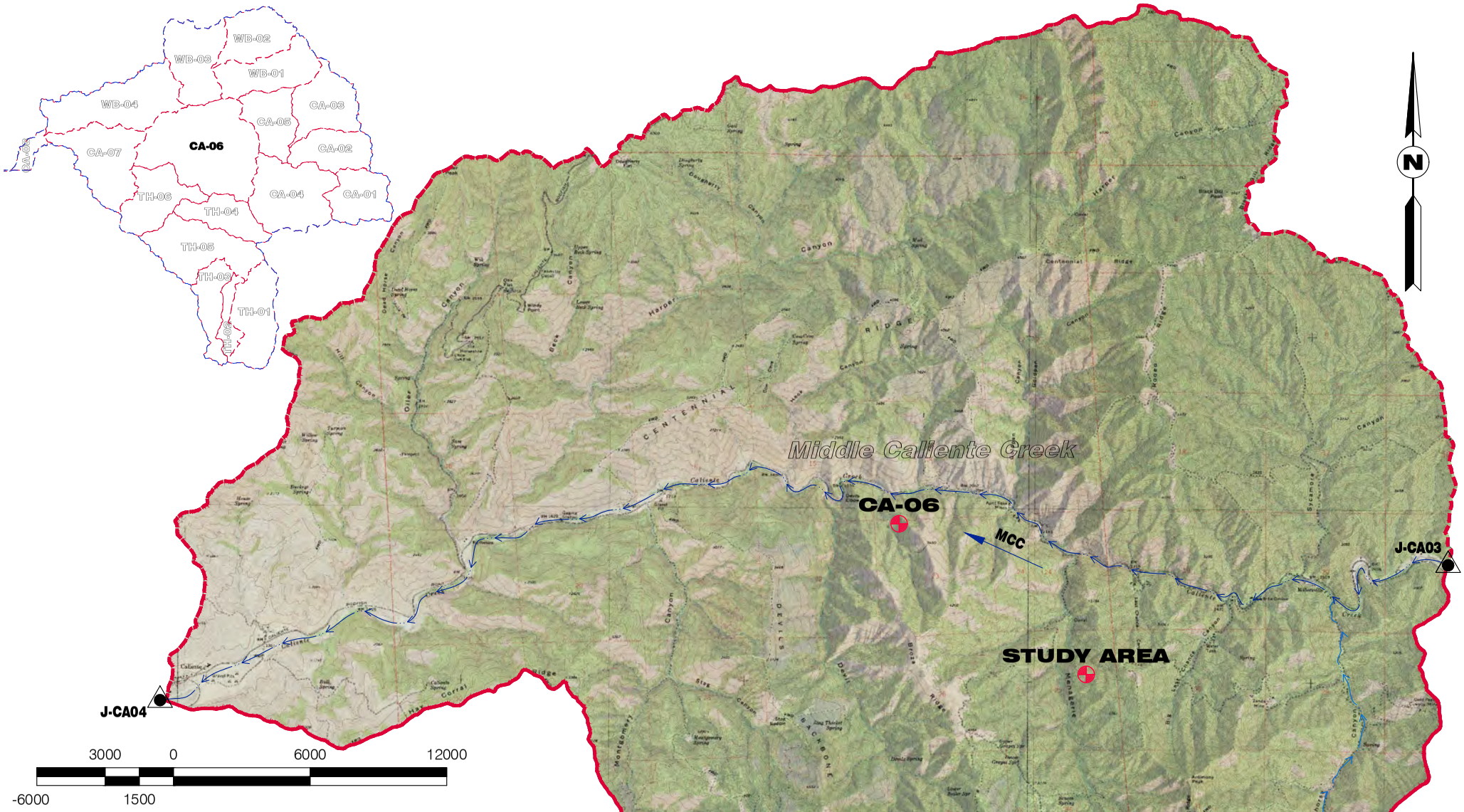


DRAINAGE AREA CA-04	
AREA, SM	37.35
CENTROID NAD83	6444985.963,2278680.272
CENTROID GEODETIC	35.2531672,-118.39081
L, F.L. LENGTH MILES	9.597
La, F.L. BELOW CENTROID	5.490
BEGIN F.L. ELEV.	6400
END F.L. ELEV.	2645
LAG TIME, HRS (100, 10, 5)	1.567, 1.787, 1.881
NRCS Cn	55.46





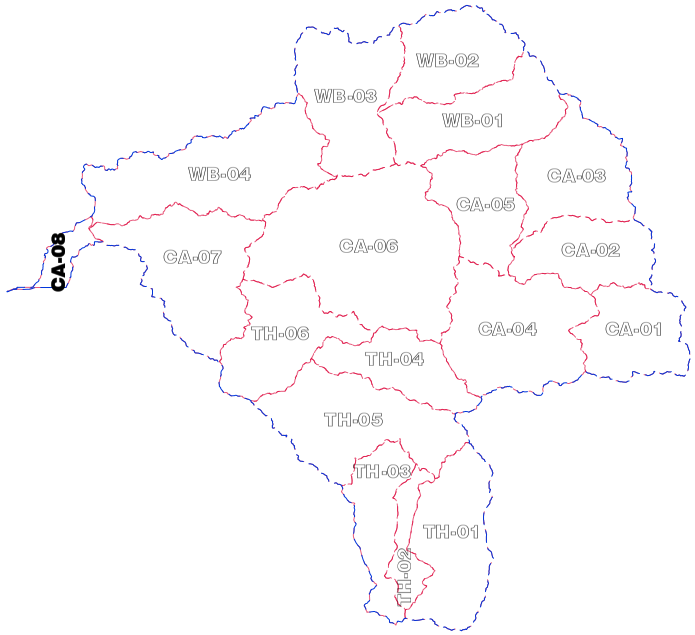
DRAINAGE AREA CA-05	
AREA, SM	20.87
CENTROID NAD83	6436325.153,2312135.043
CENTROID GEODETIC	35.3449832,-118.42028
L, F.L. LENGTH MILES	8.071
La, F.L. BELOW CENTROID	4.843
BEGIN F.L. ELEV.	4520
END F.L. ELEV.	2645
LAG TIME, HRS (100, 10, 5)	1.545, 1.761, 1.854
NRCS Cn	56.04

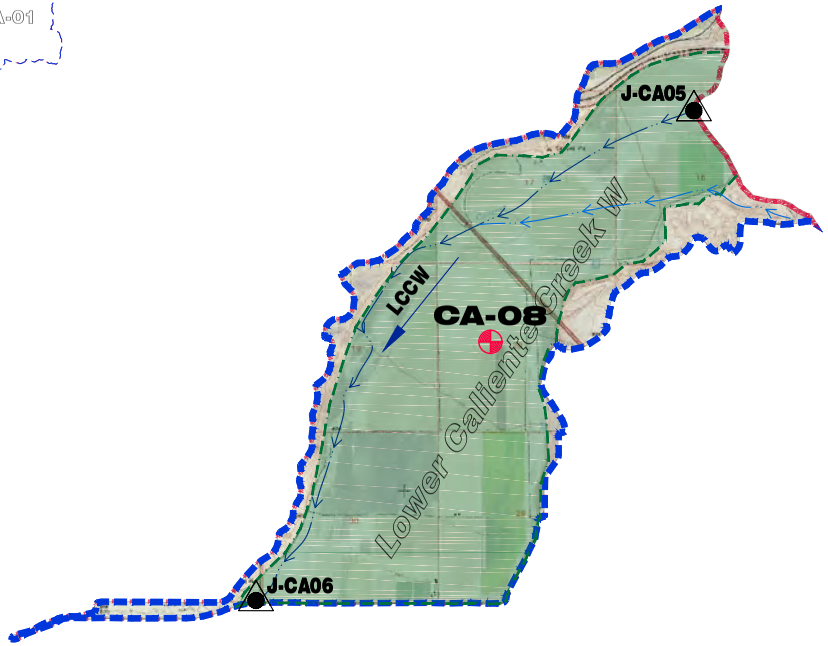


DRAINAGE AREA CA-06	
AREA, SM	62.50
CENTROID NAD83	6406524.567,2299778.442
CENTROID GEODETIC	35.3106528,-118.51999
L, F.L. LENGTH MILES	16.184
La, F.L. BELOW CENTROID	7.323
BEGIN F.L. ELEV.	5000
END F.L. ELEV.	1288
LAG TIME, HRS (100, 10, 5)	2.360, 2.691, 2.832
NRCS CN	53.09

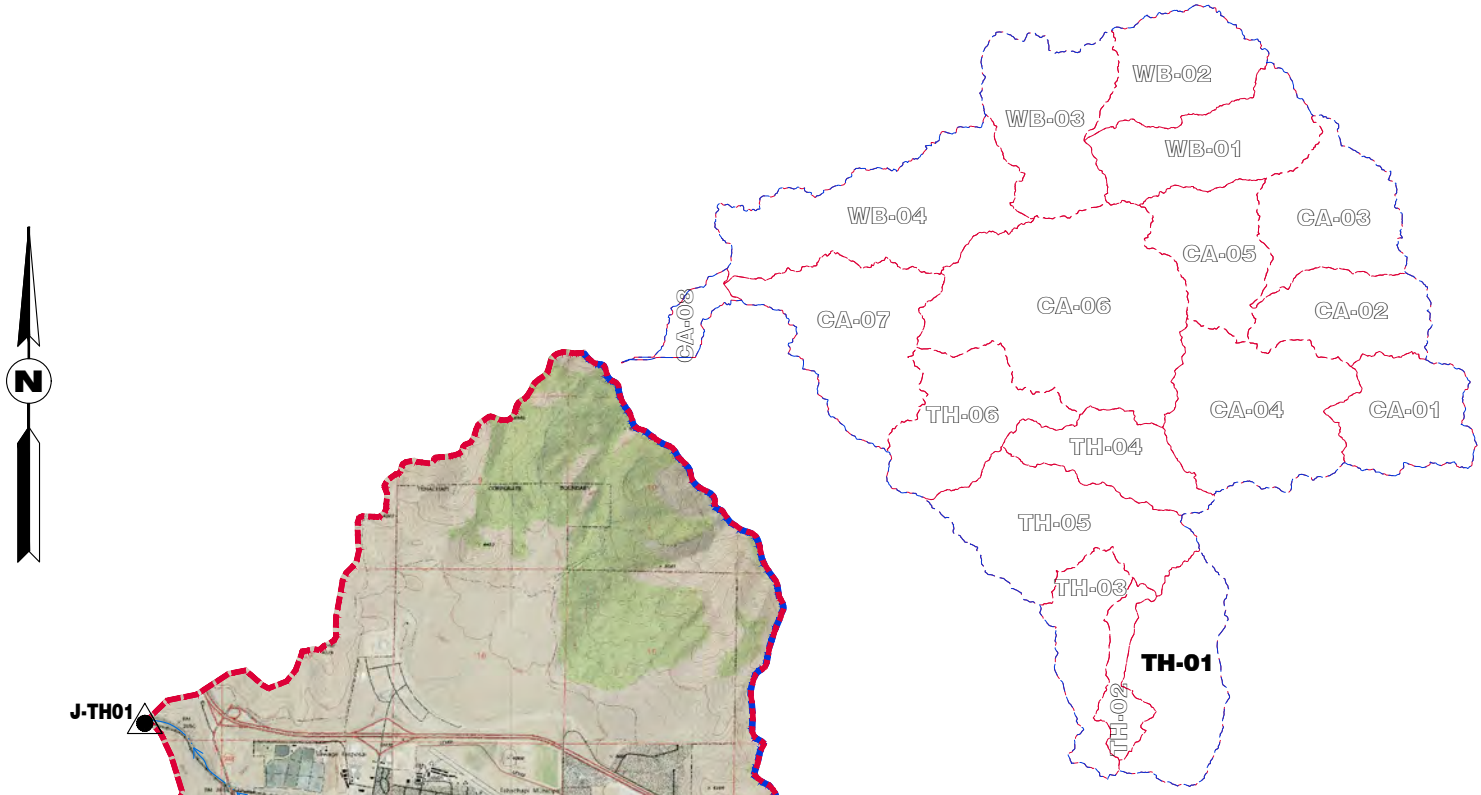
DRAINAGE AREA CA-07	
AREA, SM	34.205
CENTROID NAD83	6361386.606,2294337.233
CENTROID GEODETIC	35.2949692,-118.67116
L, F.L. LENGTH MILES	12.798
La, F.L. BELOW CENTROID	6.656
BEGIN F.L. ELEV.	3360
END F.L. ELEV.	815
LAG TIME, HRS	2.139, 2.439, 2.567
NRCS CN	40.60

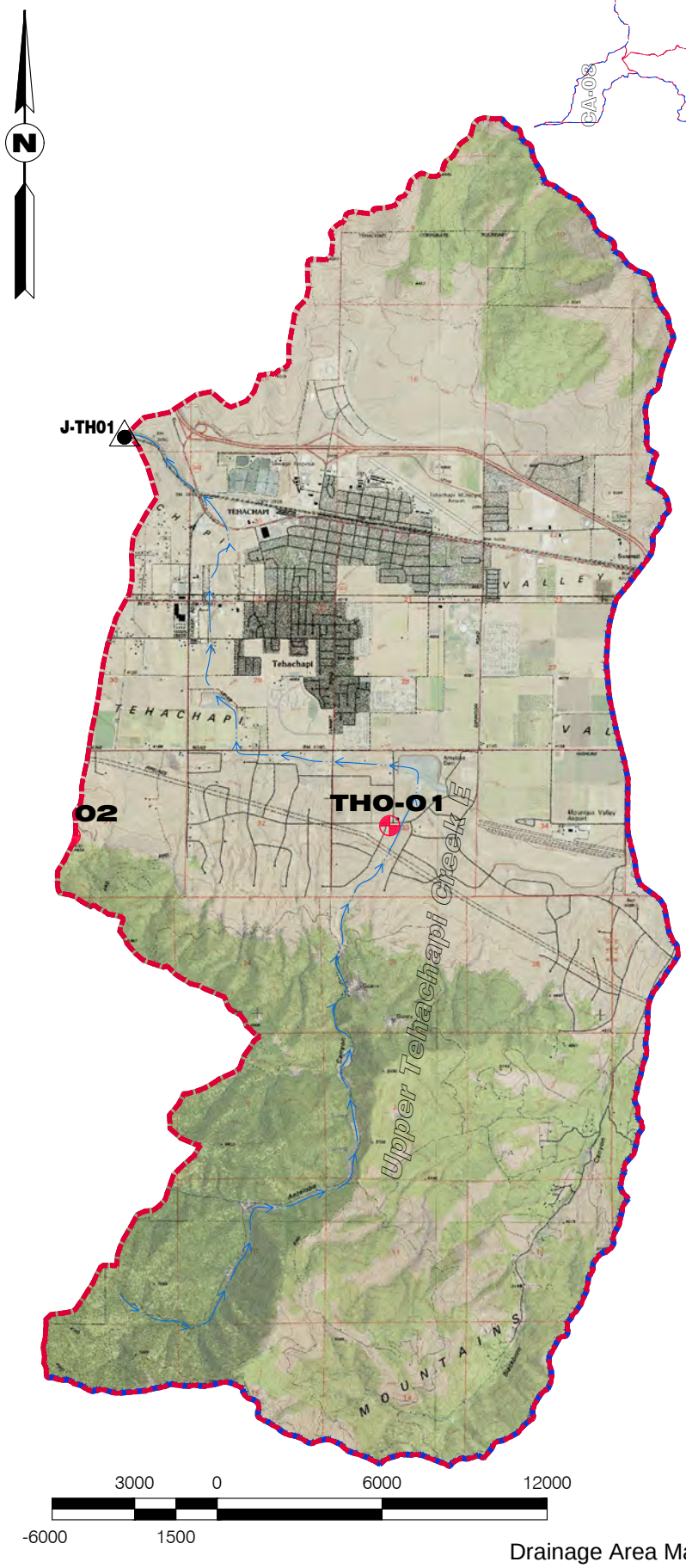
Drainage Area Maps



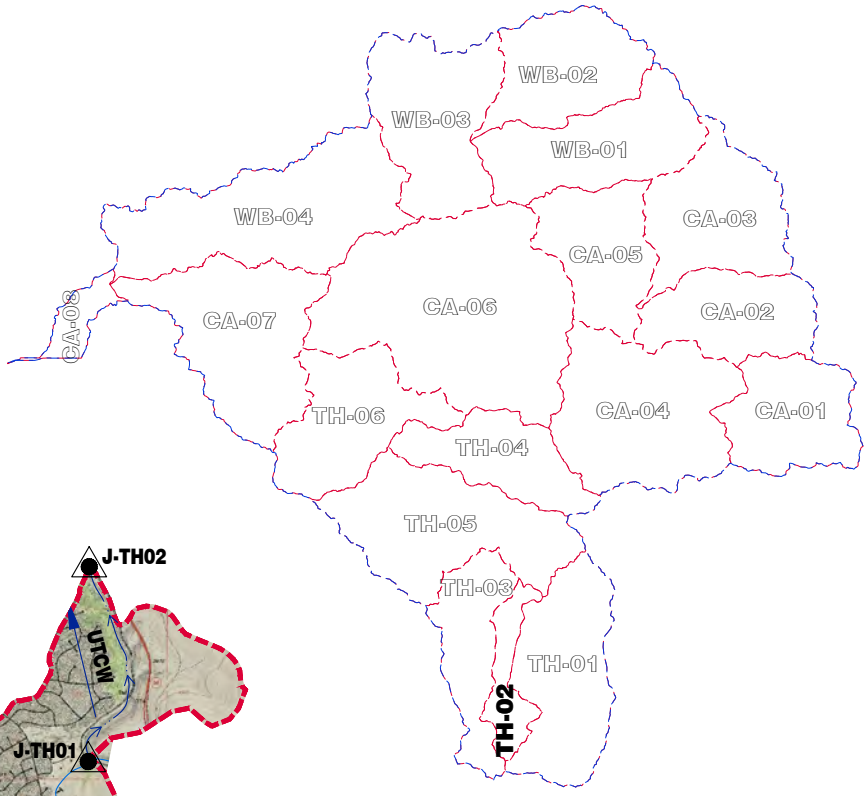


DRAINAGE AREA CA-08	
AREA, SM	4.918
CENTROID NAD83	6327788.299,2298032.234
CENTROID GEODETIC	35.3044524,-118.78384
L, F.L. LENGTH MILES	4.697
La, F.L. BELOW CENTROID	2.178
BEGIN F.L. ELEV.	1060
END F.L. ELEV.	615
LAG TIME, HRS (100, 10, 5)	1.101, 1.255, 1.321
NRCS CN	40.60





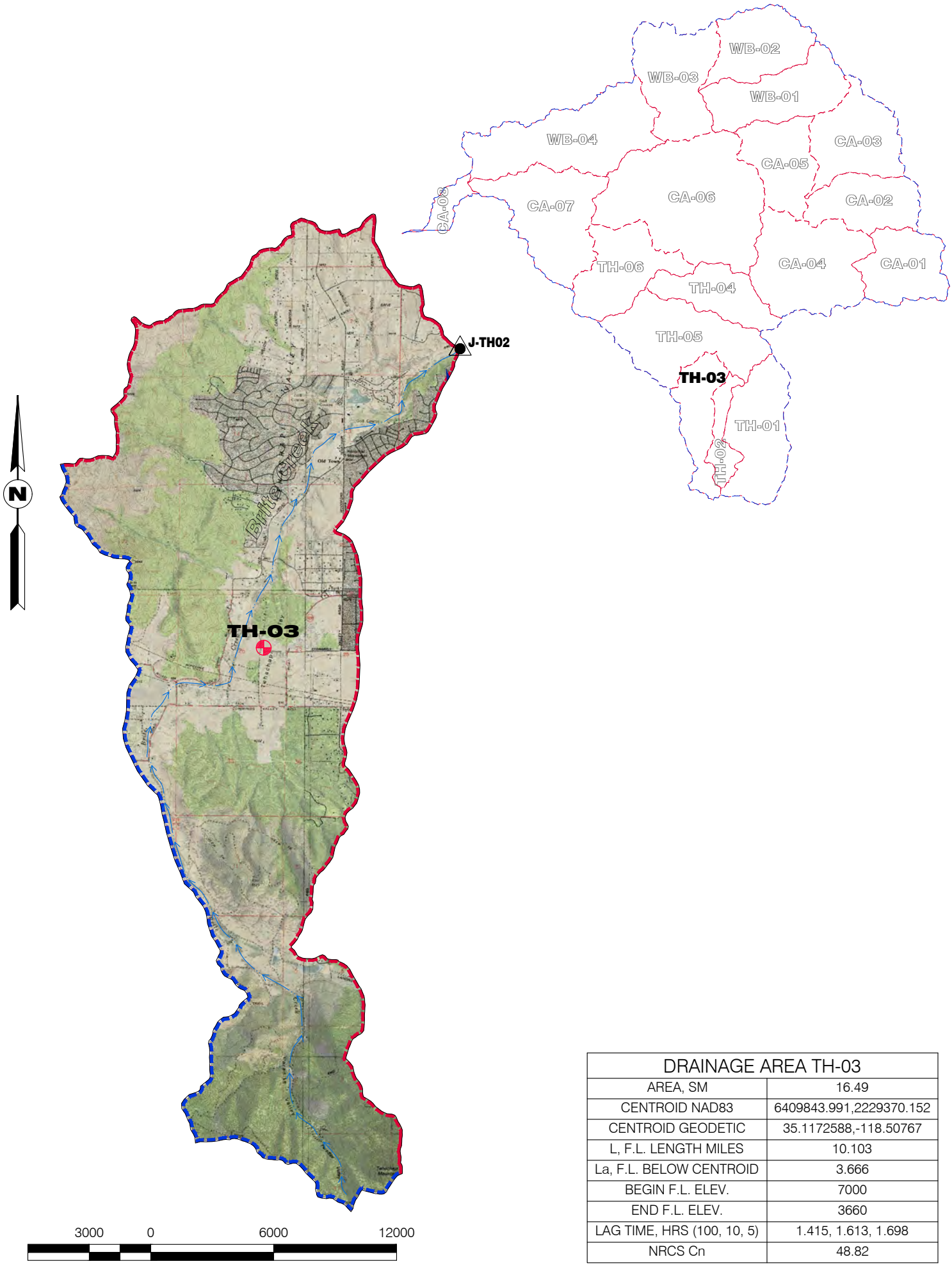
DRAINAGE AREA TH-01	
AREA, SM	27.70
CENTROID NAD83	6429051.647,2223754.199
CENTROID GEODETIC	35.1020786,-118.44337
L, F.L. LENGTH MILES	9.341
La, F.L. BELOW CENTROID	4.384
BEGIN F.L. ELEV.	6800
END F.L. ELEV.	3816
LAG TIME, HRS	1.480, 1.687, 1.776
NRCS Cn	46.57



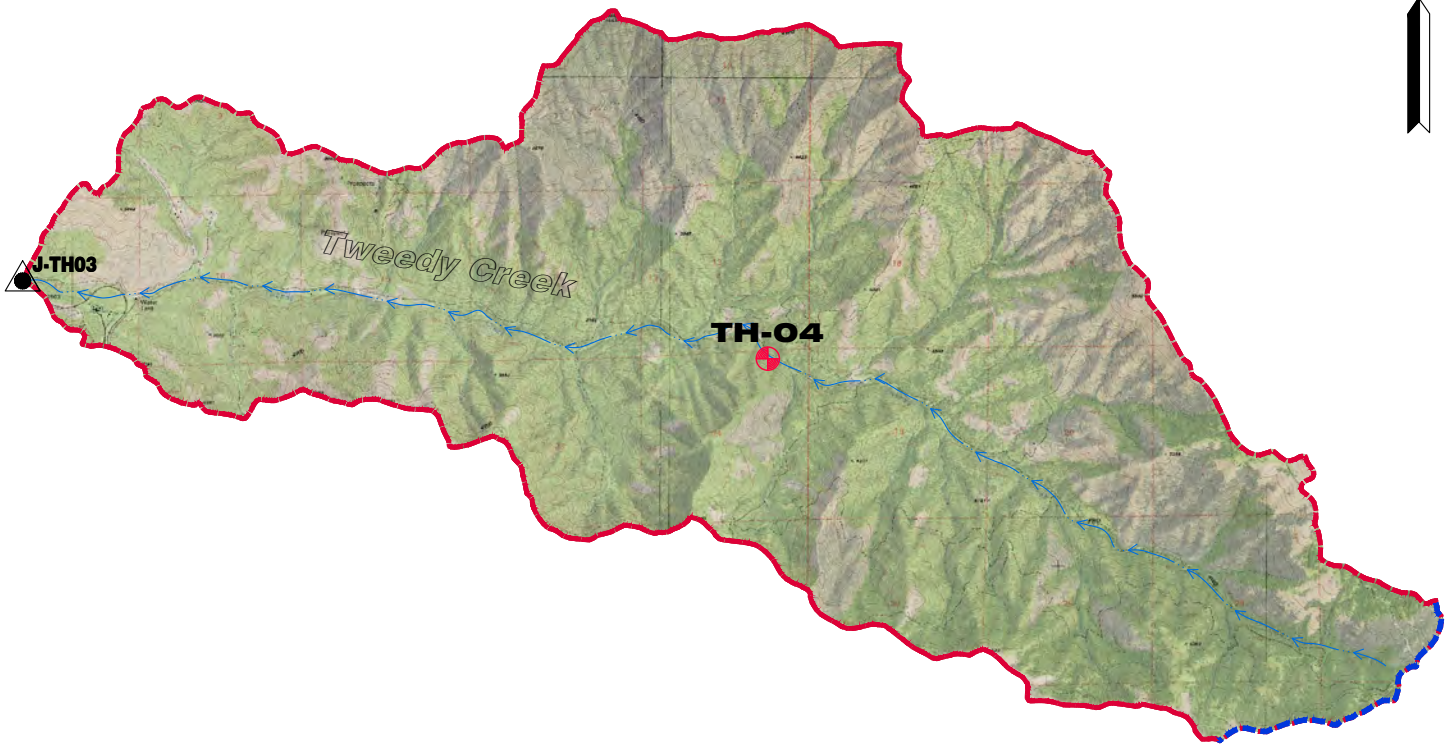
3000 0 6000 12000

-6000 1500

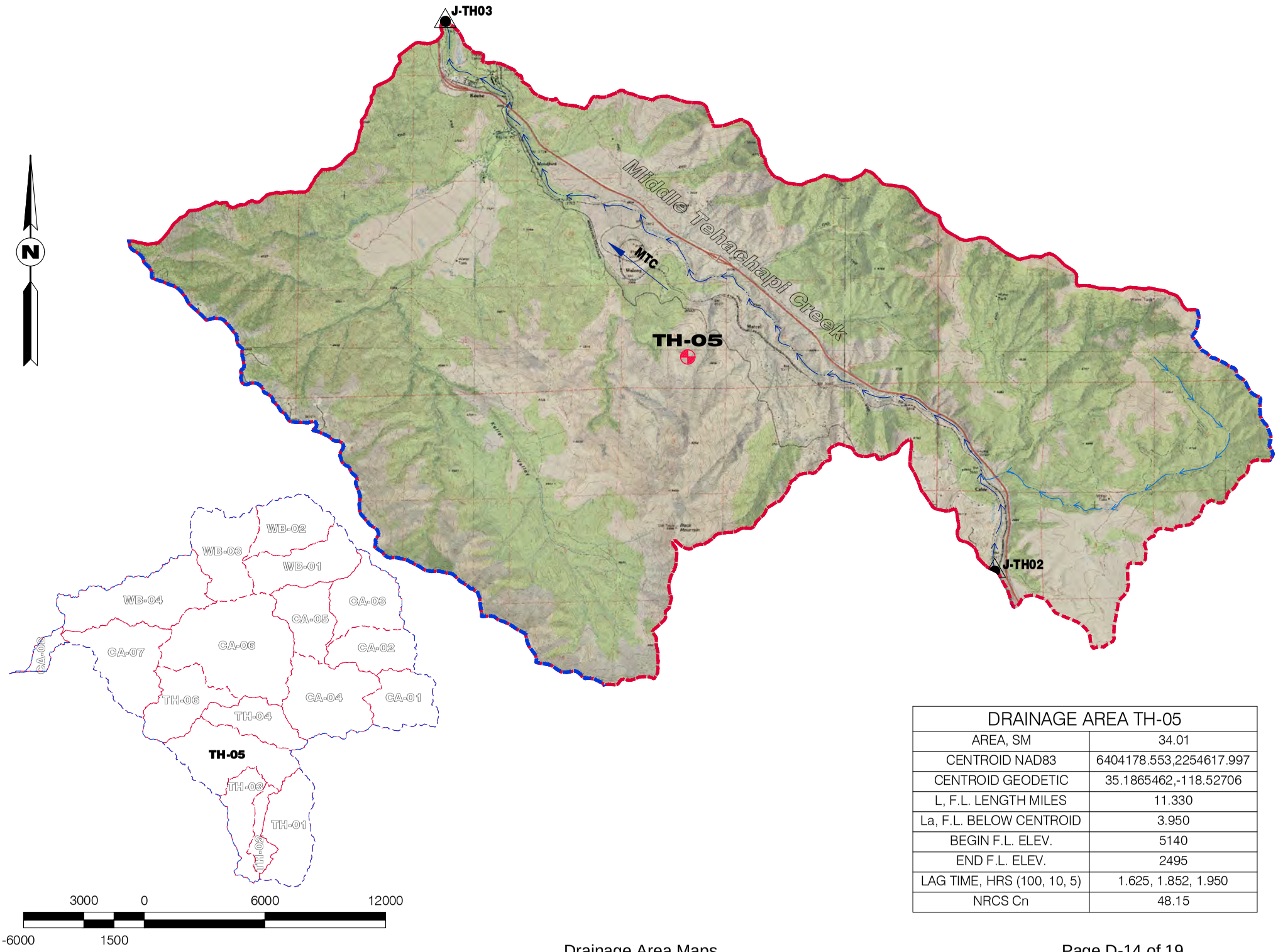
DRAINAGE AREA TH-02	
AREA, SM	7.61
CENTROID NAD83	6417430.069,2223391.932
CENTROID GEODETIC	35.1009362,-118.48221
L, F.L. LENGTH MILES	9.341
La, F.L. BELOW CENTROID	4.384
BEGIN F.L. ELEV.	7200
END F.L. ELEV.	3660
LAG TIME, HRS (100, 10, 5)	1.374, 1.566, 1.648
NRCS Cn	49.60



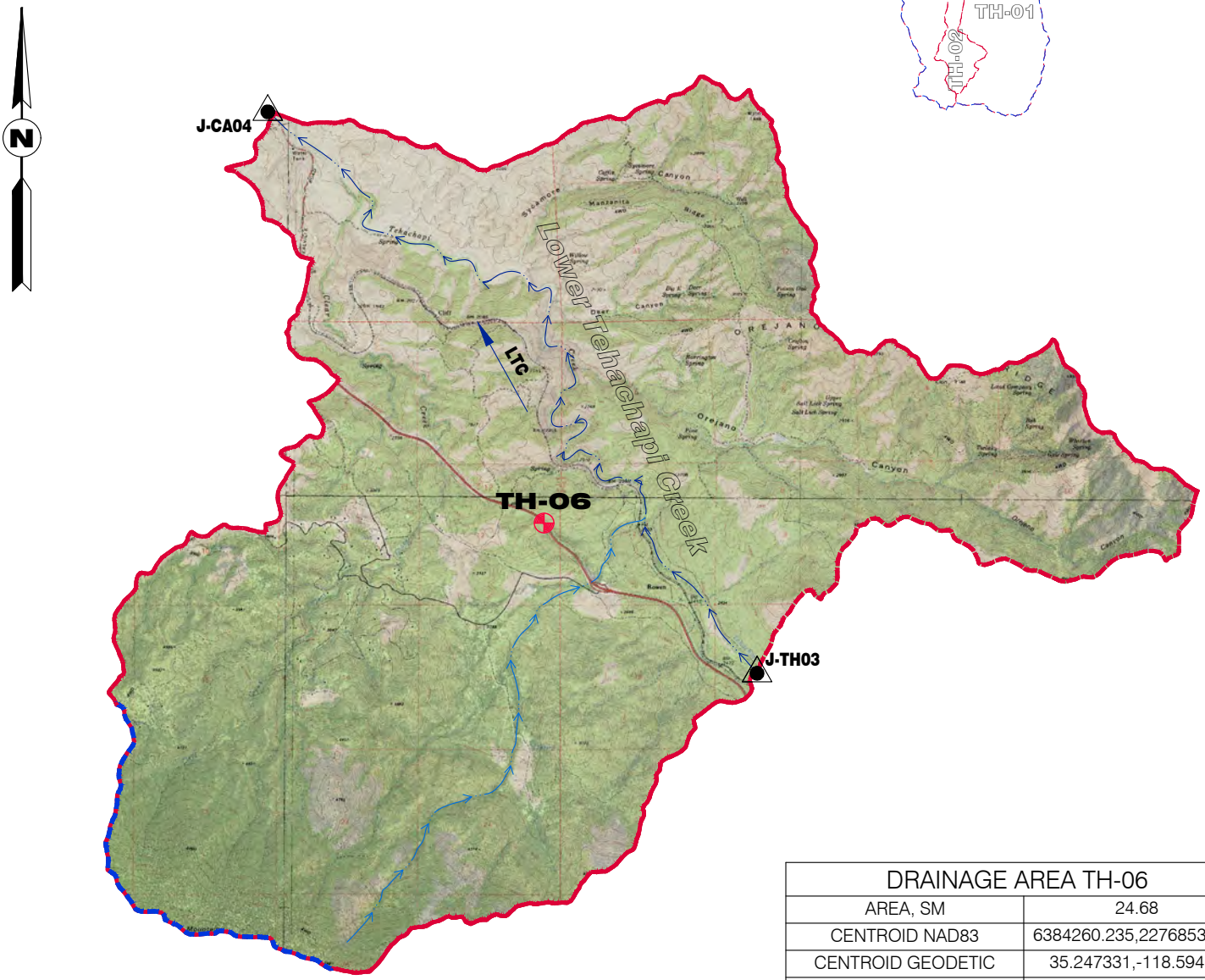
DRAINAGE AREA TH-03	
AREA, SM	16.49
CENTROID NAD83	6409843.991,2229370.152
CENTROID GEODETIC	35.1172588,-118.50767
L, F.L. LENGTH MILES	10.103
La, F.L. BELOW CENTROID	3.666
BEGIN F.L. ELEV.	7000
END F.L. ELEV.	3660
LAG TIME, HRS (100, 10, 5)	1.415, 1.613, 1.698
NRCS Cn	48.82



DRAINAGE AREA TH-04	
AREA, SM	18.06
CENTROID NAD83	6415412.667,2268876.630
CENTROID GEODETIC	35.2258768,-118.4897
L, F.L. LENGTH MILES	8.985
La, F.L. BELOW CENTROID	4.754
BEGIN F.L. ELEV.	5400
END F.L. ELEV.	2495
LAG TIME, HRS (100, 10, 5)	1.500, 1.710, 1.800
NRCS Cn	46.52



DRAINAGE AREA TH-05	
AREA, SM	34.01
CENTROID NAD83	6404178.553,2254617.997
CENTROID GEODETIC	35.1865462,-118.52706
L, F.L. LENGTH MILES	11.330
La, F.L. BELOW CENTROID	3.950
BEGIN F.L. ELEV.	5140
END F.L. ELEV.	2495
LAG TIME, HRS (100, 10, 5)	1.625, 1.852, 1.950
NRCS Cn	48.15

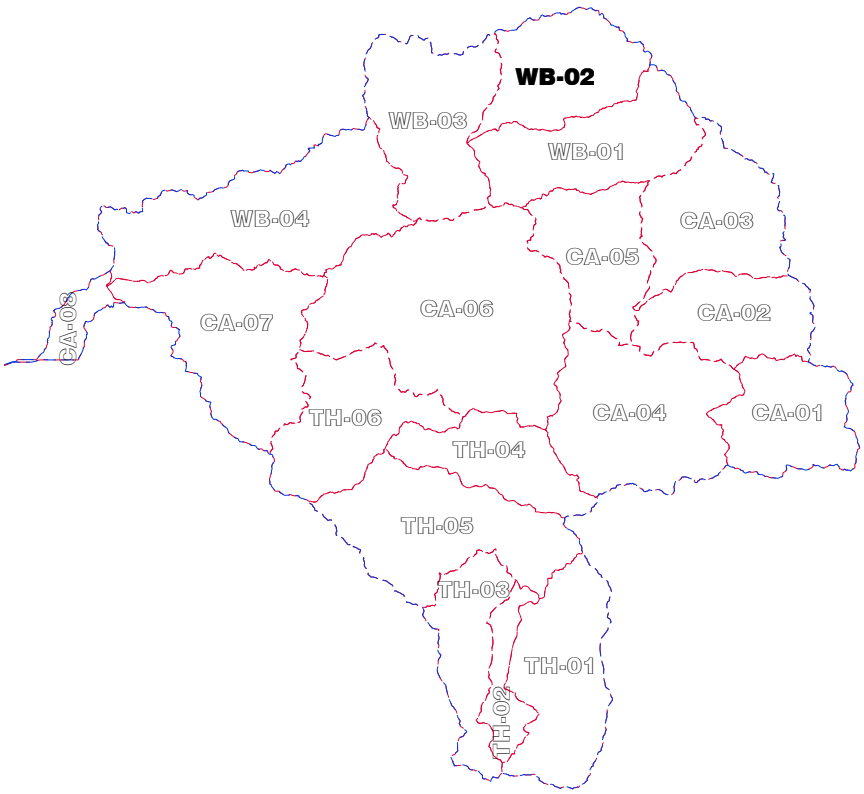


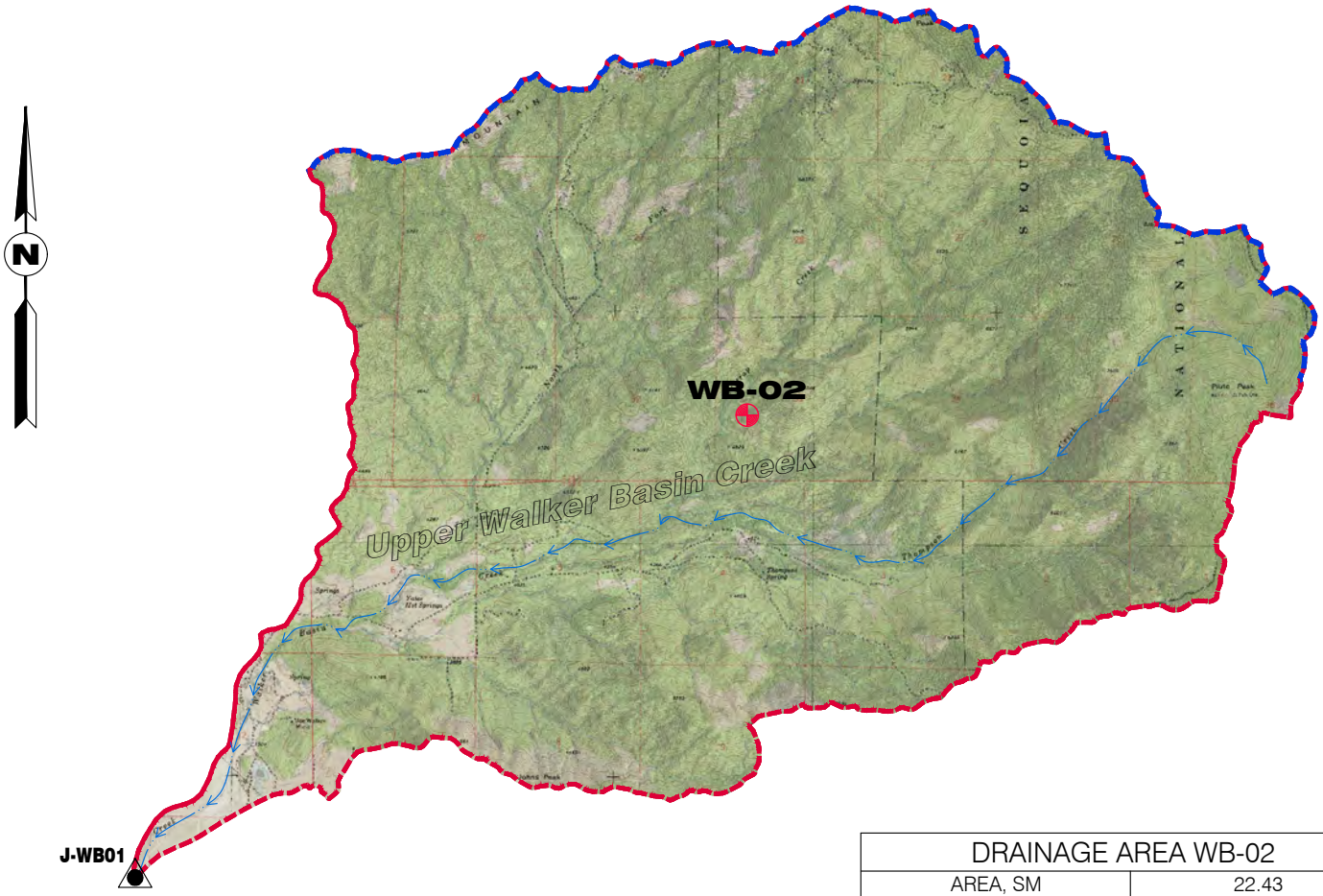
DRAINAGE AREA TH-06	
AREA, SM	24.68
CENTROID NAD83	6384260.235,2276853.537
CENTROID GEODETIC	35.247331,-118.59416
L, F.L. LENGTH MILES	9.473
La, F.L. BELOW CENTROID	5.866
BEGIN F.L. ELEV.	5800
END F.L. ELEV.	1288
LAG TIME, HRS (100, 10, 5)	1.540, 1.756, 1.849
NRCS Cn	45.20

3000 0 6000 12000

-6000 1500

DRAINAGE AREA WB-01	
AREA, SM	26.67
CENTROID NAD83	6435452.419,2334233.397
CENTROID GEODETIC	35.4056835,-118.42352
L, F.L. LENGTH MILES	12.581
La, F.L. BELOW CENTROID	5.047
BEGIN F.L. ELEV.	8060
END F.L. ELEV.	3425
LAG TIME, HRS (100, 10, 5)	1.702, 1.940, 2.042
NRCS Cn	55.64

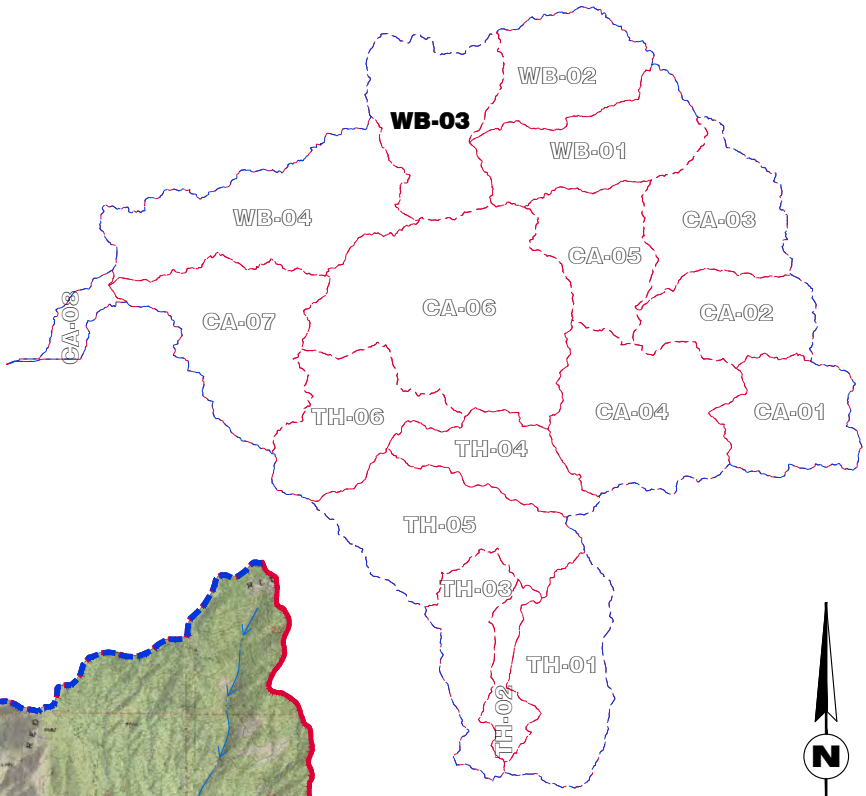


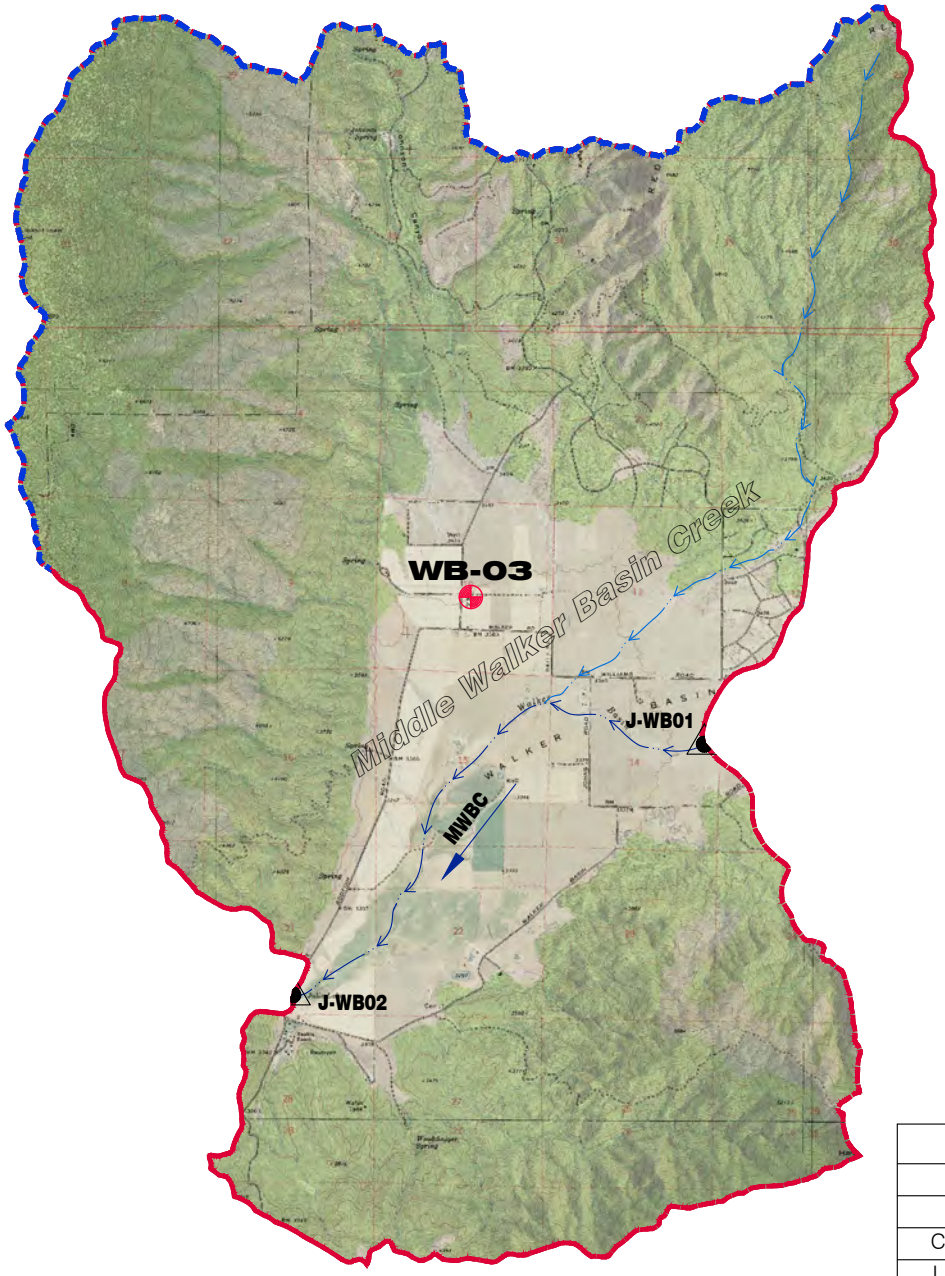


3000 0 6000 12000

-6000 1500

DRAINAGE AREA WB-02	
AREA, SM	22.43
CENTROID NAD83	6429202.607,2350027.306
CENTROID GEODETIC	35.4489987,-118.44473
L, F.L. LENGTH MILES	8.998
La, F.L. BELOW CENTROID	4.986
BEGIN F.L. ELEV.	8040
END F.L. ELEV.	3425
LAG TIME, HRS (100, 10, 5)	1.400, 1.596, 1.680
NRCS Cn	56.56



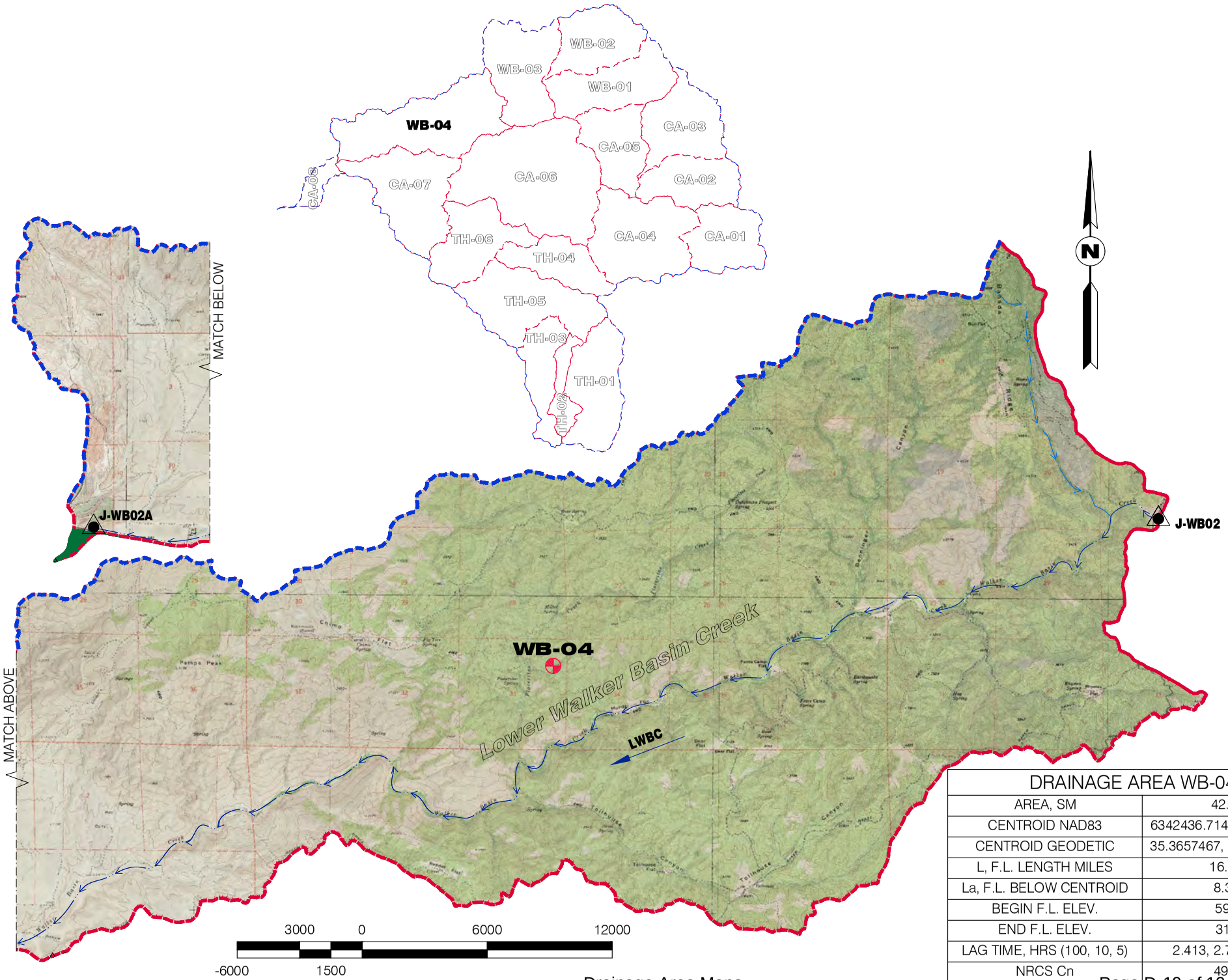


N

3000 0 6000 12000

-6000 1500

DRAINAGE AREA WB-03	
AREA, SM	29.06
CENTROID NAD83	6401967.285,2339556.414
CENTROID GEODETIC	35.419868,-118.53598
L, F.L. LENGTH MILES	7.895
La, F.L. BELOW CENTROID	2.869
BEGIN F.L. ELEV.	5920
END F.L. ELEV.	3160
LAG TIME, HRS (100, 10, 5)	1.162, 1.624, 1.394
NRCS Cn	51.29



DRAINAGE AREA WB-04	
AREA, SM	42.311
CENTROID NAD83	6342436.714,2320060.643
CENTROID GEODETIC	35.3657467, -118.6517100
L, F.L. LENGTH MILES	16.868
La, F.L. BELOW CENTROID	8.389
BEGIN F.L. ELEV.	5920
END F.L. ELEV.	3160
LAG TIME, HRS (100, 10, 5)	2.413, 2.751, 2.896
NRCS Cn	49.56

Drainage Area Maps

APPENDIX B

HYDROLOGY AND SEDIMENT TRANSPORT TECHNICAL MEMO

County of Kern

HYDRAULIC AND SEDIMENT ANALYSIS

Technical Memorandum

Project Deliverable No. 4

60513509 March 27, 2017

AECOM

William C. Black, PE

Project Manager

5001 E. Commercenter Drive, Suite 100, Bakersfield CA 93309

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Technical Memorandum Meyer 23 March 2017 – Addressing hydraulic and sediment issues for 2-year and 5-year discharges for existing conditions and proposed conditions mitigating with rip-rap ..... Section 2

Technical Memorandum Meyer 20 March 2017 – Revised hydrology to include 2-year flow (Incorporated by reference and included as an update to Deliverable 3) .....

Executive Summary

Deliverable No. 4 – This Technical Memorandum (TM), Deliverable No. 4, addresses hydraulic and sediment analysis for the Caliente Creek project. The mission of the overall feasibility study is to recommend a solution that will minimize flooding and sediment transport to areas downstream of the study area, increase groundwater recharge within the study area and minimize long-term operations and maintenance effort needed for the proposed improvements. Based on Kern County's direction during the course of the study, the proposed solution is to convert the project area back to a natural condition. Grading and other improvements will serve to remove channelization and promote the spreading of storm water. Hardened improvements such as diversion structures and sediment basins are not part of the proposed solution since they require considerable maintenance. The natural condition was chosen to provide that benefit and to do so with a minimum maintenance effort.

The two storms addressed are the 5-year and 2-year events. The original scope of work defined in the AECOM contract called for analysis of the 5-year and 10-year events. After reviewing the results of the 5-year event with Kern County, however, AECOM and Kern County determined that analysis of the 2-year event would be of greater value and more reflecting of the chronic problems that Kern County faces during more frequent smaller storm events.

The TM represents a collaborative effort within the team to present Kern County with two improvement options for the 2 and 5 year storm events. The first proposed improvement option is to regrade the site and plant it with native drought-resistant vegetation to better facilitate spreading and infiltrating storm water. The second proposed improvement option includes those recommended for the first option and adds rip-rap at strategic locations to further reduce erosion and sediment transport.

The models that analyzed these conditions were developed using Flo-2D, a two dimensional model with many applications throughout Kern County. The surface upon which the model was run was developed using aerial photogrammetry (Deliverable 1) with a 2-foot contour interval for excellent study-level resolution. Due to the vast area analyzed, the model was divided into two parts; upstream of Highway 58 (North Model) and downstream of Highway 58 (South Model). Illustrations of these areas are contained in the memoranda that follow.

This TM is divided into three separate and distinct technical memoranda. The first TM prepared by Psomas, provides background and full technical basis for the modeling. It includes modeling of the existing conditions and proposed conditions looking at vegetation only (no rip-rap). The second TM, prepared by Meyer Civil Engineering was prepared at the project manager's request, to look at the effect of placing rip-rap at strategic locations (Bridge crossings, culvert outlets, in-flow and out-flow locations and areas where high velocities occur). The third technical memorandum, also prepared by Meyer Civil Engineering, is an update to the hydrology report to include the 2-year event. This third TM is incorporated by reference and will serve as an update to the original Deliverable No. 3.

On the following page is a numerical summary of model run results presented in two tables; Table A and Table B. Table A summarizes the results of the 5-year, 24 hour storm event. It looks at existing conditions and two proposed conditions: Plantings only and Plantings with rip-rap (modeled as rigid bed tiles). Table B summarizes the results of existing and the same two proposed conditions analyzed in Table A for the 2-year, 24 hour event storm. As one may observe, the plantings provide the greatest benefit in terms of on-site water retention; where rip-rap provides the greatest benefit in terms of reducing scour and sediment transport. The draft and final feasibility studies will address and make recommendations on the improvements best suited for Kern County.

****

Executive Summary

TABLE A – Summary of Values from Models under the 5 Year, 24 Hour Event (Design Storm)

1 Model	2 Water Inflow, AF	3 Water Infiltration, AF	4 Water Outflow, AF	5 Inundated Area, AC	6 Sediment Inflow, CF	7 Sediment Remaining, CF	8 Sediment Leaving, CF
1.a. North Project, Existing Condition	5,860	3,532	2,324	997	581,128	515,910	65,218
1.b. North Project, Proposed Condition, without Rigid Bed Tiles	5,860	3,832	2,026	1077	581,128	509,006	72,121
1.c. North Project, Proposed Condition with Rigid Bed Tiles	5,860	3,936	1,811	1,113	581,143	564,253	16,889
2.a. South Project, Existing Condition	2,325	1,216	1,110	652	47,231	-90,819	138,050
2.b. South Project, Proposed Condition, without Rigid Bed Tiles	1,927	1,387	540	746	191,065	119,122	71,942
2.c. South Project, Proposed Condition with Rigid Bed Tiles	1,811	1,321	704	418	16,898	14,171	2,727

TABLE B – Summary of Values from Models under the 2 Year, 24 Hour Event

1 Model	2 Water Inflow, AF	3 Water Infiltration, AF	4 Water Outflow, AF	5 Inundated Area, AC	6 Sediment Inflow, CF	7 Sediment Remaining, CF	8 Sediment Leaving, CF
1.a. North Project, Existing Condition	3,010	2,429	495	823	298,502	287,963	10,539
1.b. North Project, Proposed Condition, without Rigid Bed Tiles	3,010	2,758	153	978	298,502	295,115	3,386
1.c. North Project, Proposed Condition with Rigid Bed Tiles	3,010	2,769	141	983	298,501	298,090	410
2.a. South Project, Existing Condition	495	315	159	195	10,539	-1,035	11,575
2.b. South Project, Proposed Condition, without Rigid Bed Tiles	153	141	0	117	3,386	3,386	0
2.c. South Project, Proposed Condition with Rigid Bed Tiles	141	130	0	109	410	410	0

To: Bill Black, PE
From: David A. Jaffe, PhD, PE, D.WRE
Date: March 20, 2017
Subject: Caliente Creek Habitat Mitigation and Groundwater Recharge
Job #: 7AEC160101

TECHNICAL MEMORANDUM

1 Executive Summary

The purpose of this study is to support efforts to reduce flooding and sediment yield below Caliente Creek's alluvial plain, Kern County, California, as well as increase groundwater recharge. The analyses contained herein are part of the larger Caliente Creek habitat mitigation and groundwater recharge feasibility study. Psomas has conducted watershed sediment yield using MUSLE and Tatum methodologies (see Section 5 and the Appendix); performed channel, surface flow hydraulics, and two dimensional sediment transport using the FLO-2D computational model (see Section 7 and the Appendix); estimated stream sediment transport potential at discrete locations within the project's study area using the SAM numerical model (see Section 8 and the Appendix). All FLO-2D analysis was conducted for the 2- and 5-year return period runoff. Model runs for the 2-year return period runoff were conducted by Meyer (2017).

The 2- and 5-year modeling of infiltration illustrates an increase between the existing and proposed condition. As a result the total outflow from the model grid system in the south models reduces, and the average grid discharge reduces. Therefore, the modeling suggests that the proposed condition will infiltrate more ground water and have a lower potential to scour, trapping more sediment, than the existing condition.

2 Introduction

The purpose of this study is to support efforts to reduce flooding and sediment yield below Caliente Creek's alluvial plain, Kern County, California, as well as increase groundwater recharge. The analyses contained herein are part of the larger Caliente Creek habitat mitigation and groundwater recharge feasibility study. Historical aerial photography of the study area suggests that changes in land use on the alluvial plain have altered the surface flow patterns. These changes in flow patterns may resulted in increased runoff and sediment yield by reducing infiltration and increasing sediment transport capacity across the floodplain surface.

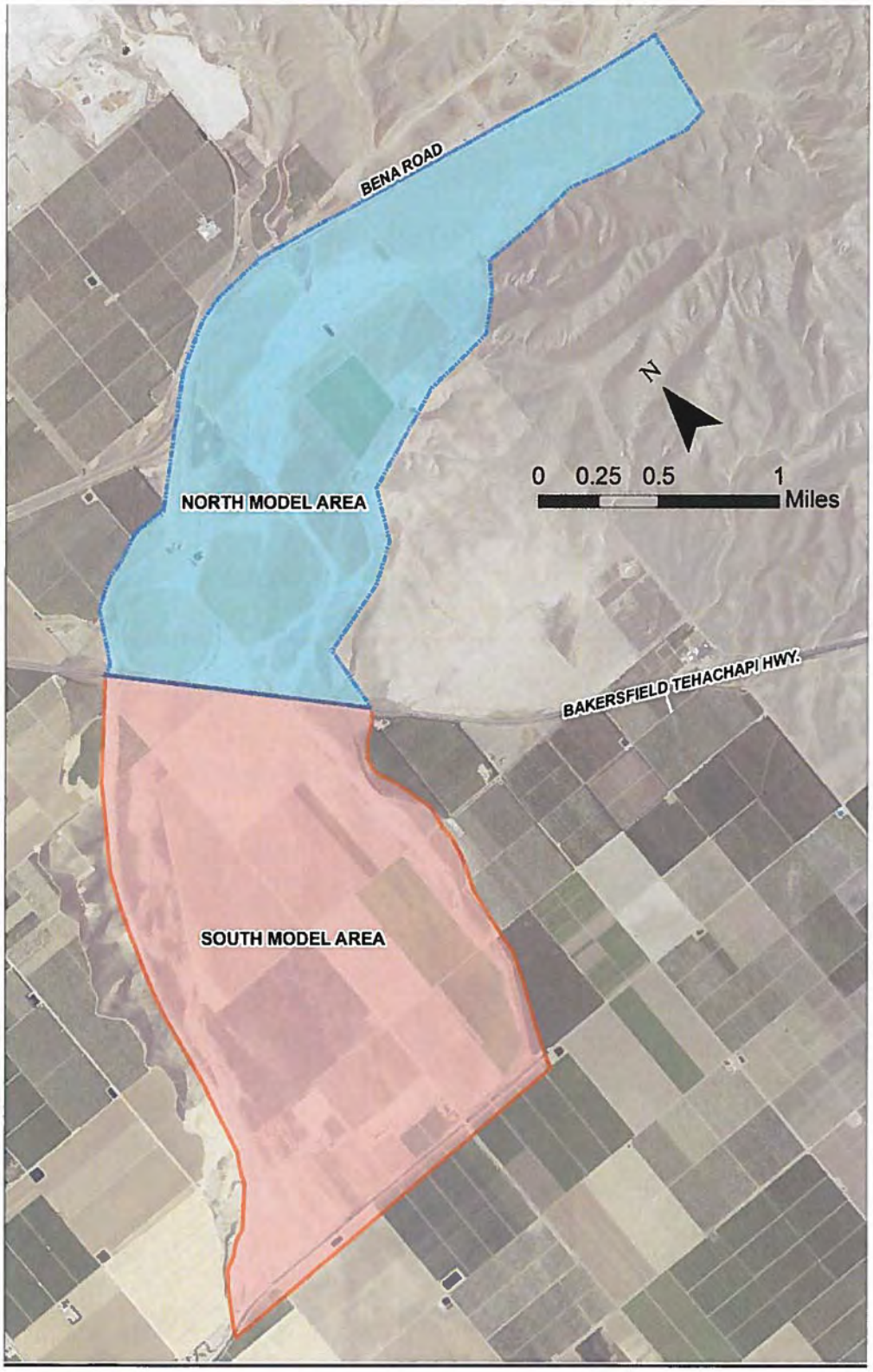
To help achieve these goals Psomas has conducted watershed sediment yield using MUSLE and Tatum methodologies (see Section 5 and the Appendix); performed channel, surface flow hydraulics, and two dimensional sediment transport using the FLO-2D computational model (see

Section 7 and the Appendix); estimated stream sediment transport potential at discrete locations within the project's study area using the SAM numerical model (see Section 8 and the Appendix); and participated in meetings with the overall project team. All FLO-2D analysis was conducted for the 2- and 5-year return period runoff. Model runs for the 2-year return period runoff were conducted by Meyer (2017). The input and output files associated with these analyses are included in the Appendix of this document. The 10-year return period runoff is not included in this study based on discussions with the County (Progress meeting with County 11/23/16), and no sediment trapping analysis is included since the proposed conditions do not include any sediment basins in an effort to reduce maintenance (Progress meeting with County 11/23/16).

3 STUDY AREA DESCRIPTION

The Caliente Creek watershed is located at the intersection of the southern Sierra Nevada Mountains and the northwesterly section of the Tehachapi Mountains at the southern end of California's Central Valley (CRMP 2000). The watershed is comprised of three major subbasins, which include Caliente, Walker Basin and Tehachapi Creeks, as well as many smaller drainages, and includes approximately 476 square miles (Meyer 2016) of tributary area. The elevations within the study area range from approximately 600 feet to approximately 8,000 feet above mean sea level. The watershed is largely ephemeral and runoff events are typically irregular and intense. The study area (Figure 1) is located below Edison Highway on the alluvial plain formed by the confluence of Caliente and Walker Basin Creeks.

Figure 1: Study Area



4 PREVIOUS STUDIES

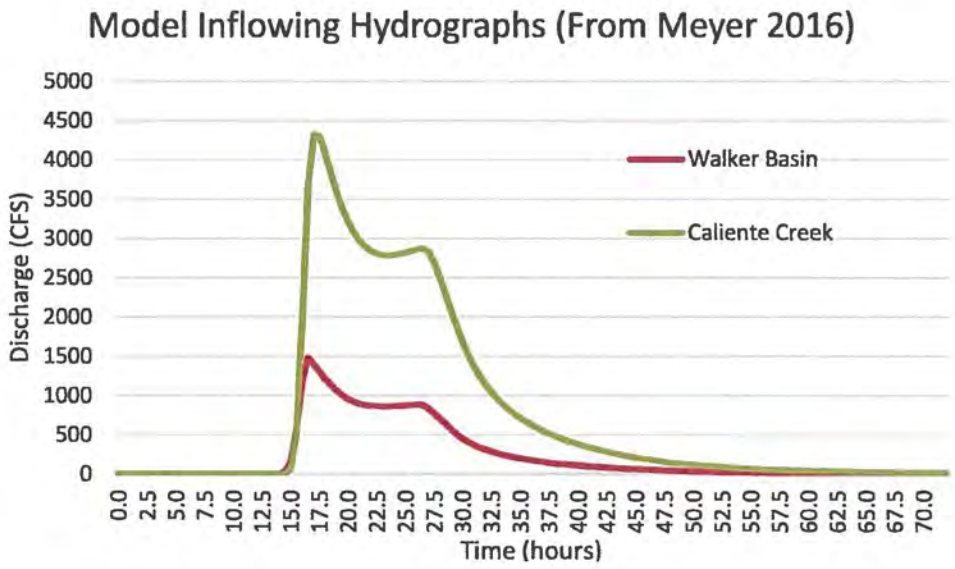
The project study area has a long history of flood analyses, the first of which was completed in 1940 by the United States Army Corps of Engineers (ACOE). Subsequent ACOE flood studies were completed in 1949, 1951, 1966, 1981 and 1995 (CRMP 2000). Non-ACOE flood studies number approximately nine and were conducted by, or on behalf of. Arvin Edison Water District, the State of California, Kern County Water Agency, United States Soil Conservation Service, and the Federal Insurance Administration (CRMP 2000).

Concurrent with the present study are two additional studies that support the larger Caliente Creek habitat mitigation and groundwater recharge project led by AECOM. These include Meyer (2016) and BSK (2016). Meyer (2016) developed the 2-, 5- and 10-year, 24-hour event hydrographs for the project area using HEC-HMS. BSK (2016) performed a preliminary geotechnical investigation that included sieve analysis of sediment samples taken within the study area, geotechnical borings within the study area, and percolation testing within the study area. Data from both of these studies is utilized in the present effort, as described below.

5 HYDROLOGY

Hydrology for the present study is taken from Meyer (2016) and includes the 5-year, 24-hour hydrographs for Caliente and Walker Basin Creeks at Edison Highway. These hydrographs are shown in Figure 2. The 2-year, 24-hour event hydrograph is developed and described in Meyer (2017).

Figure 2: Caliente and Walker Basin Creeks
5-year, 24-hour hydrographs at Edison Highway



6 WATERSHED SEDIMENT YIELD

To estimate the sediment delivery of the Caliente Creek, sediment production from the tributary watershed has been estimated. No direct measurement of sediment yield for the watershed is currently available. To estimate watershed sediment yield, the Modified Universal Soil Loss Equation (MUSLE) and Army Corps of Engineers (ACOE) (Tatum) methods for watershed sediment yield prediction are employed. These two methods are chosen because they are widely used, extensively recognized, and well-reviewed in the available literature. Neither method was originally intended for application in Tehachapi Mountains. MUSLE was originally developed for experimental watersheds in Texas and Nebraska (WEST 1994), and ACOE (Tatum) was originally developed for coastal Southern California watersheds (ACOE 2000), both of which are geologically and climatologically different from the study area. In both cases, however, there are procedures outlined for each method to account for the differences in watershed parameters used in the calculations. Specifically, ACOE (Tatum) discusses parameter adjustments in Appendix B, and AMAFCA (WEST 1994) indicates that MUSLE runoff energy coefficients can be adequately adjusted to represent watersheds outside of the original study area. Finally, it is important to recognize that these methods are an attempt to represent the bounds in which the actual watershed sediment yield lies. The paucity of data in the watershed creates a certain level of uncertainty with any analysis, and the use of multiple methods to arrive at an answer range is more likely to produce representative results than a single method.

The MUSLE method (WEST 1994) utilizes an empirical equation that considers storm energy runoff, soil erodibility, topographic relief, vegetative cover, and an erosion factor to estimate sediment yield, given as:

$$\mathbf{Ys = Rw\ K\ LS\ C\ P}$$

where storm energy runoff is given by $Rw = \alpha VQ^{\beta}$, α and β are calculation coefficients, V is the volume of runoff during the design event, Q is the peak discharge during the design event, soil erodibility is given by K, topographic relief is given by $LS = (\lambda/72.6)^m (65.41 \sin^2 S + 4.56 \sin S + 0.065)$, slope length is given by λ, percent slope is given by S, vegetative cover is given by C, and erosion factor is given by P. The variable m is a slope contingent variable; 0.5 if the slope angle is greater than 5%; 0.4 on slopes of 3% to 5%; 0.3 on slopes of 1% to 3%; 0.2 on slopes less than 1% (Hickey 2000).

The vegetative cover value was based on a review of available aerial photography of the watershed (Google Earth, image date 7/15/2016). The watershed as a whole appears to be typified by 20% cover in contact with the soil dominated by herbaceous plants and including a canopy of 25% total cover. A mix of covers based on a random sample of watershed subareas

was used to ultimately develop the value of C. The values of α and β can be adjusted based on AMAFCA (1994) to account for the unique runoff energy coefficients of the study watershed. However, they are left at the standard values of 95 and 0.056, respectively, in the absence of documented calibration. Values for Rw, K and LS are based on individual subareas as defined in Meyer (2016). P is set at P=1 for all subareas since no erosion control factors are in place in the watershed.

Using the MUSLE equation, watershed sediment yield estimation based on the design hydrologic event (Ys, tons) for Caliente Creek at the most downstream subarea is given as:

$$Ys = 2{,}246 \text{ tons}$$

The values of sediment yield using the MUSLE equation for each subarea within the tributary watershed can be found in the Appendix.

The ACOE (Tatum) method is based on regression analysis of coastal Southern California watershed sediment yields. The ACOE (Tatum) method considers unit peak runoff, tributary topography, drainage area, and potential fire impacts. The equation for yield for the peak hydrologic event, DY, for the Caliente Creek watershed is given as:

$$\mathbf{Log(DY) = C_Q\ Log(Qu) + C_{RR}\ Log(RR) + C_A\ Log(A) + C_{FF}\ FF}$$

where Qu = Q/A, and A is the area, RR is the relief ratio, and FF is the fire factor, a parameter that considers the burn frequency and burn percent. C_Q, C_{RR}, C_A, and C_{FF} are coefficients defined by the size of the study area. The values are taken from ACOE (2000) and presented in the Appendix. For all analyses FF is set to 3 indicating that the most recent burn was 10 years prior to the analysis. The equation is modified (the debris yield multiplied) by an A-T factor that accounts for soil type when compared to a baseline. Typically the A-T factor can be used for calibration. In the present study A-T is developed using soil survey data, and the parameters are shown in the Appendix. Moreover, RR and Q are based on individual subareas as defined in Meyer (2016).

Using the ACOE (Tatum) equation, watershed sediment yield estimation based on the design hydrologic event (DY, tons) for Caliente Creek at the most downstream subarea is given as:

$$DY = 20{,}003 \text{ tons}$$

assuming 1.7 g/cm^3 for sediment, resulting in an order-of-magnitude increase in the quantity predicted by the MUSLE method. Such differences are not uncommon between the two methods and the actual value is expected to range between these two values during the design event. The

values of sediment yield using the ACOE (Tatum) equation for each subarea within the tributary watershed can be found in the Appendix.

Finally, it is important to highlight that watershed debris yields developed in this study do not include calibration since the data required to complete a calibration is not known to exist at the time of writing.

7 ON-SITE SEDIMENT CHARACTERIZATION AND SURFACE INFILTRATION

Sediment Grain Size Data

Sediment data for the present study is taken from BSK (2016) and includes sieve analysis for 18 samples. The samples were taken at six different locations and the sample depths ranged from 0.5 to 5.5 feet. A complete description of the sediment data, the sampling methodology and the sampling locations can be found in BSK (2016). The raw sediment data and the overall average grain size distribution for the project are illustrated in Figures 3 and 4, respectively.

Figure 3: Caliente Creek grain size distribution, by location

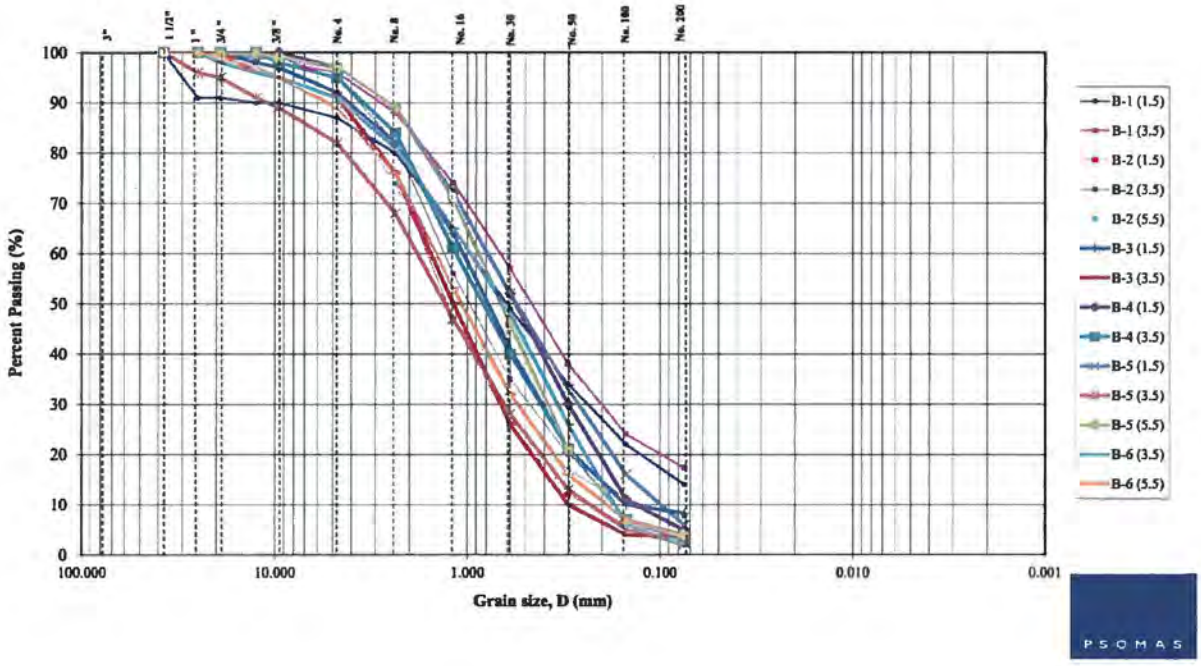


Figure 4: Caliente Creek average grain size distribution

Infiltration Data

BSK (2016) includes percolation tests at six locations within the study area. These locations are collocated with the sediment sampling, described above. The percolation tests found rates ranging from 0.05 to 0.40 minutes per inch. Previous studies found that the study area has an infiltration rate of approximately 0.03 minutes per inch (CRMP 2000). Numerical modeling for the present study utilizes that 0.03 minutes per inch value since it is more conservative and in line with values published in the soil survey of the area. The use of this data in surface water numerical modeling is described below.

8 ON-SITE HYDRAULICS

FLO-2D Overview

The FLO-2D numerical model is designed to be utilized for delineating flood hazards or designing flood mitigation. The model is made up of a series of computational parameter modules that separate an analysis into component parts including overland flow and other physical features. In FLO-2D modeling the equations of motion in two dimensions contain a mass and momentum balance and take the form,

$$\frac{\partial h}{\partial t}+\frac{\partial hv_x}{\partial x}+\frac{\partial hv_y}{\partial y}=i$$

$$S_{fx}=S_{ox}-\frac{\partial h}{\partial x}-\frac{v_x\partial v_x}{\partial x}-\frac{v_y\partial v_x}{g\partial y}-\frac{\partial v_x}{g\partial t}$$

$$S_{fy}=S_{oy}-\frac{\partial h}{\partial y}-\frac{v_y\partial v_y}{\partial y}-\frac{v_x\partial v_y}{g\partial y}-\frac{\partial v_y}{g\partial t}$$

where subscripts x and y represent the two component directions, i is inputs (e.g. precipitation), and So is the bedslope. A diffusive wave approximation neglects the last three terms on the right hand side of the latter two equations. In the case of the diffusive wave approximation, the accelerations are ignored but pressure gradients participate in the balance of momentum and balance bed slope and bed friction leaving,

$$\frac{\partial h}{\partial x}=S_{ox}-S_{fx}$$
$$\frac{\partial h}{\partial y}=S_{oy}-S_{fy}$$

This is an important difference compared with a one-dimensional model such as HEC-RAS. The diffusion model is not restricted to channels, and the time dependent components allow for

discharge to vary during a simulation. Unlike HEC-RAS, FLO-2D uses a complex set of equations, which require detailed numerical methods to solve them. In the case of FLO-2D, the differential form of Equations are solved with a central, explicit, finite difference scheme such that the discharge across one grid element boundary into another is accomplished one element at a time. The uniform grid elements that comprise the model are used to calculate discharge in eight flow directions: four compass directions and four compass diagonals.

Numerical computations begin in each grid element by estimating the depth of flow at the boundary between two adjacent elements. The equations of motion are applied to determine the velocity one direction at a time for all eight of the flow directions of a given element. Discharge across the element boundary is calculated by multiplying velocity with the cross-sectional flow area. Once all four boundary element discharges have been calculated, the change in volume for the individual element can be calculated by multiplying the sum of discharges by the time step. The change in water depth can then be determined by dividing the change in volume by the element surface area. Volume conservation is checked at every time step in every computational element to provide a check of accuracy and as a tool to determine if user selected parameters are properly exercised. One of the most important computational components of a finite element numerical scheme is the numerical stability criteria, essentially a limit of the size of the time step. In the case of FLO-2D, the stability is based on the Courant-Friedrich-Levy (CFL) condition, and is variable.

While a complete overview of the full numerical scheme of FLO-2D is beyond the scope of this report, the purpose of this section has been to provide a brief background of the assumptions and formulation of the model. For an in-depth overview, the reader is encouraged to refer to the model's user manual (FLO-2D 2013).

Model Grid Development

Digital topography flown in 2016 was provided by Aerial Photomapping Services. The topography, in the form of a digital elevation model (DEM), was used to create model grids by breaking the modeling into two individual model sections to decrease model run time and increase model resolution. The proposed condition topography was provided by AECOM. The model gridding is discussed below.

Model Assembly

The DEM data provides the model with northing, easting and elevation coordinates, and represents the study area's topography. Following DEM importation to the FLO-2D modeling environment, the actual computation grid system is created. The grid resolution is chosen

considering model run time and computer memory needs. Here, the grid resolution was chosen based on CFL condition, as noted above. Therefore, grid size was determined partially as,

$$\frac{\Delta t}{\Delta x} = \frac{Cr}{(v + c)}$$

where, t is time, x is the grid size, Cr<1 is the Courant number, v is the cross-sectionally averaged velocity and c is the wave celerity. In consideration of the CFL condition a grid size of x=40 feet was chosen because it represented a good compromise between resolution and time step. Early iterations of the model were run with 20 foot resolution, but comparisons with the 40 foot topography showed that the character of the surface flow patterns remained using the coarser grid. The elevation of a particular grid node represents the grid cell area averaged elevation. Similarly, the x and y coordinates of a node represent the center of the individual node. The computational domain for the model within the study area was based on the extent of available high resolution.

Along with elevation data, each grid cell within the computational domain requires a Manning's roughness value. The assigned values for individual grid cells represent the average roughness over the cell's surface area. The roughness values were universally set to n=0.055 in the existing condition. In the proposed condition the Manning's value was set to n=0.110 for large portions of the project site to represent the planting of dense, native scrub species. It is recommended that future analysis confirm that this value accurately represents the achievable plant density for any ultimately selected species. The assigned values are representative of average vegetation density and surface material found on the alluvial surface. Adjustments to Manning's values were made on a cell-by-cell basis to improve model stability and to better represent surface roughness within the model.

The design hydrographs, described in Section 4, above, are used for modeling this study.
As noted above, the FLO-2D modeling effort is broken into two models and two conditions. The first model covers the upper half of the alluvial surface with a downstream boundary approximately represented by California Highway 58. The second model extends from the first model boundary down to the study area's southern boundary (Figure 1). Two conditions were modeled in the present study. These two conditions represent 1) the existing condition, and 2) the proposed condition.

Infiltration testing, as described in Section 6, found an infiltration rate of 150 to 120 inches per hour. Preliminary model runs found that this range of infiltration rates resulted in the model running dry before the flood wave arrived at the downstream model boundary. Subsequent model testing with saturated hydraulic conductivity values from the soil survey of the study area,

approximately 4.0 to 12.7 inches per hour. The area-weighted average saturated hydraulic conductivity is approximately 10.9 inches per hour. As noted above CRMP (2000) reported an infiltration rate of 2.0 inches per hour, which is used for all numerical modeling in the present study.

Model Data Files and Run-Time Parameters

The FLO-2D user interface allows users to enter various model data into input data files that allow the model to be flexible in the variety and use of data, yet allow the model source code to remain robust because no changes are made directly to the code. Each model run time was set in the CONT.DAT file. Also set in CONT.DAT were the maximum overland Froude number, the shallow, overland flow Manning's number.

The full dynamic wave equation was prescribed in the TOLER.DAT file without Manning's value adjustment. Using the dynamic wave equation in lieu of the diffusive wave equation provides more accurate model output because the pressure gradient terms are resolved. This is particularly important in models where complex topography is present. Outflow nodes for both overland flow and channel out outflow were prescribed in the OUTFLOW.DAT file. The infiltration parameters, as described above, were set in the INFIL.DAT file. For all the model runs it was assumed no rainfall is present on the model surface.

FLO-2D Model Adjustment

To optimize the model runs some modifications were made to the model grid and model parameters. The model grid was modified at the inflows and outflow in order to maintain subcritical flow, a FLO-2D model requirement. The model sediment transport equation was originally selected, using the full grain size distribution, to be Engelund-Hansen (see below), a total load equation for primarily sand transport systems (Yang and Huang 2001). Based on recommendations of the model developer the transport was calculated using the median grain size, D_{50}, instead of the full grain size distribution. Additionally, the Zeller-Fullerton was utilized based on model developer recommendations. Zeller-Fullerton is based on the Meyer-Peter and Muller equation is primarily applicable to gravel stream transport (Yang and Huang 2001), however, preliminary comparisons with Engelund-Hansen runs suggest that the either the model code or the present study is insensitive to the differences between these two equations using D_{50} instead of the full grain size distribution. Finally, based on model developer recommendations the inflowing load rating curve was adjusted to facilitate a balanced sediment inflow. This change has no impact on the results since field observations and preliminary model runs indicate that sediment transport within the model system is largely a function of local scour and

deposition on the alluvial surface, and relatively independent of debris yield to the hydrographic apex of the surface.

It should be noted that sediment transport on the model surface is largely independent of sediment inflow. That is, the sediment inflow at the boundary does not impact the sediment transport on the model surface, and what flows in at the upstream boundary is not what flows out at the downstream boundary. This is true of both the north and south models. This behavior is a function of drop in velocity as the inflow spreads out over the alluvial surface, and the velocity drops immediately as water enters the model. This phenomena was observed during a field visit as deposited sediment mounded up below the inflow locations, and it is also quite clear in the perched state of some portions of the surface immediately below the inflow locations as observed in the topography. Moreover, the model boundary condition for FLO-2D was developed so that the inflow of sediment is in a balanced state according to the equilibrium slope. The model boundary conditions enforce normal depth at the outflow.

FLO-2D Model Results

The maximum depths and velocities predicted on Caliente Creek's alluvial surface are presented in Figures 5 and 6, respectively, for the existing 2-year condition, and Figures 7 and 8, respectively, for the for the existing 5-year condition, Figures 9 and 10, respectively, for the proposed 2-year condition, and Figures 11 and 12 for the proposed 5-year condition.

The figures show significant uncontained surface flows during the 2- and 5-year, 24-hour event on the upper surface, however these flows have been impacted by agricultural activity in the existing condition. The impacts are particularly evident where significant diversions toward the east have directed water under the eastern Highway 58 Bridge. Likewise, the lower surface indicates significant impact by agriculture during the 2- and 5-year, 24-hour events, but farming practice has largely eliminated uncontained surface flows. The proposed conditions plots do not show the agricultural channel containment evident in the existing conditions for either the upper or lower models, and a broader flow pattern is observed, particularly in the southern section. The maximum velocities in all models are on the order of 6 fps.

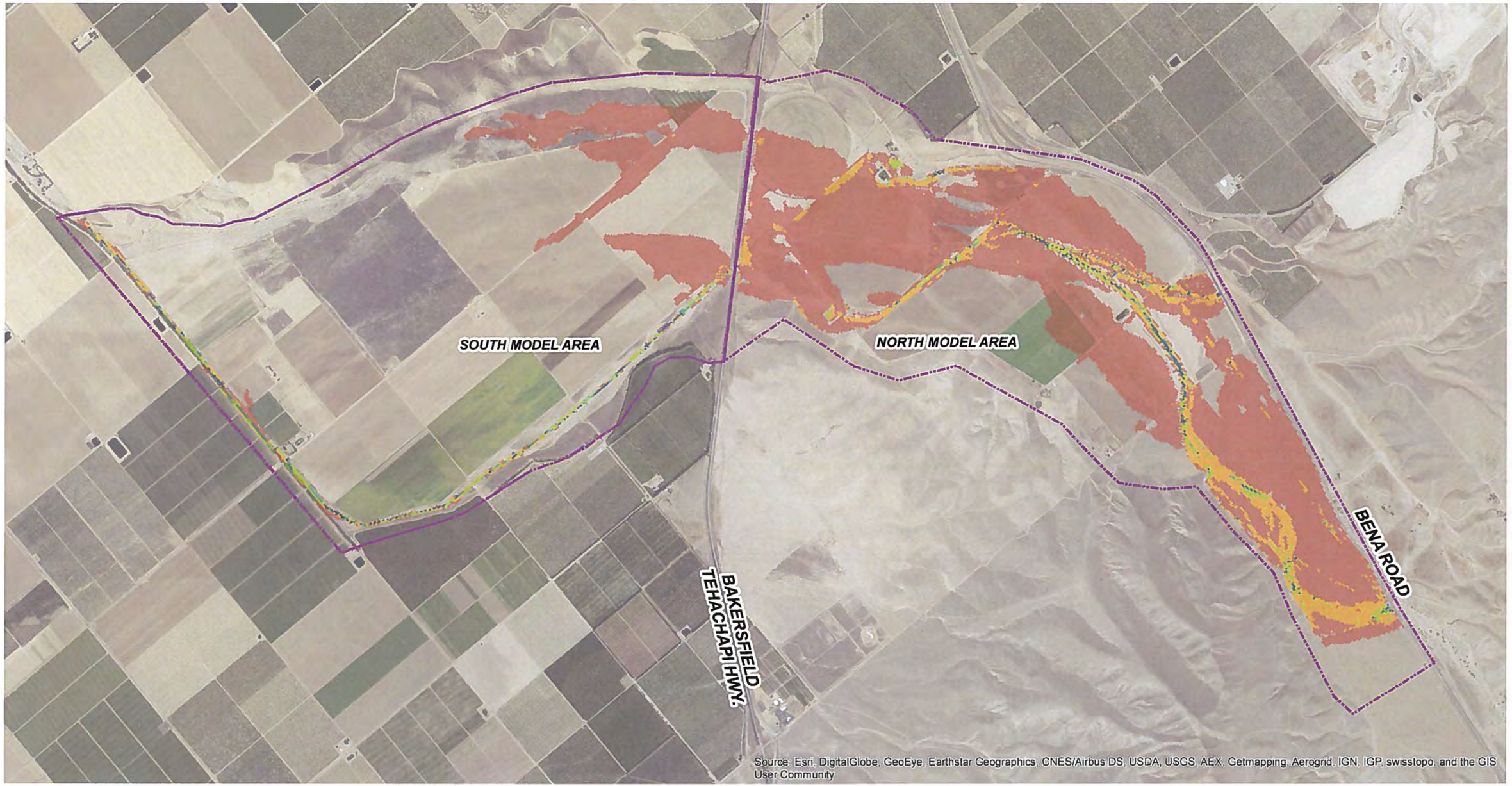
The north model predicts a more north-westerly track of discharge as indicated by the scour and deposition patterns when comparing the existing and proposed conditions, Figures 13-14 and 15-16, and 17-18 and 19-20, respectively, for the 2- and 5-year events. Likewise, the south model predicts that more water will flow unconfined over the study area's surface and toward the west in the proposed condition for both return periods.

During 2-year modeling infiltration in the existing and proposed condition north model is 2,429 and 2,758 ac-ft, respectively, and 315 and 141 ac-ft in the existing and proposed condition south model, respectively. The north and south experience a 13.5 and 123.4% increase in infiltration between the existing and proposed condition, respectively. As a result the total outflow from the model grid system in the south model reduces from 159 ac-ft to 0 ac-ft (note: 12 ac-ft of water remains on the model grid following 90 hours of simulation time), and the maximum inundated area decreases from 195 ac to 117 ac. The reduction in sediment outflow in the lower model is from 11,575 ft^3 in the existing condition to 0 ft^3in the proposed condition. Therefore, the model suggests that the proposed condition will infiltrate more ground water and have a lower potential to scour, trapping more sediment, than the existing condition.

During 5-year modeling infiltration in the existing and proposed condition north model is 3,532 and 3,928 ac-ft, respectively, and 1,216 and 1,387 ac-ft in the existing and proposed condition south model, respectively. The north and south experience an 11.5 and 14.1% increase in infiltration between the existing and proposed condition, respectively. As a result the total outflow from the model grid system in the south model reduces from 1110 ac-ft to 540 ac-ft, the maximum inundated area increases from 653 ac to 733 ac, and the average grid discharge reduces from 12.2 cfs to 6.8 cfs. The reduction in sediment outflow in the lower model is from 138,049 ft^3 in the existing condition to 71,941 ft^3in the proposed condition. Therefore, as in the case of the 2-year event, the model suggests that the proposed condition will infiltrate more ground water and have a lower potential to scour, trapping more sediment, than the existing condition.

Additional runs of the sediment transport FLO-2D models were completed by Meyer (2017) examining a hypothetical scour mitigation within the study area employing rip-rap, which is not described here. Readers are referred to Meyer (2017) for a description of the methods and results.

The full results of the FLO-2D simulations, including input and output files, are presented in the Appendix.



Legend
Flow Depth in Feet

0.1 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | 3.0 - 4.0 | >4.0

FLO2D MODEL BOUNDARY

N

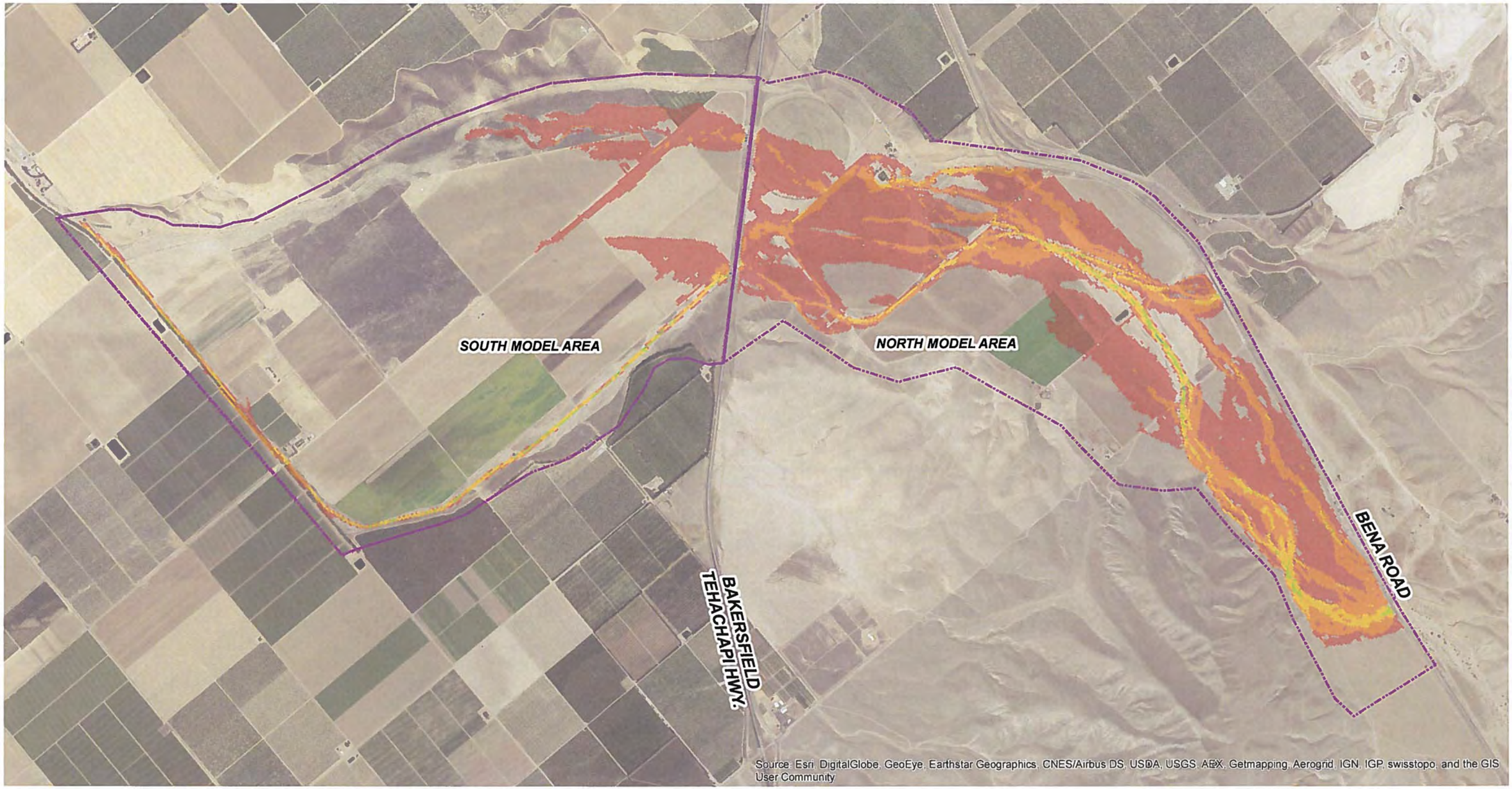
0 1,000 2,000 4,000 6,000 Feet

Caliente Creek

FIGURE 5: ALLUVIAL SURFACE 2- YEAR MAXIMUM FLOW DEPTH EXISTING CONDITIONS

Kern County

PSOMAS



Legend
Flow Velocity in ft/s

0.1 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | 3.0 - 4.0 | 4.0 - 5.0 | 5.0 - 6.0 | >6.0

FLO2D MODEL BOUNDARY

N

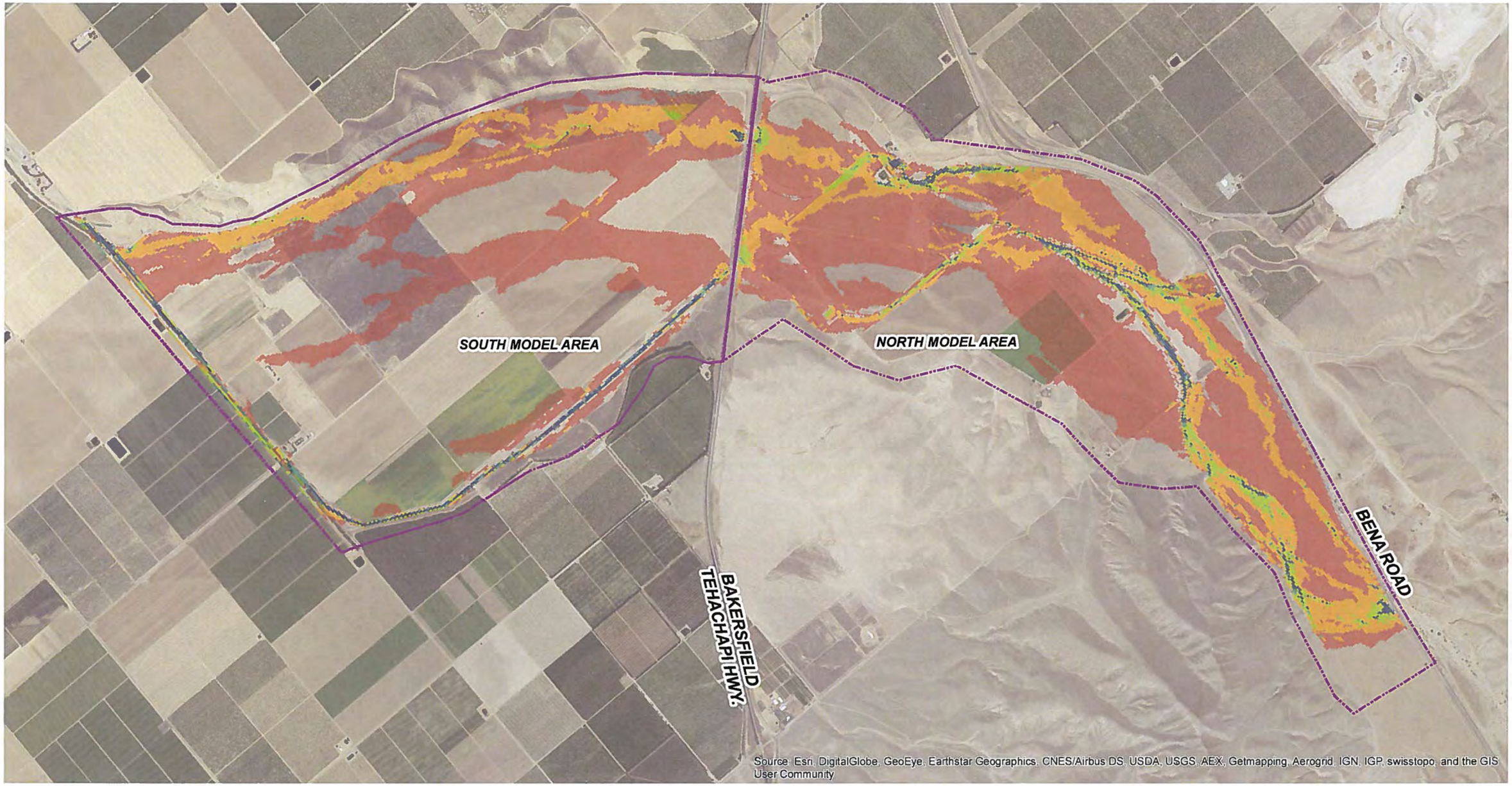
0 1,000 2,000 4,000 6,000 Feet

Caliente Creek

FIGURE 6: ALLUVIAL SURFACE 2- YEAR MAXIMUM VELOCITY EXISTING CONDITIONS

Kern County

PSOMAS



Legend
Flow Depth in Feet

0.1 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | 3.0 - 4.0 | >4.0

FLO2D MODEL BOUNDARY

N

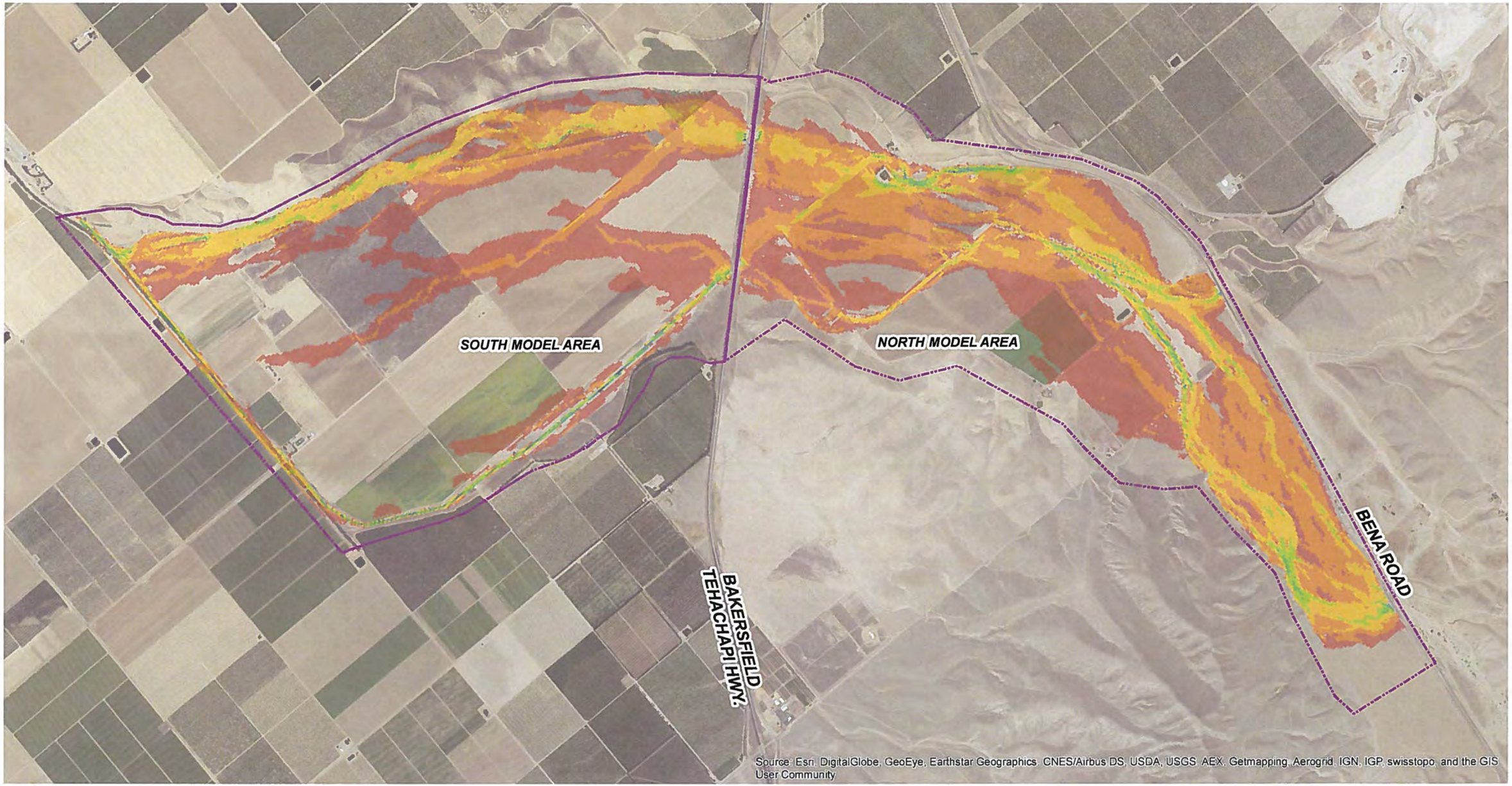
0 1,000 2,000 4,000 6,000 Feet

Caliente Creek

FIGURE 7: ALLUVIAL SURFACE 5-YEAR MAXIMUM FLOW DEPTH EXISTING CONDITIONS

Kern County

PSOMAS



Legend
Flow Velocity in ft/s

0.1 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | 3.0 - 4.0 | 4.0 - 5.0 | 5.0 - 6.0 | >6.0

FLO2D MODEL BOUNDARY

N

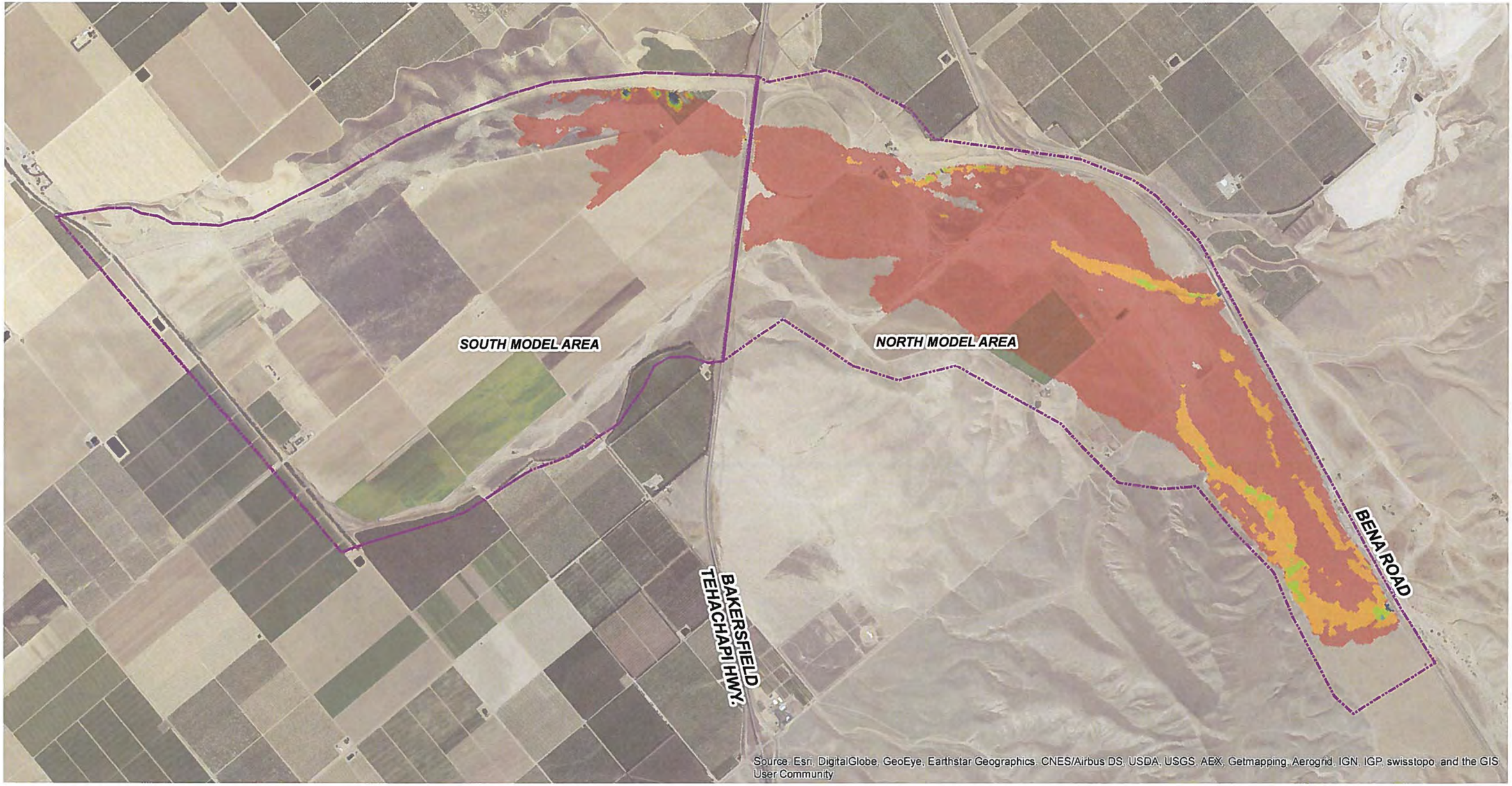
0 1,000 2,000 4,000 6,000 Feet

Caliente Creek

FIGURE 8: ALLUVIAL SURFACE 5-YEAR MAXIMUM FLOW VELOCITY EXISTING CONDITIONS

Kern County

PSOMAS



Legend
Flow Depth in Feet

0.1 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | 3.0 - 4.0 | >4.0

FLO2D MODEL BOUNDARY

N

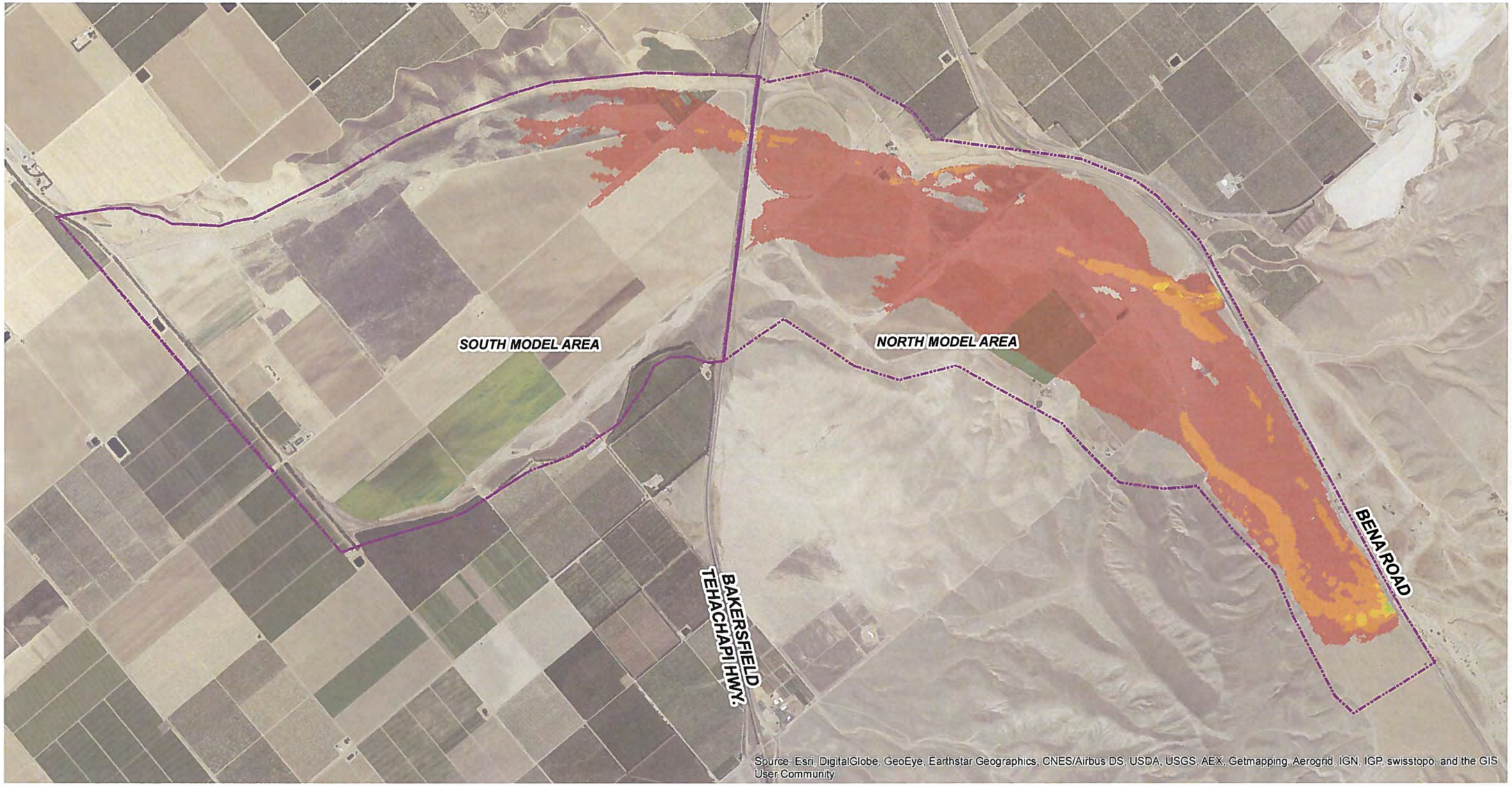
0 1,000 2,000 4,000 6,000 Feet

Caliente Creek

FIGURE 9: ALLUVIAL SURFACE 2- YEAR MAXIMUM FLOW DEPTH PROPOSED CONDITIONS

Kern County

PSOMAS



Legend
Flow Velocity in ft/s

0.1 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | 3.0 - 4.0 | 4.0 - 5.0 | 5.0 - 6.0 | >6.0

FLO2D MODEL BOUNDARY

N

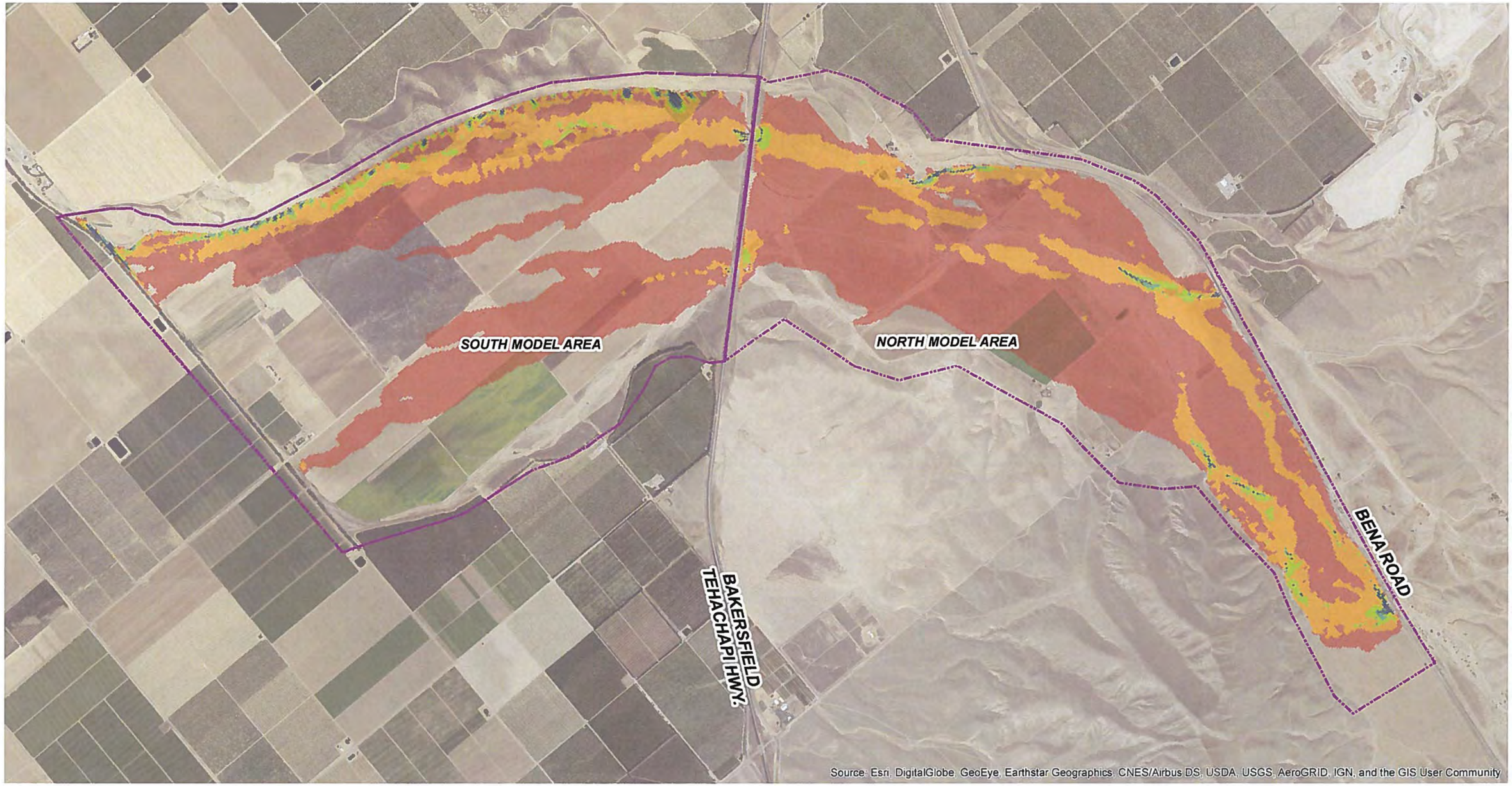
0 1,000 2,000 4,000 6,000 Feet

Caliente Creek

FIGURE 10: ALLUVIAL SURFACE 2- YEAR MAXIMUM VELOCITY PROPOSED CONDITIONS

Kern County

PSOMAS



Legend
Max Flow Depth in Feet

0.1 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | 3.0 - 4.0 | >4.0

FLO2D MODEL BOUNDARY

N

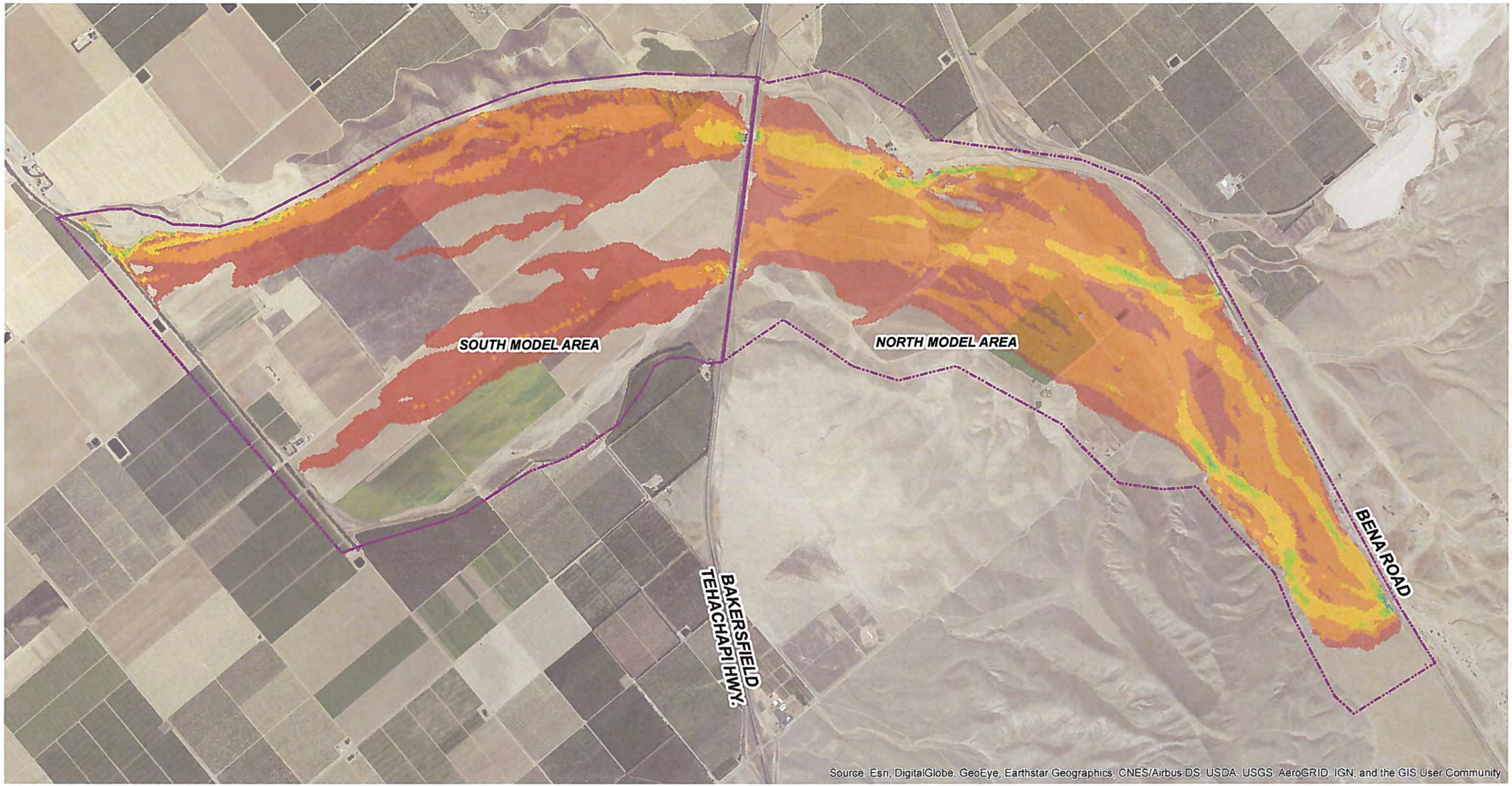
0 1,000 2,000 4,000 6,000 Feet

Caliente Creek

FIGURE 11: ALLUVIAL SURFACE 5-YEAR MAXIMUM FLOW DEPTH PROPOSED CONDITIONS

Kern County

PSOMAS



Legend
Max Flow Velocity in ft/s

0.1 - 1.0 | 1.0 - 2.0 | 2.0 - 3.0 | 3.0 - 4.0 | 4.0 - 5.0 | 5.0 - 6.0 | >6.0

FLO2D MODEL BOUNDARY

N

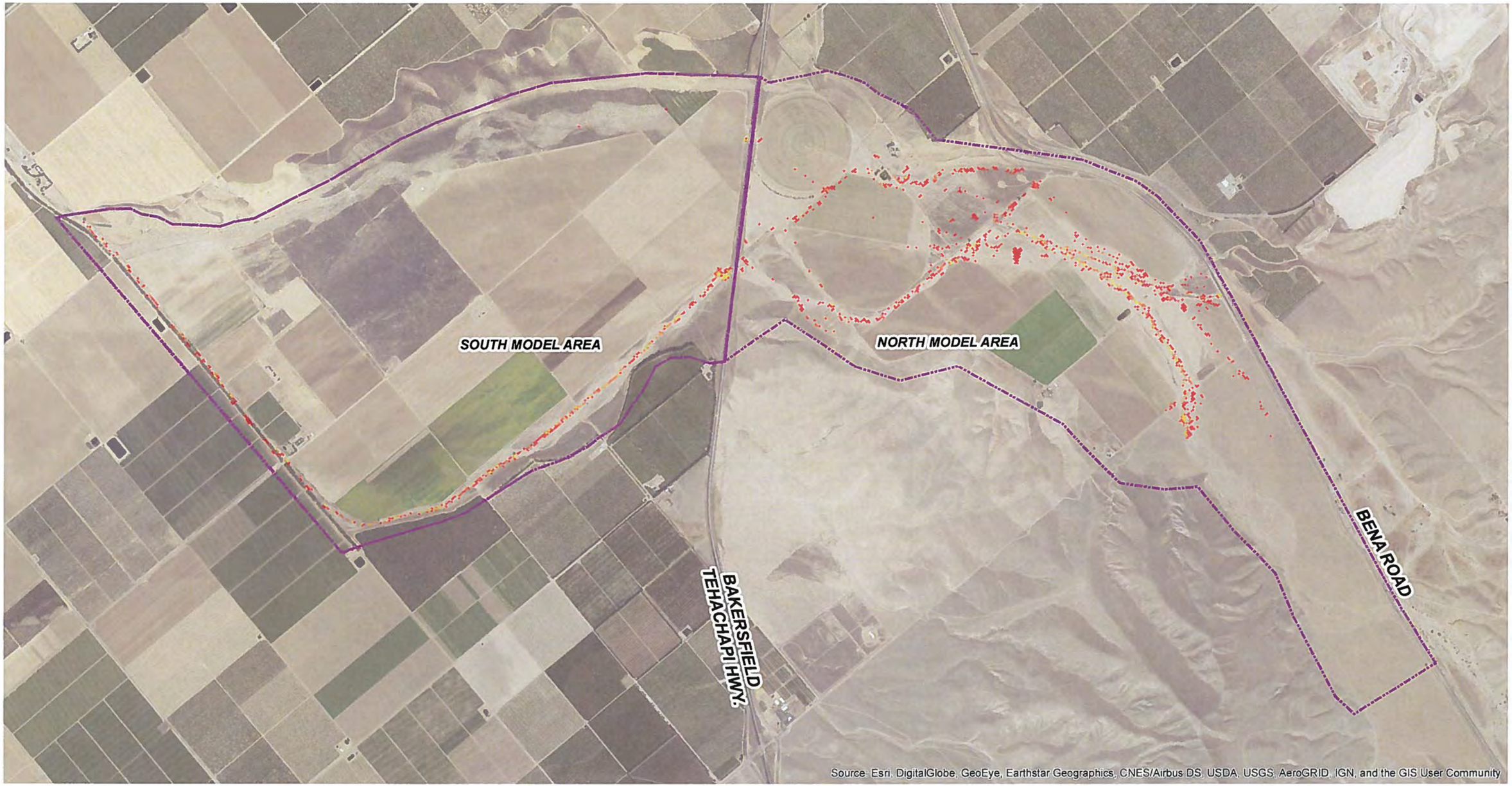
0 1,000 2,000 4,000 6,000 Feet

Caliente Creek

FIGURE 12: ALLUVIAL SURFACE 5-YEAR MAXIMUM FLOW VELOCITY PROPOSED CONDITIONS

Kern County

PSOMAS



Legend
Max Scour Depth in Feet

0.1 - 0.5 | 0.5 - 1.0 | 1.0 - 1.5 | 1.5 - 2.0 | 2.0 - 2.5 | 2.5 - 3.0 | >3.0

FLO2D MODEL BOUNDARY

N

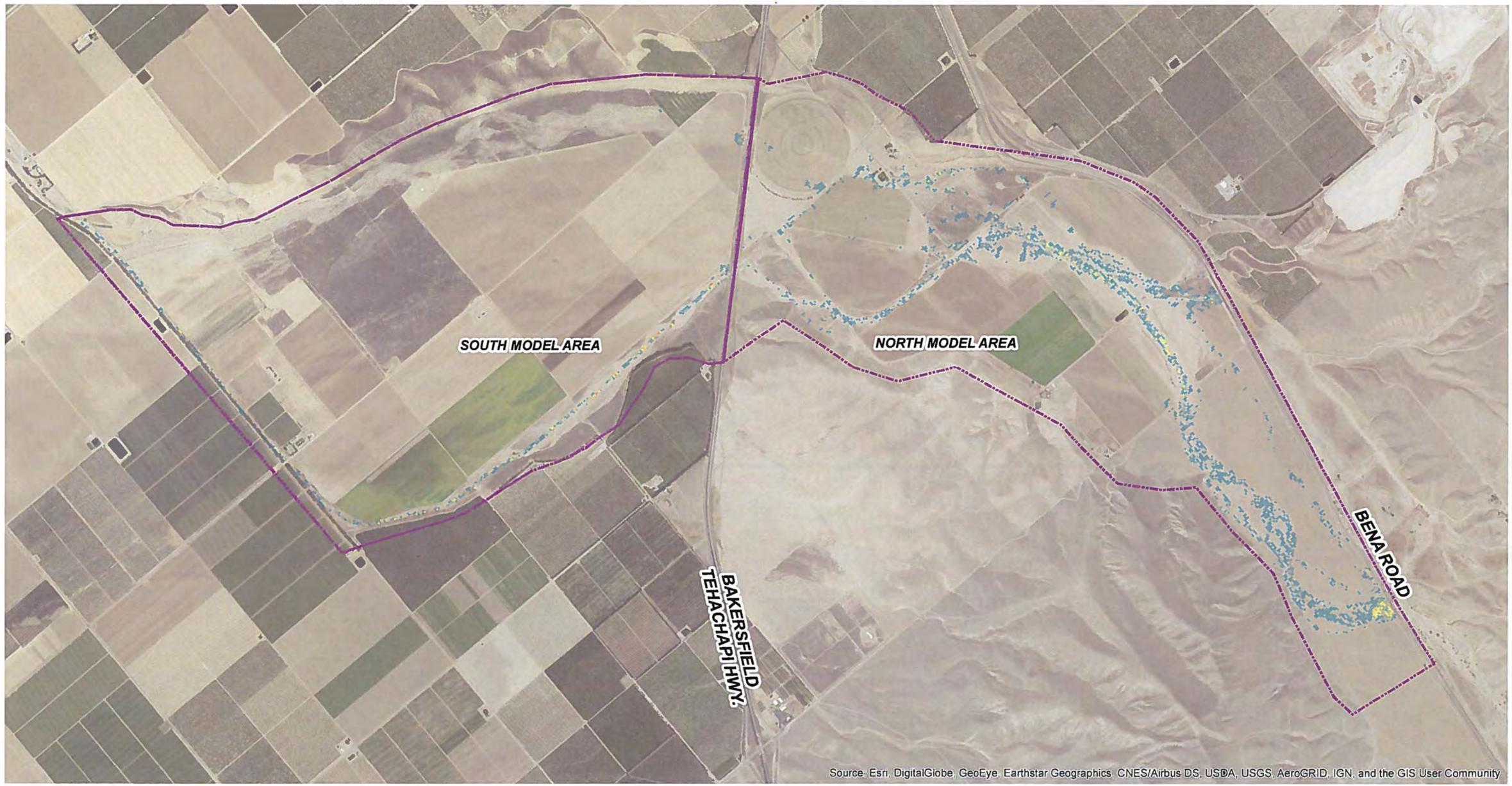
0 1,000 2,000 4,000 6,000 Feet

Caliente Creek

FIGURE 13: ALLUVIAL SURFACE 2-YEAR MAXIMUM SCOUR EXISTING CONDITIONS

Kern County

PSOMAS



Legend
Max Deposition Depth in Feet

0.1 - 0.5 | 0.5 - 1.0 | 1.0 - 1.5 | 1.5 - 2.0 | 2.0 - 2.5 | 2.5 - 3.0 | >3.0

FLO2D MODEL BOUNDARY

N

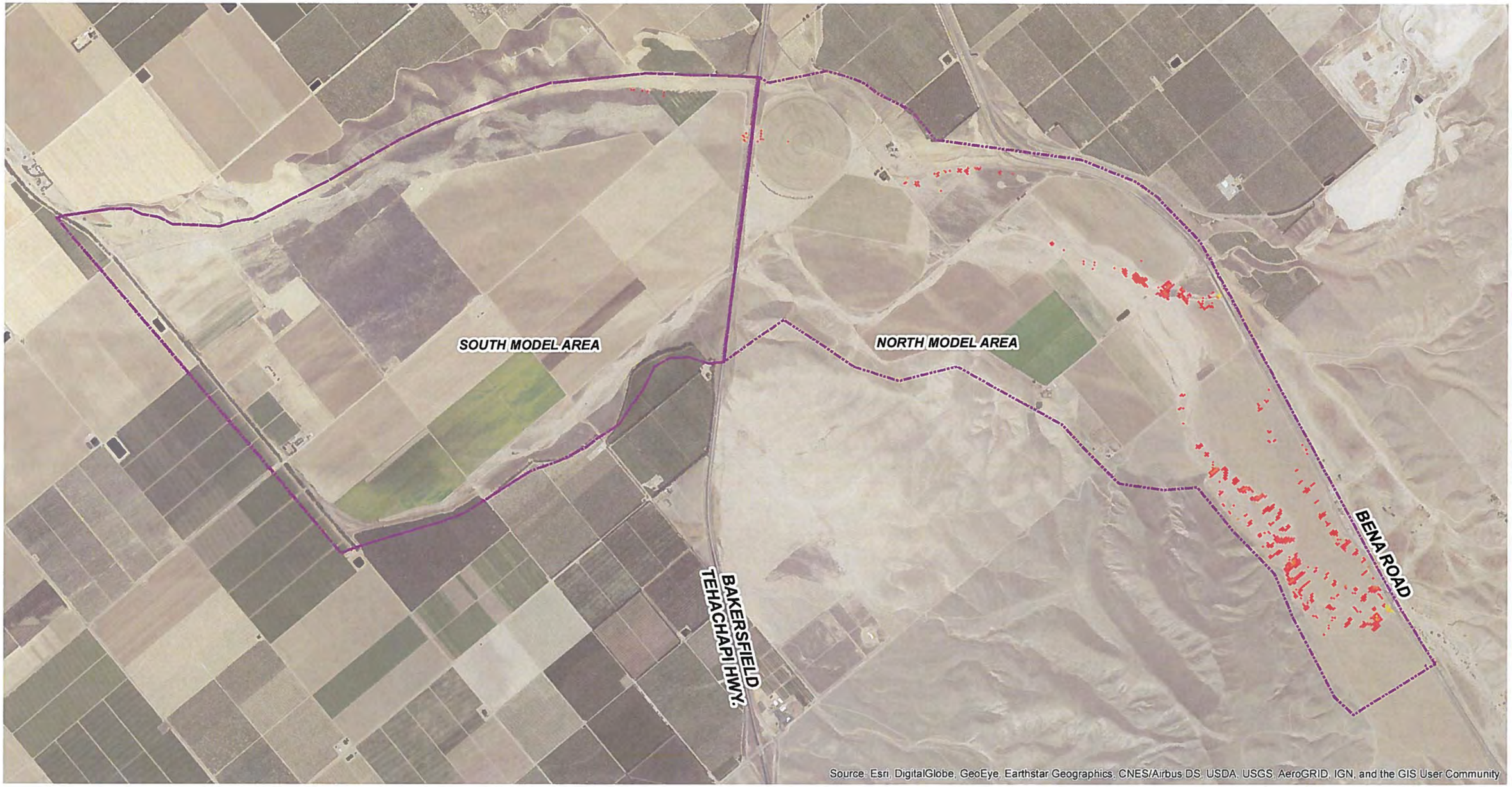
0 1,000 2,000 4,000 6,000 Feet

Caliente Creek

FIGURE 14: ALLUVIAL SURFACE 2-YEAR MAXIMUM DEPOSITION EXISTING CONDITIONS

Kern County

PSOMAS



Legend
Max Scour Depth in Feet

0.1 - 0.5 | 0.5 - 1.0 | 1.0 - 1.5 | 1.5 - 2.0 | 2.0 - 2.5 | 2.5 - 3.0 | >3.0

FLO2D MODEL BOUNDARY

N

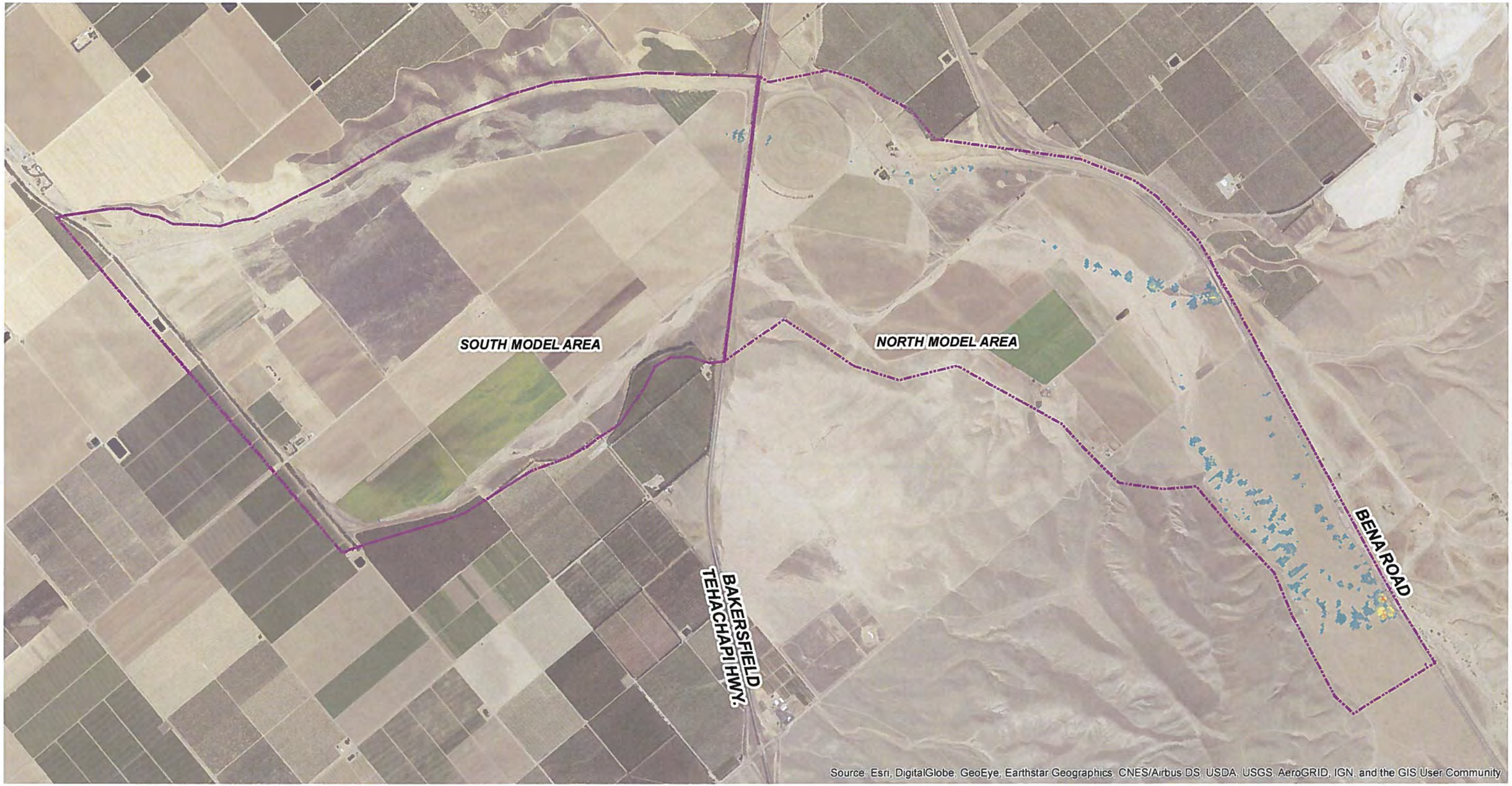
0 1,000 2,000 4,000 6,000 Feet

Caliente Creek

FIGURE 15: ALLUVIAL SURFACE 2-YEAR MAXIMUM SCOUR PROPOSED CONDITIONS

Kern County

PSOMAS



Legend
Max Deposition Depth in Feet

0.1 - 0.5 | 0.5 - 1.0 | 1.0 - 1.5 | 1.5 - 2.0 | 2.0 - 2.5 | 2.5 - 3.0 | >3.0

FLO2D MODEL BOUNDARY

N

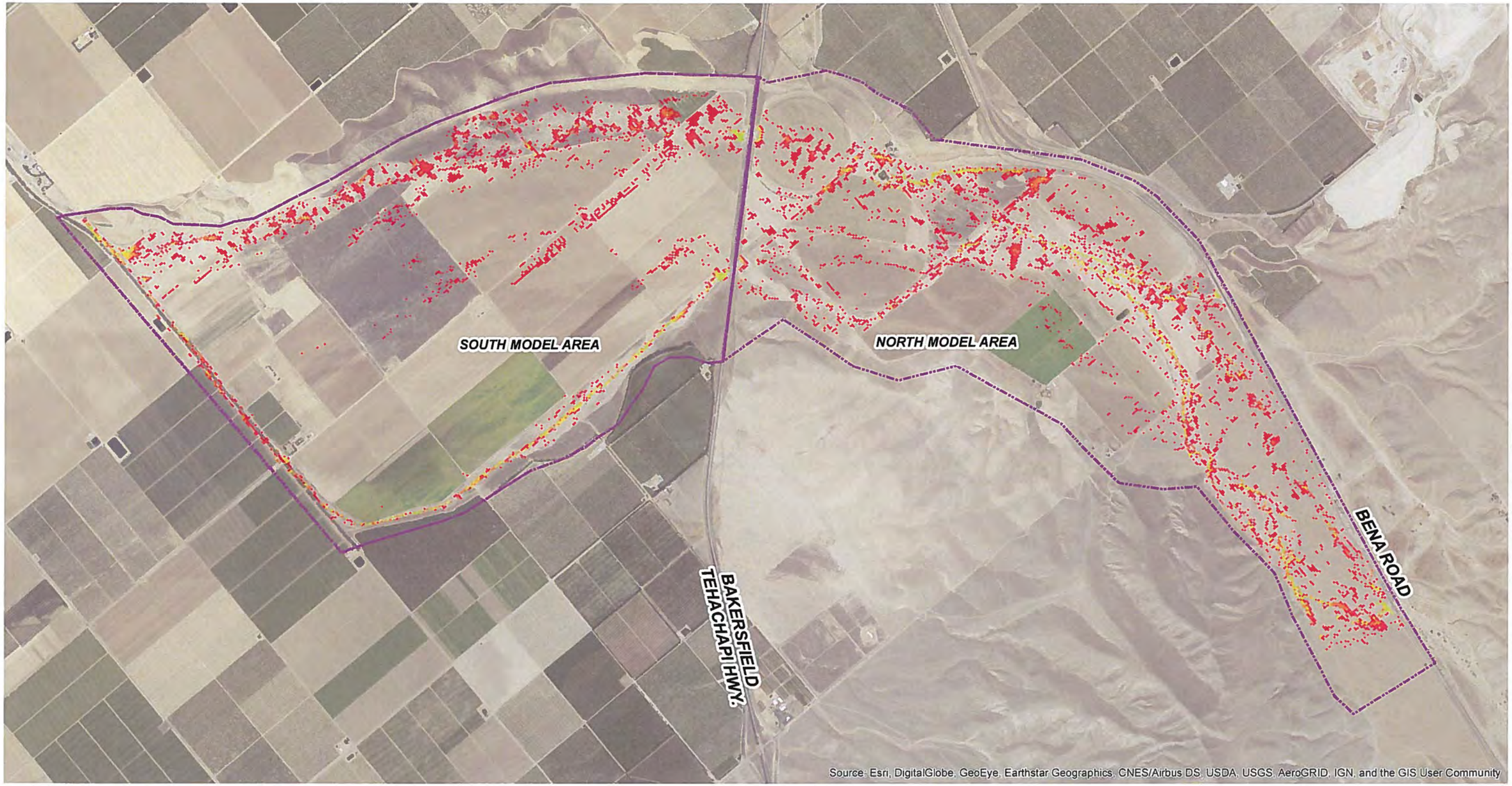
0 1,000 2,000 4,000 6,000 Feet

Caliente Creek

FIGURE 16: ALLUVIAL SURFACE 2-YEAR MAXIMUM DEPOSITION PROPOSED CONDITIONS

Kern County

PSOMAS



Legend
Max Scour Depth in Feet

0.1 - 0.5 | 0.5 - 1.0 | 1.0 - 1.5 | 1.5 - 2.0 | 2.0 - 2.5 | 2.5 - 3.0 | >3.0

FLO2D MODEL BOUNDARY

N

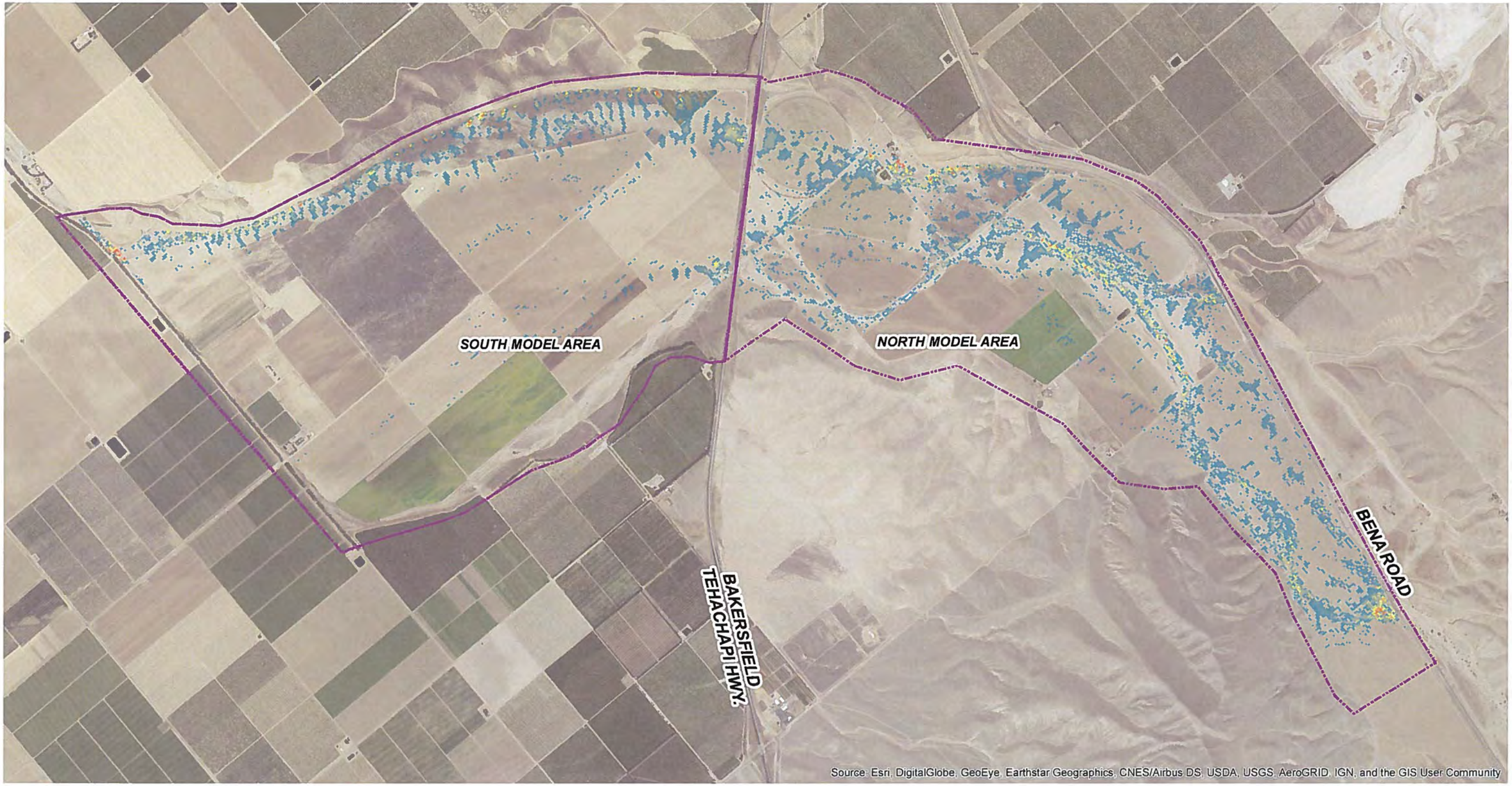
0 1,000 2,000 4,000 6,000 Feet

Caliente Creek

FIGURE 17: ALLUVIAL SURFACE 5-YEAR MAXIMUM SCOUR DEPTH EXISTING CONDITIONS

Kern County

PSOMAS



Legend
Max Deposition Depth in Feet

0.1 - 0.5 | 0.5 - 1.0 | 1.0 - 1.5 | 1.5 - 2.0 | 2.0 - 2.5 | 2.5 - 3.0 | >3.0

FLO2D MODEL BOUNDARY

N

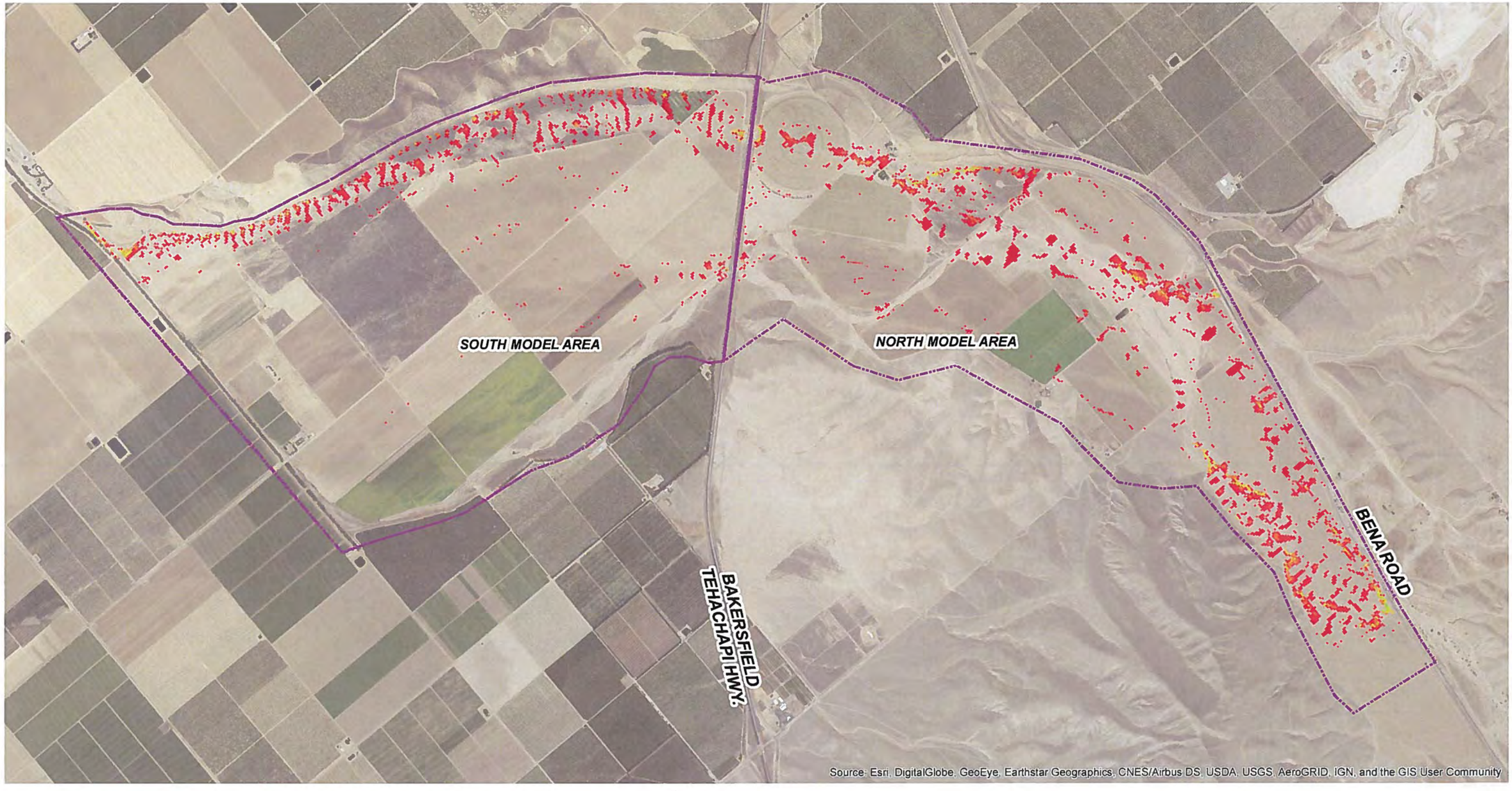
0 1,000 2,000 4,000 6,000 Feet

Caliente Creek

FIGURE 18: ALLUVIAL SURFACE 5-YEAR MAXIMUM DEPOSITION EXISTING CONDITIONS

Kern County

PSOMAS



Legend
Max Scour Depth in Feet

0.1 - 0.5 | 0.5 - 1.0 | 1.0 - 1.5 | 1.5 - 2.0 | 2.0 - 2.5 | 2.5 - 3.0 | >3.0

FLO2D MODEL BOUNDARY

N

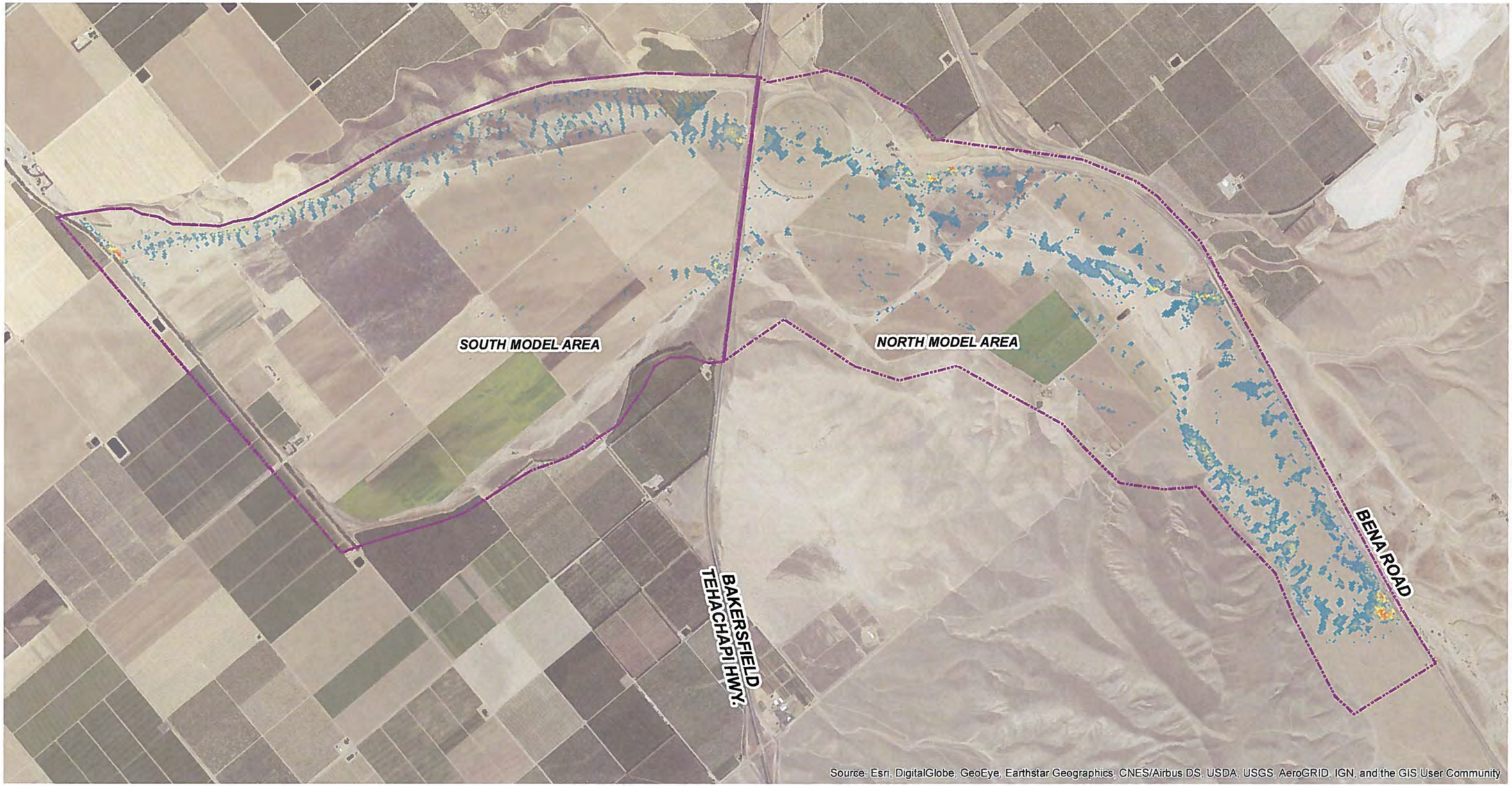
0 1,000 2,000 4,000 6,000 Feet

Caliente Creek

FIGURE 19: ALLUVIAL SURFACE 5-YEAR MAXIMUM SCOUR DEPTH PROPOSED CONDITIONS

Kern County

PSOMAS



Legend
Max Deposition Depth in Feet

0.1 - 0.5 | 0.5 - 1.0 | 1.0 - 1.5 | 1.5 - 2.0 | 2.0 - 2.5 | 2.5 - 3.0 | >3.0

FLO2D MODEL BOUNDARY

N

0 1,000 2,000 4,000 6,000 Feet

Caliente Creek

FIGURE 20: ALLUVIAL SURFACE 5-YEAR MAXIMUM DEPOSITION PROPOSED CONDITIONS

Kern County

PSOMAS

9 ON-SITE SEDIMENT TRANSPORT POTENTIAL

SAM Model

Sediment transport potential was estimated in this study using the US Army Corps of Engineers (ACOE) SAM steady-state numerical model. Here, SAM was employed to provide a first calculation of sediment transport potential for sections on the alluvial surface. The SAM Sediment Hydraulic Package is an integrated system of programs developed through the Flood Damage Reduction and Stream Restoration Research Program to aid in the analyses associated with designing, operating, and maintaining flood control channels and stream restoration projects. SAM combines the hydraulic information and the bed material gradation information to compute the sediment transport capacity for a given channel or floodplain hydraulic cross-section for a given discharge at a single point in time. A number of sediment transport functions are available for this analysis and SAM has the ability to assist in selecting the most appropriate sediment transport equation.

The four primary fluvial components of SAM are SAM.HYD, SAM.SED, SAM.YLD and SAM.AID. SAM.HYD provides a steady state, normal-depth, one-dimensional representation of channel hydraulics. The SAM.SED module combines the hydraulic parameters with the bed material gradation curve to compute bed material discharge rating curves by size classification. SAM.HYD utilizes the output from SAM.SED to estimate steam yield in an unsteady discharge condition. The SAM.AID module provides the user with recommended sediment transport equations based on the best matches between hydraulic parameters and grain size distribution of the study reach with parameters of from widely accepted and published research.

SAM Model Theory and Limitations

The SAM numerical model is built upon hydraulic and fluvial components. The hydraulic components include representations of river bed characteristics that are input into an analytical procedure. The fluvial component includes representation of bed gradation as percent finer statistics and a selection of up to twenty sediment transport equations. The SAM hydraulic component will accept either average reach parameters or cross-section data imported from HEC-2 or HEC-RAS models. Hydraulic modeling is based on a uniform flow equation where discharge is the dependent variable such that,

$$Q = f(D, n, W, z, S)$$

where Q is discharge in cfs, D is flow depth in feet, n is the Manning's number, W is bottom width in feet, z is the channel side slope, and S is the energy slope. The bottom width is representative of the total moveable bed width of the channel and Manning's number is a

composite value. Normal depth is calculated using Manning's equation, and effective values of width and depth are calculated following normal depth calculations.

The fluvial component is based on sediment transport functions to calculate the bed portion of the sediment discharge-rating curve.

The sediment transport equations are of the form,

$$GSi=f(V, D, Se, Be, de, \rho s, Gsf, ds, ib, \rho f, T)$$

where GSi is the transport rate for sediment size class i; the hydraulic terms V, D, Se, and Be, are the average velocity, effective flow depth, energy slope, and effective flow width, respectively; the sediment particle parameters de, ρs, and Gsf are the effective particle size, particle density, and grain size shape factor, respectively; he sediment particle parameters de, ρs, and Gsf are the effective particle size, particle density, and grain size shape factor, respectively; the sediment mixture properties, ds and ib are the geometric mean particle size of sediment class i and fraction of class i in the bed, respectively; and the fluid properties ρf, and T, the water density and temperature, respectively. Twenty well known, published, peer-reviewed transport equations are available including Ackers-White, Colby, Laursen-Copeland, Laursen–Madden, MPM, Toffaleti, Yang, Van Rijn and others. Once the data assembly is complete, the SAM.SED module can be used to create a sediment discharge-rating curve based on grain size distribution. The SAM.YLD module calculates the yield passing a section during a specific period as defined by a hydrograph or duration curve. The hydrograph can range in duration from a specific event to a year or more. Calculations are based on the flow-duration sediment-discharge rating curve method. The reader is referred to the SAM user's documentation for further reference.

It is important to note that the SAM model is a zero-dimensional computational package that is only based on a single cross-section or average of sections at a particular point in time. As such, SAM simulations can only represent a reach average during a steady state discharge. SAM does not recognize armoring of a section during calculations. Because SAM applies sediment transport to a point, no variability in size distribution in either space or time is calculated. With these limitations in mind, in this study SAM is intended to provide a first approximation to sediment transport to which other more sensitive calculations can be compared.

SAM Model Assembly

In this study, hydraulic representation of the channel sections on the alluvial surface is accomplished by cutting sections directly in the topography and entering station-elevation data into the model.

SAM Model Results

SAM modeling of the channel conveying discharges from Walker Basin Creek immediately downstream of the project boundary (Figure 17) projects that for the Yang, Ackers-White, Engelund-Hansen and Van Rijn equations that 2,514, 6,251, 4,376, and 4,033 tons of sediment can be transported through the section. By comparison, subarea CA-08 in which this section is located, is estimated to yield 2,246 and 20,003 tons for the MUSLE and ACOE (Tatum) methods, respectively. These results suggest that it is possible to transport all of the yielded sediment for the subarea through this section. It should be noted, however, that this section is not the limiting section within the study area and other sections of the surface may limit watershed debris yield to the lower alluvial surface. For example, a well-defined channel for Caliente Creek immediately below the model boundary. The absence of such a feature may limit watershed debris yield to the lower alluvial surface. Because of the absence of a well-defined channel for Caliente Creek SAM modeling was not conducted on this section of the alluvial surface.
SAM model input and output files can be found in the Appendix.

Figure 17: Walker Basin Creek SAM cross-section location

10 REFERENCES

1. BSK (2016) Preliminary geotechnical engineering investigation. August 26.

2. FLO-2D (2013) FLO-2D User's Manual.

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4. Kern Lake Coordinated Resource Management and Planning Group (CRMP) 2000. Preliminary status report: flood control and mitigation for the Kern Lake Basin. June.

5. Meyer, R. 2017. Review of sedimentation study and additional modeling for the propose project design for Caliente Creek habitat mitigation and groundwater recharge projects. March 23.

6. Meyer, R. 2016. Hydrology study for the Caliente Creek habitat mitigation and groundwater recharge projects. September 16.

7. United States Army Corps of Engineers (ACOE) (2000) Debris Method: Los Angeles District Method for Prediction of Debris Yield.

8. West Consultants (1994) AMAFCA Sediment Erosion Design Guide.

9. Yang, C. T., and C.-A. Huang (2001) Applicability of sediment transport formulas. Int. J. Sediment Res., Vol. 16, no. 3, pp. 335-353.

TECHNICAL MEMORANDUM

TO: Mr. Bill Black, PE, Principal Engineer, AECOM

FROM: Richard Meyer, PE, Meyer Civil Engineering, Inc.

DATE: September 16, 2016, *Revised March 20, 2017*

SUBJECT: **Hydrology Study for the Caliente Creek Habitat Mitigation and Groundwater Recharge Projects, *Revised to Include 2 Year Event***

General: The nearly 3200 acre project area receives runoff from Walker Basin and Caliente Creek Basin. These two basins encompass a watershed that contains approximately 476 square miles. The watershed begins in the Tehachapi Mountains of the Sierra Nevada and drains west starting at the divide to the Mojave Desert. These basins include Walker Basin Creek, Rancheria Creek, Caliente Creek, Weaver Creek, Indian Creek, Tehachapi Creek, Tweedy Creek and Brite Creek. Elevation varies from just over 8,000 feet to about 615 feet mean above sea level. Average streambed slopes vary from over 500 feet per mile to just under 100 feet per mile. The flows at the project area are ephemeral and have potential to be quick and large. Indeed, whenever significant rainfall occurs, the downstream communities of Arvin and Lamont suffer greatly. Damage is caused not only by floodwaters but also by sedimentation which these flows carry. Typically engineers are concerned about the one percent chance or 100 year event, but history indicates that flood damage to these two communities has been caused by much more frequent events. Thus the charge of Kern County staff to the project team is to design the project to mitigate these more frequent events. Also, the project as defined within its concept and magnitude will not be able to significantly mitigate larger events. These larger events will need to be routed through the project area with sustained damage.

Study Objective: Develop the 5 and 10 year, 24 hour event hydrographs for the project area and recommend the design event.

Assumption: Since little or no effectual stream gauge information is available and since the Army Corps of Engineers (ACOE) has studied the watershed in great detail, this new study was founded on the established ACOE Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) for Caliente Creek. Therefore it was assumed that the established ACOE HEC-HMS model adequately describes the watershed and its individual components with appropriate assigned variables to establish the relationship between rainfall and runoff. While the model utilizes a uniform 3.5" of rain over the entire watershed, which does not reflect the current Atlas rainfall, the new model was calibrated to the ACOE's rainfall for peak discharge and volume. The model was then run with current National Oceanic and Atmospheric Administration (NOAA) rainfall data to determine new 100 year, 10 year and 5 year values.

Approach: A new HEC-HMS hydrology model was constructed and calibrated to the established ACOE HEC-HMS model. The calibrated flow and volume was matched closely to the ACOE

Meteorological model run named "100 yr". This run utilized "CalGS.dat" which specified the Soil Conservation Service (SCS) Type I rainfall pattern with a 3.50" volume. The following procedure was utilized.

1. Constructed a new hydrology model in HEC-HMS:
    a. Verified or reestablished boundaries of watershed and interior drainage sub-basins based on USGS mapping.
    b. Verified or reestablished drainage paths and confluence locations.
    c. Verified or reestablished watershed characteristics, such as surface roughness (Manning's "n" values) and soils absorption.
2. The Kern County Hydrology Manual (KCHM) was followed as much as was practicable to the purpose of calibrating the new model to the ACOE values.
    a. Determination of lag times was in accordance with Section E.12.I.B.2 of the KCHM, where: Lag (hours) = $24n*[(L*Lca)/S^{\wedge 0.5}]^m$. Manning's n was varied to obtain similar routing times as the ACOE model.
    b. Infiltration was determined in accordance with SCS soil and cover Cn values. However, infiltration was not bounded by an upper limit. This was due to how the ACOE model was constructed which was with a constant infiltration rate of 0.25 inches per hour. For this reason, an antecedent moisture condition of dry was utilized (AMC I). Percent impervious was set to 1%, except for inhabited areas in which additional imperviousness was included.
    c. Hydrographs were patterned based on the KCHM S-Graphs for the "Mountains", "Foot Hills" and "Valley–Undeveloped".
3. Rainfall was studied as follows:
    a. Rainfall pattern for the calibrated model was in accordance with SCS Type I rainfall. Total rainfall was 3.50" matching the ACOE model.
    b. After calibration, rainfalls more representative of modern data were investigated:
        i. KCHM rainfall patterns paired with both Atlas 2 and Atlas 14 rainfall were investigated (Scenarios 1 & 2).
        ii. A special derived "balanced" hyetograph was developed and paired with Atlas 14 rainfall (Scenarios 3 & 4). The balanced rainfall curve is centered on 12 hours within a 24 hour duration. Intensity for the 5 minute, 30 minute, 1 hour, 12 hour and 24 hour durations is plotted symmetrically about the 12 hour centerline. Therefore each of these defined intensities was built into the curve. A 3 hour duration curve was also formulated in a similar way. The 3 hour curve was utilized in the fourth scenario listed in Table B below. The 3 hour curve was applied only to five of the lower elevation sub-basins (Scenario 4).
    c. Area Reduction Factors (ARF's) were applied to the Atlas values. The study area is approximately 476 square miles. Area Reduction Factors were taken from NOAA Atlas 2 Volume 11 for Atlas 2 rainfall and from NOAA Hydrometeorological Report No. 59 (HMR59) for Atlas 14 rainfall.

4. Routing of flows was accomplished with Kinematic Wave methodology. This was primarily due to the lack of detailed topography information for the stream cross-sections. Applied Manning's "n" values varied from 0.050 for upper reaches to 0.030 for lower reaches.
5. Calibration of the HEC-HMS model:
    a. The calibration point on the ACOE model is named "13+9 WAL". This is the confluence of Walker Basin Creek with Caliente Creek inside the project area and just downstream of the Walker Basin Creek railroad bridge and the Caliente Creek Bena Road bridge. The corresponding label on the new model is "J-CA05".
    b. Rainfall was held constant matching ACOE values for the "100yr" analysis.
    c. Cn values were adjusted to approximate total discharge volume.
    d. Manning's "n" values were adjusted to increase or decrease discharge peaks.

Results: The various model runs resulting in the following:

6. Calibration of the model resulted in the following:

TABLE A - Calibration of New Model to ACOE – 3.50" Rainfall						
Location	New Model			ACOE Model		
	Peak Flow, CFS	Time, Hrs	Volume, Inches	Peak Flow, CFS	Time, Hrs	Volume, Inches
Confluence of Walker Basin and Caliente Creeks	30,542	12.92	0.87	31,385	14.33	0.84
Caliente Creek from Bena Road Bridge	23,030	13.00	0.87	23,448	14.50	0.84
Walker Basin Flows from Railroad Bridge	8,803	12.50	0.90	8,858	13.17	0.84

7. Different rainfall curves paired with both Atlas 2 and Atlas 14 rainfall values were then studied. These are summarized as follows:

TABLE B - New Model Results of Studied Rainfall Curve and Values							
Modeled Rainfall Scenario		100 yr 24 hr Event		10 yr 24 hr Event		5 yr 24 hr Event	
		Peak Flow, CFS	Volume, Inches	Peak Flow, CFS	Volume, Inches	Peak Flow, CFS	Volume, Inches
1.	KCHM(1) with Atlas 2	47,887	1.57	23,206	0.78	16,256	0.56
2.	KCHM(1) with Atlas 14	55,287	1.37	18,985	0.52	12,464	0.35
3.	Balanced Storm with Atlas 14(2)	50,754	1.36	13,550	0.52	8,746	0.35
4.	24 hour Event on Higher Elevs. and 3 hour Event on Lower Elevs. with Balanced Storms using Atlas 14	32,062	0.97	8,891	0.37	5,639	0.23

(1) Hyetograph per Kern County Hydrology Manual.

(2) Equal amount of water is placed on rising limb as falling limb of the balanced synthetic hyetograph. 5min, 30min, 1hr, 12hr & 24hr intensities are centered on 12 hours' time.

8. When results were reviewed for the first three scenarios, concerns still existed for significantly higher resultant values of flow when compared to established 100 year flow values. For these reasons a fourth scenario was developed as shown in Table B above. Development of this scenario was based on the reasoning that; a) it is highly unlikely that the 476 square mile watershed will be affected by the 24 hour storm at once; b) the storm will be moving into the mountains from the valley and so rainfall will occur in the lower part of the basin first; and c) the storm will be more intensified in the mountains as it is affected by orographic lift. Therefore this fourth scenario utilized the 100 year 3 hour storm in the lower five sub-basins.

Conclusions: The following conclusions are offered.

9. The resultant flows due to the application of modern Atlas rainfall values revealed a significant difference from the ACOE model "100 yr" value. The area average rainfall for the 100 year 24 hour event, areal adjusted, is significantly greater than the 3.50" applied in the ACOE model:

TABLE C - 24 Hour Event Rainfall Comparison(1)

Source	100yr Volume, inches	10yr Volume, inches	5yr Volume, inches
Atlas 2 Volume 11	4.46	2.88	2.41
Atlas 14 Volume 6	4.69	2.72	2.21
ACOE HMS Model	3.50	-	-

(1) Comparison based on centroid of entire watershed.

It is noted that Kern County has adopted the Atlas 14 values for hydrologic study; therefore, Atlas 14 is the much preferred rainfall data.

10. The KCHM hyetograph design was primarily developed for the purpose of smaller watersheds under development. Therefore the KCHM curve is purposely designed to derive larger peak flows in these smaller applications. This is evidenced by the fact that the centroid of the shorter duration intensities is set at 16 hours in the 24 hour graph. This causes a long duration saturation of the watershed and then application of high intensity rainfall. Considering the largeness of the Caliente Creek watershed, it is not likely that these intensities will occur over the whole area during the same 24 hour period. For this reason, the balanced curve was studied. It is noted that the balanced hyetograph does contain the entire duration intensities specific to the study area. The balanced hyetograph produced smaller peak discharges than the KCHM curve while producing the same volume.
11. Scenario 4 (combination of 24 hour rainfall with 3 hour rainfall) helped to compensate for the significant volumetric differences. Peak flows were also significantly reduced and brought more into line with established ACOE and FEMA values.

Recommendations: These recommendations are based on detailed modeling and this engineer's experience in hydrologic study.

12. Based on the foregoing, it is recommended that values from the Balanced Storm with Atlas 14 rainfall be considered applicable to the design of the project.
13. It is also recommended that the 5 year 24 hour combined with 3 hour rainfall events be considered as the project design event. Mitigation of the peak flow and volume contained in this more frequent event hydrograph is more feasible to attain with the proposed project.
14. In response to the County's request to include analysis of the 2 year 24 hour event, this event hydrology has been developed and is included in this revised memorandum.

Application: This information is summarized to assist the designers of the project.

15. The recommended study hydrographs that enter and exit the project area are detailed in the following table.

TABLE D – Project Design Flows

Location	(5 Year 24 Hour Event)			(2 Year 24 Hour Event)		
	Peak Flow, CFS	**Time of Peak, Hours**	**Volume of Discharge, Acre-Feet**	**Peak Flow, CFS**	**Time of Peak, Hours**	**Volume of Discharge, Acre-Feet**
Walker Basin Creek at Railroad Bridge, Model Point J-WB02A	1,479	16.50	1,383	721	18.00	729
Caliente Creek at Bena Road Bridge, Model Point J-CA04A	4,328	17.00	4,449	2,086	18.50	2,267
Confluence of Walker Basin Creek and Caliente Creek, Model Point J-CA05	5,639	17.50	5,782	2,712	19.00	2,974
Unimpeded Exit at Project South Boundary, Model Point J-CA06	5,516	18.50	5,778	2,671	20.00	2,956

16. The following pages in Appendix A illustrate the plotted hydrographs along with the corresponding coordinates.

Respectfully Submitted,

Richard Meyer, CE 28104
Meyer Civil Engineering, Inc.

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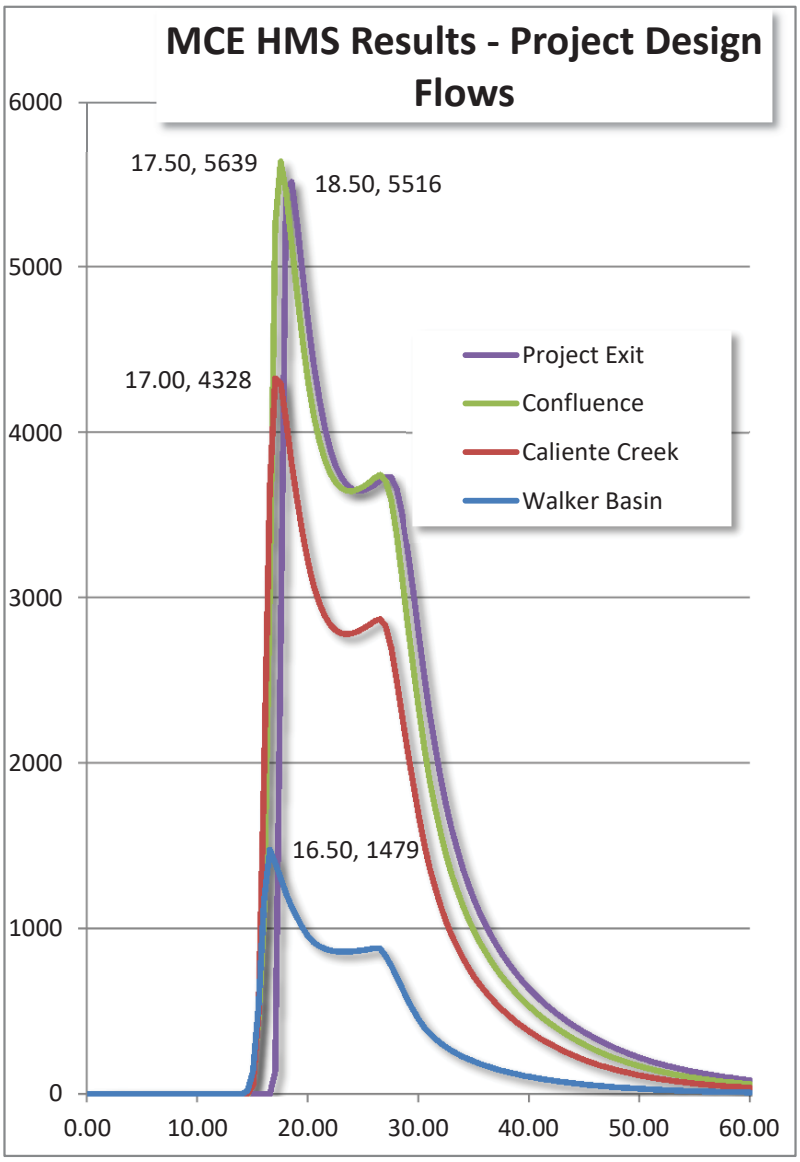
MCE HMS Results - Project Design Flows

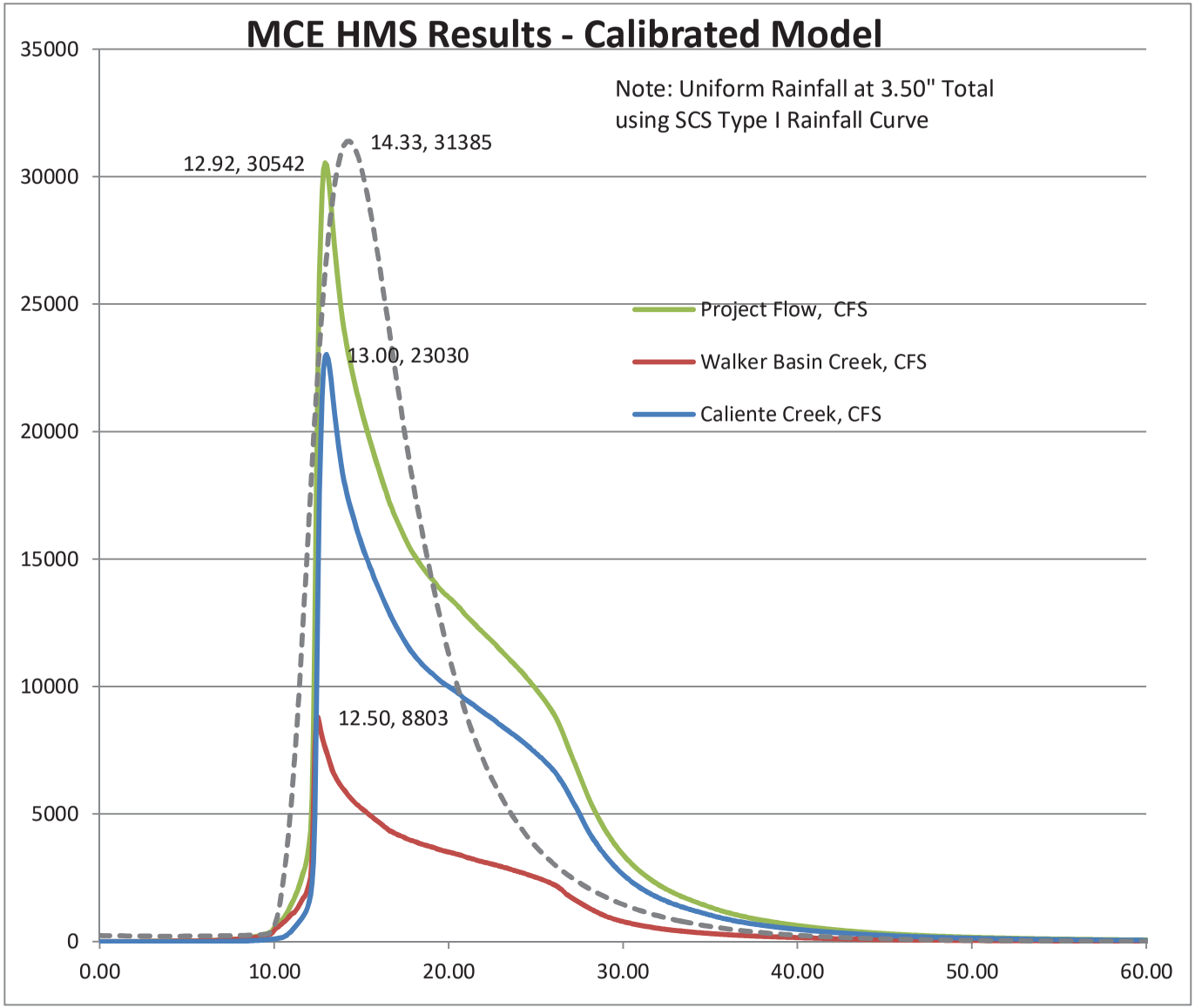
	1479 CFS	4328 CFS	5639 CFS	5516 CFS
	1383 AF	4449 AF	5782 AF	5778 AF
Time, Hrs	Walker Basin	Caliente Creek	Confluence	Project Exit
0.00	0	0	0	0
0.50	0	0	0	0
1.00	0	0	0	0
1.50	0	0	0	0
2.00	0	0	0	0
2.50	1	1	0	0
3.00	1	1	0	0
3.50	1	1	0	0
4.00	2	1	0	0
4.50	2	1	1	0
5.00	2	1	2	0
5.50	1	1	2	0
6.00	1	0	2	0
6.50	1	0	1	0
7.00	1	0	1	0
7.50	0	0	1	0
8.00	0	0	1	0
8.50	0	0	1	0
9.00	0	0	1	0
9.50	0	0	0	0
10.00	0	0	0	0
10.50	0	0	0	0
11.00	0	0	0	0
11.50	0	0	0	0
12.00	0	0	0	0
12.50	0	0	0	0
13.00	0	0	0	0
13.50	0	0	0	0
14.00	3	0	0	0
14.50	23	3	1	0
15.00	144	56	88	0
15.50	539	484	451	0
16.00	1170	1924	1081	0
16.50	1479	3661	3022	1
17.00	1398	4328	5253	139
17.50	1309	4295	5639	2727
18.00	1214	4071	5453	5480
18.50	1135	3818	5142	5516
19.00	1067	3585	4830	5253
19.50	1005	3383	4546	4951
20.00	955	3212	4303	4666
20.50	919	3073	4104	4414
21.00	895	2967	3949	4201
21.50	880	2891	3834	4028
22.00	871	2838	3752	3895



Time, Hrs	Walker Basin	Caliente Creek	Confluence	Project Exit
22.50	865	2804	3698	3797
23.00	863	2786	3664	3729
23.50	863	2781	3648	3683
24.00	865	2787	3647	3658
24.50	869	2800	3657	3648
25.00	873	2818	3675	3651
25.50	878	2839	3699	3665
26.00	884	2862	3726	3686
26.50	881	2874	3746	3711
27.00	838	2831	3711	3735
27.50	777	2698	3593	3730
28.00	710	2502	3385	3661
28.50	642	2288	3124	3509
29.00	570	2075	2846	3289
29.50	507	1872	2577	3035
30.00	452	1683	2326	2777
30.50	405	1513	2097	2530
31.00	369	1367	1896	2299
31.50	336	1243	1722	2089
32.00	308	1134	1572	1904
32.50	285	1039	1441	1740
33.00	263	960	1325	1599
33.50	245	887	1227	1474
34.00	227	822	1138	1362
34.50	213	766	1059	1266
35.00	199	712	988	1179
35.50	187	667	923	1100
36.00	175	623	864	1030
36.50	164	585	810	966
37.00	154	548	760	907
37.50	144	515	715	853
38.00	136	484	672	803
38.50	128	456	633	758
39.00	120	429	597	715
39.50	113	404	563	676
40.00	107	380	531	639
40.50	101	359	502	604
41.00	95	338	474	572
41.50	90	319	448	542
42.00	85	300	423	514
42.50	80	283	400	487
43.00	76	266	378	462
43.50	72	250	356	439
44.00	67	236	337	416
44.50	64	222	317	395
45.00	60	208	300	375
45.50	57	197	283	356
46.00	54	185	267	337

Time, Hrs	Walker Basin	Caliente Creek	Confluence	Project Exit
46.50	51	174	252	320
47.00	48	164	238	304
47.50	45	155	225	288
48.00	43	145	212	273
48.50	40	137	201	259
49.00	38	130	190	246
49.50	36	122	179	234
50.00	34	115	170	222
50.50	32	109	161	211
51.00	31	103	152	201
51.50	29	97	144	191
52.00	28	92	137	181
52.50	26	87	130	173
53.00	25	82	123	165
53.50	23	78	117	156
54.00	22	74	111	149
54.50	21	70	105	142
55.00	20	66	100	136
55.50	19	63	95	129
56.00	18	59	91	123
56.50	17	57	86	118
57.00	17	54	82	112
57.50	16	51	78	107
58.00	15	48	74	103
58.50	14	46	71	98
59.00	13	44	68	94
59.50	13	42	64	90
60.00	12	40	61	86

	23030 CFS	8803 CFS	30542 CFS
	0.87 IN	0.90 IN	0.87 IN
Time, Hrs	Caliente Creek, CFS	Walker Basin Creek, CFS	Project Flow, CFS
0.00	0	0	0
0.50	0	0	0
1.00	0	0	0
1.50	0	0	0
2.00	0	0	0
2.50	0	2	2
3.00	0	5	5
3.50	0	10	10
4.00	0	11	11
4.50	0	13	13
5.00	0	16	16
5.50	0	20	20
6.00	0	27	27
6.50	1	39	39
7.00	2	53	55
7.50	5	72	76
8.00	11	93	104
8.50	23	121	143
9.00	40	163	203
9.50	64	228	293
10.00	98	430	528
10.50	159	724	883
11.00	421	1080	1501
11.50	823	1503	2326
13.00	23030	7433	30463
13.50	20502	6479	26981
14.00	18081	5955	24036
14.50	16718	5528	22245
15.00	15600	5225	20826
15.50	14686	4943	19629



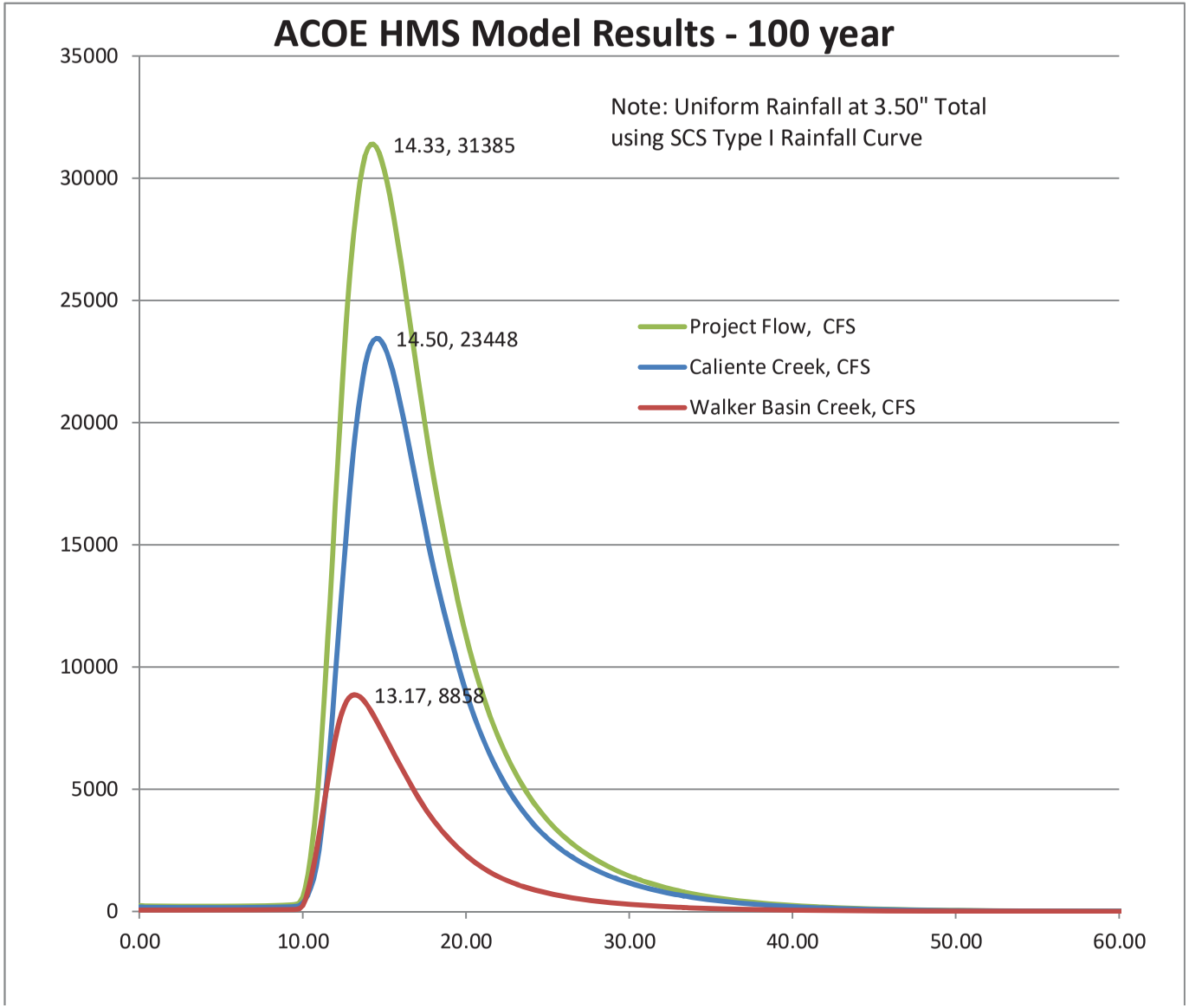
Time, Hrs	Caliente Creek, CFS	Walker Basin Creek, CFS	Project Flow, CFS
16.00	13828	4674	18502
16.50	13040	4401	17441
17.00	12355	4211	16566
17.50	11754	4064	15818
18.00	11253	3934	15187
18.50	10859	3809	14668
19.00	10535	3712	14247
19.50	10236	3594	13830
20.00	9998	3507	13505
20.50	9764	3417	13182
21.00	9477	3307	12784
21.50	9234	3210	12445
22.00	8980	3116	12096
22.50	8744	3031	11775
23.00	8473	2940	11413
23.50	8219	2841	11060
24.00	7971	2738	10710
24.50	7689	2631	10320
25.00	7390	2515	9906
25.50	7080	2388	9467
26.00	6722	2242	8964
26.50	6241	2017	8258
27.00	5639	1739	7378
27.50	5003	1526	6529
28.00	4343	1332	5675
28.50	3811	1150	4962
29.00	3357	995	4352
29.50	2963	874	3837
30.00	2624	779	3403
30.50	2340	700	3040
31.00	2099	633	2732
31.50	1897	571	2467
32.00	1725	516	2240

Time, Hrs	Caliente Creek, CFS	Walker Basin Creek, CFS	Project Flow, CFS
32.50	1576	469	2045
33.00	1445	430	1875
33.50	1328	395	1723
34.00	1225	365	1589
34.50	1129	337	1466
35.00	1034	311	1345
35.50	945	286	1231
36.00	867	265	1132
36.50	798	245	1044
37.00	737	228	965
37.50	683	213	895
38.00	633	199	832
38.50	588	185	773
39.00	547	173	720
39.50	509	161	670
40.00	473	151	624
40.50	441	140	581
41.00	411	131	542
41.50	383	121	504
42.00	358	111	469
42.50	334	103	436
43.00	312	95	406
43.50	291	88	379
44.00	271	82	353
44.50	253	76	330
45.00	237	71	308
45.50	221	66	288
46.00	207	62	269
46.50	194	58	252
47.00	182	54	236
47.50	171	51	222
48.00	161	47	208
48.50	152	44	196

Time, Hrs	Caliente Creek, CFS	Walker Basin Creek, CFS	Project Flow, CFS
49.00	143	42	185
49.50	135	39	174
50.00	127	37	164
50.50	120	35	155
51.00	113	33	146
51.50	107	31	138
52.00	101	29	131
52.50	96	28	124
53.00	91	26	117
53.50	86	25	111
54.00	81	24	105
54.50	77	22	99
55.00	73	21	94
55.50	69	20	89
56.00	65	19	85
56.50	62	18	80
57.00	59	17	76
57.50	56	16	72
58.00	53	16	69
58.50	51	15	65
59.00	48	14	62
59.50	46	13	59
60.00	44	13	57

ACOE HMS Model Results - 100 year

	23448 CFS	8858 CFS	31385 CFS
			0.84 IN
Time, Hrs	Caliente Creek, CFS	Walker Basin Creek, CFS	Project Flow, CFS
0.00	173	58	231
1.00	169	55	224
2.00	161	54	215
3.00	154	55	209
4.00	151	56	207
5.00	152	58	210
6.00	156	60	216
7.00	162	62	224
8.00	170	66	236
9.00	182	70	252
10.00	343	234	577
11.00	2516	3098	5615
12.00	9589	7036	16625
13.00	18050	8825	26875
14.00	22828	8397	31225
14.50	23448	7825	31273
15.00	23127	7201	30328
15.17	22858	6990	29848
15.33	22525	6778	29303
15.50	22137	6566	28703
15.67	21702	6354	28056
15.83	21229	6144	27373
16.00	20725	5940	26665
17.00	17373	4745	22117
18.00	14095	3738	17833
19.00	11370	2949	14319
20.00	8978	2303	11281
21.00	7128	1797	8925
22.00	5688	1419	7106
23.00	4559	1135	5694

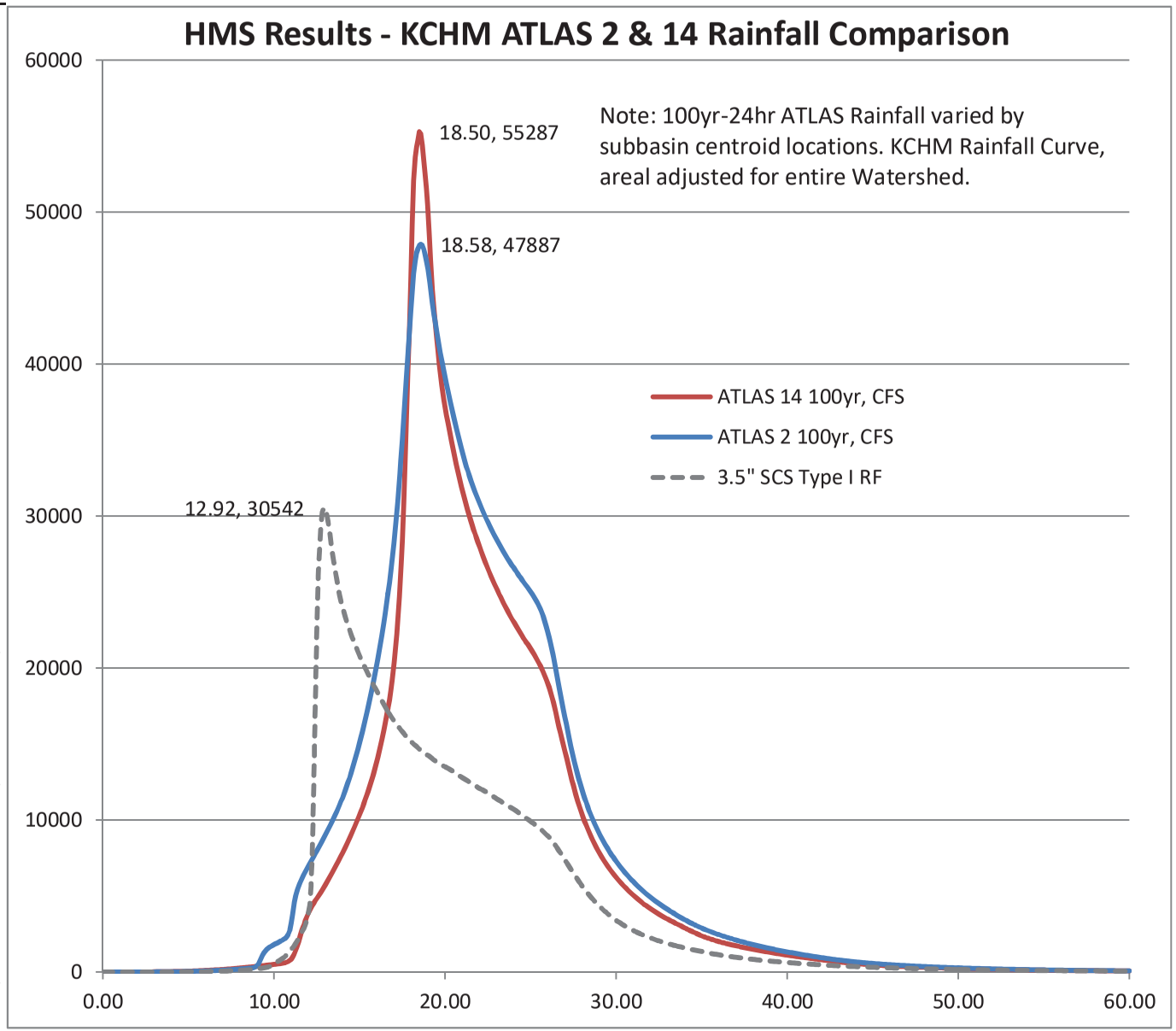


Time, Hrs	Caliente Creek, CFS	Walker Basin Creek, CFS	Project Flow, CFS
24.00	3675	915	4590
25.00	2985	744	3729
26.00	2450	611	3061
27.00	2023	504	2527
28.00	1678	418	2096
29.00	1395	347	1742
30.00	1161	290	1450
31.00	967	242	1209
32.00	807	202	1009
33.00	674	169	842
34.00	562	141	703
35.00	469	118	587
36.00	392	99	491
37.00	328	83	411
38.00	275	70	345
39.00	230	59	288
40.00	193	49	242
41.00	162	42	205
42.00	136	35	171
43.00	114	29	143
44.00	95	24	119
45.00	79	20	99
46.00	66	17	83
47.00	55	14	69
48.00	46	12	58
49.00	38	10	48
50.00	32	8	40
51.00	26	7	33
52.00	22	6	28
53.00	18	5	23
54.00	15	4	19
55.00	13	3	16
56.00	11	3	13

Time, Hrs	Caliente Creek, CFS	Walker Basin Creek, CFS	Project Flow, CFS
57.00	9	2	11
58.00	7	2	9
59.00	6	2	8
60.00	5	1	6
61.00	4	1	5
62.00	4	1	5
63.00	3	1	4
64.00	3	1	3
65.00	2	1	3
66.00	2	0	2
67.00	1	0	2
68.00	1	0	2
69.00	1	0	1
70.00	1	0	1
71.00	1	0	1
72.00	1	0	1
73.00	1	0	1
74.00	0	0	1
75.00	0	0	0
76.00	0	0	0
77.00	0	0	0
78.00	0	0	0
79.00	0	0	0
80.00	0	0	0
81.00	0	0	0
82.00	0	0	0
83.00	0	0	0
84.00	0	0	0
85.00	0	0	0
86.00	0	0	0
87.00	0	0	0
88.00	0	0	0
89.00	0	0	0

HMS Results - KCHM ATLAS 2 & 14 Rainfall Comparison

	47887 CFS	55287 CFS
	1.57 IN	1.31 IN
Time, Hrs	ATLAS 2 100yr, CFS	ATLAS 14 100yr, CFS
0.00	0	0
0.50	0	0
1.00	0	0
1.50	0	0
2.00	0	1
2.50	4	5
3.00	10	12
3.50	16	20
4.00	20	27
4.50	26	37
5.00	36	53
5.50	51	76
6.00	71	102
6.50	93	132
7.00	120	166
7.50	154	207
8.00	195	256
8.50	242	312
9.00	396	371
9.50	1395	434
10.00	1799	499
10.50	2095	576
11.00	3198	836
11.50	5810	2224
12.00	6947	3842
12.50	7952	4832
13.00	9007	5713
13.50	10144	6743
14.00	11449	7820
14.50	13060	9004
15.00	15071	10338



KCHM ATLAS 2 & 14 RF 100yr

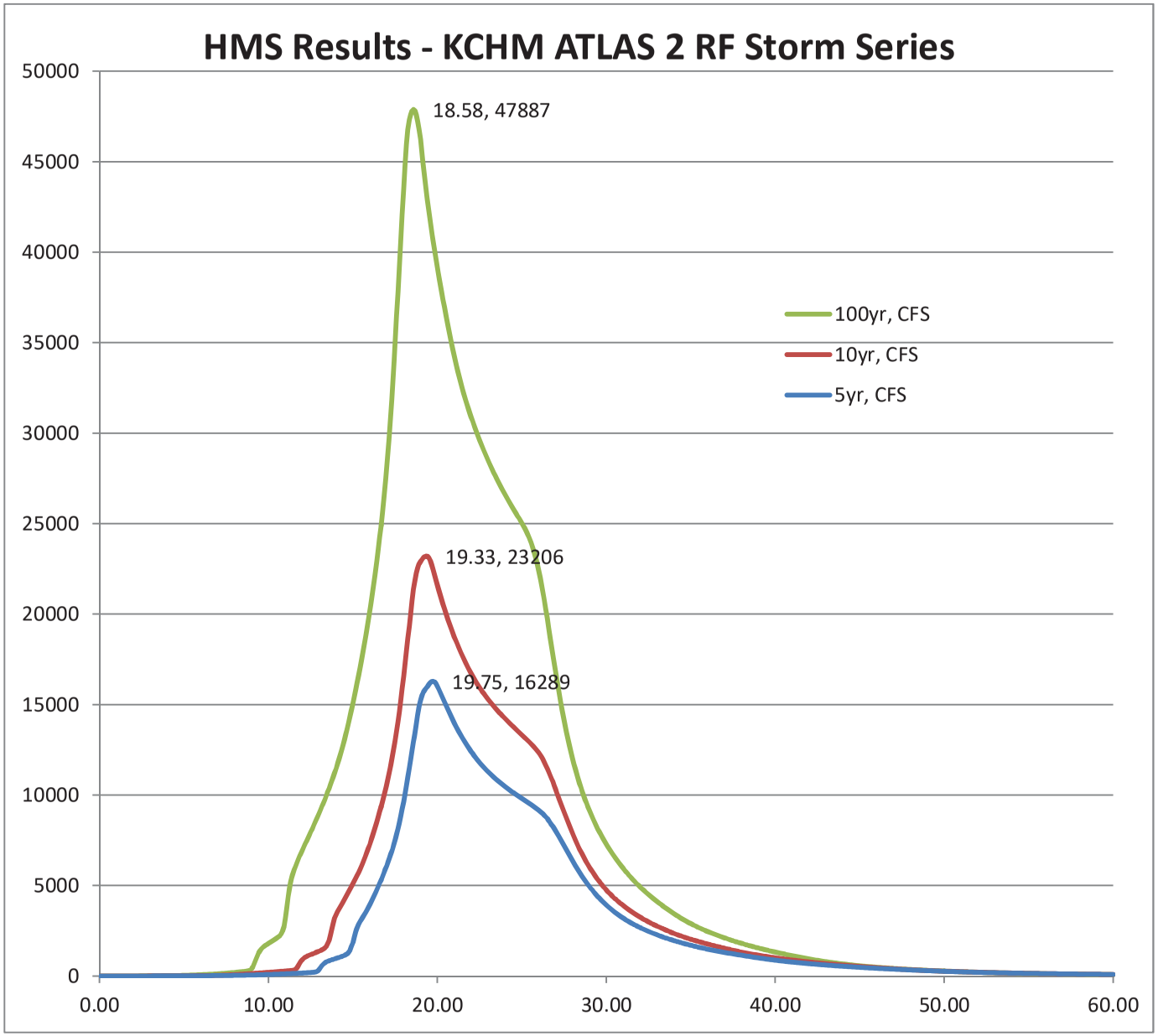
Time, Hrs	ATLAS 2 100yr, CFS	ATLAS 14 100yr, CFS
15.50	17422	11879
16.00	20164	13765
16.50	23572	16350
17.00	28104	20113
17.50	35059	28374
18.00	43512	45657
18.50	47809	55287
19.00	46227	50100
19.50	42206	41792
20.00	39157	37176
20.50	36541	34258
21.00	34257	31723
21.50	32377	29719
22.00	30880	28043
22.50	29608	26548
23.00	28489	25275
23.50	27496	24108
24.00	26616	23056
24.50	25798	22116
25.00	25035	21281
25.50	24075	20284
26.00	22388	19016
26.50	19779	16938
27.00	16792	14547
27.50	14099	12265
28.00	12013	10408
28.50	10400	8994
29.00	9144	7880
29.50	8124	6969
30.00	7284	6226
30.50	6572	5600
31.00	5948	5065
31.50	5401	4580
32.00	4923	4169

Time, Hrs	ATLAS 2 100yr, CFS	ATLAS 14 100yr, CFS
32.50	4498	3805
33.00	4120	3483
33.50	3768	3193
34.00	3444	2906
34.50	3156	2633
35.00	2894	2380
35.50	2663	2177
36.00	2458	2005
36.50	2274	1856
37.00	2105	1726
37.50	1948	1608
38.00	1804	1498
38.50	1670	1392
39.00	1545	1293
39.50	1430	1199
40.00	1322	1112
40.50	1221	1031
41.00	1124	955
41.50	1031	880
42.00	943	804
42.50	863	731
43.00	790	665
43.50	724	608
44.00	665	557
44.50	611	512
45.00	563	471
45.50	521	435
46.00	483	403
46.50	448	375
47.00	417	349
47.50	387	326
48.00	360	304
48.50	334	285
49.00	311	266

Time, Hrs	ATLAS 2 100yr, CFS	ATLAS 14 100yr, CFS
49.50	290	249
50.00	270	232
50.50	253	217
51.00	236	203
51.50	221	190
52.00	206	178
52.50	193	166
53.00	180	156
53.50	169	146
54.00	158	137
54.50	147	129
55.00	138	121
55.50	129	114
56.00	121	107
56.50	114	101
57.00	107	95
57.50	101	90
58.00	95	85
58.50	90	81
59.00	85	76
59.50	80	72
60.00	76	69

HMS Results - KCHM ATLAS 2 RF Storm Series

	16289 CFS	23206 CFS	47887 CFS
	0.56 IN	0.78 IN	1.57 IN
Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
0.00	0	0	0
0.50	0	0	0
1.00	0	0	0
1.50	0	0	0
2.00	0	0	0
2.50	0	1	4
3.00	2	3	10
3.50	5	7	16
4.00	8	10	20
4.50	9	12	26
5.00	11	14	36
5.50	12	16	51
6.00	14	20	71
6.50	16	27	93
7.00	20	38	120
7.50	27	54	154
8.00	34	76	195
8.50	44	104	242
9.00	54	135	396
9.50	67	168	1395
10.00	82	201	1799
10.50	99	236	2095
11.00	118	274	3198
11.50	140	328	5810
12.00	164	902	6947
12.50	191	1181	7952
13.00	363	1373	9007
13.50	812	1775	10144
14.00	971	3382	11449
14.50	1141	4224	13060
15.00	1853	5105	15071
15.50	3128	6062	17422



Series KCHM ATLAS 2

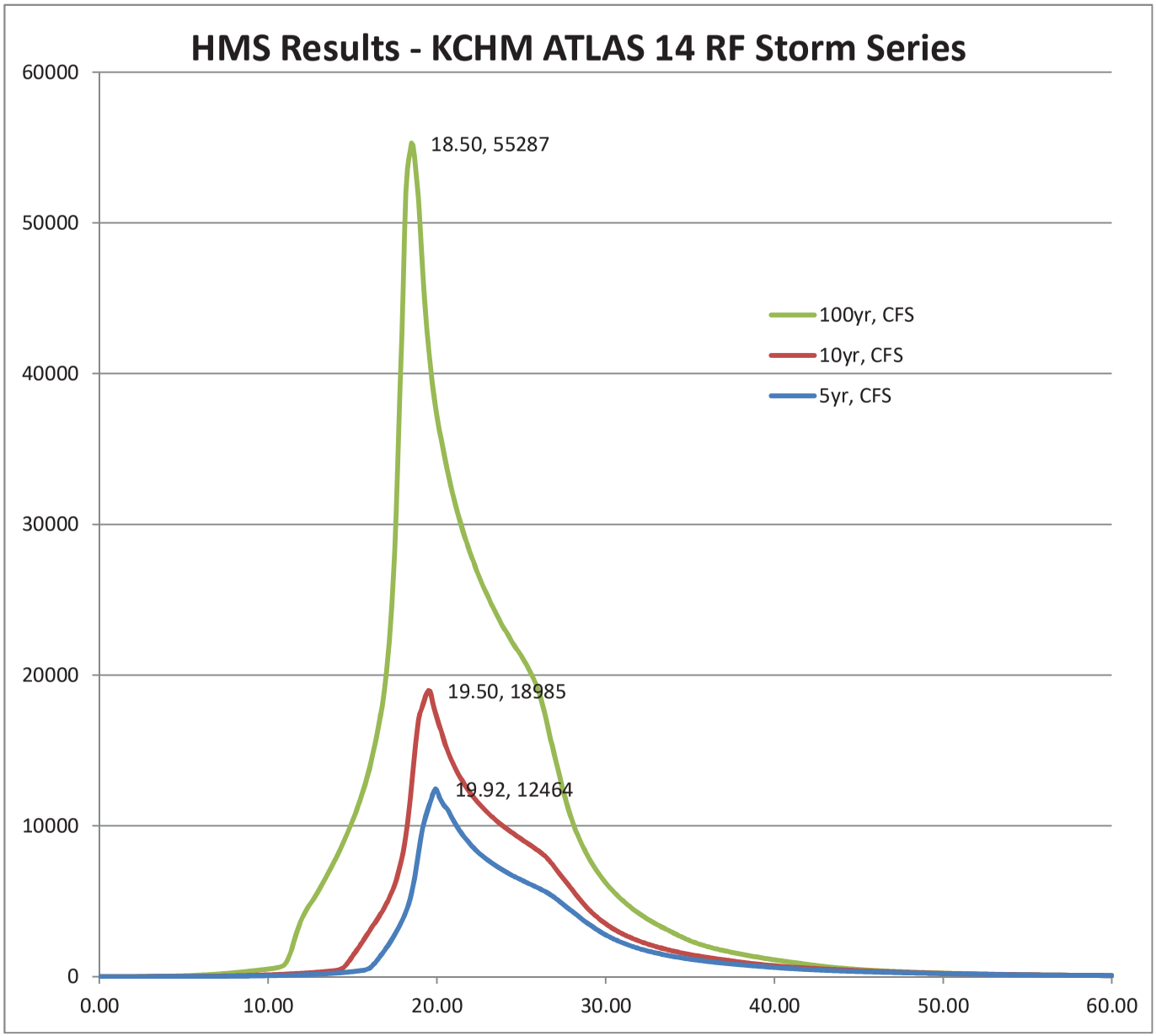
Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
16.00	3942	7278	20164
16.50	4942	8798	23572
17.00	6089	10590	28104
17.50	7520	13029	35059
18.00	9629	16562	43512
18.50	12457	20739	47809
19.00	15239	22905	46227
19.50	16120	23107	42206
20.00	16019	21587	39157
20.50	14982	20058	36541
21.00	13974	18750	34257
21.50	13130	17657	32377
22.00	12401	16706	30880
22.50	11791	15934	29608
23.00	11283	15290	28489
23.50	10851	14725	27496
24.00	10471	14234	26616
24.50	10130	13766	25798
25.00	9811	13318	25035
25.50	9501	12880	24075
26.00	9158	12341	22388
26.50	8704	11472	19779
27.00	8024	10311	16792
27.50	7204	9065	14099
28.00	6374	7886	12013
28.50	5595	6855	10400
29.00	4944	6016	9144
29.50	4389	5327	8124
30.00	3922	4756	7284
30.50	3526	4285	6572
31.00	3195	3892	5948
31.50	2914	3550	5401
32.00	2673	3251	4923
32.50	2464	2988	4498
33.00	2274	2757	4120

Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
33.50	2106	2548	3768
34.00	1957	2356	3444
34.50	1822	2184	3156
35.00	1697	2032	2894
35.50	1584	1894	2663
36.00	1482	1766	2458
36.50	1389	1647	2274
37.00	1303	1532	2105
37.50	1223	1421	1948
38.00	1148	1319	1804
38.50	1073	1228	1670
39.00	1000	1147	1545
39.50	934	1073	1430
40.00	874	1005	1322
40.50	820	942	1221
41.00	770	882	1124
41.50	724	826	1031
42.00	682	775	943
42.50	642	728	863
43.00	605	684	790
43.50	570	642	724
44.00	538	602	665
44.50	507	564	611
45.00	479	529	563
45.50	452	494	521
46.00	426	462	483
46.50	401	430	448
47.00	378	400	417
47.50	356	372	387
48.00	335	346	360
48.50	315	323	334
49.00	295	302	311
49.50	276	283	290
50.00	258	266	270
50.50	242	250	253

Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
51.00	228	235	236
51.50	215	222	221
52.00	203	209	206
52.50	191	197	193
53.00	181	185	180
53.50	171	175	169
54.00	162	165	158
54.50	153	155	147
55.00	145	146	138
55.50	138	138	129
56.00	130	130	121
56.50	124	123	114
57.00	117	116	107
57.50	111	110	101
58.00	105	104	95
58.50	100	99	90
59.00	95	93	85
59.50	90	88	80
60.00	85	83.606	76

HMS Results - KCHM ATLAS 14 RF Storm Series

	12464 CFS	18985 CFS	55287 CFS
	0.34 IN	0.50 IN	1.37 IN
Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
0.00	0	0	0
0.50	0	0	0
1.00	0	0	0
1.50	0	0	0
2.00	0	0	1
2.50	0	1	5
3.00	2	3	12
3.50	4	7	20
4.00	7	10	27
4.50	8	11	37
5.00	9	13	53
5.50	10	16	76
6.00	12	19	102
6.50	14	24	132
7.00	16	32	166
7.50	20	42	207
8.00	26	53	256
8.50	33	66	312
9.00	41	81	371
9.50	51	98	434
10.00	61	117	499
10.50	73	139	576
11.00	87	163	836
11.50	102	191	2224
12.00	120	222	3842
12.50	141	257	4832
13.00	166	297	5713
13.50	196	344	6743
14.00	231	404	7820
14.50	273	631	9004
15.00	327	1360	10338
15.50	398	2156	11879



Series KCHM ATLAS 14

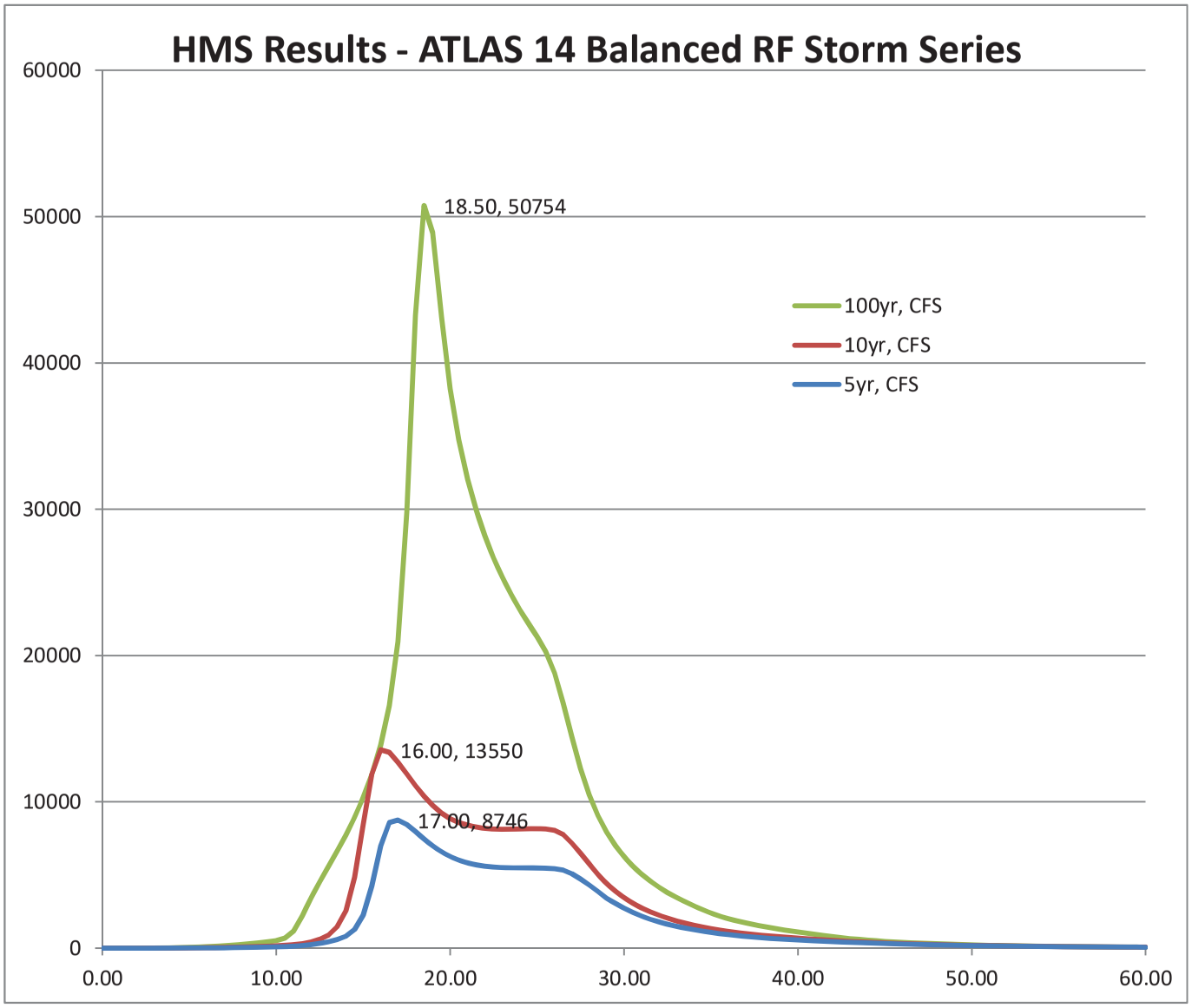
Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
16.00	555	3015	13765
16.50	1145	3853	16350
17.00	1904	4817	20113
17.50	2782	6066	28374
18.00	3856	8263	45657
18.50	5540	12744	55287
19.00	8811	17471	50100
19.50	11246	18985	41792
20.00	12347	17174	37176
20.50	11255	15393	34258
21.00	10316	14028	31723
21.50	9441	13004	29719
22.00	8760	12149	28043
22.50	8193	11474	26548
23.00	7738	10884	25275
23.50	7348	10368	24108
24.00	7002	9915	23056
24.50	6688	9516	22116
25.00	6414	9124	21281
25.50	6144	8749	20284
26.00	5880	8357	19016
26.50	5591	7890	16938
27.00	5224	7213	14547
27.50	4777	6497	12265
28.00	4339	5792	10408
28.50	3900	5081	8994
29.00	3481	4450	7880
29.50	3105	3938	6969
30.00	2769	3509	6226
30.50	2487	3140	5600
31.00	2244	2835	5065
31.50	2034	2579	4580
32.00	1854	2356	4169
32.50	1700	2160	3805
33.00	1567	1985	3483

Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
33.50	1447	1833	3193
34.00	1341	1697	2906
34.50	1244	1573	2633
35.00	1158	1463	2380
35.50	1082	1364	2177
36.00	1012	1274	2005
36.50	948	1190	1856
37.00	890	1114	1726
37.50	836	1038	1608
38.00	787	959	1498
38.50	741	888	1392
39.00	695	826	1293
39.50	650	771	1199
40.00	607	720	1112
40.50	569	674	1031
41.00	533	633	955
41.50	500	596	880
42.00	469	562	804
42.50	441	530	731
43.00	416	501	665
43.50	393	473	608
44.00	372	446	557
44.50	353	420	512
45.00	335	396	471
45.50	318	373	435
46.00	302	351	403
46.50	286	331	375
47.00	271	312	349
47.50	257	292	326
48.00	244	273	304
48.50	231	255	285
49.00	220	239	266
49.50	208	223	249
50.00	197	210	232
50.50	186	197	217

Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
51.00	175	185	203
51.50	165	174	190
52.00	156	164	178
52.50	148	155	166
53.00	140	147	156
53.50	132	139	146
54.00	125	131	137
54.50	119	125	129
55.00	113	118	121
55.50	107	112	114
56.00	102	107	107
56.50	97	101	101
57.00	92	96	95
57.50	88	91	90
58.00	84	87	85
58.50	80	82	81
59.00	76	78	76
59.50	73	74	72
60.00	69.386	71	69

HMS Results - ATLAS 14 Balanced RF Storm Series

	8746 CFS	13550 CFS	50754 CFS
	0.35 IN	0.52 IN	1.36 IN
Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
0.00	0	0	0
0.50	0	0	0
1.00	0	0	0
1.50	0	0	0
2.00	0	0	1
2.50	1	2	5
3.00	3	5	12
3.50	6	10	20
4.00	9	14	27
4.50	11	16	38
5.00	13	20	54
5.50	15	25	77
6.00	17	33	103
6.50	21	43	132
7.00	27	55	167
7.50	34	67	208
8.00	42	81	257
8.50	51	97	312
9.00	60	114	372
9.50	72	136	438
10.00	88	163	522
10.50	107	195	691
11.00	132	237	1180
11.50	166	296	2210
12.00	234	421	3425
12.50	336	609	4560
13.00	445	888	5588
13.50	597	1467	6623
14.00	821	2574	7735
14.50	1270	4845	8963
15.00	2259	8449	10327
15.50	4250	11897	11889



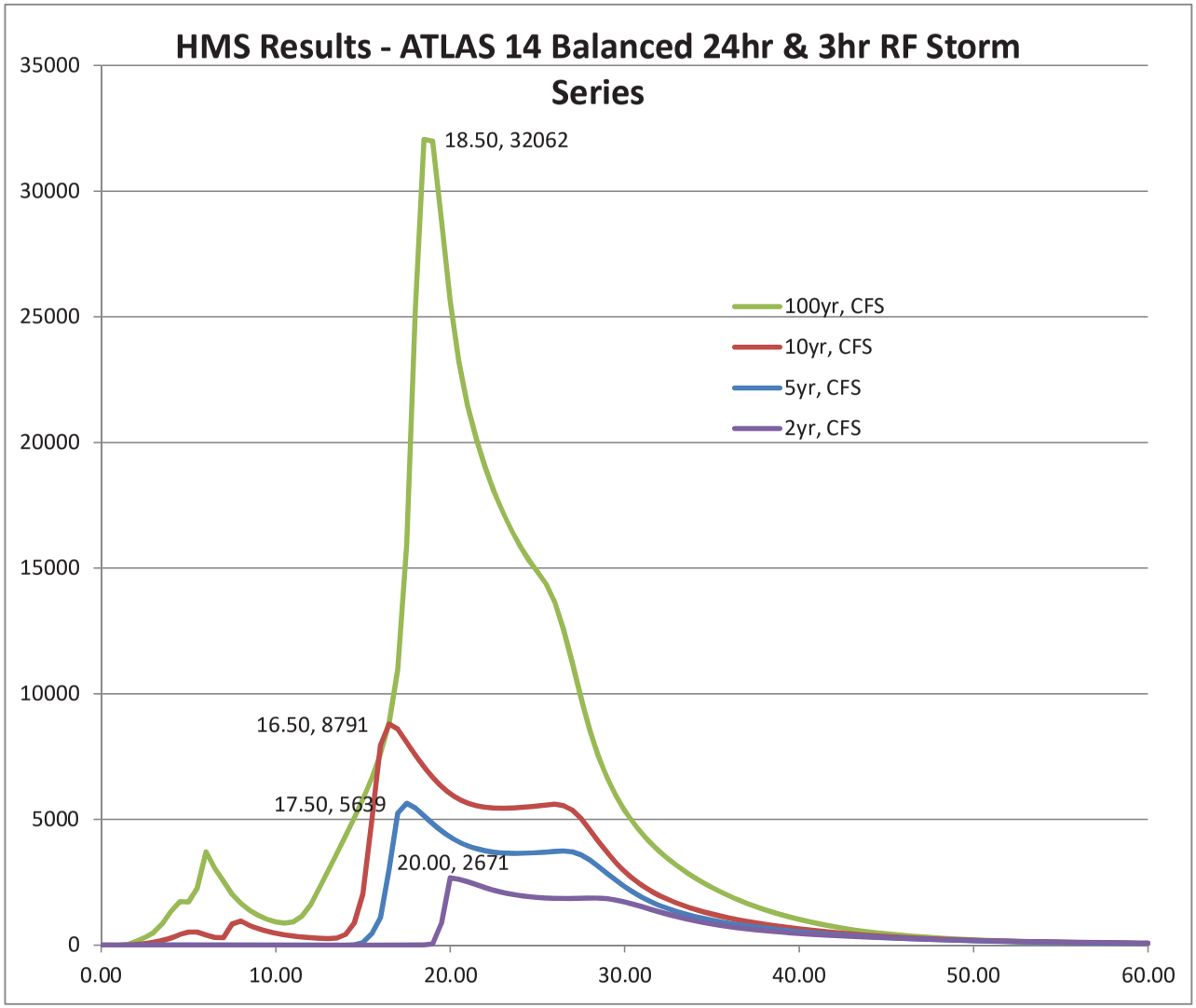
Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
16.00	6995	13550	13874
16.50	8581	13386	16582
17.00	8746	12703	20949
17.50	8451	11916	29822
18.00	7976	11101	43254
18.50	7466	10383	50754
19.00	7006	9752	48905
19.50	6597	9237	43140
20.00	6261	8853	38231
20.50	6013	8589	34725
21.00	5830	8404	32043
21.50	5696	8275	29940
22.00	5602	8191	28188
22.50	5540	8143	26675
23.00	5502	8121	25349
23.50	5483	8129	24185
24.00	5484	8156	23149
24.50	5489	8164	22197
25.00	5488	8159	21283
25.50	5476	8138	20257
26.00	5441	8049	18791
26.50	5342	7758	16730
27.00	5091	7182	14445
27.50	4734	6496	12295
28.00	4313	5757	10480
28.50	3871	5047	9056
29.00	3428	4416	7935
29.50	3055	3899	7013
30.00	2732	3455	6258
30.50	2444	3078	5617
31.00	2199	2759	5068
31.50	1985	2488	4592
32.00	1798	2254	4173
32.50	1638	2051	3808
33.00	1500	1870	3479

Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
33.50	1377	1708	3177
34.00	1265	1561	2897
34.50	1166	1437	2634
35.00	1074	1328	2390
35.50	994	1229	2180
36.00	922	1142	2008
36.50	857	1063	1856
37.00	799	993	1722
37.50	746	931	1599
38.00	700	873	1487
38.50	658	821	1382
39.00	619	773	1283
39.50	585	728	1190
40.00	553	686	1101
40.50	524	645	1019
41.00	496	606	940
41.50	470	568	863
42.00	445	532	789
42.50	421	497	719
43.00	398	465	656
43.50	376	435	600
44.00	355	407	549
44.50	334	380	505
45.00	315	356	465
45.50	296	333	431
46.00	278	312	399
46.50	262	293	370
47.00	247	275	345
47.50	232	258	321
48.00	219	243	299
48.50	207	228	279
49.00	194	214	260
49.50	183	202	243
50.00	174	191	227
50.50	164	180	211

Time, Hrs	5yr, CFS	10yr, CFS	100yr, CFS
51.00	155	170	197
51.50	147	161	185
52.00	140	152	173
52.50	133	144	161
53.00	126	137	151
53.50	120	130	142
54.00	114	123	133
54.50	109	117	125
55.00	103	111	117
55.50	99	106	110
56.00	94	101	103
56.50	90	96	97
57.00	86	91	92
57.50	82	86	87
58.00	78	82	82
58.50	74	78	78
59.00	71	74	73
59.50	68	71	70
60.00	65	67	66

HMS Results - ATLAS 14 Balanced 24hr & 3hr RF Storm Series

	2671 CFS	5639 CFS	8791 CFS	32062 CFS
	0.12 IN	0.23 IN	0.37 IN	0.97 IN
Time, Hrs	2yr, CFS	5yr, CFS	10yr, CFS	100yr, CFS
0.00	0	0	0	0
0.50	0	0	0	0
1.00	0	0	0	0
1.50	0	0	0	14
2.00	0	0	22	145
2.50	0	0	66	298
3.00	0	0	119	498
3.50	0	0	179	839
4.00	0	0	281	1352
4.50	0	1	421	1725
5.00	0	2	515	1714
5.50	0	2	520	2255
6.00	0	2	398	3707
6.50	0	1	302	3059
7.00	0	1	291	2546
7.50	0	1	836	2028
8.00	0	1	952	1660
8.50	0	1	783	1384
9.00	0	1	651	1175
9.50	0	0	551	1024
10.00	0	0	473	922
10.50	0	0	412	871
11.00	0	0	360	922
11.50	0	0	321	1142
12.00	0	0	287	1610
12.50	0	0	264	2273
13.00	0	0	256	2964
13.50	0	0	281	3643
14.00	0	0	425	4338
14.50	0	1	878	5064
15.00	0	88	2032	5822
15.50	0	451	4966	6646
16.00	0	1081	7958	7595
16.50	0	3022	8791	8838



Time, Hrs	2yr, CFS	5yr, CFS	10yr, CFS	100yr, CFS
17.00	0	5253	8596	10966
17.50	0	5639	8079	15936
18.00	0	5453	7568	25305
18.50	1	5142	7098	32062
19.00	46	4830	6674	31983
19.50	884	4546	6310	28799
20.00	2671	4303	6018	25619
20.50	2618	4104	5805	23208
21.00	2522	3949	5654	21465
21.50	2405	3834	5549	20123
22.00	2284	3752	5482	19017
22.50	2181	3698	5449	18075
23.00	2090	3664	5439	17259
23.50	2021	3648	5448	16530
24.00	1965	3647	5470	15882
24.50	1924	3657	5500	15323
25.00	1893	3675	5536	14845
25.50	1873	3699	5575	14359
26.00	1860	3726	5609	13641
26.50	1855	3746	5552	12560
27.00	1855	3711	5369	11220
27.50	1862	3593	5031	9829
28.00	1870	3385	4591	8573
28.50	1866	3124	4128	7521
29.00	1843	2846	3681	6645
29.50	1790	2577	3281	5938
30.00	1714	2326	2929	5353
30.50	1623	2097	2625	4854
31.00	1522	1896	2368	4426
31.50	1420	1722	2149	4055
32.00	1318	1572	1965	3725
32.50	1221	1441	1806	3429
33.00	1129	1325	1666	3159
33.50	1046	1227	1539	2911
34.00	969	1138	1427	2687
34.50	900	1059	1327	2480
35.00	837	988	1235	2291

Time, Hrs	2yr, CFS	5yr, CFS	10yr, CFS	100yr, CFS
35.50	781	923	1152	2115
36.00	731	864	1076	1952
36.50	685	810	1006	1800
37.00	644	760	942	1661
37.50	607	715	883	1533
38.00	573	672	829	1415
38.50	541	633	779	1303
39.00	513	597	731	1202
39.50	486	563	687	1108
40.00	461	531	646	1020
40.50	438	502	607	940
41.00	416	474	570	865
41.50	396	448	535	795
42.00	377	423	502	731
42.50	359	400	471	670
43.00	342	378	441	616
43.50	327	356	415	566
44.00	312	337	389	521
44.50	298	317	365	479
45.00	284	300	343	442
45.50	272	283	322	408
46.00	260	267	303	376
46.50	248	252	285	348
47.00	238	238	267	322
47.50	227	225	252	299
48.00	217	212	237	278
48.50	208	201	223	257
49.00	199	190	210	239
49.50	191	179	198	223
50.00	182	170	187	207
50.50	175	161	176	192
51.00	167	152	166	180
51.50	160	144	157	168
52.00	153	137	148	157
52.50	147	130	140	147
53.00	140	123	132	137
53.50	134	117	125	128

Time, Hrs	2yr, CFS	5yr, CFS	10yr, CFS	100yr, CFS
54.00	129	111	118	120
54.50	123	105	112	113
55.00	118	100	106	107
55.50	113	95	100	100
56.00	109	91	95	94
56.50	104	86	90	88
57.00	100	82	86	84
57.50	96	78	81	79
58.00	92	74	77	75
58.50	88	71	73	71
59.00	85	68	69	67
59.50	81	64	66	63
60.00	78	61	63	60

NOAA Atlas 2

Subarea	Area, SM
CA-01	20.76
CA-02	20.48
CA-03	25.55
CA-04	37.35
CA-05	20.87
CA-06	62.5
CA-07	34.21
CA-08	4.92
TH-01	27.7
TH-02	7.61
TH-03	16.49
TH-04	18.06
TH-05	34.01
TH-06	24.68
WB-01	26.67
WB-02	22.43
WB-03	29.06
WB-04	42.31
TOTAL:	475.66

Aerial Adjustment Factors:

476 SM

Duration	%
5-min	21
30-min	43.5
60-min	52.5
3-hr	66
6-hr	74.5
24-hr	91

CA-01 Coordinates: 35.2510069 -118.28675

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.232"	0.267"	0.384"	0.049"	0.056"	0.081"
30min	0.520"	0.599"	0.861"	0.226"	0.261"	0.374"
60min	0.711"	0.818"	1.176"	0.373"	0.430"	0.617"
180min	1.242"	1.438"	2.088"	0.820"	0.949"	1.378"
360min	1.767"	2.052"	3.000"	1.316"	1.529"	2.235"
1440min	3.279"	3.906"	5.990"	2.984"	3.555"	5.451"

3.251007 =X5

Event		Point Rainfall	
2yr	6hr	1.390"	=X1
100yr	6hr	3.000"	=X3
2yr	24hr	2.450"	=X2
100yr	24hr	5.990"	=X4
2yr	1hr	0.568"	Y2
100yr	1hr	1.176"	Y100
		1.177"	Y100

CA-02 Coordinates: 35.3083785 -118.32769

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.234"	0.267"	0.380"	0.049"	0.056"	0.080"
30min	0.523"	0.599"	0.850"	0.228"	0.260"	0.370"
60min	0.714"	0.818"	1.162"	0.375"	0.429"	0.610"
180min	1.235"	1.420"	2.036"	0.815"	0.937"	1.344"
360min	1.744"	2.011"	2.900"	1.299"	1.498"	2.161"
1440min	3.196"	3.799"	5.800"	2.909"	3.457"	5.278"

3.308378 =X5

Event		Point Rainfall	
2yr	6hr	1.390"	=X1
100yr	6hr	2.900"	=X3
2yr	24hr	2.400"	=X2
100yr	24hr	5.800"	=X4
2yr	1hr	0.578"	Y2
100yr	1hr	1.162"	Y100
		1.163"	Y100

CA-03 Coordinates: 35.3653537 -118.33955

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.232"	0.269"	0.392"	0.049"	0.057"	0.082"
30min	0.521"	0.603"	0.877"	0.226"	0.262"	0.382"
60min	0.711"	0.824"	1.198"	0.373"	0.433"	0.629"
180min	1.256"	1.462"	2.146"	0.829"	0.965"	1.416"
360min	1.798"	2.099"	3.100"	1.340"	1.564"	2.310"
1440min	3.335"	3.952"	6.000"	3.035"	3.596"	5.460"

3.365354 =X5

Event		Point Rainfall	
2yr	6hr	1.400"	=X1
100yr	6hr	3.100"	=X3
2yr	24hr	2.520"	=X2
100yr	24hr	6.000"	=X4
2yr	1hr	0.562"	Y2
100yr	1hr	1.198"	Y100
		1.199"	Y100

CA-04 Coordinates: 35.2531672 -118.39081

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.236"	0.272"	0.392"	0.049"	0.057"	0.082"
30min	0.528"	0.609"	0.879"	0.230"	0.265"	0.382"
60min	0.721"	0.832"	1.201"	0.378"	0.437"	0.630"
180min	1.242"	1.442"	2.105"	0.820"	0.952"	1.389"
360min	1.752"	2.041"	3.000"	1.305"	1.520"	2.235"
1440min	3.158"	3.769"	5.800"	2.874"	3.430"	5.278"

3.253167 =X5

Event		Point Rainfall	
2yr	6hr	1.370"	=X1
100yr	6hr	3.000"	=X3
2yr	24hr	2.350"	=X2
100yr	24hr	5.800"	=X4
2yr	1hr	0.574"	Y2
100yr	1hr	1.201"	Y100
		1.202"	Y100

CA-05 Coordinates: 35.3449832 -118.42028

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5.000"	10.000"	100.000"
5min	0.224"	0.258"	0.370"	0.047"	0.054"	0.078"
30min	0.502"	0.577"	0.829"	0.218"	0.251"	0.361"
60min	0.685"	0.789"	1.132"	0.360"	0.414"	0.594"
180min	1.199"	1.385"	2.003"	0.791"	0.914"	1.322"
360min	1.706"	1.975"	2.870"	1.271"	1.472"	2.138"
1440min	3.174"	3.745"	5.640"	2.889"	3.408"	5.132"

3.344983 =X5

Event		Point Rainfall	
2yr	6hr	1.350"	=X1
100yr	6hr	2.870"	=X3
2yr	24hr	2.420"	=X2
100yr	24hr	5.640"	=X4
2yr	1hr	0.548"	Y2
100yr	1hr	1.132"	Y100
		1.133"	Y100

CA-06 Coordinates: 35.3106528 -118.51999

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.222"	0.256"	0.369"	0.047"	0.054"	0.078"
30min	0.497"	0.573"	0.827"	0.216"	0.249"	0.360"
60min	0.678"	0.783"	1.130"	0.356"	0.411"	0.593"
180min	1.115"	1.292"	1.879"	0.736"	0.853"	1.240"
360min	1.526"	1.772"	2.590"	1.137"	1.320"	1.930"
1440min	2.522"	2.954"	4.390"	2.295"	2.688"	3.995"

3.310653 =X5

Event		Point Rainfall	
2yr	6hr	1.200"	=X1
100yr	6hr	2.590"	=X3
2yr	24hr	1.950"	=X2
100yr	24hr	4.390"	=X4
2yr	1hr	0.540"	Y2
100yr	1hr	1.130"	Y100
		1.131"	Y100

CA-07 Coordinates: 35.2949692 -118.67116

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.198"	0.231"	0.342"	0.042"	0.049"	0.072"
30min	0.443"	0.518"	0.765"	0.193"	0.225"	0.333"
60min	0.605"	0.707"	1.046"	0.318"	0.371"	0.549"
180min	0.988"	1.157"	1.718"	0.652"	0.764"	1.134"
360min	1.347"	1.579"	2.350"	1.003"	1.176"	1.751"
1440min	2.264"	2.645"	3.910"	2.060"	2.407"	3.558"

3.294969 =X5

Event		Point Rainfall	
2yr	6hr	1.040"	=X1
100yr	6hr	2.350"	=X3
2yr	24hr	1.760"	=X2
100yr	24hr	3.910"	=X4
2yr	1hr	0.471"	Y2
100yr	1hr	1.046"	Y100
		1.046"	Y100

CA-08 Coordinates: 35.3044524 -118.78384

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.196"	0.227"	0.331"	0.041"	0.048"	0.069"
30min	0.439"	0.509"	0.741"	0.191"	0.221"	0.322"
60min	0.599"	0.695"	1.012"	0.314"	0.365"	0.531"
180min	0.903"	1.049"	1.532"	0.596"	0.692"	1.011"
360min	1.171"	1.360"	1.990"	0.872"	1.013"	1.483"
1440min	1.728"	1.999"	2.900"	1.573"	1.820"	2.639"

3.304452 =X5

Event		Point Rainfall	
2yr	6hr	0.920"	=X1
100yr	6hr	1.990"	=X3
2yr	24hr	1.370"	=X2
100yr	24hr	2.900"	=X4
2yr	1hr	0.473"	Y2
100yr	1hr	1.012"	Y100
		1.013"	Y100

TH-01 Coordinates: 35.1020786 -118.44337

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.208"	0.244"	0.364"	0.044"	0.051"	0.076"
30min	0.465"	0.546"	0.815"	0.202"	0.238"	0.355"
60min	0.636"	0.746"	1.113"	0.334"	0.392"	0.584"
180min	1.026"	1.211"	1.824"	0.677"	0.799"	1.204"
360min	1.387"	1.642"	2.490"	1.034"	1.224"	1.855"
1440min	2.372"	2.881"	4.570"	2.159"	2.621"	4.159"

3.102079 =X5

Event		Point Rainfall	
2yr	6hr	1.050"	=X1
100yr	6hr	2.490"	=X3
2yr	24hr	1.700"	=X2
100yr	24hr	4.570"	=X4
2yr	1hr	0.490"	Y2
100yr	1hr	1.113"	Y100
		1.114"	Y100

TH-02 Coordinates: 35.1009362 -118.48221

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.219"	0.252"	0.360"	0.046"	0.053"	0.076"
30min	0.491"	0.564"	0.806"	0.214"	0.245"	0.351"
60min	0.671"	0.770"	1.101"	0.352"	0.404"	0.578"
180min	1.089"	1.257"	1.816"	0.719"	0.830"	1.199"
360min	1.479"	1.713"	2.490"	1.102"	1.276"	1.855"
1440min	2.544"	3.061"	4.780"	2.315"	2.786"	4.350"

3.100936 =X5

Event		Point Rainfall	
2yr	6hr	1.170"	=X1
100yr	6hr	2.490"	=X3
2yr	24hr	1.860"	=X2
100yr	24hr	4.780"	=X4
2yr	1hr	0.539"	Y2
100yr	1hr	1.101"	Y100
		1.102"	Y100

TH-03 Coordinates: 35.1172588 -118.50767

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.201"	0.232"	0.335"	0.042"	0.049"	0.070"
30min	0.451"	0.520"	0.749"	0.196"	0.226"	0.326"
60min	0.616"	0.711"	1.024"	0.324"	0.373"	0.537"
180min	1.055"	1.221"	1.770"	0.696"	0.806"	1.168"
360min	1.482"	1.717"	2.500"	1.104"	1.279"	1.863"
1440min	2.756"	3.252"	4.900"	2.508"	2.959"	4.459"

3.117259 =X5

Event		Point Rainfall	
2yr	6hr	1.170"	=X1
100yr	6hr	2.500"	=X3
2yr	24hr	2.100"	=X2
100yr	24hr	4.900"	=X4
2yr	1hr	0.492"	Y2
100yr	1hr	1.024"	Y100
		1.024"	Y100

TH-04 Coordinates: 35.2258768 -118.4897

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.224"	0.257"	0.370"	0.047"	0.054"	0.078"
30min	0.501"	0.577"	0.828"	0.218"	0.251"	0.360"
60min	0.684"	0.788"	1.131"	0.359"	0.413"	0.594"
180min	1.212"	1.401"	2.032"	0.800"	0.925"	1.341"
360min	1.738"	2.016"	2.940"	1.295"	1.502"	2.190"
1440min	3.163"	3.664"	5.330"	2.878"	3.334"	4.850"

3.225877 =X5

Event		Point Rainfall	
2yr	6hr	1.370"	=X1
100yr	6hr	2.940"	=X3
2yr	24hr	2.500"	=X2
100yr	24hr	5.330"	=X4
2yr	1hr	0.547"	Y2
100yr	1hr	1.131"	Y100
		1.132"	Y100

TH-05 Coordinates: 35.1865462 -118.52706

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.216"	0.248"	0.355"	0.045"	0.052"	0.074"
30min	0.483"	0.555"	0.794"	0.210"	0.242"	0.345"
60min	0.660"	0.759"	1.085"	0.347"	0.398"	0.569"
180min	1.086"	1.253"	1.805"	0.717"	0.827"	1.192"
360min	1.487"	1.719"	2.490"	1.108"	1.281"	1.855"
1440min	2.523"	2.971"	4.460"	2.296"	2.703"	4.059"

3.186546 =X5

Event		Point Rainfall	
2yr	6hr	1.180"	=X1
100yr	6hr	2.490"	=X3
2yr	24hr	1.930"	=X2
100yr	24hr	4.460"	=X4
2yr	1hr	0.531"	Y2
100yr	1hr	1.085"	Y100
		1.085"	Y100

TH-06 Coordinates: 35.247331 -118.59416

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.208"	0.243"	0.356"	0.044"	0.051"	0.075"
30min	0.467"	0.543"	0.797"	0.203"	0.236"	0.347"
60min	0.638"	0.742"	1.089"	0.335"	0.390"	0.572"
180min	1.048"	1.224"	1.808"	0.692"	0.808"	1.193"
360min	1.433"	1.678"	2.490"	1.068"	1.250"	1.855"
1440min	2.431"	2.870"	4.330"	2.212"	2.612"	3.940"

3.247331 =X5

Event		Point Rainfall	
2yr	6hr	1.110"	=X1
100yr	6hr	2.490"	=X3
2yr	24hr	1.850"	=X2
100yr	24hr	4.330"	=X4
2yr	1hr	0.500"	Y2
100yr	1hr	1.089"	Y100
		1.090"	Y100

WB-01 Coordinates: 35.4056835 -118.42352

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.244"	0.283"	0.412"	0.051"	0.059"	0.086"
30min	0.546"	0.633"	0.922"	0.238"	0.275"	0.401"
60min	0.746"	0.865"	1.259"	0.392"	0.454"	0.661"
180min	1.349"	1.573"	2.315"	0.890"	1.038"	1.528"
360min	1.960"	2.293"	3.400"	1.460"	1.709"	2.533"
1440min	3.749"	4.466"	6.850"	3.411"	4.064"	6.234"

3.405683 =X5

Event		Point Rainfall	
2yr	6hr	1.520"	=X1
100yr	6hr	3.400"	=X3
2yr	24hr	2.800"	=X2
100yr	24hr	6.850"	=X4
2yr	1hr	0.589"	Y2
100yr	1hr	1.259"	Y100
		1.260"	Y100

WB-02 Coordinates: 35.4489987 -118.44473

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.251"	0.291"	0.424"	0.053"	0.061"	0.089"
30min	0.561"	0.651"	0.950"	0.244"	0.283"	0.413"
60min	0.767"	0.890"	1.298"	0.403"	0.467"	0.681"
180min	1.409"	1.644"	2.426"	0.930"	1.085"	1.601"
360min	2.068"	2.423"	3.600"	1.541"	1.805"	2.682"
1440min	4.101"	4.934"	7.700"	3.732"	4.490"	7.007"

3.448999 =X5

Event		Point Rainfall	
2yr	6hr	1.600"	=X1
100yr	6hr	3.600"	=X3
2yr	24hr	3.000"	=X2
100yr	24hr	7.700"	=X4
2yr	1hr	0.605"	Y2
100yr	1hr	1.298"	Y100
		1.298"	Y100

WB-03 Coordinates: 35.419868 -118.53598

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.218"	0.251"	0.358"	0.046"	0.053"	0.075"
30min	0.489"	0.562"	0.803"	0.213"	0.244"	0.349"
60min	0.668"	0.767"	1.096"	0.351"	0.403"	0.576"
180min	1.218"	1.401"	2.012"	0.804"	0.925"	1.328"
360min	1.778"	2.049"	2.950"	1.325"	1.527"	2.198"
1440min	3.507"	4.079"	5.980"	3.191"	3.712"	5.442"

3.419868 =X5

Event		Point Rainfall	
2yr	6hr	1.420"	=X1
100yr	6hr	2.950"	=X3
2yr	24hr	2.750"	=X2
100yr	24hr	5.980"	=X4
2yr	1hr	0.537"	Y2
100yr	1hr	1.096"	Y100
		1.097"	Y100

WB-04 Coordinates: 35.3657467 -118.65171

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.212"	0.250"	0.379"	0.04	0.05	0.08
30min	0.474"	0.561"	0.848"	0.21	0.24	0.37
60min	0.648"	0.766"	1.158"	0.34	0.40	0.61
180min	1.129"	1.340"	2.042"	0.75	0.88	1.35
360min	1.603"	1.908"	2.920"	1.19	1.42	2.18
1440min	2.805"	3.255"	4.750"	2.55	2.96	4.32

3.365747 =X5

Event		Point Rainfall	
2yr	6hr	1.200"	=X1
100yr	6hr	2.920"	=X3
2yr	24hr	2.210"	=X2
100yr	24hr	4.750"	=X4
2yr	1hr	0.492"	Y2
100yr	1hr	1.158"	Y100
		1.159"	Y100

STUDY AREA Coordinates: 35.2925815 -118.49236

Duration	Average recurrence interval (years)			Adjusted Ave recurrence interval		
	5	10	100	5	10	100
5min	0.223"	0.261"	0.385"	0.047"	0.055"	0.081"
30min	0.500"	0.584"	0.863"	0.218"	0.254"	0.376"
60min	0.683"	0.798"	1.179"	0.359"	0.419"	0.619"
180min	1.131"	1.328"	1.982"	0.747"	0.877"	1.308"
360min	1.555"	1.832"	2.750"	1.159"	1.365"	2.049"
1440min	2.649"	3.170"	4.900"	2.410"	2.884"	4.459"

3.292581 =X5

Event		Point Rainfall	
2yr	6hr	1.190"	=X1
100yr	6hr	2.750"	=X3
2yr	24hr	1.960"	=X2
100yr	24hr	4.900"	=X4
2yr	1hr	0.531"	Y2
100yr	1hr	1.179"	Y100
		1.180"	Y100

RF-01

CA-01, CA-02, & CA-03

Subarea	Area	Proportion
CA-01	20.76	0.311
CA-02	20.48	0.307
CA-03	25.55	0.383
TOTAL:	66.79	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.049"	0.056"	0.081"
30-min	0.227"	0.261"	0.376"
60-min	0.374"	0.431"	0.620"
3-hr	0.822"	0.952"	1.382"
6-hr	1.320"	1.533"	2.241"
24-hr	2.980"	3.541"	5.401"

RF-02

CA-04, CA-05, TH-03 & WB-03

Subarea	Area	Proportion
CA-04	37.35	0.360
CA-05	20.87	0.201
TH-03	16.49	0.159
WB-03	29.06	0.280
TOTAL:	103.77	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.047"	0.054"	0.078"
30-min	0.217"	0.250"	0.360"
60-min	0.358"	0.413"	0.593"
3-hr	0.790"	0.913"	1.323"
6-hr	1.272"	1.474"	2.146"
24-hr	2.907"	3.430"	5.164"

RF-03

TH-01 & TH-02

Subarea	Area	Proportion
TH-01	27.70	0.784
TH-02	7.61	0.216
TOTAL:	35.31	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.044"	0.052"	0.076"
30-min	0.205"	0.239"	0.354"
60-min	0.338"	0.395"	0.583"
3-hr	0.686"	0.806"	1.203"
6-hr	1.048"	1.235"	1.855"
24-hr	2.192"	2.657"	4.200"

RF-04

TH-04 & TH-05

Subarea	Area	Proportion
TH-04	18.06	0.347
TH-05	34.01	0.653
TOTAL:	52.07	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.046"	0.053"	0.076"
30-min	0.213"	0.245"	0.351"
60-min	0.351"	0.404"	0.578"
3-hr	0.746"	0.861"	1.243"
6-hr	1.173"	1.357"	1.971"
24-hr	2.498"	2.922"	4.333"

RF-05

CA-06, TH-06 & WB-04

Subarea	Area	Proportion
CA-06	62.5	0.483
TH-06	24.68	0.191
WB-04	42.31	0.327
TOTAL:	129.49	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.045"	0.053"	0.078"
30-min	0.210"	0.245"	0.360"
60-min	0.347"	0.404"	0.594"
3-hr	0.730"	0.854"	1.266"
6-hr	1.142"	1.340"	1.996"
24-hr	2.363"	2.763"	4.092"

RF-06

CA-07

Subarea	Area	Proportion
CA-07	34.21	1.000
TOTAL:	34.21	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.042"	0.049"	0.072"
30-min	0.193"	0.225"	0.333"
60-min	0.318"	0.371"	0.549"
3-hr	0.652"	0.764"	1.134"
6-hr	1.003"	1.176"	1.751"
24-hr	2.060"	2.407"	3.558"

RF-07

CA-08

Subarea	Area	Proportion
CA-08	4.92	1.000
TOTAL:	4.92	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.041"	0.048"	0.069"
30-min	0.191"	0.221"	0.322"
60-min	0.314"	0.365"	0.531"
3-hr	0.596"	0.692"	1.011"
6-hr	0.872"	1.013"	1.483"
24-hr	1.573"	1.820"	2.639"

RF-08

WB-01 & WB-02

Subarea	Area	Proportion
WB-01	26.67	0.543
WB-02	22.43	0.457
TOTAL:	49.1	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.052"	0.060"	0.088"
30-min	0.241"	0.279"	0.407"
60-min	0.397"	0.460"	0.670"
3-hr	0.908"	1.060"	1.561"
6-hr	1.497"	1.753"	2.601"
24-hr	3.558"	4.259"	6.587"

RF-09

STUDY AREA - WEIGHTED AVERAGE

Subarea	Area	Proportion
CA-01	20.76	0.044
CA-02	20.48	0.043
CA-03	25.55	0.054
CA-04	37.35	0.079
CA-05	20.87	0.044
CA-06	62.5	0.131
CA-07	34.21	0.072
CA-08	4.92	0.010
TH-01	27.7	0.058
TH-02	7.61	0.016
TH-03	16.49	0.035
TH-04	18.06	0.038
TH-05	34.01	0.072
TH-06	24.68	0.052
WB-01	26.67	0.056
WB-02	22.43	0.047
WB-03	29.06	0.061
WB-04	42.31	0.089
TOTAL:	475.66	1.000

Duration	Adjusted Ave recurrence interval		
	5	10	100
5-min	0.046"	0.054"	0.078"
30-min	0.216"	0.250"	0.363"
60-min	0.356"	0.412"	0.599"
3-hr	0.766"	0.891"	1.306"
6-hr	1.216"	1.418"	2.089"
24-hr	2.664"	3.146"	4.748"

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Subarea	Area, SM
CA-01	20.76
CA-02	20.48
CA-03	25.55
CA-04	37.35
CA-05	20.87
CA-06	62.5
CA-07	34.21
CA-08	4.92
TH-01	27.7
TH-02	7.61
TH-03	16.49
TH-04	18.06
TH-05	34.01
TH-06	24.68
WB-01	26.67
WB-02	22.43
WB-03	29.06
WB-04	42.31
TOTAL:	475.66

Aerial Adjustment Factors:

476 SM

Duration	%
5-min	63.2
30-min	68
60-min	69.7
3-hr	72.4
6-hr	74.2
24-hr	77.2

CA-01 Coordinates: 35.2510069 -118.28675

Duration	Average recurrence interval (years)				Adjusted Ave recurrence interval (years)			
	2	5	10	100	2	5	10	100
5-min	0.130"	0.170"	0.210"	0.380"	0.082"	0.107"	0.133"	0.240"
30-min	0.300"	0.400"	0.490"	0.900"	0.190"	0.272"	0.333"	0.612"
60-min	0.420"	0.560"	0.690"	1.260"	0.265"	0.390"	0.481"	0.878"
3-hr	0.780"	1.010"	1.220"	2.070"	0.493"	0.731"	0.883"	1.499"
6-hr	1.090"	1.430"	1.720"	2.870"	0.689"	1.061"	1.276"	2.130"
24-hr	1.990"	2.750"	3.390"	5.760"	1.258"	2.123"	2.617"	4.447"

CA-02 Coordinates: 35.3083785 -118.32769

Duration	Average recurrence interval (years)				Adjusted Ave recurrence interval (years)			
	2	5	10	100	2	5	10	100
5-min	0.120"	0.170"	0.200"	0.360"	0.076"	0.107"	0.126"	0.228"
30-min	0.290"	0.390"	0.480"	0.840"	0.197"	0.265"	0.326"	0.571"
60-min	0.410"	0.550"	0.670"	1.190"	0.286"	0.383"	0.467"	0.829"
3-hr	0.770"	1.000"	1.210"	2.050"	0.557"	0.724"	0.876"	1.484"
6-hr	1.070"	1.400"	1.690"	2.840"	0.794"	1.039"	1.254"	2.107"
24-hr	1.930"	2.660"	3.290"	5.630"	1.490"	2.054"	2.540"	4.346"

CA-03 Coordinates: 35.3653537 -118.33955

Duration	Average recurrence interval (years)				Adjusted Ave recurrence interval (years)			
	2	5	10	100	2	5	10	100
5-min	0.120"	0.170"	0.200"	0.360"	0.076"	0.107"	0.126"	0.228"
30-min	0.290"	0.390"	0.480"	0.860"	0.197"	0.265"	0.326"	0.585"
60-min	0.410"	0.560"	0.680"	1.210"	0.286"	0.390"	0.474"	0.843"
3-hr	0.770"	1.010"	1.220"	2.080"	0.557"	0.731"	0.883"	1.506"
6-hr	1.080"	1.410"	1.710"	2.880"	0.801"	1.046"	1.269"	2.137"
24-hr	1.930"	2.670"	3.300"	5.670"	1.490"	2.061"	2.548"	4.377"

CA-04 Coordinates: 35.2531672 -118.39081

Duration	Average recurrence interval (years)				Adjusted Ave recurrence interval (years)			
	2	5	10	100	2	5	10	100
5-min	0.130"	0.170"	0.210"	0.370"	0.082"	0.107"	0.133"	0.234"
30-min	0.300"	0.400"	0.490"	0.870"	0.204"	0.272"	0.333"	0.592"
60-min	0.420"	0.560"	0.690"	1.220"	0.293"	0.390"	0.481"	0.850"
3-hr	0.800"	1.030"	1.250"	2.110"	0.579"	0.746"	0.905"	1.528"
6-hr	1.110"	1.450"	1.750"	2.930"	0.824"	1.076"	1.299"	2.174"
24-hr	2.020"	2.780"	3.440"	5.880"	1.559"	2.146"	2.656"	4.539"

CA-05 Coordinates: 35.3449832 -118.42028

Duration	Average recurrence interval (years)				Adjusted Ave recurrence interval (years)			
	2	5	10	100	2	5	10	100
5-min	0.130"	0.170"	0.200"	0.350"	0.082"	0.107"	0.126"	0.221"
30-min	0.300"	0.400"	0.480"	0.830"	0.204"	0.272"	0.326"	0.564"
60-min	0.420"	0.560"	0.680"	1.170"	0.293"	0.390"	0.474"	0.815"
3-hr	0.810"	1.050"	1.270"	2.150"	0.586"	0.760"	0.919"	1.557"
6-hr	1.120"	1.470"	1.780"	3.000"	0.831"	1.091"	1.321"	2.226"
24-hr	2.010"	2.780"	3.430"	5.910"	1.552"	2.146"	2.648"	4.563"

CA-06 Coordinates: 35.3106528 -118.51999

Duration	Average				Adjusted Ave recurrence interval (years)			
	2	5	10	100	2	5	10	100
5-min	0.130"	0.180"	0.220"	0.380"	0.082"	0.114"	0.139"	0.240"
30-min	0.310"	0.420"	0.510"	0.900"	0.211"	0.286"	0.347"	0.612"
60-min	0.440"	0.590"	0.720"	1.270"	0.307"	0.411"	0.502"	0.885"
3-hr	0.840"	1.090"	1.320"	2.230"	0.608"	0.789"	0.956"	1.615"
6-hr	1.180"	1.540"	1.860"	3.130"	0.876"	1.143"	1.380"	2.322"
24-hr	2.140"	2.940"	3.620"	6.190"	1.652"	2.270"	2.795"	4.779"

CA-07 Coordinates: 35.2949692 -118.67116

Duration	Average recurrence interval (years)				Adjusted Ave recurrence interval (years)			
	2	5	10	100	2	5	10	100
5-min	0.110"	0.150"	0.180"	0.320"	0.070"	0.095"	0.114"	0.202"
30-min	0.260"	0.350"	0.430"	0.760"	0.177"	0.238"	0.292"	0.517"
60-min	0.370"	0.500"	0.610"	1.080"	0.258"	0.349"	0.425"	0.753"
3-hr	0.680"	0.887"	1.070"	1.780"	0.492"	0.642"	0.775"	1.289"
6-hr	0.950"	1.240"	1.480"	2.440"	0.705"	0.920"	1.098"	1.810"
24-hr	1.690"	2.290"	2.790"	4.660"	1.305"	1.768"	2.154"	3.598"

CA-08 Coordinates: 35.3044524 -118.78384

Duration	Average recurrence interval (years)				Adjusted Ave recurrence interval (years)			
	2	5	10	100	2	5	10	100
5-min	0.100"	0.130"	0.160"	0.280"	0.063"	0.082"	0.101"	0.177"
30-min	0.230"	0.310"	0.380"	0.660"	0.156"	0.211"	0.258"	0.449"
60-min	0.330"	0.440"	0.540"	0.930"	0.230"	0.307"	0.376"	0.648"
3-hr	0.590"	0.760"	0.920"	1.510"	0.427"	0.550"	0.666"	1.093"
6-hr	0.800"	1.040"	1.240"	2.030"	0.594"	0.772"	0.920"	1.506"
24-hr	1.370"	1.830"	2.230"	3.690"	1.058"	1.413"	1.722"	2.849"

TH-01 Coordinates: 35.1020786 -118.44337

Duration	Average recurrence interval (years)				Adjusted Ave recurrence interval (years)			
	2	5	10	100	2	5	10	100
5-min	0.140"	0.200"	0.250"	0.490"	0.088"	0.126"	0.158"	0.310"
30-min	0.340"	0.460"	0.570"	1.140"	0.231"	0.313"	0.388"	0.775"
60-min	0.460"	0.630"	0.790"	1.570"	0.321"	0.439"	0.551"	1.094"
3-hr	0.820"	1.070"	1.280"	2.160"	0.594"	0.775"	0.927"	1.564"
6-hr	1.180"	1.520"	1.810"	2.930"	0.876"	1.128"	1.343"	2.174"
24-hr	2.260"	3.170"	3.920"	6.550"	1.745"	2.447"	3.026"	5.057"

TH-02 Coordinates: 35.1009362 -118.48221

Duration	Average recurrence interval (years)				Adjusted Ave recurrence interval (years)			
	2	5	10	100	2	5	10	100
5-min	0.140"	0.190"	0.240"	0.480"	0.088"	0.120"	0.152"	0.303"
30-min	0.330"	0.450"	0.570"	1.120"	0.224"	0.306"	0.388"	0.762"
60-min	0.460"	0.630"	0.780"	1.550"	0.321"	0.439"	0.544"	1.080"
3-hr	0.830"	1.080"	1.290"	2.180"	0.601"	0.782"	0.934"	1.578"
6-hr	1.200"	1.550"	1.850"	2.990"	0.890"	1.150"	1.373"	2.219"
24-hr	2.290"	3.200"	3.950"	6.600"	1.768"	2.470"	3.049"	5.095"

TH-03 Coordinates: 35.1172588 -118.50767

Duration	Average recurrence interval (years)				Adjusted Ave recurrence interval (years)			
	2	5	10	100	2	5	10	100
5-min	0.130"	0.180"	0.230"	0.450"	0.082"	0.114"	0.145"	0.284"
30-min	0.310"	0.420"	0.520"	1.030"	0.211"	0.286"	0.354"	0.700"
60-min	0.420"	0.570"	0.720"	1.410"	0.293"	0.397"	0.502"	0.983"
3-hr	0.760"	0.980"	1.180"	1.980"	0.550"	0.710"	0.854"	1.434"
6-hr	1.080"	1.390"	1.660"	2.670"	0.801"	1.031"	1.232"	1.981"
24-hr	2.040"	2.850"	3.520"	5.860"	1.575"	2.200"	2.717"	4.524"

TH-04 Coordinates: 35.2258768 -118.4897

Duration	Average recurrence interval (years)				Adjusted Ave recurrence interval (years)			
	2	5	10	100	2	5	10	100
5-min	0.130"	0.170"	0.210"	0.390"	0.082"	0.107"	0.133"	0.246"
30-min	0.300"	0.400"	0.490"	0.920"	0.204"	0.272"	0.333"	0.626"
60-min	0.410"	0.560"	0.690"	1.280"	0.286"	0.390"	0.481"	0.892"
3-hr	0.770"	0.990"	1.200"	2.020"	0.557"	0.717"	0.869"	1.462"
6-hr	1.080"	1.400"	1.680"	2.770"	0.801"	1.039"	1.247"	2.055"
24-hr	1.980"	2.740"	3.380"	5.710"	1.529"	2.115"	2.609"	4.408"

TH-05 Coordinates: 35.1865462 -118.52706

Duration	Average				Adjusted Ave recurrence interval (years)			
	2	5	10	100	2	5	10	100
5-min	0.130"	0.170"	0.210"	0.410"	0.082"	0.107"	0.133"	0.259"
30-min	0.300"	0.400"	0.490"	0.950"	0.204"	0.272"	0.333"	0.646"
60-min	0.410"	0.550"	0.680"	1.310"	0.286"	0.383"	0.474"	0.913"
3-hr	0.740"	0.960"	1.150"	1.930"	0.536"	0.695"	0.833"	1.397"
6-hr	1.040"	1.350"	1.610"	2.620"	0.772"	1.002"	1.195"	1.944"
24-hr	1.950"	2.700"	3.320"	5.540"	1.505"	2.084"	2.563"	4.277"

TH-06 Coordinates: 35.247331 -118.59416

Duration	Average recurrence interval (years)				Adjusted Ave recurrence interval (years)			
	2	5	10	100	2	5	10	100
5-min	0.130"	0.170"	0.210"	0.390"	0.082"	0.107"	0.133"	0.246"
30-min	0.310"	0.410"	0.500"	0.910"	0.211"	0.279"	0.340"	0.619"
60-min	0.440"	0.580"	0.710"	1.290"	0.307"	0.404"	0.495"	0.899"
3-hr	0.820"	0.850"	1.020"	1.750"	0.594"	0.615"	0.738"	1.267"
6-hr	1.170"	1.520"	1.820"	3.000"	0.868"	1.128"	1.350"	2.226"
24-hr	2.150"	2.940"	3.600"	6.030"	1.660"	2.270"	2.779"	4.655"

WB-01 Coordinates: 35.4056835 -118.42352

Duration	Average recurrence interval (years)				Adjusted Ave recurrence interval (years)			
	2	5	10	100	2	5	10	100
5-min	0.120"	0.170"	0.200"	0.360"	0.076"	0.107"	0.126"	0.228"
30-min	0.290"	0.390"	0.480"	0.850"	0.197"	0.265"	0.326"	0.578"
60-min	0.410"	0.550"	0.680"	1.200"	0.286"	0.383"	0.474"	0.836"
3-hr	0.750"	0.990"	1.200"	2.040"	0.543"	0.717"	0.869"	1.477"
6-hr	1.040"	1.360"	1.650"	2.800"	0.772"	1.009"	1.224"	2.078"
24-hr	1.850"	2.550"	3.150"	5.420"	1.428"	1.969"	2.432"	4.184"

WB-02 Coordinates: 35.4489987 -118.44473

Duration	Average recurrence interval (years)				Adjusted Ave recurrence interval (years)			
	2	5	10	100	2	5	10	100
5-min	0.120"	0.170"	0.210"	0.380"	0.076"	0.107"	0.133"	0.240"
30-min	0.290"	0.400"	0.490"	0.890"	0.197"	0.272"	0.333"	0.605"
60-min	0.410"	0.560"	0.700"	1.250"	0.286"	0.390"	0.488"	0.871"
3-hr	0.750"	0.990"	1.200"	2.070"	0.543"	0.717"	0.869"	1.499"
6-hr	1.030"	1.360"	1.640"	2.800"	0.764"	1.009"	1.217"	2.078"
24-hr	1.830"	2.530"	3.120"	5.390"	1.413"	1.953"	2.409"	4.161"

WB-03 Coordinates: 35.419868 -118.53598

Duration	Average recurrence interval (years)				Adjusted Ave recurrence interval (years)			
	2	5	10	100	2	5	10	100
5-min	0.130"	0.180"	0.220"	0.390"	0.082"	0.114"	0.139"	0.246"
30-min	0.310"	0.420"	0.520"	0.920"	0.211"	0.286"	0.354"	0.626"
60-min	0.440"	0.600"	0.740"	1.300"	0.307"	0.418"	0.516"	0.906"
3-hr	0.810"	1.070"	1.300"	2.210"	0.586"	0.775"	0.941"	1.600"
6-hr	1.140"	1.500"	1.810"	3.070"	0.846"	1.113"	1.343"	2.278"
24-hr	2.050"	2.810"	3.460"	5.920"	1.583"	2.169"	2.671"	4.570"

WB-04 Coordinates: 35.3657467 -118.65171

Duration	Average recurrence interval (years)				Adjusted Ave recurrence interval (years)			
	2	5	10	100	2	5	10	100
5-min	0.140"	0.190"	0.230"	0.400"	0.088"	0.120"	0.145"	0.253"
30-min	0.330"	0.440"	0.540"	0.940"	0.224"	0.299"	0.367"	0.639"
60-min	0.470"	0.630"	0.770"	1.340"	0.328"	0.439"	0.537"	0.934"
3-hr	0.870"	1.140"	1.370"	2.290"	0.630"	0.825"	0.992"	1.658"
6-hr	1.240"	1.630"	1.950"	3.240"	0.920"	1.209"	1.447"	2.404"
24-hr	2.250"	3.020"	3.670"	6.140"	1.737"	2.331"	2.833"	4.740"

STUDY AREA Coordinates: 35.2925815 -118.49236

Duration	Average recurrence interval (years)				Adjusted Ave recurrence interval (years)			
	2	5	10	100	2	5	10	100
5-min	0.130"	0.170"	0.210"	0.370"	0.082"	0.107"	0.133"	0.234"
30-min	0.310"	0.410"	0.490"	0.860"	0.211"	0.279"	0.333"	0.585"
60-min	0.430"	0.570"	0.700"	1.220"	0.300"	0.397"	0.488"	0.850"
3-hr	0.820"	1.070"	1.290"	2.180"	0.594"	0.775"	0.934"	1.578"
6-hr	1.150"	1.510"	1.820"	3.060"	0.853"	1.120"	1.350"	2.271"
24-hr	2.080"	2.860"	3.530"	6.070"	1.606"	2.208"	2.725"	4.686"

RF-01

CA-01, CA-02, & CA-03

Subarea	Area	Proportion
CA-01	20.76	0.311
CA-02	20.48	0.307
CA-03	25.55	0.383
TOTAL:	66.79	1.000

Duration	Adjusted Ave recurrence interval (years)			
	2	5	10	100
5-min	0.078"	0.107"	0.128"	0.231"
30-min	0.195"	0.267"	0.329"	0.589"
60-min	0.279"	0.388"	0.474"	0.850"
3-hr	0.537"	0.729"	0.881"	1.497"
6-hr	0.764"	1.049"	1.267"	2.126"
24-hr	1.418"	2.078"	2.567"	4.389"

RF-02

CA-04, CA-05, TH-03 & WB-03

Subarea	Area	Proportion
CA-04	37.35	0.360
CA-05	20.87	0.201
TH-03	16.49	0.159
WB-03	29.06	0.280
TOTAL:	103.77	1.000

Duration	Adjusted Ave recurrence interval (years)			
	2	5	10	100
5-min	0.082"	0.110"	0.135"	0.243"
30-min	0.207"	0.278"	0.341"	0.613"
60-min	0.297"	0.399"	0.493"	0.880"
3-hr	0.578"	0.751"	0.910"	1.539"
6-hr	0.828"	1.082"	1.305"	2.183"
24-hr	1.567"	2.161"	2.668"	4.550"

RF-03

TH-01 & TH-02

Subarea	Area	Proportion
TH-01	27.70	0.784
TH-02	7.61	0.216
TOTAL:	35.31	1.000

Duration	Adjusted Ave recurrence interval (years)			
	2	5	10	100
5-min	0.088"	0.125"	0.157"	0.308"
30-min	0.230"	0.311"	0.388"	0.772"
60-min	0.321"	0.439"	0.549"	1.091"
3-hr	0.595"	0.776"	0.928"	1.567"
6-hr	0.879"	1.133"	1.349"	2.184"
24-hr	1.750"	2.452"	3.031"	5.065"

RF-04

TH-04 & TH-05

Subarea	Area	Proportion
TH-04	18.06	0.347
TH-05	34.01	0.653
TOTAL:	52.07	1.000

Duration	Adjusted Ave recurrence interval (years)			
	2	5	10	100
5-min	0.082"	0.107"	0.133"	0.255"
30-min	0.204"	0.272"	0.333"	0.639"
60-min	0.286"	0.386"	0.476"	0.906"
3-hr	0.543"	0.703"	0.845"	1.420"
6-hr	0.782"	1.015"	1.213"	1.983"
24-hr	1.513"	2.095"	2.579"	4.322"

RF-05

CA-06, TH-06 & WB-04

Subarea	Area	Proportion
CA-06	62.5	0.483
TH-06	24.68	0.191
WB-04	42.31	0.327
TOTAL:	129.49	1.000

Duration	Adjusted Ave recurrence interval (years)			
	2	5	10	100
5-min	0.084"	0.115"	0.140"	0.245"
30-min	0.215"	0.289"	0.352"	0.622"
60-min	0.314"	0.419"	0.512"	0.904"
3-hr	0.612"	0.768"	0.926"	1.562"
6-hr	0.889"	1.162"	1.396"	2.331"
24-hr	1.681"	2.290"	2.804"	4.743"

RF-06

CA-07

Subarea	Area	Proportion
CA-07	34.21	1.000
TOTAL:	34.21	1.000

Duration	Adjusted Ave recurrence interval (years)			
	2	5	10	100
5-min	0.070"	0.095"	0.114"	0.202"
30-min	0.177"	0.238"	0.292"	0.517"
60-min	0.258"	0.349"	0.425"	0.753"
3-hr	0.492"	0.642"	0.775"	1.289"
6-hr	0.705"	0.920"	1.098"	1.810"
24-hr	1.305"	1.768"	2.154"	3.598"

RF-07

CA-08

Subarea	Area	Proportion
CA-08	4.92	1.000
TOTAL:	4.92	1.000

Duration	Adjusted Ave recurrence interval (years)			
	2	5	10	100
5-min	0.063"	0.082"	0.101"	0.177"
30-min	0.156"	0.211"	0.258"	0.449"
60-min	0.230"	0.307"	0.376"	0.648"
3-hr	0.427"	0.550"	0.666"	1.093"
6-hr	0.594"	0.772"	0.920"	1.506"
24-hr	1.058"	1.413"	1.722"	2.849"

RF-08

WB-01 & WB-02

Subarea	Area	Proportion
WB-01	26.67	0.543
WB-02	22.43	0.457
TOTAL:	49.1	1.000

Duration	Adjusted Ave recurrence interval (years)			
	2	5	10	100
5-min	0.076"	0.107"	0.129"	0.233"
30-min	0.197"	0.268"	0.330"	0.590"
60-min	0.286"	0.387"	0.480"	0.852"
3-hr	0.543"	0.717"	0.869"	1.487"
6-hr	0.768"	1.009"	1.221"	2.078"
24-hr	1.421"	1.962"	2.421"	4.174"

RF-09

STUDY AREA - WEIGHTED AVERAGE

Subarea	Area	Proportion
CA-01	20.76	0.044
CA-02	20.48	0.043
CA-03	25.55	0.054
CA-04	37.35	0.079
CA-05	20.87	0.044
CA-06	62.5	0.131
CA-07	34.21	0.072
CA-08	4.92	0.010
TH-01	27.7	0.058
TH-02	7.61	0.016
TH-03	16.49	0.035
TH-04	18.06	0.038
TH-05	34.01	0.072
TH-06	24.68	0.052
WB-01	26.67	0.056
WB-02	22.43	0.047
WB-03	29.06	0.061
WB-04	42.31	0.089
TOTAL:	475.66	1.000

Duration	Adjusted Ave recurrence interval (years)			
	2	5	10	100
5-min	0.081"	0.110"	0.134"	0.244"
30-min	0.205"	0.277"	0.339"	0.616"
60-min	0.295"	0.399"	0.490"	0.886"
3-hr	0.568"	0.736"	0.888"	1.500"
6-hr	0.817"	1.073"	1.290"	2.149"
24-hr	1.546"	2.142"	2.636"	4.468"

STUDY AREA

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.376230	30	0.0209
630.0	0.506040	60	0.0418
690.0	0.653025	90	0.0627
705.0	0.697480	120	0.0836
717.5	0.761800	150	0.1045
722.5	0.843960	180	0.1254
735.0	0.908280	210	0.1463
750.0	0.952735	240	0.1672
810.0	1.099720	270	0.1881
900.0	1.229530	300	0.2090
1440.0	1.605760	330	0.2299
		360	0.2508
		390	0.2717
		420	0.2926
		450	0.3135
		480	0.3344
		510	0.3553
		540	0.3762
		570	0.4195
		600	0.4628
		630	0.5060
		660	0.5795
		690	0.6530
		720	0.8029
		750	0.9527
		780	1.0262
		810	1.0997
		840	1.1430
		870	1.1863
		900	1.2295
		930	1.2504
		960	1.2713
		990	1.2922
		1020	1.3131
		1050	1.3340
		1080	1.3549
		1110	1.3758
		1140	1.3967
		1170	1.4176
		1200	1.4385
		1230	1.4594
		1260	1.4804
		1290	1.5013
		1320	1.5222
		1350	1.5431
		1380	1.5640
		1410	1.5849
		1440	1.6058

RF-01

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.326819	30	0.0182
630.0	0.440168	60	0.0363
690.0	0.569155	90	0.0545
705.0	0.611462	120	0.0726
717.5	0.669979	150	0.0908
722.5	0.747783	180	0.1089
735.0	0.806300	210	0.1271
750.0	0.848606	240	0.1453
810.0	0.977594	270	0.1634
900.0	1.090942	300	0.1816
1440.0	1.417762	330	0.1997
		360	0.2179
		390	0.2360
		420	0.2542
		450	0.2723
		480	0.2905
		510	0.3087
		540	0.3268
		570	0.3646
		600	0.4024
		630	0.4402
		660	0.5047
		690	0.5692
		720	0.7089
		750	0.8486
		780	0.9131
		810	0.9776
		840	1.0154
		870	1.0532
		900	1.0909
		930	1.1091
		960	1.1273
		990	1.1454
		1020	1.1636
		1050	1.1817
		1080	1.1999
		1110	1.2180
		1140	1.2362
		1170	1.2544
		1200	1.2725
		1230	1.2907
		1260	1.3088
		1290	1.3270
		1320	1.3451
		1350	1.3633
		1380	1.3814
		1410	1.3996
		1440	1.4178

RF-02

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.369509	30	0.0205
630.0	0.494373	60	0.0411
690.0	0.635091	90	0.0616
705.0	0.679921	120	0.0821
717.5	0.742333	150	0.1026
722.5	0.824493	180	0.1232
735.0	0.886906	210	0.1437
750.0	0.931735	240	0.1642
810.0	1.072454	270	0.1848
900.0	1.197318	300	0.2053
1440.0	1.566827	330	0.2258
		360	0.2463
		390	0.2669
		420	0.2874
		450	0.3079
		480	0.3285
		510	0.3490
		540	0.3695
		570	0.4111
		600	0.4528
		630	0.4944
		660	0.5647
		690	0.6351
		720	0.7834
		750	0.9317
		780	1.0021
		810	1.0725
		840	1.1141
		870	1.1557
		900	1.1973
		930	1.2178
		960	1.2384
		990	1.2589
		1020	1.2794
		1050	1.3000
		1080	1.3205
		1110	1.3410
		1140	1.3615
		1170	1.3821
		1200	1.4026
		1230	1.4231
		1260	1.4437
		1290	1.4642
		1320	1.4847
		1350	1.5052
		1380	1.5258
		1410	1.5463
		1440	1.5668

RF-03

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.435477	30	0.0242
630.0	0.577236	60	0.0484
690.0	0.714546	90	0.0726
705.0	0.759988	120	0.0968
717.5	0.830616	150	0.1210
722.5	0.919096	180	0.1452
735.0	0.989723	210	0.1694
750.0	1.035166	240	0.1935
810.0	1.172476	270	0.2177
900.0	1.314235	300	0.2419
1440.0	1.749711	330	0.2661
		360	0.2903
		390	0.3145
		420	0.3387
		450	0.3629
		480	0.3871
		510	0.4113
		540	0.4355
		570	0.4827
		600	0.5300
		630	0.5772
		660	0.6459
		690	0.7145
		720	0.8749
		750	1.0352
		780	1.1038
		810	1.1725
		840	1.2197
		870	1.2670
		900	1.3142
		930	1.3384
		960	1.3626
		990	1.3868
		1020	1.4110
		1050	1.4352
		1080	1.4594
		1110	1.4836
		1140	1.5078
		1170	1.5320
		1200	1.5562
		1230	1.5804
		1260	1.6046
		1290	1.6287
		1320	1.6529
		1350	1.6771
		1380	1.7013
		1410	1.7255
		1440	1.7497

RF-04

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.365729	30	0.0203
630.0	0.485070	60	0.0406
690.0	0.613831	90	0.0610
705.0	0.654716	120	0.0813
717.5	0.715636	150	0.1016
722.5	0.797796	180	0.1219
735.0	0.858716	210	0.1422
750.0	0.899601	240	0.1625
810.0	1.028363	270	0.1829
900.0	1.147704	300	0.2032
1440.0	1.513433	330	0.2235
		360	0.2438
		390	0.2641
		420	0.2845
		450	0.3048
		480	0.3251
		510	0.3454
		540	0.3657
		570	0.4055
		600	0.4453
		630	0.4851
		660	0.5495
		690	0.6138
		720	0.7567
		750	0.8996
		780	0.9640
		810	1.0284
		840	1.0681
		870	1.1079
		900	1.1477
		930	1.1680
		960	1.1883
		990	1.2087
		1020	1.2290
		1050	1.2493
		1080	1.2696
		1110	1.2899
		1140	1.3102
		1170	1.3306
		1200	1.3509
		1230	1.3712
		1260	1.3915
		1290	1.4118
		1320	1.4322
		1350	1.4525
		1380	1.4728
		1410	1.4931
		1440	1.5134

RF-05

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.396303	30	0.0220
630.0	0.534401	60	0.0440
690.0	0.683893	90	0.0661
705.0	0.733027	120	0.0881
717.5	0.798537	150	0.1101
722.5	0.882762	180	0.1321
735.0	0.948271	210	0.1541
750.0	0.997405	240	0.1761
810.0	1.146898	270	0.1982
900.0	1.284995	300	0.2202
1440.0	1.681298	330	0.2422
		360	0.2642
		390	0.2862
		420	0.3082
		450	0.3303
		480	0.3523
		510	0.3743
		540	0.3963
		570	0.4423
		600	0.4884
		630	0.5344
		660	0.6091
		690	0.6839
		720	0.8406
		750	0.9974
		780	1.0722
		810	1.1469
		840	1.1929
		870	1.2390
		900	1.2850
		930	1.3070
		960	1.3290
		990	1.3510
		1020	1.3731
		1050	1.3951
		1080	1.4171
		1110	1.4391
		1140	1.4611
		1170	1.4831
		1200	1.5052
		1230	1.5272
		1260	1.5492
		1290	1.5712
		1320	1.5932
		1350	1.6152
		1380	1.6373
		1410	1.6593
		1440	1.6813

RF-05 - 3 Hr

From Series		Expanded	
Time	Cummu-lative, Inches	Time, Min	Cummu-lative, Inches
0	0.000000	0	0.0000
60	0.149492	15	0.0374
75	0.198627	30	0.0747
90	0.306249	45	0.1121
105	0.413870	60	0.1495
120	0.463005	75	0.1986
180	0.612497	90	0.3062
		105	0.4139
		120	0.4630
		135	0.5004
		150	0.5378
		165	0.5751
		180	0.6125

RF-06

From Series		Expanded	
Time	Cummu-lative, Inches	Time, Min	Cummu-lative, Inches
0.0	0.000000	0	0.0000
540.0	0.299890	30	0.0167
630.0	0.406180	60	0.0333
690.0	0.523395	90	0.0500
705.0	0.563940	120	0.0666
717.5	0.617580	150	0.0833
722.5	0.687100	180	0.1000
735.0	0.740740	210	0.1166
750.0	0.781285	240	0.1333
810.0	0.898500	270	0.1499
900.0	1.004790	300	0.1666
1440.0	1.304680	330	0.1833
		360	0.1999
		390	0.2166
		420	0.2332
		450	0.2499
		480	0.2666
		510	0.2832
		540	0.2999
		570	0.3353
		600	0.3708
		630	0.4062
		660	0.4648
		690	0.5234
		720	0.6523
		750	0.7813
		780	0.8399
		810	0.8985
		840	0.9339
		870	0.9694
		900	1.0048
		930	1.0215
		960	1.0381
		990	1.0548
		1020	1.0714
		1050	1.0881
		1080	1.1048
		1110	1.1214
		1140	1.1381
		1170	1.1547
		1200	1.1714
		1230	1.1881
		1260	1.2047
		1290	1.2214
		1320	1.2380
		1350	1.2547
		1380	1.2714
		1410	1.2880
		1440	1.3047

RF-06 - 3 Hr

From Series		Expanded	
Time	Cummu-lative, Inches	Time, Min	Cummu-lative, Inches
0	0.000000	0	0.0000
60	0.117215	15	0.0293
75	0.157760	30	0.0586
90	0.246160	45	0.0879
105	0.334560	60	0.1172
120	0.375105	75	0.1578
180	0.492320	90	0.2462
		105	0.3346
		120	0.3751
		135	0.4044
		150	0.4337
		165	0.4630
		180	0.4923

RF-07

From Series		Expanded	
Time	Cummu-lative, Inches	Time, Min	Cummu-lative, Inches
0.0	0.000000	0	0.0000
540.0	0.232020	30	0.0129
630.0	0.315240	60	0.0258
690.0	0.413815	90	0.0387
705.0	0.450620	120	0.0516
717.5	0.497220	150	0.0645
722.5	0.560420	180	0.0773
735.0	0.607020	210	0.0902
750.0	0.643825	240	0.1031
810.0	0.742400	270	0.1160
900.0	0.825620	300	0.1289
1440.0	1.057640	330	0.1418
		360	0.1547
		390	0.1676
		420	0.1805
		450	0.1934
		480	0.2062
		510	0.2191
		540	0.2320
		570	0.2598
		600	0.2875
		630	0.3152
		660	0.3645
		690	0.4138
		720	0.5288
		750	0.6438
		780	0.6931
		810	0.7424
		840	0.7701
		870	0.7979
		900	0.8256
		930	0.8385
		960	0.8514
		990	0.8643
		1020	0.8772
		1050	0.8901
		1080	0.9030
		1110	0.9159
		1140	0.9287
		1170	0.9416
		1200	0.9545
		1230	0.9674
		1260	0.9803
		1290	0.9932
		1320	1.0061
		1350	1.0190
		1380	1.0319
		1410	1.0448
		1440	1.0576

RF-07 - 3 Hr

From Series		Expanded	
Time	Cummu-lative, Inches	Time, Min	Cummu-lative, Inches
0	0.000000	0	0.0000
60	0.098575	15	0.0246
75	0.135380	30	0.0493
90	0.213580	45	0.0739
105	0.291780	60	0.0986
120	0.328585	75	0.1354
180	0.427160	90	0.2136
		105	0.2918
		120	0.3286
		135	0.3532
		150	0.3779
		165	0.4025
		180	0.4272

RF-08

From Series		Expanded	
Time	Cummu-lative, Inches	Time, Min	Cummu-lative, Inches
0.0	0.000000	0	0.0000
540.0	0.326428	30	0.0181
630.0	0.439073	60	0.0363
690.0	0.567688	90	0.0544
705.0	0.611973	120	0.0725
717.5	0.672653	150	0.0907
722.5	0.748493	180	0.1088
735.0	0.809173	210	0.1269
750.0	0.853458	240	0.1451
810.0	0.982073	270	0.1632
900.0	1.094719	300	0.1813
1440.0	1.421147	330	0.1995
		360	0.2176
		390	0.2358
		420	0.2539
		450	0.2720
		480	0.2902
		510	0.3083
		540	0.3264
		570	0.3640
		600	0.4015
		630	0.4391
		660	0.5034
		690	0.5677
		720	0.7106
		750	0.8535
		780	0.9178
		810	0.9821
		840	1.0196
		870	1.0572
		900	1.0947
		930	1.1129
		960	1.1310
		990	1.1491
		1020	1.1673
		1050	1.1854
		1080	1.2035
		1110	1.2217
		1140	1.2398
		1170	1.2579
		1200	1.2761
		1230	1.2942
		1260	1.3123
		1290	1.3305
		1320	1.3486
		1350	1.3667
		1380	1.3849
		1410	1.4030
		1440	1.4211

STUDY AREA

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.543750	30	0.0302
630.0	0.716620	60	0.0604
690.0	0.905315	90	0.0906
705.0	0.964560	120	0.1208
717.5	1.050240	150	0.1510
722.5	1.157680	180	0.1813
735.0	1.243360	210	0.2115
750.0	1.302605	240	0.2417
810.0	1.491300	270	0.2719
900.0	1.664170	300	0.3021
1440.0	2.207920	330	0.3323
		360	0.3625
		390	0.3927
		420	0.4229
		450	0.4531
		480	0.4833
		510	0.5135
		540	0.5438
		570	0.6014
		600	0.6590
		630	0.7166
		660	0.8110
		690	0.9053
		720	1.1040
		750	1.3026
		780	1.3970
		810	1.4913
		840	1.5489
		870	1.6065
		900	1.6642
		930	1.6944
		960	1.7246
		990	1.7548
		1020	1.7850
		1050	1.8152
		1080	1.8454
		1110	1.8756
		1140	1.9058
		1170	1.9360
		1200	1.9663
		1230	1.9965
		1260	2.0267
		1290	2.0569
		1320	2.0871
		1350	2.1173
		1380	2.1475
		1410	2.1777
		1440	2.2079

RF-01

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.514756	30	0.0286
630.0	0.674525	60	0.0572
690.0	0.844943	90	0.0858
705.0	0.905378	120	0.1144
717.5	0.985315	150	0.1430
722.5	1.092755	180	0.1716
735.0	1.172691	210	0.2002
750.0	1.233126	240	0.2288
810.0	1.403545	270	0.2574
900.0	1.563313	300	0.2860
1440.0	2.078069	330	0.3146
		360	0.3432
		390	0.3718
		420	0.4004
		450	0.4290
		480	0.4576
		510	0.4862
		540	0.5148
		570	0.5680
		600	0.6213
		630	0.6745
		660	0.7597
		690	0.8449
		720	1.0390
		750	1.2331
		780	1.3183
		810	1.4035
		840	1.4568
		870	1.5101
		900	1.5633
		930	1.5919
		960	1.6205
		990	1.6491
		1020	1.6777
		1050	1.7063
		1080	1.7349
		1110	1.7635
		1140	1.7921
		1170	1.8207
		1200	1.8493
		1230	1.8779
		1260	1.9065
		1290	1.9351
		1320	1.9637
		1350	1.9923
		1380	2.0209
		1410	2.0495
		1440	2.0781

RF-02

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.539517	30	0.0300
630.0	0.705122	60	0.0599
690.0	0.880999	90	0.0899
705.0	0.941632	120	0.1199
717.5	1.025510	150	0.1499
722.5	1.135724	180	0.1798
735.0	1.219601	210	0.2098
750.0	1.280234	240	0.2398
810.0	1.456111	270	0.2698
900.0	1.621716	300	0.2997
1440.0	2.161233	330	0.3297
		360	0.3597
		390	0.3897
		420	0.4196
		450	0.4496
		480	0.4796
		510	0.5095
		540	0.5395
		570	0.5947
		600	0.6499
		630	0.7051
		660	0.7931
		690	0.8810
		720	1.0806
		750	1.2802
		780	1.3682
		810	1.4561
		840	1.5113
		870	1.5665
		900	1.6217
		930	1.6517
		960	1.6817
		990	1.7116
		1020	1.7416
		1050	1.7716
		1080	1.8016
		1110	1.8315
		1140	1.8615
		1170	1.8915
		1200	1.9214
		1230	1.9514
		1260	1.9814
		1290	2.0114
		1320	2.0413
		1350	2.0713
		1380	2.1013
		1410	2.1313
		1440	2.1612

RF-03

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.659797	30	0.0367
630.0	0.837996	60	0.0733
690.0	1.006561	90	0.1100
705.0	1.070448	120	0.1466
717.5	1.163597	150	0.1833
722.5	1.288635	180	0.2199
735.0	1.381783	210	0.2566
750.0	1.445671	240	0.2932
810.0	1.614236	270	0.3299
900.0	1.792434	300	0.3666
1440.0	2.452231	330	0.4032
		360	0.4399
		390	0.4765
		420	0.5132
		450	0.5498
		480	0.5865
		510	0.6231
		540	0.6598
		570	0.7192
		600	0.7786
		630	0.8380
		660	0.9223
		690	1.0066
		720	1.2261
		750	1.4457
		780	1.5300
		810	1.6142
		840	1.6736
		870	1.7330
		900	1.7924
		930	1.8291
		960	1.8657
		990	1.9024
		1020	1.9391
		1050	1.9757
		1080	2.0124
		1110	2.0490
		1140	2.0857
		1170	2.1223
		1200	2.1590
		1230	2.1956
		1260	2.2323
		1290	2.2690
		1320	2.3056
		1350	2.3423
		1380	2.3789
		1410	2.4156
		1440	2.4522

RF-04

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.540271	30	0.0300
630.0	0.696269	60	0.0600
690.0	0.854671	90	0.0900
705.0	0.911555	120	0.1201
717.5	0.993835	150	0.1501
722.5	1.101275	180	0.1801
735.0	1.183555	210	0.2101
750.0	1.240439	240	0.2401
810.0	1.398842	270	0.2701
900.0	1.554839	300	0.3002
1440.0	2.095110	330	0.3302
		360	0.3602
		390	0.3902
		420	0.4202
		450	0.4502
		480	0.4802
		510	0.5103
		540	0.5403
		570	0.5923
		600	0.6443
		630	0.6963
		660	0.7755
		690	0.8547
		720	1.0476
		750	1.2404
		780	1.3196
		810	1.3988
		840	1.4508
		870	1.5028
		900	1.5548
		930	1.5849
		960	1.6149
		990	1.6449
		1020	1.6749
		1050	1.7049
		1080	1.7349
		1110	1.7649
		1140	1.7950
		1170	1.8250
		1200	1.8550
		1230	1.8850
		1260	1.9150
		1290	1.9450
		1320	1.9751
		1350	2.0051
		1380	2.0351
		1410	2.0651
		1440	2.0951

RF-05

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.564094	30	0.0313
630.0	0.760995	60	0.0627
690.0	0.935424	90	0.0940
705.0	1.000556	120	0.1254
717.5	1.087620	150	0.1567
722.5	1.202240	180	0.1880
735.0	1.289304	210	0.2194
750.0	1.354435	240	0.2507
810.0	1.528865	270	0.2820
900.0	1.725766	300	0.3134
1440.0	2.289860	330	0.3447
		360	0.3761
		390	0.4074
		420	0.4387
		450	0.4701
		480	0.5014
		510	0.5328
		540	0.5641
		570	0.6297
		600	0.6954
		630	0.7610
		660	0.8482
		690	0.9354
		720	1.1449
		750	1.3544
		780	1.4417
		810	1.5289
		840	1.5945
		870	1.6601
		900	1.7258
		930	1.7571
		960	1.7884
		990	1.8198
		1020	1.8511
		1050	1.8825
		1080	1.9138
		1110	1.9451
		1140	1.9765
		1170	2.0078
		1200	2.0392
		1230	2.0705
		1260	2.1018
		1290	2.1332
		1320	2.1645
		1350	2.1958
		1380	2.2272
		1410	2.2585
		1440	2.2899

RF-05 - 3 Hr

From Series		Expanded	
Time	Cummu-lative, Inches	Time, Min	Cummu-lative, Inches
0	0.000000	0	0.0000
60	0.174430	15	0.0436
75	0.239561	30	0.0872
90	0.383935	45	0.1308
105	0.528309	60	0.1744
120	0.593441	75	0.2396
180	0.767871	90	0.3839
		105	0.5283
		120	0.5934
		135	0.6370
		150	0.6807
		165	0.7243
		180	0.7679

RF-06

From Series		Expanded	
Time	Cummu-lative, Inches	Time, Min	Cummu-lative, Inches
0.0	0.000000	0	0.0000
540.0	0.423900	30	0.0236
630.0	0.562846	60	0.0471
690.0	0.709690	90	0.0707
705.0	0.764940	120	0.0942
717.5	0.836540	150	0.1178
722.5	0.931340	180	0.1413
735.0	1.002940	210	0.1649
750.0	1.058190	240	0.1884
810.0	1.205034	270	0.2120
900.0	1.343980	300	0.2355
1440.0	1.767880	330	0.2591
		360	0.2826
		390	0.3062
		420	0.3297
		450	0.3533
		480	0.3768
		510	0.4004
		540	0.4239
		570	0.4702
		600	0.5165
		630	0.5628
		660	0.6363
		690	0.7097
		720	0.8839
		750	1.0582
		780	1.1316
		810	1.2050
		840	1.2513
		870	1.2977
		900	1.3440
		930	1.3675
		960	1.3911
		990	1.4146
		1020	1.4382
		1050	1.4617
		1080	1.4853
		1110	1.5088
		1140	1.5324
		1170	1.5559
		1200	1.5795
		1230	1.6030
		1260	1.6266
		1290	1.6501
		1320	1.6737
		1350	1.6972
		1380	1.7208
		1410	1.7443
		1440	1.7679

RF-06 - 3 Hr

From Series		Expanded	
Time	Cummu-lative, Inches	Time, Min	Cummu-lative, Inches
0	0.000000	0	0.0000
60	0.146844	15	0.0367
75	0.202094	30	0.0734
90	0.321094	45	0.1101
105	0.440094	60	0.1468
120	0.495344	75	0.2021
180	0.642188	90	0.3211
		105	0.4401
		120	0.4953
		135	0.5321
		150	0.5688
		165	0.6055
		180	0.6422

RF-07

From Series		Expanded	
Time	Cummu-lative, Inches	Time, Min	Cummu-lative, Inches
0.0	0.000000	0	0.0000
540.0	0.320540	30	0.0178
630.0	0.431260	60	0.0356
690.0	0.553040	90	0.0534
705.0	0.600980	120	0.0712
717.5	0.665300	150	0.0890
722.5	0.747460	180	0.1068
735.0	0.811780	210	0.1247
750.0	0.859720	240	0.1425
810.0	0.981500	270	0.1603
900.0	1.092220	300	0.1781
1440.0	1.412760	330	0.1959
		360	0.2137
		390	0.2315
		420	0.2493
		450	0.2671
		480	0.2849
		510	0.3027
		540	0.3205
		570	0.3574
		600	0.3944
		630	0.4313
		660	0.4922
		690	0.5530
		720	0.7064
		750	0.8597
		780	0.9206
		810	0.9815
		840	1.0184
		870	1.0553
		900	1.0922
		930	1.1100
		960	1.1278
		990	1.1456
		1020	1.1635
		1050	1.1813
		1080	1.1991
		1110	1.2169
		1140	1.2347
		1170	1.2525
		1200	1.2703
		1230	1.2881
		1260	1.3059
		1290	1.3237
		1320	1.3415
		1350	1.3593
		1380	1.3771
		1410	1.3950
		1440	1.4128

RF-07 - 3 Hr

From Series		Expanded	
Time	Cummu-lative, Inches	Time, Min	Cummu-lative, Inches
0	0.000000	0	0.0000
60	0.121780	15	0.0304
75	0.169720	30	0.0609
90	0.275120	45	0.0913
105	0.380520	60	0.1218
120	0.428460	75	0.1697
180	0.550240	90	0.2751
		105	0.3805
		120	0.4285
		135	0.4589
		150	0.4894
		165	0.5198
		180	0.5502

RF-08

From Series		Expanded	
Time	Cummu-lative, Inches	Time, Min	Cummu-lative, Inches
0.0	0.000000	0	0.0000
540.0	0.476213	30	0.0265
630.0	0.622393	60	0.0529
690.0	0.787506	90	0.0794
705.0	0.846620	120	0.1058
717.5	0.927053	150	0.1323
722.5	1.034493	180	0.1587
735.0	1.114927	210	0.1852
750.0	1.174040	240	0.2117
810.0	1.339153	270	0.2381
900.0	1.485333	300	0.2646
1440.0	1.961547	330	0.2910
		360	0.3175
		390	0.3439
		420	0.3704
		450	0.3968
		480	0.4233
		510	0.4498
		540	0.4762
		570	0.5249
		600	0.5737
		630	0.6224
		660	0.7049
		690	0.7875
		720	0.9808
		750	1.1740
		780	1.2566
		810	1.3392
		840	1.3879
		870	1.4366
		900	1.4853
		930	1.5118
		960	1.5382
		990	1.5647
		1020	1.5912
		1050	1.6176
		1080	1.6441
		1110	1.6705
		1140	1.6970
		1170	1.7234
		1200	1.7499
		1230	1.7764
		1260	1.8028
		1290	1.8293
		1320	1.8557
		1350	1.8822
		1380	1.9086
		1410	1.9351
		1440	1.9615

STUDY AREA

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.687360	30	0.0382
630.0	0.895600	60	0.0764
690.0	1.118630	90	0.1146
705.0	1.195980	120	0.1527
717.5	1.296220	150	0.1909
722.5	1.428940	180	0.2291
735.0	1.529180	210	0.2673
750.0	1.606530	240	0.3055
810.0	1.829560	270	0.3437
900.0	2.037800	300	0.3819
1440.0	2.725160	330	0.4201
		360	0.4582
		390	0.4964
		420	0.5346
		450	0.5728
		480	0.6110
		510	0.6492
		540	0.6874
		570	0.7568
		600	0.8262
		630	0.8956
		660	1.0071
		690	1.1186
		720	1.3626
		750	1.6065
		780	1.7180
		810	1.8296
		840	1.8990
		870	1.9684
		900	2.0378
		930	2.0760
		960	2.1142
		990	2.1524
		1020	2.1905
		1050	2.2287
		1080	2.2669
		1110	2.3051
		1140	2.3433
		1170	2.3815
		1200	2.4197
		1230	2.4579
		1260	2.4960
		1290	2.5342
		1320	2.5724
		1350	2.6106
		1380	2.6488
		1410	2.6870
		1440	2.7252

RF-01

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.650127	30	0.0361
630.0	0.842884	60	0.0722
690.0	1.046420	90	0.1084
705.0	1.119158	120	0.1445
717.5	1.219232	150	0.1806
722.5	1.347597	180	0.2167
735.0	1.447671	210	0.2528
750.0	1.520409	240	0.2889
810.0	1.723944	270	0.3251
900.0	1.916702	300	0.3612
1440.0	2.566829	330	0.3973
		360	0.4334
		390	0.4695
		420	0.5057
		450	0.5418
		480	0.5779
		510	0.6140
		540	0.6501
		570	0.7144
		600	0.7786
		630	0.8429
		660	0.9447
		690	1.0464
		720	1.2834
		750	1.5204
		780	1.6222
		810	1.7239
		840	1.7882
		870	1.8524
		900	1.9167
		930	1.9528
		960	1.9889
		990	2.0251
		1020	2.0612
		1050	2.0973
		1080	2.1334
		1110	2.1695
		1140	2.2056
		1170	2.2418
		1200	2.2779
		1230	2.3140
		1260	2.3501
		1290	2.3862
		1320	2.4224
		1350	2.4585
		1380	2.4946
		1410	2.5307
		1440	2.5668

RF-02

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.681717	30	0.0379
630.0	0.879135	60	0.0757
690.0	1.087827	90	0.1136
705.0	1.163739	120	0.1515
717.5	1.266519	150	0.1894
722.5	1.401746	180	0.2272
735.0	1.504526	210	0.2651
750.0	1.580438	240	0.3030
810.0	1.789131	270	0.3409
900.0	1.986549	300	0.3787
1440.0	2.668265	330	0.4166
		360	0.4545
		390	0.4924
		420	0.5302
		450	0.5681
		480	0.6060
		510	0.6438
		540	0.6817
		570	0.7475
		600	0.8133
		630	0.8791
		660	0.9835
		690	1.0878
		720	1.3341
		750	1.5804
		780	1.6848
		810	1.7891
		840	1.8549
		870	1.9207
		900	1.9865
		930	2.0244
		960	2.0623
		990	2.1002
		1020	2.1380
		1050	2.1759
		1080	2.2138
		1110	2.2517
		1140	2.2895
		1170	2.3274
		1200	2.3653
		1230	2.4032
		1260	2.4410
		1290	2.4789
		1320	2.5168
		1350	2.5546
		1380	2.5925
		1410	2.6304
		1440	2.6683

RF-03

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.840907	30	0.0467
630.0	1.051476	60	0.0934
690.0	1.241052	90	0.1402
705.0	1.321816	120	0.1869
717.5	1.437297	150	0.2336
722.5	1.593935	180	0.2803
735.0	1.709416	210	0.3270
750.0	1.790180	240	0.3737
810.0	1.979756	270	0.4205
900.0	2.190324	300	0.4672
1440.0	3.031231	330	0.5139
		360	0.5606
		390	0.6073
		420	0.6540
		450	0.7008
		480	0.7475
		510	0.7942
		540	0.8409
		570	0.9111
		600	0.9813
		630	1.0515
		660	1.1463
		690	1.2411
		720	1.5156
		750	1.7902
		780	1.8850
		810	1.9798
		840	2.0499
		870	2.1201
		900	2.1903
		930	2.2370
		960	2.2838
		990	2.3305
		1020	2.3772
		1050	2.4239
		1080	2.4706
		1110	2.5173
		1140	2.5641
		1170	2.6108
		1200	2.6575
		1230	2.7042
		1260	2.7509
		1290	2.7976
		1320	2.8444
		1350	2.8911
		1380	2.9378
		1410	2.9845
		1440	3.0312

RF-04

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.683235	30	0.0380
630.0	0.866975	60	0.0759
690.0	1.051364	90	0.1139
705.0	1.122953	120	0.1518
717.5	1.223193	150	0.1898
722.5	1.355913	180	0.2277
735.0	1.456153	210	0.2657
750.0	1.527742	240	0.3037
810.0	1.712131	270	0.3416
900.0	1.895870	300	0.3796
1440.0	2.579106	330	0.4175
		360	0.4555
		390	0.4934
		420	0.5314
		450	0.5694
		480	0.6073
		510	0.6453
		540	0.6832
		570	0.7445
		600	0.8057
		630	0.8670
		660	0.9592
		690	1.0514
		720	1.2896
		750	1.5277
		780	1.6199
		810	1.7121
		840	1.7734
		870	1.8346
		900	1.8959
		930	1.9338
		960	1.9718
		990	2.0097
		1020	2.0477
		1050	2.0857
		1080	2.1236
		1110	2.1616
		1140	2.1995
		1170	2.2375
		1200	2.2754
		1230	2.3134
		1260	2.3514
		1290	2.3893
		1320	2.4273
		1350	2.4652
		1380	2.5032
		1410	2.5411
		1440	2.5791

RF-05

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.704013	30	0.0391
630.0	0.939099	60	0.0782
690.0	1.146205	90	0.1173
705.0	1.226070	120	0.1564
717.5	1.332205	150	0.1956
722.5	1.472105	180	0.2347
735.0	1.578240	210	0.2738
750.0	1.658104	240	0.3129
810.0	1.865210	270	0.3520
900.0	2.100296	300	0.3911
1440.0	2.804310	330	0.4302
		360	0.4693
		390	0.5085
		420	0.5476
		450	0.5867
		480	0.6258
		510	0.6649
		540	0.7040
		570	0.7824
		600	0.8607
		630	0.9391
		660	1.0427
		690	1.1462
		720	1.4022
		750	1.6581
		780	1.7617
		810	1.8652
		840	1.9436
		870	2.0219
		900	2.1003
		930	2.1394
		960	2.1785
		990	2.2176
		1020	2.2567
		1050	2.2959
		1080	2.3350
		1110	2.3741
		1140	2.4132
		1170	2.4523
		1200	2.4914
		1230	2.5305
		1260	2.5696
		1290	2.6088
		1320	2.6479
		1350	2.6870
		1380	2.7261
		1410	2.7652
		1440	2.8043

RF-05 - 3 Hr

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0	0.000000	0	0.0000
60	0.207106	15	0.0518
75	0.286971	30	0.1036
90	0.463056	45	0.1553
105	0.639140	60	0.2071
120	0.719005	75	0.2870
180	0.926111	90	0.4631
		105	0.6391
		120	0.7190
		135	0.7708
		150	0.8226
		165	0.8743
		180	0.9261

RF-06

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.527860	30	0.0293
630.0	0.689600	60	0.0587
690.0	0.864355	90	0.0880
705.0	0.930740	120	0.1173
717.5	1.020060	150	0.1466
722.5	1.133820	180	0.1760
735.0	1.223140	210	0.2053
750.0	1.289525	240	0.2346
810.0	1.464280	270	0.2639
900.0	1.626020	300	0.2933
1440.0	2.153880	330	0.3226
		360	0.3519
		390	0.3812
		420	0.4106
		450	0.4399
		480	0.4692
		510	0.4985
		540	0.5279
		570	0.5818
		600	0.6357
		630	0.6896
		660	0.7770
		690	0.8644
		720	1.0769
		750	1.2895
		780	1.3769
		810	1.4643
		840	1.5182
		870	1.5721
		900	1.6260
		930	1.6553
		960	1.6847
		990	1.7140
		1020	1.7433
		1050	1.7726
		1080	1.8020
		1110	1.8313
		1140	1.8606
		1170	1.8900
		1200	1.9193
		1230	1.9486
		1260	1.9779
		1290	2.0073
		1320	2.0366
		1350	2.0659
		1380	2.0952
		1410	2.1246
		1440	2.1539

RF-06 - 3 Hr

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0	0.000000	0	0.0000
60	0.174755	15	0.0437
75	0.241140	30	0.0874
90	0.387340	45	0.1311
105	0.533540	60	0.1748
120	0.599925	75	0.2411
180	0.774680	90	0.3873
		105	0.5335
		120	0.5999
		135	0.6436
		150	0.6873
		165	0.7310
		180	0.7747

RF-07

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.400740	30	0.0223
630.0	0.527740	60	0.0445
690.0	0.672590	90	0.0668
705.0	0.731580	120	0.0891
717.5	0.810220	150	0.1113
722.5	0.911340	180	0.1336
735.0	0.989980	210	0.1558
750.0	1.048970	240	0.1781
810.0	1.193820	270	0.2004
900.0	1.320820	300	0.2226
1440.0	1.721560	330	0.2449
		360	0.2672
		390	0.2894
		420	0.3117
		450	0.3340
		480	0.3562
		510	0.3785
		540	0.4007
		570	0.4431
		600	0.4854
		630	0.5277
		660	0.6002
		690	0.6726
		720	0.8608
		750	1.0490
		780	1.1214
		810	1.1938
		840	1.2362
		870	1.2785
		900	1.3208
		930	1.3431
		960	1.3653
		990	1.3876
		1020	1.4099
		1050	1.4321
		1080	1.4544
		1110	1.4767
		1140	1.4989
		1170	1.5212
		1200	1.5435
		1230	1.5657
		1260	1.5880
		1290	1.6102
		1320	1.6325
		1350	1.6548
		1380	1.6770
		1410	1.6993
		1440	1.7216

RF-07 - 3 Hr

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0	0.000000	0	0.0000
60	0.144850	15	0.0362
75	0.203840	30	0.0724
90	0.333040	45	0.1086
105	0.462240	60	0.1449
120	0.521230	75	0.2038
180	0.666080	90	0.3330
		105	0.4622
		120	0.5212
		135	0.5574
		150	0.5937
		165	0.6299
		180	0.6661

RF-08

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.600155	30	0.0333
630.0	0.776210	60	0.0667
690.0	0.970446	90	0.1000
705.0	1.045857	120	0.1334
717.5	1.145966	150	0.1667
722.5	1.275254	180	0.2001
735.0	1.375363	210	0.2334
750.0	1.450774	240	0.2667
810.0	1.645010	270	0.3001
900.0	1.821065	300	0.3334
1440.0	2.421220	330	0.3668
		360	0.4001
		390	0.4334
		420	0.4668
		450	0.5001
		480	0.5335
		510	0.5668
		540	0.6002
		570	0.6588
		600	0.7175
		630	0.7762
		660	0.8733
		690	0.9704
		720	1.2106
		750	1.4508
		780	1.5479
		810	1.6450
		840	1.7037
		870	1.7624
		900	1.8211
		930	1.8544
		960	1.8877
		990	1.9211
		1020	1.9544
		1050	1.9878
		1080	2.0211
		1110	2.0545
		1140	2.0878
		1170	2.1211
		1200	2.1545
		1230	2.1878
		1260	2.2212
		1290	2.2545
		1320	2.2879
		1350	2.3212
		1380	2.3545
		1410	2.3879
		1440	2.4212

STUDY AREA

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	1.207760	30	0.0671
630.0	1.553860	60	0.1342
690.0	1.917850	90	0.2013
705.0	2.050620	120	0.2684
717.5	2.226100	150	0.3355
722.5	2.459940	180	0.4026
735.0	2.635420	210	0.4697
750.0	2.768190	240	0.5368
810.0	3.132180	270	0.6039
900.0	3.478280	300	0.6710
1440.0	4.686040	330	0.7381
		360	0.8052
		390	0.8723
		420	0.9394
		450	1.0065
		480	1.0736
		510	1.1407
		540	1.2078
		570	1.3231
		600	1.4385
		630	1.5539
		660	1.7359
		690	1.9179
		720	2.3430
		750	2.7682
		780	2.9502
		810	3.1322
		840	3.2475
		870	3.3629
		900	3.4783
		930	3.5454
		960	3.6125
		990	3.6796
		1020	3.7467
		1050	3.8138
		1080	3.8809
		1110	3.9480
		1140	4.0151
		1170	4.0822
		1200	4.1493
		1230	4.2164
		1260	4.2835
		1290	4.3506
		1320	4.4176
		1350	4.4847
		1380	4.5518
		1410	4.6189
		1440	4.6860

RF-01

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	1.131907	30	0.0629
630.0	1.446179	60	0.1258
690.0	1.769720	90	0.1887
705.0	1.900142	120	0.2515
717.5	2.078959	150	0.3144
722.5	2.310408	180	0.3773
735.0	2.489226	210	0.4402
750.0	2.619648	240	0.5031
810.0	2.943188	270	0.5660
900.0	3.257460	300	0.6288
1440.0	4.389367	330	0.6917
		360	0.7546
		390	0.8175
		420	0.8804
		450	0.9433
		480	1.0061
		510	1.0690
		540	1.1319
		570	1.2367
		600	1.3414
		630	1.4462
		660	1.6079
		690	1.7697
		720	2.1947
		750	2.6196
		780	2.7814
		810	2.9432
		840	3.0479
		870	3.1527
		900	3.2575
		930	3.3203
		960	3.3832
		990	3.4461
		1020	3.5090
		1050	3.5719
		1080	3.6348
		1110	3.6976
		1140	3.7605
		1170	3.8234
		1200	3.8863
		1230	3.9492
		1260	4.0121
		1290	4.0749
		1320	4.1378
		1350	4.2007
		1380	4.2636
		1410	4.3265
		1440	4.3894

RF-02

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	1.183636	30	0.0658
630.0	1.505715	60	0.1315
690.0	1.835111	90	0.1973
705.0	1.968636	120	0.2630
717.5	2.153670	150	0.3288
722.5	2.396542	180	0.3945
735.0	2.581576	210	0.4603
750.0	2.715101	240	0.5261
810.0	3.044497	270	0.5918
900.0	3.366576	300	0.6576
1440.0	4.550212	330	0.7233
		360	0.7891
		390	0.8548
		420	0.9206
		450	0.9864
		480	1.0521
		510	1.1179
		540	1.1836
		570	1.2910
		600	1.3984
		630	1.5057
		660	1.6704
		690	1.8351
		720	2.2751
		750	2.7151
		780	2.8798
		810	3.0445
		840	3.1519
		870	3.2592
		900	3.3666
		930	3.4323
		960	3.4981
		990	3.5638
		1020	3.6296
		1050	3.6954
		1080	3.7611
		1110	3.8269
		1140	3.8926
		1170	3.9584
		1200	4.0242
		1230	4.0899
		1260	4.1557
		1290	4.2214
		1320	4.2872
		1350	4.3529
		1380	4.4187
		1410	4.4845
		1440	4.5502

RF-03

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	1.440632	30	0.0800
630.0	1.748979	60	0.1601
690.0	1.986817	90	0.2401
705.0	2.146325	120	0.3201
717.5	2.378301	150	0.4002
722.5	2.686618	180	0.4802
735.0	2.918594	210	0.5602
750.0	3.078102	240	0.6403
810.0	3.315940	270	0.7203
900.0	3.624287	300	0.8004
1440.0	5.064919	330	0.8804
		360	0.9604
		390	1.0405
		420	1.1205
		450	1.2005
		480	1.2806
		510	1.3606
		540	1.4406
		570	1.5434
		600	1.6462
		630	1.7490
		660	1.8679
		690	1.9868
		720	2.5325
		750	3.0781
		780	3.1970
		810	3.3159
		840	3.4187
		870	3.5215
		900	3.6243
		930	3.7043
		960	3.7844
		990	3.8644
		1020	3.9444
		1050	4.0245
		1080	4.1045
		1110	4.1845
		1140	4.2646
		1170	4.3446
		1200	4.4246
		1230	4.5047
		1260	4.5847
		1290	4.6647
		1320	4.7448
		1350	4.8248
		1380	4.9048
		1410	4.9849
		1440	5.0649

RF-04

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	1.169878	30	0.0650
630.0	1.451240	60	0.1300
690.0	1.708291	90	0.1950
705.0	1.841737	120	0.2600
717.5	2.033832	150	0.3250
722.5	2.288568	180	0.3900
735.0	2.480662	210	0.4550
750.0	2.614108	240	0.5199
810.0	2.871160	270	0.5849
900.0	3.152521	300	0.6499
1440.0	4.322399	330	0.7149
		360	0.7799
		390	0.8449
		420	0.9099
		450	0.9749
		480	1.0399
		510	1.1049
		540	1.1699
		570	1.2637
		600	1.3575
		630	1.4512
		660	1.5798
		690	1.7083
		720	2.1612
		750	2.6141
		780	2.7426
		810	2.8712
		840	2.9649
		870	3.0587
		900	3.1525
		930	3.2175
		960	3.2825
		990	3.3475
		1020	3.4125
		1050	3.4775
		1080	3.5425
		1110	3.6075
		1140	3.6725
		1170	3.7375
		1200	3.8025
		1230	3.8674
		1260	3.9324
		1290	3.9974
		1320	4.0624
		1350	4.1274
		1380	4.1924
		1410	4.2574
		1440	4.3224

RF-05

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	1.205891	30	0.0670
630.0	1.590023	60	0.1340
690.0	1.919368	90	0.2010
705.0	2.060171	120	0.2680
717.5	2.248515	150	0.3350
722.5	2.494010	180	0.4020
735.0	2.682355	210	0.4690
750.0	2.823157	240	0.5360
810.0	3.152502	270	0.6029
900.0	3.536635	300	0.6699
1440.0	4.742526	330	0.7369
		360	0.8039
		390	0.8709
		420	0.9379
		450	1.0049
		480	1.0719
		510	1.1389
		540	1.2059
		570	1.3339
		600	1.4620
		630	1.5900
		660	1.7547
		690	1.9194
		720	2.3713
		750	2.8232
		780	2.9878
		810	3.1525
		840	3.2805
		870	3.4086
		900	3.5366
		930	3.6036
		960	3.6706
		990	3.7376
		1020	3.8046
		1050	3.8716
		1080	3.9386
		1110	4.0056
		1140	4.0726
		1170	4.1396
		1200	4.2066
		1230	4.2736
		1260	4.3406
		1290	4.4076
		1320	4.4745
		1350	4.5415
		1380	4.6085
		1410	4.6755
		1440	4.7425

RF-05 - 3 Hr

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0	0.000000	0	0.0000
60	0.329345	15	0.0823
75	0.470148	30	0.1647
90	0.781239	45	0.2470
105	1.092331	60	0.3293
120	1.233134	75	0.4701
180	1.562479	90	0.7812
		105	1.0923
		120	1.2331
		135	1.3155
		150	1.3978
		165	1.4801
		180	1.5625

RF-06

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.893520	30	0.0496
630.0	1.154400	60	0.0993
690.0	1.422380	90	0.1489
705.0	1.540360	120	0.1986
717.5	1.697640	150	0.2482
722.5	1.899880	180	0.2978
735.0	2.057160	210	0.3475
750.0	2.175140	240	0.3971
810.0	2.443120	270	0.4468
900.0	2.704000	300	0.4964
1440.0	3.597520	330	0.5460
		360	0.5957
		390	0.6453
		420	0.6950
		450	0.7446
		480	0.7942
		510	0.8439
		540	0.8935
		570	0.9805
		600	1.0674
		630	1.1544
		660	1.2884
		690	1.4224
		720	1.7988
		750	2.1751
		780	2.3091
		810	2.4431
		840	2.5301
		870	2.6170
		900	2.7040
		930	2.7536
		960	2.8033
		990	2.8529
		1020	2.9026
		1050	2.9522
		1080	3.0018
		1110	3.0515
		1140	3.1011
		1170	3.1508
		1200	3.2004
		1230	3.2500
		1260	3.2997
		1290	3.3493
		1320	3.3990
		1350	3.4486
		1380	3.4982
		1410	3.5479
		1440	3.5975

RF-06 - 3 Hr

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0	0.000000	0	0.0000
60	0.267980	15	0.0670
75	0.385960	30	0.1340
90	0.644360	45	0.2010
105	0.902760	60	0.2680
120	1.020740	75	0.3860
180	1.288720	90	0.6444
		105	0.9028
		120	1.0207
		135	1.0877
		150	1.1547
		165	1.2217
		180	1.2887

RF-07

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	0.671210	30	0.0373
630.0	0.877720	60	0.0746
690.0	1.100235	90	0.1119
705.0	1.199940	120	0.1492
717.5	1.335860	150	0.1864
722.5	1.512820	180	0.2237
735.0	1.648740	210	0.2610
750.0	1.748445	240	0.2983
810.0	1.970960	270	0.3356
900.0	2.177470	300	0.3729
1440.0	2.848680	330	0.4102
		360	0.4475
		390	0.4848
		420	0.5221
		450	0.5593
		480	0.5966
		510	0.6339
		540	0.6712
		570	0.7400
		600	0.8089
		630	0.8777
		660	0.9890
		690	1.1002
		720	1.4243
		750	1.7484
		780	1.8597
		810	1.9710
		840	2.0398
		870	2.1086
		900	2.1775
		930	2.2148
		960	2.2520
		990	2.2893
		1020	2.3266
		1050	2.3639
		1080	2.4012
		1110	2.4385
		1140	2.4758
		1170	2.5131
		1200	2.5504
		1230	2.5877
		1260	2.6249
		1290	2.6622
		1320	2.6995
		1350	2.7368
		1380	2.7741
		1410	2.8114
		1440	2.8487

RF-07 - 3 Hr

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0	0.000000	0	0.0000
60	0.222515	15	0.0556
75	0.322220	30	0.1113
90	0.546620	45	0.1669
105	0.771020	60	0.2225
120	0.870725	75	0.3222
180	1.093240	90	0.5466
		105	0.7710
		120	0.8707
		135	0.9264
		150	0.9820
		165	1.0376
		180	1.0932

RF-08

From Series		Expanded	
Time	Cummulative, Inches	Time, Min	Cummulative, Inches
0.0	0.000000	0	0.0000
540.0	1.048030	30	0.0582
630.0	1.343389	60	0.1164
690.0	1.660670	90	0.1747
705.0	1.791617	120	0.2329
717.5	1.970183	150	0.2911
722.5	2.203477	180	0.3493
735.0	2.382043	210	0.4076
750.0	2.512990	240	0.4658
810.0	2.830271	270	0.5240
900.0	3.125630	300	0.5822
1440.0	4.173660	330	0.6405
		360	0.6987
		390	0.7569
		420	0.8151
		450	0.8734
		480	0.9316
		510	0.9898
		540	1.0480
		570	1.1465
		600	1.2449
		630	1.3434
		660	1.5020
		690	1.6607
		720	2.0868
		750	2.5130
		780	2.6716
		810	2.8303
		840	2.9287
		870	3.0272
		900	3.1256
		930	3.1839
		960	3.2421
		990	3.3003
		1020	3.3585
		1050	3.4167
		1080	3.4750
		1110	3.5332
		1140	3.5914
		1170	3.6496
		1200	3.7079
		1230	3.7661
		1260	3.8243
		1290	3.8825
		1320	3.9408
		1350	3.9990
		1380	4.0572
		1410	4.1154
		1440	4.1737

LAG

Tc(T)=Tc(100)*KT

Return Period	KT Value
2	1.32
5	1.20
10	1.14
25	1.07
50	1.03
100	1.00

LAG EQUATION: Lag (hours)=24n[(L*Lca)/s^0.5]^m

Basin	Manning's n	L, miles	Lca, miles	elev1	elev2	H, feet	s, ft per mile	m, constant	100yr Lag, hours	10yr Lag, hours	5yr Lag, hours	2yr Lag, hours
CA-01	0.045	6.958	3.430	6000.0	3640.0	2360.0	339.2	0.38	1.192	1.359	1.430	1.573
CA-02	0.045	8.628	4.399	5400.0	2865.0	2535.0	293.8	0.38	1.461	1.665	1.753	1.928
CA-03	0.045	9.710	5.047	7360.0	2865.0	4495.0	462.9	0.38	1.477	1.683	1.772	1.949
CA-04	0.045	9.597	5.490	6400.0	2645.0	3755.0	391.3	0.38	1.567	1.787	1.881	2.069
CA-05	0.045	8.071	4.843	4520.0	2645.0	1875.0	232.3	0.38	1.545	1.761	1.854	2.039
CA-06	0.045	16.184	7.323	5000.0	1288.0	3712.0	229.4	0.38	2.360	2.691	2.832	3.116
CA-07	0.045	12.798	6.656	3360.0	815.0	2545.0	198.9	0.38	2.139	2.439	2.567	2.824
CA-08	0.045	4.697	2.178	1060.0	615.0	445.0	94.7	0.38	1.101	1.255	1.321	1.453
TH-01	0.045	9.341	4.384	6800.0	3816.0	2984.0	319.5	0.38	1.480	1.687	1.776	1.954
TH-02	0.045	8.325	4.664	7200.0	3660.0	3540.0	425.2	0.38	1.374	1.566	1.648	1.813
TH-03	0.045	10.103	3.666	7000.0	3660.0	3340.0	330.6	0.38	1.415	1.613	1.698	1.868
TH-04	0.045	8.985	4.754	5400.0	2495.0	2905.0	323.3	0.38	1.500	1.710	1.800	1.980
TH-05	0.045	11.330	3.950	5140.0	2495.0	2645.0	233.4	0.38	1.625	1.852	1.950	2.145
TH-06	0.045	9.473	5.866	5800.0	1288.0	4512.0	476.3	0.38	1.540	1.756	1.849	2.033
WB-01	0.050	12.581	5.047	8060.0	3425.0	4635.0	368.4	0.38	1.891	2.155	2.269	2.496
WB-02	0.050	8.998	4.986	8040.0	3425.0	4615.0	512.9	0.38	1.556	1.774	1.867	2.054
WB-03	0.050	7.895	2.869	5920.0	3160.0	2760.0	349.6	0.38	1.291	1.471	1.549	1.704
WB-04	0.050	16.868	8.389	5720.0	815.0	4905.0	290.8	0.38	2.682	3.057	3.218	3.540

KINEMATIC WAVE

From Junction	Reach Name	To Junction	Length	Elev 1	Elev 2	Ave Slope	Manning's	Shape	Width	Sideslopes (xV:1H)
CA05	LCCW	CA06	22432	815	615	0.008916	0.040	Rectangle	600	-
CA04	LCCE	CA05	49291	1288	815	0.009596	0.040	Trapeziod	175	0.5
CA03	MCC	CA04	67111	2645	1288	0.02022	0.040	Trapeziod	115	0.5
CA02	UCC	CA03	16398	2865	2645	0.013416	0.040	Rectangle	525	-
CA01	LIC	CA03	44672	3640	2645	0.022273	0.040	Trapeziod	170	0.5
TH03	LTC	CA04	36137	2495	815	0.04649	0.040	Trapeziod	250	0.5
TH02	MTC	TH03	44865	3660	2495	0.025967	0.040	Trapeziod	220	0.5
TH01	UTCW	TH02	6820	3816	3660	0.022874	0.040	Trapeziod	115	0.5
WB02	LWBC	CA05	74910	3160	815	0.031304	0.040	Trapeziod	175	0.5
WB01	MWBC	WB02	21147	3425	3160	0.012531	0.040	Rectangle	200	-

Subarea	Total Area	Developed Area	% Imp.	Remainder Area	Background % Imp.	Imp. Area	Ave. % Imp.
TH-01	17733	2085	25	15647	1	678	4
TH-02	4866	798	25	4067	1	240	5
TH-03	10551	1023	25	9528	1	351	3

Cn Summary

Subarea	Cn, AMC-I
CA-01	57.81
CA-02	53.82
CA-03	54.62
CA-04	55.46
CA-05	56.04
CA-06	53.09
CA-07 & 08	40.60
TH-01	46.57
TH-02	49.60
TH-03	48.82
TH-04	46.52
TH-05	48.15
TH-06	45.20
WB-01	55.64
WB-02	56.56
WB-03	51.29
WB-04	49.56

Soil Group	Cn, AMC-I	Cn, AMC-II
Type_A_Soils	22	39
Type_B_Soils	41	61
Type_C_Soils	56	74
Type_D_Soils	63	80

Subarea CA-01

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
32308	Type_D_Soils	63	2035380	
99529	Type_D_Soils	63	6270335	
119465	Type_C_Soils	56	6690017	
319549	Type_D_Soils	63	20131573	
411245	Type_D_Soils	63	25908457	
547787	Type_D_Soils	63	34510570	
840668	Type_D_Soils	63	52962056	
1194106	Type_B_Soils	41	48958363	
1519385	Type_D_Soils	63	95721265	
1639172	Type_C_Soils	56	91793643	
2179969	Type_D_Soils	63	137338036	
2926704	Type_D_Soils	63	184382382	
3492535	Type_D_Soils	63	220029699	
5654120	Type_B_Soils	41	231818929	
9728878	Type_D_Soils	63	612919312	
14654643	Type_D_Soils	63	923242507	
48952836	Type_D_Soils	63	3084028690	
78480788	Type_D_Soils	63	4944289659	
405663204	Type_C_Soils	56	22717139452	
578456892			33440170325	**57.81**
578666854	DRAINAREA			

Soil Group	Cn, AMC-I
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea CA-02

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
35199	Type_D_Soils	63	2217508	
49433	Type_D_Soils	63	3114302	
87518	Type_D_Soils	63	5513638	
112998	Type_D_Soils	63	7118857	
198753	Type_D_Soils	63	12521453	
212186	Type_D_Soils	63	13367728	
252255	Type_D_Soils	63	15892085	
341292	Type_D_Soils	63	21501375	
1069519	Type_D_Soils	63	67379687	
2327190	Type_B_Soils	41	95414799	
2524157	Type_D_Soils	63	159021907	
2673776	Type_D_Soils	63	168447864	
3017092	Type_D_Soils	63	190076816	
3765662	Type_D_Soils	63	237236702	
5091994	Type_D_Soils	63	320795639	
5816436	Type_D_Soils	63	366435473	
7077554	Type_D_Soils	63	445885891	
7463402	Type_D_Soils	63	470194342	
7764775	Type_B_Soils	41	318355776	
7951302	Type_B_Soils	41	326003366	
10313945	Type_D_Soils	63	649778522	
10598081	Type_D_Soils	63	667679109	
13506193	Type_D_Soils	63	850890143	
17066093	Type_D_Soils	63	1075163867	
17975551	Type_C_Soils	56	1006630880	
18486485	Type_D_Soils	63	1164648578	
19289146	Type_D_Soils	63	1215216220	
32928160	Type_D_Soils	63	2074474051	
33547937	Type_D_Soils	63	2113520043	
33672168	Type_D_Soils	63	2121346589	
36847772	Type_D_Soils	63	2321409619	
43027056	Type_B_Soils	41	1764109310	
54005882	Type_D_Soils	63	3402370535	
171118195	Type_B_Soils	41	7015846003	
570215158			30689578675	**53.82**
570942475	DRAINAREA			

Soil Group	, AMC-I
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea CA-03

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
44983	Type_B_Soils	41	1844284	
92356	Type_B_Soils	41	3786601	
127375	Type_D_Soils	63	8024650	
314864	Type_D_Soils	63	19836451	
457047	Type_C_Soils	56	25594635	
944640	Type_B_Soils	41	38730259	
1289019	Type_B_Soils	41	52849767	
1547767	Type_B_Soils	41	63458446	
1928471	Type_D_Soils	63	121493689	
2275650	Type_B_Soils	41	93301669	
2645319	Type_D_Soils	63	166655078	
2779241	Type_B_Soils	41	113948874	
4003207	Type_D_Soils	63	252202012	
4741152	Type_D_Soils	63	298692584	
5865481	Type_C_Soils	56	328466935	
6092549	Type_B_Soils	41	249794525	
6382731	Type_D_Soils	63	402112067	
7230649	Type_B_Soils	41	296456595	
8510207	Type_B_Soils	41	348918474	
8592575	Type_B_Soils	41	352295585	
8967407	Type_B_Soils	41	367663696	
8991922	Type_B_Soils	41	368668794	
12017691	Type_B_Soils	41	492725311	
12042955	Type_B_Soils	41	493761153	
12057682	Type_B_Soils	41	494364980	
12467294	Type_B_Soils	41	511159040	
12649740	Type_D_Soils	63	796933625	
18924060	Type_B_Soils	41	775886460	
19393494	Type_D_Soils	63	1221790140	
41041594	Type_D_Soils	63	2585620411	
53277795	Type_D_Soils	63	3356501096	
144036509	Type_B_Soils	41	5905496885	
289715615	Type_D_Soils	63	18252083742	
711449042			38861118513	**54.62**
712180876	DRAINAREA			

Soil Group	Cn, AMC-I
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea CA-04

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
78325	Type_D_Soils	63	4934499	
88362	Type_D_Soils	63	5566797	
293648	Type_D_Soils	63	18499802	
336306	Type_C_Soils	56	18833162	
395119	Type_D_Soils	63	24892481	
634043	Type_D_Soils	63	39944688	
1120173	Type_D_Soils	63	70570881	
1402129	Type_B_Soils	41	57487270	
1518449	Type_B_Soils	41	62256394	
1562747	Type_B_Soils	41	64072622	
1626670	Type_B_Soils	41	66693484	
1934530	Type_D_Soils	63	121875421	
2064748	Type_C_Soils	56	115625915	
2389280	Type_B_Soils	41	97960496	
2494734	Type_B_Soils	41	102284109	
2931492	Type_B_Soils	41	120191189	
3042177	Type_B_Soils	41	124729273	
3447231	Type_B_Soils	41	141336465	
3863724	Type_D_Soils	63	243414602	
3863724	Type_B_Soils	41	158412678	
4109406	Type_D_Soils	63	258892606	
4501877	Type_B_Soils	41	184576977	
4661631	Type_D_Soils	63	293682782	
4987430	Type_B_Soils	41	204484611	
5222520	Type_B_Soils	41	214123310	
5303369	Type_D_Soils	63	334112272	
5365887	Type_B_Soils	41	220001354	
5474266	Type_D_Soils	63	344878742	
6191581	Type_C_Soils	56	346728554	
6634380	Type_D_Soils	63	417965964	
7059635	Type_B_Soils	41	289445050	
7091192	Type_D_Soils	63	446745109	
7337720	Type_B_Soils	41	300846502	
7450145	Type_C_Soils	56	417208094	
8371533	Type_B_Soils	41	343232854	
8747902	Type_D_Soils	63	551117824	
8815925	Type_B_Soils	41	361452920	
8983802	Type_B_Soils	41	368335882	
9200277	Type_D_Soils	63	579617453	
9202234	Type_B_Soils	41	377291585	
9581777	Type_B_Soils	41	392852844	
9994900	Type_D_Soils	63	629678729	
9998900	Type_D_Soils	63	629930710	
10354023	Type_D_Soils	63	652303460	
11215199	Type_D_Soils	63	706557509	
11658580	Type_C_Soils	56	652880453	
11679375	Type_B_Soils	41	478854381	
13383340	Type_B_Soils	41	548716951	
16459169	Type_D_Soils	63	1036927647	
17436651	Type_D_Soils	63	1098509028	
18312574	Type_D_Soils	63	1153692138	
20589156	Type_B_Soils	41	844155398	
20696324	Type_C_Soils	56	1158994120	
21393664	Type_D_Soils	63	1347800807	
22138552	Type_B_Soils	41	907680635	
24015706	Type_B_Soils	41	984643931	
24441414	Type_D_Soils	63	1539809101	
27740859	Type_B_Soils	41	1137375220	
28546725	Type_C_Soils	56	1598616611	
30753264	Type_B_Soils	41	1260883843	
41828254	Type_D_Soils	63	2635179985	
42320764	Type_D_Soils	63	2666208155	
44273076	Type_D_Soils	63	2789203803	
44674875	Type_D_Soils	63	2814517127	
58734163	Type_B_Soils	41	2408100664	
64663766	Type_C_Soils	56	3621170914	
217614366	Type_D_Soils	63	13709705062	
1044299741			57919271900	**55.46**

Soil Group	Cn, AMC-I
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

1041326626 DRAINAREA

Subarea CA-05

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
49906	Type_B_Soils	41	2046152	
53319	Type_D_Soils	63	3359073	
83595	Type_D_Soils	63	5266514	
91471	Type_D_Soils	63	5762683	
145582	Type_B_Soils	41	5968871	
157328	Type_D_Soils	63	9911643	
180056	Type_B_Soils	41	7382306	
181905	Type_D_Soils	63	11459990	
1098101	Type_B_Soils	41	45022149	
1144604	Type_D_Soils	63	72110028	
1214734	Type_D_Soils	63	76528235	
1232390	Type_B_Soils	41	50527982	
1699793	Type_B_Soils	41	69691498	
1750343	Type_D_Soils	63	110271586	
1826429	Type_B_Soils	41	74883580	
1873755	Type_D_Soils	63	118046546	
3903723	Type_D_Soils	63	245934559	
4019427	Type_D_Soils	63	253223926	
10601578	Type_B_Soils	41	434664681	
10971515	Type_B_Soils	41	449832125	
11970337	Type_C_Soils	56	670338848	
13286955	Type_D_Soils	63	837078179	
14131167	Type_D_Soils	63	890263533	
14403008	Type_B_Soils	41	590523319	
19829689	Type_B_Soils	41	813017242	
20137070	Type_B_Soils	41	825619861	
27225191	Type_B_Soils	41	1116232814	
32919345	Type_B_Soils	41	1349693130	
37699246	Type_D_Soils	63	2375052496	
42034549	Type_D_Soils	63	2648176587	
53284589	Type_C_Soils	56	2983936975	
65508270	Type_C_Soils	56	3668463112	
82504231	Type_D_Soils	63	5197766568	
104397899	Type_D_Soils	63	6577067640	
581611097			32595124430	**56.04**
581700004	DRAINAREA			

Soil Group	Cn, AMC-I
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea CA-06

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
78947	Type_B_Soils	41	3236807	
119284	Type_D_Soils	63	7514912	
159298	Type_B_Soils	41	6531202	
338579	Type_B_Soils	41	13881747	
556676	Type_D_Soils	63	35070560	
720490	Type_B_Soils	41	29540107	
766301	Type_B_Soils	41	31418336	
1137355	Type_B_Soils	41	46631539	
1443576	Type_B_Soils	41	59186600	
1474460	Type_B_Soils	41	60452866	
1609785	Type_B_Soils	41	66001181	
1961002	Type_C_Soils	56	109816095	
2088954	Type_B_Soils	41	85647122	
2631366	Type_B_Soils	41	107886025	
2770225	Type_D_Soils	63	174524190	
2882043	Type_C_Soils	56	161394416	
2957107	Type_D_Soils	63	186297760	
3044378	Type_D_Soils	63	191795801	
3071478	Type_D_Soils	63	193503135	
3485259	Type_B_Soils	41	142895616	
3559360	Type_C_Soils	56	199324176	
3590449	Type_B_Soils	41	147208399	
3933169	Type_B_Soils	41	161259945	
4052518	Type_C_Soils	56	226941018	
4072605	Type_B_Soils	41	166976819	
4072605	Type_D_Soils	63	256574136	
4142590	Type_B_Soils	41	169846191	
4227625	Type_C_Soils	56	236746979	
4366327	Type_C_Soils	56	244514303	
4486425	Type_D_Soils	63	282644804	
4624977	Type_C_Soils	56	258998714	
4809295	Type_B_Soils	41	197181088	
4886411	Type_B_Soils	41	200342845	
5018093	Type_B_Soils	41	205741799	
6004937	Type_B_Soils	41	246202437	
6026184	Type_D_Soils	63	379649617	
6534532	Type_B_Soils	41	267915823	
6641937	Type_D_Soils	63	418442061	
6730117	Type_D_Soils	63	423997398	
6735159	Type_D_Soils	63	424315041	
6763052	Type_B_Soils	41	277285113	
6829439	Type_C_Soils	56	382448612	
7080914	Type_B_Soils	41	290317470	
7195786	Type_C_Soils	56	402964043	
7629518	Type_B_Soils	41	312810237	
8649458	Type_B_Soils	41	354627775	
8886872	Type_D_Soils	63	559872939	
9415577	Type_B_Soils	41	386038654	
9502241	Type_C_Soils	56	532125511	
9824683	Type_B_Soils	41	402812011	
11005702	Type_D_Soils	63	693359216	
11814873	Type_C_Soils	56	661632897	
12619794	Type_C_Soils	56	706708468	
12834642	Type_B_Soils	41	526220331	
13577174	Type_D_Soils	63	855361950	
14369053	Type_B_Soils	41	589131181	
14598808	Type_B_Soils	41	598551119	
14808371	Type_B_Soils	41	607143211	
14849606	Type_B_Soils	41	608833830	
15671672	Type_C_Soils	56	877613634	
16699251	Type_D_Soils	63	1052052837	
17781765	Type_C_Soils	56	995778854	
19928105	Type_B_Soils	41	817052290	
20311260	Type_D_Soils	63	1279609350	
22608812	Type_B_Soils	41	926961310	
22688305	Type_B_Soils	41	930220492	
22702390	Type_C_Soils	56	1271333856	
27765591	Type_B_Soils	41	1138389242	
36541268	Type_B_Soils	41	1498191985	
36904843	Type_C_Soils	56	2066671209	
37215261	Type_D_Soils	63	2344561424	
37950825	Type_B_Soils	41	1555983815	
38168061	Type_D_Soils	63	2404587867	
45697484	Type_C_Soils	56	2559059130	
50180722	Type_D_Soils	63	3161385505	
50659049	Type_C_Soils	56	2836906735	
50777873	Type_B_Soils	41	2081892808	
54417060	Type_D_Soils	63	3428274803	
66070220	Type_D_Soils	63	4162423858	
66157306	Type_D_Soils	63	4167910266	
101478676	Type_C_Soils	56	5682805871	
114217308	Type_B_Soils	41	4682909645	
120745286	Type_C_Soils	56	6761736019	
133499099	Type_B_Soils	41	5473463049	
214897758	Type_D_Soils	63	13538558769	
1775802696			94272628800	**53.09**

Soil Group	Cn, AMC-I
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

1741527005 DRAINAREA

Subarea CA-07

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
49199	Type_C_Soils	56	2755160	
83074	Type_C_Soils	56	4652142	
91655	Type_D_Soils	63	5774240	
104242	Type_D_Soils	63	6567242	
107079	Type_B_Soils	41	4390228	
113227	Type_B_Soils	41	4642291	
170062	Type_B_Soils	41	6972555	
182499	Type_D_Soils	63	11497425	
183490	Type_B_Soils	41	7523071	
207705	Type_A_Soils	22	4569502	
215284	Type_B_Soils	41	8826657	
233707	Type_B_Soils	41	9581998	
238619	Type_B_Soils	41	9783392	
257441	Type_B_Soils	41	10555091	
296908	Type_A_Soils	22	6531977	
468898	Type_D_Soils	63	29540546	
524278	Type_B_Soils	41	21495391	
576247	Type_D_Soils	63	36303581	
620656	Type_B_Soils	41	25446903	
849118	Type_B_Soils	41	34813850	
864988	Type_A_Soils	22	19029738	
907854	Type_B_Soils	41	37222006	
978449	Type_D_Soils	63	61642299	
1041859	Type_A_Soils	22	22920905	
1045493	Type_C_Soils	56	58547592	
1049219	Type_B_Soils	41	43017993	
1070315	Type_B_Soils	41	43882920	
1104419	Type_D_Soils	63	69578405	
1113783	Type_B_Soils	41	45665118	
1418837	Type_B_Soils	41	58172298	
1421280	Type_B_Soils	41	58272498	
1579630	Type_A_Soils	22	34751861	
1581502	Type_B_Soils	41	64841575	
1608513	Type_B_Soils	41	65949039	
1737373	Type_B_Soils	41	71232279	
1895007	Type_A_Soils	22	41690152	
1957189	Type_B_Soils	41	80244751	
2074062	Type_B_Soils	41	85036544	
2128809	Type_B_Soils	41	87281167	
2349432	Type_B_Soils	41	96326725	
2485133	Type_B_Soils	41	101890470	
2570173	Type_B_Soils	41	105377085	
2611027	Type_B_Soils	41	107052109	
3028157	Type_C_Soils	56	169576805	
3033018	Type_B_Soils	41	124353722	
3038183	Type_B_Soils	41	124565505	
3395724	Type_B_Soils	41	139224703	
3531283	Type_C_Soils	56	197751869	
3574990	Type_C_Soils	56	200199434	
3713292	Type_B_Soils	41	152244972	
3729772	Type_B_Soils	41	152920666	
3892280	Type_B_Soils	41	159583462	
3949375	Type_B_Soils	41	161924385	
4035802	Type_B_Soils	41	165467897	
4300713	Type_B_Soils	41	176329216	
4328962	Type_B_Soils	41	177487442	
4507055	Type_D_Soils	63	283944472	
4775147	Type_C_Soils	56	267408228	
5056715	Type_B_Soils	41	207325330	
5661226	Type_B_Soils	41	232110252	
5847962	Type_B_Soils	41	239766426	
5966168	Type_D_Soils	63	375868597	
6536901	Type_B_Soils	41	268012943	
6571402	Type_A_Soils	22	144570840	
6753027	Type_B_Soils	41	276874097	
7100975	Type_B_Soils	41	291139965	
7507041	Type_B_Soils	41	307788663	
7958938	Type_B_Soils	41	326316443	
7979839	Type_A_Soils	22	175556447	
8200752	Type_B_Soils	41	336230814	
8663731	Type_B_Soils	41	355212988	
8667820	Type_B_Soils	41	355380605	
10382476	Type_A_Soils	22	228414476	
10501325	Type_B_Soils	41	430554341	
11497418	Type_B_Soils	41	471394135	
11648767	Type_A_Soils	22	256272875	
12004715	Type_B_Soils	41	492193326	
12059411	Type_D_Soils	63	759742898	
12642411	Type_A_Soils	22	278133050	
12687112	Type_C_Soils	56	710478281	
14489762	Type_B_Soils	41	594080238	
15980048	Type_C_Soils	56	894882705	
17124504	Type_D_Soils	63	1078843744	
18592770	Type_B_Soils	41	762303566	
18904767	Type_B_Soils	41	775095433	
20324360	Type_A_Soils	22	447135910	
25423845	Type_B_Soils	41	1042377659	
26938901	Type_B_Soils	41	1104494930	
27188889	Type_A_Soils	22	598155554	
32986036	Type_D_Soils	63	2078120272	
35749346	Type_B_Soils	41	1465723173	
37201792	Type_B_Soils	41	1525273485	
37701241	Type_B_Soils	41	1545750871	
43620529	Type_D_Soils	63	2748093299	
47316836	Type_B_Soils	41	1939990273	
52693707	Type_B_Soils	41	2160441991	
60648104	Type_B_Soils	41	2486572280	
66816949	Type_B_Soils	41	2739494926	
99136000	Type_B_Soils	41	4064576014	
99955723	Type_C_Soils	56	5597520482	
1089691728			44238901848	**40.60**

1090797414 DRAINAREA

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea TH-01

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
27429	Type_C_Soils	56	1536020	
104399	Type_B_Soils	41	4280357	
108477	Type_C_Soils	56	6074691	
215033	Type_C_Soils	56	12041836	
234090	Type_B_Soils	41	9597707	
283840	Type_B_Soils	41	11637447	
329316	Type_C_Soils	56	18441720	
352156	Type_C_Soils	56	19720717	
357504	Type_D_Soils	63	22522783	
368270	Type_B_Soils	41	15099051	
370078	Type_D_Soils	63	23314943	
403101	Type_C_Soils	56	22573649	
438748	Type_B_Soils	41	17988649	
443534	Type_B_Soils	41	18184901	
456036	Type_B_Soils	41	18697464	
468464	Type_C_Soils	56	26233986	
484718	Type_B_Soils	41	19873444	
544139	Type_B_Soils	41	22309714	
633695	Type_B_Soils	41	25981483	
702421	Type_B_Soils	41	28799262	
711213	Type_C_Soils	56	39827950	
722186	Type_C_Soils	56	40442435	
727172	Type_C_Soils	56	40721617	
777267	Type_C_Soils	56	43526936	
796822	Type_C_Soils	56	44622013	
855230	Type_D_Soils	63	53879460	
886223	Type_B_Soils	41	36335160	
897493	Type_C_Soils	56	50259599	
1079603	Type_B_Soils	41	44263708	
1117180	Type_B_Soils	41	45804360	
1212603	Type_C_Soils	56	67905770	
1224758	Type_C_Soils	56	68586439	
1250554	Type_B_Soils	41	51272711	
1316023	Type_A_Soils	22	28952499	
1440357	Type_B_Soils	41	59054644	
1467204	Type_C_Soils	56	82163441	
1534864	Type_B_Soils	41	62929439	
1859446	Type_C_Soils	56	104128982	
1917571	Type_B_Soils	41	78620415	
1931981	Type_B_Soils	41	79211229	
2106350	Type_C_Soils	56	117955620	
2163894	Type_A_Soils	22	47605667	
2332175	Type_B_Soils	41	95619164	
2360699	Type_B_Soils	41	96788647	
2446091	Type_B_Soils	41	100289736	
2463451	Type_B_Soils	41	101001506	
2507212	Type_A_Soils	22	55158670	
2643870	Type_C_Soils	56	148056722	
2671529	Type_C_Soils	56	149605646	
2692702	Type_B_Soils	41	110400791	
2699369	Type_C_Soils	56	151164648	
2809702	Type_B_Soils	41	115197796	
2841823	Type_D_Soils	63	179034865	
2867580	Type_B_Soils	41	117570771	
3049318	Type_A_Soils	22	67085004	
3167078	Type_B_Soils	41	129850206	
3214212	Type_D_Soils	63	202495382	
3301624	Type_B_Soils	41	135366567	
3331867	Type_B_Soils	41	136606552	
3458672	Type_B_Soils	41	141805532	
3794753	Type_B_Soils	41	155584891	
3858305	Type_C_Soils	56	216065061	
3876593	Type_B_Soils	41	158940308	
3941825	Type_B_Soils	41	161614830	
4016883	Type_B_Soils	41	164692191	
4026127	Type_B_Soils	41	165071219	
4166153	Type_C_Soils	56	233304565	
4533275	Type_A_Soils	22	99732049	
4812505	Type_C_Soils	56	269500297	
4831654	Type_B_Soils	41	198097794	
5511156	Type_B_Soils	41	225957415	
5685487	Type_B_Soils	41	233104970	
5716058	Type_B_Soils	41	234358377	
5819082	Type_B_Soils	41	238582380	
5908100	Type_B_Soils	41	242232105	
6029663	Type_B_Soils	41	247216185	
6149875	Type_B_Soils	41	252144885	
6257308	Type_A_Soils	22	137660765	
6324986	Type_B_Soils	41	259324426	
6550866	Type_B_Soils	41	268585524	
6580750	Type_B_Soils	41	269810752	
6760902	Type_B_Soils	41	277196983	
7430030	Type_B_Soils	41	304631228	
7508759	Type_B_Soils	41	307859119	
7590821	Type_B_Soils	41	311223679	
7745905	Type_C_Soils	56	433770676	
8393160	Type_C_Soils	56	470016938	
9041233	Type_C_Soils	56	506309032	
9298244	Type_B_Soils	41	381227989	
9370717	Type_D_Soils	63	590355195	
9806602	Type_B_Soils	41	402070672	
9826727	Type_B_Soils	41	402895795	
10017498	Type_B_Soils	41	410717420	
10086448	Type_B_Soils	41	413544380	
11388496	Type_C_Soils	56	637755799	
13208864	Type_C_Soils	56	739696407	
13927206	Type_B_Soils	41	571015427	
14554439	Type_C_Soils	56	815048586	
14810615	Type_D_Soils	63	933068730	
16134557	Type_C_Soils	56	903535206	
17211448	Type_B_Soils	41	705669376	
17814156	Type_C_Soils	56	997592738	
18015979	Type_B_Soils	41	738655144	
19592718	Type_B_Soils	41	803301438	
21315663	Type_B_Soils	41	873942203	
21364695	Type_C_Soils	56	1196422902	
23503749	Type_C_Soils	56	1316209928	
28522327	Type_B_Soils	41	1169415390	
29986912	Type_B_Soils	41	1229463412	
30437931	Type_D_Soils	63	1917589648	
35640819	Type_B_Soils	41	1461273588	
42421464	Type_C_Soils	56	2375601993	
75201802	Type_B_Soils	41	3083273878	
772502708			35978010008	**46.57**

772145187 DRAINAREA

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea TH-02

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
18684	Type_B_Soils	41	766049	
59543	Type_B_Soils	41	2441265	
146307	Type_C_Soils	56	8193186	
169287	Type_B_Soils	41	6940787	
179510	Type_B_Soils	41	7359891	
179510	Type_C_Soils	56	10052534	
218153	Type_D_Soils	63	13743631	
266096	Type_C_Soils	56	14901349	
323271	Type_B_Soils	41	13254092	
378150	Type_B_Soils	41	15504164	
393938	Type_B_Soils	41	16151442	
543029	Type_B_Soils	41	22264189	
608111	Type_B_Soils	41	24932532	
1041074	Type_B_Soils	41	42684014	
1237157	Type_C_Soils	56	69280769	
1302862	Type_B_Soils	41	53417336	
1342193	Type_B_Soils	41	55029911	
1416660	Type_B_Soils	41	58083064	
1714061	Type_B_Soils	41	70276494	
1994805	Type_A_Soils	22	43885718	
2135329	Type_C_Soils	56	119578445	
2193409	Type_B_Soils	41	89929762	
2242233	Type_C_Soils	56	125565040	
2578361	Type_D_Soils	63	162436732	
2698035	Type_B_Soils	41	110619424	
2770696	Type_A_Soils	22	60955315	
2803214	Type_B_Soils	41	114931767	
2952835	Type_C_Soils	56	165358739	
3384071	Type_B_Soils	41	138746893	
3539813	Type_C_Soils	56	198229504	
4531115	Type_B_Soils	41	185775705	
5020331	Type_C_Soils	56	281138528	
5705109	Type_C_Soils	56	319486118	
6383122	Type_B_Soils	41	261708013	
8830185	Type_C_Soils	56	494490364	
9622070	Type_B_Soils	41	394504889	
9654280	Type_D_Soils	63	608219617	
9682414	Type_B_Soils	41	396978954	
14698777	Type_B_Soils	41	602649840	
15338096	Type_C_Soils	56	858933390	
15444277	Type_B_Soils	41	633215348	
17611945	Type_B_Soils	41	722089733	
21658644	Type_C_Soils	56	1212884082	
27576468	Type_D_Soils	63	1737317454	
212587225			10544906075	**49.60**

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

212230450 DRAINAREA

Subarea TH-03

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
12283	Type_D_Soils	63	773809	
12291	Type_C_Soils	56	688308	
12291	Type_D_Soils	63	774347	
21645	Type_D_Soils	63	1363637	
21645	Type_C_Soils	56	1212122	
25311	Type_D_Soils	63	1594617	
29169	Type_D_Soils	63	1837674	
29625	Type_B_Soils	41	1214614	
29625	Type_D_Soils	63	1866358	
54863	Type_B_Soils	41	2249372	
97472	Type_B_Soils	41	3996363	
159654	Type_D_Soils	63	10058174	
200730	Type_C_Soils	56	11240871	
276661	Type_B_Soils	41	11343106	
360975	Type_B_Soils	41	14799989	
403066	Type_D_Soils	63	25393160	
427900	Type_B_Soils	41	17543907	
436899	Type_B_Soils	41	17912850	
445246	Type_D_Soils	63	28050478	
469577	Type_C_Soils	56	26296294	
519904	Type_C_Soils	56	29114620	
563915	Type_C_Soils	56	31579265	
566463	Type_C_Soils	56	31721945	
592044	Type_B_Soils	41	24273807	
676744	Type_B_Soils	41	27746487	
737046	Type_C_Soils	56	41274563	
774810	Type_D_Soils	63	48813061	
819149	Type_B_Soils	41	33585125	
913009	Type_C_Soils	56	51128491	
913841	Type_B_Soils	41	37467467	
1158615	Type_B_Soils	41	47503221	
1198339	Type_B_Soils	41	49131880	
1333728	Type_B_Soils	41	54682843	
1354047	Type_B_Soils	41	55515917	
1489339	Type_A_Soils	22	32765464	
1614459	Type_C_Soils	56	90409691	
1649710	Type_B_Soils	41	67638100	
1747796	Type_B_Soils	41	71659621	
1846321	Type_B_Soils	41	75699149	
2006846	Type_C_Soils	56	112383387	
2171449	Type_B_Soils	41	89029417	
2477726	Type_B_Soils	41	101586746	
2487432	Type_C_Soils	56	139296182	
2576303	Type_B_Soils	41	105628403	
2664437	Type_B_Soils	41	109241915	
2945770	Type_B_Soils	41	120776575	
2951879	Type_C_Soils	56	165305223	
2972935	Type_B_Soils	41	121890348	
3063300	Type_C_Soils	56	171544817	
3223229	Type_B_Soils	41	132152375	
3562200	Type_A_Soils	22	78368400	
4399717	Type_C_Soils	56	246384136	
4691858	Type_B_Soils	41	192366185	
4924228	Type_C_Soils	56	275756747	
4964847	Type_B_Soils	41	203558732	
5653292	Type_B_Soils	41	231784989	
5825825	Type_B_Soils	41	238858842	
6404580	Type_B_Soils	41	262587763	
6547803	Type_C_Soils	56	366676957	
6825054	Type_B_Soils	41	279827211	
6933417	Type_C_Soils	56	388271367	
7251471	Type_C_Soils	56	406082385	
7360383	Type_B_Soils	41	301775719	
9265425	Type_B_Soils	41	379882440	
9637027	Type_D_Soils	63	607132720	
10235855	Type_B_Soils	41	419670052	
10287872	Type_B_Soils	41	421802746	
11731521	Type_B_Soils	41	480992367	
13547549	Type_B_Soils	41	555449492	
13489954	Type_B_Soils	41	553088106	
13379984	Type_B_Soils	41	548579353	
16634628	Type_C_Soils	56	931539142	
18042506	Type_D_Soils	63	1136677857	
19612678	Type_B_Soils	41	804119798	
30705216	Type_D_Soils	63	1934428602	
45909571	Type_C_Soils	56	2570935956	
48649509	Type_C_Soils	56	2724372531	
59498931	Type_B_Soils	41	2439456165	
459510412			22431182919	**48.82**

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

459599145.5309 DRAINAREA

Subarea TH-04

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
70074	Type_B_Soils	41	2873030	
158469	Type_B_Soils	41	6497237	
167881	Type_B_Soils	41	6883123	
187095	Type_B_Soils	41	7670876	
211563	Type_B_Soils	41	8674079	
250375	Type_D_Soils	63	15773632	
267116	Type_B_Soils	41	10951737	
381787	Type_C_Soils	56	21380064	
492999	Type_B_Soils	41	20212961	
599923	Type_B_Soils	41	24596836	
780559	Type_C_Soils	56	43711297	
787105	Type_C_Soils	56	44077886	
1006606	Type_B_Soils	41	41270832	
1040781	Type_B_Soils	41	42672022	
1177669	Type_D_Soils	63	74193167	
1579958	Type_B_Soils	41	64778280	
1747929	Type_D_Soils	63	110119509	
1894679	Type_C_Soils	56	106102005	
2017841	Type_B_Soils	41	82731501	
2150484	Type_C_Soils	56	120427126	
2344508	Type_D_Soils	63	147703974	
2391254	Type_D_Soils	63	150648990	
2503520	Type_A_Soils	22	55077441	
2875388	Type_D_Soils	63	181149448	
3118541	Type_B_Soils	41	127860164	
3208095	Type_D_Soils	63	202110015	
3589843	Type_D_Soils	63	226160096	
3647974	Type_D_Soils	63	229822368	
3739403	Type_B_Soils	41	153315540	
4063802	Type_B_Soils	41	166615882	
4087051	Type_C_Soils	56	228874836	
4103880	Type_B_Soils	41	168259081	
4601203	Type_B_Soils	41	188649304	
4673200	Type_B_Soils	41	191601201	
4868873	Type_B_Soils	41	199623784	
5002550	Type_B_Soils	41	205104547	
5187516	Type_B_Soils	41	212688159	
5237508	Type_D_Soils	63	329963026	
5254011	Type_C_Soils	56	294224603	
5656624	Type_B_Soils	41	231921568	
7160867	Type_B_Soils	41	293595530	
8018207	Type_B_Soils	41	328746467	
8909208	Type_B_Soils	41	365277524	
8980441	Type_B_Soils	41	368198087	
9658733	Type_B_Soils	41	396008062	
9994273	Type_C_Soils	56	559679310	
10610727	Type_C_Soils	56	594200732	
10996683	Type_D_Soils	63	692791037	
16239693	Type_B_Soils	41	665827408	
16541560	Type_B_Soils	41	678203963	
16784085	Type_B_Soils	41	688147471	
18750351	Type_D_Soils	63	1181272088	
19317054	Type_B_Soils	41	791999205	
22914944	Type_B_Soils	41	939512702	
30648538	Type_B_Soils	41	1256590043	
47491660	Type_D_Soils	63	2991974569	
54286261	Type_B_Soils	41	2225736684	
88298919	Type_B_Soils	41	3620255665	
502727837			23384987774	**46.52**

503473893 DRAINAREA

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea TH-05

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
3709	Type_C_Soils	56	207705	
6311	Type_C_Soils	56	353433	
10096	Type_C_Soils	56	565352	
12140	Type_D_Soils	63	764849	
20217	Type_B_Soils	41	828889	
21515	Type_D_Soils	63	1355437	
28686	Type_B_Soils	41	1176124	
29842	Type_B_Soils	41	1223524	
94228	Type_C_Soils	56	5276761	
127669	Type_D_Soils	63	8043145	
213166	Type_B_Soils	41	8739821	
308049	Type_D_Soils	63	19407085	
389459	Type_C_Soils	56	21809695	
389459	Type_B_Soils	41	15967813	
635586	Type_C_Soils	56	35592838	
897868	Type_C_Soils	56	50280604	
932553	Type_B_Soils	41	38234657	
1046804	Type_B_Soils	41	42918979	
1074735	Type_C_Soils	56	60185133	
1177407	Type_B_Soils	41	48273702	
1287686	Type_B_Soils	41	52795118	
1336762	Type_D_Soils	63	84216017	
1365972	Type_B_Soils	41	56004871	
1437580	Type_B_Soils	41	58940768	
1585564	Type_D_Soils	63	99890556	
1696736	Type_D_Soils	63	106894359	
1799622	Type_B_Soils	41	73784499	
1809168	Type_B_Soils	41	74175886	
1827435	Type_B_Soils	41	74924847	
2067051	Type_D_Soils	63	130224228	
2459954	Type_C_Soils	56	137757408	
2713697	Type_C_Soils	56	151967041	
2806479	Type_D_Soils	63	176808172	
2865285	Type_D_Soils	63	180512936	
3032988	Type_C_Soils	56	169847311	
3178405	Type_B_Soils	41	130314618	
3217445	Type_B_Soils	41	131915249	
3241594	Type_C_Soils	56	181529237	
3356252	Type_A_Soils	22	73837542	
3540247	Type_B_Soils	41	145150108	
3554231	Type_D_Soils	63	223916544	
3964615	Type_B_Soils	41	162549205	
4163826	Type_B_Soils	41	170716882	
4257489	Type_B_Soils	41	174557037	
4345281	Type_B_Soils	41	178156520	
4410826	Type_B_Soils	41	180843882	
4417419	Type_D_Soils	63	278297404	
4427416	Type_B_Soils	41	181524042	
4556397	Type_C_Soils	56	255158229	
4651405	Type_C_Soils	56	260478690	
4980181	Type_D_Soils	63	313751392	
5194121	Type_C_Soils	56	290870803	
5288042	Type_D_Soils	63	333146648	
5796102	Type_D_Soils	63	365154401	
5890597	Type_D_Soils	63	371107626	
6028410	Type_C_Soils	56	337590982	
6037307	Type_D_Soils	63	380350357	
6080604	Type_B_Soils	41	249304758	
6228435	Type_B_Soils	41	255365830	
6286526	Type_B_Soils	41	257747582	
6700544	Type_D_Soils	63	422134256	
6831423	Type_D_Soils	63	430379635	
7752347	Type_C_Soils	56	434131420	
8071941	Type_B_Soils	41	330949575	
8144188	Type_B_Soils	41	333911715	
8330961	Type_B_Soils	41	341569406	
8900507	Type_B_Soils	41	364920789	
9375318	Type_D_Soils	63	590645034	
11022756	Type_B_Soils	41	451932984	
11118291	Type_C_Soils	56	622624289	
11240160	Type_D_Soils	63	708130076	
13703348	Type_B_Soils	41	561837251	
14259530	Type_B_Soils	41	584640745	
14259686	Type_B_Soils	41	584647119	
14588491	Type_C_Soils	56	816955471	
15049667	Type_B_Soils	41	617036355	
15087583	Type_C_Soils	56	844904642	
16043264	Type_D_Soils	63	1010725617	
16228020	Type_B_Soils	41	665348820	
20361909	Type_B_Soils	41	834838258	
21920179	Type_D_Soils	63	1380971253	
23951527	Type_C_Soils	56	1341285509	
27131984	Type_B_Soils	41	1112411336	
27831257	Type_B_Soils	41	1141081555	
28641606	Type_B_Soils	41	1174305853	
29147666	Type_D_Soils	63	1836302935	
29523300	Type_B_Soils	41	1210455309	
36632115	Type_D_Soils	63	2307823268	
46497464	Type_B_Soils	41	1906396006	
51388966	Type_D_Soils	63	3237504846	
68123596	Type_B_Soils	41	2793067424	
166108810	Type_B_Soils	41	6810461196	
948573052			45677615080	**48.15**

948080938 DRAINAREA

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea TH-06

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
13482	Type_B_Soils	41	552775	
85698	Type_B_Soils	41	3513624	
153456	Type_B_Soils	41	6291697	
264528	Type_B_Soils	41	10845642	
278744	Type_B_Soils	41	11428503	
290802	Type_B_Soils	41	11922893	
304551	Type_B_Soils	41	12486595	
393017	Type_B_Soils	41	16113695	
867330	Type_D_Soils	63	54641764	
869668	Type_D_Soils	63	54789065	
1191244	Type_B_Soils	41	48840999	
1552437	Type_B_Soils	41	63649900	
1686188	Type_B_Soils	41	69133709	
1790983	Type_B_Soils	41	73430304	
1861840	Type_B_Soils	41	76335435	
1949507	Type_B_Soils	41	79929785	
2041256	Type_B_Soils	41	83691510	
2074897	Type_B_Soils	41	85070797	
2077486	Type_A_Soils	22	45704685	
2352796	Type_A_Soils	22	51761508	
2578223	Type_B_Soils	41	105707148	
3049736	Type_B_Soils	41	125039190	
3513986	Type_D_Soils	63	221381119	
3541194	Type_B_Soils	41	145188949	
3784222	Type_B_Soils	41	155153087	
3798495	Type_B_Soils	41	155738278	
3852825	Type_D_Soils	63	242727949	
4251050	Type_B_Soils	41	174293038	
4428177	Type_C_Soils	56	247977912	
5512662	Type_D_Soils	63	347297724	
6444055	Type_B_Soils	41	264206266	
6477379	Type_B_Soils	41	265572535	
6560998	Type_C_Soils	56	367415872	
6988384	Type_B_Soils	41	286523758	
7313483	Type_B_Soils	41	299852795	
7632706	Type_B_Soils	41	312940939	
8022024	Type_D_Soils	63	505387522	
8413819	Type_D_Soils	63	530070627	
8740116	Type_B_Soils	41	358344756	
11342844	Type_D_Soils	63	714599181	
11479800	Type_B_Soils	41	470671817	
11636541	Type_B_Soils	41	477098197	
12191662	Type_B_Soils	41	499858150	
13160828	Type_C_Soils	56	737006374	
13233821	Type_B_Soils	41	542586649	
13584254	Type_D_Soils	63	855808016	
14543220	Type_D_Soils	63	916222884	
16101130	Type_B_Soils	41	660146324	
16341717	Type_B_Soils	41	670010397	
16556886	Type_B_Soils	41	678832336	
19140718	Type_B_Soils	41	784769434	
19890008	Type_B_Soils	41	815490327	
20230998	Type_B_Soils	41	829470937	
21589150	Type_C_Soils	56	1208992393	
22890291	Type_B_Soils	41	938501948	
24624688	Type_B_Soils	41	1009612198	
25844170	Type_B_Soils	41	1059610989	
33382084	Type_D_Soils	63	2103071264	
34448795	Type_B_Soils	41	1412400577	
34824624	Type_B_Soils	41	1427809566	
36695922	Type_B_Soils	41	1504532809	
51749578	Type_B_Soils	41	2121732711	
64831396	Type_B_Soils	41	2658087216	
687318569			31067877037	**45.20**

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

688056035 DRAINAREA

Subarea WB-01

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
420056	Type_B_Soils	41	17222298	
501791	Type_B_Soils	41	20573415	
794376	Type_B_Soils	41	32569415	
827454	Type_D_Soils	63	52129632	
1512081	Type_B_Soils	41	61995334	
1991155	Type_D_Soils	63	125442768	
2555521	Type_B_Soils	41	104776343	
3318575	Type_B_Soils	41	136061565	
3695494	Type_A_Soils	22	81300861	
3834162	Type_B_Soils	41	157200636	
3971011	Type_B_Soils	41	162811431	
4437691	Type_B_Soils	41	181945351	
5774693	Type_B_Soils	41	236762409	
6251954	Type_D_Soils	63	393873105	
6667645	Type_D_Soils	63	420061647	
8237822	Type_D_Soils	63	518982765	
8479552	Type_D_Soils	63	534211755	
8900694	Type_B_Soils	41	364928446	
9520379	Type_D_Soils	63	599783886	
14640862	Type_B_Soils	41	600275326	
15526408	Type_B_Soils	41	636582735	
15659397	Type_B_Soils	41	642035268	
16063681	Type_D_Soils	63	1012011928	
17252483	Type_D_Soils	63	1086906448	
19232642	Type_D_Soils	63	1211656418	
23785669	Type_D_Soils	63	1498497171	
24169262	Type_D_Soils	63	1522663501	
24751107	Type_C_Soils	56	1386061999	
25709511	Type_B_Soils	41	1054089940	
27311248	Type_B_Soils	41	1119761185	
29805867	Type_D_Soils	63	1877769625	
30738134	Type_D_Soils	63	1936502454	
34368953	Type_D_Soils	63	2165244022	
35008949	Type_A_Soils	22	770196873	
42217777	Type_C_Soils	56	2364195505	
43429339	Type_D_Soils	63	2736048379	
57026551	Type_D_Soils	63	3592672687	
62988384	Type_C_Soils	56	3527349523	
101009003	Type_D_Soils	63	6363567217	
742387333			41306721267	**55.64**
743572791	DRAINAREA			

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea WB-02

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
38536	Type_B_Soils	41	1579980	
186005	Type_D_Soils	63	11718304	
1083971	Type_B_Soils	41	44442801	
2703393	Type_B_Soils	41	110839108	
3551772	Type_B_Soils	41	145622643	
3649113	Type_D_Soils	63	229894140	
4774636	Type_D_Soils	63	300802088	
5248984	Type_B_Soils	41	215208331	
6109619	Type_D_Soils	63	384905984	
6423204	Type_A_Soils	22	141310483	
17694339	Type_D_Soils	63	1114743349	
21034709	Type_D_Soils	63	1325186648	
21921978	Type_D_Soils	63	1381084610	
25031464	Type_D_Soils	63	1576982206	
33939802	Type_D_Soils	63	2138207517	
44374663	Type_D_Soils	63	2795603764	
56241977	Type_D_Soils	63	3543244580	
63985875	Type_D_Soils	63	4031110122	
64976400	Type_D_Soils	63	4093513172	
66445756	Type_B_Soils	41	2724276003	
83588454	Type_D_Soils	63	5266072589	
91731433	Type_B_Soils	41	3760988735	
624736081			35337337158	**56.56**
625211770	DRAINAREA			

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea WB-03

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
45333	Type_B_Soils	41	1858662	
110657	Type_C_Soils	56	6196777	
126741	Type_C_Soils	56	7097511	
171761	Type_D_Soils	63	10820956	
523648	Type_D_Soils	63	32989811	
524895	Type_B_Soils	41	21520701	
672847	Type_B_Soils	41	27586727	
800350	Type_B_Soils	41	32814337	
2737586	Type_B_Soils	41	112241011	
3894081	Type_B_Soils	41	159657312	
5009045	Type_D_Soils	63	315569838	
5020968	Type_C_Soils	56	281174217	
5902104	Type_B_Soils	41	241986254	
6663314	Type_D_Soils	63	419788770	
6675852	Type_B_Soils	41	273709950	
7711744	Type_D_Soils	63	485839882	
8569321	Type_D_Soils	63	539867208	
10492840	Type_B_Soils	41	430206438	
15110678	Type_D_Soils	63	951972735	
19868710	Type_D_Soils	63	1251728723	
20562714	Type_D_Soils	63	1295450951	
21227816	Type_D_Soils	63	1337352411	
21542481	Type_B_Soils	41	883241720	
22289719	Type_D_Soils	63	1404252297	
27708068	Type_B_Soils	41	1136030800	
32062973	Type_D_Soils	63	2019967328	
33144971	Type_B_Soils	41	1358943825	
34865619	Type_D_Soils	63	2196534023	
37082029	Type_B_Soils	41	1520363199	
41713256	Type_D_Soils	63	2627935106	
89510155	Type_C_Soils	56	5012568695	
93395182	Type_D_Soils	63	5883896481	
100300553	Type_D_Soils	63	6318934842	
134108857	Type_A_Soils	22	2950394849	
810146869			41550494350	**51.29**
810141136	DRAINAREA			

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

Subarea WB-04

Polygon Area	Layer	Cn Grass, Annual or Perennial, Good	Cn X Area	Average Cn
9794	Type_D_Soils	63	616993	
12396	Type_B_Soils	41	508247	
15248	Type_D_Soils	63	960634	
15347	Type_B_Soils	41	629234	
15446	Type_D_Soils	63	973120	
16464	Type_B_Soils	41	675016	
30040	Type_C_Soils	56	1682246	
38085	Type_B_Soils	41	1561471	
40363	Type_D_Soils	63	2542881	
57420	Type_D_Soils	63	3617469	
68624	Type_D_Soils	63	4323338	
87472	Type_D_Soils	63	5510748	
150714	Type_B_Soils	41	6179254	
179202	Type_D_Soils	63	11289716	
212922	Type_B_Soils	41	8729788	
243698	Type_D_Soils	63	15352988	
255597	Type_B_Soils	41	10479469	
297869	Type_D_Soils	63	18765728	
313460	Type_D_Soils	63	19747955	
339829	Type_B_Soils	41	13932982	
477518	Type_B_Soils	41	19578233	
484936	Type_A_Soils	22	10668581	
629934	Type_B_Soils	41	25827289	
722108	Type_B_Soils	41	29606434	
788527	Type_D_Soils	63	49677170	
790523	Type_B_Soils	41	32411426	
841170	Type_D_Soils	63	52993697	
997660	Type_A_Soils	22	21948526	
1031024	Type_D_Soils	63	64954500	
1121209	Type_D_Soils	63	70636193	
1167439	Type_C_Soils	56	65376574	
1518493	Type_C_Soils	56	85035620	
1548861	Type_C_Soils	56	86736219	
1709863	Type_B_Soils	41	70104366	
2056729	Type_A_Soils	22	45248048	
2345851	Type_B_Soils	41	96179884	
2571320	Type_A_Soils	22	56569033	
2717987	Type_B_Soils	41	111437453	
2918693	Type_B_Soils	41	119666400	
2996624	Type_A_Soils	22	65925722	
3097050	Type_C_Soils	56	173434773	
3164788	Type_B_Soils	41	129756309	
4720222	Type_B_Soils	41	193529083	
4734065	Type_B_Soils	41	194096651	
5555874	Type_B_Soils	41	227790854	
5844458	Type_D_Soils	63	368200859	
6152913	Type_D_Soils	63	387633537	
6288086	Type_D_Soils	63	396149445	
7605688	Type_B_Soils	41	311833211	
8030614	Type_C_Soils	56	449714409	
9235580	Type_A_Soils	22	203182770	
9303481	Type_B_Soils	41	381442737	
9814761	Type_B_Soils	41	402405203	
9929668	Type_D_Soils	63	625569106	
10334652	Type_B_Soils	41	423720718	
11329639	Type_B_Soils	41	464515194	
11609487	Type_B_Soils	41	475988966	
12855981	Type_B_Soils	41	527095229	
13109441	Type_C_Soils	56	734128670	
13385575	Type_B_Soils	41	548808582	
13903106	Type_B_Soils	41	570027352	
14977060	Type_D_Soils	63	943554798	
18287889	Type_C_Soils	56	1024121763	
20339994	Type_D_Soils	63	1281419595	
25021189	Type_D_Soils	63	1576334938	
29790203	Type_B_Soils	41	1221398321	
29989289	Type_B_Soils	41	1229560847	
32716449	Type_B_Soils	41	1341374396	
35151127	Type_D_Soils	63	2214521028	
44927603	Type_C_Soils	56	2515945768	
50523425	Type_B_Soils	41	2071460416	
53922681	Type_D_Soils	63	3397128896	
105100929	Type_B_Soils	41	4309138101	
131427300	Type_D_Soils	63	8279919914	
143468026	Type_C_Soils	56	8034209439	
231549547	Type_B_Soils	41	9493531440	
1179034297			58431303963	49.56

Soil Group	Cn, AMC-I
Type_A_Soils	22
Type_B_Soils	41
Type_C_Soils	56
Type_D_Soils	63

1179551569 DRAINAREA

WB-02
WB-03
WB-01
WB-04
CA-03
CA-05
CA-06
CA-08
CA-02
CA-07
CA-04
CA-01
TH-06
TH-04
TH-05
TH-03
TH-02
TH-01

N

5000 0 10000 20000
-10000 2500

LEGEND

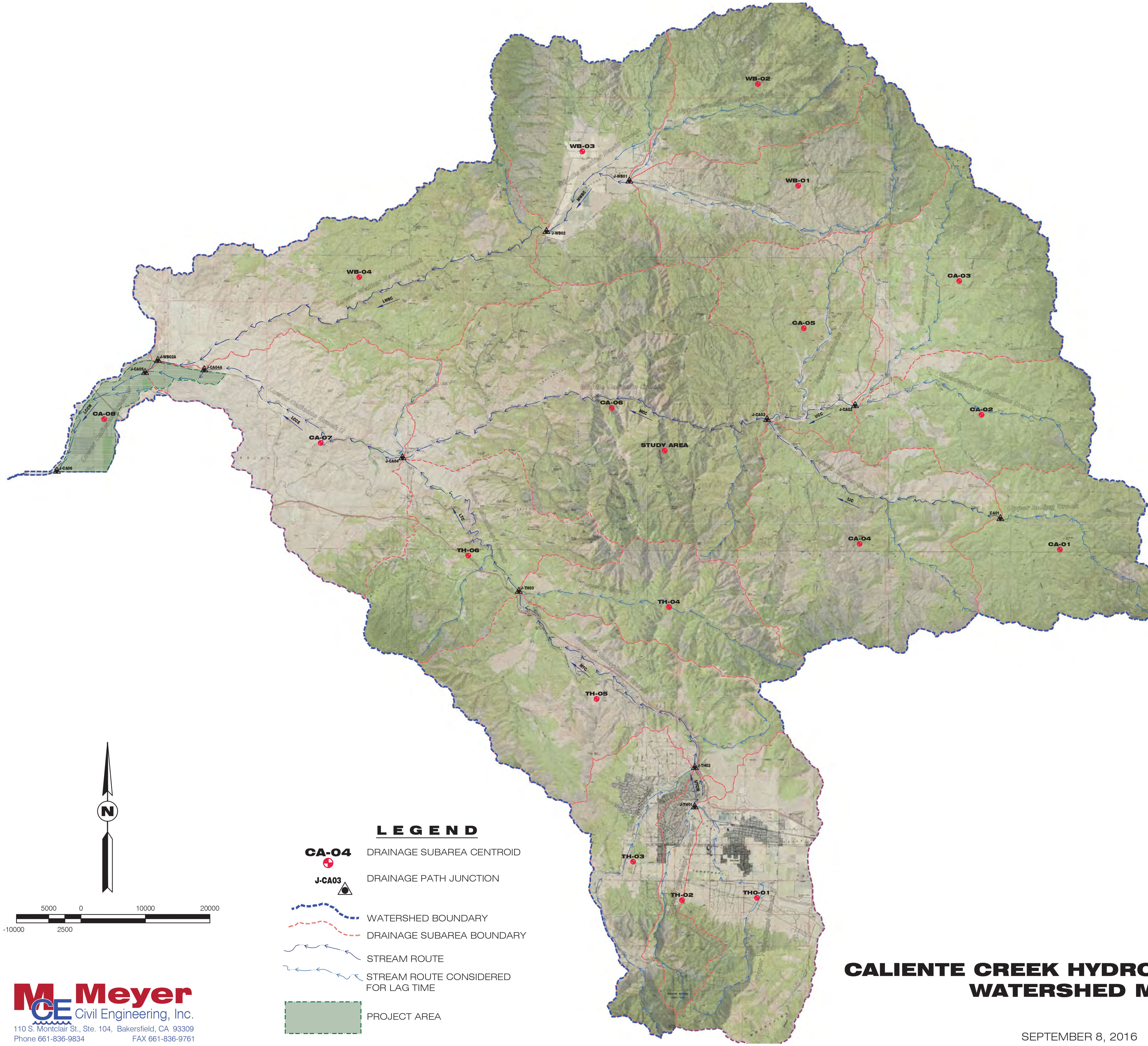
WATERSHED BOUNDARY

PROJECT AREA

CALIENTE CREEK HYDROLOGY STUDY
SCS SOIL GROUP MAP

SEPTEMBER 8, 2016

Meyer Civil Engineering, Inc.
110 S. Montclair St., Ste. 104, Bakersfield, CA 93309
Phone 661-836-9834 FAX 661-836-9761



LEGEND

CA-04 DRAINAGE SUBAREA CENTROID

J-CA03 DRAINAGE PATH JUNCTION

WATERSHED BOUNDARY

DRAINAGE SUBAREA BOUNDARY

STREAM ROUTE

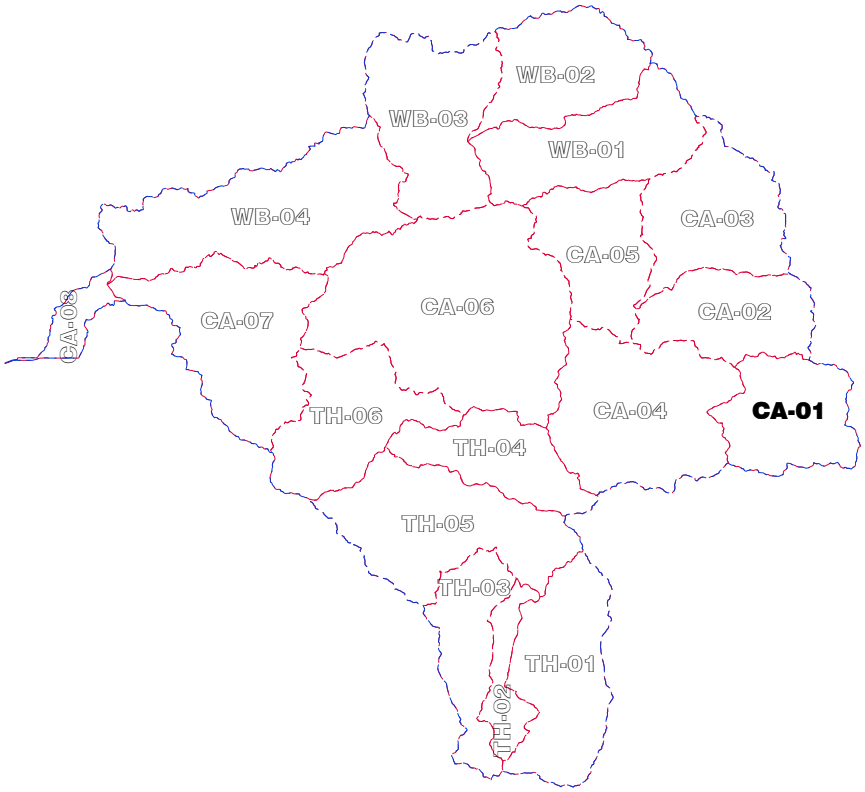
STREAM ROUTE CONSIDERED FOR LAG TIME

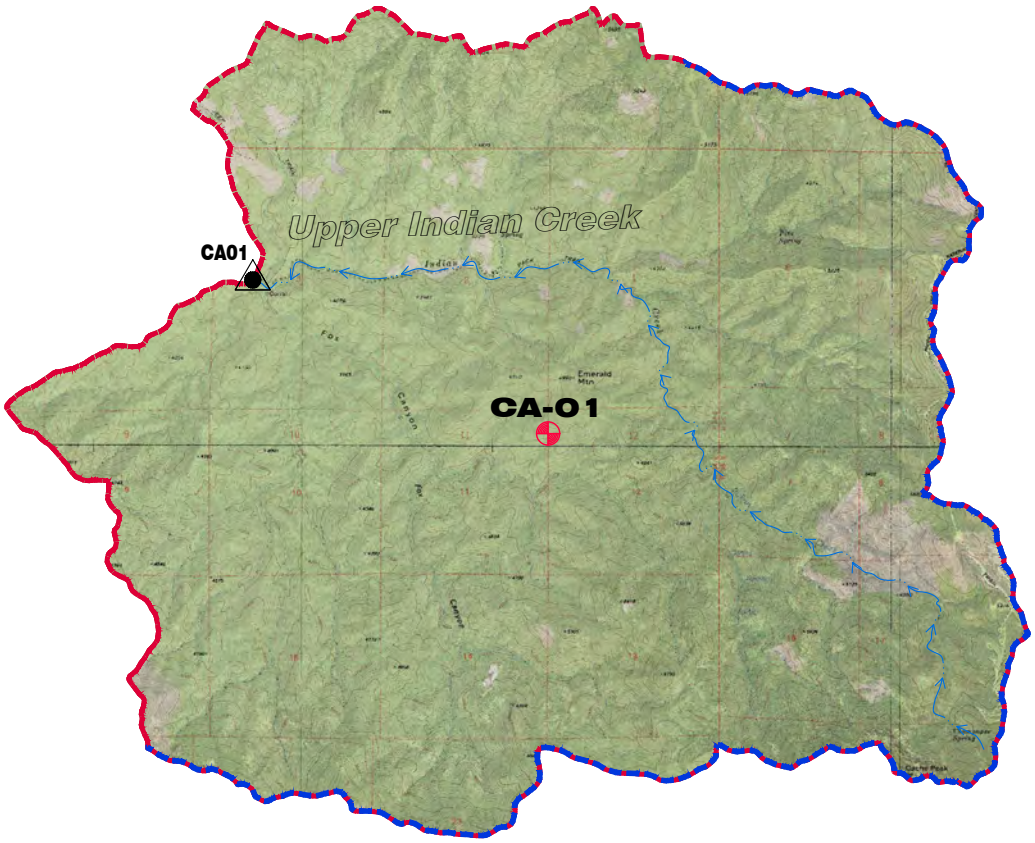
PROJECT AREA

Meyer Civil Engineering, Inc.
110 S. Montclair St., Ste. 104, Bakersfield, CA 93309
Phone 661-836-9834 FAX 661-836-9761

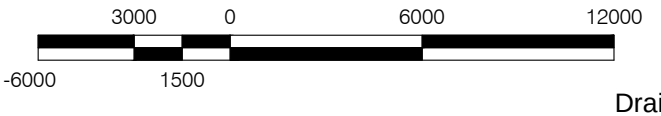
CALIENTE CREEK HYDROLOGY STUDY
WATERSHED MAP

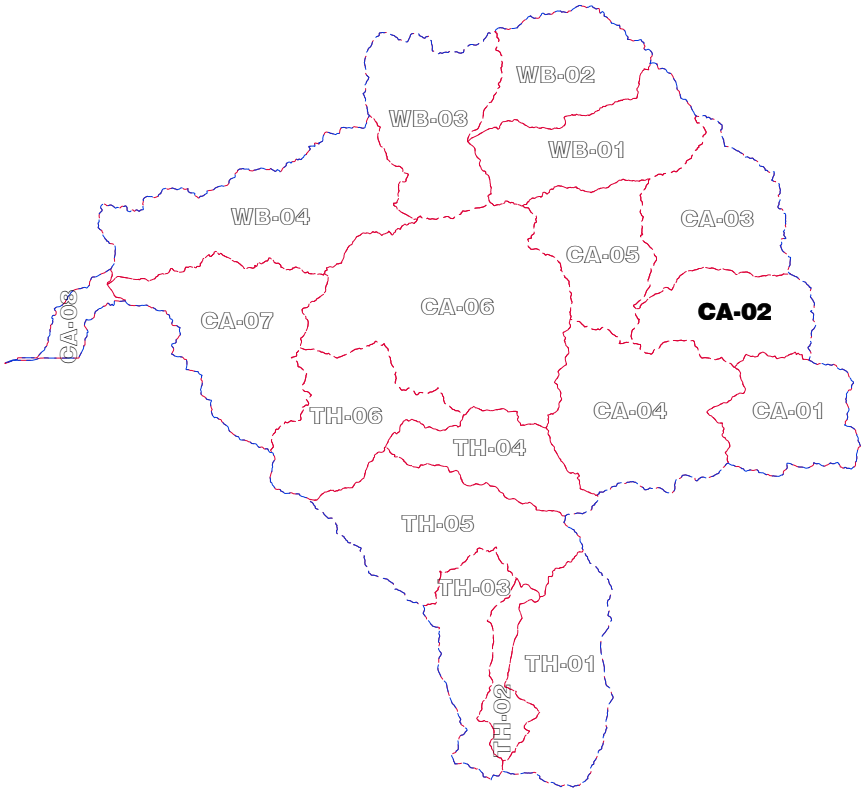
SEPTEMBER 8, 2016





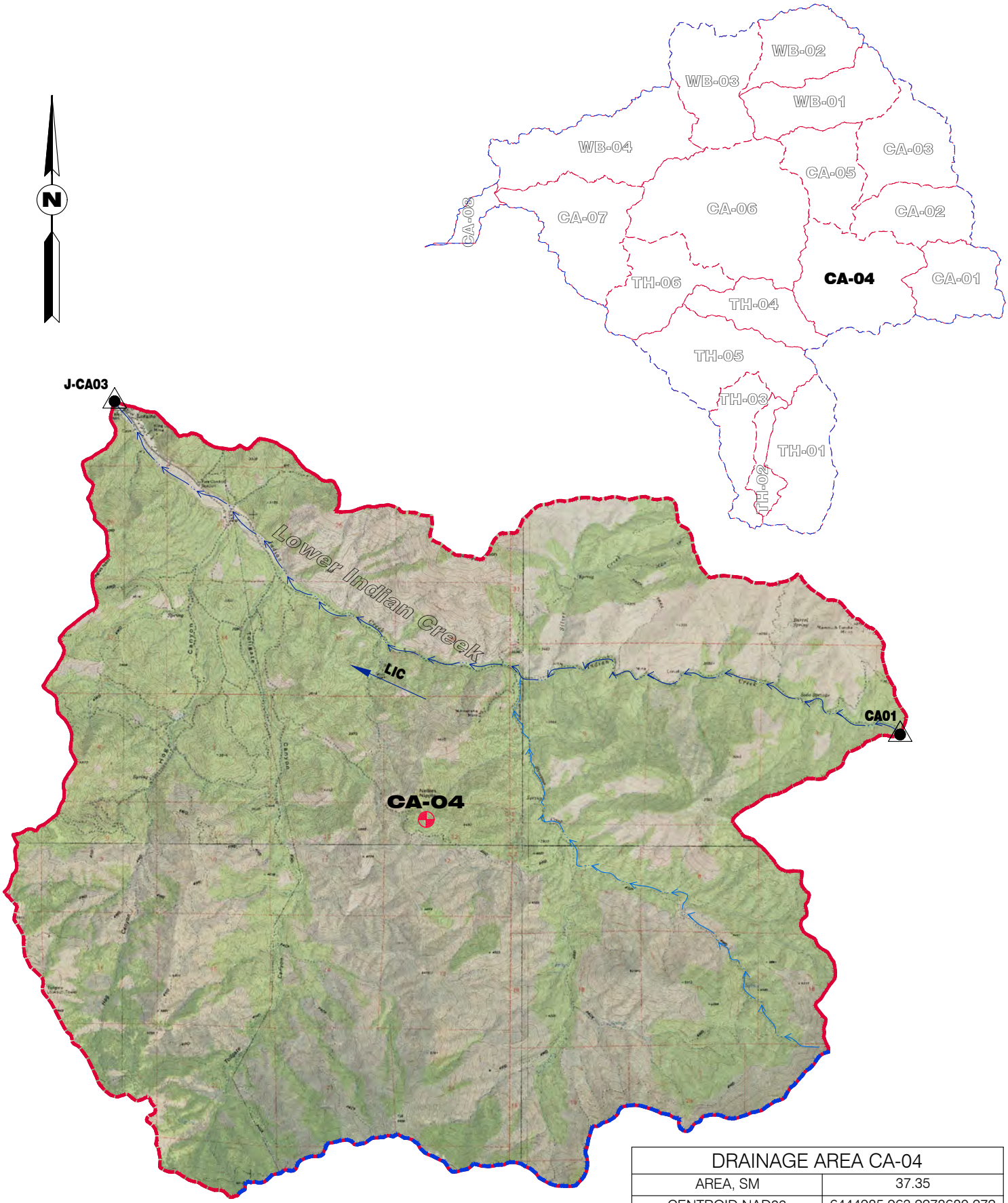
DRAINAGE AREA CA-01	
AREA, SM	20.76
CENTROID NAD83	6476050.441,2277789.285
CENTROID GEODETIC	35.2510069,-118.28675
L, F.L. LENGTH MILES	6.958
La, F.L. BELOW CENTROID	3.430
BEGIN F.L. ELEV.	6000
END F.L. ELEV.	3640
LAG TIME, HRS (100, 10, 5)	1.192, 1.359, 1.430
NRCS Cn	57.81



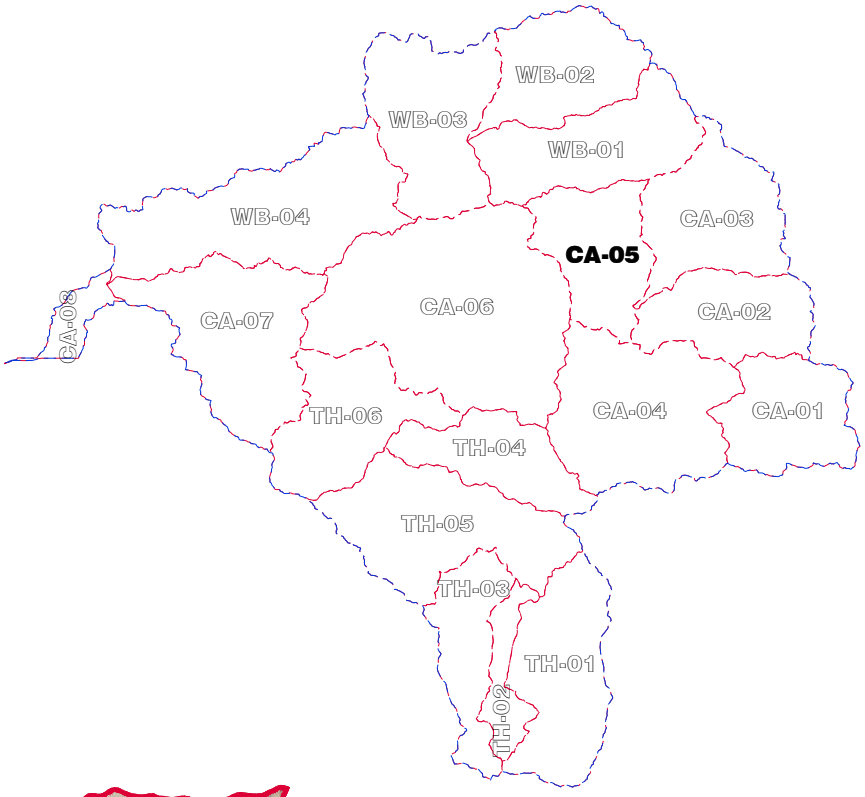


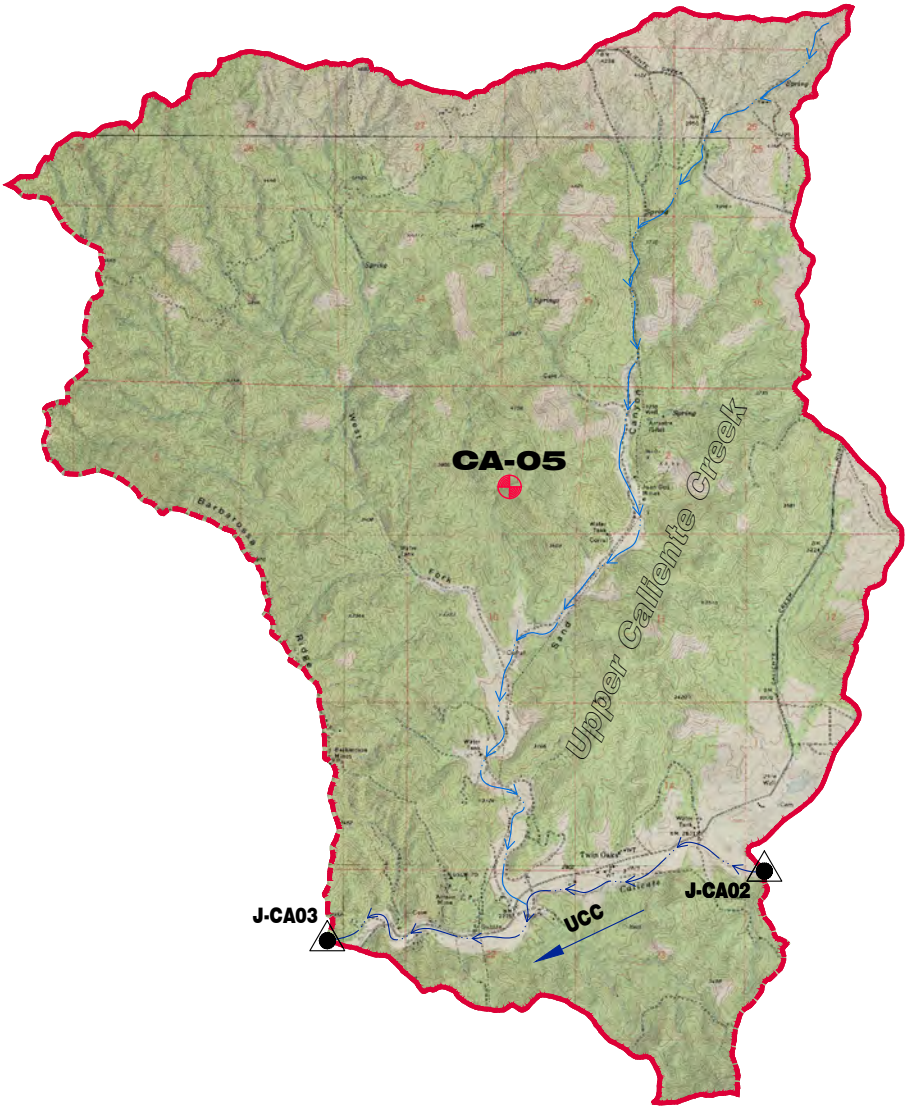
DRAINAGE AREA CA-02	
AREA, SM	20.48
CENTROID NAD83	6463895.964,2298708.723
CENTROID GEODETIC	35.3083785,-118.32769
L, F.L. LENGTH MILES	8.628
La, F.L. BELOW CENTROID	4.399
BEGIN F.L. ELEV.	5400
END F.L. ELEV.	2865
LAG TIME, HRS (100, 10, 5)	1.461, 1.665, 1.753
NRCS Cn	53.82

DRAINAGE AREA CA-03	
AREA, SM	25.55
CENTROID NAD83	6460428.381,2319458.682
CENTROID GEODETIC	35.3653537,-118.33955
L, F.L. LENGTH MILES	9.710
La, F.L. BELOW CENTROID	5.047
BEGIN F.L. ELEV.	7360
END F.L. ELEV.	2865
LAG TIME, HRS (100, 10, 5)	1.477, 1.683, 1.772
NRCS Cn	54.62

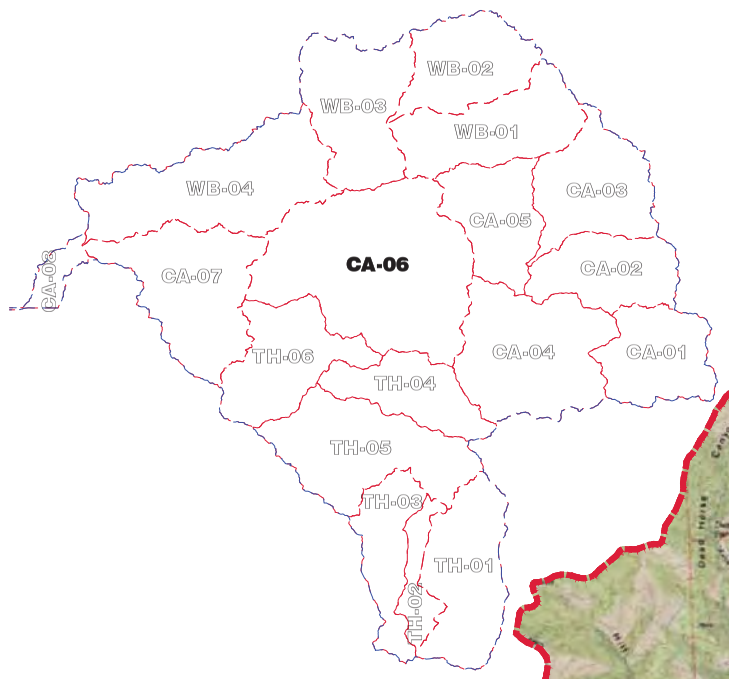


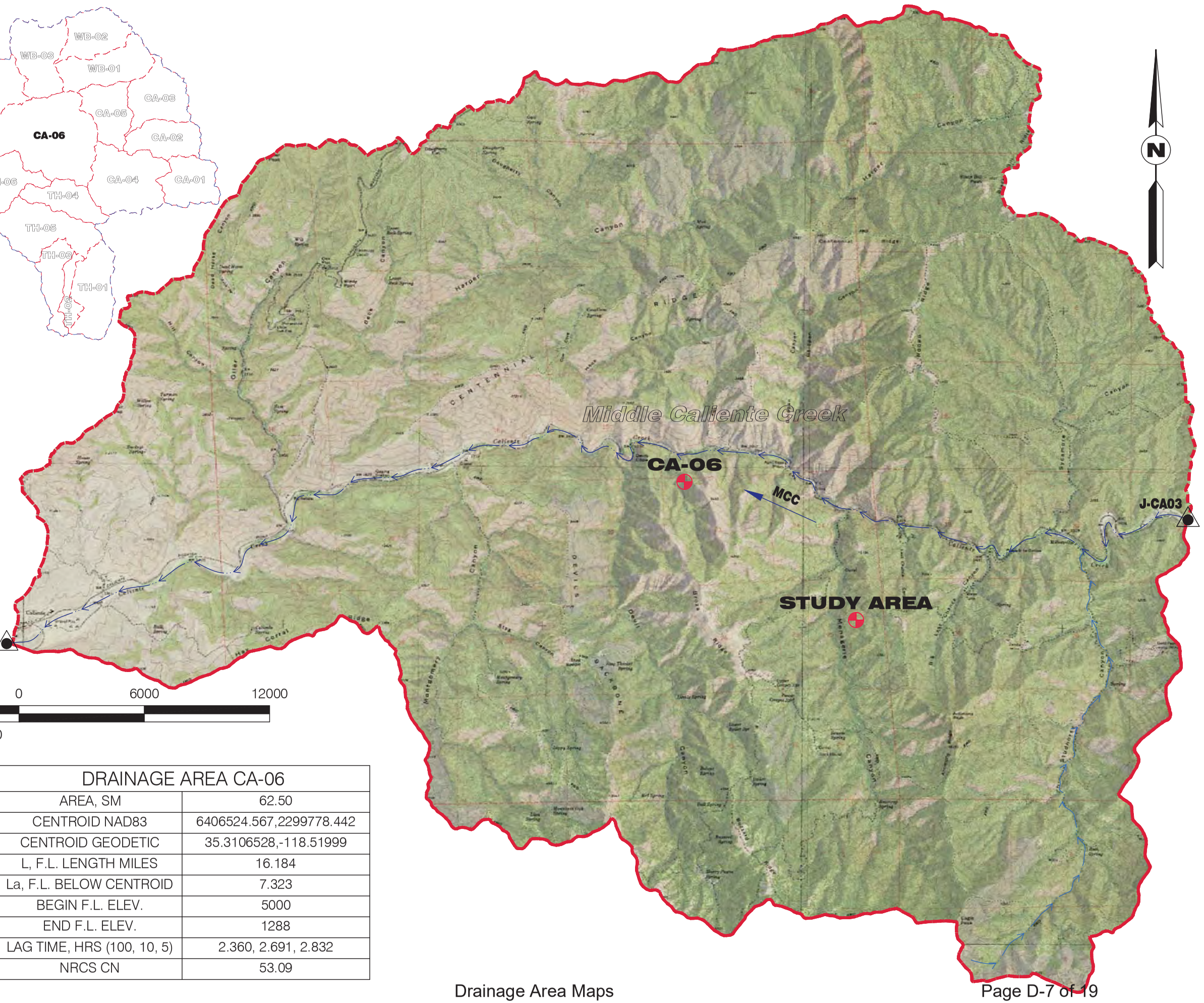
DRAINAGE AREA CA-04	
AREA, SM	37.35
CENTROID NAD83	6444985.963,2278680.272
CENTROID GEODETIC	35.2531672,-118.39081
L, F.L. LENGTH MILES	9.597
La, F.L. BELOW CENTROID	5.490
BEGIN F.L. ELEV.	6400
END F.L. ELEV.	2645
LAG TIME, HRS (100, 10, 5)	1.567, 1.787, 1.881
NRCS Cn	55.46





DRAINAGE AREA CA-05	
AREA, SM	20.87
CENTROID NAD83	6436325.153,2312135.043
CENTROID GEODETIC	35.3449832,-118.42028
L, F.L. LENGTH MILES	8.071
La, F.L. BELOW CENTROID	4.843
BEGIN F.L. ELEV.	4520
END F.L. ELEV.	2645
LAG TIME, HRS (100, 10, 5)	1.545, 1.761, 1.854
NRCS Cn	56.04



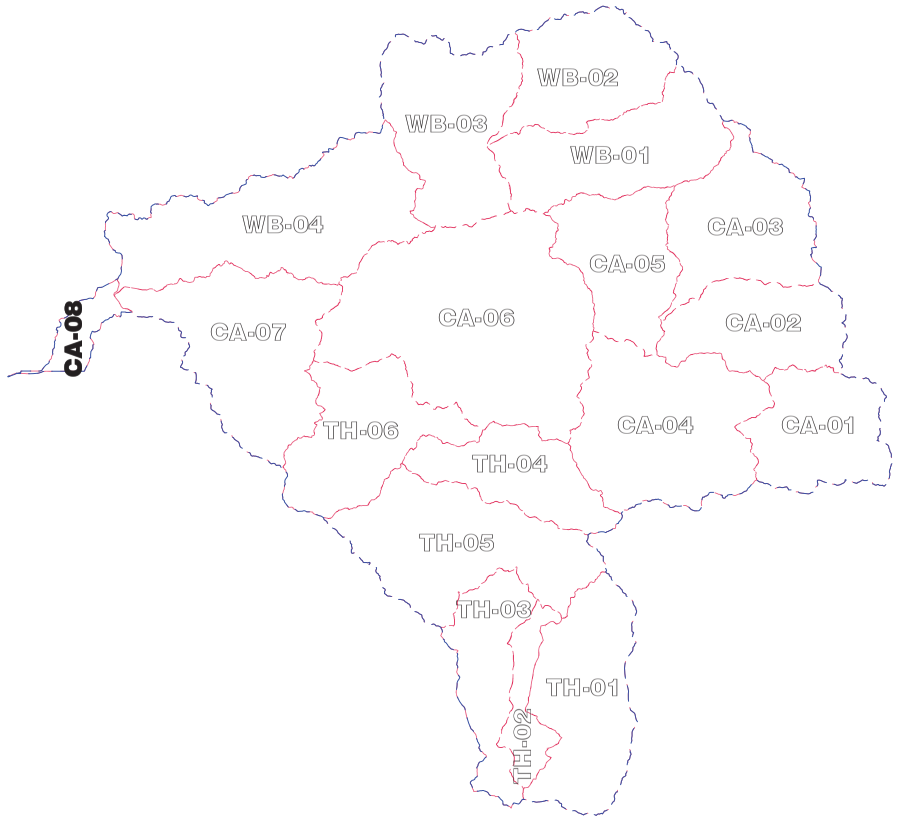


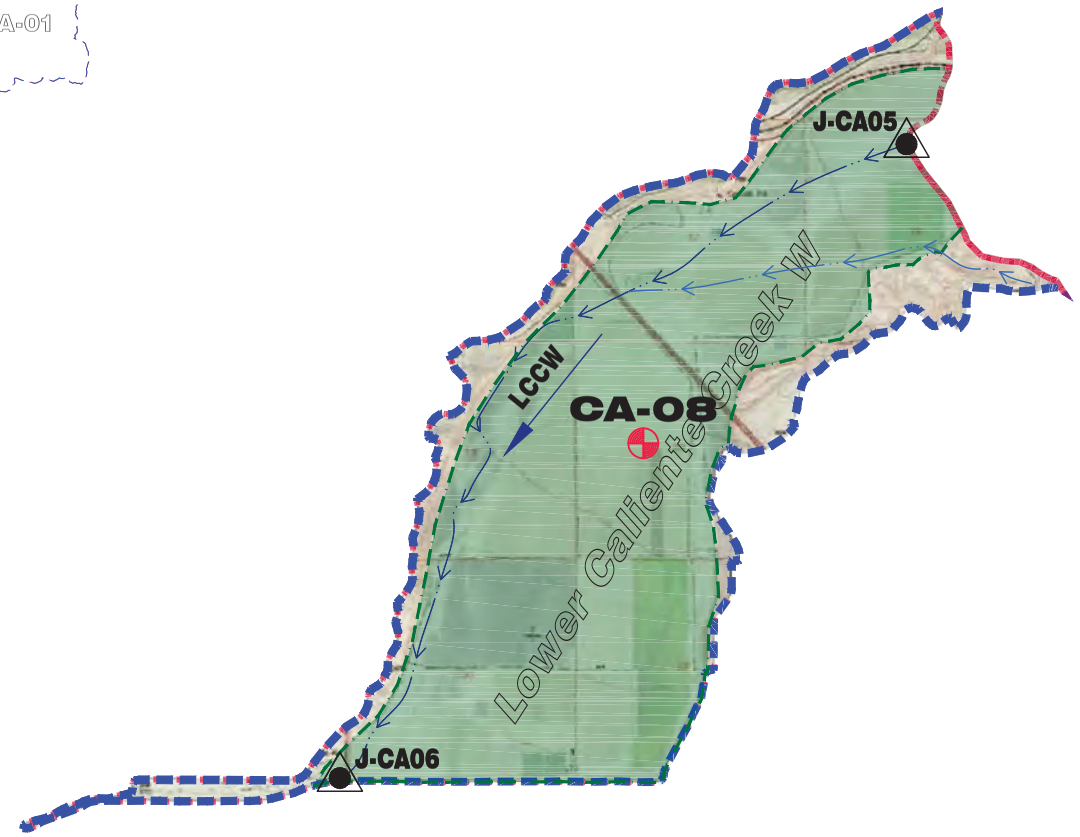
3000 0 6000 12000

-6000 1500

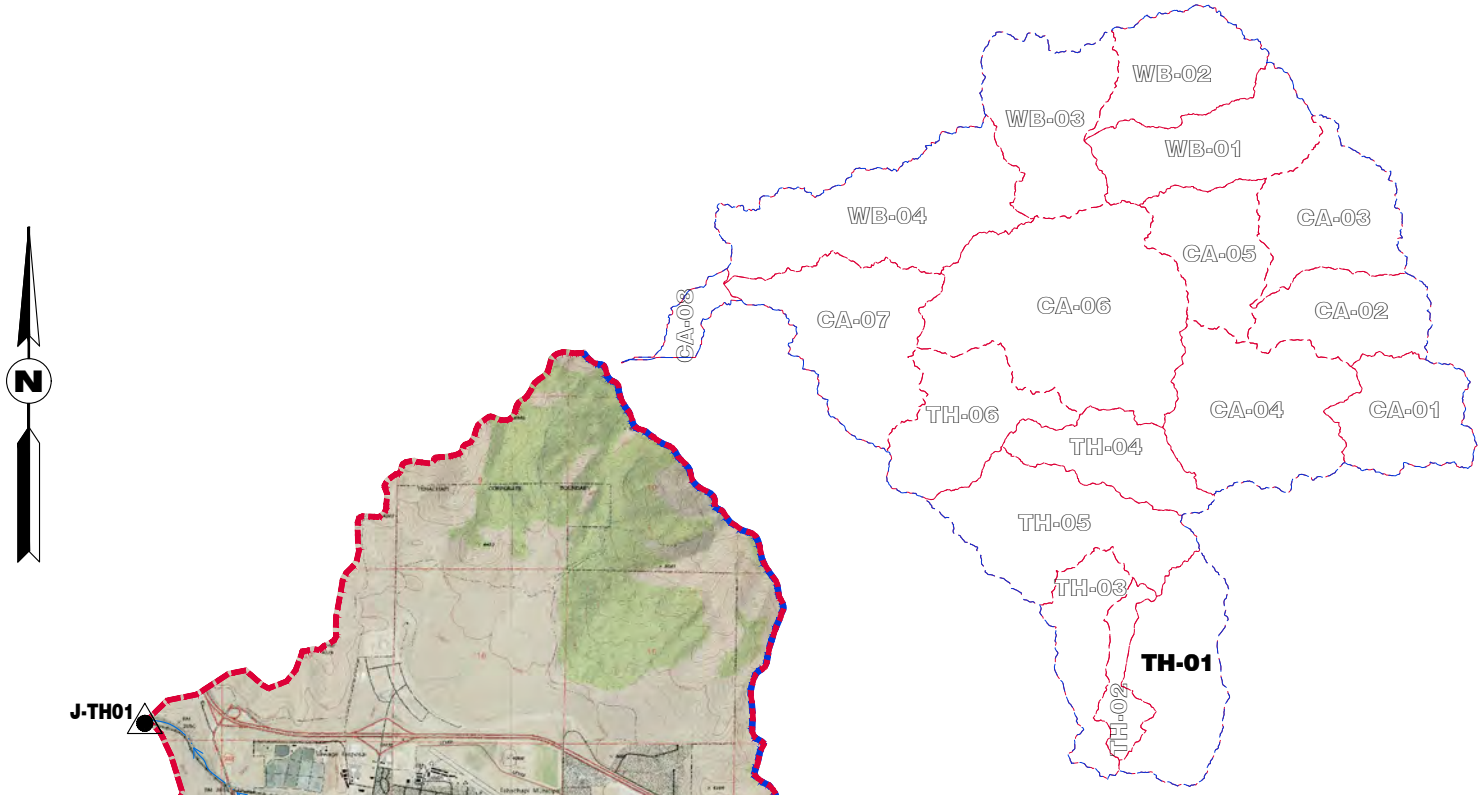
DRAINAGE AREA CA-06	
AREA, SM	62.50
CENTROID NAD83	6406524.567,2299778.442
CENTROID GEODETIC	35.3106528,-118.51999
L, F.L. LENGTH MILES	16.184
La, F.L. BELOW CENTROID	7.323
BEGIN F.L. ELEV.	5000
END F.L. ELEV.	1288
LAG TIME, HRS (100, 10, 5)	2.360, 2.691, 2.832
NRCS CN	53.09

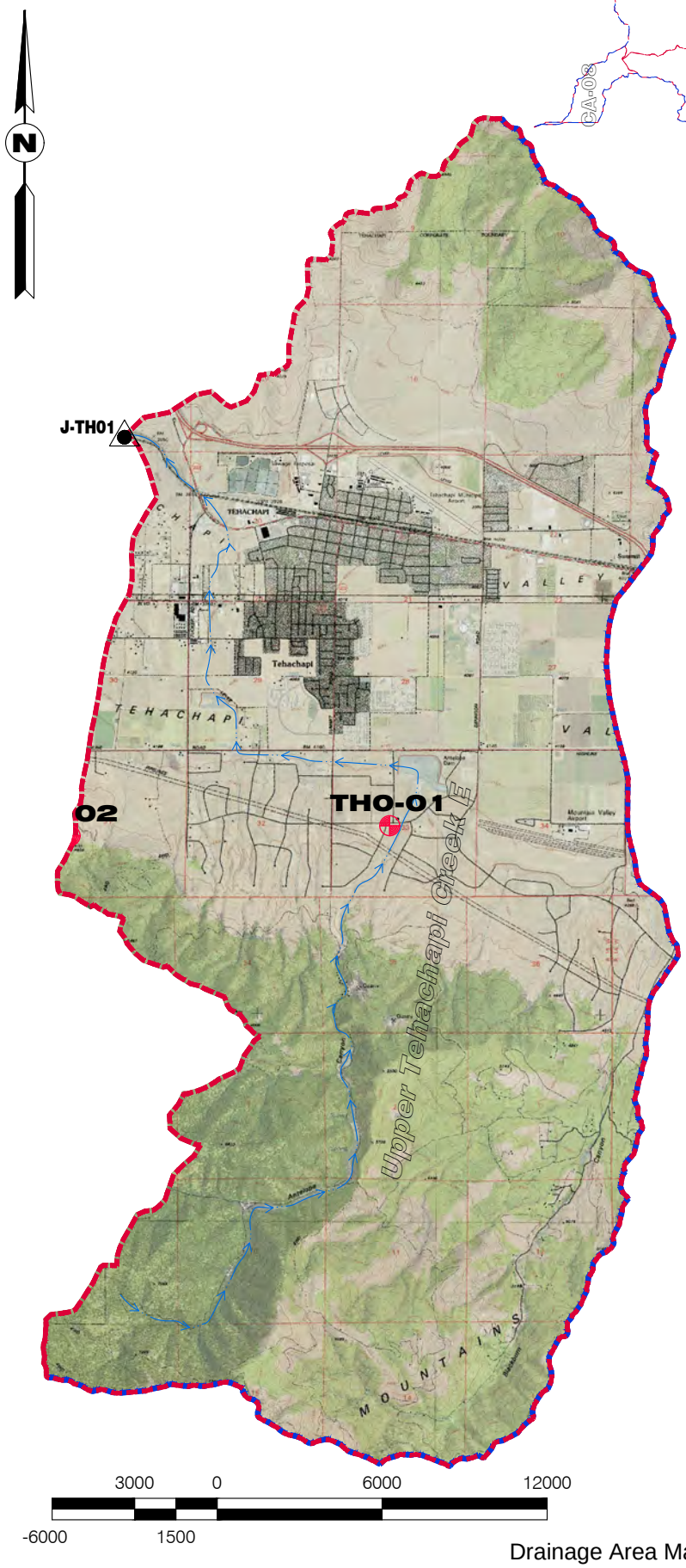
DRAINAGE AREA CA-07	
AREA, SM	34.205
CENTROID NAD83	6361386.606,2294337.233
CENTROID GEODETIC	35.2949692,-118.67116
L, F.L. LENGTH MILES	12.798
La, F.L. BELOW CENTROID	6.656
BEGIN F.L. ELEV.	3360
END F.L. ELEV.	815
LAG TIME, HRS	2.139, 2.439, 2.567
NRCS CN	40.60



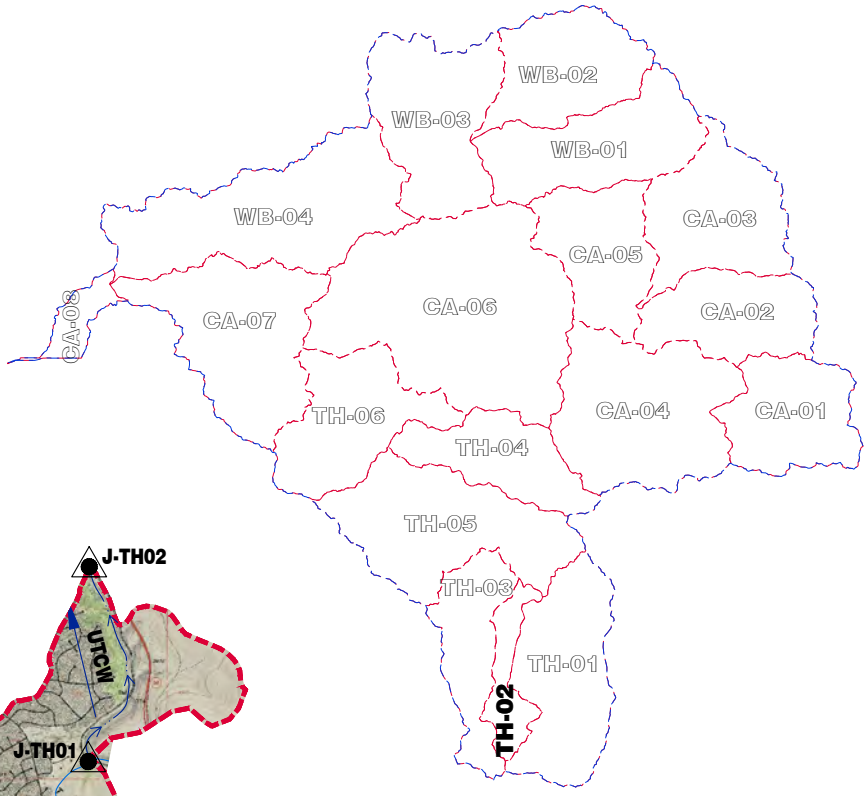


DRAINAGE AREA CA-08	
AREA, SM	4.918
CENTROID NAD83	6327788.299,2298032.234
CENTROID GEODETIC	35.3044524,-118.78384
L, F.L. LENGTH MILES	4.697
La, F.L. BELOW CENTROID	2.178
BEGIN F.L. ELEV.	1060
END F.L. ELEV.	615
LAG TIME, HRS (100, 10, 5)	1.101, 1.255, 1.321
NRCS CN	40.60





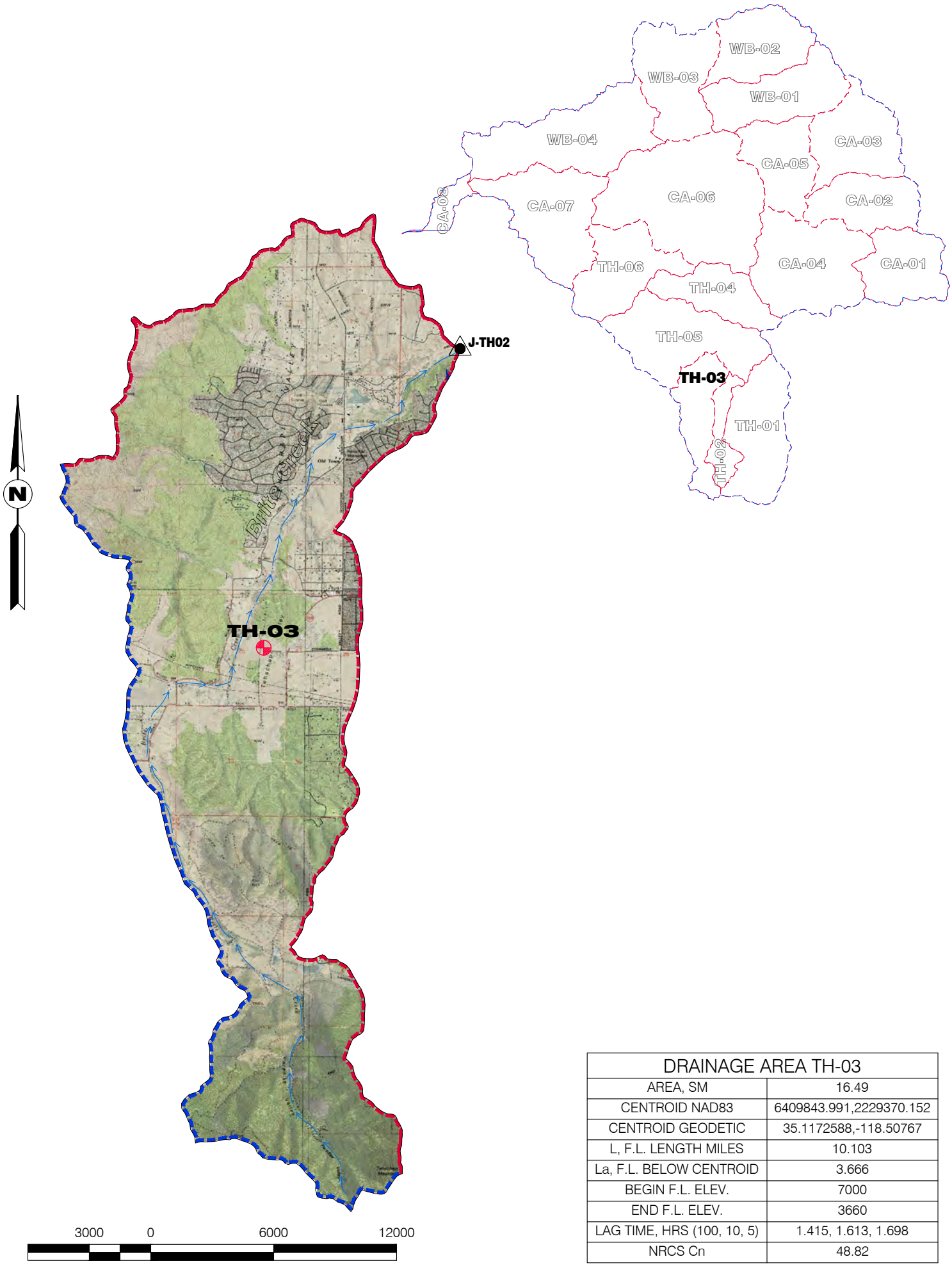
DRAINAGE AREA TH-01	
AREA, SM	27.70
CENTROID NAD83	6429051.647,2223754.199
CENTROID GEODETIC	35.1020786,-118.44337
L, F.L. LENGTH MILES	9.341
La, F.L. BELOW CENTROID	4.384
BEGIN F.L. ELEV.	6800
END F.L. ELEV.	3816
LAG TIME, HRS	1.480, 1.687, 1.776
NRCS Cn	46.57



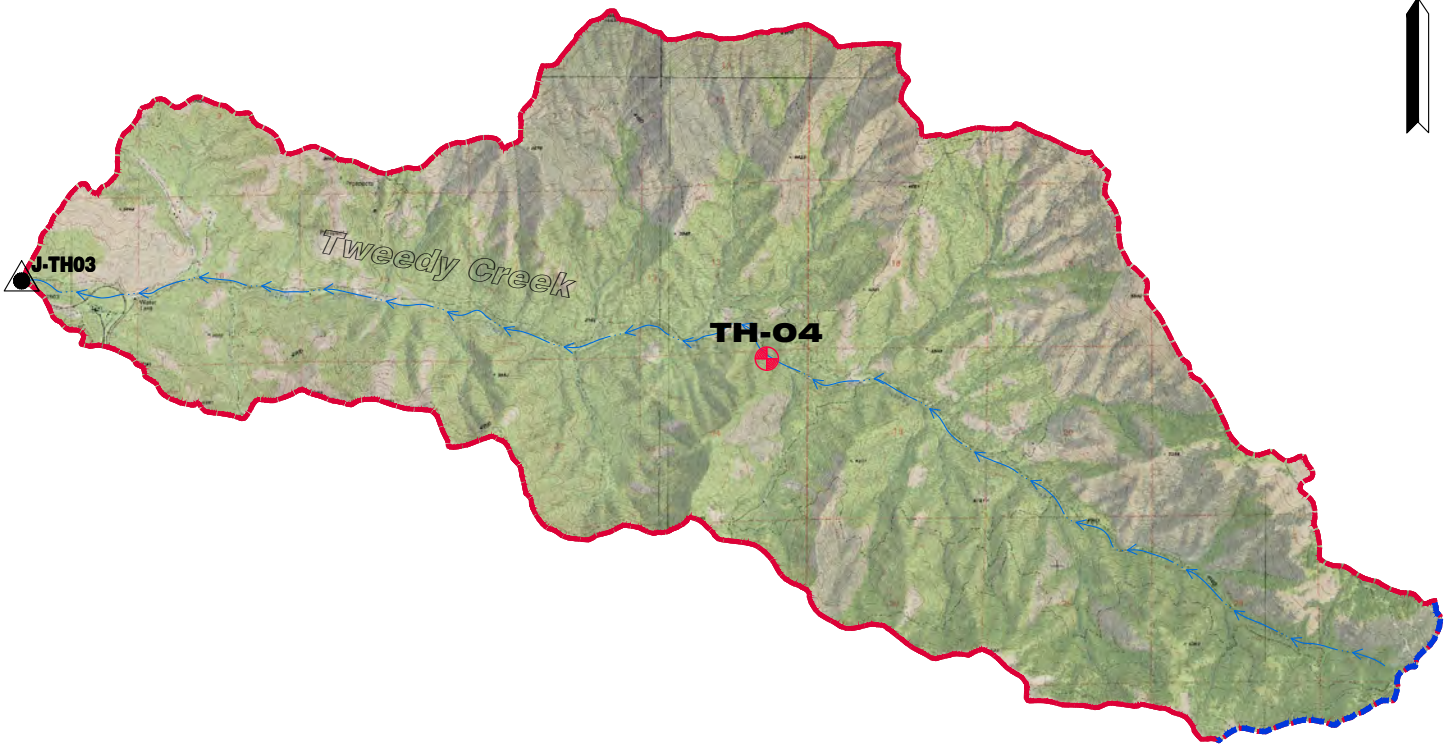
3000 0 6000 12000

-6000 1500

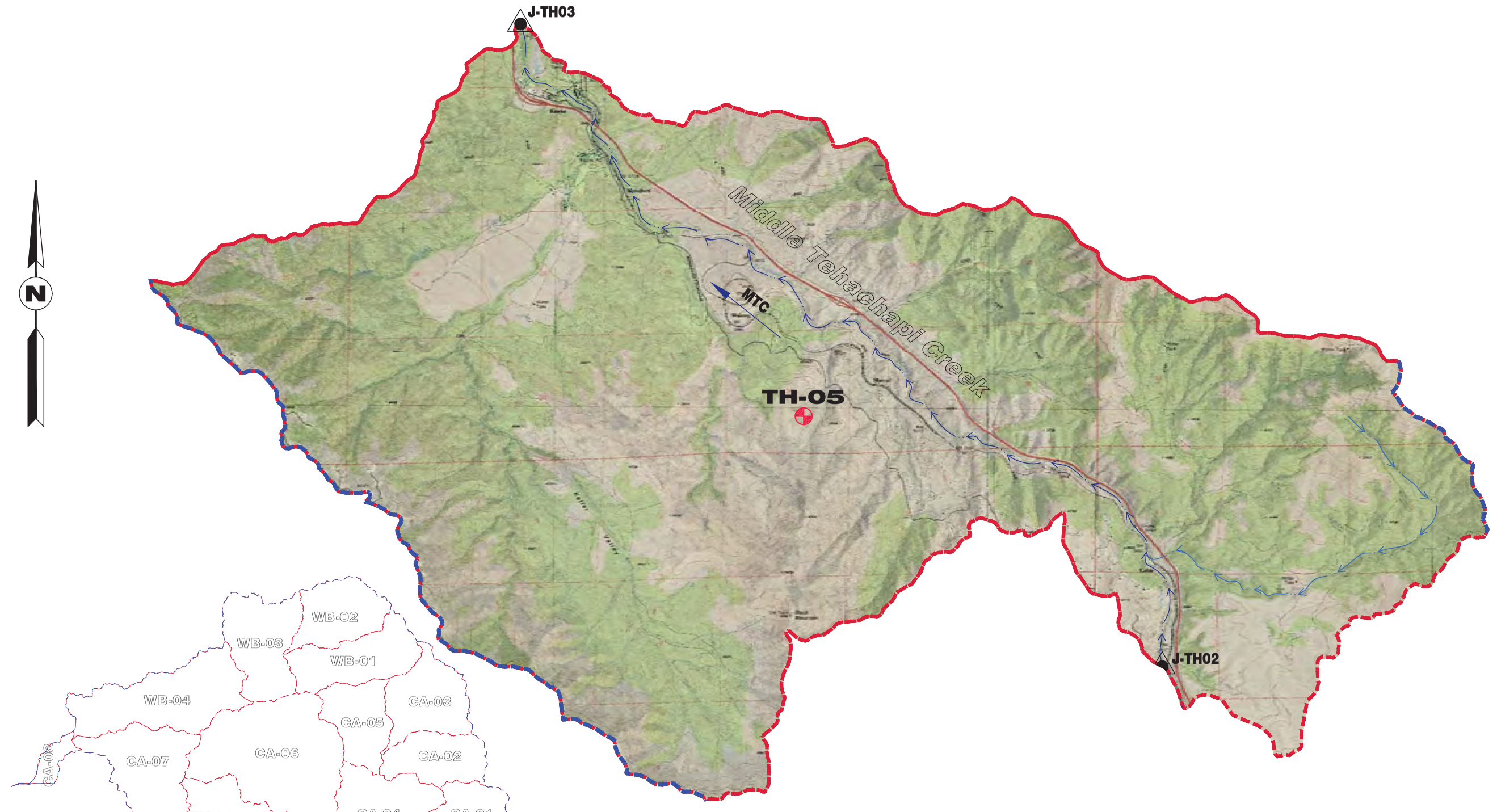
DRAINAGE AREA TH-02	
AREA, SM	7.61
CENTROID NAD83	6417430.069,2223391.932
CENTROID GEODETIC	35.1009362,-118.48221
L, F.L. LENGTH MILES	9.341
La, F.L. BELOW CENTROID	4.384
BEGIN F.L. ELEV.	7200
END F.L. ELEV.	3660
LAG TIME, HRS (100, 10, 5)	1.374, 1.566, 1.648
NRCS Cn	49.60

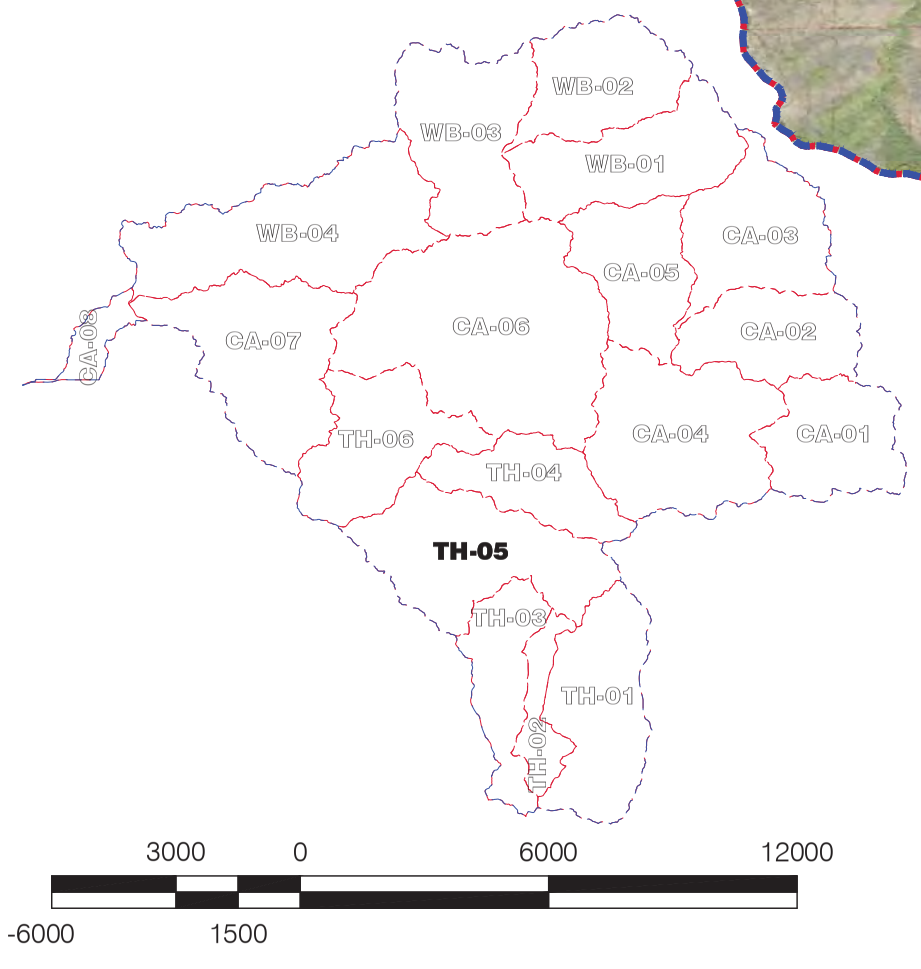


DRAINAGE AREA TH-03	
AREA, SM	16.49
CENTROID NAD83	6409843.991,2229370.152
CENTROID GEODETIC	35.1172588,-118.50767
L, F.L. LENGTH MILES	10.103
La, F.L. BELOW CENTROID	3.666
BEGIN F.L. ELEV.	7000
END F.L. ELEV.	3660
LAG TIME, HRS (100, 10, 5)	1.415, 1.613, 1.698
NRCS Cn	48.82

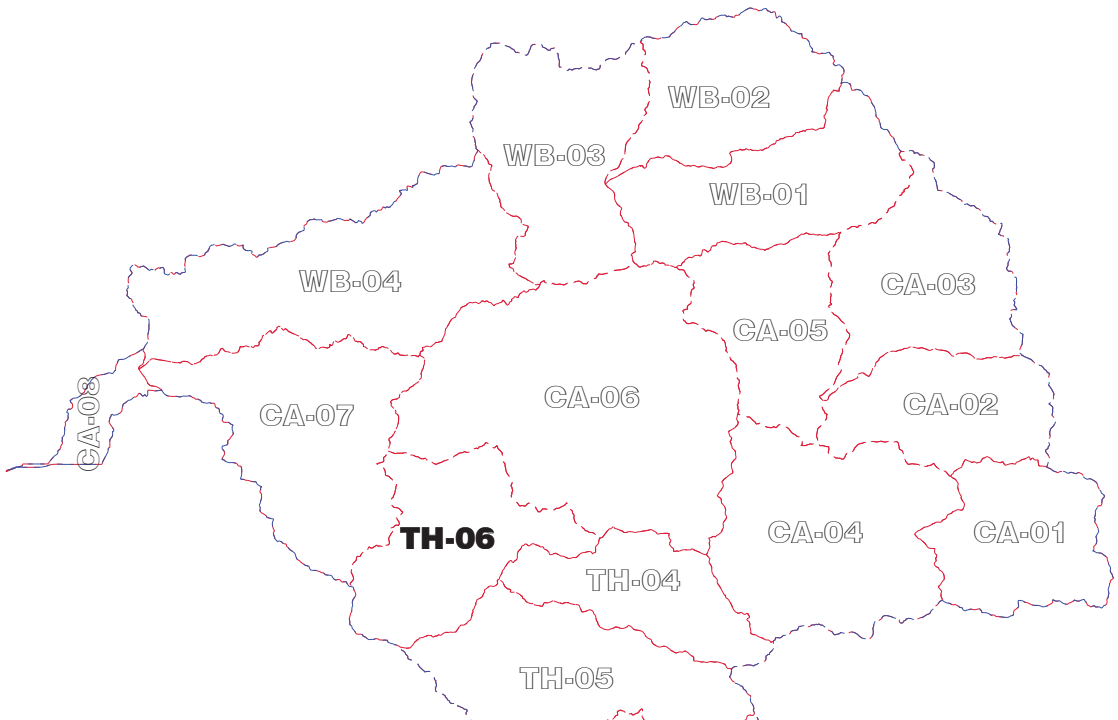


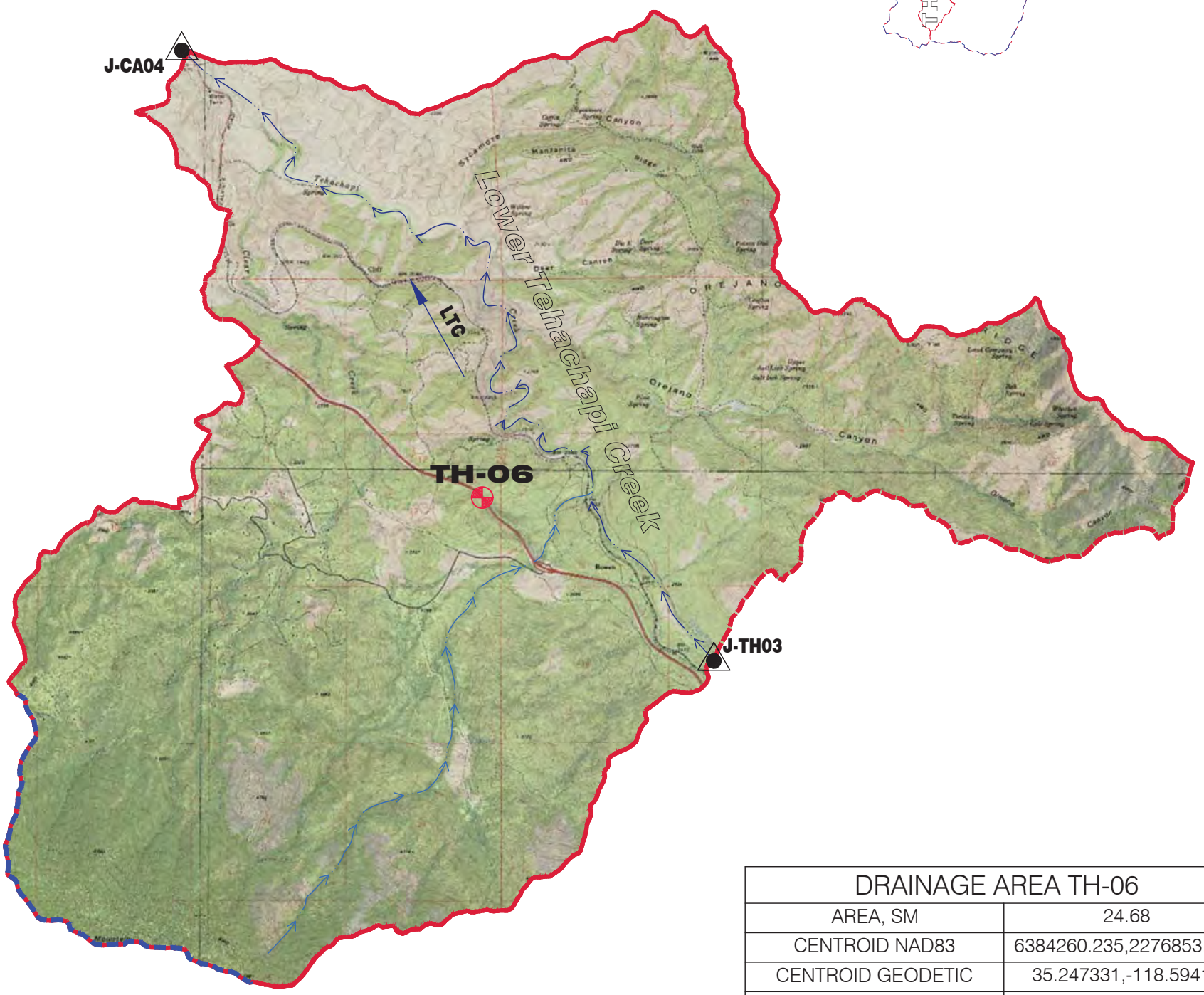
DRAINAGE AREA TH-04	
AREA, SM	18.06
CENTROID NAD83	6415412.667,2268876.630
CENTROID GEODETIC	35.2258768,-118.4897
L, F.L. LENGTH MILES	8.985
La, F.L. BELOW CENTROID	4.754
BEGIN F.L. ELEV.	5400
END F.L. ELEV.	2495
LAG TIME, HRS (100, 10, 5)	1.500, 1.710, 1.800
NRCS Cn	46.52





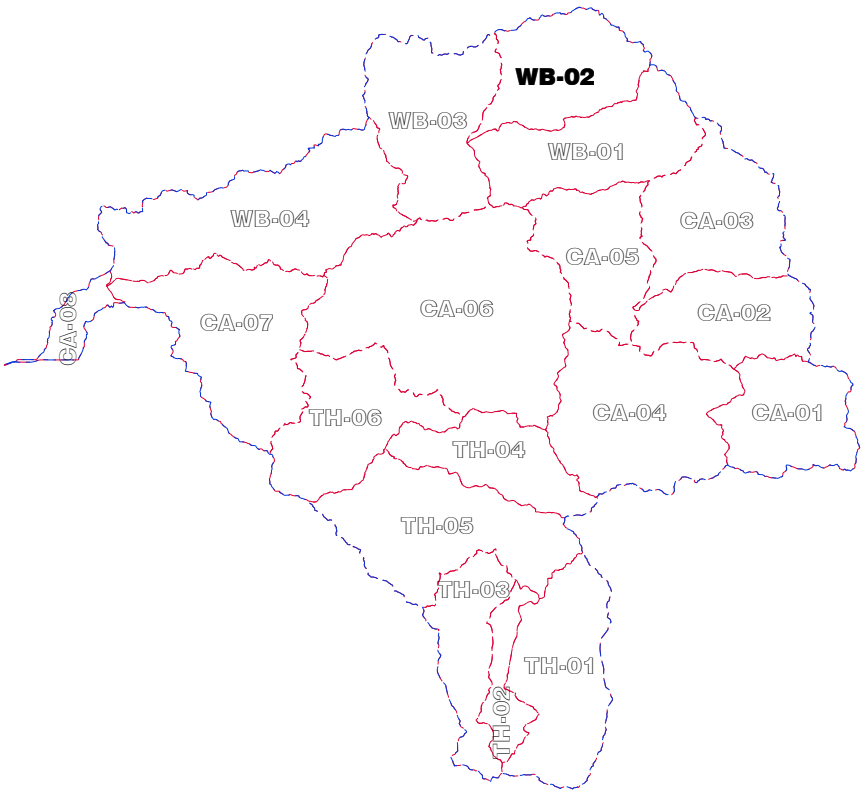
DRAINAGE AREA TH-05	
AREA, SM	34.01
CENTROID NAD83	6404178.553,2254617.997
CENTROID GEODETIC	35.1865462,-118.52706
L, F.L. LENGTH MILES	11.330
La, F.L. BELOW CENTROID	3.950
BEGIN F.L. ELEV.	5140
END F.L. ELEV.	2495
LAG TIME, HRS (100, 10, 5)	1.625, 1.852, 1.950
NRCS Cn	48.15

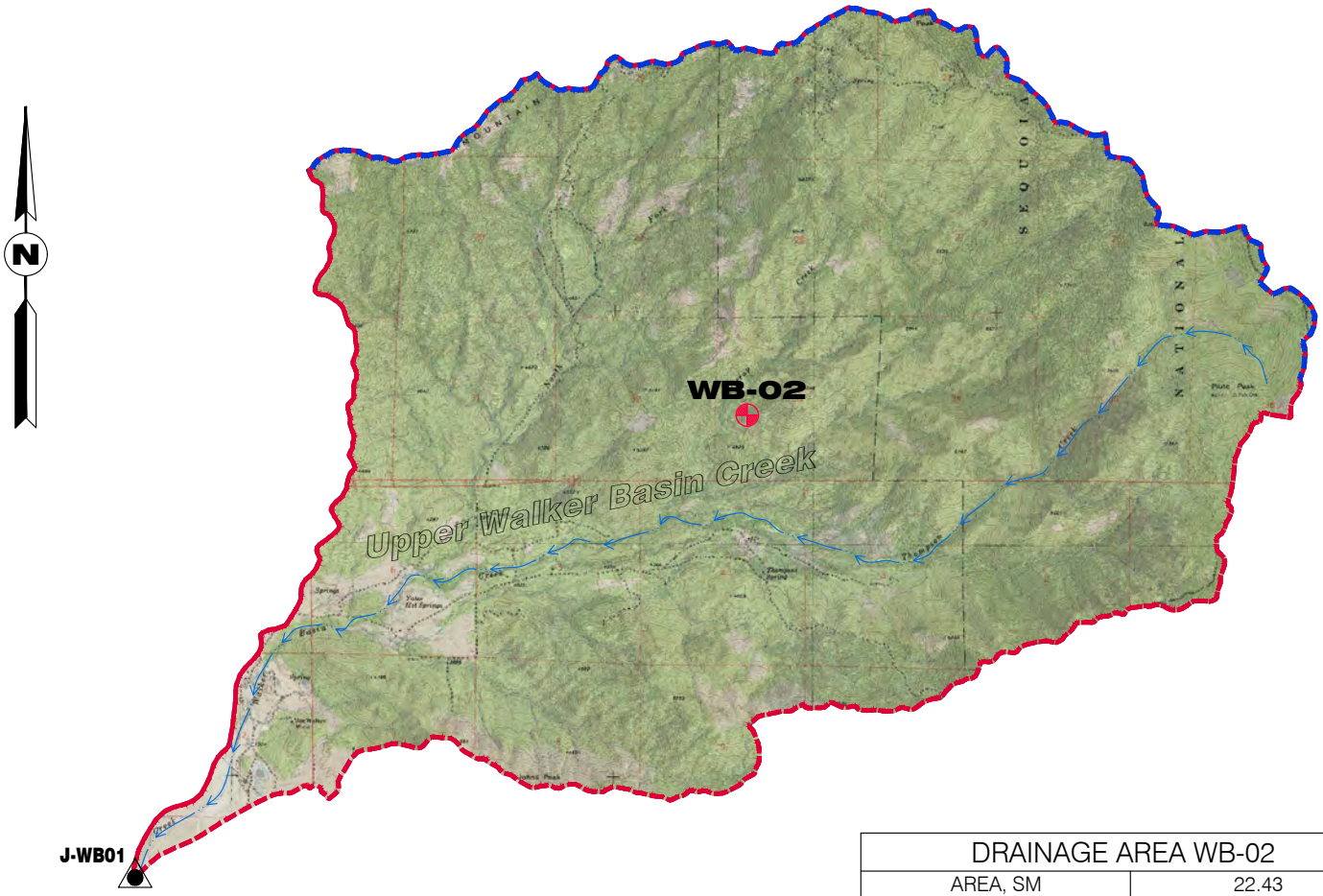




DRAINAGE AREA TH-06	
AREA, SM	24.68
CENTROID NAD83	6384260.235,2276853.537
CENTROID GEODETIC	35.247331,-118.59416
L, F.L. LENGTH MILES	9.473
La, F.L. BELOW CENTROID	5.866
BEGIN F.L. ELEV.	5800
END F.L. ELEV.	1288
LAG TIME, HRS (100, 10, 5)	1.540, 1.756, 1.849
NRCS Cn	45.20

DRAINAGE AREA WB-01	
AREA, SM	26.67
CENTROID NAD83	6435452.419,2334233.397
CENTROID GEODETIC	35.4056835,-118.42352
L, F.L. LENGTH MILES	12.581
La, F.L. BELOW CENTROID	5.047
BEGIN F.L. ELEV.	8060
END F.L. ELEV.	3425
LAG TIME, HRS (100, 10, 5)	1.702, 1.940, 2.042
NRCS Cn	55.64

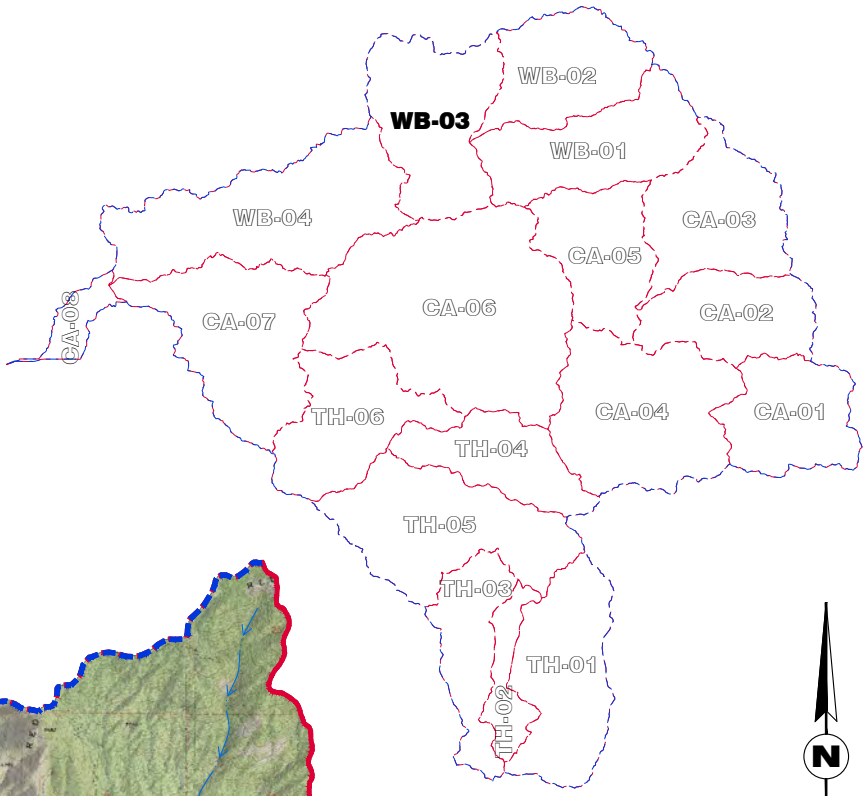


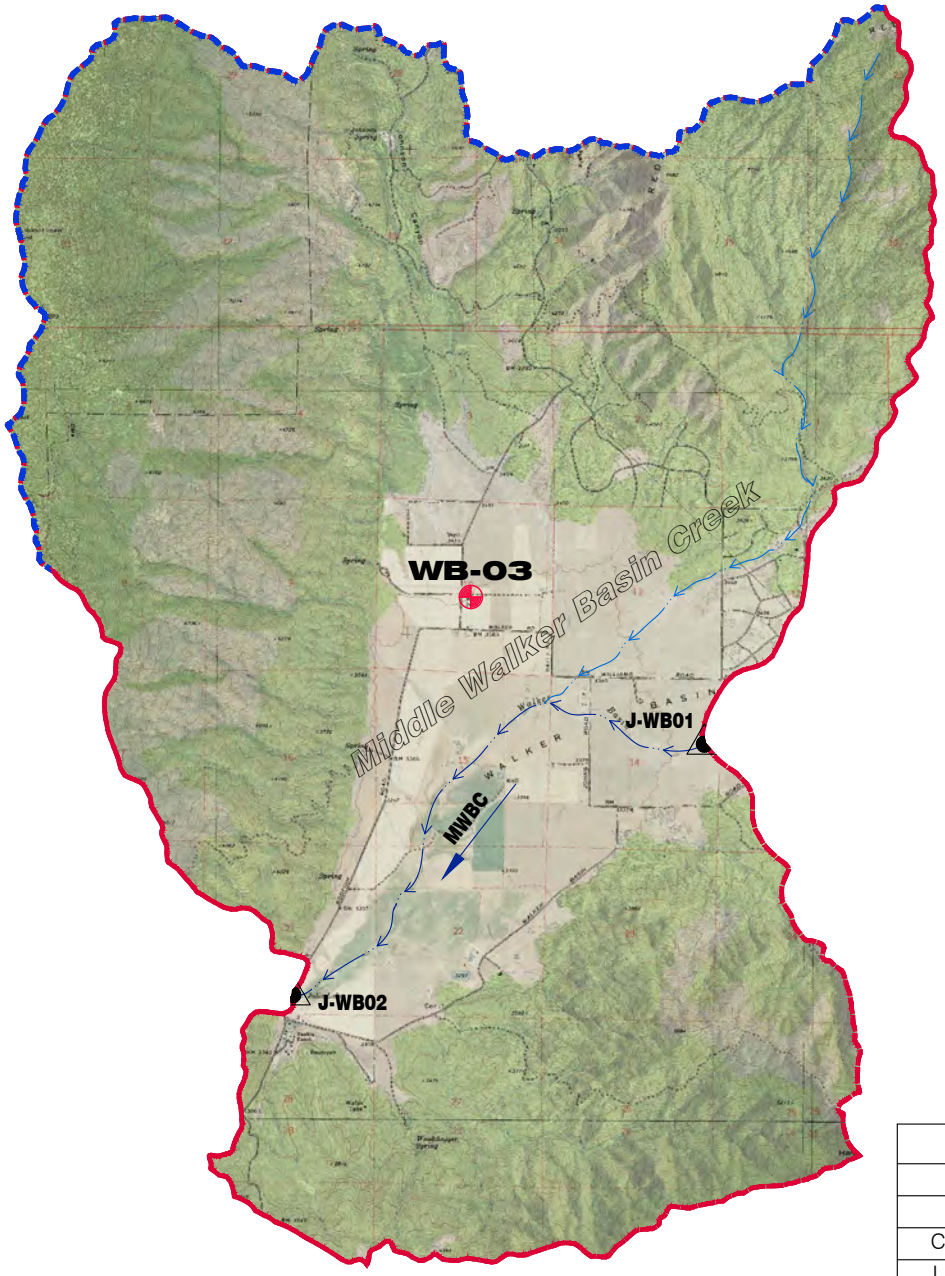


3000 0 6000 12000

-6000 1500

DRAINAGE AREA WB-02	
AREA, SM	22.43
CENTROID NAD83	6429202.607,2350027.306
CENTROID GEODETIC	35.4489987,-118.44473
L, F.L. LENGTH MILES	8.998
La, F.L. BELOW CENTROID	4.986
BEGIN F.L. ELEV.	8040
END F.L. ELEV.	3425
LAG TIME, HRS (100, 10, 5)	1.400, 1.596, 1.680
NRCS Cn	56.56



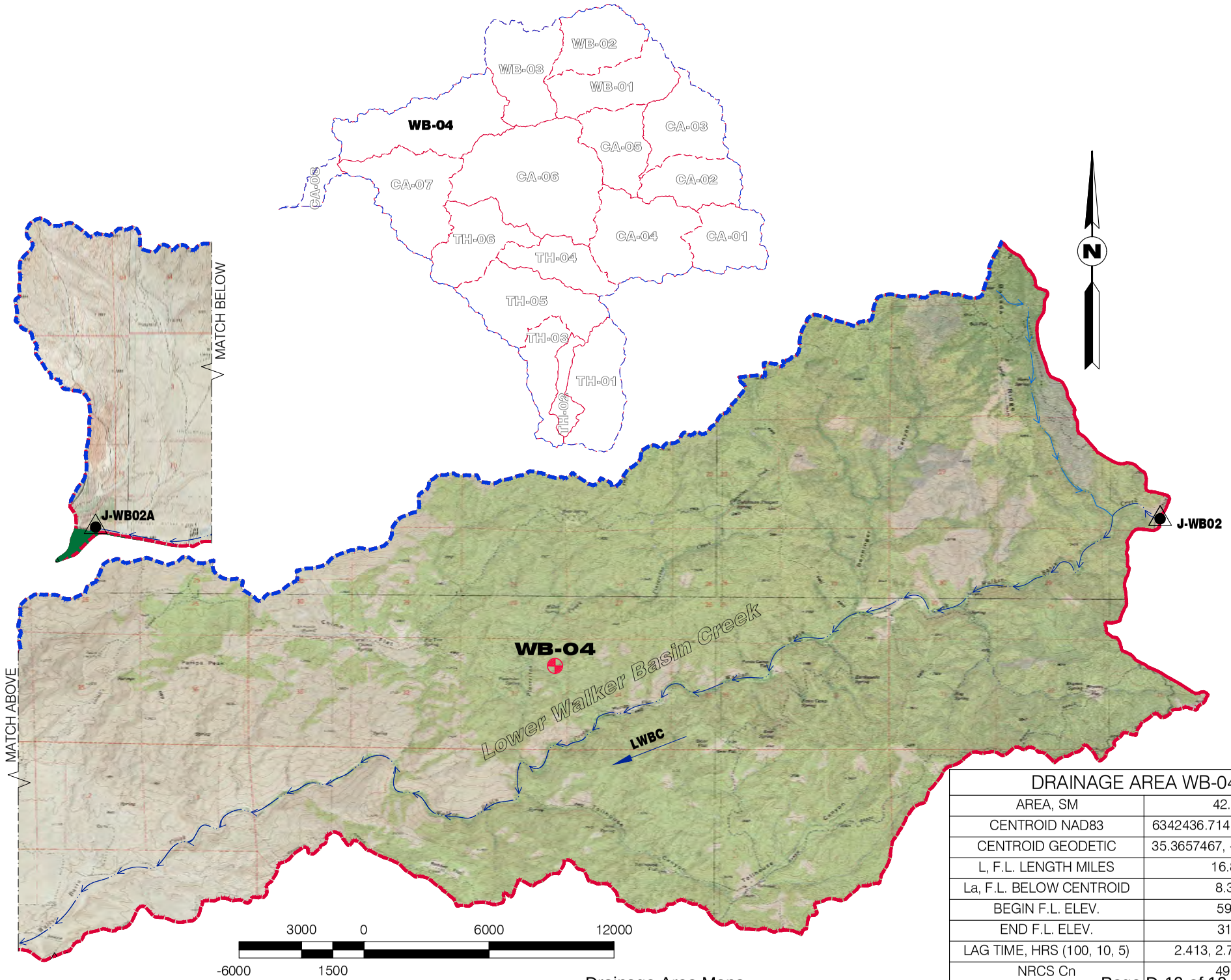


N

3000 0 6000 12000

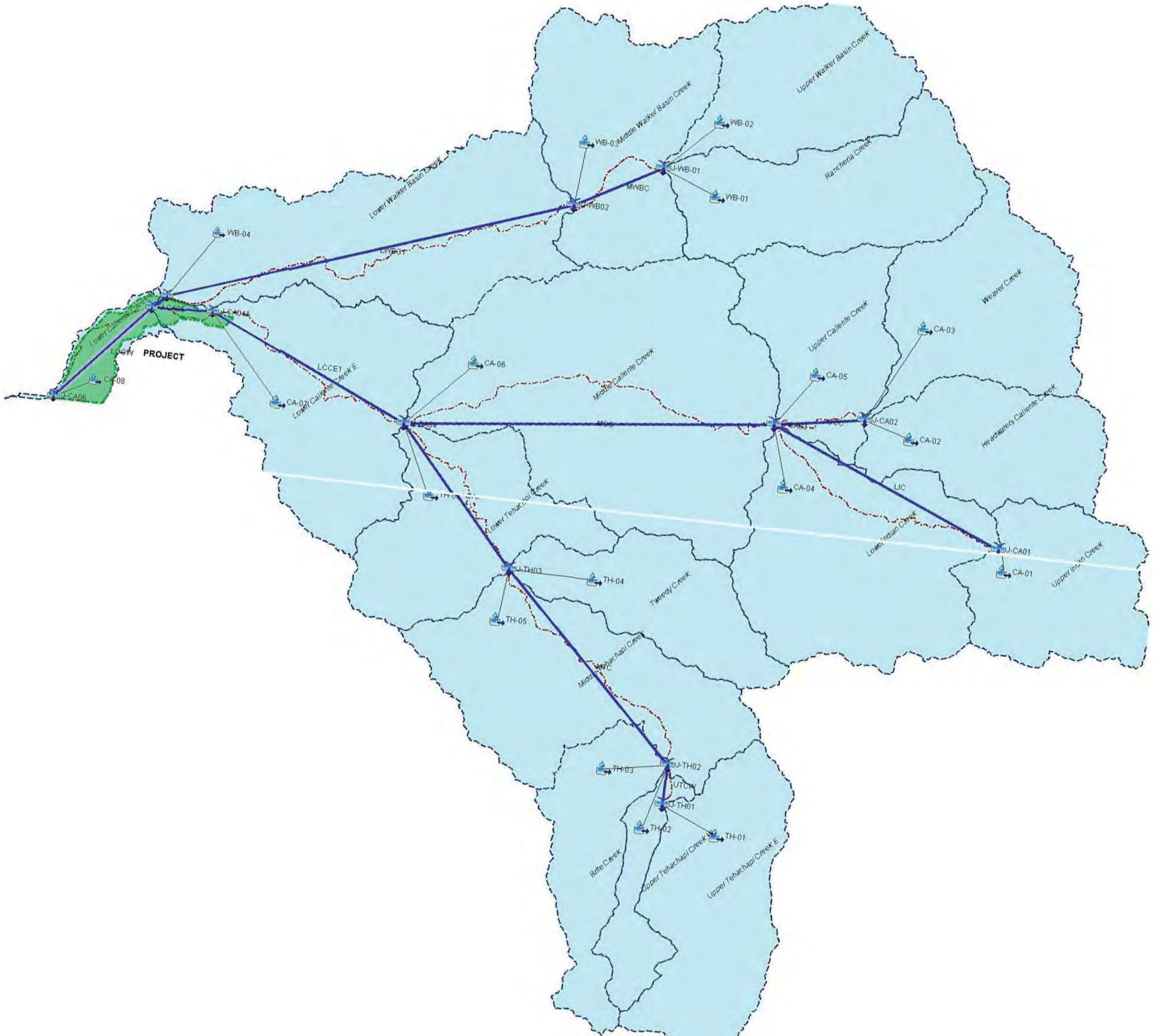
-6000 1500

DRAINAGE AREA WB-03	
AREA, SM	29.06
CENTROID NAD83	6401967.285,2339556.414
CENTROID GEODETIC	35.419868,-118.53598
L, F.L. LENGTH MILES	7.895
La, F.L. BELOW CENTROID	2.869
BEGIN F.L. ELEV.	5920
END F.L. ELEV.	3160
LAG TIME, HRS (100, 10, 5)	1.162, 1.624, 1.394
NRCS Cn	51.29



DRAINAGE AREA WB-04	
AREA, SM	42.311
CENTROID NAD83	6342436.714,2320060.643
CENTROID GEODETIC	35.3657467, -118.6517100
L, F.L. LENGTH MILES	16.868
La, F.L. BELOW CENTROID	8.389
BEGIN F.L. ELEV.	5920
END F.L. ELEV.	3160
LAG TIME, HRS (100, 10, 5)	2.413, 2.751, 2.896
NRCS Cn	49.56

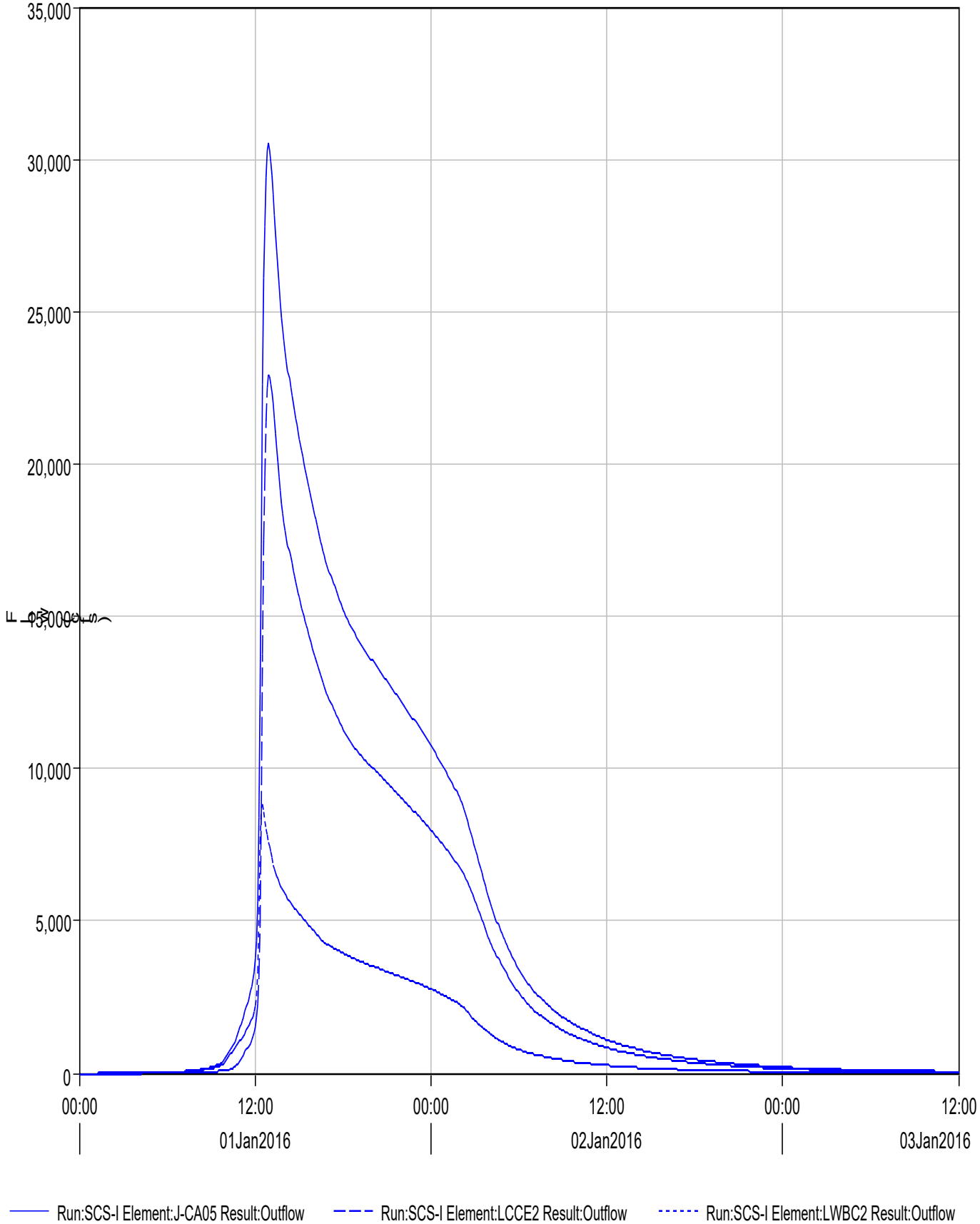
Drainage Area Maps



Upper Walker Basin Creek
Middle Walker Basin Creek
Lower Walker Basin Creek
Rancheria Creek
WB-02
WB-03
WB-01
WB-04
MWBC
LWBC1
Weaver Creek
Upper Caliente Creek
Middle Caliente Creek
Lower Caliente Creek
Lower Caliente Creek E
Headwaters Caliente Creek
Lower Tehachapi Creek
Lower Indian Creek
Upper Indian Creek
Tweedy Creek
Middle Tehachapi Creek
Brite Creek
Upper Tehachapi Creek
Upper Tehachapi Creek E
PROJECT
LCCE1
LIC
UTCW
CA-01
CA-02
CA-03
CA-04
CA-05
CA-06
CA-07
CA-08
TH-01
TH-02
TH-03
TH-04
TH-05
J-CA01
J-CA02
J-CA06
J-TH01
J-TH02
J-TH03
J-WB-01
J-WB02

CALIBRATE TO ACOE MODEL

Junction "J-CA05" Results for Run "SCS-I"



Project: Caliente Simulation Run: SCS-I

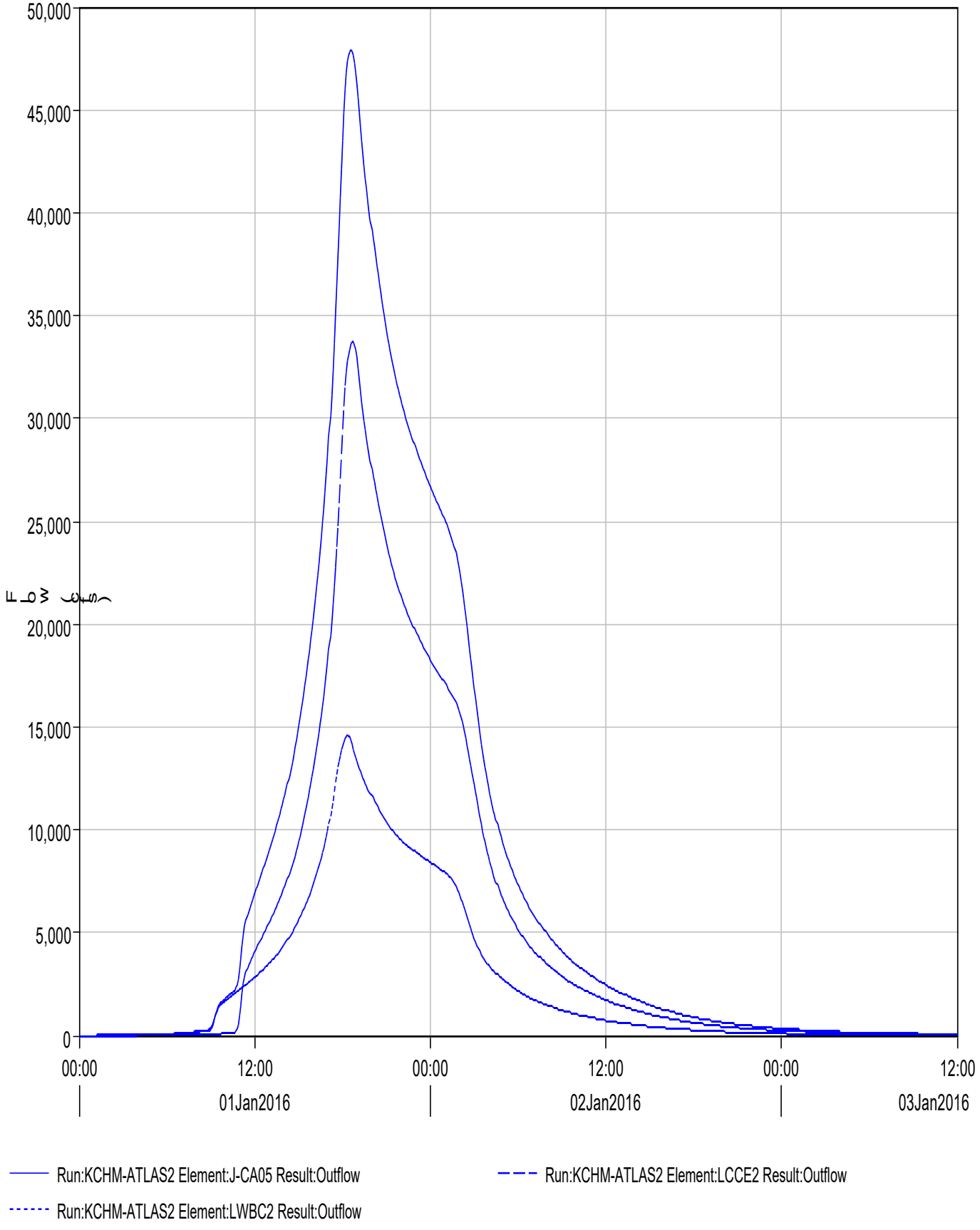
Start of Run: 01Jan2016, 00:00 Basin Model: Caliente
End of Run: 03Jan2016, 12:00 Meteorologic Model: SCS-I-ACOE
Compute Time: 09Sep2016, 09:54:21 Control Specifications: 100yr

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
CA-03	25.55	2294.11	01Jan2016, 10:45	1313.26
CA-02	20.48	1791.29	01Jan2016, 10:45	1029.42
J-CA02	46.03	4085.40	01Jan2016, 10:45	2342.68
UCC	46.03	4035.77	01Jan2016, 11:10	2334.80
CA-01	20.76	2342.84	01Jan2016, 10:35	1165.08
J-CA01	20.76	2342.84	01Jan2016, 10:35	1165.08
LIC	20.76	2268.37	01Jan2016, 11:40	1160.29
CA-04	37.35	3195.02	01Jan2016, 10:45	1914.98
CA-05	20.87	1905.60	01Jan2016, 10:45	1115.74
J-CA03	125.01	9208.07	01Jan2016, 11:35	6525.81
MCC	125.01	9017.37	01Jan2016, 12:20	6498.41
TH-01	27.70	2179.59	01Jan2016, 10:45	1252.29
J-TH01	27.70	2179.59	01Jan2016, 10:45	1252.29
UTCW	27.70	2151.57	01Jan2016, 10:55	1251.60
TH-03	16.49	1352.48	01Jan2016, 10:40	766.35
TH-02	7.61	707.76	01Jan2016, 10:40	382.95
J-TH02	51.80	4062.60	01Jan2016, 10:50	2400.89
MTC	51.80	4035.33	01Jan2016, 11:40	2389.64
TH-05	34.01	2351.39	01Jan2016, 10:50	1453.51
TH-04	18.06	1254.43	01Jan2016, 10:45	735.54
J-TH03	103.87	6603.33	01Jan2016, 11:35	4578.69
LTC	103.87	6530.45	01Jan2016, 12:05	4564.85
CA-06	62.50	6011.61	01Jan2016, 12:05	3079.96
TH-06	24.68	2267.52	01Jan2016, 11:20	966.78
J-CA04	316.06	21762.70	01Jan2016, 12:05	15110.00
LCCE1	316.06	21646.40	01Jan2016, 12:45	15029.05
CA-07	34.205	2302.46	01Jan2016, 11:50	1161.52
J-CA04A	350.265	23029.10	01Jan2016, 12:45	16190.56
LCCE2	350.265	22936.48	01Jan2016, 12:55	16161.54

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
WB-01	26.67	2057.29	01Jan2016, 11:00	1374.47
WB-02	22.43	2063.81	01Jan2016, 10:45	1216.43
J-WB-01	49.10	3994.63	01Jan2016, 10:55	2590.90
MWBC	49.10	3978.13	01Jan2016, 11:25	2581.13
WB-03	29.06	2501.24	01Jan2016, 10:40	1359.97
J-WB02	78.16	5656.32	01Jan2016, 11:20	3941.09
LWBC1	78.16	5638.07	01Jan2016, 12:30	3916.91
WB-04	42.31	3381.43	01Jan2016, 12:25	1885.33
J-WB02A	120.47	8925.54	01Jan2016, 12:25	5802.24
LWBC2	120.47	8836.29	01Jan2016, 12:30	5801.69
J-CA05	470.735	30536.55	01Jan2016, 12:55	21963.23
LCCW	470.735	30410.44	01Jan2016, 13:15	21879.26
CA-08	4.918	612.81	01Jan2016, 10:45	280.10
J-CA06	475.653	30681.66	01Jan2016, 13:15	22159.36

100 YEAR KCHM CURVE WITH ATLAS 2

Junction "J-CA05" Results for Run "KCHM-ATLAS2"



Project: Caliente Simulation Run: KCHM-ATLAS2

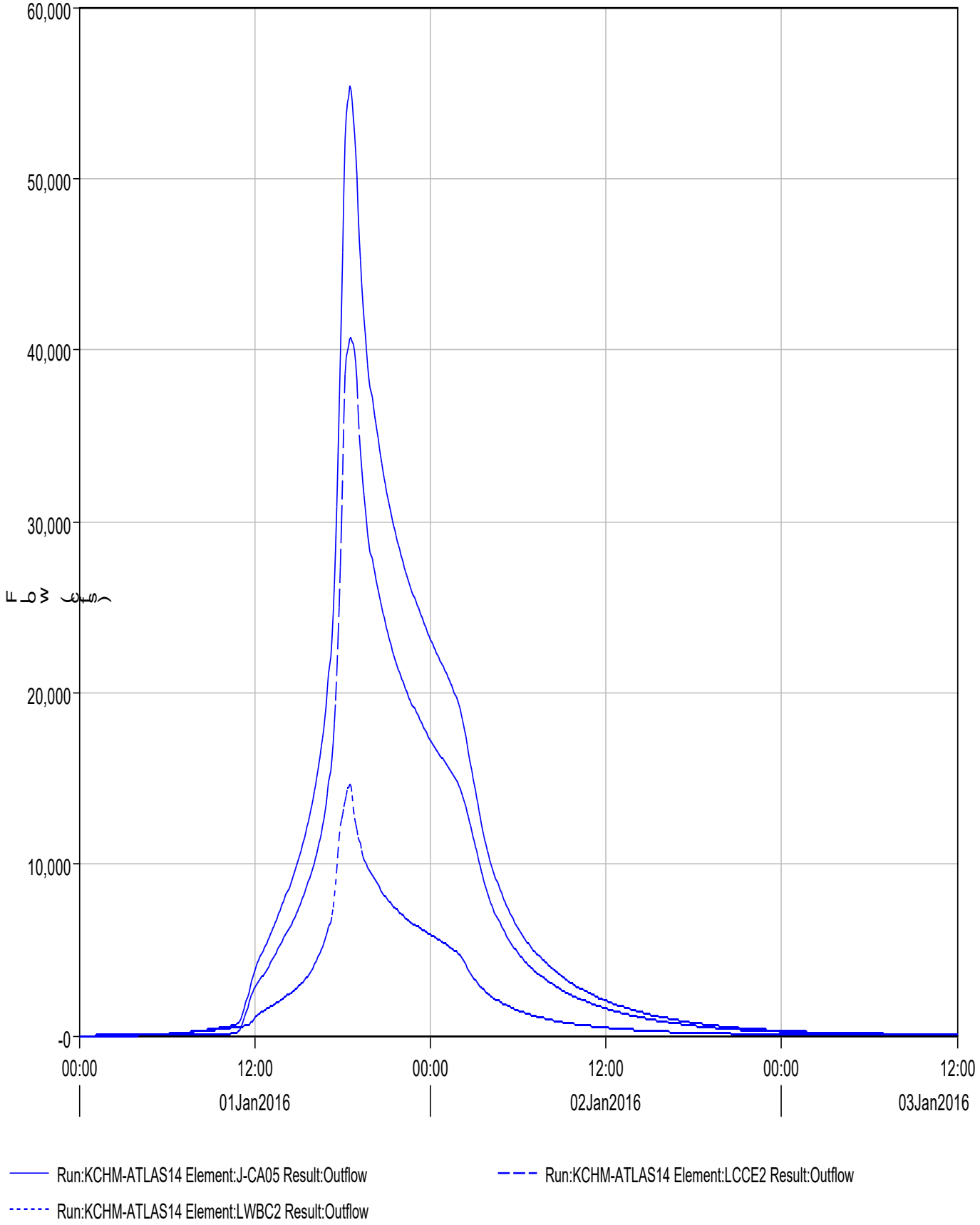
Start of Run: 01Jan2016, 00:00 Basin Model: Caliente
End of Run: 03Jan2016, 12:00 Meteorologic Model: 100yr24hr-ATLAS2
Compute Time: 09Sep2016, 09:54:11 Control Specifications: 100yr

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
CA-03	25.55	3393.47	01Jan2016, 16:55	2775.02
CA-02	20.48	2671.57	01Jan2016, 16:50	2181.60
J-CA02	46.03	6063.65	01Jan2016, 16:55	4956.62
UCC	46.03	6047.85	01Jan2016, 17:15	4949.96
CA-01	20.76	3196.96	01Jan2016, 16:45	2432.18
J-CA01	20.76	3196.96	01Jan2016, 16:45	2432.18
LIC	20.76	3178.53	01Jan2016, 17:35	2425.22
CA-04	37.35	4553.40	01Jan2016, 16:55	3777.54
CA-05	20.87	2630.07	01Jan2016, 16:55	2177.22
J-CA03	125.01	15599.79	01Jan2016, 17:20	13329.93
MCC	125.01	15590.67	01Jan2016, 17:50	13304.37
TH-01	27.70	2332.06	01Jan2016, 16:55	1714.73
J-TH01	27.70	2332.06	01Jan2016, 16:55	1714.73
UTCW	27.70	2328.31	01Jan2016, 17:00	1714.36
TH-03	16.49	1837.34	01Jan2016, 16:50	1496.92
TH-02	7.61	728.80	01Jan2016, 16:50	520.87
J-TH02	51.80	4842.99	01Jan2016, 16:55	3732.14
MTC	51.80	4840.27	01Jan2016, 17:40	3722.50
TH-05	34.01	2824.96	01Jan2016, 17:00	2137.23
TH-04	18.06	1480.12	01Jan2016, 16:55	1084.01
J-TH03	103.87	8604.76	01Jan2016, 17:35	6943.74
LTC	103.87	8583.12	01Jan2016, 18:00	6931.97
CA-06	62.50	6372.23	01Jan2016, 18:15	4065.71
TH-06	24.68	2312.01	01Jan2016, 17:30	1286.93
J-CA04	316.06	32089.76	01Jan2016, 18:00	25588.99
LCCE1	316.06	32074.80	01Jan2016, 18:35	25510.60
CA-07	34.205	2016.98	01Jan2016, 18:00	1197.96
J-CA04A	350.265	33738.43	01Jan2016, 18:35	26708.56
LCCE2	350.265	33716.06	01Jan2016, 18:45	26687.23

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
WB-01	26.67	4193.25	01Jan2016, 17:05	4040.97
WB-02	22.43	3879.69	01Jan2016, 16:55	3512.81
J-WB-01	49.10	8022.95	01Jan2016, 17:00	7553.79
MWBC	49.10	8009.90	01Jan2016, 17:25	7545.80
WB-03	29.06	3449.73	01Jan2016, 16:45	2694.31
J-WB02	78.16	11055.28	01Jan2016, 17:20	10240.11
LWBC1	78.16	11035.51	01Jan2016, 18:10	10206.10
WB-04	42.31	3736.68	01Jan2016, 18:30	2498.68
J-WB02A	120.47	14611.18	01Jan2016, 18:20	12704.78
LWBC2	120.47	14599.34	01Jan2016, 18:20	12703.81
J-CA05	470.735	47933.56	01Jan2016, 18:35	39391.04
LCCW	470.735	47883.45	01Jan2016, 18:50	39313.02
CA-08	4.918	389.00	01Jan2016, 16:50	168.19
J-CA06	475.653	48079.39	01Jan2016, 18:50	39481.21

100 YEAR KCHM CURVE WITH ATLAS 14

Junction "J-CA05" Results for Run "KCHM-ATLAS14"



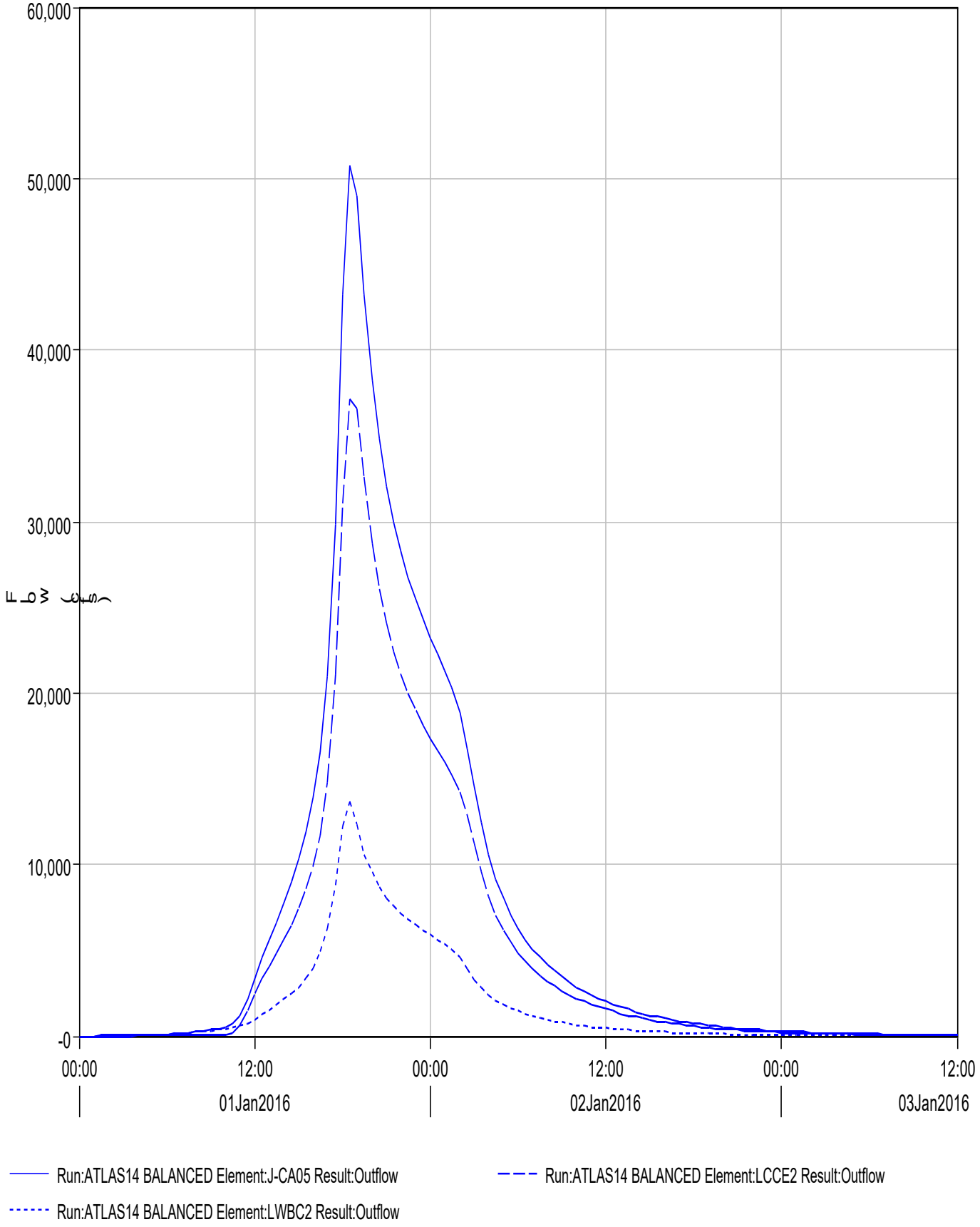
Project: Caliente Simulation Run: KCHM-ATLAS14

Start of Run: 01Jan2016, 00:00 Basin Model: Caliente
End of Run: 03Jan2016, 12:00 Meteorologic Model: 100yr24hr-ATLAS14
Compute Time: 09Sep2016, 09:53:59 Control Specifications: 100yr

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
CA-03	25.55	3641.55	01Jan2016, 16:55	1954.32
CA-02	20.48	2841.00	01Jan2016, 16:55	1534.15
J-CA02	46.03	6482.55	01Jan2016, 16:55	3488.47
UCC	46.03	6372.42	01Jan2016, 17:15	3480.64
CA-01	20.76	3581.13	01Jan2016, 16:45	1723.31
J-CA01	20.76	3581.13	01Jan2016, 16:45	1723.31
LIC	20.76	3533.69	01Jan2016, 17:35	1714.72
CA-04	37.35	5454.28	01Jan2016, 16:55	3045.33
CA-05	20.87	3197.45	01Jan2016, 16:55	1760.70
J-CA03	125.01	16006.94	01Jan2016, 17:10	10001.38
MCC	125.01	15986.22	01Jan2016, 17:50	9973.90
TH-01	27.70	4401.12	01Jan2016, 16:55	2353.80
J-TH01	27.70	4401.12	01Jan2016, 16:55	2353.80
UTCW	27.70	4376.02	01Jan2016, 17:00	2353.29
TH-03	16.49	2238.50	01Jan2016, 16:50	1208.40
TH-02	7.61	1398.50	01Jan2016, 16:50	710.09
J-TH02	51.80	7741.14	01Jan2016, 16:50	4271.78
MTC	51.80	7697.39	01Jan2016, 17:30	4257.69
TH-05	34.01	3879.59	01Jan2016, 17:00	2127.74
TH-04	18.06	2079.72	01Jan2016, 16:55	1079.17
J-TH03	103.87	11949.16	01Jan2016, 17:30	7464.61
LTC	103.87	11940.03	01Jan2016, 17:50	7449.10
CA-06	62.50	10528.64	01Jan2016, 18:15	5251.48
TH-06	24.68	3983.84	01Jan2016, 17:30	1676.93
J-CA04	316.06	39017.08	01Jan2016, 17:50	24351.40
LCCE1	316.06	38905.97	01Jan2016, 18:25	24268.20
CA-07	34.205	2709.85	01Jan2016, 18:00	1222.76
J-CA04A	350.265	40824.75	01Jan2016, 18:25	25490.97
LCCE2	350.265	40712.82	01Jan2016, 18:35	25469.16

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
WB-01	26.67	3206.06	01Jan2016, 17:10	1880.33
WB-02	22.43	3115.26	01Jan2016, 16:55	1654.44
J-WB-01	49.10	6163.10	01Jan2016, 17:00	3534.77
MWBC	49.10	6119.01	01Jan2016, 17:25	3525.64
WB-03	29.06	4244.15	01Jan2016, 16:45	2167.48
J-WB02	78.16	9180.29	01Jan2016, 17:20	5693.12
LWBC1	78.16	9124.68	01Jan2016, 18:20	5661.13
WB-04	42.31	6036.86	01Jan2016, 18:30	3240.79
J-WB02A	120.47	14856.24	01Jan2016, 18:30	8901.92
LWBC2	120.47	14713.81	01Jan2016, 18:30	8901.16
J-CA05	470.735	55366.37	01Jan2016, 18:30	34370.33
LCCW	470.735	55251.70	01Jan2016, 18:50	34285.03
CA-08	4.918	497.46	01Jan2016, 16:50	193.61
J-CA06	475.653	55460.65	01Jan2016, 18:50	34478.64

100 YEAR BALANCED CURVE WITH ATLAS 14
Junction "J-CA05" Results for Run "ATLAS14 BALANCED"

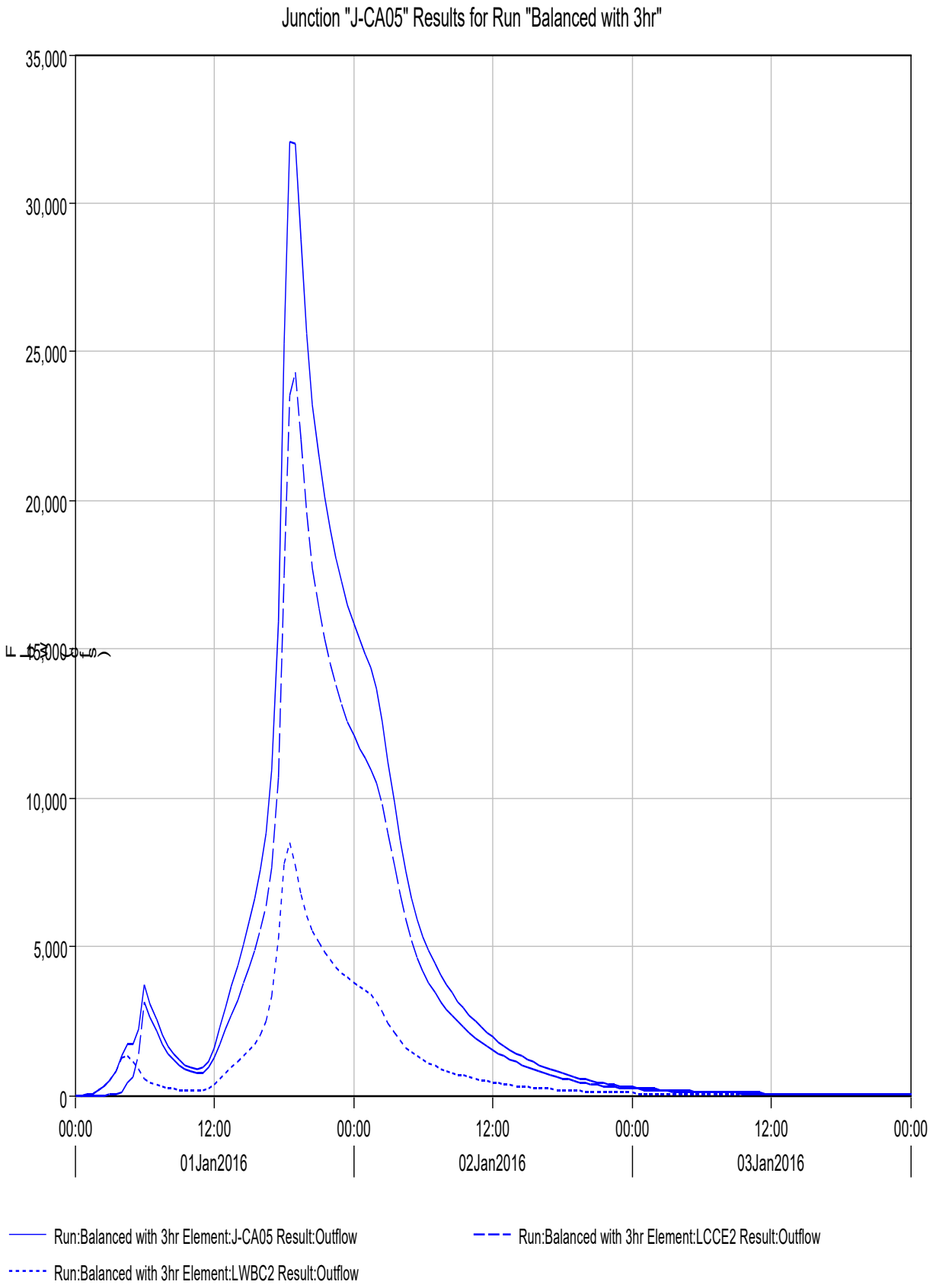


Project: Caliente Simulation Run: ATLAS14 BALANCED

Start of Run: 01Jan2016, 00:00 Basin Model: Caliente
End of Run: 03Jan2016, 12:00 Meteorologic Model: 100yr24hr-14-Bal
Compute Time: 09Sep2016, 09:53:48 Control Specifications: Balanced Storm

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
CA-03	25.55	3296.34	01Jan2016, 17:00	1954.32
CA-02	20.48	2599.90	01Jan2016, 17:00	1534.15
J-CA02	46.03	5896.23	01Jan2016, 17:00	3488.47
UCC	46.03	5655.84	01Jan2016, 17:30	3476.41
CA-01	20.76	3129.61	01Jan2016, 17:00	1723.31
J-CA01	20.76	3129.61	01Jan2016, 17:00	1723.31
LIC	20.76	2985.59	01Jan2016, 18:00	1701.54
CA-04	37.35	5001.78	01Jan2016, 17:00	3045.33
CA-05	20.87	2894.89	01Jan2016, 17:00	1760.70
J-CA03	125.01	15113.90	01Jan2016, 17:30	9983.98
MCC	125.01	15036.37	01Jan2016, 18:00	9942.87
TH-01	27.70	3853.88	01Jan2016, 17:00	2353.80
J-TH01	27.70	3853.88	01Jan2016, 17:00	2353.80
UTCW	27.70	3734.32	01Jan2016, 17:00	2355.25
TH-03	16.49	2038.47	01Jan2016, 17:00	1208.40
TH-02	7.61	1193.51	01Jan2016, 17:00	710.09
J-TH02	51.80	6966.30	01Jan2016, 17:00	4273.74
MTC	51.80	6524.95	01Jan2016, 17:30	4246.50
TH-05	34.01	3466.00	01Jan2016, 17:00	2127.74
TH-04	18.06	1826.83	01Jan2016, 17:00	1079.17
J-TH03	103.87	10945.04	01Jan2016, 17:30	7453.42
LTC	103.87	10613.09	01Jan2016, 18:00	7431.38
CA-06	62.50	8798.58	01Jan2016, 18:30	5251.45
TH-06	24.68	3312.61	01Jan2016, 17:30	1676.86
J-CA04	316.06	36701.55	01Jan2016, 18:00	24302.55
LCCE1	316.06	36295.41	01Jan2016, 18:30	24183.91
CA-07	34.205	2258.42	01Jan2016, 18:00	1222.76
J-CA04A	350.265	38291.33	01Jan2016, 18:30	25406.67
LCCE2	350.265	37137.01	01Jan2016, 18:30	25390.69

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
WB-01	26.67	2872.67	01Jan2016, 17:00	1880.33
WB-02	22.43	2840.29	01Jan2016, 17:00	1654.44
J-WB-01	49.10	5712.96	01Jan2016, 17:00	3534.77
MWBC	49.10	5666.97	01Jan2016, 17:30	3525.10
WB-03	29.06	3837.77	01Jan2016, 17:00	2167.48
J-WB02	78.16	8679.39	01Jan2016, 17:30	5692.58
LWBC1	78.16	8538.34	01Jan2016, 18:30	5625.09
WB-04	42.31	5191.41	01Jan2016, 18:30	3240.78
J-WB02A	120.47	13729.75	01Jan2016, 18:30	8865.87
LWBC2	120.47	13655.43	01Jan2016, 18:30	8867.74
J-CA05	470.735	50792.44	01Jan2016, 18:30	34258.43
LCCW	470.735	49978.10	01Jan2016, 19:00	34147.21
CA-08	4.918	463.32	01Jan2016, 17:00	193.61
J-CA06	475.653	50180.37	01Jan2016, 19:00	34340.82


Junction "J-CA05" Results for Run "Balanced with 3hr"
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
00:00
12:00
00:00
12:00
00:00
12:00
00:00
01Jan2016
02Jan2016
03Jan2016
Run:Balanced with 3hr Element:J-CA05 Result:Outflow
Run:Balanced with 3hr Element:LCCE2 Result:Outflow
Run:Balanced with 3hr Element:LWBC2 Result:Outflow

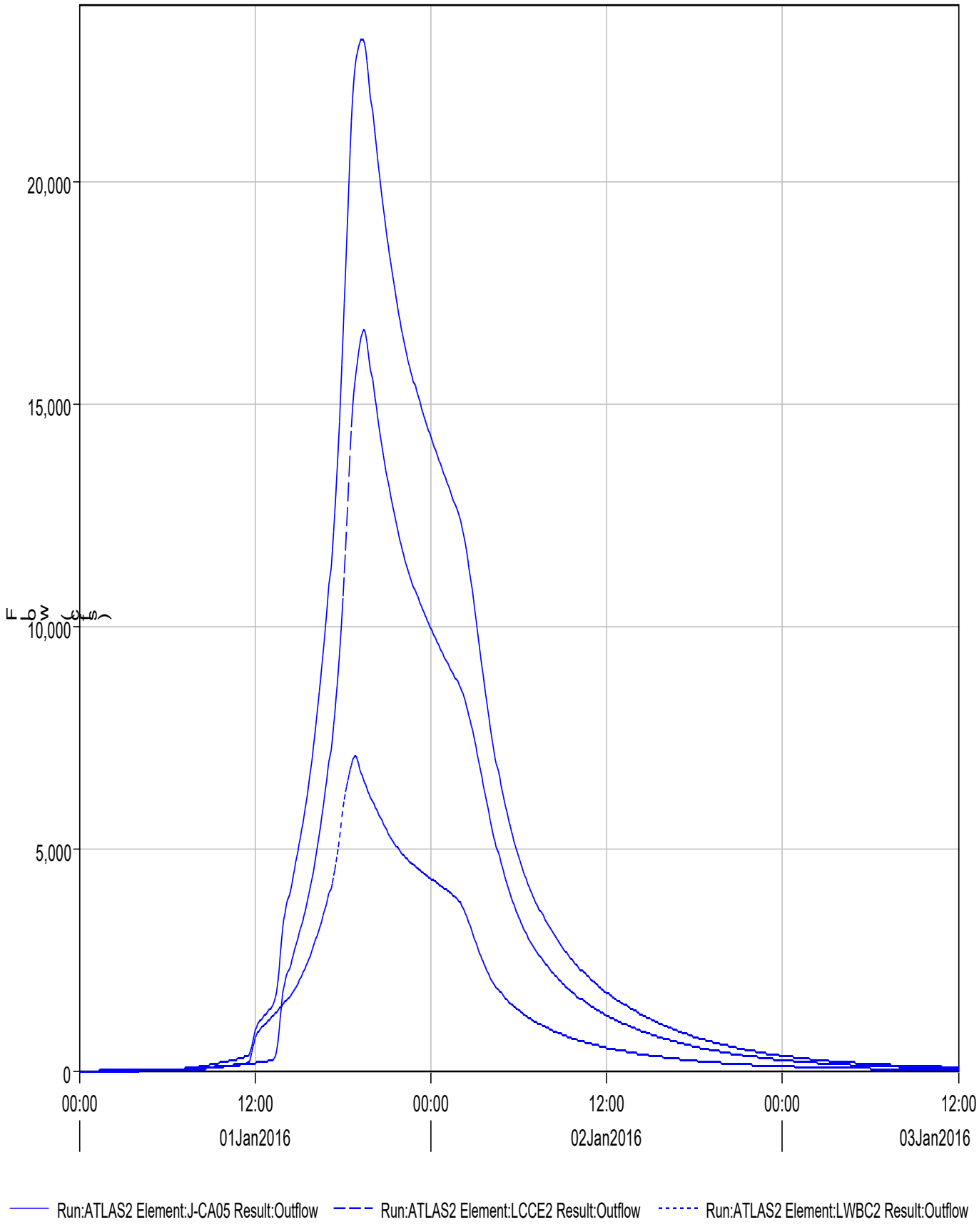
Project: Caliente Simulation Run: Balanced with 3hr

Start of Run: 01Jan2016, 00:00 Basin Model: Caliente
End of Run: 04Jan2016, 00:00 Meteorologic Model: 100yr3&24hr-14
Compute Time: 16Sep2016, 09:36:53 Control Specifications: Balanced with 3hr

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
CA-03	25.55	3296.34	01Jan2016, 17:00	1954.32
CA-02	20.48	2599.90	01Jan2016, 17:00	1534.15
J-CA02	46.03	5896.23	01Jan2016, 17:00	3488.47
UCC	46.03	5655.84	01Jan2016, 17:30	3476.67
CA-01	20.76	3129.61	01Jan2016, 17:00	1723.31
J-CA01	20.76	3129.61	01Jan2016, 17:00	1723.31
LIC	20.76	2985.59	01Jan2016, 18:00	1702.23
CA-04	37.35	5001.78	01Jan2016, 17:00	3045.33
CA-05	20.87	2894.89	01Jan2016, 17:00	1760.70
J-CA03	125.01	15113.90	01Jan2016, 17:30	9984.93
MCC	125.01	15036.37	01Jan2016, 18:00	9947.20
TH-01	27.70	3853.88	01Jan2016, 17:00	2353.80
J-TH01	27.70	3853.88	01Jan2016, 17:00	2353.80
UTCW	27.70	3734.32	01Jan2016, 17:00	2355.26
TH-03	16.49	2038.47	01Jan2016, 17:00	1208.40
TH-02	7.61	1193.51	01Jan2016, 17:00	710.09
J-TH02	51.80	6966.30	01Jan2016, 17:00	4273.75
MTC	51.80	6524.95	01Jan2016, 17:30	4247.69
TH-05	34.01	3466.00	01Jan2016, 17:00	2127.74
TH-04	18.06	1826.83	01Jan2016, 17:00	1079.17
J-TH03	103.87	10945.04	01Jan2016, 17:30	7454.60
LTC	103.87	10613.09	01Jan2016, 18:00	7434.54
CA-06	62.50	2519.41	01Jan2016, 04:00	653.22
TH-06	24.68	904.11	01Jan2016, 03:00	200.07
J-CA04	316.06	25649.45	01Jan2016, 18:00	18235.02
LCCE1	316.06	25109.03	01Jan2016, 18:30	18152.72
CA-07	34.205	519.33	01Jan2016, 04:00	126.77

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
J-CA04A	350.265	25109.03	01Jan2016, 18:30	18279.49
LCCE2	350.265	24283.42	01Jan2016, 19:00	18263.31
WB-01	26.67	2872.67	01Jan2016, 17:00	1880.33
WB-02	22.43	2840.29	01Jan2016, 17:00	1654.44
J-WB-01	49.10	5712.96	01Jan2016, 17:00	3534.77
MWBC	49.10	5666.97	01Jan2016, 17:30	3525.70
WB-03	29.06	3837.77	01Jan2016, 17:00	2167.48
J-WB02	78.16	8679.39	01Jan2016, 17:30	5693.19
LWBC1	78.16	8538.34	01Jan2016, 18:30	5632.42
WB-04	42.31	1316.15	01Jan2016, 04:00	394.90
J-WB02A	120.47	8539.76	01Jan2016, 18:30	6027.31
LWBC2	120.47	8501.96	01Jan2016, 18:30	6029.71
J-CA05	470.735	32061.53	01Jan2016, 18:30	24293.02
LCCW	470.735	32034.86	01Jan2016, 19:00	24211.90
CA-08	4.918	133.80	01Jan2016, 03:00	28.66
J-CA06	475.653	32034.86	01Jan2016, 19:00	24240.56

10 YEAR KCHM CURVE WITH ATLAS 2
Junction "J-CA05" Results for Run "ATLAS2"



Project: Caliente Simulation Run: ATLAS2

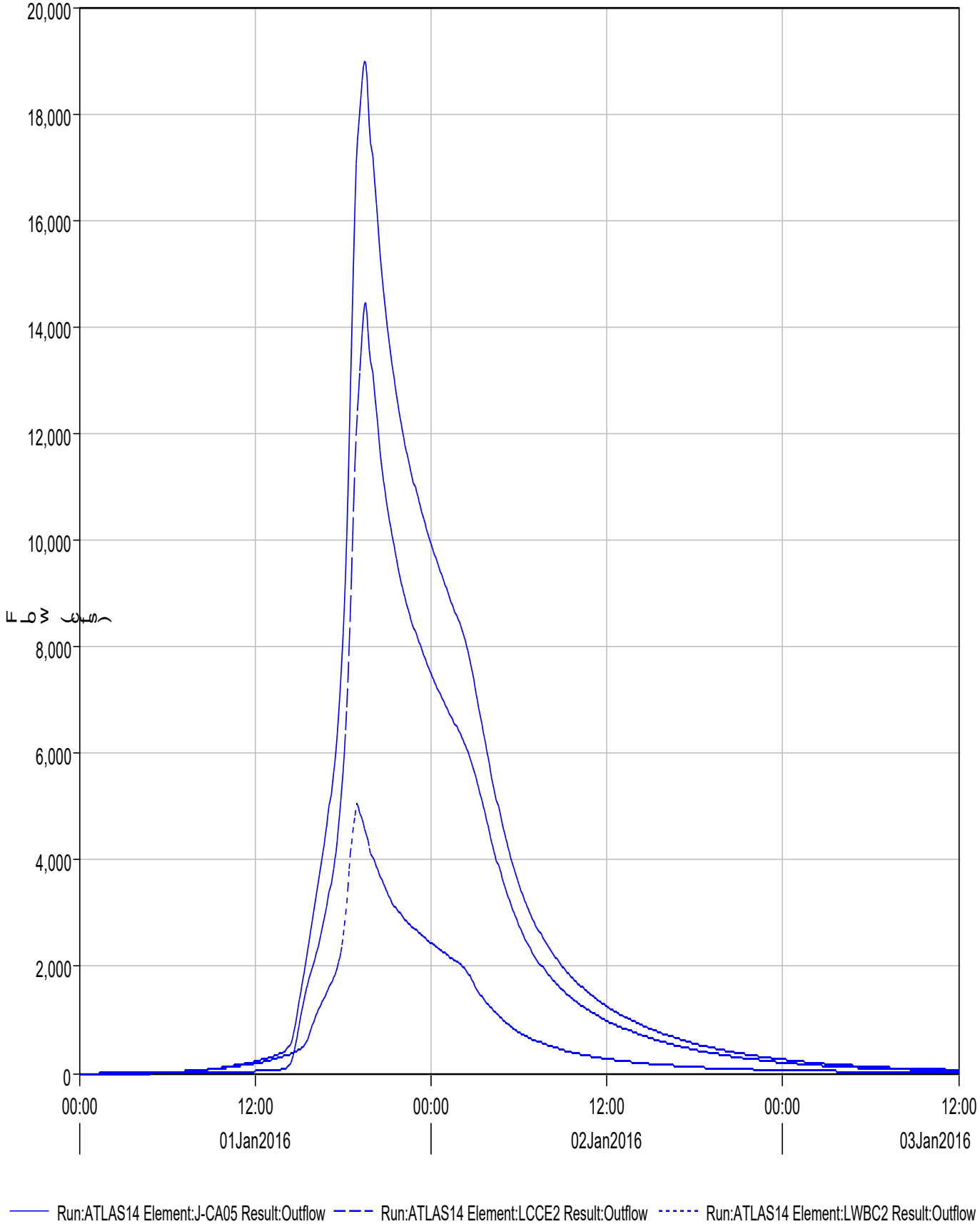
Start of Run: 01Jan2016, 00:00 Basin Model: Caliente
End of Run: 03Jan2016, 12:00 Meteorologic Model: 10yr24hr-ATLAS2
Compute Time: 09Sep2016, 09:48:13 Control Specifications: 10yr-24hr RF

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
CA-03	25.55	1650.68	01Jan2016, 17:00	1340.76
CA-02	20.48	1299.34	01Jan2016, 17:00	1051.05
J-CA02	46.03	2950.02	01Jan2016, 17:00	2391.81
UCC	46.03	2934.00	01Jan2016, 17:30	2387.81
CA-01	20.76	1585.17	01Jan2016, 16:50	1189.12
J-CA01	20.76	1585.17	01Jan2016, 16:50	1189.12
LIC	20.76	1575.93	01Jan2016, 18:00	1184.08
CA-04	37.35	2217.77	01Jan2016, 17:05	1846.11
CA-05	20.87	1288.90	01Jan2016, 17:05	1076.34
J-CA03	125.01	7444.54	01Jan2016, 17:35	6494.34
MCC	125.01	7443.10	01Jan2016, 18:20	6474.60
TH-01	27.70	1046.99	01Jan2016, 17:00	771.43
J-TH01	27.70	1046.99	01Jan2016, 17:00	771.43
UTCW	27.70	1044.69	01Jan2016, 17:10	771.10
TH-03	16.49	897.45	01Jan2016, 17:00	739.54
TH-02	7.61	331.06	01Jan2016, 16:55	238.32
J-TH02	51.80	2240.04	01Jan2016, 17:00	1748.97
MTC	51.80	2236.80	01Jan2016, 18:05	1742.37
TH-05	34.01	1344.49	01Jan2016, 17:05	1039.59
TH-04	18.06	699.53	01Jan2016, 17:00	525.23
J-TH03	103.87	3959.70	01Jan2016, 18:00	3307.20
LTC	103.87	3956.95	01Jan2016, 18:30	3297.87
CA-06	62.50	3006.95	01Jan2016, 18:30	1995.58
TH-06	24.68	1089.95	01Jan2016, 17:40	619.75
J-CA04	316.06	15232.62	01Jan2016, 18:30	12387.80
LCCE1	316.06	15203.80	01Jan2016, 19:15	12325.59
CA-07	34.205	1910.82	01Jan2016, 18:15	1196.70
J-CA04A	350.265	16663.99	01Jan2016, 19:15	13522.29
LCCE2	350.265	16649.96	01Jan2016, 19:25	13501.67

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
WB-01	26.67	2036.72	01Jan2016, 17:15	1947.84
WB-02	22.43	1906.63	01Jan2016, 17:05	1712.78
J-WB-01	49.10	3899.73	01Jan2016, 17:05	3660.62
MWBC	49.10	3897.49	01Jan2016, 17:40	3654.52
WB-03	29.06	1673.32	01Jan2016, 16:55	1311.02
J-WB02	78.16	5350.80	01Jan2016, 17:35	4965.55
LWBC1	78.16	5344.77	01Jan2016, 18:45	4937.39
WB-04	42.31	1738.92	01Jan2016, 18:50	1215.25
J-WB02A	120.47	7074.49	01Jan2016, 18:50	6152.63
LWBC2	120.47	7066.12	01Jan2016, 18:50	6151.55
J-CA05	470.735	23229.44	01Jan2016, 19:20	19653.22
LCCW	470.735	23217.83	01Jan2016, 19:45	19590.12
CA-08	4.918	180.84	01Jan2016, 17:00	82.53
J-CA06	475.653	23296.24	01Jan2016, 19:45	19672.65

10 YEAR KCHM CURVE WITH ATLAS 14

Junction "J-CA05" Results for Run "ATLAS14"



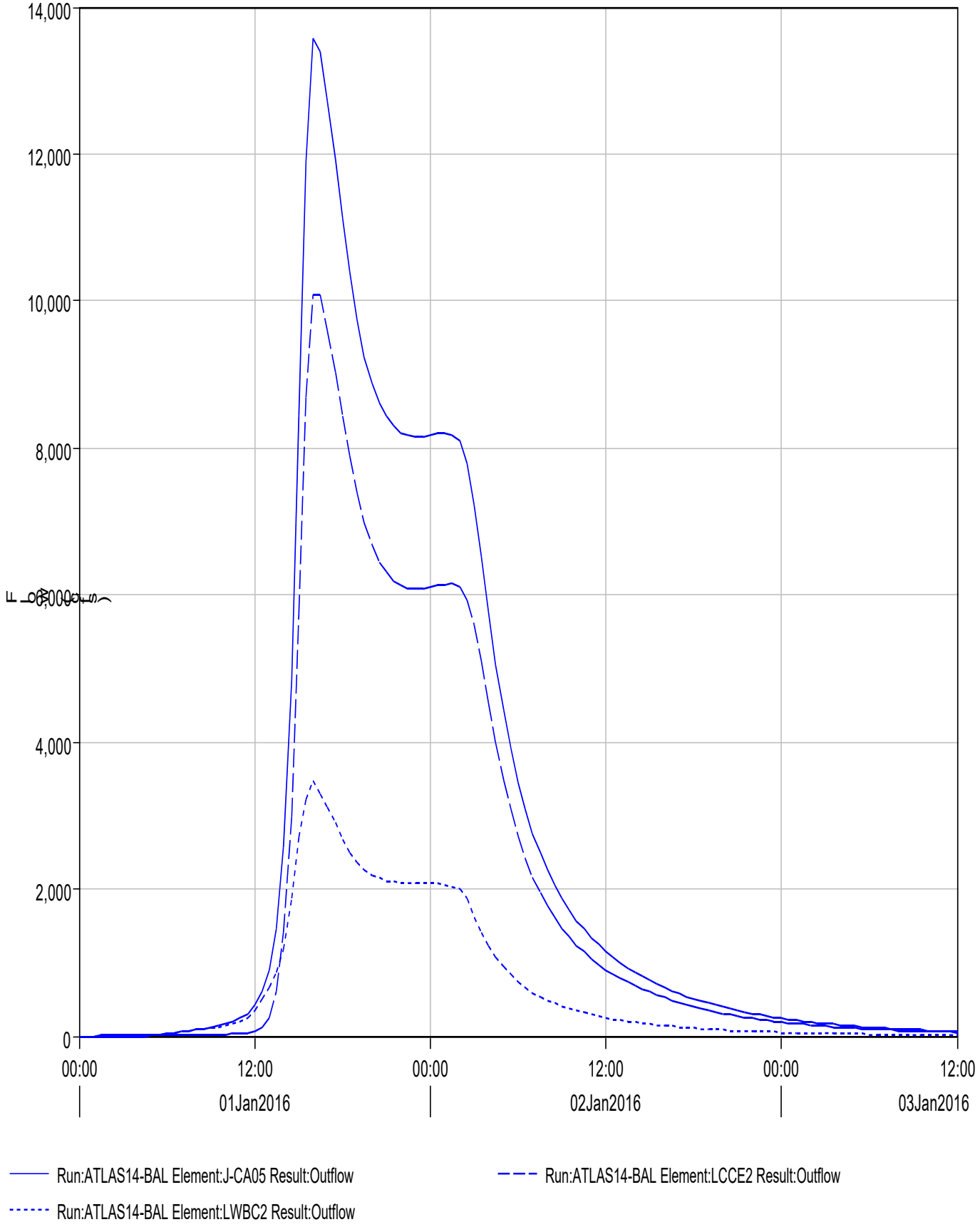
Project: Caliente Simulation Run: ATLAS14

Start of Run: 01Jan2016, 00:00 Basin Model: Caliente
End of Run: 03Jan2016, 12:00 Meteorologic Model: 10yr24hr-ATLAS14
Compute Time: 09Sep2016, 09:47:59 Control Specifications: 10yr-24hr RF

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
CA-03	25.55	1284.22	01Jan2016, 17:00	742.86
CA-02	20.48	1015.50	01Jan2016, 17:00	581.34
J-CA02	46.03	2299.72	01Jan2016, 17:00	1324.20
UCC	46.03	2251.38	01Jan2016, 17:30	1320.18
CA-01	20.76	1290.32	01Jan2016, 16:50	663.71
J-CA01	20.76	1290.32	01Jan2016, 16:50	663.71
LIC	20.76	1253.25	01Jan2016, 18:10	659.18
CA-04	37.35	1957.94	01Jan2016, 17:05	1156.32
CA-05	20.87	1141.60	01Jan2016, 17:05	680.69
J-CA03	125.01	5338.42	01Jan2016, 17:30	3816.38
MCC	125.01	5302.01	01Jan2016, 18:25	3798.33
TH-01	27.70	1547.81	01Jan2016, 17:00	973.95
J-TH01	27.70	1547.81	01Jan2016, 17:00	973.95
UTCW	27.70	1526.10	01Jan2016, 17:10	973.72
TH-03	16.49	805.46	01Jan2016, 17:00	471.69
TH-02	7.61	485.71	01Jan2016, 16:55	299.42
J-TH02	51.80	2710.20	01Jan2016, 17:00	1744.82
MTC	51.80	2699.48	01Jan2016, 18:00	1737.40
TH-05	34.01	1310.04	01Jan2016, 17:05	819.80
TH-04	18.06	685.55	01Jan2016, 17:00	413.80
J-TH03	103.87	4112.64	01Jan2016, 17:55	2971.00
LTC	103.87	4105.10	01Jan2016, 18:30	2961.41
CA-06	62.50	3763.77	01Jan2016, 18:30	2051.23
TH-06	24.68	1474.46	01Jan2016, 17:40	637.41
J-CA04	316.06	13990.05	01Jan2016, 18:30	9448.38
LCCE1	316.06	13957.42	01Jan2016, 19:20	9386.99
CA-07	34.205	928.72	01Jan2016, 18:20	455.33
J-CA04A	350.265	14525.57	01Jan2016, 19:20	9842.33
LCCE2	350.265	14452.37	01Jan2016, 19:35	9821.09

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
WB-01	26.67	1097.57	01Jan2016, 17:15	688.74
WB-02	22.43	1094.04	01Jan2016, 17:05	619.11
J-WB-01	49.10	2115.68	01Jan2016, 17:05	1307.85
MWBC	49.10	2093.98	01Jan2016, 17:50	1303.13
WB-03	29.06	1503.75	01Jan2016, 16:55	822.62
J-WB02	78.16	3126.61	01Jan2016, 17:45	2125.75
LWBC1	78.16	3121.31	01Jan2016, 19:10	2103.01
WB-04	42.31	2163.50	01Jan2016, 18:55	1249.50
J-WB02A	120.47	5101.98	01Jan2016, 18:55	3352.50
LWBC2	120.47	5060.63	01Jan2016, 19:00	3351.63
J-CA05	470.735	18990.91	01Jan2016, 19:30	13172.72
LCCW	470.735	18965.29	01Jan2016, 19:55	13111.46
CA-08	4.918	176.84	01Jan2016, 17:05	73.95
J-CA06	475.653	19033.29	01Jan2016, 19:55	13185.41

10 YEAR BALANCED CURVE WITH ATLAS 14
Junction "J-CA05" Results for Run "ATLAS14-BAL"

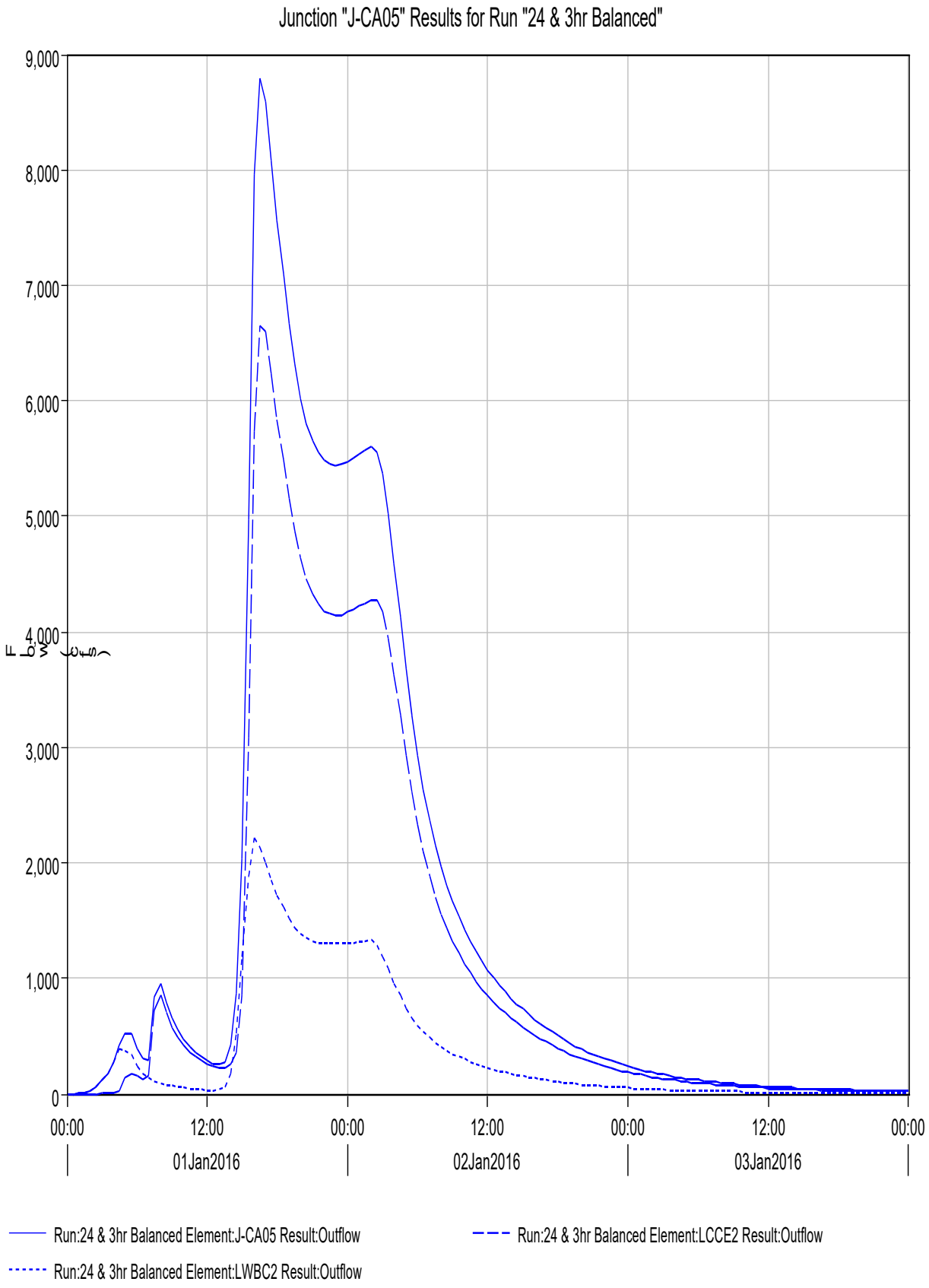


Project: Caliente Simulation Run: ATLAS14-BAL

Start of Run: 01Jan2016, 00:00 Basin Model: Caliente
End of Run: 03Jan2016, 12:00 Meteorologic Model: 10yr24hr-14-Bal
Compute Time: 09Sep2016, 09:47:49 Control Specifications: Balanced Storm

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
CA-03	25.55	875.00	01Jan2016, 13:00	742.88
CA-02	20.48	688.18	01Jan2016, 13:00	581.36
J-CA02	46.03	1563.17	01Jan2016, 13:00	1324.25
UCC	46.03	1527.99	01Jan2016, 14:00	1317.27
CA-01	20.76	878.22	01Jan2016, 13:00	663.74
J-CA01	20.76	878.22	01Jan2016, 13:00	663.74
LIC	20.76	876.08	01Jan2016, 14:30	655.87
CA-04	37.35	1328.35	01Jan2016, 13:30	1156.33
CA-05	20.87	781.42	01Jan2016, 13:30	680.70
J-CA03	125.01	4012.87	01Jan2016, 14:30	3810.16
MCC	125.01	3931.07	01Jan2016, 15:30	3770.85
TH-01	27.70	1090.00	01Jan2016, 13:00	973.86
J-TH01	27.70	1090.00	01Jan2016, 13:00	973.86
UTCW	27.70	1040.04	01Jan2016, 13:30	973.43
TH-03	16.49	565.16	01Jan2016, 13:00	471.69
TH-02	7.61	350.58	01Jan2016, 13:00	299.39
J-TH02	51.80	1925.45	01Jan2016, 13:00	1744.52
MTC	51.80	1889.94	01Jan2016, 14:30	1725.05
TH-05	34.01	897.64	01Jan2016, 13:30	819.86
TH-04	18.06	467.72	01Jan2016, 13:00	413.83
J-TH03	103.87	2973.42	01Jan2016, 14:30	2958.74
LTC	103.87	2944.17	01Jan2016, 15:00	2944.60
CA-06	62.50	2566.02	01Jan2016, 14:30	2051.28
TH-06	24.68	909.98	01Jan2016, 14:00	637.43
J-CA04	316.06	9950.50	01Jan2016, 15:00	9404.15
LCCE1	316.06	9860.10	01Jan2016, 16:00	9297.92
CA-07	34.205	622.59	01Jan2016, 14:30	455.34
J-CA04A	350.265	10304.18	01Jan2016, 16:00	9753.26
LCCE2	350.265	10096.03	01Jan2016, 16:00	9724.12

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
WB-01	26.67	784.72	01Jan2016, 13:30	688.70
WB-02	22.43	745.89	01Jan2016, 13:30	619.08
J-WB-01	49.10	1530.61	01Jan2016, 13:30	1307.78
MWBC	49.10	1477.87	01Jan2016, 14:00	1297.55
WB-03	29.06	1036.20	01Jan2016, 13:00	822.63
J-WB02	78.16	2332.20	01Jan2016, 14:00	2120.18
LWBC1	78.16	2249.17	01Jan2016, 16:00	2075.51
WB-04	42.31	1502.17	01Jan2016, 15:00	1249.51
J-WB02A	120.47	3487.77	01Jan2016, 16:00	3325.02
LWBC2	120.47	3466.56	01Jan2016, 16:00	3325.30
J-CA05	470.735	13562.59	01Jan2016, 16:00	13049.42
LCCW	470.735	13479.86	01Jan2016, 16:30	12979.99
CA-08	4.918	123.34	01Jan2016, 13:00	73.94
J-CA06	475.653	13534.00	01Jan2016, 16:30	13053.93


Junction "J-CA05" Results for Run "24 & 3hr Balanced"
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Flow (cfs)
00:00
12:00
00:00
12:00
00:00
12:00
00:00
01Jan2016
02Jan2016
03Jan2016
Run:24 & 3hr Balanced Element:J-CA05 Result:Outflow
Run:24 & 3hr Balanced Element:LCCE2 Result:Outflow
Run:24 & 3hr Balanced Element:LWBC2 Result:Outflow

Project: Caliente Simulation Run: 24 & 3hr Balanced

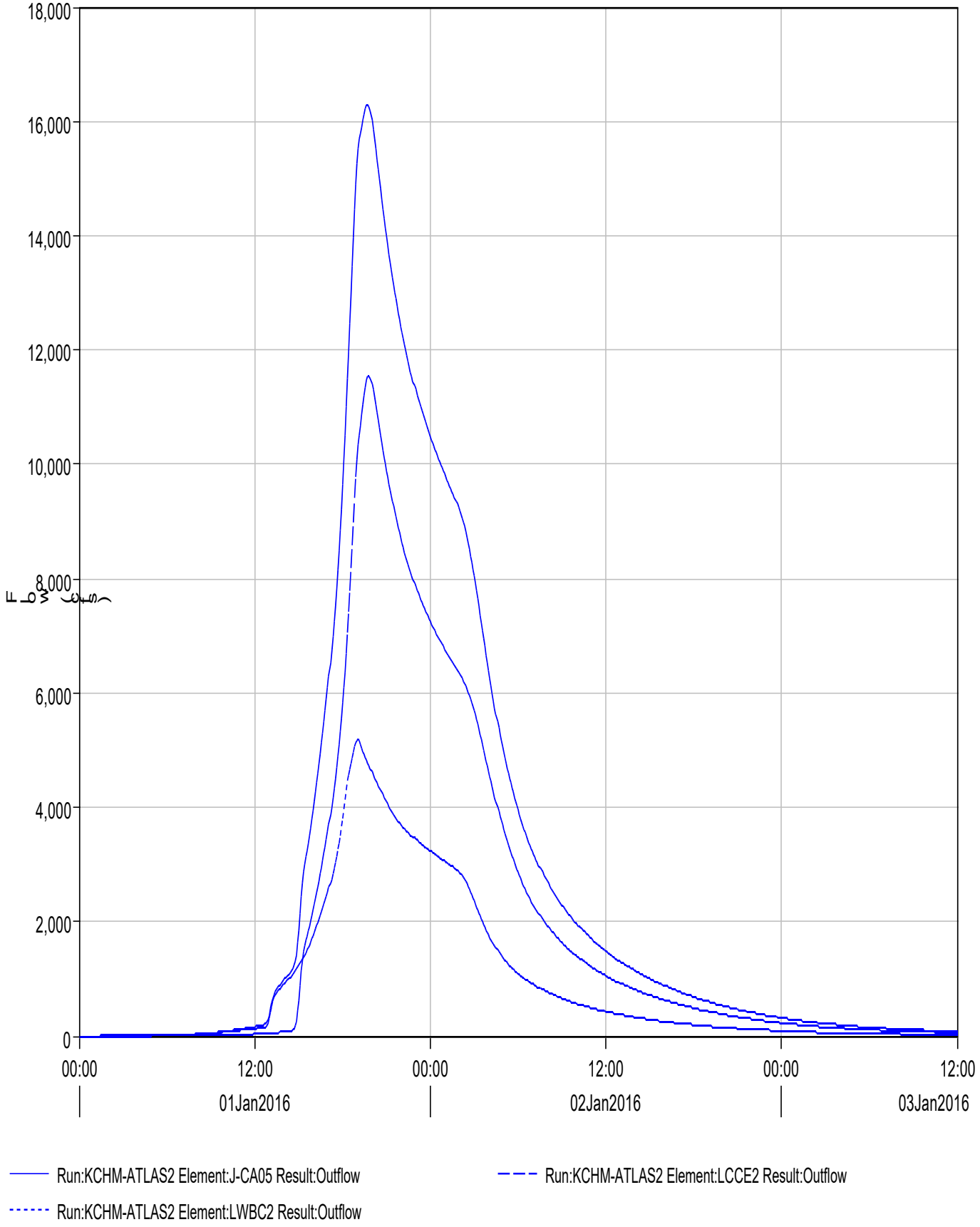
Start of Run: 01Jan2016, 00:00 Basin Model: Caliente
End of Run: 04Jan2016, 00:00 Meteorologic Model: 10yr24&3hr-14-Bal
Compute Time: 16Sep2016, 09:48:30 Control Specifications: 24 & 3hr Balanced

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
CA-03	25.55	875.00	01Jan2016, 13:00	743.43
CA-02	20.48	688.18	01Jan2016, 13:00	581.80
J-CA02	46.03	1563.17	01Jan2016, 13:00	1325.23
UCC	46.03	1527.99	01Jan2016, 14:00	1317.58
CA-01	20.76	878.22	01Jan2016, 13:00	664.26
J-CA01	20.76	878.22	01Jan2016, 13:00	664.26
LIC	20.76	876.08	01Jan2016, 14:30	656.59
CA-04	37.35	1328.35	01Jan2016, 13:30	1157.18
CA-05	20.87	781.42	01Jan2016, 13:30	681.19
J-CA03	125.01	4012.87	01Jan2016, 14:30	3812.55
MCC	125.01	3931.07	01Jan2016, 15:30	3775.60
TH-01	27.70	1090.00	01Jan2016, 13:00	974.40
J-TH01	27.70	1090.00	01Jan2016, 13:00	974.40
UTCW	27.70	1040.04	01Jan2016, 13:30	973.65
TH-03	16.49	565.16	01Jan2016, 13:00	472.03
TH-02	7.61	350.58	01Jan2016, 13:00	299.56
J-TH02	51.80	1925.45	01Jan2016, 13:00	1745.24
MTC	51.80	1889.94	01Jan2016, 14:30	1726.41
TH-05	34.01	897.64	01Jan2016, 13:30	820.43
TH-04	18.06	467.72	01Jan2016, 13:00	414.13
J-TH03	103.87	2973.42	01Jan2016, 14:30	2960.96
LTC	103.87	2944.17	01Jan2016, 15:00	2948.21
CA-06	62.50	711.69	01Jan2016, 04:30	212.97
TH-06	24.68	283.88	01Jan2016, 03:30	65.70
J-CA04	316.06	6811.10	01Jan2016, 15:00	7002.47
LCCE1	316.06	6754.28	01Jan2016, 16:30	6970.12
CA-07	34.205	192.09	01Jan2016, 04:00	53.40

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
J-CA04A	350.265	6754.80	01Jan2016, 16:30	7023.52
LCCE2	350.265	6652.03	01Jan2016, 16:30	7003.49
WB-01	26.67	784.72	01Jan2016, 13:30	689.19
WB-02	22.43	745.89	01Jan2016, 13:30	619.53
J-WB-01	49.10	1530.61	01Jan2016, 13:30	1308.72
MWBC	49.10	1477.87	01Jan2016, 14:00	1298.31
WB-03	29.06	1036.20	01Jan2016, 13:00	823.27
J-WB02	78.16	2332.20	01Jan2016, 14:00	2121.58
LWBC1	78.16	2249.17	01Jan2016, 16:00	2083.13
WB-04	42.31	416.58	01Jan2016, 04:30	129.00
J-WB02A	120.47	2257.30	01Jan2016, 16:00	2212.14
LWBC2	120.47	2224.21	01Jan2016, 16:00	2213.12
J-CA05	470.735	8790.91	01Jan2016, 16:30	9216.62
LCCW	470.735	8675.75	01Jan2016, 17:00	9181.31
CA-08	4.918	41.62	01Jan2016, 03:00	9.17
J-CA06	475.653	8675.75	01Jan2016, 17:00	9190.48

5 YEAR KCHM CURVE WITH ATLAS 2

Junction "J-CA05" Results for Run "KCHM-ATLAS2"



Project: Caliente Simulation Run: KCHM-ATLAS2

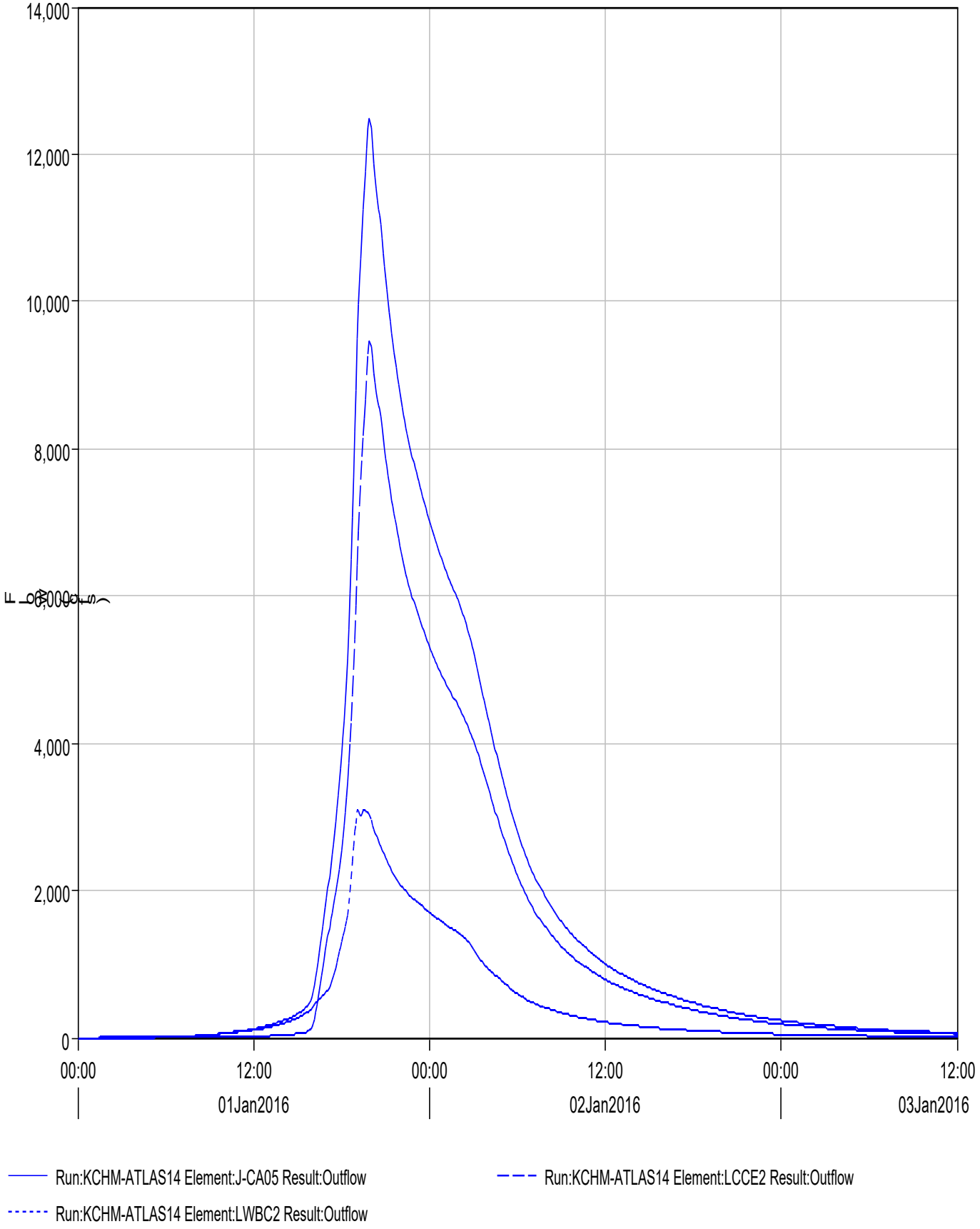
Start of Run: 01Jan2016, 00:00 Basin Model: Caliente
End of Run: 03Jan2016, 12:00 Meteorologic Model: 5yr24hr-ATLAS2
Compute Time: 09Sep2016, 09:36:31 Control Specifications: 5yr-24hr Storm

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
CA-03	25.55	1211.97	01Jan2016, 17:05	980.93
CA-02	20.48	951.02	01Jan2016, 17:05	768.22
J-CA02	46.03	2162.99	01Jan2016, 17:05	1749.15
UCC	46.03	2157.83	01Jan2016, 17:35	1745.98
CA-01	20.76	1167.76	01Jan2016, 16:50	873.62
J-CA01	20.76	1167.76	01Jan2016, 16:50	873.62
LIC	20.76	1160.52	01Jan2016, 18:10	869.36
CA-04	37.35	1633.70	01Jan2016, 17:05	1360.09
CA-05	20.87	958.59	01Jan2016, 17:05	797.79
J-CA03	125.01	5442.17	01Jan2016, 17:55	4773.22
MCC	125.01	5436.81	01Jan2016, 18:45	4755.06
TH-01	27.70	744.34	01Jan2016, 17:05	547.70
J-TH01	27.70	744.34	01Jan2016, 17:05	547.70
UTCW	27.70	742.23	01Jan2016, 17:15	547.39
TH-03	16.49	669.33	01Jan2016, 17:00	550.73
TH-02	7.61	238.55	01Jan2016, 17:00	170.44
J-TH02	51.80	1623.58	01Jan2016, 17:05	1268.56
MTC	51.80	1619.44	01Jan2016, 18:15	1262.85
TH-05	34.01	989.59	01Jan2016, 17:10	771.05
TH-04	18.06	515.30	01Jan2016, 17:05	389.11
J-TH03	103.87	2865.64	01Jan2016, 18:10	2423.02
LTC	103.87	2860.70	01Jan2016, 18:50	2414.73
CA-06	62.5	2202.65	01Jan2016, 18:40	1483.72
TH-06	24.68	794.65	01Jan2016, 17:45	458.22
J-CA04	316.06	11084.40	01Jan2016, 18:40	9111.73
LCCE1	316.06	11074.35	01Jan2016, 19:35	9053.13
CA-07	34.205	655.46	01Jan2016, 18:25	416.75
J-CA04A	350.265	11561.54	01Jan2016, 19:35	9469.88
LCCE2	350.265	11545.40	01Jan2016, 19:50	9449.22

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
WB-01	26.67	1490.75	01Jan2016, 17:20	1415.78
WB-02	22.43	1405.53	01Jan2016, 17:05	1252.26
J-WB-01	49.10	2865.33	01Jan2016, 17:10	2668.04
MWBC	49.10	2861.33	01Jan2016, 17:45	2662.78
WB-03	29.06	1237.49	01Jan2016, 16:55	966.55
J-WB02	78.16	3927.05	01Jan2016, 17:45	3629.33
LWBC1	78.16	3922.02	01Jan2016, 19:00	3602.81
WB-04	42.31	1269.90	01Jan2016, 19:00	901.03
J-WB02A	120.47	5191.92	01Jan2016, 19:00	4503.83
LWBC2	120.47	5187.25	01Jan2016, 19:05	4502.70
J-CA05	470.735	16300.90	01Jan2016, 19:45	13951.92
LCCW	470.735	16288.18	01Jan2016, 20:10	13889.40
CA-08	4.918	131.73	01Jan2016, 17:05	61.59
J-CA06	475.653	16343.46	01Jan2016, 20:10	13951.00

5 YEAR KCHM CURVE WITH ATLAS 14

Junction "J-CA05" Results for Run "KCHM-ATLAS14"



Project: Caliente Simulation Run: KCHM-ATLAS14

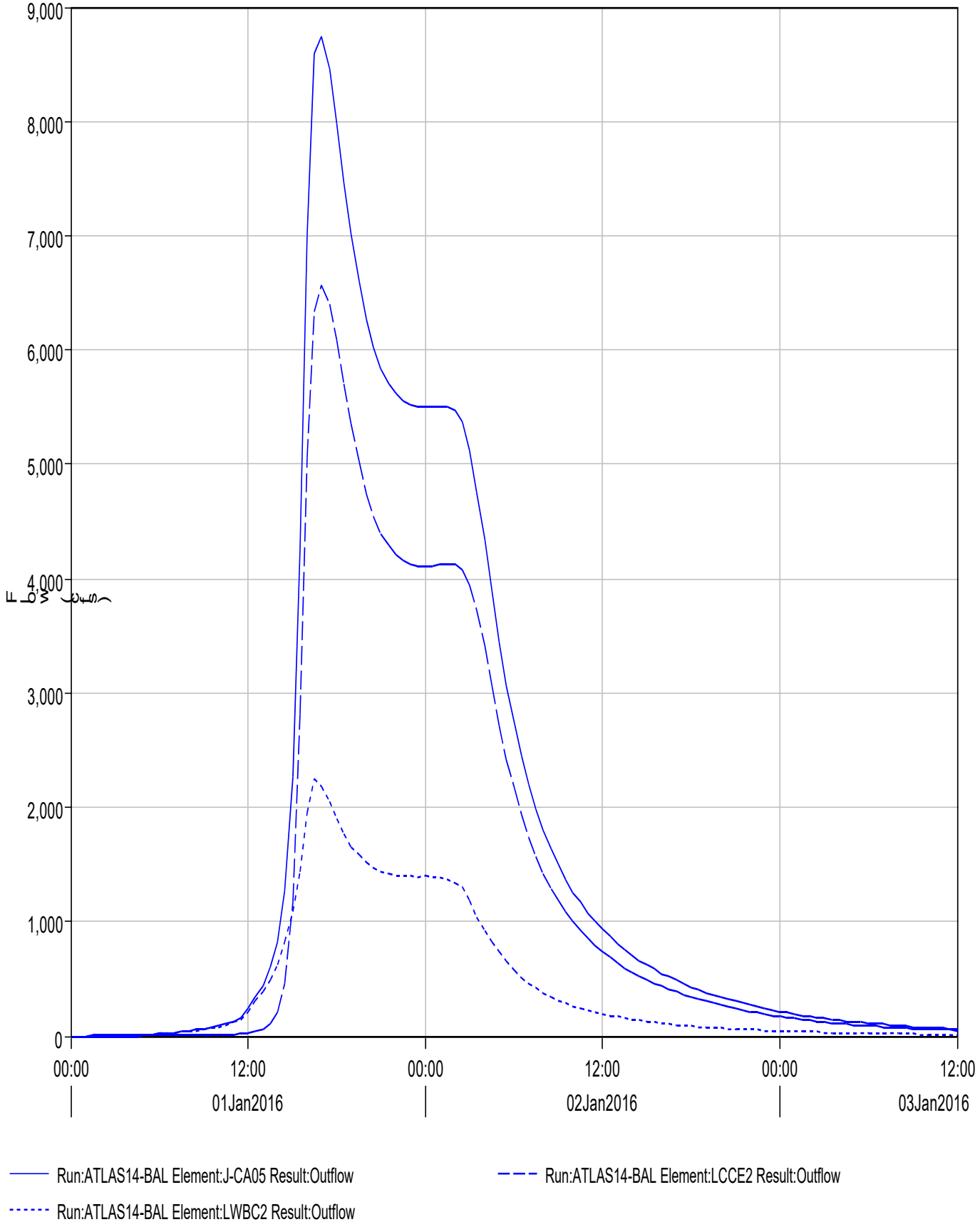
Start of Run: 01Jan2016, 00:00 Basin Model: Caliente
End of Run: 03Jan2016, 12:00 Meteorologic Model: 5yr24hr-ATLAS14
Compute Time: 09Sep2016, 09:36:15 Control Specifications: 5yr-24hr Storm

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
CA-03	25.55	848.64	01Jan2016, 17:05	495.46
CA-02	20.48	661.53	01Jan2016, 17:05	387.40
J-CA02	46.03	1510.17	01Jan2016, 17:05	882.86
UCC	46.03	1473.63	01Jan2016, 17:40	879.99
CA-01	20.76	829.81	01Jan2016, 16:50	444.36
J-CA01	20.76	829.81	01Jan2016, 16:50	444.36
LIC	20.76	821.25	01Jan2016, 18:25	440.85
CA-04	37.35	1261.82	01Jan2016, 17:10	767.12
CA-05	20.87	751.50	01Jan2016, 17:05	456.29
J-CA03	125.01	3406.37	01Jan2016, 17:35	2544.25
MCC	125.01	3399.20	01Jan2016, 18:40	2528.47
TH-01	27.70	1041.62	01Jan2016, 17:05	669.06
J-TH01	27.70	1041.62	01Jan2016, 17:05	669.06
UTCW	27.70	1028.39	01Jan2016, 17:15	668.70
TH-03	16.49	538.08	01Jan2016, 17:00	320.68
TH-02	7.61	336.24	01Jan2016, 17:00	207.32
J-TH02	51.80	1809.17	01Jan2016, 17:05	1196.71
MTC	51.80	1806.10	01Jan2016, 18:10	1190.52
TH-05	34.01	870.77	01Jan2016, 17:10	547.30
TH-04	18.06	457.77	01Jan2016, 17:05	275.93
J-TH03	103.87	2730.70	01Jan2016, 18:10	2013.74
LTC	103.87	2714.56	01Jan2016, 18:50	2005.23
CA-06	62.5	2599.83	01Jan2016, 18:40	1396.51
TH-06	24.68	983.05	01Jan2016, 17:45	430.87
J-CA04	316.06	9236.07	01Jan2016, 18:40	6361.08
LCCE1	316.06	9133.23	01Jan2016, 19:40	6305.70
CA-07	34.205	628.37	01Jan2016, 18:25	306.55
J-CA04A	350.265	9500.61	01Jan2016, 19:40	6612.24
LCCE2	350.265	9456.70	01Jan2016, 19:55	6591.60

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
WB-01	26.67	719.38	01Jan2016, 17:20	453.64
WB-02	22.43	706.55	01Jan2016, 17:05	412.67
J-WB-01	49.10	1384.02	01Jan2016, 17:10	866.31
MWBC	49.10	1365.69	01Jan2016, 17:55	862.18
WB-03	29.06	987.63	01Jan2016, 16:55	548.55
J-WB02	78.16	2039.65	01Jan2016, 17:55	1410.73
LWBC1	78.16	2023.92	01Jan2016, 19:40	1390.16
WB-04	42.31	1469.14	01Jan2016, 19:00	847.65
J-WB02A	120.47	3100.15	01Jan2016, 19:30	2237.81
LWBC2	120.47	3098.73	01Jan2016, 19:35	2236.94
J-CA05	470.735	12491.53	01Jan2016, 19:55	8828.54
LCCW	470.735	12428.52	01Jan2016, 20:25	8771.79
CA-08	4.918	114.39	01Jan2016, 17:00	49.44
J-CA06	475.653	12471.64	01Jan2016, 20:25	8821.23

5 YEAR BALANCED CURVE WITH ATLAS 14

Junction "J-CA05" Results for Run "ATLAS14-BAL"

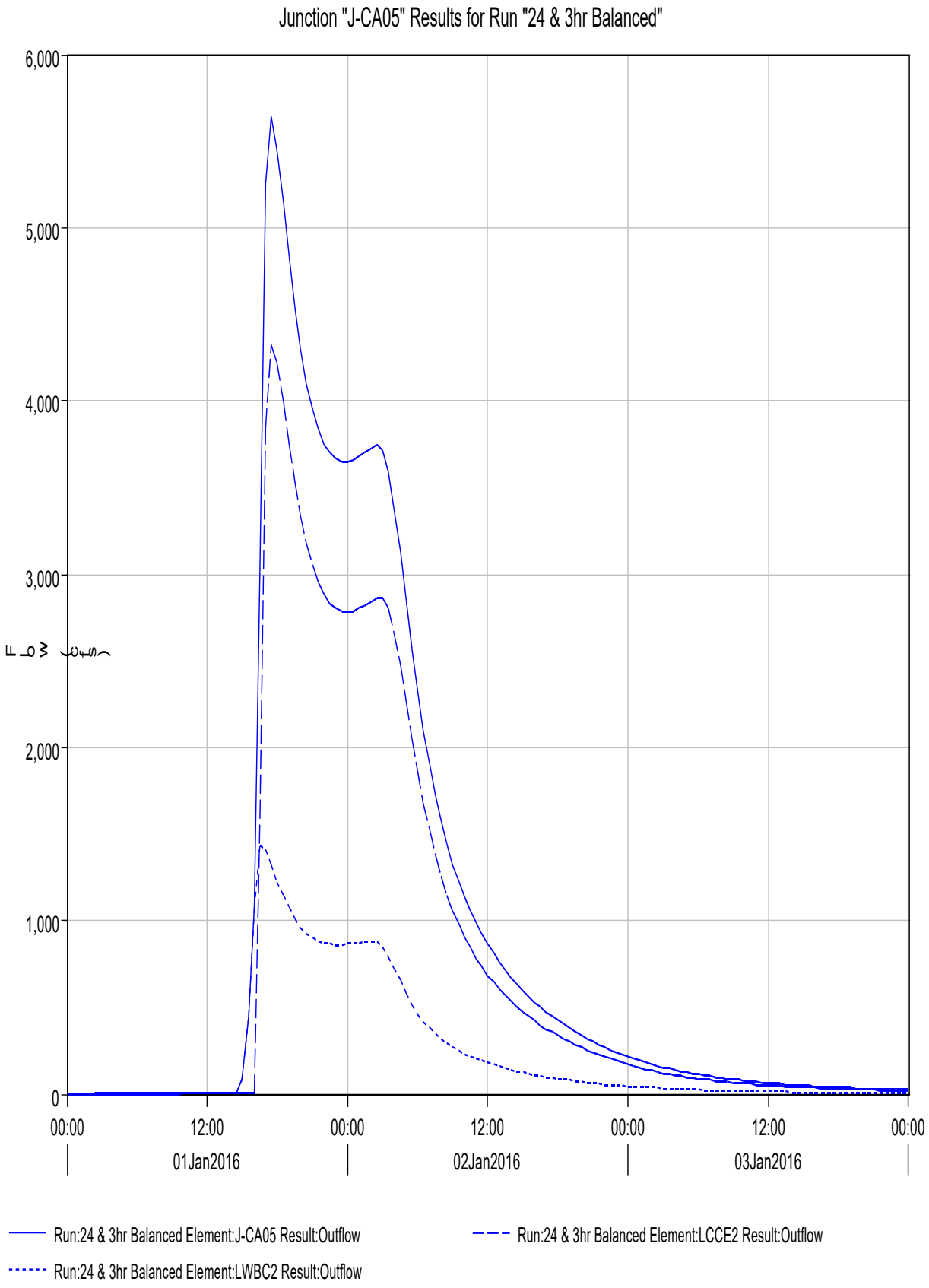


Project: Caliente Simulation Run: ATLAS14-BAL

Start of Run: 01Jan2016, 00:00 Basin Model: Caliente
End of Run: 03Jan2016, 12:00 Meteorologic Model: 5yr-24hr-14-Bal
Compute Time: 09Sep2016, 08:50:07 Control Specifications: Balanced Storm

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
CA-03	25.55	573.15	01Jan2016, 13:30	495.45
CA-02	20.48	447.56	01Jan2016, 13:30	387.39
J-CA02	46.03	1020.72	01Jan2016, 13:30	882.84
UCC	46.03	1012.71	01Jan2016, 14:00	876.43
CA-01	20.76	574.43	01Jan2016, 13:00	444.35
J-CA01	20.76	574.43	01Jan2016, 13:00	444.35
LIC	20.76	556.72	01Jan2016, 15:00	437.75
CA-04	37.35	872.31	01Jan2016, 13:30	767.13
CA-05	20.87	521.67	01Jan2016, 13:30	456.30
J-CA03	125.01	2544.25	01Jan2016, 15:00	2537.61
MCC	125.01	2513.75	01Jan2016, 16:00	2506.11
TH-01	27.70	722.11	01Jan2016, 13:00	669.04
J-TH01	27.70	722.11	01Jan2016, 13:00	669.04
UTCW	27.70	714.79	01Jan2016, 13:30	668.44
TH-03	16.49	371.37	01Jan2016, 13:00	320.69
TH-02	7.61	235.41	01Jan2016, 13:00	207.32
J-TH02	51.80	1297.56	01Jan2016, 13:30	1196.44
MTC	51.80	1248.17	01Jan2016, 15:00	1182.00
TH-05	34.01	594.35	01Jan2016, 13:30	547.27
TH-04	18.06	304.49	01Jan2016, 13:30	275.92
J-TH03	103.87	1978.18	01Jan2016, 14:30	2005.19
LTC	103.87	1960.48	01Jan2016, 15:30	1991.72
CA-06	62.5	1715.83	01Jan2016, 15:00	1396.47
TH-06	24.68	612.37	01Jan2016, 14:00	430.85
J-CA04	316.06	6323.97	01Jan2016, 15:00	6325.15
LCCE1	316.06	6321.34	01Jan2016, 16:30	6228.91
CA-07	34.205	405.87	01Jan2016, 14:30	306.54
J-CA04A	350.265	6611.36	01Jan2016, 16:30	6535.45
LCCE2	350.265	6569.34	01Jan2016, 17:00	6509.79

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
WB-01	26.67	501.65	01Jan2016, 13:30	453.64
WB-02	22.43	492.61	01Jan2016, 13:30	412.66
J-WB-01	49.10	994.26	01Jan2016, 13:30	866.30
MWBC	49.10	967.32	01Jan2016, 14:30	857.98
WB-03	29.06	668.08	01Jan2016, 13:00	548.56
J-WB02	78.16	1494.46	01Jan2016, 14:30	1406.54
LWBC1	78.16	1478.75	01Jan2016, 16:30	1374.38
WB-04	42.31	985.29	01Jan2016, 15:00	847.62
J-WB02A	120.47	2277.01	01Jan2016, 16:30	2221.99
LWBC2	120.47	2246.85	01Jan2016, 16:30	2221.85
J-CA05	470.735	8749.80	01Jan2016, 17:00	8731.65
LCCW	470.735	8721.70	01Jan2016, 17:30	8666.57
CA-08	4.918	79.25	01Jan2016, 13:30	49.44
J-CA06	475.653	8754.42	01Jan2016, 17:30	8716.01

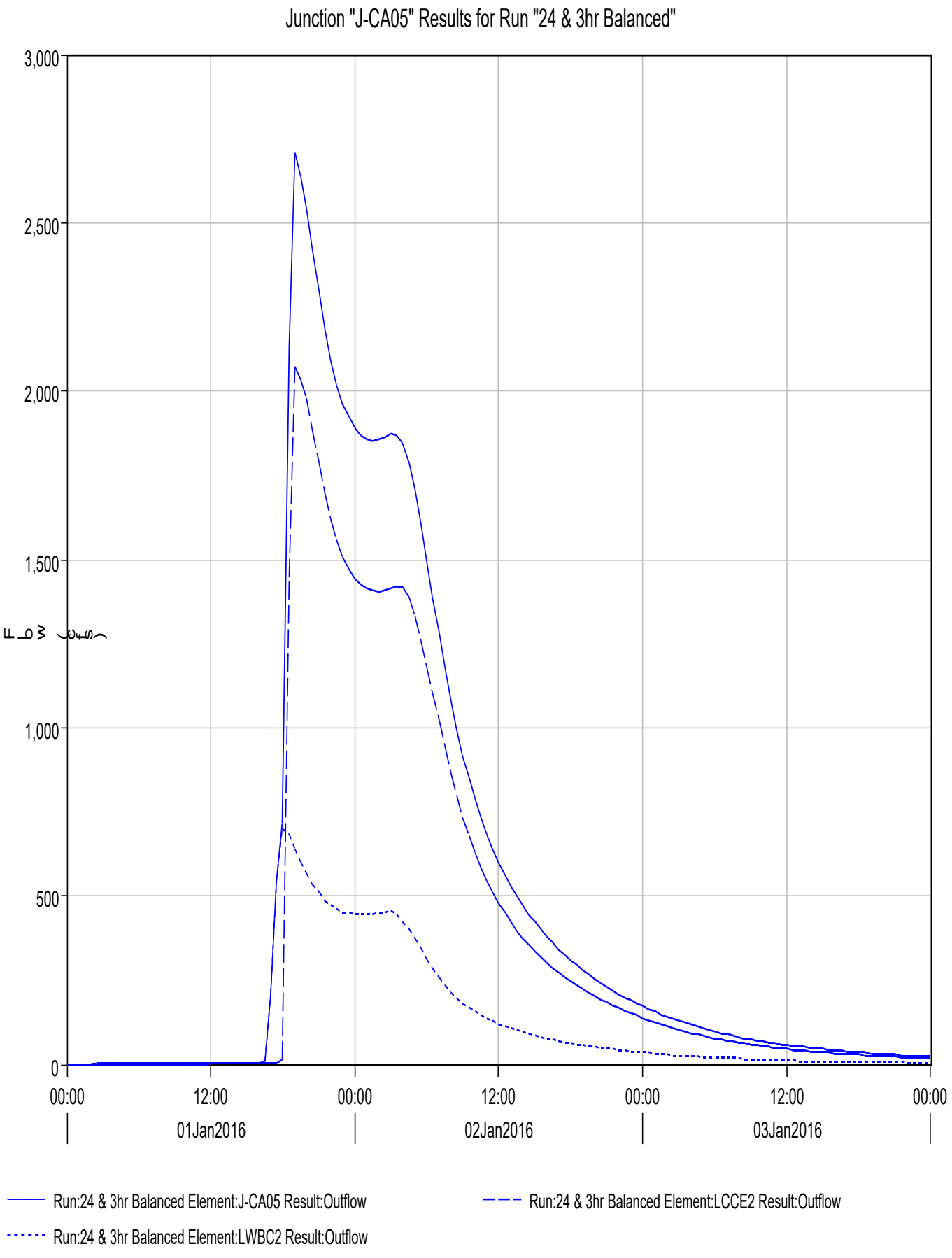

Junction "J-CA05" Results for Run "24 & 3hr Balanced"
6,000
5,000
4,000
3,000
2,000
1,000
0
Flow (cfs)
00:00
12:00
00:00
12:00
00:00
12:00
00:00
01Jan2016
02Jan2016
03Jan2016
Run:24 & 3hr Balanced Element:J-CA05 Result:Outflow
Run:24 & 3hr Balanced Element:LCCE2 Result:Outflow
Run:24 & 3hr Balanced Element:LWBC2 Result:Outflow

Project: Caliente Simulation Run: 24 & 3hr Balanced

Start of Run: 01Jan2016, 00:00 Basin Model: Caliente
End of Run: 04Jan2016, 00:00 Meteorologic Model: 5yr24&3hr-Bal
Compute Time: 16Sep2016, 09:56:31 Control Specifications: 24hr & 3hr Balance

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
CA-03	25.55	573.15	01Jan2016, 13:30	495.45
CA-02	20.48	447.56	01Jan2016, 13:30	387.39
J-CA02	46.03	1020.72	01Jan2016, 13:30	882.84
UCC	46.03	1012.71	01Jan2016, 14:00	876.75
CA-01	20.76	574.43	01Jan2016, 13:00	444.35
J-CA01	20.76	574.43	01Jan2016, 13:00	444.35
LIC	20.76	556.72	01Jan2016, 15:00	438.48
CA-04	37.35	872.31	01Jan2016, 13:30	767.13
CA-05	20.87	521.67	01Jan2016, 13:30	456.30
J-CA03	125.01	2544.25	01Jan2016, 15:00	2538.66
MCC	125.01	2513.75	01Jan2016, 16:00	2510.97
TH-01	27.70	722.11	01Jan2016, 13:00	669.04
J-TH01	27.70	722.11	01Jan2016, 13:00	669.04
UTCW	27.70	714.79	01Jan2016, 13:30	668.45
TH-03	16.49	371.37	01Jan2016, 13:00	320.69
TH-02	7.61	235.41	01Jan2016, 13:00	207.32
J-TH02	51.80	1297.56	01Jan2016, 13:30	1196.46
MTC	51.80	1248.17	01Jan2016, 15:00	1183.40
TH-05	34.01	594.35	01Jan2016, 13:30	547.27
TH-04	18.06	304.49	01Jan2016, 13:30	275.92
J-TH03	103.87	1978.18	01Jan2016, 14:30	2006.60
LTC	103.87	1960.48	01Jan2016, 15:30	1995.32
CA-06	62.5	3.08	01Jan2016, 04:00	1.01
TH-06	24.68	1.49	01Jan2016, 03:00	0.40
J-CA04	316.06	4381.68	01Jan2016, 16:00	4507.69
LCCE1	316.06	4327.84	01Jan2016, 17:00	4448.66
CA-07	34.205	1.47	01Jan2016, 04:00	0.46

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
J-CA04A	350.265	4327.84	01Jan2016, 17:00	4449.13
LCCE2	350.265	4317.39	01Jan2016, 17:30	4435.23
WB-01	26.67	501.65	01Jan2016, 13:30	453.64
WB-02	22.43	492.61	01Jan2016, 13:30	412.66
J-WB-01	49.10	994.26	01Jan2016, 13:30	866.30
MWBC	49.10	967.32	01Jan2016, 14:30	858.79
WB-03	29.06	668.08	01Jan2016, 13:00	548.56
J-WB02	78.16	1494.46	01Jan2016, 14:30	1407.35
LWBC1	78.16	1478.75	01Jan2016, 16:30	1381.91
WB-04	42.31	1.95	01Jan2016, 04:30	0.68
J-WB02A	120.47	1478.79	01Jan2016, 16:30	1382.59
LWBC2	120.47	1435.57	01Jan2016, 16:30	1383.28
J-CA05	470.735	5638.92	01Jan2016, 17:30	5818.51
LCCW	470.735	5515.68	01Jan2016, 18:30	5777.09
CA-08	4.918	0.23	01Jan2016, 02:30	0.06
J-CA06	475.653	5515.68	01Jan2016, 18:30	5777.15


Junction "J-CA05" Results for Run "24 & 3hr Balanced"
3,000
2,500
2,000
1,500
1,000
500
0
Flow (cfs)
00:00
12:00
00:00
12:00
00:00
12:00
00:00
01Jan2016
02Jan2016
03Jan2016
Run:24 & 3hr Balanced Element:J-CA05 Result:Outflow
Run:24 & 3hr Balanced Element:LCCE2 Result:Outflow
Run:24 & 3hr Balanced Element:LWBC2 Result:Outflow

Project: 2Yr-24&3hr-Bal Simulation Run: 24 & 3hr Balanced

Start of Run: 01Jan2016, 00:00
End of Run: 04Jan2016, 00:00
Compute Time: 07Mar2017, 11:35:36

Basin Model: Caliente
Meteorologic Model: 2yr24&3hr-Bal
Control Specifications: 24hr & 3hr Balanced

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
CA-03	25.55	270.36	01Jan2016, 13:30	229.34
CA-02	20.48	211.44	01Jan2016, 13:30	179.16
J-CA02	46.03	481.81	01Jan2016, 13:30	408.50
UCC	46.03	477.89	01Jan2016, 14:30	403.97
CA-01	20.76	259.43	01Jan2016, 13:00	206.59
J-CA01	20.76	259.43	01Jan2016, 13:00	206.59
LIC	20.76	251.21	01Jan2016, 16:00	206.62
CA-04	37.35	448.06	01Jan2016, 13:30	396.25
CA-05	20.87	275.17	01Jan2016, 13:30	240.93
J-CA03	125.01	1164.76	01Jan2016, 16:00	1247.77
MCC	125.01	1118.73	01Jan2016, 17:30	1228.74
TH-01	27.70	396.99	01Jan2016, 13:30	364.94
J-TH01	27.70	396.99	01Jan2016, 13:30	364.94
UTCW	27.70	385.91	01Jan2016, 13:30	364.36
TH-03	16.49	204.52	01Jan2016, 13:30	175.82
TH-02	7.61	127.12	01Jan2016, 13:30	114.58
J-TH02	51.80	717.55	01Jan2016, 13:30	654.76
MTC	51.80	688.79	01Jan2016, 15:30	644.60
TH-05	34.01	306.09	01Jan2016, 13:30	283.84
TH-04	18.06	159.68	01Jan2016, 13:30	142.99
J-TH03	103.87	1050.78	01Jan2016, 15:30	1071.43
LTC	103.87	1032.59	01Jan2016, 16:30	1062.58
CA-06	62.5	2.27	01Jan2016, 04:30	0.80
TH-06	24.68	1.13	01Jan2016, 03:30	0.32
J-CA04	316.06	2114.10	01Jan2016, 16:30	2292.44
LCCE1	316.06	2086.08	01Jan2016, 18:30	2267.01
CA-07	34.205	1.07	01Jan2016, 04:00	0.35
J-CA04A Caliente Flow	350.265	2086.08	01Jan2016, 18:30	2267.37
LCCE2	350.265	2071.80	01Jan2016, 19:00	2260.20

Hydrologic Element	Drainage Area (MI2)	Peak Discharge (CFS)	Time of Peak	Volume (AC-FT)
WB-01	26.67	241.16	01Jan2016, 13:30	230.87
WB-02	22.43	253.48	01Jan2016, 13:30	215.38
J-WB-01	49.10	494.64	01Jan2016, 13:30	446.25
MWBC	49.10	483.01	01Jan2016, 15:00	440.86
WB-03	29.06	340.56	01Jan2016, 13:30	288.13
J-WB02	78.16	756.96	01Jan2016, 15:00	728.99
LWBC1	78.16	721.32	01Jan2016, 18:00	713.67
WB-04	42.31	1.43	01Jan2016, 04:30	0.54
J-WB02A Walker Bas Flows	120.47	721.35	01Jan2016, 18:00	714.22
LWBC2	120.47	701.36	01Jan2016, 18:00	713.96
J-CA05 Conflu. of Walker Bas. & Caliente	470.735	2711.71	01Jan2016, 19:00	2974.17
LCCW	470.735	2670.85	01Jan2016, 20:00	2945.47
CA-08	4.918	0.16	01Jan2016, 02:30	0.04
J-CA06 South End of Proj	475.653	2670.85	01Jan2016, 20:00	2945.52

Meyer Civil Engineering, Inc.
110 S. Montclair Street - Suite 104, Bakersfield, CA 93309
Phone 661-836-9834 FAX 661-836-9761

TECHNICAL MEMORANDUM

Attention: Mr. Bill Black, PE, Principal Engineer MCE File: AEC-16-001

Company: AECOM

From: Richard Meyer, Meyer Civil Engineering, Inc.

Date: March 21, 2017, Revised March 24, 2017, *Corrections April 11, 2017*

RE: **Review of Sedimentation Study and Additional Modeling for the Proposed Project Design for Caliente Creek Habitat Mitigation and Groundwater Recharge Projects**

Revised proposed design FLO2d Models were provided by David Jaffe of Psomas which included revised Manning's N values of 0.11. As the team discussed, these new models were requested in order that an improved condition reflecting a well-developed planting on the floodway is to be included.

Modeling Overview: The two new proposed design models were essentially the same as provided by Psomas on February 21, 2017, with the exception being the noted N value change.

Observations:

1. Based on the revision noted above, SUMMARY.OUT files are again summarized in table form. Previous model run values are included for comparison.

TABLE A – Values from Models with N=0.055 Compared to Models with N=0.11 5 year Design Storm

1 Model	2 Water Inflow, AF	3 Water Infiltration, AF	4 Water Outflow, AF	5 Inundated Area, AC	6 Sediment Inflow, CF	7 Sediment Remaining, CF	8 Sediment Leaving, CF
1. North, Existing	5,860	3,532	2,325	997	581,128	515,910	65,218
2.a. North, Proposed N=0.055	5,860	3,832	2,026	1,077	581,128	509,006	72,121
2.b. North, Proposed N=0.11	5,860	*3,929*	*1,928*	*1,103*	*581,128*	*513,372*	*67,756*
3. South, Existing	2,325	1,216	1,110	652	47,231	-90,819	138,050
4.a. South, Proposed N=0.055	2,021	1,358	663	744	200,417	111,245	89,172
4.b. South, Proposed N=0.11	1,927	1,387	540	*733*	*184,888*	*112,947*	*71,941*

2. It is noted that the revised N value did result in decreases in water outflow, and sediment outflow. Net end effect in discharge from the project resulted in an 18.5% decrease of flow rate and a 19.3% decrease in sediment outflow.

Additional Study: Project Manager, Bill Black asked that rigid bed tiles be investigated in the proposed sediment models. These would be purposed to represent rock protection to prevent scour in high velocity areas in the vicinity of the bridges, culverts and high velocity channel banks. The

question to be answered is: "Will adding invert and side slope rock protection in these areas reduce net sediment transport out of the project area?"

Therefore, two additional models utilizing rigid bed tiles were developed by this engineer from the revised Psomas models. All other values were held constant. The results of this modeling are summarized below:

TABLE B – Values from Models with Rigid Bed Tiles
5 year Design Storm

1 Model	2 Water Inflow, AF	3 Water Infiltration, AF	4 Water Outflow, AF	5 Inundated Area, AC	6 Sediment Inflow, CF	7 Sediment Remaining, CF	8 Sediment Leaving, CF
2.c. North, Proposed with Rigid Bed Tiles	5,860	3,936	1,811(1)	1,113	581,143	564,253	16,889
4.c. South, Proposed with Rigid bed Tiles	1,811	1,321	418(2)	704	16,898	14,171	2,727

(1) 112 acre feet of water was left on the floodplain at the end of the 90 hour model run.
(2) 72 acre feet of water was left on the floodplain at the end of the 90 hour model run.

Based on the above results, rigid bed tiles were very effective.

The 2 year, 24 hour event was also analyzed. The results of this model are as follows:

TABLE C – Values from Models under the 2 Year, 24 Hour Event

1 Model	2 Water Inflow, AF	3 Water Infiltration, AF	4 Water Outflow, AF	5 Inundated Area, AC	6 Sediment Inflow, CF	7 Sediment Remaining, CF	8 Sediment Leaving, CF
1. North, Existing	3,010	2,429	495(1)	823	298,502	287,963	10,539
2.b. North Proposed without Rigid Bed Tiles	3,010	2,758	153(2)	978	298,502	295,115	3,386
2.d. North, Proposed with Rigid Bed Tiles	3,010	2,769	141(2)	983	298,501	298,090	410
3. South, Existing	495	315	159(3)	195	10,539	-1,035(6)	11,575
3.b. South Proposed without Rigid Bed Tiles	153	141	0(4)	117	*3,672*	*3,672*	0
4.d. South, Proposed with Rigid bed Tiles	141	130	0(5)	109	410	410	0

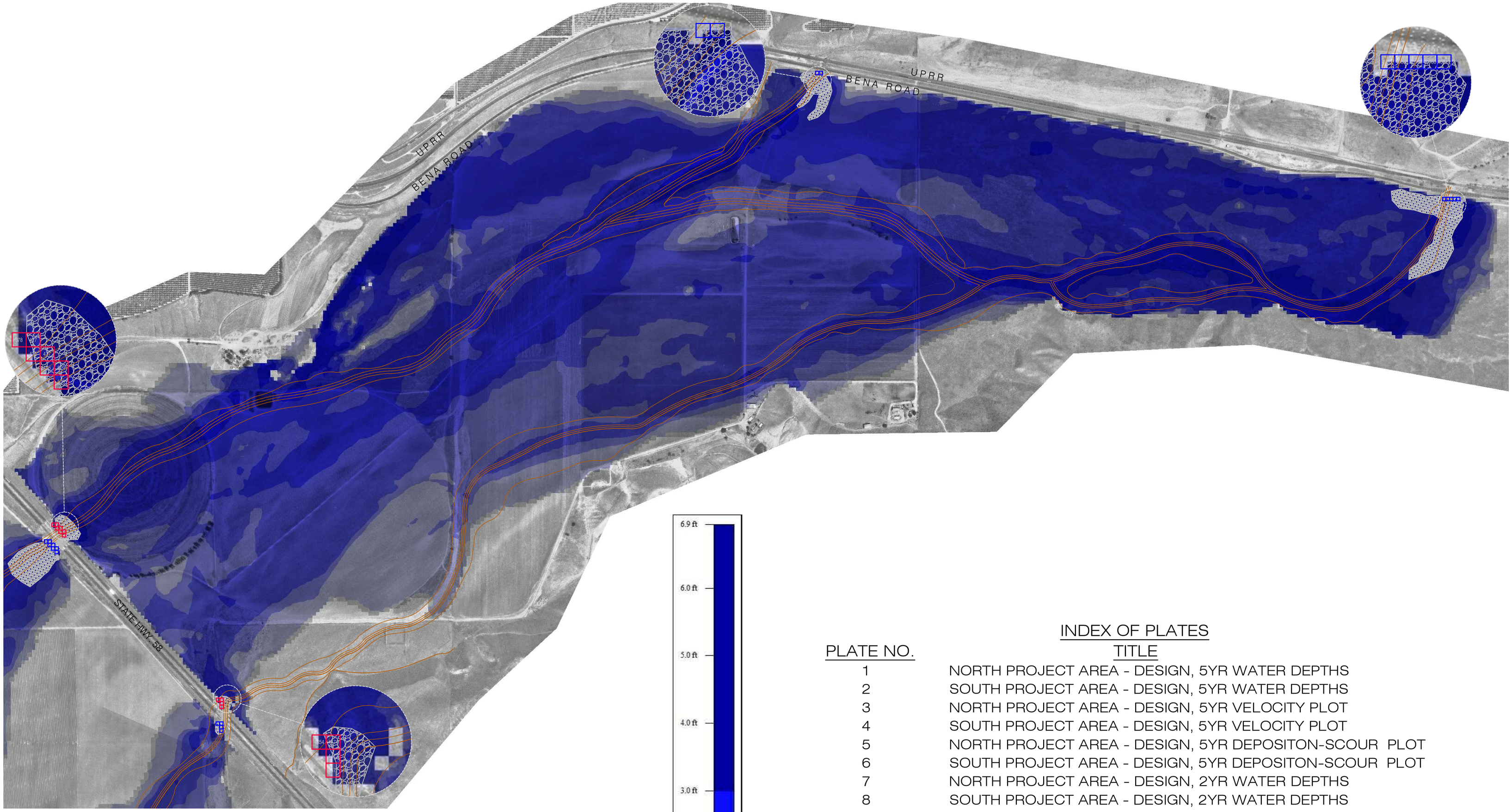
(1) 86 acre feet of water was left on the floodplain at the end of the 90 hour model run.
(2) 99 acre feet of water was left on the floodplain at the end of the 90 hour model run.
(3) 20 acre feet of water was left on the floodplain at the end of the 90 hour model run.
(4) 12 acre feet of water was left on the floodplain at the end of the 90 hour model run.
(5) 11 acre feet of water was left on the floodplain at the end of the 90 hour model run.
(6) Negative value indicates additional scour.

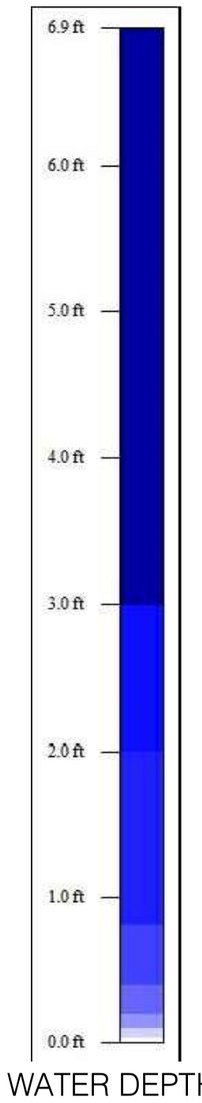
Conclusions & Recommendations:

1. Higher Manning's N values represented a good improvement on the proposed project performance.
2. Model runs with rigid bed tiles imply that adding rock protection in high velocity areas would greatly enhance the proposed project's performance. Preliminary design of the rocked areas total 22 acres. Thickness can be estimated at 18" at this time.
3. Two year value comparisons represent excellent performance of the proposed design.

Respectfully,

Attachments:
FLO-2d Modeling Plots,
Model Result Hgraphs,
Model Result Sedimentation Graphs





WATER DEPTH

LEGEND

34247 FLO-2D MODEL INFLOW TILES

378 FLO-2D MODEL OUTFLOW TILES

PROPOSED GRADED CHANNELS

PROPOSED ROCK PROTECTION

N

400 0 800 1600

800 200

INDEX OF PLATES

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1	NORTH PROJECT AREA - DESIGN, 5YR WATER DEPTHS
2	SOUTH PROJECT AREA - DESIGN, 5YR WATER DEPTHS
3	NORTH PROJECT AREA - DESIGN, 5YR VELOCITY PLOT
4	SOUTH PROJECT AREA - DESIGN, 5YR VELOCITY PLOT
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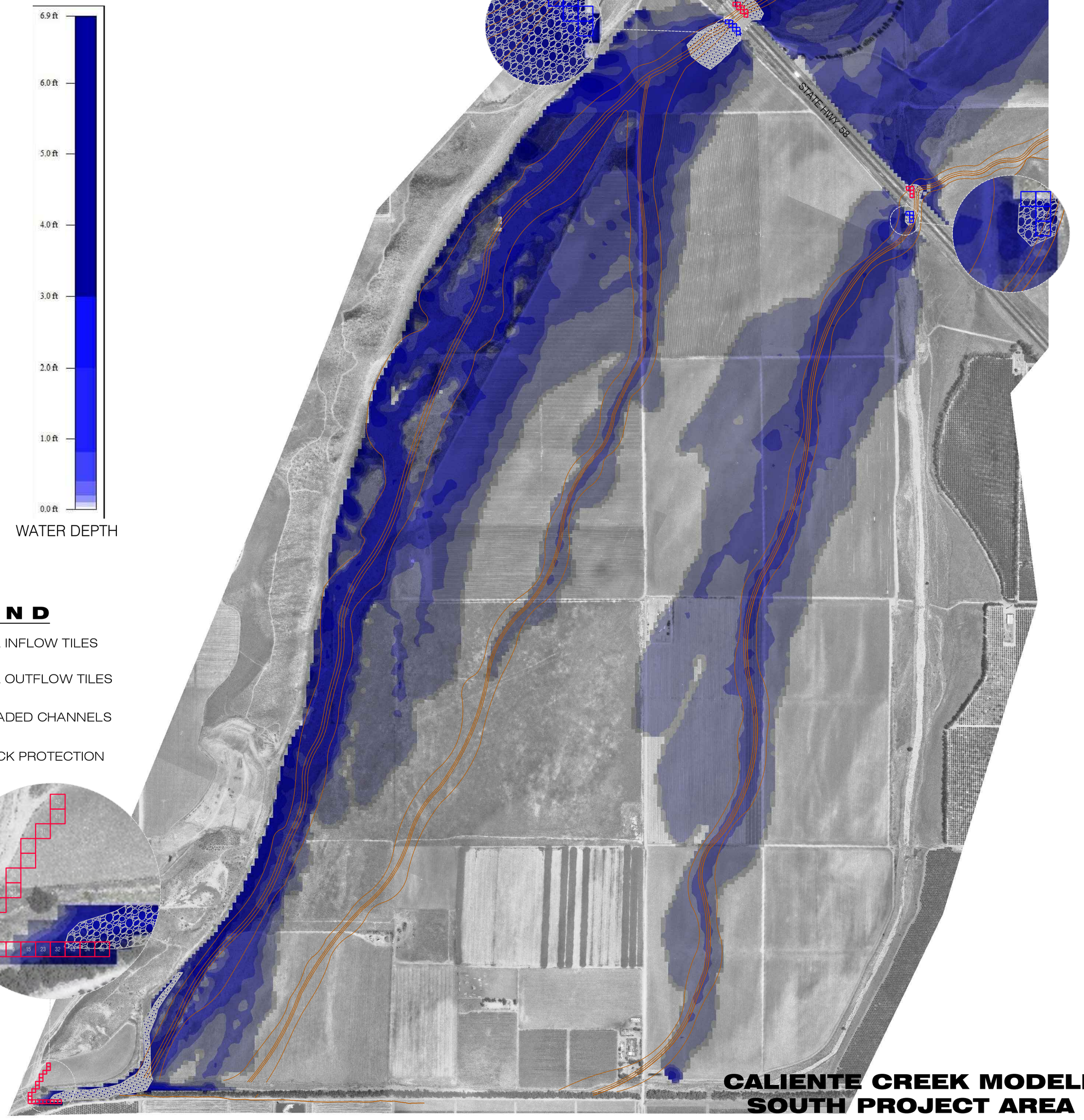
CALIENTE CREEK MODELING STUDY
NORTH PROJECT AREA - DESIGN
5 YR WATER DEPTHS

APRIL 11, 2017



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5 YR WATER DEPTHS

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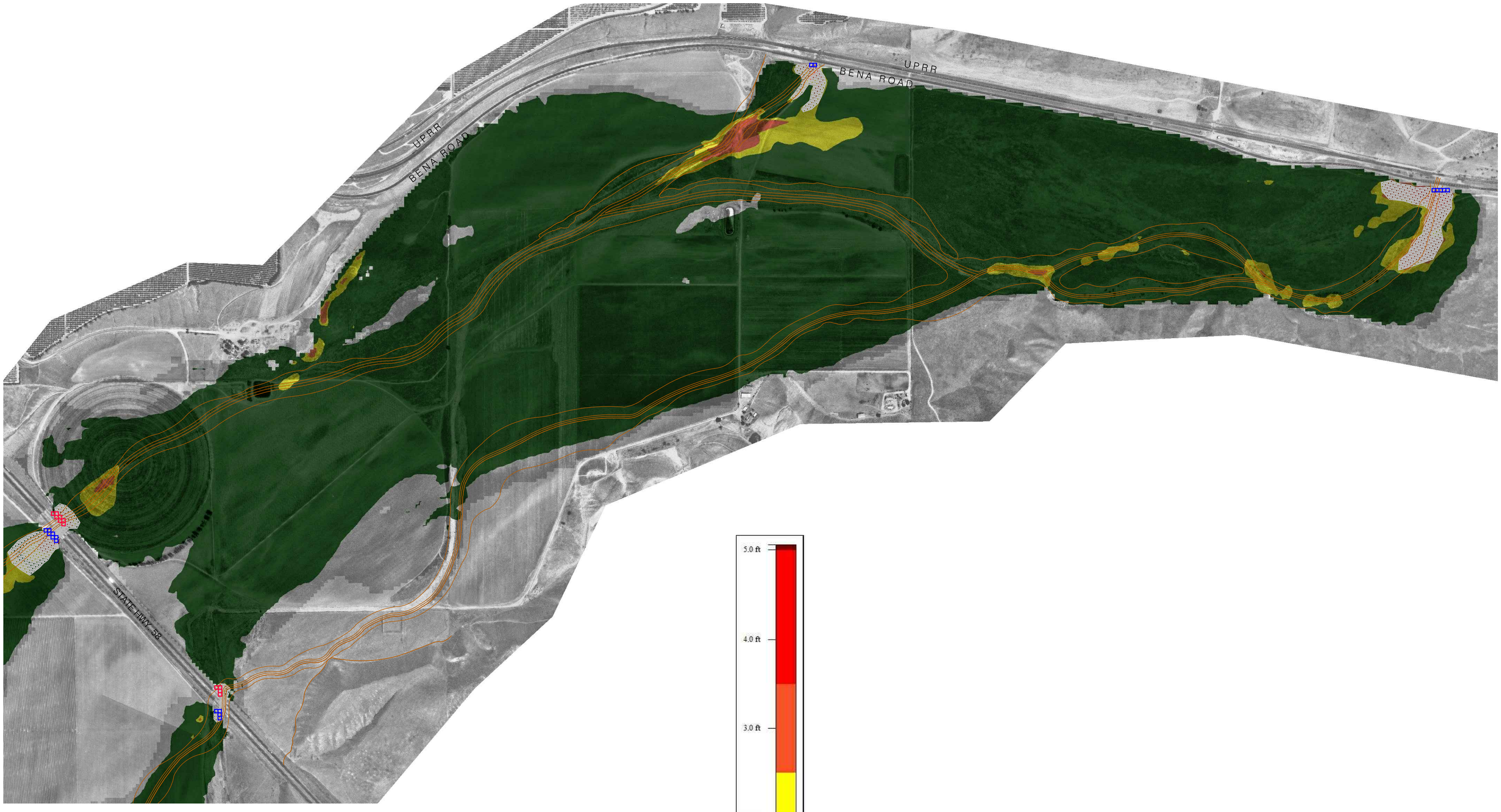
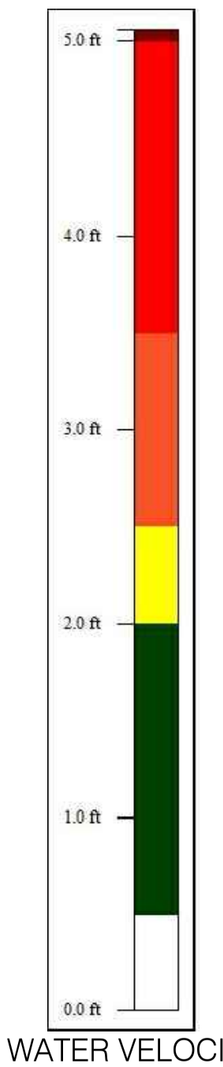
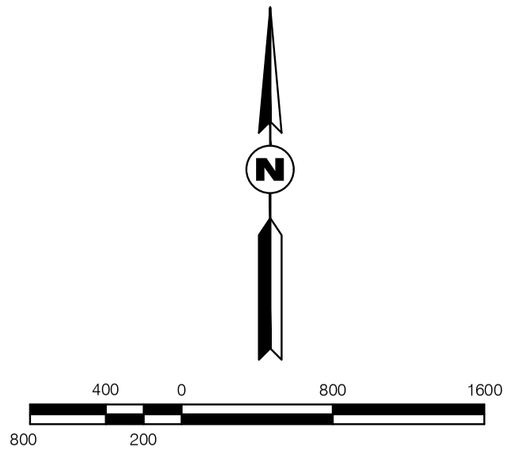




WATER VELOCITY



LEGEND

34247 FLO-2D MODEL INFLOW TILES

378 FLO-2D MODEL OUTFLOW TILES

PROPOSED GRADED CHANNELS

PROPOSED ROCK PROTECTION

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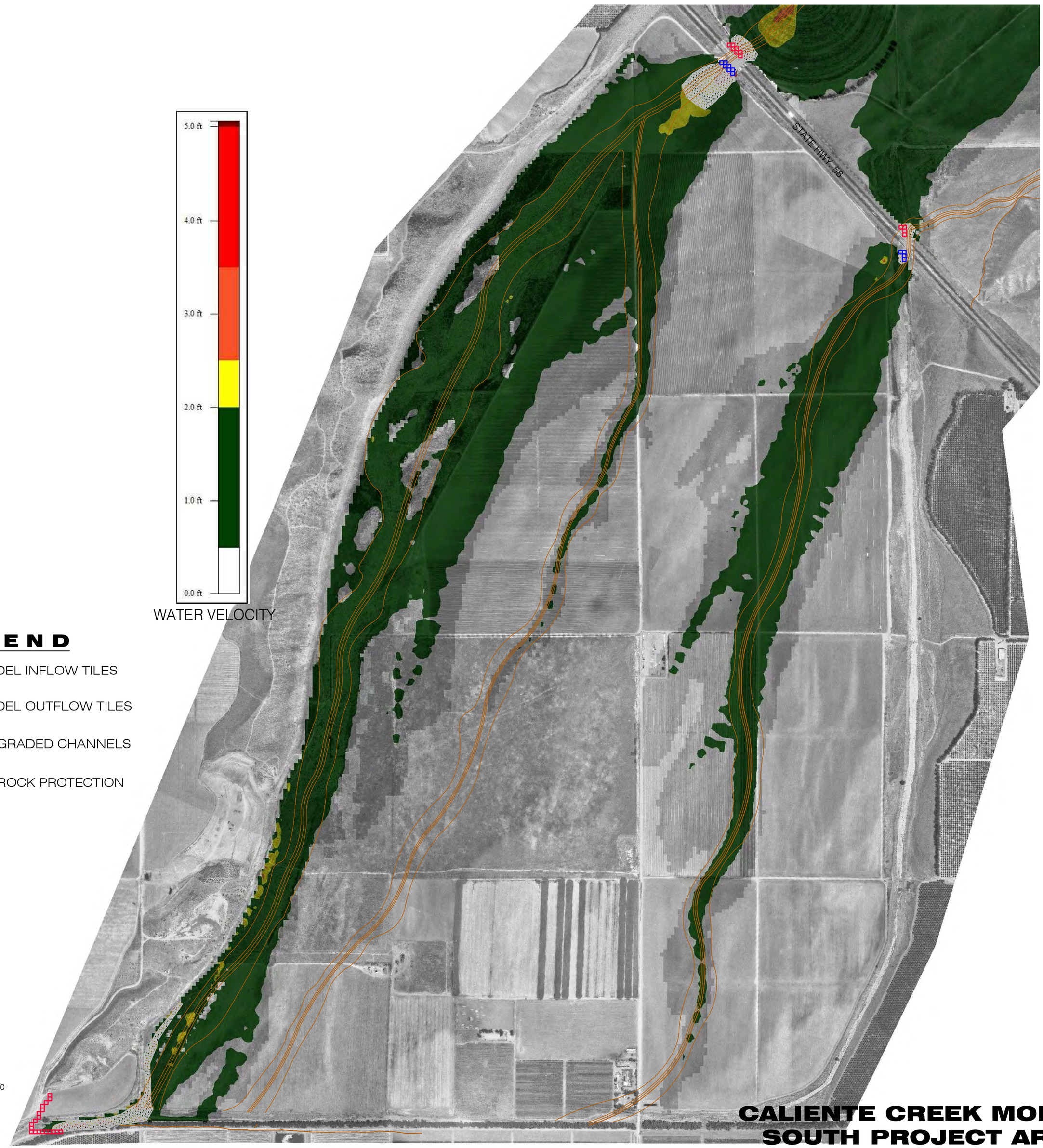
CALIENTE CREEK MODELING STUDY
NORTH PROJECT AREA - DESIGN
5 YR VELOCITY PLOT

APRIL 11, 2017



LEGEND

34247 FLO-2D MODEL INFLOW TILES

378 FLO-2D MODEL OUTFLOW TILES

PROPOSED GRADED CHANNELS

PROPOSED ROCK PROTECTION

N

400 0 800 1600

800 200

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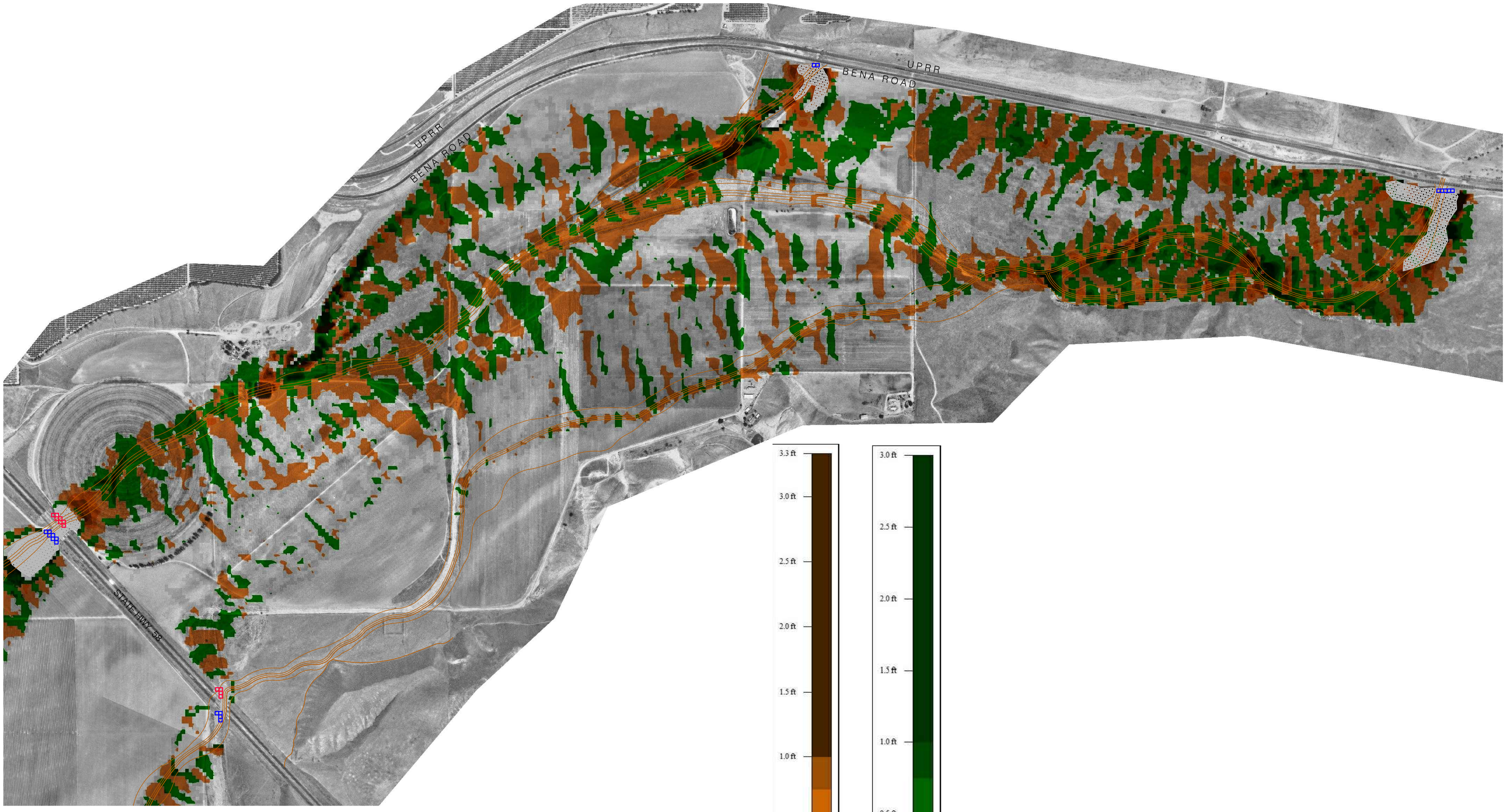
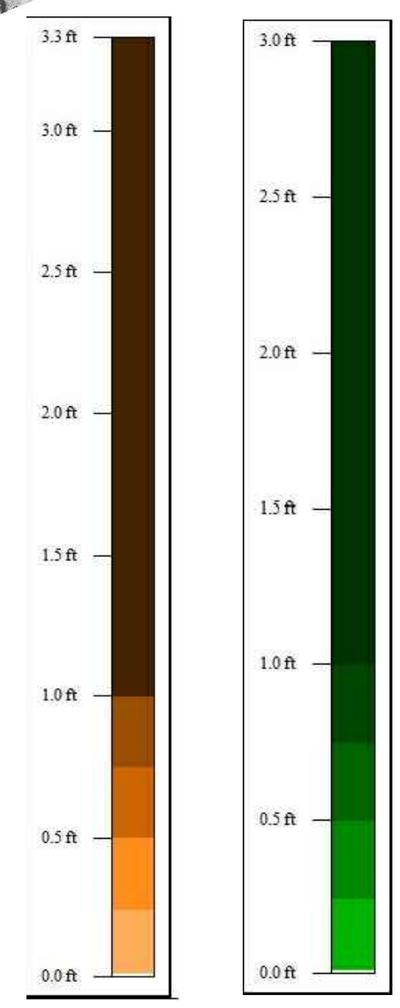
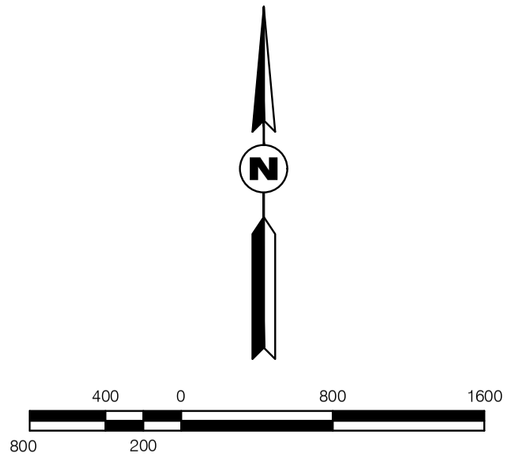
CALIENTE CREEK MODELING STUDY
SOUTH PROJECT AREA - DESIGN
5 YR VELOCITY PLOT

APRIL 11, 2017







LEGEND

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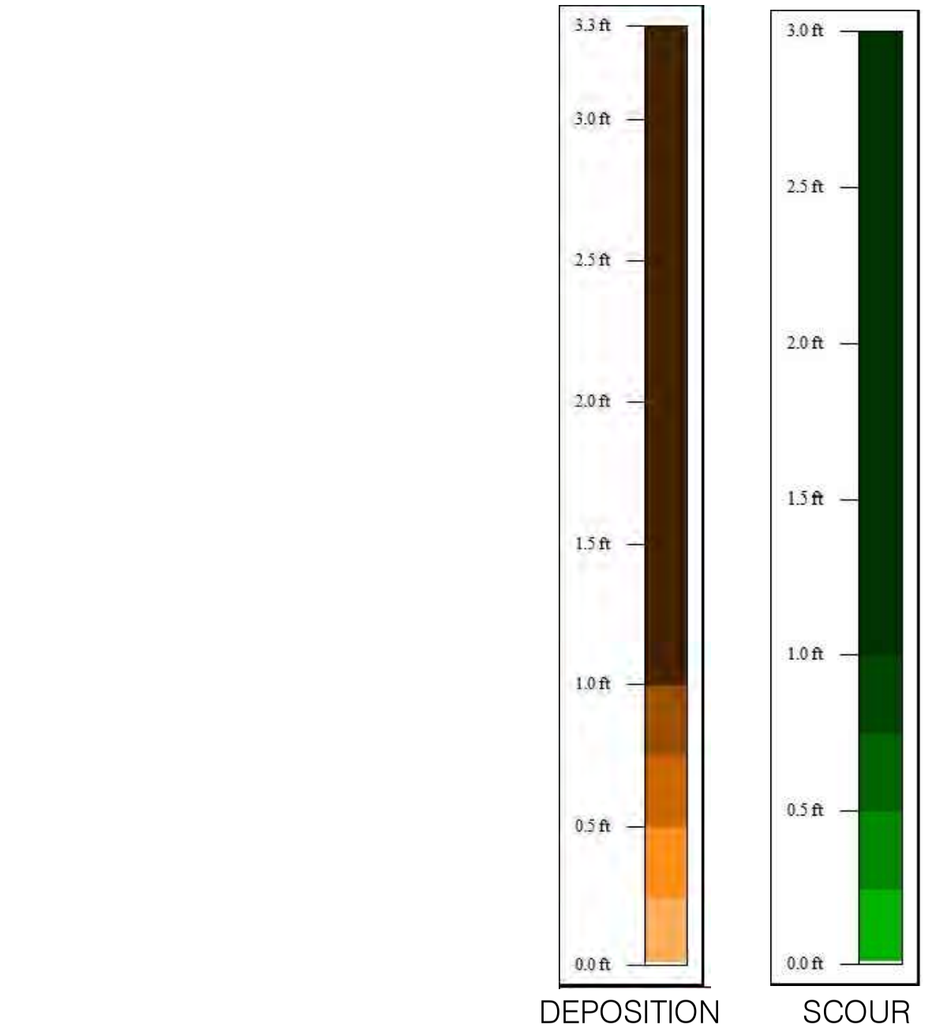
CALIENTE CREEK MODELING STUDY
NORTH PROJECT AREA - DESIGN
5 YR DEPOSITION-SCOUR PLOT

APRIL 11, 2017



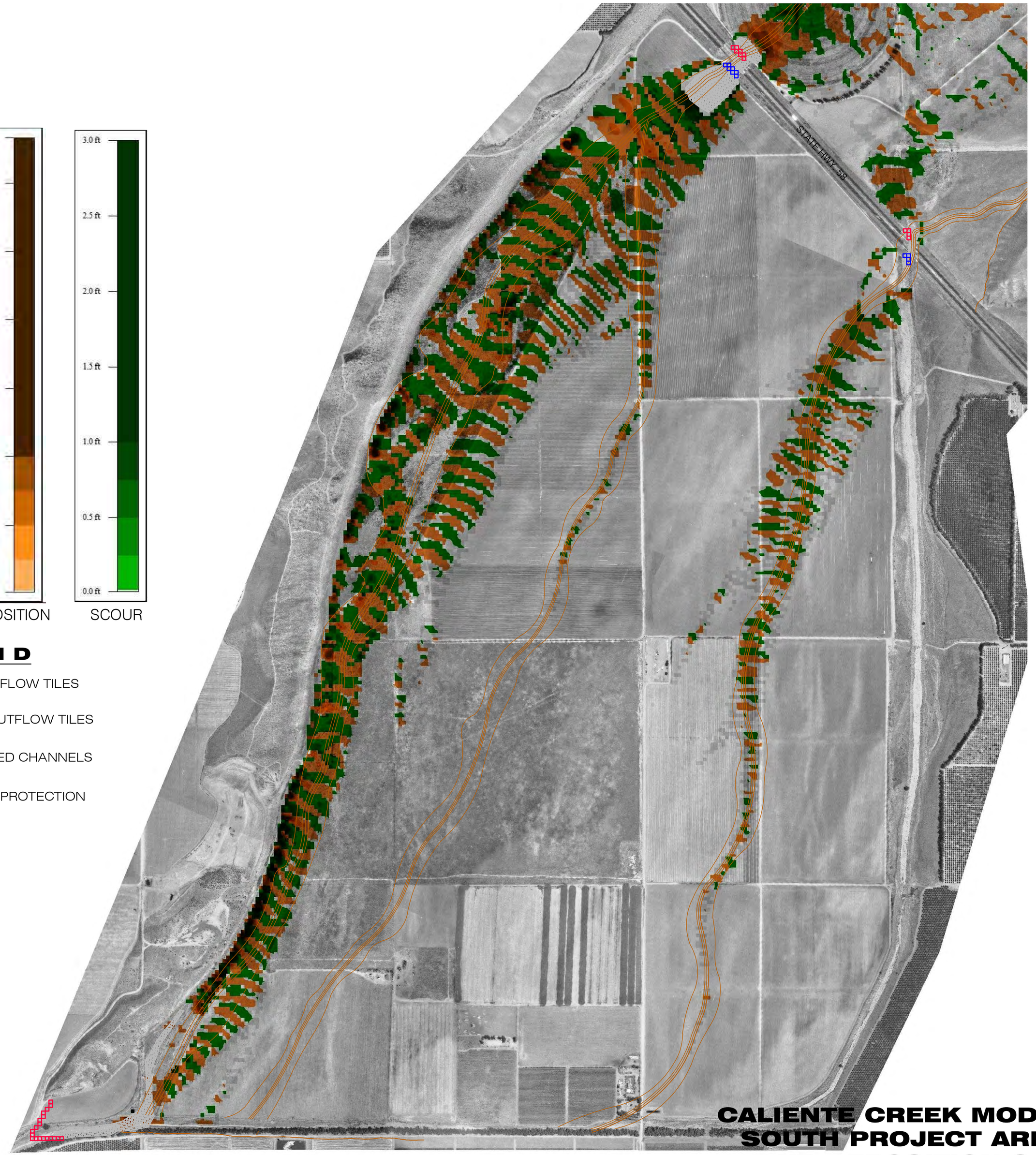
LEGEND

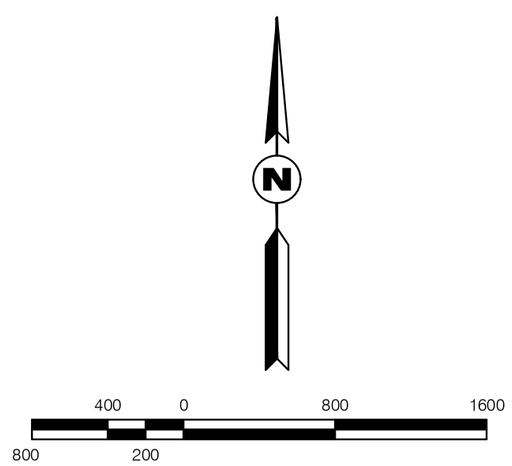
34247 FLO-2D MODEL INFLOW TILES

378 FLO-2D MODEL OUTFLOW TILES

PROPOSED GRADED CHANNELS

PROPOSED ROCK PROTECTION





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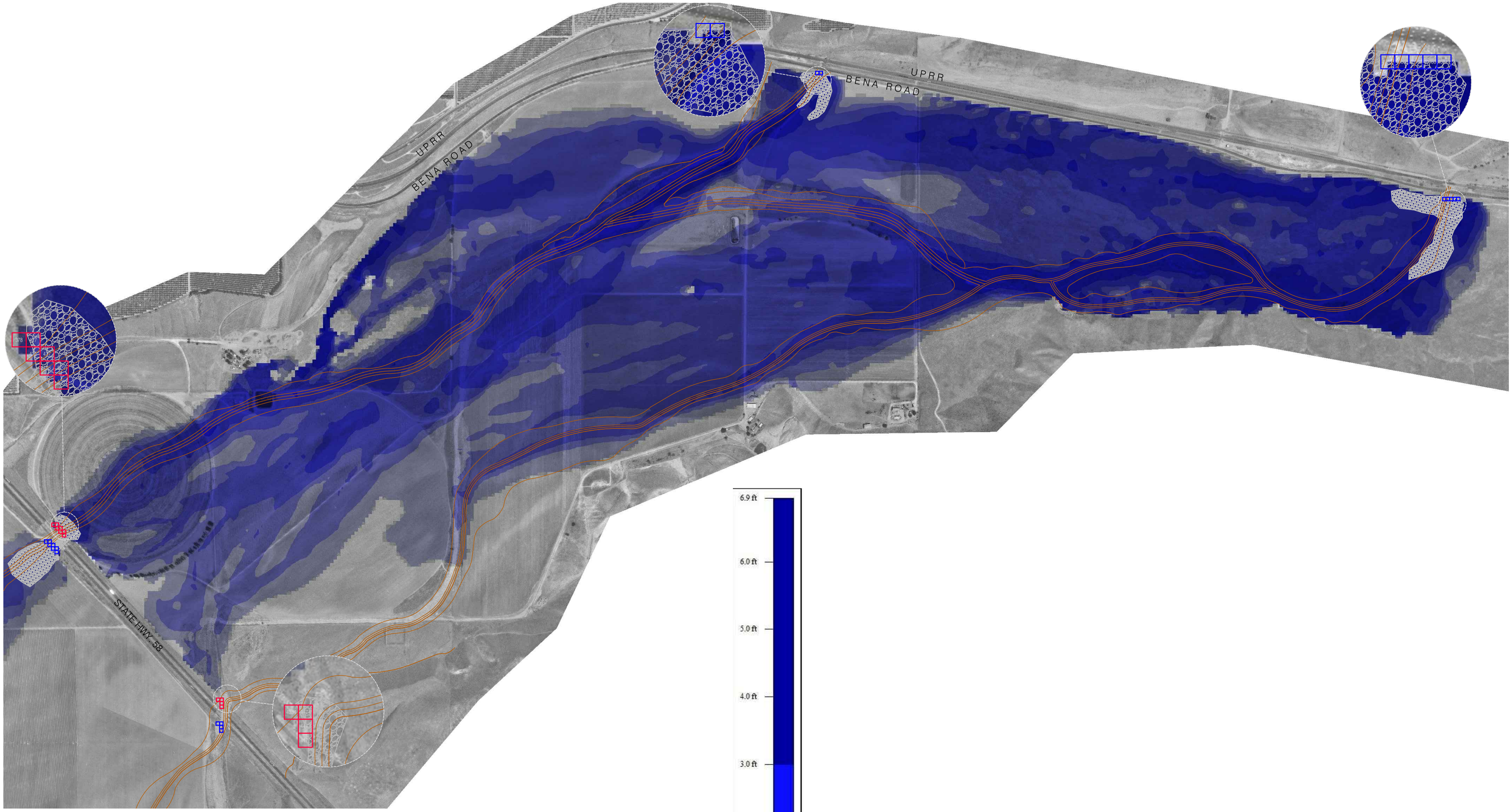
CALIENTE CREEK MODELING STUDY
SOUTH PROJECT AREA - DESIGN
5 YR DEPOSITION-SCOUR PLOT

APRIL 11, 2017



LEGEND

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- 378 — FLO-2D MODEL OUTFLOW TILES
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- PROPOSED ROCK PROTECTION

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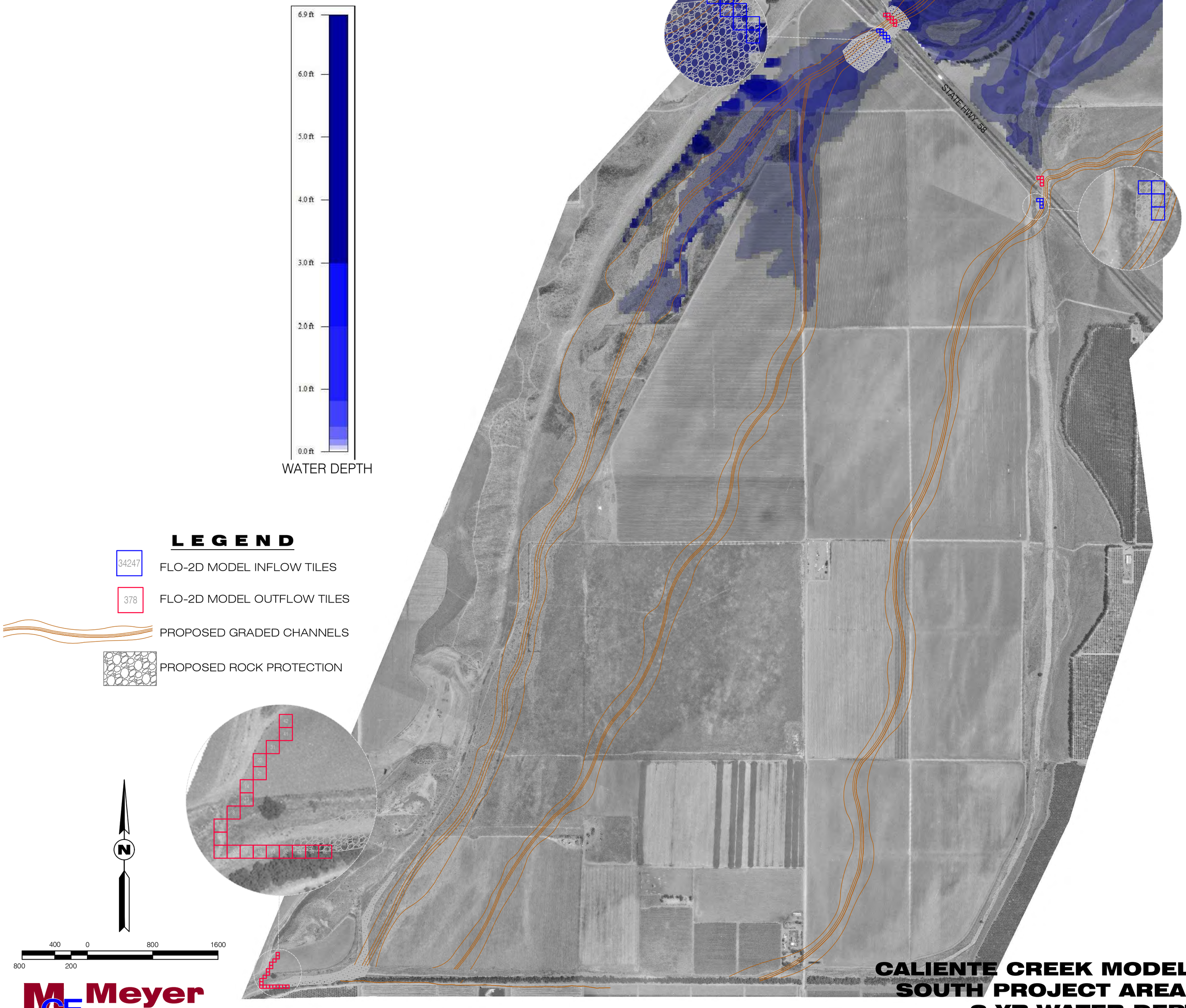
CALIENTE CREEK MODELING STUDY
NORTH PROJECT AREA - DESIGN
2 YR WATER DEPTHS

APRIL 11, 2017



CALIENTE CREEK MODELING STUDY
SOUTH PROJECT AREA - DESIGN
2 YR WATER DEPTHS

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PLATE 8 OF 14

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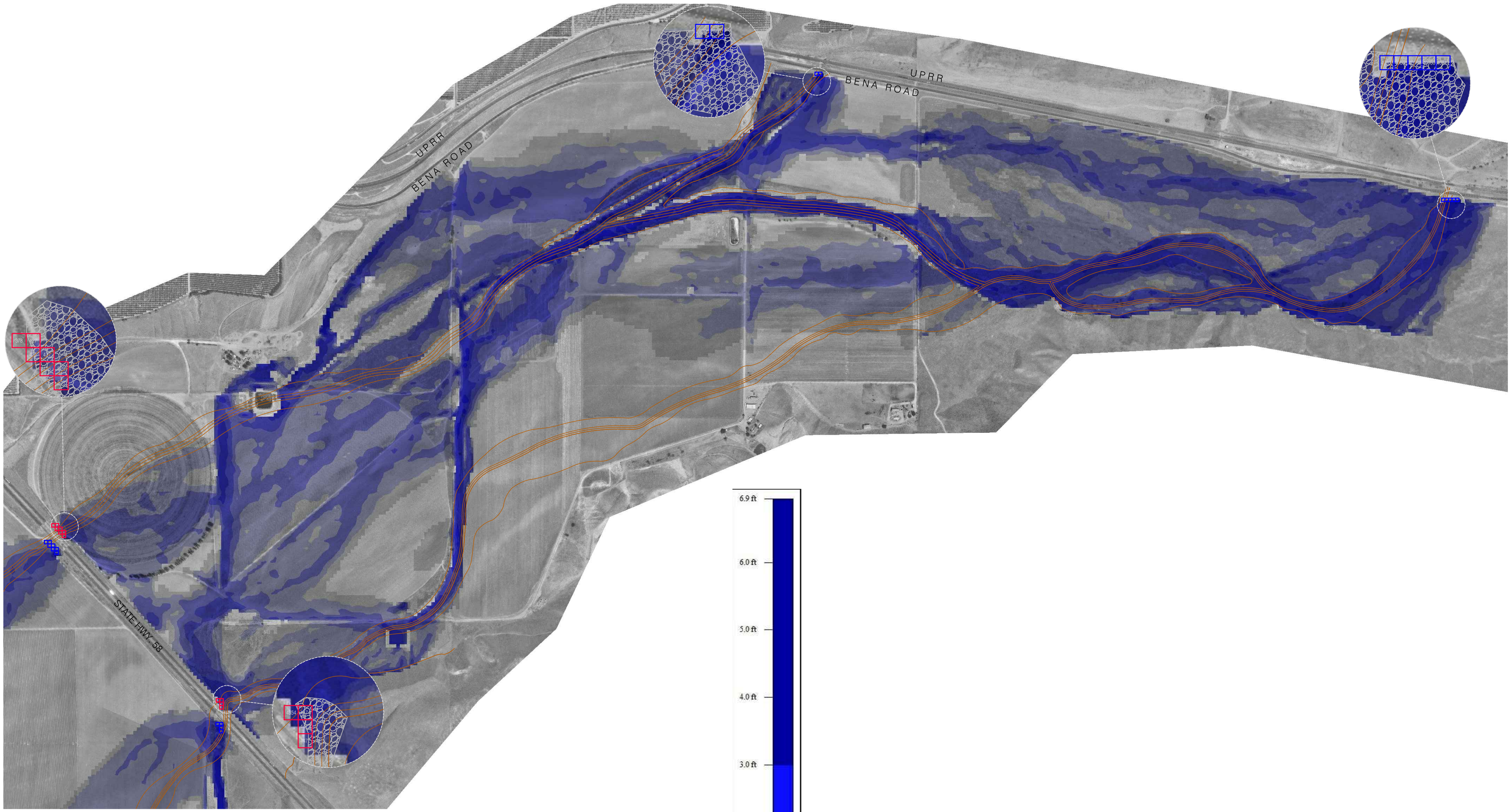

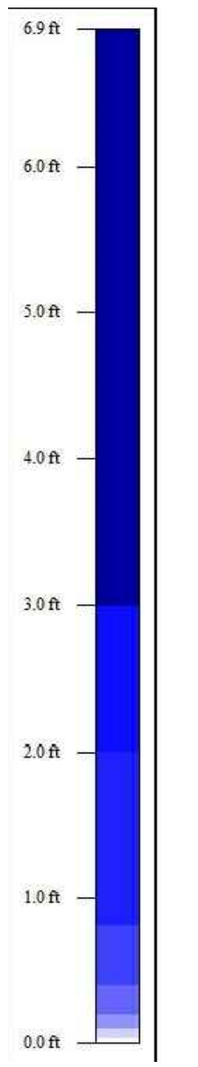

LEGEND

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- PROPOSED ROCK PROTECTION

N

400 0 800 1600

800 200

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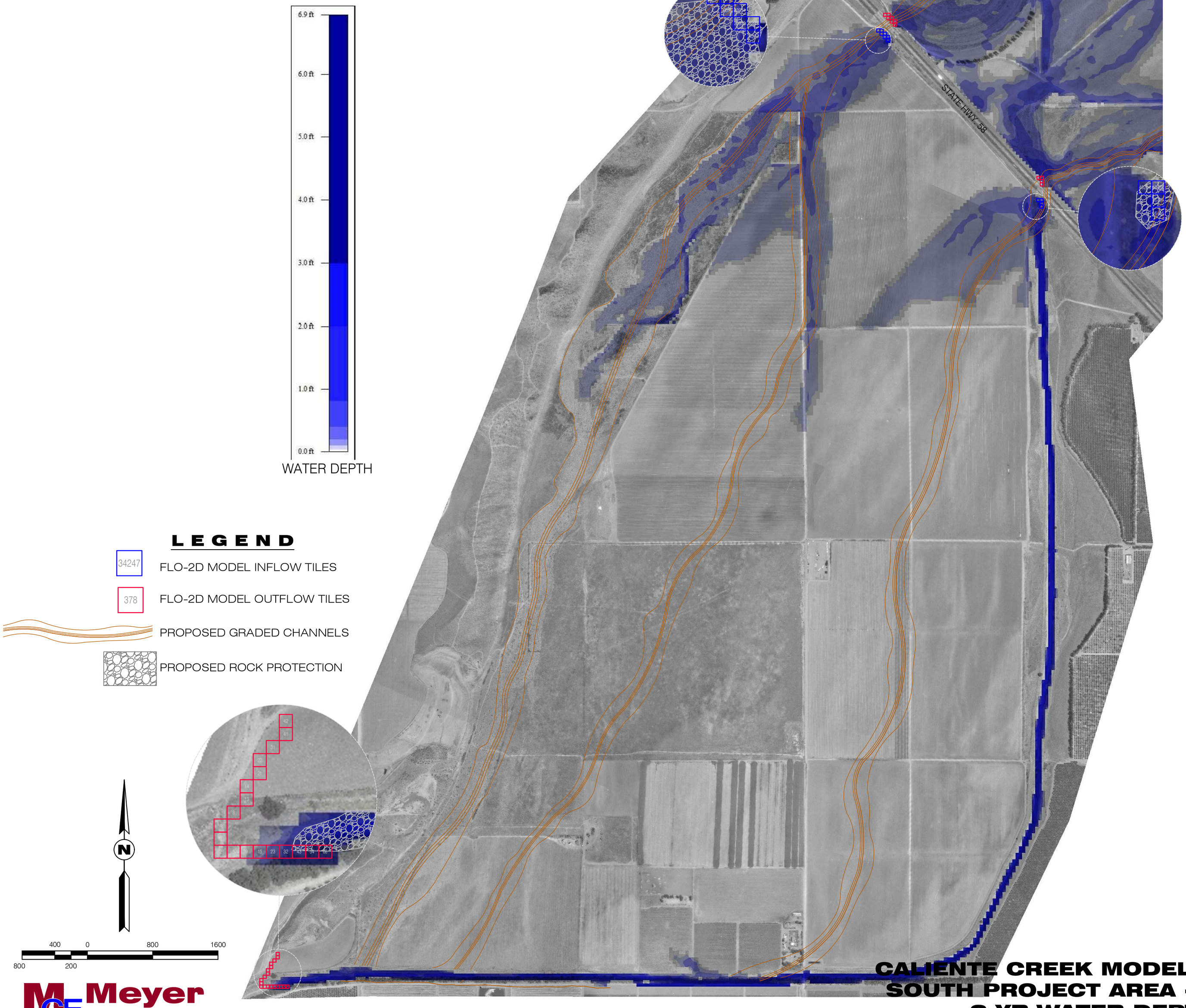
CALIENTE CREEK MODELING STUDY
NORTH PROJECT AREA - EXISTING
2 YR WATER DEPTHS

APRIL 11, 2017



CALIENTE CREEK MODELING STUDY
SOUTH PROJECT AREA - EXISTING
2 YR WATER DEPTHS

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PLATE 10 OF 14

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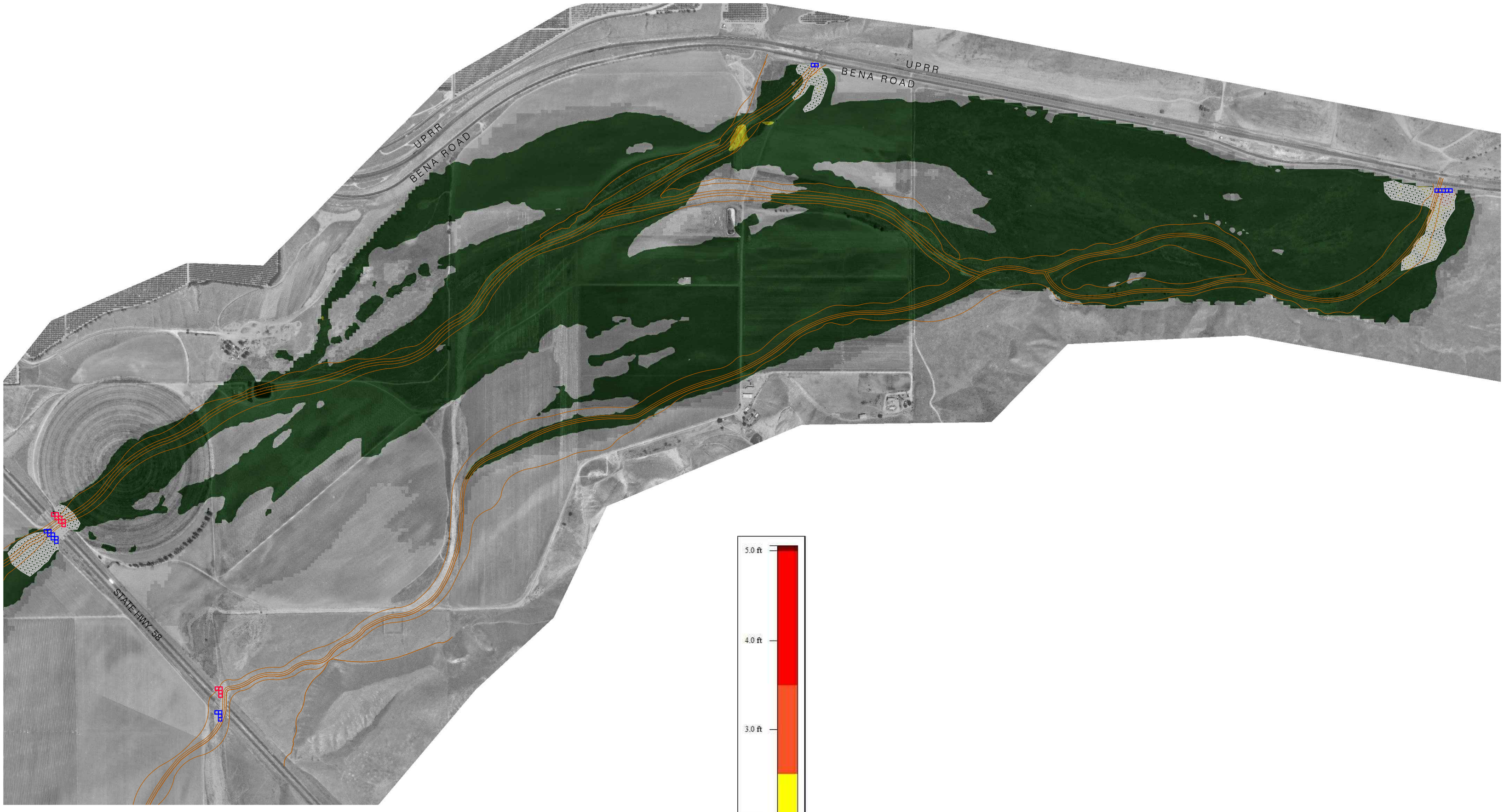

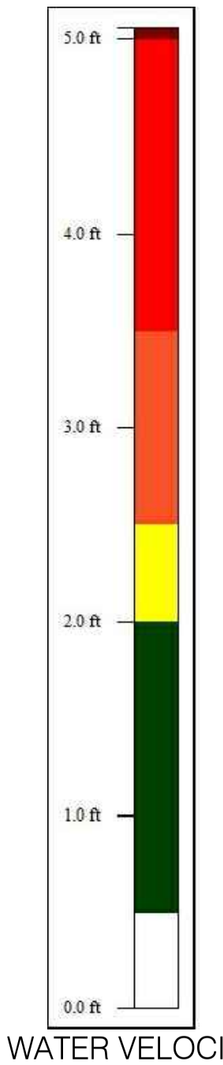

WATER VELOCITY

LEGEND

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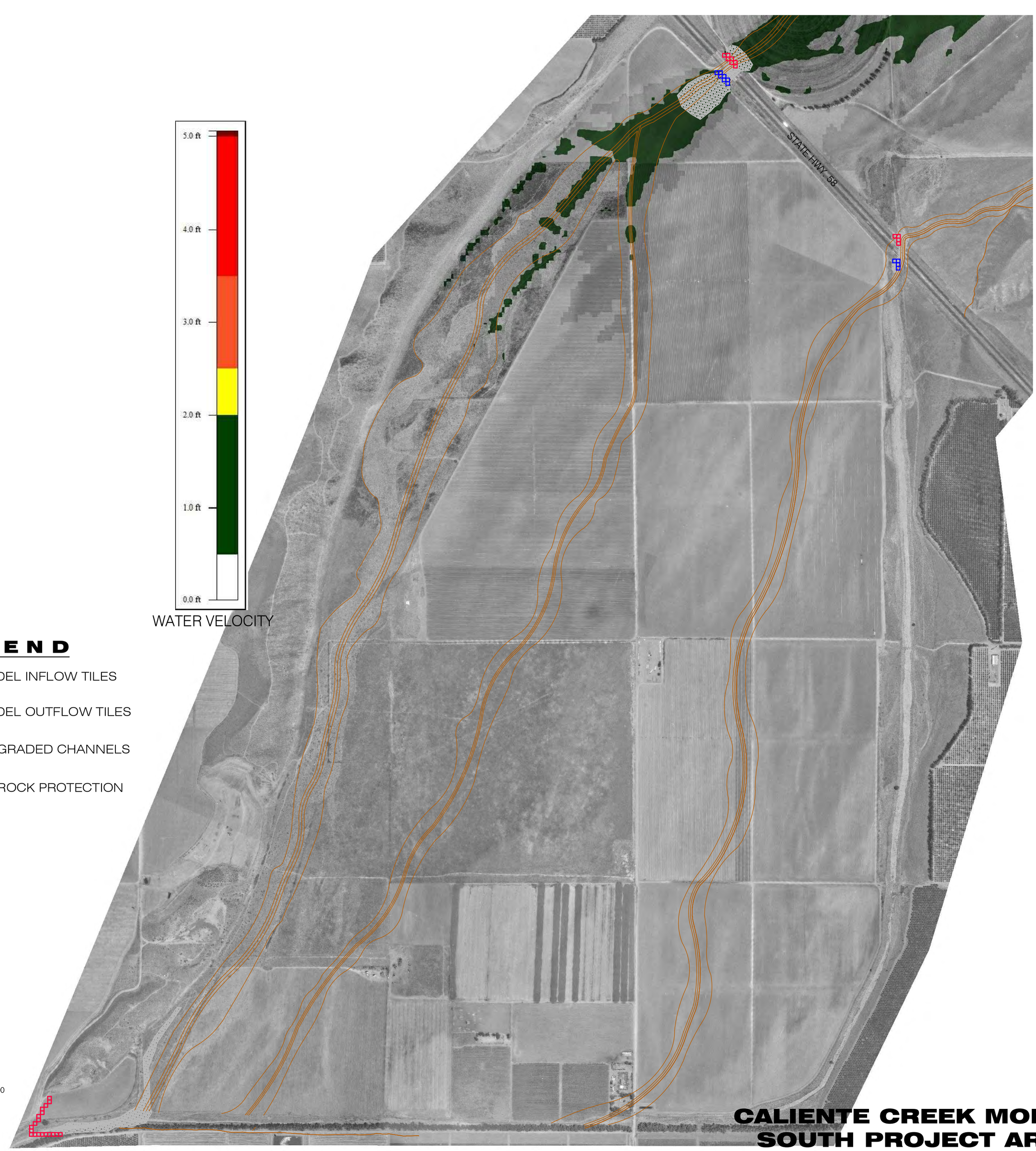
CALIENTE CREEK MODELING STUDY
NORTH PROJECT AREA - DESIGN
2 YR VELOCITY PLOT

APRIL 11, 2017



LEGEND

- 34247 — FLO-2D MODEL INFLOW TILES
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- PROPOSED GRADED CHANNELS
- PROPOSED ROCK PROTECTION

N

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CALIENTE CREEK MODELING STUDY
SOUTH PROJECT AREA - DESIGN
2 YR VELOCITY PLOT

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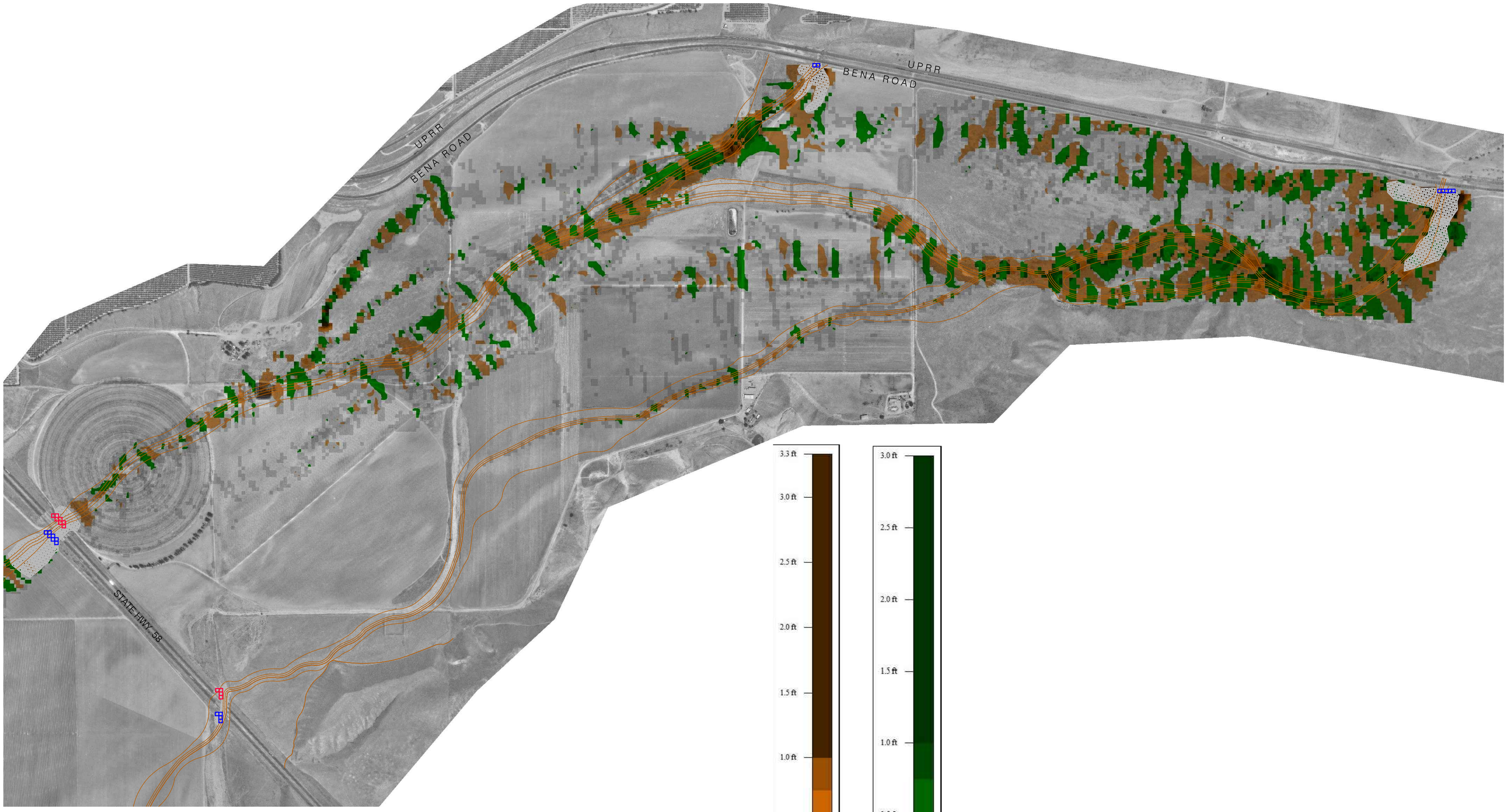

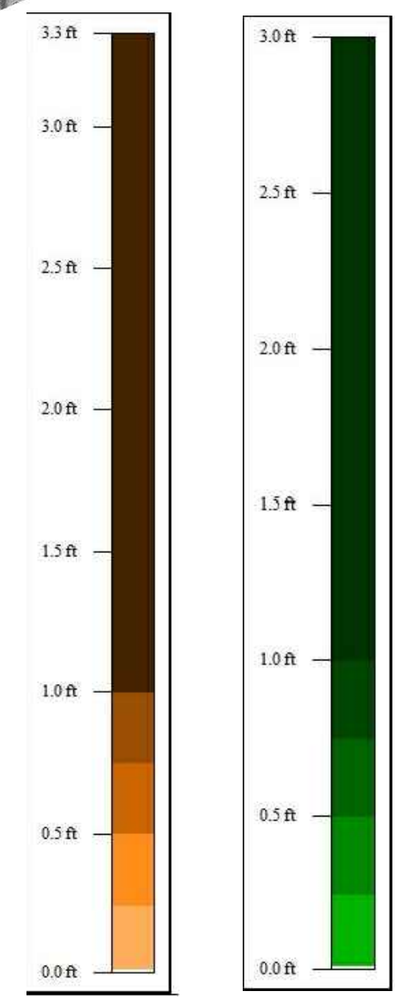

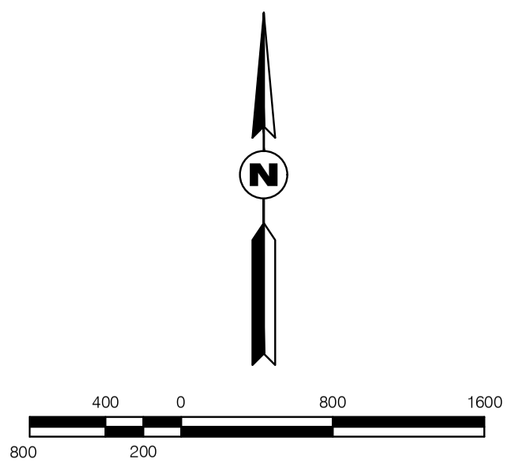

LEGEND

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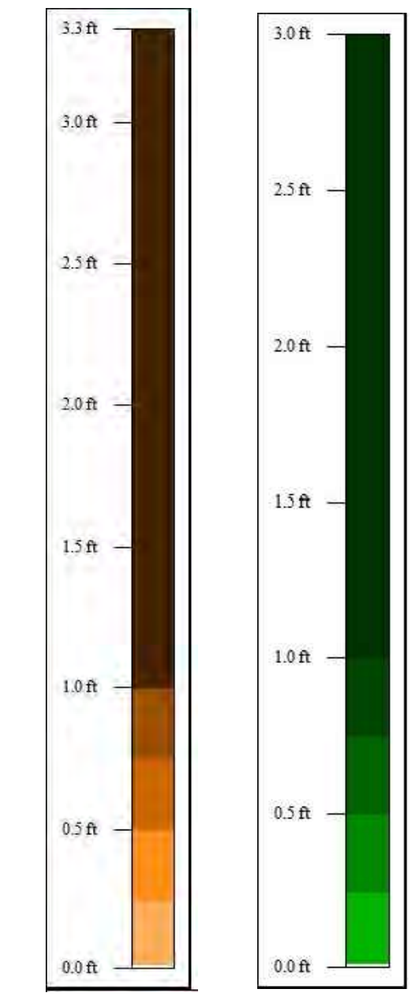
CALIENTE CREEK MODELING STUDY
NORTH PROJECT AREA - DESIGN
2 YR DEPOSITION-SCOUR PLOT

APRIL 11, 2017



DEPOSITION

SCOUR

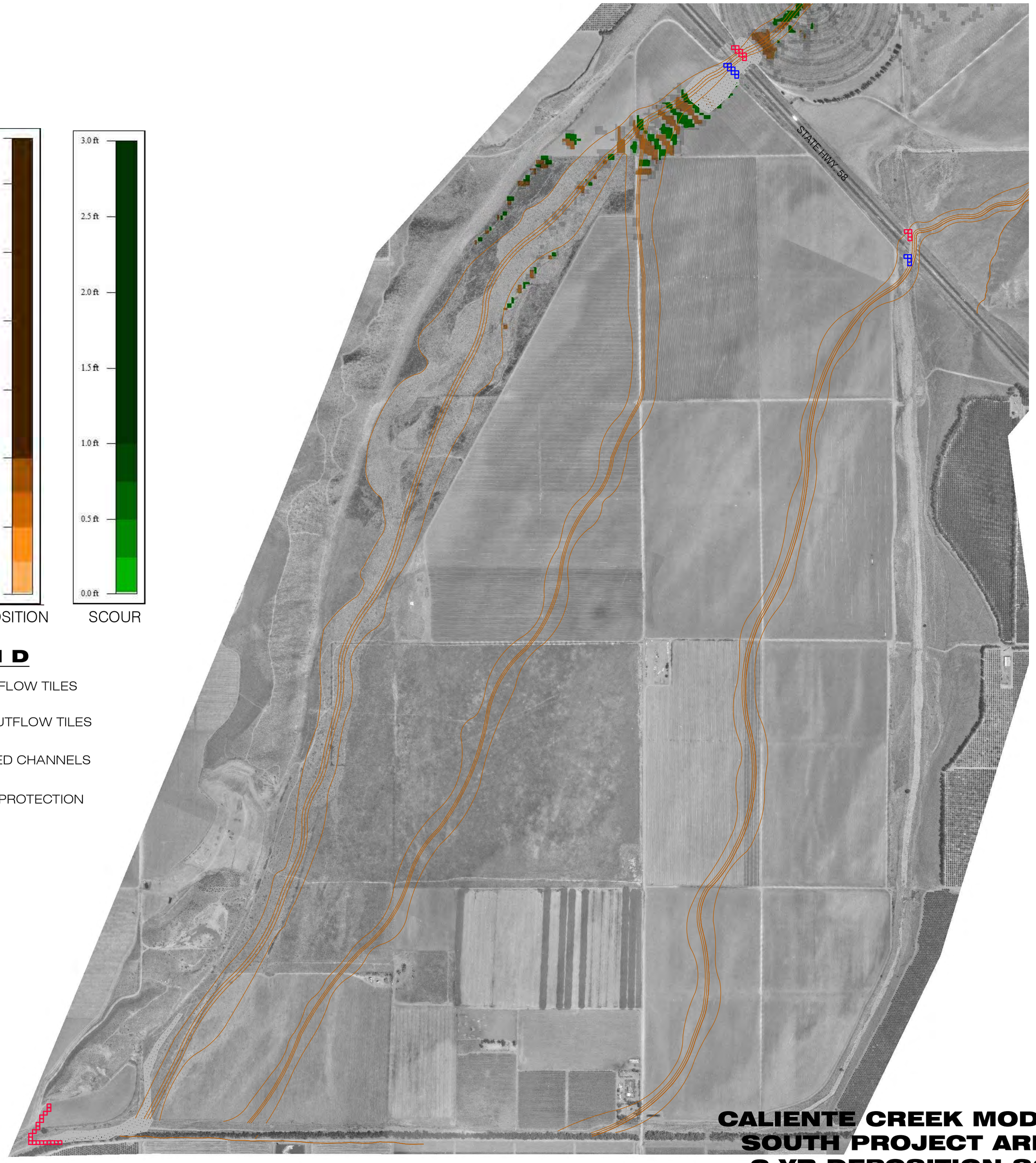
LEGEND

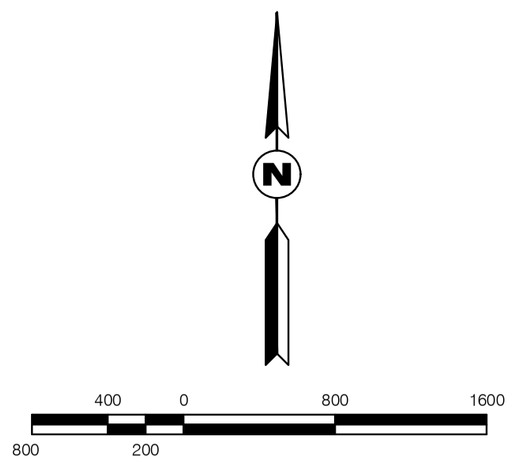
34247 FLO-2D MODEL INFLOW TILES

378 FLO-2D MODEL OUTFLOW TILES

PROPOSED GRADED CHANNELS

PROPOSED ROCK PROTECTION





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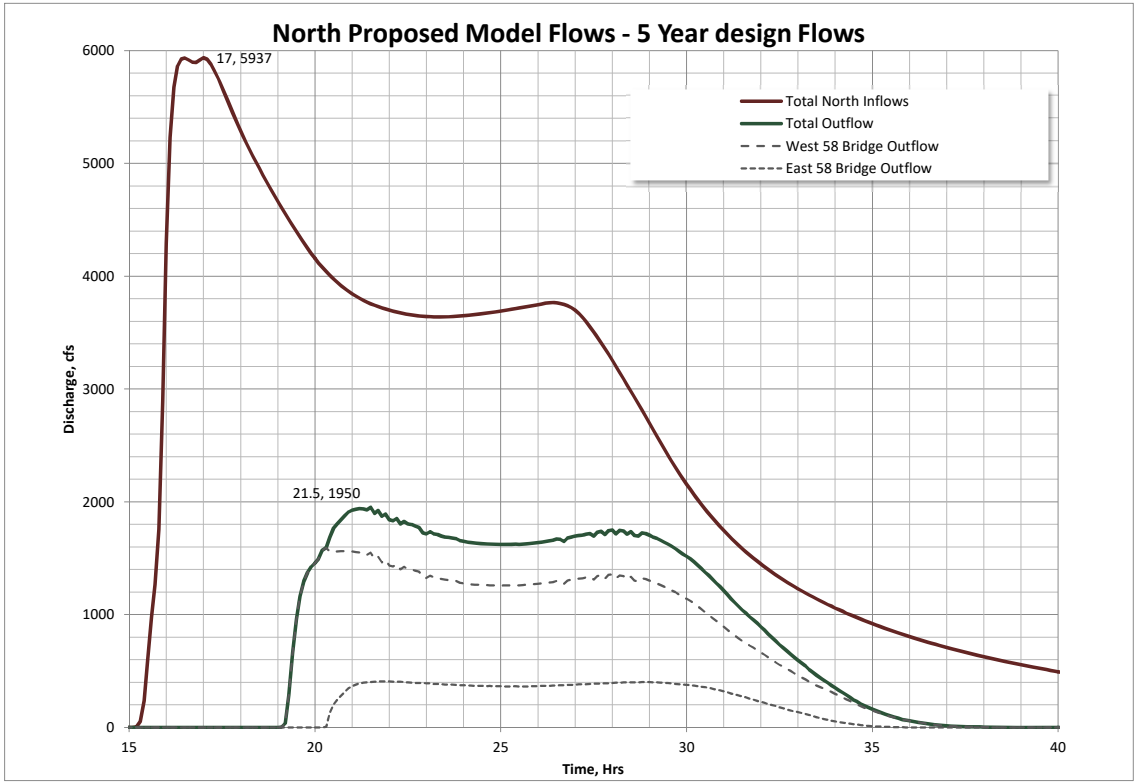
CALIENTE CREEK MODELING STUDY
SOUTH PROJECT AREA - DESIGN
2 YR DEPOSITION-SCOUR PLOT

APRIL 11, 2017

North Proposed Model Flows - 5 Year design Flows

Peak--->	5937 cfs	1540 cfs	4533 cfs	1590 cfs	407 cfs	1950 cfs
Time, Hrs	Total North Inflows	Walker Basin	Caliente Creek	West 58 Bridge Outflow Discharge, cfs	East 58 Bridge Outflow Discharge, cfs	Total Outflow Discharge, cfs
0.0	0	0	0	0	0	0
1.9	1	0	0	0	0	0
3.3	2	1	1	0	0	0
5.8	2	1	1	0	0	0
8.5	1	0	0	0	0	0
16.9	5917	1420.42	4496.73	0	0	0
17.0	5937	1404.43	4532.25	0	0	0
17.1	5921	1388.15	4532.93	0	0	0
17.2	5876	1371.36	4504.87	0	0	0
17.3	5818	1353.91	4464.26	0	0	0
17.4	5751	1335.81	4415.05	0	0	0
17.5	5677	1317.03	4359.83	0	0	0
17.6	5598	1297.31	4300.77	0	0	0
17.7	5517	1276.67	4240.18	0	0	0
17.8	5437	1255.62	4181.1	0	0	0
17.9	5360	1234.9	4125.21	0	0	0
18.0	5287	1214.98	4072.36	0	0	0
18.1	5218	1196.2	4021.51	0	0	0
18.2	5150	1178.74	3971.68	0	0	0
18.3	5085	1162.6	3922.34	0	0	0
18.4	5021	1147.78	3873.24	0	0	0
18.5	4958	1134.13	3824.16	0	0	0
18.6	4896	1121.4	3775.09	0	0	0
18.7	4836	1109.19	3726.68	0	0	0
18.8	4777	1097.01	3679.75	0	0	0
18.9	4719	1084.71	3634.53	0	0	0
19.0	4663	1072.21	3590.94	0	0	0
19.1	4608	1059.47	3548.94	1.09	0	1
19.2	4555	1046.5	3508.38	37.24	0	37
19.3	4502	1033.33	3468.84	285.44	0	285
19.4	4450	1020.1	3429.67	662.07	0	662
19.5	4398	1007.12	3390.39	962.17	0	962
19.6	4346	994.64	3351.13	1163.17	0	1163
19.7	4295	982.85	3312.48	1295.54	0	1296
19.8	4247	971.78	3275	1376.3	0	1376
19.9	4200	961.43	3239.06	1424.32	0	1424
20.0	4157	951.82	3205.1	1457.24	0	1457
20.1	4116	942.99	3173.21	1494.59	0	1495
20.2	4078	934.87	3143.1	1569.56	0	1570
20.3	4042	927.5	3114.51	1590	4.78	1595
20.4	4008	920.85	3087.21	1558.48	127.2	1686
20.5	3976	914.79	3061.1	1562.91	202.83	1766
20.6	3945	909.24	3036.25	1559.27	243.85	1803
20.7	3917	904.05	3012.77	1561.71	279.61	1841
20.8	3890	899.24	2991.09	1562.54	314.88	1877
20.9	3866	894.85	2971.01	1562.63	344.96	1908
21.0	3843	890.88	2952.5	1558.74	365.79	1925
21.1	3823	887.4	2935.4	1553.82	380.17	1934
21.2	3804	884.43	2919.49	1550.3	389.55	1940
21.3	3787	881.92	2904.64	1541.38	396.16	1938
21.4	3771	879.82	2890.83	1528.89	400.37	1929
21.5	3756	878.03	2878.27	1546.71	403.33	1950
21.6	3743	876.41	2866.77	1492.84	405.11	1898
21.7	3731	874.78	2856.17	1515.43	406.62	1922
21.8	3720	873.14	2846.36	1463.84	407.17	1871
21.9	3709	871.51	2837.26	1484.85	407.03	1892



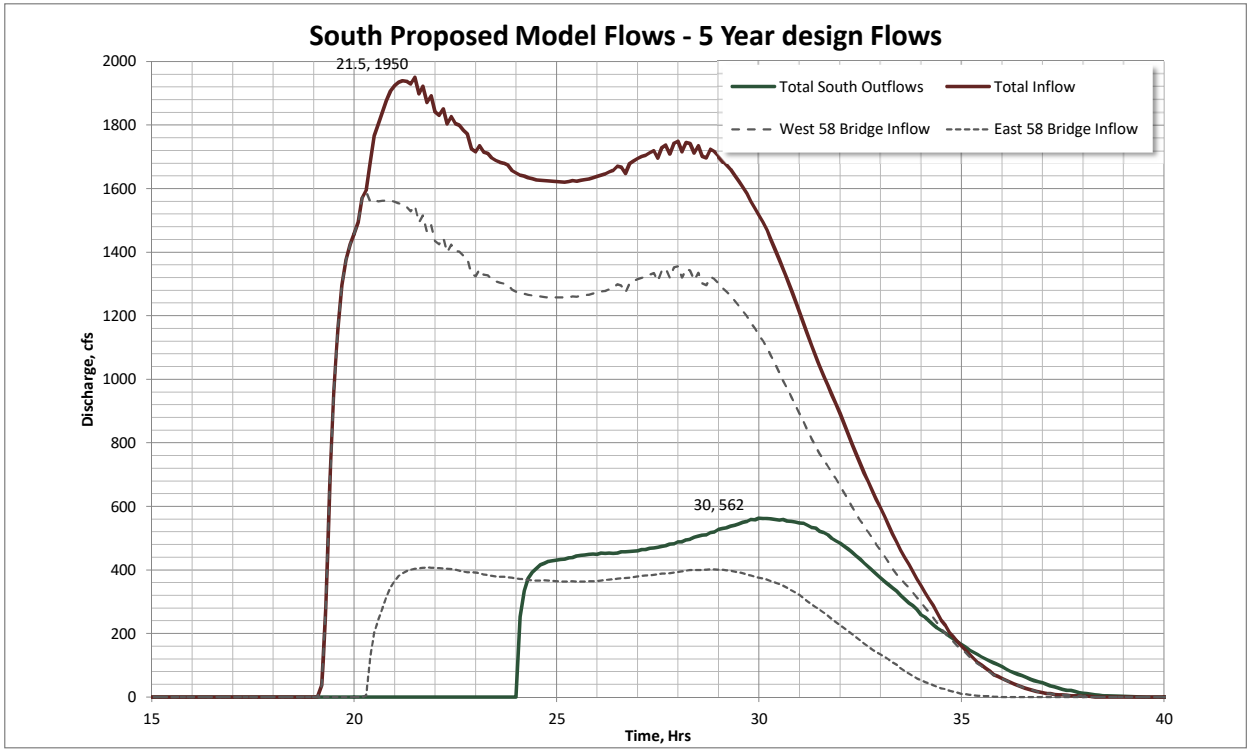
Time, Hrs	Total North Inflows	Walker Basin	Caliente Creek	West 58 Bridge Outflow Discharge, cfs	East 58 Bridge Outflow Discharge, cfs	Total Outflow Discharge, cfs
22.0	3699	869.97	2828.89	1434.96	406.43	1841
22.1	3690	868.6	2821.39	1425.24	405.81	1831
22.2	3682	867.41	2814.54	1445.38	405.09	1850
22.3	3675	866.36	2808.3	1399.39	403.66	1803
22.4	3668	865.42	2802.59	1424.03	402.3	1826
22.5	3662	864.57	2797.32	1403.78	400.25	1804
22.6	3656	863.83	2792.48	1401.25	397.77	1799
22.7	3652	863.28	2788.22	1388.23	394.72	1783
22.8	3647	862.91	2784.54	1379.75	392.93	1773
22.9	3644	862.71	2781.5	1331.5	392.99	1724
23.0	3642	862.67	2779.17	1323.95	391.83	1716
23.1	3640	862.73	2777.58	1344.84	389.64	1734
23.2	3639	862.82	2776.58	1328.85	385.99	1715
23.3	3639	862.89	2776.07	1326.98	383.7	1711
23.4	3639	862.94	2775.96	1314.81	381.59	1696
23.5	3639	863	2776.29	1308.44	379.8	1688
23.6	3640	863.13	2777.09	1304.15	378.86	1683
23.7	3642	863.39	2778.34	1301.25	378.06	1679
23.8	3644	863.75	2779.95	1297.12	376.78	1674
23.9	3646	864.22	2781.87	1281.67	375.04	1657
24.0	3649	864.77	2784.08	1276.21	373.37	1650
24.1	3652	865.44	2786.57	1270.82	371.68	1643
24.2	3655	866.14	2789.29	1268.61	370.27	1639
24.3	3659	866.86	2792.22	1265.76	368.79	1635
24.4	3663	867.6	2795.4	1263.25	367.62	1631
24.5	3667	868.35	2798.74	1260.56	366.78	1627
24.6	3671	869.14	2802.23	1260.21	366.22	1626
24.7	3676	869.94	2805.86	1258.14	367.11	1625
24.8	3680	870.77	2809.62	1257.99	366.18	1624
24.9	3685	871.65	2813.5	1258.05	364.87	1623
25.0	3690	872.6	2817.5	1257.33	364.34	1622
25.1	3695	873.62	2821.59	1257.58	363.37	1621
25.2	3700	874.71	2825.76	1257.72	362.89	1621
25.3	3706	875.85	2830.01	1258.8	363.42	1622
25.4	3711	877.06	2834.35	1260.39	364.43	1625
25.5	3717	878.31	2838.78	1259.94	363.34	1623
25.6	3723	879.62	2843.35	1262.34	363.42	1626
25.7	3729	880.95	2848	1264.58	363.57	1628
25.8	3735	882.31	2852.72	1266.14	363.98	1630
25.9	3741	883.66	2857.51	1269.85	364.71	1635
26.0	3747	885.02	2862.34	1272.42	365.79	1638
26.1	3754	886.36	2867.16	1275.9	366.8	1643
26.2	3760	887.68	2871.84	1278.14	368.19	1646
26.3	3765	888.67	2875.9	1283.11	369.23	1652
26.4	3767	888.35	2878.57	1287.07	370.71	1658
26.5	3764	884.92	2878.98	1298.96	371.98	1671
26.6	3757	880.73	2876.71	1294.51	373.27	1668
26.7	3749	875.72	2873.45	1272.65	374.62	1647
26.8	3738	869.17	2868.4	1302.31	375.89	1678
26.9	3722	860.91	2860.64	1308.88	377.85	1687
27.0	3700	851.41	2848.35	1315.26	379.21	1694
27.1	3670	839.36	2831.13	1319.26	381.45	1701
27.2	3636	825.79	2809.83	1322.28	382.37	1705
27.3	3595	811.41	2783.58	1329.07	383.35	1712
27.4	3552	796.93	2754.67	1334.21	384.74	1719
27.5	3506	783.55	2722.02	1308.77	386.43	1695
27.6	3458	770.69	2687.03	1340.91	388.37	1729
27.7	3409	758.01	2651.27	1348.84	388.59	1737

Time, Hrs	Total North Inflows	Walker Basin	Caliente Creek	West 58 Bridge Outflow Discharge, cfs	East 58 Bridge Outflow Discharge, cfs	Total Outflow Discharge, cfs
27.8	3361	745.41	2615.71	1318.83	389.97	1709
27.9	3310	732.87	2577.55	1351.79	391.37	1743
28.0	3257	720.19	2536.47	1355.65	393.41	1749
28.1	3201	707.5	2493.92	1320.37	395.78	1716
28.2	3146	694.8	2450.85	1347.59	397.74	1745
28.3	3090	682.09	2408.02	1342.34	399.3	1742
28.4	3035	669.24	2366.09	1311.86	399.49	1711
28.5	2981	656.16	2324.64	1335.4	400.03	1735
28.6	2926	642.78	2283.32	1302.4	399.68	1702
28.7	2871	628.76	2241.89	1295.61	400.58	1696
28.8	2814	614.4	2200.01	1321.94	401.55	1723
28.9	2757	599.78	2157.59	1315.31	401.62	1717
29.0	2700	584.98	2114.63	1301.87	401.11	1703
29.1	2641	570.29	2071.16	1287.17	400.15	1687
29.2	2583	555.76	2027.28	1276.05	398.44	1674
29.3	2525	541.55	1983.57	1262.99	397.11	1660
29.4	2468	527.83	1940.26	1246.56	394.88	1641
29.5	2412	514.45	1897.51	1231.15	392.79	1624
29.6	2358	501.6	1856.25	1214.78	389.39	1604
29.7	2305	489.33	1815.95	1198.35	385.42	1584
29.8	2254	477.41	1776.54	1177.88	382.25	1560
29.9	2204	466.14	1738.28	1159.75	378.13	1538
30.0	2156	455.3	1700.95	1140.18	375.8	1516
30.1	2109	444.77	1664.34	1121.08	373.2	1494
30.2	2064	434.91	1628.69	1099.77	369.48	1469
30.3	2019	425.29	1594.2	1073.34	364.71	1438
30.4	1977	416.09	1560.42	1047.74	360.34	1408
30.5	1935	407.33	1527.6	1020.71	355.5	1376
30.6	1895	398.76	1495.89	995.15	350.33	1345
30.7	1856	390.78	1464.83	970.66	342.73	1313
30.8	1818	382.97	1434.76	943.54	335.09	1279
30.9	1781	375.55	1405.62	918.74	328.76	1248
31.0	1745	368.41	1377.03	892	320.62	1213
31.1	1711	361.49	1349.6	865.55	311.11	1177
31.2	1678	354.92	1322.91	838.42	301.26	1140
31.3	1645	348.45	1296.87	812.79	292.33	1105
31.4	1614	342.37	1272.09	788	282.85	1071
31.5	1584	336.37	1247.79	765.65	274.25	1040
31.6	1555	330.65	1224.44	746.03	265.33	1011
31.7	1527	325.08	1201.87	725.84	255.61	981
31.8	1499	319.7	1179.78	705.69	245.91	952
31.9	1473	314.49	1158.77	686.93	235.92	923
32.0	1448	309.41	1138.09	665.54	226.65	892
32.1	1423	304.5	1118.26	643.49	217.08	861
32.2	1399	299.66	1098.96	621.1	207.47	829
32.3	1375	295	1080.17	599.11	197.76	797
32.4	1353	290.37	1062.14	576.42	188.36	765
32.5	1330	285.91	1044.33	555.75	178.23	734
32.6	1309	281.48	1027.41	537.11	168.12	705
32.7	1288	277.22	1010.68	518.89	158.98	678
32.8	1268	272.98	994.59	500.12	149.23	649
32.9	1248	268.92	978.82	480	141.7	622
33.0	1228	264.86	963.49	461.63	134.25	596
33.1	1210	260.98	948.57	442.49	126.57	569
33.2	1191	257.11	933.92	424.49	118.58	543
33.3	1173	253.4	919.74	404.12	108.79	513
33.4	1155	249.69	905.71	385.57	101.25	487
33.5	1138	246.15	892.18	372.09	90.04	462

Time, Hrs	Total North Inflows	Walker Basin	Caliente Creek	West 58 Bridge Outflow Discharge, cfs	East 58 Bridge Outflow Discharge, cfs	Total Outflow Discharge, cfs
33.6	1121	242.61	878.72	357.69	81.01	439
33.7	1105	239.24	865.77	343.79	73.53	417
33.8	1089	235.86	852.88	329.34	66.19	396
33.9	1073	232.64	840.47	313.16	58.38	372
34.0	1058	229.43	828.12	297.04	53.18	350
34.1	1043	226.33	816.22	282.03	46.96	329
34.2	1028	223.27	804.41	266.28	41.7	308
34.3	1013	220.29	793.02	249.93	37.54	287
34.4	999	217.35	781.72	233.46	32.25	266
34.5	985	214.46	770.79	214.28	27	241
34.6	972	211.62	759.95	200.69	24.9	226
34.7	958	208.82	749.44	185.08	19.6	205
34.8	945	206.08	738.99	173.54	17.08	191
34.9	932	203.36	728.86	161.42	13.45	175
35.0	920	200.72	718.78	150.7	10.38	161
35.1	907	198.09	709.03	139.38	8.71	148
35.2	895	195.55	699.3	127.12	7.26	134
35.3	883	193.02	689.93	115.65	6.16	122
35.4	871	190.56	680.57	104.64	3.78	108
35.5	860	188.14	671.56	96.17	4.26	100
35.6	848	185.75	662.57	87.88	2.59	90
35.7	837	183.42	653.88	78.47	2.46	81
35.8	826	181.09	645.26	69.64	1.12	71
35.9	816	178.83	636.87	64.56	0.37	65
36.0	805	176.57	628.59	58.45	0	58
36.1	795	174.35	620.47	52.11	0	52
36.2	785	172.14	612.5	47.1	0	47
36.3	775	169.96	604.64	40.72	0	41
36.4	765	167.81	596.96	36.05	0	36
36.5	755	165.66	589.32	30.77	0	31
36.6	745	163.57	581.92	26.26	0	26
36.7	736	161.47	574.52	22.51	0	23
36.8	727	159.42	567.35	19.61	0	20
36.9	718	157.4	560.21	15.85	0	16
37.0	709	155.39	553.22	13.79	0	14
37.1	700	153.45	546.33	11.25	0	11
37.2	691	151.51	539.52	11.14	0	11
37.3	683	149.63	532.87	7.42	0	7
37.4	674	147.78	526.23	6.97	0	7
37.5	666	145.94	519.81	6.37	0	6
37.6	658	144.17	513.4	6.14	0	6
37.7	650	142.39	507.14	3.97	0	4
37.8	642	140.67	500.95	4.34	0	4
37.9	634	138.97	494.82	3.51	0	4
38.0	626	137.27	488.85	1.7	0	2
38.1	619	135.63	482.88	2.71	0	3
38.2	611	133.99	477.11	1.38	0	1
90.0				0	0	0

South Proposed Model Flows - 5 Year design Flows

Peak--->	1590 cfs	407 cfs	562 cfs
Time, Hrs	West 58 Bridge Inflow Discharge, cfs	East 58 Bridge Inflow Discharge, cfs	Total South Outflows Discharge, cfs
0	0	0	0
19.1	1.09	0	0
19.2	37.24	0	0
19.3	285.44	0	0
19.4	662.07	0	0
19.5	962.17	0	0
19.6	1163.17	0	0
19.7	1295.54	0	0
19.8	1376.3	0	0
19.9	1424.32	0	0
20	1457.24	0	0
20.1	1494.59	0	0
20.2	1569.56	0	0
20.3	1590	4.78	0
20.4	1558.48	127.2	0
20.5	1562.91	202.83	0
20.6	1559.27	243.85	0
20.7	1561.71	279.61	0
20.8	1562.54	314.88	0
20.9	1562.63	344.96	0
21	1558.74	365.79	0
21.1	1553.82	380.17	0
21.2	1550.3	389.55	0
21.3	1541.38	396.16	0
21.4	1528.89	400.37	0
21.5	1546.71	403.33	0
21.6	1492.84	405.11	0
21.7	1515.43	406.62	0
21.8	1463.84	407.17	0
21.9	1484.85	407.03	0
22	1434.96	406.43	0
22.1	1425.24	405.81	0
22.2	1445.38	405.09	0
22.3	1399.39	403.66	0
22.4	1424.03	402.3	0
22.5	1403.78	400.25	0
22.6	1401.25	397.77	0
22.7	1388.23	394.72	0
22.8	1379.75	392.93	0
22.9	1331.5	392.99	0
23	1323.95	391.83	0
23.1	1344.84	389.64	0
23.2	1328.85	385.99	0
23.3	1326.98	383.7	0
23.4	1314.81	381.59	0
23.5	1308.44	379.8	0
23.6	1304.15	378.86	0
23.7	1301.25	378.06	0
23.8	1297.12	376.78	0
23.9	1281.67	375.04	0
24	1276.21	373.37	0



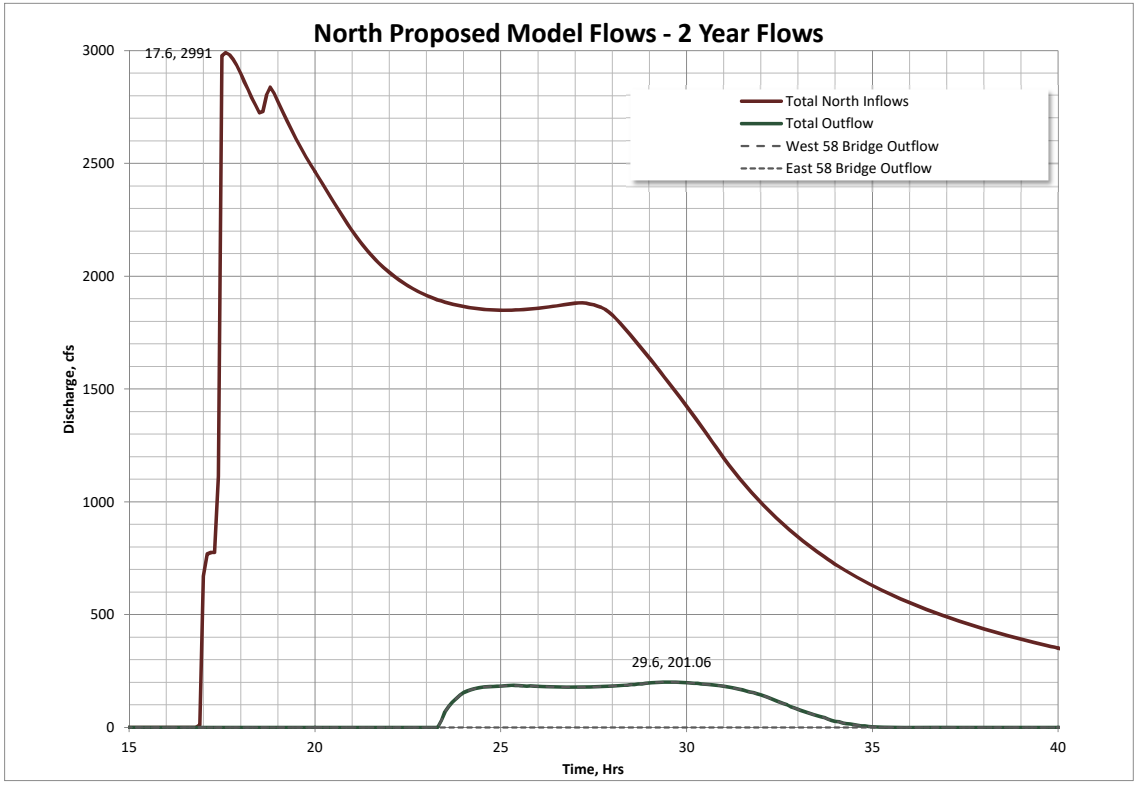
Time, Hrs	West 58 Bridge Inflow Discharge, cfs	East 58 Bridge Inflow Discharge, cfs	Total South Outflows Discharge, cfs
24.1	1270.82	371.68	252
24.2	1268.61	370.27	334
24.3	1265.76	368.79	374
24.4	1263.25	367.62	392
24.5	1260.56	366.78	405
24.6	1260.21	366.22	415
24.7	1258.14	367.11	421
24.8	1257.99	366.18	427
24.9	1258.05	364.87	429
25	1257.33	364.34	431
25.1	1257.58	363.37	433
25.2	1257.72	362.89	434
25.3	1258.8	363.42	438
25.4	1260.39	364.43	439
25.5	1259.94	363.34	444
25.6	1262.34	363.42	446
25.7	1264.58	363.57	447
25.8	1266.14	363.98	449
25.9	1269.85	364.71	450
26	1272.42	365.79	449
26.1	1275.9	366.8	453
26.2	1278.14	368.19	452
26.3	1283.11	369.23	453
26.4	1287.07	370.71	452
26.5	1298.96	371.98	453
26.6	1294.51	373.27	457
26.7	1272.65	374.62	457
26.8	1302.31	375.89	458
26.9	1308.88	377.85	459
27	1315.26	379.21	460
27.1	1319.26	381.45	464
27.2	1322.28	382.37	464
27.3	1329.07	383.35	468
27.4	1334.21	384.74	469
27.5	1308.77	386.43	471
27.6	1340.91	388.37	474
27.7	1348.84	388.59	476
27.8	1318.83	389.97	481
27.9	1351.79	391.37	482
28	1355.65	393.41	488
28.1	1320.37	395.78	488
28.2	1347.59	397.74	494
28.3	1342.34	399.3	496
28.4	1311.86	399.49	503
28.5	1335.4	400.03	506
28.6	1302.4	399.68	510
28.7	1295.61	400.58	510
28.8	1321.94	401.55	517
28.9	1315.31	401.62	519
29	1301.87	401.11	528
29.1	1287.17	400.15	530
29.2	1276.05	398.44	533
29.3	1262.99	397.11	538

Time, Hrs	West 58 Bridge Inflow Discharge, cfs	East 58 Bridge Inflow Discharge, cfs	Total South Outflows Discharge, cfs
29.4	1246.56	394.88	541
29.5	1231.15	392.79	545
29.6	1214.78	389.39	550
29.7	1198.35	385.42	552
29.8	1177.88	382.25	559
29.9	1159.75	378.13	557
30	1140.18	375.8	562
30.1	1121.08	373.2	561
30.2	1099.77	369.48	561
30.3	1073.34	364.71	560
30.4	1047.74	360.34	559
30.5	1020.71	355.5	557
30.6	995.15	350.33	558
30.7	970.66	342.73	554
30.8	943.54	335.09	552
30.9	918.74	328.76	550
31	892	320.62	548
31.1	865.55	311.11	547
31.2	838.42	301.26	540
31.3	812.79	292.33	533
31.4	788	282.85	531
31.5	765.65	274.25	522
31.6	746.03	265.33	517
31.7	725.84	255.61	510
31.8	705.69	245.91	499
31.9	686.93	235.92	491
32	665.54	226.65	484
32.1	643.49	217.08	475
32.2	621.1	207.47	466
32.3	599.11	197.76	456
32.4	576.42	188.36	444
32.5	555.75	178.23	433
32.6	537.11	168.12	422
32.7	518.89	158.98	411
32.8	500.12	149.23	398
32.9	480	141.7	387
33	461.63	134.25	375
33.1	442.49	126.57	363
33.2	424.49	118.58	354
33.3	404.12	108.79	344
33.4	385.57	101.25	333
33.5	372.09	90.04	320
33.6	357.69	81.01	308
33.7	343.79	73.53	296
33.8	329.34	66.19	288
33.9	313.16	58.38	276
34	297.04	53.18	259
34.1	282.03	46.96	251
34.2	266.28	41.7	240
34.3	249.93	37.54	227
34.4	233.46	32.25	217
34.5	214.28	27	209
34.6	200.69	24.9	201

Time, Hrs	West 58 Bridge Inflow Discharge, cfs	East 58 Bridge Inflow Discharge, cfs	Total South Outflows Discharge, cfs
34.7	185.08	19.6	192
34.8	173.54	17.08	183
34.9	161.42	13.45	174
35	150.7	10.38	166
35.1	139.38	8.71	157
35.2	127.12	7.26	148
35.3	115.65	6.16	140
35.4	104.64	3.78	133
35.5	96.17	4.26	127
35.6	87.88	2.59	120
35.7	78.47	2.46	113
35.8	69.64	1.12	108
35.9	64.56	0.37	102
36	58.45	0	96
36.1	52.11	0	88
36.2	47.1	0	82
36.3	40.72	0	76
36.4	36.05	0	71
36.5	30.77	0	67
36.6	26.26	0	61
36.7	22.51	0	56
36.8	19.61	0	51
36.9	15.85	0	48
37	13.79	0	45
37.1	11.25	0	40
37.2	11.14	0	35
37.3	7.42	0	32
37.4	6.97	0	28
37.5	6.37	0	24
37.6	6.14	0	21
37.7	3.97	0	21
37.8	4.34	0	18
37.9	3.51	0	14
38	1.7	0	12
38.1	2.71	0	10
38.2	1.38	0	9
38.3	0	0	7
38.4	0	0	6
38.5	0	0	4
38.6	0	0	4
38.7	0	0	4
38.8	0	0	3
38.9	0	0	3
39	0	0	2
39.1	0	0	2
39.2	0	0	2
39.3	0	0	1
90	0	0	0

North Proposed Model Flows - 2 Year Flows

Peak--->	2991 cfs	775 cfs	2233 cfs	201 cfs	0 cfs	201 cfs
Time, Hrs	Total North Inflows	Walker Basin	Caliente Creek	West 58 Bridge Outflow Discharge, cfs	East 58 Bridge Outflow Discharge, cfs	Total Outflow Discharge, cfs
0.0	0	0	0	0	0	0
1.9	1	0	0	0	0	0
3.3	2	1	1	0	0	0
5.8	1	1	0	0	0	0
8.5	0	0	0	0	0	0
16.9	11	10.71	0.01	0	0	0
17.0	670	670.15	0.01	0	0	0
17.1	768	767.99	0.01	0	0	0
17.2	775	775.24	0.01	0	0	0
17.3	775	774.89	0.03	0	0	0
17.4	1113	770.69	342.21	0	0	0
17.5	2977	764.06	2213.02	0	0	0
17.6	2991	757.69	2233.02	0	0	0
17.7	2981	748.09	2233.34	0	0	0
17.8	2961	740.91	2220.39	0	0	0
17.9	2933	734.01	2199.06	0	0	0
18.0	2897	726.7	2170.61	0	0	0
18.1	2862	719	2142.62	0	0	0
18.2	2827	711.26	2115.36	0	0	0
18.3	2792	702.4	2089.79	0	0	0
18.4	2758	692.32	2065.98	0	0	0
18.5	2725	681.4	2043.5	0	0	0
18.6	2730	670.27	2059.55	0	0	0
18.7	2805	659.42	2145.31	0	0	0
18.8	2838	649.09	2189.37	0	0	0
18.9	2811	639.44	2171.54	0	0	0
19.0	2775	630.55	2144.38	0	0	0
19.1	2740	622.38	2117.35	0	0	0
19.2	2705	614.81	2090.48	0	0	0
19.3	2671	607.66	2063.55	0	0	0
19.4	2638	600.82	2037.23	0	0	0
19.5	2606	594.31	2011.59	0	0	0
19.6	2575	588.1	1986.92	0	0	0
19.7	2546	582.15	1963.47	0	0	0
19.8	2517	576.37	1941.04	0	0	0
19.9	2490	570.62	1919.53	0	0	0
20.0	2464	564.77	1898.81	0	0	0
20.1	2437	558.68	1878.63	0	0	0
20.2	2411	552.29	1858.71	0	0	0
20.3	2384	545.64	1838.8	0	0	0
20.4	2358	538.87	1818.75	0	0	0
20.5	2331	532.15	1798.49	0	0	0
20.6	2304	525.56	1778.08	0	0	0
20.7	2277	519.21	1757.64	0	0	0
20.8	2251	513.16	1737.41	0	0	0
20.9	2225	507.44	1717.68	0	0	0
21.0	2201	502.07	1698.67	0	0	0
21.1	2178	497.11	1680.5	0	0	0
21.2	2156	492.49	1663.15	0	0	0
21.3	2135	488.14	1646.55	0	0	0
21.4	2115	484.06	1630.64	0	0	0
21.5	2096	480.25	1615.46	0	0	0
21.6	2078	476.72	1601.05	0	0	0
21.7	2061	473.53	1587.42	0	0	0
21.8	2045	470.67	1574.58	0	0	0
21.9	2031	468.1	1562.5	0	0	0



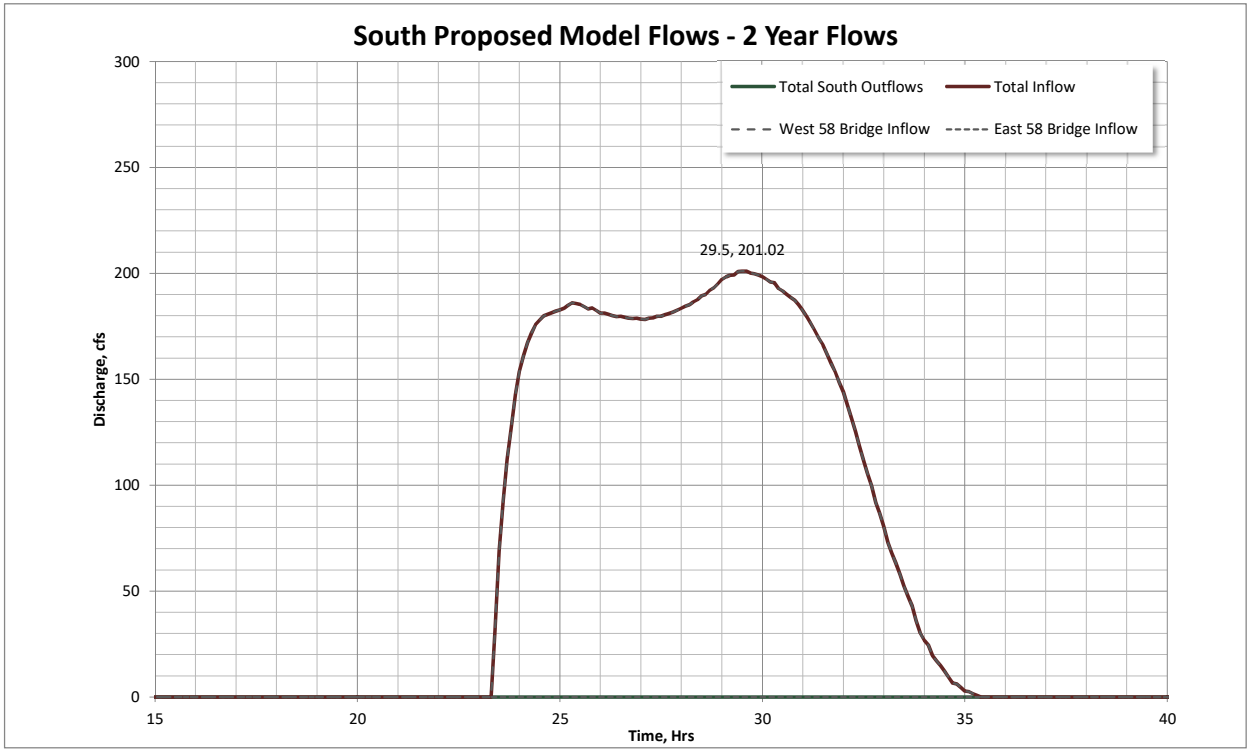
Time, Hrs	Total North Inflows	Walker Basin	Caliente Creek	West 58 Bridge Outflow Discharge, cfs	East 58 Bridge Outflow Discharge, cfs	Total Outflow Discharge, cfs
22.0	2017	465.77	1551.09	0	0	0
22.1	2004	463.65	1540.26	0	0	0
22.2	1992	461.67	1529.92	0	0	0
22.3	1980	459.81	1520.09	0	0	0
22.4	1969	458.05	1510.65	0	0	0
22.5	1958	456.42	1501.6	0	0	0
22.6	1948	454.96	1492.95	0	0	0
22.7	1938	453.71	1484.73	0	0	0
22.8	1930	452.72	1476.98	0	0	0
22.9	1922	451.92	1469.79	0	0	0
23.0	1914	451.24	1463.12	0	0	0
23.1	1908	450.63	1456.9	0	0	0
23.2	1901	450.05	1451.1	0	0	0
23.3	1895	449.48	1445.71	0	0	0
23.4	1890	448.94	1440.73	31.1	0	31
23.5	1885	448.42	1436.2	68.87	0	69
23.6	1880	447.94	1432.15	93.02	0	93
23.7	1876	447.5	1428.46	112.23	0	112
23.8	1872	447.08	1425.11	127.31	0	127
23.9	1869	446.71	1422.02	142.82	0	143
24.0	1866	446.38	1419.15	153.66	0	154
24.1	1863	446.1	1416.45	160.97	0	161
24.2	1860	445.91	1413.92	167.4	0	167
24.3	1857	445.82	1411.59	171.65	0	172
24.4	1855	445.86	1409.47	175.85	0	176
24.5	1854	445.98	1407.61	177.95	0	178
24.6	1852	446.15	1406.02	179.83	0	180
24.7	1851	446.33	1404.75	180.66	0	181
24.8	1850	446.51	1403.72	181.34	0	181
24.9	1850	446.67	1402.92	182.16	0	182
25.0	1849	446.82	1402.36	182.8	0	183
25.1	1849	446.98	1402.04	183.44	0	183
25.2	1849	447.17	1401.95	184.91	0	185
25.3	1849	447.4	1402.08	186.14	0	186
25.4	1850	447.69	1402.36	185.73	0	186
25.5	1851	448.03	1402.8	185.29	0	185
25.6	1852	448.39	1403.39	184.3	0	184
25.7	1853	448.79	1404.15	183.21	0	183
25.8	1854	449.22	1405.07	183.65	0	184
25.9	1856	449.67	1406.16	182.5	0	183
26.0	1858	450.13	1407.37	181.27	0	181
26.1	1859	450.61	1408.71	181.31	0	181
26.2	1861	451.09	1410.19	180.6	0	181
26.3	1863	451.6	1411.79	179.98	0	180
26.4	1866	452.11	1413.53	179.6	0	180
26.5	1868	452.66	1415.36	179.77	0	180
26.6	1870	453.23	1417.26	179.32	0	179
26.7	1873	453.83	1419.23	178.77	0	179
26.8	1876	454.45	1421.27	178.69	0	179
26.9	1878	455.07	1423.36	178.79	0	179
27.0	1881	455.63	1425.44	178.43	0	178
27.1	1882	455.37	1427.05	178.29	0	178
27.2	1882	454.13	1427.75	178.87	0	179
27.3	1880	452.25	1427.54	178.97	0	179
27.4	1877	449.99	1426.64	179.77	0	180
27.5	1873	447.24	1425.39	179.8	0	180
27.6	1868	443.95	1423.56	180.43	0	180
27.7	1861	440	1421.28	181.14	0	181

Time, Hrs	Total North Inflows	Walker Basin	Caliente Creek	West 58 Bridge Outflow Discharge, cfs	East 58 Bridge Outflow Discharge, cfs	Total Outflow Discharge, cfs
27.8	1853	435.39	1417.98	181.67	0	182
27.9	1843	430.08	1412.5	182.55	0	183
28.0	1828	423.94	1404.12	183.55	0	184
28.1	1812	417.29	1394.37	184.39	0	184
28.2	1794	410.84	1383.22	185.17	0	185
28.3	1775	404.77	1370.69	186.48	0	186
28.4	1756	399.17	1357.11	187.53	0	188
28.5	1737	394.16	1342.88	189.43	0	189
28.6	1718	389.53	1328.37	189.99	0	190
28.7	1699	384.92	1313.7	191.93	0	192
28.8	1679	380.24	1298.95	193.2	0	193
28.9	1659	375.39	1283.77	195.01	0	195
29.0	1639	370.48	1268.02	197.08	0	197
29.1	1617	365.53	1251.69	198.34	0	198
29.2	1596	360.54	1235.05	199.1	0	199
29.3	1574	355.53	1218.48	199.2	0	199
29.4	1553	350.47	1202.11	200.95	0	201
29.5	1531	345.33	1186	201.02	0	201
29.6	1510	340.07	1170.21	201.06	0	201
29.7	1489	334.62	1154.64	200.09	0	200
29.8	1468	328.94	1139.05	199.86	0	200
29.9	1446	323.1	1123.39	199.21	0	199
30.0	1425	317.12	1107.6	198.35	0	198
30.1	1402	310.94	1091.5	197.27	0	197
30.2	1380	304.71	1075.14	195.91	0	196
30.3	1357	298.44	1058.51	195.53	0	196
30.4	1334	292.18	1041.62	192.84	0	193
30.5	1310	285.97	1024.4	191.7	0	192
30.6	1287	279.84	1007.02	190.22	0	190
30.7	1263	273.83	989.54	188.68	0	189
30.8	1240	267.98	972.03	187.33	0	187
30.9	1217	262.26	954.68	185.22	0	185
31.0	1194	256.73	937.53	182.25	0	182
31.1	1172	251.39	920.62	179.4	0	179
31.2	1150	246.18	904.17	176.59	0	177
31.3	1129	241.19	888.02	172.59	0	173
31.4	1109	236.36	872.16	169.19	0	169
31.5	1088	231.64	856.83	166.33	0	166
31.6	1069	227.18	841.87	161.97	0	162
31.7	1050	222.82	827.21	157.39	0	157
31.8	1032	218.61	813.04	153.6	0	154
31.9	1014	214.59	799.2	148.52	0	149
32.0	996	210.66	785.6	143.98	0	144
32.1	979	206.91	772.42	138.08	0	138
32.2	963	203.28	759.5	131.7	0	132
32.3	947	199.74	746.77	125.24	0	125
32.4	931	196.37	734.44	118.35	0	118
32.5	915	193.06	722.3	111.57	0	112
32.6	900	189.9	710.38	105.52	0	106
32.7	886	186.82	698.84	99.62	0	100
32.8	871	183.83	687.46	91.75	0	92
32.9	857	180.95	676.35	86.76	0	87
33.0	844	178.13	665.53	80.53	0	81
33.1	830	175.43	654.86	72.9	0	73
33.2	817	172.77	644.53	67.99	0	68
33.3	805	170.23	634.35	63.15	0	63
33.4	792	167.73	624.38	57.8	0	58
33.5	780	165.32	614.68	52.37	0	52

Time, Hrs	Total North Inflows	Walker Basin	Caliente Creek	West 58 Bridge Outflow Discharge, cfs	East 58 Bridge Outflow Discharge, cfs	Total Outflow Discharge, cfs
33.6	768	162.97	605.09	47.45	0	47
33.7	757	160.67	595.83	42.92	0	43
33.8	745	158.44	586.73	36.13	0	36
33.9	734	156.25	577.84	30.25	0	30
34.0	723	154.12	569.23	26.64	0	27
34.1	713	152.01	560.73	24.57	0	25
34.2	703	149.98	552.59	19.67	0	20
34.3	693	147.95	544.55	17.11	0	17
34.4	683	146	536.78	14.91	0	15
34.5	673	144.05	529.16	12.24	0	12
34.6	664	142.17	521.73	9.13	0	9
34.7	655	140.31	514.51	6.62	0	7
34.8	646	138.51	507.39	6.09	0	6
34.9	637	136.72	500.51	4.55	0	5
35.0	629	134.99	493.68	2.84	0	3
35.1	620	133.28	487.11	2.56	0	3
35.2	612	131.62	480.59	1.58	0	2
35.3	604	129.98	474.27	0.73	0	1
35.4	596	128.38	468.03	0	0	0
35.5	589	126.79	461.95	0	0	0
35.6	581	125.26	455.97	0	0	0
35.7	574	123.73	450.11	0	0	0
35.8	567	122.25	444.38	0	0	0
35.9	560	120.78	438.74	0	0	0
36.0	553	119.36	433.24	0	0	0
36.1	546	117.94	427.81	0	0	0
36.2	539	116.57	422.52	0	0	0
36.3	532	115.2	417.29	0	0	0
36.4	526	113.87	412.21	0	0	0
36.5	520	112.55	407.17	0	0	0
36.6	514	111.26	402.28	0	0	0
36.7	507	109.98	397.43	0	0	0
36.8	501	108.73	392.71	0	0	0
36.9	496	107.49	388.03	0	0	0
37.0	490	106.27	383.48	0	0	0
37.1	484	105.06	378.95	0	0	0
37.2	478	103.87	374.55	0	0	0
37.3	473	102.7	370.17	0	0	0
37.4	467	101.54	365.91	0	0	0
37.5	462	100.42	361.69	0	0	0
37.6	457	99.29	357.56	0	0	0
37.7	452	98.2	353.48	0	0	0
37.8	447	97.11	349.48	0	0	0
37.9	442	96.05	345.54	0	0	0
38.0	437	94.99	341.66	0	0	0
38.1	432	93.96	337.85	0	0	0
38.2	427	92.94	334.08	0	0	0
90.0				0	0	0

South Proposed Model Flows - 2 Year Flows

Peak--->	201 cfs	0 cfs	201 cfs	0 cfs
Time, Hrs	West 58 Bridge Inflow Discharge, cfs	East 58 Bridge Inflow Discharge, cfs	Total Inflow Discharge, cfs	Total South Outflows Discharge, cfs
0	0	0	0	0
19.1	0	0	0	0
19.2	0	0	0	0
19.3	0	0	0	0
19.4	0	0	0	0
19.5	0	0	0	0
19.6	0	0	0	0
19.7	0	0	0	0
19.8	0	0	0	0
19.9	0	0	0	0
20	0	0	0	0
20.1	0	0	0	0
20.2	0	0	0	0
20.3	0	0	0	0
20.4	0	0	0	0
20.5	0	0	0	0
20.6	0	0	0	0
20.7	0	0	0	0
20.8	0	0	0	0
20.9	0	0	0	0
21	0	0	0	0
21.1	0	0	0	0
21.2	0	0	0	0
21.3	0	0	0	0
21.4	0	0	0	0
21.5	0	0	0	0
21.6	0	0	0	0
21.7	0	0	0	0
21.8	0	0	0	0
21.9	0	0	0	0
22	0	0	0	0
22.1	0	0	0	0
22.2	0	0	0	0
22.3	0	0	0	0
22.4	0	0	0	0
22.5	0	0	0	0
22.6	0	0	0	0
22.7	0	0	0	0
22.8	0	0	0	0
22.9	0	0	0	0
23	0	0	0	0
23.1	0	0	0	0
23.2	0	0	0	0
23.3	0	0	0	0
23.4	31.1	0	31	0
23.5	68.87	0	69	0
23.6	93.02	0	93	0
23.7	112.23	0	112	0
23.8	127.31	0	127	0
23.9	142.82	0	143	0
24	153.66	0	154	0



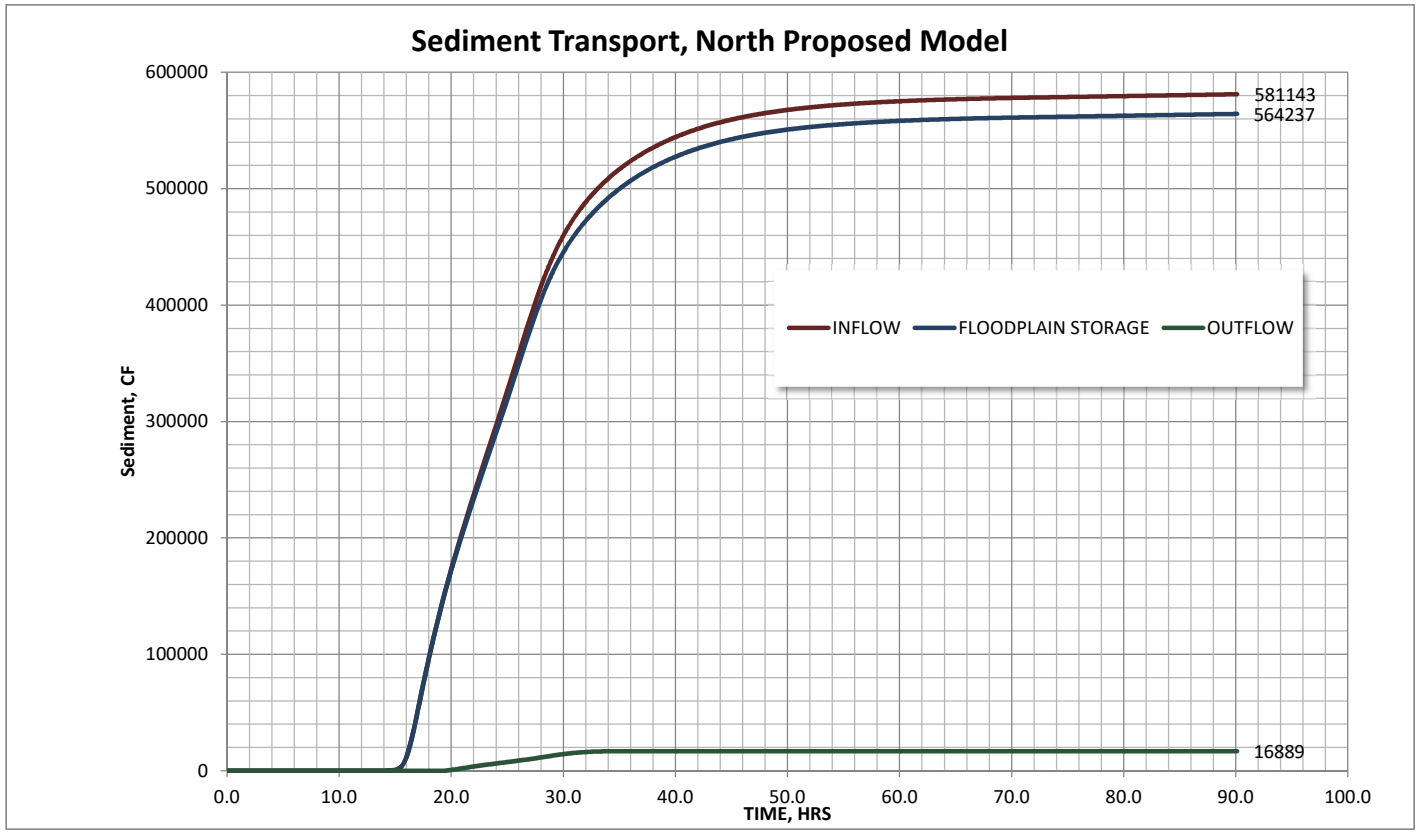
Time, Hrs	West 58 Bridge Inflow Discharge, cfs	East 58 Bridge Inflow Discharge, cfs	Total Inflow Discharge, cfs	Total South Outflows Discharge, cfs
24.1	160.97	0	161	0
24.2	167.4	0	167	0
24.3	171.65	0	172	0
24.4	175.85	0	176	0
24.5	177.95	0	178	0
24.6	179.83	0	180	0
24.7	180.66	0	181	0
24.8	181.34	0	181	0
24.9	182.16	0	182	0
25	182.8	0	183	0
25.1	183.44	0	183	0
25.2	184.91	0	185	0
25.3	186.14	0	186	0
25.4	185.73	0	186	0
25.5	185.29	0	185	0
25.6	184.3	0	184	0
25.7	183.21	0	183	0
25.8	183.65	0	184	0
25.9	182.5	0	183	0
26	181.27	0	181	0
26.1	181.31	0	181	0
26.2	180.6	0	181	0
26.3	179.98	0	180	0
26.4	179.6	0	180	0
26.5	179.77	0	180	0
26.6	179.32	0	179	0
26.7	178.77	0	179	0
26.8	178.69	0	179	0
26.9	178.79	0	179	0
27	178.43	0	178	0
27.1	178.29	0	178	0
27.2	178.87	0	179	0
27.3	178.97	0	179	0
27.4	179.77	0	180	0
27.5	179.8	0	180	0
27.6	180.43	0	180	0
27.7	181.14	0	181	0
27.8	181.67	0	182	0
27.9	182.55	0	183	0
28	183.55	0	184	0
28.1	184.39	0	184	0
28.2	185.17	0	185	0
28.3	186.48	0	186	0
28.4	187.53	0	188	0
28.5	189.43	0	189	0
28.6	189.99	0	190	0
28.7	191.93	0	192	0
28.8	193.2	0	193	0
28.9	195.01	0	195	0
29	197.08	0	197	0
29.1	198.34	0	198	0
29.2	199.1	0	199	0
29.3	199.2	0	199	0

Time, Hrs	West 58 Bridge Inflow Discharge, cfs	East 58 Bridge Inflow Discharge, cfs	Total Inflow Discharge, cfs	Total South Outflows Discharge, cfs
29.4	200.95	0	201	0
29.5	201.02	0	201	0
29.6	201.06	0	201	0
29.7	200.09	0	200	0
29.8	199.86	0	200	0
29.9	199.21	0	199	0
30	198.35	0	198	0
30.1	197.27	0	197	0
30.2	195.91	0	196	0
30.3	195.53	0	196	0
30.4	192.84	0	193	0
30.5	191.7	0	192	0
30.6	190.22	0	190	0
30.7	188.68	0	189	0
30.8	187.33	0	187	0
30.9	185.22	0	185	0
31	182.25	0	182	0
31.1	179.4	0	179	0
31.2	176.59	0	177	0
31.3	172.59	0	173	0
31.4	169.19	0	169	0
31.5	166.33	0	166	0
31.6	161.97	0	162	0
31.7	157.39	0	157	0
31.8	153.6	0	154	0
31.9	148.52	0	149	0
32	143.98	0	144	0
32.1	138.08	0	138	0
32.2	131.7	0	132	0
32.3	125.24	0	125	0
32.4	118.35	0	118	0
32.5	111.57	0	112	0
32.6	105.52	0	106	0
32.7	99.62	0	100	0
32.8	91.75	0	92	0
32.9	86.76	0	87	0
33	80.53	0	81	0
33.1	72.9	0	73	0
33.2	67.99	0	68	0
33.3	63.15	0	63	0
33.4	57.8	0	58	0
33.5	52.37	0	52	0
33.6	47.45	0	47	0
33.7	42.92	0	43	0
33.8	36.13	0	36	0
33.9	30.25	0	30	0
34	26.64	0	27	0
34.1	24.57	0	25	0
34.2	19.67	0	20	0
34.3	17.11	0	17	0
34.4	14.91	0	15	0
34.5	12.24	0	12	0
34.6	9.13	0	9	0

Time, Hrs	West 58 Bridge Inflow Discharge, cfs	East 58 Bridge Inflow Discharge, cfs	Total Inflow Discharge, cfs	Total South Outflows Discharge, cfs
34.7	6.62	0	7	0
34.8	6.09	0	6	0
34.9	4.55	0	5	0
35	2.84	0	3	0
35.1	2.56	0	3	0
35.2	1.58	0	2	0
35.3	0.73	0	1	0
35.4	0	0	0	0
35.5	0	0	0	0
35.6	0	0	0	0
35.7	0	0	0	0
35.8	0	0	0	0
35.9	0	0	0	0
36	0	0	0	0
36.1	0	0	0	0
36.2	0	0	0	0
36.3	0	0	0	0
36.4	0	0	0	0
36.5	0	0	0	0
36.6	0	0	0	0
36.7	0	0	0	0
36.8	0	0	0	0
36.9	0	0	0	0
37	0	0	0	0
37.1	0	0	0	0
37.2	0	0	0	0
37.3	0	0	0	0
37.4	0	0	0	0
37.5	0	0	0	0
37.6	0	0	0	0
37.7	0	0	0	0
37.8	0	0	0	0
37.9	0	0	0	0
38	0	0	0	0
38.1	0	0	0	0
38.2	0	0	0	0
38.3	0	0	0	0
38.4	0	0	0	0
38.5	0	0	0	0
38.6	0	0	0	0
38.7	0	0	0	0
38.8	0	0	0	0
38.9	0	0	0	0
39	0	0	0	0
39.1	0	0	0	0
39.2	0	0	0	0
39.3	0	0	0	0
90	0	0	0	0

Sediment Transport, North Proposed Model

TIME, HRS	INFLOW Sediment, CF	FLOODPLAIN STORAGE Sediment, CF	OUTFLOW Sediment, CF
0.1	0	0	0
1.0	1	1	0
2.0	5	5	0
3.0	17	17	0
4.0	39	39	0
5.0	64	64	0
6.0	80	80	0
7.0	90	90	0
8.0	96	96	0
9.0	101	101	0
10.0	104	104	0
11.0	107	107	0
12.0	109	109	0
13.0	111	111	0
14.0	120	120	0
15.0	645	645	0
16.0	11598	11598	0
17.0	50739	50739	0
18.0	96258	96258	0
19.0	136914	136914	0
20.0	172963	172300	663
21.0	205768	203673	2094
22.0	236729	233118	3611
23.0	266840	261851	4988
24.0	296728	290477	6251
25.0	326804	319334	7470
26.0	357270	348562	8709
27.0	387850	377829	10021
28.0	416194	404754	11440
29.0	440190	427276	12914
30.0	459736	445454	14283
31.0	475521	460162	15358
32.0	488506	472428	16078
33.0	499385	482872	16514
34.0	508678	491933	16746
35.0	516709	499864	16845
36.0	523704	506824	16880
37.0	529846	512957	16889
38.0	535256	518366	16889
39.0	540041	523152	16889
40.0	544284	527395	16889
41.0	548056	531167	16889

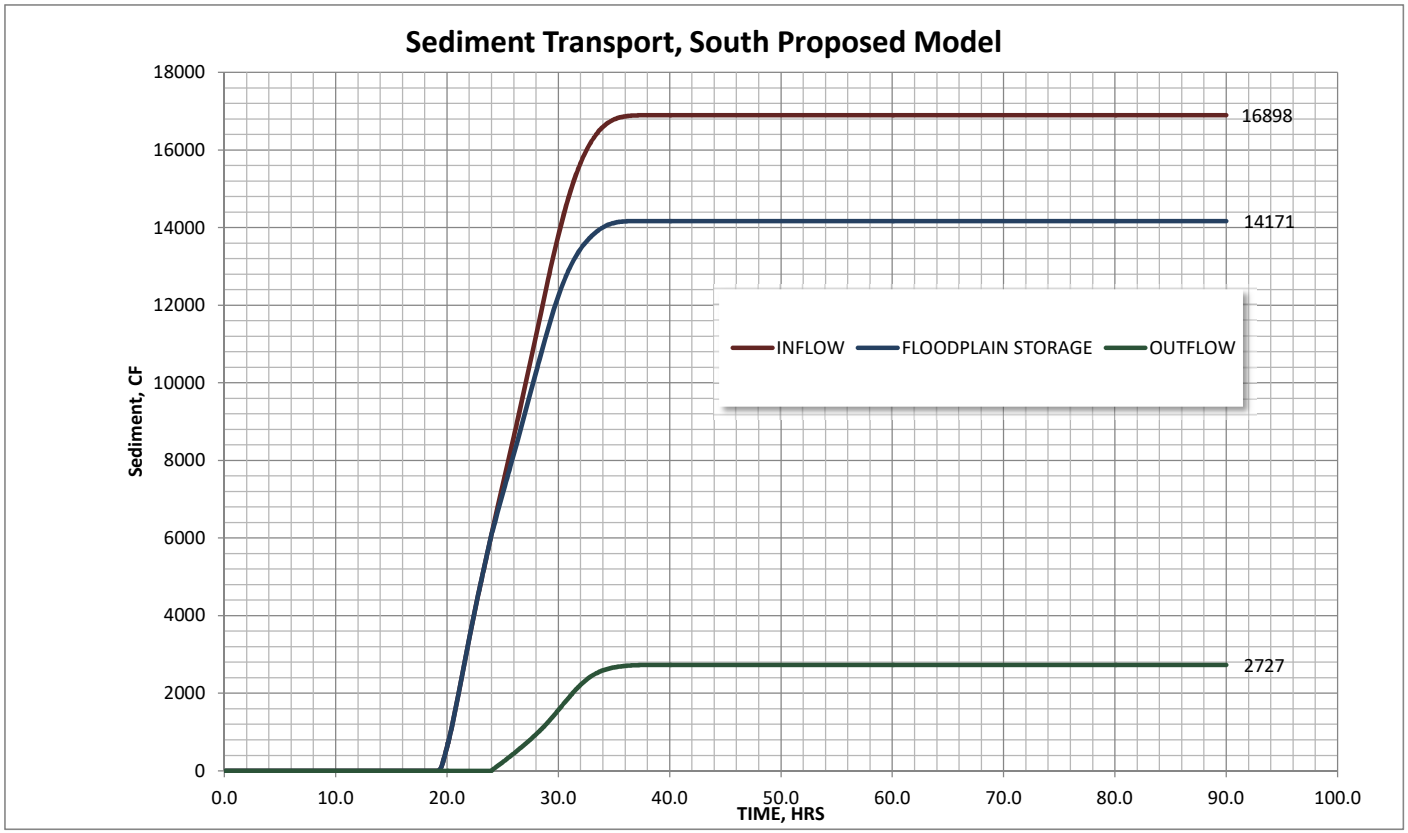


TIME, HRS	INFLOW Sediment, CF	FLOODPLAIN STORAGE Sediment, CF	OUTFLOW Sediment, CF
42.0	551410	534521	16889
43.0	554389	537499	16889
44.0	557030	540140	16889
45.0	559370	542481	16889
46.0	561445	544556	16889
47.0	563288	546398	16889
48.0	564924	548034	16889
49.0	566380	549490	16889
50.0	567676	550787	16889
51.0	568835	551945	16889
52.0	569868	552978	16889
54.0	571625	554735	16889
55.0	572373	555483	16889
56.0	573044	556155	16889
57.0	573650	556760	16889
58.0	574197	557308	16889
59.0	574691	557801	16889
60.0	575140	558251	16889
61.0	575547	558658	16889
62.0	575917	559028	16889
63.0	576256	559366	16889
64.0	576565	559675	16889
65.0	576848	559958	16889
66.0	577108	560218	16889
67.0	577347	560457	16889
68.0	577567	560677	16889
69.0	577771	560882	16889
70.0	577960	561071	16889
71.0	578135	561246	16889
72.0	578298	561408	16889
74.0	578612	561723	16889
75.0	578769	561880	16889
76.0	578926	562037	16889
77.0	579084	562194	16889
78.0	579241	562351	16889
79.0	579398	562508	16889
80.0	579555	562666	16889
81.0	579712	562823	16889
82.0	579870	562980	16889
83.0	580027	563137	16889
84.0	580184	563294	16889
85.0	580341	563452	16889
86.0	580498	563609	16889
87.0	580655	563766	16889

	INFLOW	FLOODPLAIN STORAGE	OUTFLOW
TIME, HRS	Sediment, CF	Sediment, CF	Sediment, CF
88.0	580813	563923	16889
89.0	580970	564080	16889
90.0	581127	564237	16889
90.1	581143	564253	16889

Sediment Transport, South Proposed Model

TIME, HRS	INFLOW Sediment, CF	FLOODPLAIN STORAGE Sediment, CF	OUTFLOW Sediment, CF
0.1	0	0	0
1.0	0	0	0
2.0	0	0	0
3.0	0	0	0
4.0	0	0	0
5.0	0	0	0
6.0	0	0	0
7.0	0	0	0
8.0	0	0	0
9.0	0	0	0
10.0	0	0	0
11.0	0	0	0
12.0	0	0	0
13.0	0	0	0
14.0	0	0	0
15.0	0	0	0
16.0	0	0	0
17.0	0	0	0
18.0	0	0	0
19.0	0	0	0
20.0	607	607	0
21.0	1935	1935	0
22.0	3413	3413	0
23.0	4799	4799	0
24.0	6104	6104	0
25.0	7362	7138	224
26.0	8616	8167	449
27.0	9897	9211	686
28.0	11221	10280	941
29.0	12549	11316	1232
30.0	13797	12234	1563
31.0	14857	12948	1909
32.0	15664	13447	2218
33.0	16234	13787	2447
34.0	16595	14007	2588
35.0	16787	14121	2665
36.0	16867	14161	2705
37.0	16892	14168	2724
38.0	16897	14170	2727
39.0	16898	14171	2727
40.0	16898	14171	2727
41.0	16898	14171	2727



	INFLOW	FLOODPLAIN STORAGE	OUTFLOW
TIME, HRS	Sediment, CF	Sediment, CF	Sediment, CF
42.0	16898	14171	2727
43.0	16898	14171	2727
44.0	16898	14171	2727
45.0	16898	14171	2727
46.0	16898	14171	2727
47.0	16898	14171	2727
48.0	16898	14171	2727
49.0	16898	14171	2727
50.0	16898	14171	2727
51.0	16898	14171	2727
52.0	16898	14171	2727
54.0	16898	14171	2727
55.0	16898	14171	2727
56.0	16898	14171	2727
57.0	16898	14171	2727
58.0	16898	14171	2727
59.0	16898	14171	2727
60.0	16898	14171	2727
61.0	16898	14171	2727
62.0	16898	14171	2727
63.0	16898	14171	2727
64.0	16898	14171	2727
65.0	16898	14171	2727
66.0	16898	14171	2727
67.0	16898	14171	2727
68.0	16898	14171	2727
69.0	16898	14171	2727
70.0	16898	14171	2727
71.0	16898	14171	2727
72.0	16898	14171	2727
74.0	16898	14171	2727
75.0	16898	14171	2727
76.0	16898	14171	2727
77.0	16898	14171	2727
78.0	16898	14171	2727
79.0	16898	14171	2727
80.0	16898	14171	2727
81.0	16898	14171	2727
82.0	16898	14171	2727
83.0	16898	14171	2727
84.0	16898	14171	2727
85.0	16898	14171	2727
86.0	16898	14171	2727
87.0	16898	14171	2727

	INFLOW	FLOODPLAIN STORAGE	OUTFLOW
TIME, HRS	Sediment, CF	Sediment, CF	Sediment, CF
88.0	16898	14171	2727
89.0	16898	14171	2727
90.0	16898	14171	2727

APPENDIX C

ENVIRONMENTAL CONDITIONS TECHNICAL MEMO

AECOM
401 West A Street
Suite 1200
San Diego, CA 92101
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619.610.7600 tel
619.610.7601 fax

Memorandum

To	Bill Black, Project Manager	Page	1
CC			
Subject	Caliente Creek Environmental Setting Memo		
From	AECOM Staff		
Date	October 14, 2016		

1. Environmental Setting

The proposed project consists of a roughly 3,200-acre portion of Caliente Creek and its associated floodplain in Kern County, California. Kern County is a diverse county, with the western half dominated by the flat agricultural landscape of the San Joaquin Valley, the southeastern portion consisting of the desert landscape of the Antelope Valley, and the Sierra Nevada mountains separating the two. The Project is entirely within the San Joaquin Valley, on the alluvial fan created by Caliente Creek as it emerges from the Sierra Nevada and enters the Valley. The Caliente Creek project area is approximately 15 miles southeast of the City of Bakersfield and approximately five miles north east of the community of Arvin.

Caliente Creek is an intermittent stream whose headwaters originate in the Sierra Nevada west of the project. As Caliente Creek enters the Project area, it has gathered flow from Tehachapi Creek and Walker Basin Creek.. Caliente Creek ends as a defined drainage feature approximately three miles downstream from the Project area, near Malaga Road. During storm events, however, water and sediment flows continue further into the Valley's agricultural fields and communities.

2. Regulatory Setting

Federal Endangered Species Act

Federal Endangered Species Act (16 United States Code [USC] 1531-1544, 87 Stat. 884, as amended) provides for the conservation of threatened and endangered species and their ecosystems. Section 9 of FESA prohibits actions that result in the "take" of threatened and endangered species, without special exemption. Under FESA, "take" is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct." "Harm" is further defined to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. "Harass" is defined as intentional or negligent actions that create the likelihood of injury to listed species by annoying them to such an extent as to significantly disrupt normal behavioral patterns

including, but not limited to, breeding, feeding, or sheltering (50 Code of Federal Regulations Section 17.3).

"Incidental take" is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Two sections of FESA contain provisions for allowing take that would otherwise be prohibited under Section 9. Section 7 requires Federal agencies proposing to conduct, fund, or approve an action that may result in take of listed species to ensure that their actions, including issuing permits, do not jeopardize the continued existence of listed species or destroy or adversely modify critical habitat. Under Section 7, Federal agencies must consult with the U.S. Fish and Wildlife Service (USFWS). The result of this formal consultation is either a Biological Opinion that includes a non-jeopardy determination and authorization for incidental take, or a jeopardy opinion prohibiting the incidental take.

Section 10(a) of FESA provides a method for permitting a state or private action (in the absence of a Federal nexus) that may result in the incidental take of threatened or endangered species from an otherwise lawful activity. Under Section 10(a), the project proponent must provide USFWS with an HCP for the affected species, and publish notification of the application for a permit in the Federal Register.

FESA also prohibits the adverse modification of critical habitat for listed species. Section 3(5)(A) of FESA defines critical habitat as "(i) the specific areas within the geographical area occupied by the species on which are found those physical or biological features (I) essential to the conservation of the species, and (I) which may require special management considerations or protection; and (i) specific areas outside the geographical area occupied by the species upon a determination by the Secretary of Commerce or the Secretary of the Interior (Secretary) that such areas are essential for the conservation of the species."

Formal consultation under Section 10 of FESA would be required if the proposed project has the potential to adversely affect the federally listed species detected within or adjacent to the proposed project, or destroy or adversely modify designated critical habitat.

Clean Water Act

Section 404 of the Clean Water Act (CWA) requires that project proponents obtain a permit from the U.S. Army Corps of Engineers (USACE) before performing any activity that involves any discharge of dredged or fill material into "waters of the U.S.," including wetlands. Waters of the U.S. include navigable waters of the U.S., interstate waters, all other waters where the use or degradation or destruction of the waters could affect interstate or foreign commerce, tributaries to any of these waters, and wetlands that meet any of these criteria or that are adjacent to any of these waters or their tributaries (33 Code of Federal Regulations [CFR] 328.3(a)). Many surface waters and wetlands in California meet the criteria for waters of the U.S. In accordance with Section 401 of the CWA, projects that apply for a USACE permit for discharge of dredged or fill material must obtain water quality

certification from the appropriate Regional Water Quality Control Board, indicating that the project will not violate California water quality standards.

Porter-Cologne Water Quality Control Act

Pursuant to Section 13000 et seq. of the California Water Code (CWC) (Porter-Cologne), the Regional Water Quality Control Board (RWQCB) is authorized to regulate any activity that would result in discharges of waste or fill material into waters of the state, including "isolated" waters and/or wetlands (e.g., vernal pools and seeps), saline waters, and groundwater within the boundaries of the state (CWC Section 13050[e]). Porter-Cologne authorizes the State Water Resources Control Board (SWRCB) to adopt, review, and revise policies for all waters of the state, and directs the RWQCB to develop and implement regional Basin Plans that recognize and are designed to maintain the unique characteristics of each region with regard to natural water quality, actual and potential beneficial uses, and addressing water quality problems of that region (CWC Section 13050[j]).

California Endangered Species Act
CFGC considers that threatened and endangered species are of ecological, educational, historical, recreational, esthetic, economic, and scientific value to the people of California. The State of California enacted CESA of 1973 (CFGC Sections 2050-2115.5) to protect threatened and endangered species. CESA prohibits take of any species that the California Fish and Game Commission determines to be a threatened or endangered species, and allows for take incidental to otherwise lawful development projects upon approval from California Department of Fish and Wildlife (CDFW). Under Section 2080 of the CFGC, "No person shall import into this state, export out of this state, or take, possess, purchase, or sell within this state, any species, or any part or product thereof, that the commission determines to be an endangered species or a threatened species, or attempt any of those acts, except as otherwise provided" in the CFGC.

Title 14, Section 670.2 of the California Code of Regulations (CCR), lists the subspecies and varieties of California native plants that are endangered, threatened (as defined by Section 2067 of the CFGC), and Section 670.5 lists the wildlife species and subspecies that are designated as threatened or endangered in California. California also has identified wildlife species of special concern. These species are rare, restricted in geographic distribution, or declining throughout their geographic range. Having been so designated, sensitive species are also considered in resource planning and management. The rare designation applies to plants only and includes those plants that are not threatened or endangered, but that could become eligible due to decreasing numbers or further restrictions to habitat. Title 14, Section 670.2 of the CCR lists the subspecies and varieties of California native plants that are rare (as defined by Section 1901 of the CFGC).

CESA contains provisions to authorize take of California-listed rare, threatened, or endangered species under Section 2081 of the CFGC, through issuance of permits or memorandums of understanding. In the case of a typical development project or similar

private action, the take must be deemed "incidental to an otherwise lawful activity." In most cases, the applicant must agree to mitigate proportionally to the impacts to identified species, implement protection measures for the affected species, and define the list of permitted/allowable activities. Any proposed impact to state-listed species within the proposed project area would require a permit under CESA.

Lake and Streambed Alteration Program

Pursuant to Section 1600 et seq. of the California Fish and Game Code, California Department of Fish and Wildlife (CDFW) is authorized to regulate any activity that would alter the flow, bed, channel, or bank of all streams and lakes. Jurisdictional waters of the state, as defined by Section 1600 regulations, include the "bed, channel, or bank of any river, stream, or lake designated by [CDFW] in which there is at any time an existing fish or wildlife resource or from which these resources derive benefit." In practice, CDFW usually extends its jurisdictional limit to the top of the bank of a stream or lake, or to the continuous outer edge of its riparian extent, whichever is wider.

Section 1601(a) is based on Title 14 California Code of Regulations (CCR) 720, which designates "all rivers, streams, lakes, and streambeds in the state of California, including all rivers, streams, and streambeds which may have intermittent flows of water" as regulated by the Lake and Streambed Alteration Program. Therefore, all semi-arid and arid region aquatic features with ephemeral flow (including some swales that exhibit short-duration, low-volume flow) are under CDFW's regulation and protection because these semi-arid and arid region aquatic features can and do support fish and wildlife (directly or indirectly). CDFW links stream protection, conservation, and management with the presence (and/or indirect consideration) of fish and wildlife and their habitats.

Because of the difficulty of delineating stream bed and banks in intermittent streams and arid regions, CDFW has produced a manual, *Methods to Describe and Delineate Episodic Stream Processes on Arid Landscapes for Permitting Utility-Scale Solar Power Plants* (Brady and Vyverberg 2013). This publication describes best practices for delineating CDFW jurisdiction in environmental conditions, which include (1) recognizing the dryland episodic stream forms and processes, (2) documenting indicators of fluvial activity and inactivity, and (3) mapping the active watercourse.

California Natural Communities Conservation Planning Act

The California Natural Communities Conservation Planning (NCCP) Act of 1991 was enacted to help local government collaborate with wildlife agencies to conserve ecosystems and threatened and endangered species and habitats. Many local governments have wildlife-agency-approved plans, which allows them to issue Incidental Take Permits for covered species on behalf of the wildlife agencies.

The project area is within the boundaries of the Valley Floor Habitat Conservation Plan (VFHCP) (Kern County 2006). The VFHCP was prepared pursuant to the general outline

developed by USFWS and CDFW to meet the requirements of the NCCP Act of 1991. The VFHCP was established to preserve and enhance native habitats and support endangered and sensitive species. The VFHCP is designed to offset impacts that may result from a loss of habitat incurred through the authorization of an activity. The VFHCP identifies certain species as covered that are adequately conserved within the VFHCP. The VFHCP specifies conditions of coverage for each covered species that must be applied when those species occur in a project area.

The VFHCP has mapped the area covered by the plan into a hierarchy of zone. The Red Zones, of highest importance, include habitat for VFHCP covered species. Green Zones contain habitat of moderate importance for conservation purposes. Some Green Zone lands are/will be targeted for acquisition for preserves. White Zones are of lower conservation importance due primarily to existing intensive agricultural and other uses.

1. Existing Conditions

A desktop investigation for the project area was performed to research the existing site conditions, presence/absence of special-status species, and presence/absence of regulated waters. The following sections describe the available information on Caliente Creek.

Vegetation Communities

As seen from recent aerial photograph, a large portion of the project area has been transformed into agricultural fields. However, the VFHCP provides some information on the historical ecological conditions of the area. The original composition of the San Joaquin Valley grassland communities was dominated by purple needlegrass (*Stipa pulchra*). Perennial broad-leaved herbaceous plants and many annual species were also closely associated with the grassland vegetation community. However, the introduction and spread of nonnative grassland species began during Mexican colonization of the San Joaquin Valley, and accelerated after 1850. This is closely associated with the decline of native vegetation communities and native grassland species (Kern County 2006).

The project area is partially labelled in the VFHCP as a Green Zone, and partially labelled as a White Zone. The White Zone part of the project area is mapped as agricultural land, while the Green Zone portion is mapped as nonnative grassland area. Nonnative grassland, including pasture and rangeland, is the most common vegetation community in the San Joaquin Valley.

Critical Habitat

A review of U.S. Fish and Wildlife Service designated critical habitat indicates that there is no critical habitat in the vicinity of the project area.

Special-Status Species

A California Natural Diversity Database (CNDDB) (CDFW 2016) search for special-status species occurrences in the 1-mile vicinity of the project are produced the following plant and animal special-status species. Table 1-1 described the special-status species, status, and habitats.

Table 1-1
Special-Status Species in Project Vicinity

SPECIES NAME	STATUS	HABITAT
Plants		
Layia leucopappa Comanche Point layia	1B.1	Annual herb, native and endemic to California. Blooms March-April. Habitat includes Chenopod scrub, valley and foothill grassland
Monolopia congdonii San Joaquin woollythreads	FE 1B.2	Annual herb, native and endemic to California. Blooms February-May. Habitat includes Chenopod scrub, valley and foothill grassland
Caulanthus californicus California jewelflower	FE SE 1B.1	Annual herb, native and endemic to California. Blooms February-May. Habitat includes Chenopod scrub, pinyon and juniper woodland, and valley and foothill grassland
Opuntia basilaris var. treleasei Bakersfield cactus	FE SE 1B.1	Perennial stem succulent, native and endemic to California. Blooms April-May. Habitat includes Chenopod scrub, cismontane woodland, and valley and foothill grassland
Clarkia tembloriensis ssp. calientensis Vasek's clarkia	1B.1	Annual herb, native and endemic to California. Blooms April. Habitat includes valley and foothill grassland
Animals		
Andrena macswaini An andrenid bee		
Athene cunicularia burrowing owl	CDFW SSC	Habitats include open spaces with sparse vegetation such as prairie, pastures, desert, or shrubsteppe. Use nest burrows that can be several yards long, less than 3 feet deep.
Antrozous pallidus	CDFW SSC	Habitats include rocky mountainous areas,

pallid bat		usually near water, and open, sparsely vegetated grasslands. Prefer to forage in the open. Roost in warm, horizontal openings.
Gambelia sila blunt-nosed leopard lizard	FE SE CDFW FP	Habitats include semi-arid grasslands, alkali flats, low foothills, canyon floors, large washes, arroyos, usually on sandy, gravelly, or loamy substrate.
Onychomys torridus tularensis Tulare grasshopper mouse	CDFW SSC	Habitats include hot, arid grassland and shrubland communities, alkali sink, mesquite associations on the valley floor, upper Sonoran shrub associations, and grassland associations.
Spea hammondii western spadefoot	CDFW SSC	Temporary ponds, vernal pools, and backwaters of slow-flowing creeks for breeding and upland habitats such as grasslands and coastal sage scrub for aestivation.

CNPS: California Native Plant Society's California Rare Plant Rank:

1B: Considered rare, threatened, or endangered in California and elsewhere
2: Plants rare, threatened, or endangered in California, but more common elsewhere
3: Plants for which we need more information – review list
4: Plants of limited distribution a watch list
Decimal notations: .1 – Seriously endangered in California, .2 – Fairly endangered in California, .3 – Not very endangered in California

The following codes indicate whether a species has been included on a federal or state (California) list as endangered, threatened, rare, candidate, etc.

CDFW SSC: listed as California Department of Fish and Wildlife Species of Special Concern; (**FP**) listed as Fully Protected.
State listed wildlife: (**SE**) state listed, endangered; (**ST**) state listed, threatened.
Federal candidate and listed wildlife: (**FE**) federally listed, endangered; (**FT**) federally listed, threatened.

Of the species described in Table 1-1, Bakersfield cactus (*Opuntia basilaris var. treleasei)* was reported within the project area by the CNDDB. This species is a federally and state endangered species, and the presence of the species in the project area would need to be confirmed and mitigated, if the project were to impact the species. In addition, the VFHCP reports that extant populations of Comacnche Point layia (*Layia leucopappa*), a nonlisted special-status species, are primarily located in the Caliente Creek drainage, and at the bases of the Tejon and Comanche Hills (Kern County 2006).

Wetland Delineations

The project area includes a creek bed which the project would enhance/restore. Waters and wetlands are regulated by resource agencies charged with carrying out the Clean Water Act (federal), and the Streambed Alteration Program (state). A jurisdictional delineation would be necessary to delineate the jurisdictional extents of each of the resource agencies, and

permits would be required prior to construction for any activities within the resource agencies' jurisdiction.

Clean Water Act, Section 404

A recent jurisdictional delineation along Caliente Creek, Hetachapi Creek, and their unnamed headwaters was performed, and a determination was released by the USACE (SPK-2014-00236). In this determination, the USACE concluded that there were no CWA jurisdictional waters along the length of the creek, primarily because the creek is considered isolated waters, and does not contain a significant nexus with traditional navigable waters. Caliente Creek ends at Malaga Road. The roadway does not contain any culverts, and there are no other indications of a hydrologic connection to traditional navigable waters.

Clean Water Act, Section 401

Because it was determined that actions within Caliente Creek would not require a permit pursuant to Section 404 of the CWA, a certification pursuant to Section 401 of the CWA, would also not be required. However, a certification from the RWQCB may still be necessary for the discharge of waste or fill material into isolated waters under the Porter-Cologne Water Quality Control Act, as described below, may be necessary.

Porter-Cologne Water Quality Control Act

Pursuant to Section 13000 et seq. of the California Water Code (CWC) (Porter-Cologne), the Regional Water Quality Control Board (RWQCB) is authorized to regulate any activity that would result in discharges of waste or fill material into waters of the state, including "isolated" waters and/or wetlands (e.g., vernal pools and seeps), saline waters, and groundwater within the boundaries of the state (CWC Section 13050[e]). Parties proposing to discharge waste that could affect state waters may need to file a Report of Waste Discharge, and the RWQCB may respond by issuing Waste Discharge Requirements (WDR), or waiving the WDR.

Lake and Streambed Alteration Program

Because of the difficulty of delineating stream bed and banks in intermittent streams and arid regions, CDFW has produced a manual, *Methods to Describe and Delineate Episodic Stream Processes on Arid Landscapes for Permitting Utility-Scale Solar Power Plants* (Brady and Vyverberg 2014). This publication describes best practices for delineating CDFW jurisdiction in environmental conditions that Caliente Creek is subject to, and a delineation utilizing the methods in this manual would most likely be necessary.

The steps prescribed for determining CDFW jurisdiction of episodic streams are to:

(1) Recognize the dryland episodic stream forms and processes

a. Review aerial imagery of the project area that shows stream behavior across water years
b. Select and outline the watercourses and related landscape forms based on their aerial signatures
c. Consult with e licenses professional Geologist to identify the basic geological and geomorphic units
d. Select transects for detailed field examination across representative watercourses

(2) Document indicators of fluvial activity and inactivity
a. Walk the transect lines prepared in (1)d. above, documenting the presence and absence of all indicators of fluvial activity and inactivity
b. Photograph points of transition between geomorphic units and watercourse boundaries
c. Draw a representative watercourse cross-section that identifies the fluvially active and inactive geomorphic unites, and not vegetation relationships present.

(3) Map the active watercourse
a. Use the Definitions of Stream and Upland Lanforms for suggestions on mapping dormant, abandoned, or relict channels or terraces
b. Use the Guidance for Determining the Watercourse Boundaries to determine areas of fluvial activity and inactivity, and map the watercourse boundaries

Given the period flows and flooding of Caliente Creek, and the extent to which CDFW takes jurisdiction of episodic streams, it is likely that CDFW would take jurisdiction of at least some channels in the upper and lower portions of the stream where there is a more well defined channel bed and bank. A delineation study could help identify the reach of CDFW jurisdiction, where channels may be relict, and the current extent of the creek bed and bank.

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APPENDIX D

COMPREHENSIVE RESOURCE MANAGEMENT PLAN

Kern County
Engineering
And
Survey Services

Kern Lake
Coordinated Resource Management and Planning (CRMP) Group

Preliminary Status Report:

Flood Control and Mitigation
for The Kern Lake Basin

June, 2000

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SYLLABUS

This is a preliminary, status report from the Kern Lake Coordinated Resource Management and Planning (CRMP) Group.

The Kern Lake CRMP has developed a conceptual approach to mitigating the flooding problems impacting the communities of Lamont and Arvin. The "Concept" requires an integrated approach which mitigates sediment, peak flow rate, flow volume, and habitat for all watersheds contributing to the Kern Lake Bed. This report details (see **Chapter V**) the conceptual planning and projects identified for mitigating the flooding problems of the southern end of the San Joaquin Valley, including the Town of Lamont and City of Arvin.

In order for the Kern Lake CRMP to further evaluate potential solutions additional technical studies are required. These study needs are discussed in **Chapter VI**.

The CRMP still must identify resources which can be used to implement the plan. This will be performed after the plan's feasibility has been determined.

An action plan which outlines and prioritizes the implementation of projects and resources will follow the identification of resources.

Once an action plan has been established, a final plan will be submitted for approval.

Propositions 12 and 13 (March 2000) have established funding sources which match well to the conceptual projects outlined in this report. It is recommended that the Board of Supervisors direct appropriate staff to work toward acquisition of this funding.

It is also recommended that the Board of Supervisors strongly consider the creation of a Flood Control District to facilitate financing, planning, design, construction, and maintenance of future (and existing) flood control works.

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CHAPTER I: INTRODUCTION

Purpose

The Kern Lake Coordinated Resource Management and Planning (CRMP) Group was formed August 26, 1998. The CRMP's Mission Statement is:

> "The Kern Lake CRMP Group will develop and implement a plan for the mitigation of flood waters originating from the Caliente Stream Group and Southern Stream Group."

This report is a preliminary status report from the Kern Lake CRMP. Additional study and evaluation (requiring funding) is required in order for the CRMP to continue its tasks.

Scope

The terminus for runoff and flood waters from the Caliente Stream Group and the Southern Stream Group Watersheds, as well as the Valley Floor from Lamont to the Grapevine, is the Kern Lake Bed. The limits of the CRMP Group investigation were drawn around those areas impacted by Flood Waters originating from watersheds which flow to the Kern Lake Bed. This enables a broader more flexible consideration of means to mitigate the probable negative impacts associated with various flood control options.

The watersheds covered by the Kern Lake CRMP are:

- Caliente Stream Group
  - Walker Basin
  - Tehachapi Creek
  - Caliente Creek
  - Little Sycamore Creek
  - Sycamore Creek
  - Comanche Creek
- Southern Stream Group
  - Tejon Creek
  - El Paso Creek
  - Tunis Creek
  - Pastoria Creek
  - Grapevine Creek
  - Tecuya Creek
  - Salt Creek
  - Pleito Creek
  - Pleititio Creek
  - San Emigdio Creek

Authority:

The Engineering and Survey Services Department was directed to prepare a plan for flood control and flood mitigation for the Lamont and Arvin areas. Flood control for these areas is integrally linked to the Kern Lake Bed. The Kern Lake Bed is then linked to flood mitigation in the South East end of the San Joaquin Valley.

The CRMP process was chosen to evaluate flood mitigation for the study area. CRMP is a resource planning, problem-solving and management process that allows for direct participation of everyone concerned with natural resource management, in a given planning area. The concept underlying CRMP is that coordinating resource management strategies results in improved resource management and minimizes conflicts among land users, landowners, governmental agencies and interest groups.

CRMP Participants:

Table 1, lists those persons, and their affiliations, that have assisted as members of the Kern Lake CRMP:

Table 1
Kern Lake CRMP Volunteer List

Volunteer Name	Volunteer Affiliation
Dennis Atkinson	
Jim Beagle	Sunview Vineyards
Bruce Beretta	Ag Wise East Inc.
Steve Collup	Arvin Edison WSD
Rebecca Countryman	
Tom Edwards	
Mike Elder	Pacific Bell
Tom Fisher	CalTrans
Dennis Fox	
Peter Frick	Kern County Water Agency
Frank Gonzales	CalTrans
Ramona Herrera	Supervisorial District #5, Field Representative
Rick Iger	Kern County Water Agency
Doug Kindig	Kindig Bros. Inc.
Dale Kuzminski	AT&T
Harold H. Lawler	
Barbara Lawrence	
Cheryl Lehn	Congressman Calvin Dooley
Steve Lewis	Arvin Edison WSD
George Lusich	Civil Engineer
Joe Lutje	J. G. Boswell Co.

Table 1 Kern Lake CRMP Volunteer List	
Volunteer Name	**Volunteer Affiliation**
Brent McGinty	Pacific Bell
Jim Moreno	City of Arvin
Mark Mulkay	Kern Delta Water District
Glen and Terrie Stoller	Sunridge Nurseries
Shem D. Oesch	Grimmway Farms
Joan Schraff	Senator Costa
Darrel Towery	
Jack Wright	Natural Resource Conservation Service
Clark Farr	Kern County Engineering and Survey Services

Prior Studies

Investigations of flood problems associated with Caliente Creek have been conducted over many decades. The State of California, Kern County, and the Kern County Water Agency (KCWA), as well as the Corps of Engineers, have all developed flood control plans, but none have resulted in significant flood control projects for the area.

Most recently, starting in February 1981, the United States Army Corps of Engineers (USACE) investigated the potential of constructing a Dam to control flood waters originating from Caliente Creek. It was determined that sediment deposited into the dam from the watersheds and the channel immediately upstream of the dam site could fill more than 40% of the available storage in a single 100 year flood event. A Dam on Caliente Creek was deemed infeasible as a result of this determination. Flood Control focus was then turned to the construction of large scale levees and channels to protect the town of Lamont and City of Arvin.

The levee system investigated to protect the City of Arvin was found to have benefits less than the cost of construction and maintenance. The levee system, with the best benefit to cost ratio, intended to protect Lamont had an initial cost of ~ $30,000,000 with an annual maintenance cost of ~ $90,000. The annualized cost of the project would have been ~ $2,400,000. Since the levee system minimized the benefit area, the town of Lamont would have been the primary funding source for the project with an annual cost of between $400 and 500 per home per year for 50 years. An advisory "Election" was used to ascertain if the residents of Lamont were willing to pay this much for flood control. The vast majority of those responding indicated that they found this cost to be excessive. The levee project was, therefore, terminated in 1995.

Prior to the USACE study that was terminated in 1995, the USACE had conducted four previous flood control studies within the Caliente Creek Stream Group.

- First Study; Contained in House Document No. 513, transmitted to Congress on 20 March 1940.
- Second Study; Contained in House Document No. 367, transmitted 12 January 1949.
- Third Study; Described in Review Report completed 15 August 1951.

- Fourth Study; Described in Review Report completed 20 May 1966.

In addition to these USACE studies there have been the following other reports which identified potential flood control projects:

- Arvin-Edison WSD, 1943 and 1950.
- State of California, 1947.
- Kern County Water Agency, 1972, 1974, 1978
- Kern County Board of Supervisors, 1979.
- United States Soil Conservation Service, completed a study of providing flood and watershed protection to the Tehachapi Valley and adjacent areas.
- Federal Insurance Administration (FIA), conducted a study of the Caliente Creek floodplain and established the flood insurance program for the area.

CHAPTER II: STUDY AREA

General Location and Transportation Network:

The study area is situated at the Southeast end of the San Joaquin Valley. **Table 2** lists the watersheds and their approximate drainage areas.

TABLE 2

KERN LAKE BED
CONTRIBUTING WATERSHEDS

Watershed Name:	Watershed Size (square miles) Upstream of Foothills
Walker Basin Creek	128
Tehachapi Creek	165
Caliente Creek	142
Little Sycamore Creek	5
Sycamore Creek	28
Comanche Creek	34
Tejon Creek	106
El Paso Creek	32
Tunis Creek	17
Pastoria Creek	31
Grapevine Creek	27
Tecuya Creek	17
Pleito Creek	40
Pleitito Creek	21
San Emigdio Creek	51

These watersheds constitute a portion of the southern end of the Sierra Nevada Mountain range and the North Westerly slopes of the Tehachapi Mountains, a mountain range connecting the Sierra Nevada and Coast Range, and providing the southern closure of the Central Valley. The total drainage area upstream from the foothills is approximately 844 square miles. The valley floor comprises about 415 square miles. All of the streams are tributary to the Kern Lake Bed, which is a sub basin of the Tulare Lake Bed which in turn forms the southern portion of the San Joaquin Valley and is essentially a closed basin. Caliente Creek is a major contributor of runoff that reaches the valley floor, and provides much of the alluvium that forms the largest alluvial fan on the valley floor.

Over the last century many of the natural stream channels on the alluvial fans have been minimized or obliterated by farming practices. The lack of clearly definable flow paths from the foothills to the lake bed result in meandering, inconsistent flood paths during flood events.

The streams discharge onto the valley floor, where their waters evaporate or percolate into the underground basin, which mostly lies within the Arvin-Edison Water Storage District, Wheeler Ridge Maricopa Water Storage District, and the Kern Delta Water District.

The area is served by two railroads, the Union Pacific and the Burlington Northern-Santa Fe Railroad share (and alternate maintenance of) one rail system, and the San Joaquin Railroad. The Union Pacific (et al) railroad passes through Bakersfield to the North of the study area, following State Routes 99 and 58 from the Central Valley through the Tehachapi Mountains. The Railroad crosses Caliente Creek 2 miles upstream of Highway 58. The San Joaquin Railroad is a single line spur that ties into the Southern Pacific Railroad in Bakersfield and runs south through Lamont, traverses the Caliente Alluvial Fan 5.5 miles to the east, then runs south through Arvin where it terminates. Rail traffic on the San Joaquin Railroad is sporadic and is used to load and ship agricultural products harvested and packed in the immediate area.

The major road network consists of the four lane Route 99 that passes through Bakersfield 7 miles to the west of Lamont, Interstate 5 which ties into Highway 99 near the Kern Lake Bed and travels North West along the westerly foothills of the Central Valley, Highway 58 which runs through Bakersfield through the Tehachapi Mountains and east to Mojave, State Route 119 which runs east-west through Lamont as Panama Road and ties into Highway 99 and Interstate 5 to the west, State Route 184 (also known as Weedpatch Highway) which passes through Lamont in a north-south direction and ties into Highway 58 to the north, and State Route 223 which runs east-west through Arvin and ties into Highway 99 and Interstate 5 to the west and Highway 58 to the east.

Topography, Geology, and Soils

A well-defined foothill line divides the rugged mountains from a steep alluvial plain which constitutes the edge of the valley floor. Elevations range from about 8,000 feet along the easterly divide of the drainage basin to about 300 feet on the valley floor.

The Caliente stream group forms an area which is roughly bounded on the southeast by the Garlock Fault and on the southwest by the San Andreas Fault. Uplift along these faults has been instrumental in forming the Tehachapi Mountains and has greatly affected the gradients of the streams as well as the limits of their drainage areas. Within the areas of granitic and metamorphic rocks, the streams have gradients that range from 125 to 375 feet per mile, but where these rocks pass beneath the valley sediments, the gradients flatten abruptly to 25 to 30 feet per mile. An abundance of alluvial material, lack of heavy vegetative cover, and intermittent yet torrential stream flow, are building large piedmont alluvial fans. The surface of these fans is subject to frequent modification due to erosion and sediment deposition in the frequent shifting of stream courses across the fans.

The soils of the area vary widely in character, ranging from excellent agricultural types in portions of the alluvial plain below the foothill line and in some of the large mountain valleys, to shallow, barren types on the steep mountain slopes. Gravelly and stony soils predominate in the area above the foothill line, with bare rock exposed in places on the steeper upland slopes. Soils in the Caliente Creek wash above the foothill line consists of loose granitic alluvial sand. Significant quantities of this material are stored in deep layers in the wide washes of the Caliente Creek channel, which are washed downstream onto the alluvial fan during large flows. This material is highly permeable and infiltration rates vary from 20-to 2-inches per hour (U.S. Soil Conservation Service Soil Survey). Soil in the alluvial fan consist of courser grained alluvial sand at the apex to finer grained material on the lower fan margins. Infiltration varies from 6-to 2-inches per hour in the upper fan margins to 6-to 0.2 inches per hour in the lower margins.

Socioeconomic, Cultural Resources, and Recreation

Socioeconomic - Lamont and Arvin are the two main communities in the study area, and have populations of 14,500 and 11,400, respectively (Kern Council of Governments, 1999). The population of the greater Bakersfield area, 15 miles northwest of Lamont and Arvin, is 390,000. The total population of Kern County is 650,000 (California Department of Finance, 1994). From 1980 to 1999, the population of Lamont increased 24 percent and the population of Arvin increased 39 percent during the same time period. The migrant working force in the agricultural sector can increase the population in Arvin to 16,000 during the growing season.

The study area has one of the lowest per capita incomes in the county. The median income in Kern County (for 1998) was $38,700. However, the median incomes of Lamont and Arvin were just $24,800 and $25,100, respectively. The unemployment rate for the Arvin-Lamont area ranges from 32 to 38 percent depending on the time of year (State Employment Development Department 1994).

Agriculture is the primary land use in the study area. Kern County ranks fourth in the state in agricultural production. In 1990, the gross value of crops for the study area was estimated at $64,746,000. This is less than 5 percent of the total gross revenue for agricultural products produced in Kern County for that year. The total value of improvements in the flood plains of Caliente Creek Stream Group is estimated at $440,000,000, exclusive of lands, bridges, utilities, and roads. Crude oil production is also an important industry in the area. Numerous oil wells and rigs, storage tanks, and pipelines are located throughout the study area.

Cultural Resources - The watersheds in the study area have not been systematically studied for archeological or historical significance. However, sites or potential survey areas have been identified or located through cultural resource investigations conducted for the 1988 feasibility study effort and in July 1994. The regional archeologist for the State of California found 55 sites through spot checking on Tehachapi Creek in the upper drainage basin and anticipates that the number could double once a specific analysis is completed. The State Historical Resources Commission and the Department of Parks and Recreation have identified seven sites in the study area as having significance to the State of California. There are seven California Historical Landmark sites located within the Kern Lake Basin:

- Sebastian Indian Reservation, Grapevine
- Fages-Zalvdea Crossing, near Mettler
- Rose Station, Grapevine
- Outermost Point in the San Joaquin Valley (visited by Padre Garces), Arvin
- Kern River Slough Station, near Lamont
- Fort Tejon
- Meridian School

The earliest occupation of the study area dates back to about 11,000 years ago. Buena Vista Lake, 25 miles west of the study area, contains artifacts related to big game hunting 9,500 years ago. Prehistoric occupation of the study area likely centered around Tulare, Buena Vista, and Kern Lakes during the Pleistocene era. Some settlement may have taken place along Caliente Creek, a seasonal waterway.

The study area is the traditional home of the Southern Valley Yokuts. The Yokuts may have inhabited the area for 2,000 years before Spanish contact in the 1700's. The Southern Valley Yokuts followed a mixed subsistence economy of hunting, fishing, waterfowl, and foraging. The Hometwoli were the nearest tribal group to the study area. Limited data exists on the Yokuts because of the tremendous loss of life among the Native Americans after Euro-American encroachment into their territory. Disease, especially malaria, devastated the Native American population.

In 1772, Pedro Fages, acting governor of Alta California, led an expedition into the study area in pursuit of deserters. Francisco Garcas entered the study area in 1776 and arrived at the site of present-day Arvin on April 30. No permanent Spanish or Mexican settlements were established in the study area. Settlement began after American acquisition of California in 1848, but did not become widespread in the study area until the completion of the San Joaquin Valley branch of the Central Pacific Railroad in Kern County in 1873.

Petroleum was discovered throughout Kern County in 1860, providing additional economic opportunity. Much of the early farming and settlement dates to the 1930's when the Depression and Dust Bowl led to a large influx of rural farmers into the area.

Recreation - Recreational development in the study area is meager. Intensive agricultural land use of the area, especially in reclaimed lake beds and sparse rainfall in the region contribute to the lack of recreation. The main recreation areas are the Buena Vista Aquatic Recreation Area at Buena Vista Lake; Tehachapi Mountain Park, a 470-acre site located 8 miles southwest of the city of Tehachapi; and various other minor areas consisting of duck hunting clubs and private water ski lakes on the valley floor, and scenic spots in the mountains.

Hydrology - The streams of the Caliente Creek Stream Group produces two types of flood flows; those occurring in the summer and fall (June through October) from the so-called "desert" storms which come from the south or south east; and those occurring in the winter and spring (November through May), caused by the general storms coming from the northwest, west, or southwest. The majority of the historic flood events were of winter-spring, or general rain origin. Summer-fall, or cloudburst floods seem to occur more frequently on Caliente Creek and its tributaries than on the other streams groups in the study. This may be due to the exposure of the Caliente Creek basin to summer-fall moisture through the Tehachapi Pass. Cloudburst type floods are usually small in areal coverage and runoff of flood magnitude occurs on only one stream. These floods characteristically have high peak flows, short duration, and small volumes. Floods having characteristics approaching that of the cloudburst type have occurred on Sycamore Creek, but there are no indications that any cloudburst type floods have occurred on Comanche, Tejon, or El Paso Creeks. Flow-frequency curves for the general rain and cloudburst events (without-expected probability) are shown on Plates 4 and 5, respectively.

Concurrent flooding from all streams of the group result from general rain (winter-spring) type storms. These storms are usually of longer duration and have a more general distribution over the entire drainage area than the cloudburst type storms. General rain storms can, however, produce the high peak flows, but short duration and small volumes characteristic to the cloudburst-type of flood. This was evidenced by the April 1943 flood, which was large in areal extent, but had cloudburst characteristics in Sycamore Creek.

The simultaneous occurrence of maximum floods in all watersheds is highly improbable because of the varying degrees of shelter provided by the mountain peaks and ridges to the individual watersheds included in the Caliente Creek Stream Group. Flood peaks and volumes on Caliente Creek are reduced by the wide washes with large in-channel storage and percolation between the gaging station site at the town of Bena and the foothill line. The loss in volume depends on several factors, such as preceding runoff, magnitude of flood, and shape of the flood hydrograph.

The first flood of record occurred in 1913 at Caliente according to officials of the Southern Pacific Company, newspaper accounts, statements by local residents, and field observations. The greatest known flood in the history of the Caliente Creek Stream Group watershed occurred 30 September 1932 as a result of a cloudburst in the Tehachapi tributary of Caliente Creek above Woodford. Railroad cars were parked on a crossing over Tehachapi Creek, which created a dam where debris collected. The crossing failed, sending a torrent of water down the canyon. No definite information is available from which the volume of runoff during the flood can be established, but from high watermarks and other information, it is estimated that the peak flow in Caliente Creek at Bena was 23,500 cubic feet per second. Another cloudburst-type flood occurred on 6 October 1945 and had an estimated peak flow of 17,600 cfs. Large winter-spring type floods occurred in

March 1937, March 1943, April 1943, February 1944, March 1944, December 1966, February 1969, February 1978, April 1981, and March 1983. The March 1983 flood had a peak flow of 15,500 cfs (estimated to be an ~71 year event).

A hydrology report was completed in December 1980 and revised in January 1993 to include new hydrologic data and hydrographs for cloudburst events. Hydrographs for the cloudburst events were routed downstream to delineate a cloudburst flood plain. Coordination with FEMA was conducted from August 1994 to present regarding discrepancies in composite peak flow used by FEMA (43,000 cfs) in their 100-year flood plain analysis and the Corps' analysis (19,000 cfs). Based on the discussions on methodology used, the Corps cloudburst flow-frequency curve was modified to better represent a composite 100-year peak flow of 27,000 cfs that FEMA supported.

Climate

The climate of the study area is temperate and characterized by long, hot summers and mild winters. The average maximum and minimum daily temperatures on the valley floor are about 80 and 50 degrees Fahrenheit respectively, and the relative humidity ranges from 15 to 90 percent. The growing season averages about 277 days per year. The frost-free period usually extends from mid-February to mid-November. The mean temperature during this period averages about 70 degrees Fahrenheit. Normal annual precipitation on the drainage basin ranges from 6 inches on the valley floor to a maximum of approximately 25 inches in the high elevation areas. About 90 percent of the annual precipitation occurs during general winter rainstorms in the November-April period. During the remainder of the year, most precipitation occurs as isolated thunderstorms. Snowfall usually occurs only at higher elevations and has little flood-producing effect.

Environmental Conditions

Water Quality - In early 1986, water quality samples were collected from Caliente and Walker Basin Creeks. The flow rate at each sampling site was estimated to be 150 to 200 cfs. These samples were analyzed for a wide variety of constituents, including inorganic chemicals, nutrients, toxic metals, oil and grease, pesticides, and PCB's. In addition, turbidity, particle size distribution, and radioactivity levels were determined.

Results of these analyses indicated that all parameters except hardness, salinity, sulfate, and oil and grease pose no threat to human health but may not be acceptable to some consumers. The Environmental Protection Agency's freshwater aquatic criteria was exceeded by mercury and zinc levels in Caliente and Walker Basin Creeks, respectively. In addition, both creeks' water contained high concentrations of calcium carbonate and was classified as hard to very hard. This salinity is caused by the weathering of upstream geological formations and exceeds the criteria for some salt-sensitive agricultural crops.

The quality of ground water is especially important since it is consumed (after being pumped to the surface) by humans, livestock, various agricultural crops, and wildlife. High quality ground water exists beneath most of the study area. Total dissolved solids range on average from 200 to 500 parts per million (KCWA and KCEHSD 1994). In general, the groundwater, quality decreases in areas further south from the current bed of the Kern River due to limited recharge in the less permeable deposits (Kern Council of Governments 1994).

Depths to ground water vary from about 5 feet below the ground surface along the western margin of the project area to about 500 feet below the ground surface in the eastern edge of the project area. Although no depth studies have been conducted to delineate the aquifer system, existing ground water data suggest the presence of a single, unconfined aquifer with limited areas of perched ground water. The perched groundwater conditions exist in the area underneath the abandoned channel of the Kern River, which runs north and south along the western margin of the study area and eventually into Kern Lake bed. Contaminants present in the perched groundwater could possibly migrate to lower intervals of the aquifer (KCWA and KCEHSD 1994).

Vegetation - The study area contains a diverse collection of plants. Three distinct plant communities are present in the area where the construction alternatives are proposed: saltbush scrub, annual grassland, and agricultural lands. In addition, a small amount of seasonal wetlands associated with agricultural drainage and irrigation ditches and sumps are found in the area.

Historically, grassland and saltbush scrub were widespread in the project area and throughout the southern San Joaquin Valley. However, may of these lands have been lost to agricultural, commercial, and residential development. A majority of the few remaining examples of these native habitats have been disturbed, degraded, and/or invaded by non-native plant species. Today, less than 10 percent of the valley floor retains characteristics capable of sustaining native species. The vast majority of the project area is under irrigated agricultural production. Below are descriptions of the three vegetation cover types found in the project area.

Two types of saltbush scrub vegetation are found in the project area: xerophytic and halophytic. Xerophytic saltbush scrub is typically found in dry areas on sandy soils of alluvial origin. This type of desert scrub is common in the Mojave Desert but uncommon in the San Joaquin Valley where it is limited to the western and southern margins (Vasek and Barbour 1990). Typical shrubs associated with the valley saltbush scrub include desert saltbush, big saltbush, arrowscale, spiny saltbush, and goldenbush. Typical herbs found in this community include red brome, alkali larkspur, common spikeweed, cream cups, and bird's eye gilia. In the study area, saltbush scrub vegetation is confined to an area south of Sand Ridge on the Caliente Creek alluvial fan. Most other historical occurrences have been destroyed.

Halophytic saltbush scrub vegetation, also known as alkaline sink scrub, historically occurred around the lakes of the southern San Joaquin Valley in saline or alkaline clay soils with a high ground water table. This community type is common in the Mojave Desert but rare in the San Joaquin Valley. Species typical of halophytic saltbush scrub vegetation include iodine bush and sea-blite (Vasek and Barbour 1990; Kern Council of Governments 1994). This vegetation type is found near the western margin of the study area in the former channel of the Kern River and the Kern Lake area.

Grasslands in the project area are dominated by non-native annual species first introduced during the first European contact with California (Heady 1990). This habitat type is widespread in the foothills but relatively scarce in the area of the valley floor where the alternatives would be located. Common non-native species of this community include wild oats, various bromes, filaree, clover, and Italian ryegrass. Native species occurring in the valley grassland include the California poppy, alkali peppergrass, owl's clover, fiddleneck, baby blue eyes, fescues, gillia, tarweed, and various species of lupine.

A wide variety of agricultural crops exist in the project area as well. These include grain and hay crops (barley, wheat, and oats), field crops (cotton, safflower, and corn), truck and berry crops (potatoes, carrots, melons, and onions), deciduous fruits and nuts (plums, peaches, and almonds), subtropical fruits (lemons, oranges, and jojoba), vineyards, pasture (alfalfa and mixed pasture), and idle land (fallow).

Wildlife - The agricultural lands and remaining valley grassland and saltbush scrub support a variety of wildlife, both game and nongame. Many species are well adapted to the agricultural ecosystem man has created. Others, however, are found only in their undisturbed natural habitat. Wildlife species typical of the habitats in the project area are listed below.

The native saltbush and annual grassland communities are home to many sensitive species such as the San Joaquin kit fox, blunt-nosed leopard lizard, Tipton kangaroo rat, and the San Joaquin antelope squirrel. In addition, numerous other small mammals, birds, and reptiles inhabit these areas.

Agricultural lands are important to many species. Raptors and other birds of prey including red-tailed hawk, American kestral, and burrowing owl forage on the rodents found on theses lands. Other herbivorous and insectivorous birds such as western kingbird, morning dove, western meadowlark, Brewers' blackbird, and red-winged blackbird often forage on agricultural lands. Small mammals such as California ground squirrel,

Valley pocket gopher, jackrabbit, California vole, western harvest mouse, and house mouse use the fields for food, refuge, and sites to breed. Coyote, red fox, and San Joaquin kit fox often enter agricultural fields to forage on these small mammals. Reptiles that may inhabit agricultural areas include the side-blotched lizard and the western fence lizard (Kern Council of Governments 1994).

None of the streams in the study area provide fish habitat because they are characteristically intermittent (flows concentrated during periodic winter storms and little or no flows from mid-June to mid-October). Fishery resources are extremely limited in the study area and throughout the southern Central Valley region.

Threatened and Endangered Species - Eight Federally listed threatened and endangered species and 18 candidate species may inhabit the study area. In addition, one state-listed (not Federally listed) species is thought to occur in the study area. The Federally listed endangered species include the blunt-nosed leopard lizard, San Joaquin kit fox, Tipton kangaroo rat, California jewelflower, San Joaquin wooly-threads, and Bakersfield cactus. Two threatened species, the valley elderberry longhorn beetle and Hoover's wooly-star, may also be found in the project area. Bakersfield saltbush is listed as endangered by the State of California.

Existing Water and Related Development

No significant flood control projects have been constructed within the study area. Irrigation water supply improvements have been constructed by local water districts. Private interest (i.e. farmers, private land owners) have constructed numerous small unconnected levees which furnish a low degree of flood protection to localized areas, but most often exacerbates the flood problem in adjacent and downstream unleveed areas. The Tamarisk Treeline was constructed across the apex of Caliente Creek purportedly for wind erosion control and insect migration protection, but has been maintained as a levee, protecting the farming to the south. This "protection" forces all lower flows from Caliente Creek to flow westerly toward Lamont. The Arvin-Edison Water Storage District operates ground water recharge basins at the foot of Sycamore Creek, and at the apex of Tejon Creek.

The County built a small sump - bypass system to provide limited protection to Lamont from more frequent, low discharges from Caliente Creek and from runoff waters originating upon the farmlands lying between Caliente Creek's apex and the town of Lamont. This system has storage capacity of approximately 80 acre feet in the upstream and downstream sumps, with a maximum underground conveyance of ~100 cfs. Sediment basins have been constructed upstream of the east side sump. A 450-acre foot surge basin has been designed for construction adjacent to the sediment basins. (These facilities are included in this report as *Project No. 4, "Lamont Drainfield Improvements"*). These drainfield Improvements will increase the system capacity from 100 cfs up to 325 cfs. This system provides less than 10-year level of protection. The soil conservation service (currently renamed Natural Resource Conservation Service) has constructed flood control facilities on Antelope and Blackburn Creeks, in the Tehachapi Creek watershed.

Hazardous, Toxic, and Radiological Waste (HTRW) Sites

In 1993, the Kern County Water Agency (KCWA) and the Kern County Environmental Health Services Department (KCEHSD) conducted a preliminary assessment of HTRW sites in the study area. The information for this preliminary assessment was obtained from records searches and field investigations. A total of 76 sites were identified as having the potential to affect soil or ground water within the study area, including one site on the National Priorities List. Three of these sites are considered serious enough to avoid because of soil and/or ground water contamination and hazardous materials stored on site. These sites were Clean Soils, a petroleum contaminated soils remediation facility; Kern Oil Refinery, an oil refinery with petroleum contaminated soils and groundwater and hazardous materials stored on site; and the Greenfield Burn Dump #1, an abandoned burn dump.

Potential concerns related to these sites include worker exposure to contaminated soils during construction and the redistribution of contaminated material over a larger area as a result of project induced modifications in flooding. In addition to pointing out these concerns, KCWA and KCEHSD (1994) recommended that two crop dusting facilities, the sewage effluent surface spreading facility, and the numerous dairies in the area be studied further to determine what, if any, impacts they may have on the project.

Land Use

The study area covers approximately 52,500 acres in Kern County and includes the communities of Lamont and Arvin. Land use in the study area can be divided into three different categories: agricultural, natural open space, and urban.

Agriculture is by far the most prevalent land use in the study area, occupying approximately 86% of the total land area in the flood plain. Cotton, corn, hay, and grains are the predominant crops grown on the lower portion of the alluvial fan, southwest of Lamont and Arvin. Subtropical and deciduous fruits, almonds, vineyard and table grapes, and truck crops (potatoes, melons, carrots, etc.) Are the predominant crops grown on the upper portion of the fan, northeast of Lamont and Arvin.

Oilfields are common in the study area and oil wells/rigs are often interspersed with agriculture. Oil storage tanks and buried crude oil pipes and natural gas lines are common in the area.

Natural open space is rare in the study area. Open space focal points are the Sand Ridge area and the Kern Lake Bed.

Urban areas are clustered around the towns of Lamont and Arvin. Lamont is an unincorporated community located in the northwest portion of the study area. Several small communities surround Lamont including Weedpatch to the south and Mountain View and Fuller Acres to the north. Arvin is an incorporated city located in the southeast portion of the study area. The city of Bakersfield, the largest city in Kern County, is located about 10 miles northwest of Lamont. Land use in Lamont is residential with commercial segments confined along Weedpatch Highway, which is a main transportation artery. There is a half-mile strip between Mountain View Road and Panama Road that consists of rural, agricultural, and low density residential land use.

Future Population and Land Use

Although future development benefits are not being claimed in the benefit analysis for this study, data on future growth in the study area was included for informational purposes only. Predicted population growth for Kern County, Lamont, and Arvin is shown in **Table 3**. Kern County prediction of population growth (California Department of Finance, Report 93-1, April 1994) was used to project population growth for Lamont and Arvin assuming linear population growth. Population data from 1970 to 1994 for Kern County was used to linearly project population growth for Lamont and Arvin.

TABLE 3
Population Projections to the Year 2040[1]

	1994	2000	2010	2020	2030	2040
Kern County	617,000	802,000	1,037,700	1,310,100	1,616,100	1,954,800
Lamont	12,690	13,800	16,000	18,200	20,300	22,500
Arvin	10,674	11,400	13,500	15,600	17,800	19,900

[1] Note: Future development benefits were not claimed in this study.

Future land use in the study area is expected to remain primarily agricultural with urban development projected around Lamont and Arvin along the major road corridors. Future land use projections for the Lamont area include:

- A 0.75 mile wide, 1.25 mile long (600 acres) residential corridor north of Lamont along Weedpatch Highway. Approximately 185 acres of the corridor is currently developed as either residential (150 acres) or general commercial, service industrial, and schools (35 acres).
- Residential growth east of Lamont between the East Side Canal and the town. Currently 20 acres are developed and development of an additional 160 acres is predicted by 2010.
- Residential (70 acres) and general commercial (20 acres) growth northwest of the intersection of Weedpatch Highway and Panama Road (south of the residential corridor mentioned above).
- Service Industrial growth (180 acres) west of Lamont between Panama Road and Di Giorgio Road.
- Residential (110 acres) and general commercial (25 acres) growth south of Lamont and in Weedpatch.

- Land use outside of Lamont and Arvin between the apex of the fan and Eastside Canal is expected to remain largely unchanged (intensive agriculture). Urban and commercial development is expected in Lamont within a 0.5 mile corridor along major roads such as Weedpatch Highway and DiGiorgio Road. Most growth in Lamont will take place north of Lamont and south of Lamont in Weedpatch along Weedpatch Highway.

CHAPTER III: PROBLEMS AND OPPORTUNITIES

Flood Problems

Within the Kern Lake Bed Drainage Basin, Caliente Creek poses the greatest threat to public health and safety and causes the most frequent, large scale damages.

The communities of Lamont and Arvin, as well as many smaller population clusters lie upon the Caliente Creek Alluvial Fan. Lamont is 6 miles downstream of its Apex, Arvin is 5 miles downstream. Flow velocities are high at the Apex (~ 12-16 feet per second) and scour deep gullies into adjacent fields, often destroying irrigation systems, buried pipe lines, and roads. Much of the flows are not confined within any channel and are characterized by over bank flooding and sheet flow less than 2 feet deep. Ponding occurs upstream of major flow obstructions, such as railroad embankments road embankments, canal embankments, levees, etc. Large quantities of sediment (mostly sand) is entrained in the flows and is deposited downstream at obstructions or within the channel reaches as flood flows begin to slow, this causes subsequent flows to overtop channel banks, breach levees (or other obstructions) and abruptly change direction. Much of this sediment is carried down from the upper channel washes or from erosion from channels and fields within the fan margin. The investigation into placing a Dam on Caliente Creek noted that vast quantities of sediment are deposited immediately upstream of Highway 58. The sediment is anticipated to become entrained within future large flood events. The annualized sediment yield from Caliente Creek is estimated to be less than 500 acre-feet. During the 100-year flood, approximately 16,000 acre feet of sediment may be moved, much of which is currently staged in the channel reach between Highway 58 and Bena Road. Most natural creek channels, sinks, and depressions on the alluvial fan and valley have been filled and developed for crop production. Levees, intended to protect the agricultural lands from flooding, extensively modify the flood patterns downstream of the various creek outlet's onto the valley floor. These levees are not structurally sound, potentially unable to withstand flooding, and as such can not be considered as flood control facilities. The potential for failure of these facilities creates uncertain flow path conditions. The diversions caused by these levees concentrate flood waters and minimize overland flow absorption, as such these levees contribute to the flood problems faced by downstream property owners..

A review of the 1937 aerial photographs of the Caliente Creek Apex shows a well defined flow path through the alignment upon which Highway 58 was constructed, with the Caliente Creek Bridge roughly corresponding to the location of the Creek Bed. The channel at that time follows a flow path due south to approximately the intersection of where Rockpile Road now meets the Tamarisk Treeline. At this point the channel disperses across its Alluvial Fan with waters flowing both westerly (towards Lamont) and southerly (towards Arvin) In subsequent years this central tendency was obliterated, with no distinguishable trace remaining today. It is unclear from the aerial evidence whether the channels disappearance is the result of natural causes, or farming practices, though a combination is most likely. The channel after passing under Highway 58 currently follows a path along the westerly limits of the Alluvial Fan at the foot of the "Sand Ridge".

This path intersects the Tamarisk Tree Line at the Towerline Road alignment, one mile west of Rockpile. Flows skewed this far west primarily flow toward Lamont. Portions of larger flows will break to the alignment along the easterly confinement of Caliente Creek, crossing Highway 58 at the Nuemarkel Road underpass. Flows following this path should flow southerly toward Arvin. The Tamarisk Tree Line diverts these flows westerly toward Lamont. The necessity of year round crop production has led to the construction of numerous protection levees surrounding fields on the Caliente flow path to Lamont. These diversions increase the velocity of flow, (by confining the flood waters to paved roadways), increases the volume of flood waters reaching downstream properties (by bypassing the natural absorptive capacity of the farm land), increases the amount of sediment transported to downstream properties (by maintaining high flow energy through confinement), and increases the damage to the County roadway infrastructure (by using the roads as channels, a function for which they were not designed).

The shallow depths of flow on the fan pose only a limited direct hazard to human life or livestock, although a hazard exists to motorists at certain road intersections And at levees where flows are concentrated or converging from different directions. Damages resulting from erosion and deposition are typically a greater problem to farm production than is the direct inundation.

In addition to Caliente Creek the other Kern Lake Bed contributing water sheds impact the public, through road damages, the threat to the traveling public, and through damages to farm lands resulting in loss of jobs, wages, and farm production. Sycamore Creek regularly deposits large amounts of sediment into the Arvin-Edison WSD northerly spreading grounds. Comanche Creek deposited 6'-8' of sediment on the roadways south of Arvin. Tejon Creek deposits large volumes of sediment onto the Arvin Edison WSD southerly spreading grounds.

The watershed along the southerly boundary of the basin consistently damage, often destroy, the County roadways in the area.

The increased levee construction in these southerly areas are increasing the rate and volume of flood waters reaching the new rim ditch at Highway 99, endangering the traveling public on this major north-south freeway.

Historic Flood Damages.

The Caliente Creek Stream Group flood plain has a history of flooding. Since 1913, a total of 13 flood events have occurred. The majority of the historic flood events were of winter-spring rainfall origin, through the 1932 and 1945 events resulted from intensive cloudburst.

Table 4 details historic flood damages for relevant significant flood events. Though the average acreage covered by flooding is not radically different between those events occurring prior to 1966 versus those occurring after 1966, the latter events display larger dollar estimates due to flood plain development including residential and agricultural improvements.

Table 4
Historic Flood Damage (Estimated)

Year	Acres Inundated	Damage At Year Of Flood ($)	Damage at Price Levels ($)
1932	8,000	1,000,000[1]	10, 650,000
1943	11,700	100,000	995,000
1944	7,600	200,000	1,870,000
1945	7,300	200,000	1,840,000
1966	4,800	1,100,000	5,650,000
1969	5,800	500,000	2,330,00
1978	13,000	7,600,000	20,300,000
1983	12,000	18,000,000 [2]	30,150,000
1995	1,200	1,500,000 [3]	1,640,000
1995	1,900	1,500,000 [4]	1,640,000
1998	5,500	30,000,000	30,000,000

[1] Highly influenced by damage to Southern Pacific Railroad facilities in upstream portion of flood plain (north of Highway 58).
[2] Damages from Caliente Creek only. Does not include losses upstream of Highway 58.
[3] Flood on January 25, 1995. Damages upstream of Lamont. Estimate from Lamont Reporter, February 1, 1995
[4] Flood on 11 March 1995. Damages upstream of Lamont.

Lamont, a community of approximately 14,500 residents, lies directly in the western path of flood flows. Damages occurred to residential, commercial and some industrial facilities in Lamont during the 1932, 1943, 1944, 1945, 1966, 1969, 1978, 1983, 1995, and 1998 events. Over 580 homes were damaged in the 1978 event in Lamont alone. The City of Arvin, portions of which lie in the "50-year" (15,800 cfs) flood plain areas, experienced flooding in parts of the city in 1932, 1945, and 1983.

Historic flood damages are predominantly attributed to losses in the agricultural and public sectors. For example, during the 1978 flood, approximately 41 percent ($5,228,000) and 39 percent ($4,976,000) of the $12,745,000 in damages (1990 dollars) were to agricultural and public facilities, respectively. These damages include direct crop losses, planting delay, irrigation system damages, and erosion and deposition damages to agricultural lands and improvements other than structures and structure contents. Public facilities severely damaged during flood events in 1978 and 1983 include water facilities of the Arvin-Edison Water Storage District and the Kern-Delta Water District. Damages and flood-fighting costs incurred by the Arvin-Edison and Kern-Delta facilities totaled $3,837,000 and $132,000, respectively in the March 1983 event. Bridges and highways built and maintained by Kern County Public Works and the

California Department of Transportation also incurred damages. Preliminary estimates of damages in March 1983 to county roads and State Highways 18 and 223 totaled $552,000. No urban damages were sustained to Lamont during the January and March 1995 flood events; however, estimates of damages to roads and agricultural lands upstream of Lamont totaled $1,500,000.

Extensive railroad damages and losses have also occurred during flood events in the canyon portion of Caliente Creek north of Highway 58. Loss of two railroad locomotive engines and tracks accounted for a large percentage of the total dollar damage in the record 1932 event. Following the March 1983 flood, Southern Pacific Railroad sustained $4.2 million in flood damage to service tracks.

In addition to direct dollar damages, flooding has also resulted in loss of life in upstream canyon locations (15 people in 1932), disruption of area schools due to flood damages, temporary closure of roads and railroads, evacuation of homes and resultant dislocations of area residents, etc. Though easily recognized, the latter costs and intangible damages are not included in the historic damages cited above.

Water Supply and Ground Water.

This portion of the San Joaquin Valley has been developed from a desert-like region to one of high agricultural productivity. This is primarily because irrigation water for crops is imported from outside sources via the California Aqueduct, Central Valley Project (CVP), and nearby Kern River. Additional water supplies are needed to bring available lands into production and to offset the declining ground water table. The average rainfall in the area (about 6 inches per year), is not adequate for full irrigation. Although several canals have been constructed to supplement the water supply, ground water pumping continues to exceed the average recharge by about 250,000 acre-feet per year. The flow of the streams in the study area is the principal source of recharge, although water is imported via the California Aqueduct for recharge purposes. Virtually all of the runoff, except for surface evaporation and transpiration, reaches the ground water.

Recreation.

The California State Recreation Plan notes the general lack of regional parks and limited camping facilities along major transportation routes within the CRMP area. For Kern County, the Park and Recreation Information System (PARIS), project the following deficiencies for 1990: 4,646 camping units; 4,407 picnic tables; 8,438 boat access sites; and 1,544 miles of trail. Due to the intermittent nature of the runoff from the study streams, water oriented recreation is not feasible. The proposed flood control alternatives in this report were not directly intended for use as for camping, picnicking and trail facilities. However, several of these projects may work well for these functions.

Wildlife Resources.

The potential for flooding does not appear to limit agricultural activities in the study area. Most of the natural stream beds of the study area are used for crop production. Areas of existing riparian vegetation and other wildlife habitat will continue to be reduced by expanded agricultural and urbanization activities.

CHAPTER IV: PLAN FORMULATION

CRMP Objectives:

The CRMP has recognized that mitigation of flooding results in unintended impacts upon adjacent and downstream properties, as well as upon the natural environment. For every flood mitigation action, impact mitigation must be implemented.

A broad area of study, all watersheds draining to the Kern Lake Bed, affords the opportunity for mitigation and flood control implementation within the same basin study area.

The specific objectives identified by the CRMP were:

- Define and establish a working group comprised of representatives from local, state, and federal agencies; local agriculture, commercial, and industrial concerns; and, representatives from local residents in the Lamont, Arvin, and rural areas.
- Identify Resources.
- Identify the actions required to meet the prioritized objectives.
- Develop and review a draft CRMP plan.
- Formally adopt the CRMP plan.
- Implement the CRMP plan.
- Monitor the implementation of the CRMP plan for success.

This report is a preliminary status report which represents the work to date on the first and fourth objectives. This report also identifies the need for additional detailed analysis so that the CRMP can proceed with the identification of resources, development of an action plan, and the eventual formal adoption of a CRMP Plan (the second, third, and fifth objectives).

Formulation Criteria:

Floods have three constituents:

- **Peak:** The maximum rate at which flood waters enter the floodplain.
- **Volume:** The total runoff which leaves the watershed, and must be mitigated upon the floodplain or at the terminus of the flood waters (i.e. the Kern Lake Bed).
- **Sediment:** Flood waters move sands, gravels, silts, of varying sizes from the watersheds onto the floodplain. The deposition and scour of these sediments is typically more damaging than the presence of the flood waters themselves.

The general formulation criteria was based upon the needs of the most damaged areas; Primary projects which could meet those needs; Projects required in order to mitigate probable failure, or maintenance requirements of the primary projects; Projects required to mitigate significant environmental impacts which would result from construction of the primary facility.

Potential Management Measures:

Each project idea discussed in this report is intended to meet one or more of the following mitigation features:

- **Flood Warning:**

  Early warning of impending disaster makes early evacuation, flood fight preparation, and interactive flood control operations possible. Net damages and loss of life are therefore limited or prevented.

- **Flow Conveyance:**

  The best way to protect properties and limit personnel injuries related to flooding is to move flood waters away from property and people. Flow conveyance includes leveed floodways that confine damaging flood waters to specific areas, and constructed channels. Flow conveyance has a downside. Channelized flood waters move faster, thus increasing the peak flow realized by downstream properties; they maintain higher flow energy, thus increasing the amount of sediment deposited upon downstream properties; they confine the flow, thus increasing the volume of flood water transferred to downstream properties; constructed channels typically become single purpose lands which can not be farmed and do not support natural habitat, all of which are significant environmental impacts which require mitigation.

  In addition, these facilities are directly (adversely) impacted by heavy sediment amounts entrained in the flow. Sediment deposited in the channels limits their carrying capacity and thus increases the likelihood of catastrophic failure, where the channel breaches its confined limits and randomly redirects (often with severe impacts). Flow conveyance also works more efficiently if the peaks of the flood flows are regulated. Rapid rises and falls of flow will typically cause serious damage to channel banks.

- **Volume Mitigation:**

  Volume mitigation takes two forms;

  - Detention
  - Retention

  Detention facilities receive flood waters and slowly meter these flows back into the floodplain. This process protects downstream properties from the higher peak flow and from the deleterious impacts of higher energy of flow. The detention of flood waters does provide some mitigation for volume, from the absorption time that the water resides in the detention basin.

  Retention basins remove a volume of water from the flood and allow this water to replenish the ground water. These facilities typically have limited impact upon peak flow or peak energy since the flood volumes antecedent to peak typically fill the retention volume prior to the peak.

  Volume mitigation is directly (adversely) impacted by sediment entrained in the flow. Retention basins are poor habitat mitigation areas. Shallow detention basins can be conducive with habitat.

  In the absense of physical mitigation the purchase of easements, intended to compensate land owners for their damages, would be required.

- **Sediment Mitigation:**

  The transport of sediment is the most destructive aspect of flooding. Sediments entrained within the flood waters emanating from the watershed are rapidly deposited upon natural alluvial fans as the energy of the flood waters are dissipated across the widening sediment cone. If these waters are confined, the sediment is transported downstream to a point where the energy of the flow can no longer maintain the motion of the small solid particles and deposition begins.

  After sediment is allowed to deposit, the flow can become erosive again if the clean water is confined. This confinement raises the energy level of the flow, and thus its ability to move sediment. The flow will then scour the channel reach, depositing the newly entrained sediment when the flow energy is once again decreased. This process of flow loading with sediment (with the correlated degradation of the channel) then depositing (with the channel aggradation) occurs continuously as flows leave the steep natural channels of the watersheds and move toward the Kern Lake Bed. Sediment Basins, designed to facilitate the deposition of sediment at designated and maintainable locations, only temporarily solve the sediment problem. The sediment "starved" flow leaving these sites will rapidly degrade downstream channels if not mitigated.

  Natural riparian floodplains are ideal sediment mitigation. The dense, deep rooting vegetation holds the existing soils in place, limiting degradation; slows the flood waters as they proliferate through the water course, which forces sediment deposition; after the flood event subsides the vegetation re-seeds, re-roots, and grows through the newly deposited materials, healing most of the damage which the flood waters have caused.

  Man made sedimentation basins will typically require sediment removal in order to maintain their design performance.

- **Channel Stabilization:**

  The climate encompassing the Kern Lake Bed watersheds is very dry. Intermittently, rainfall will result in significant high flows which result in channel scour in the upstream reaches of the watershed. These scoured reaches have unstable banks and beds that produce heavy sediment yields during subsequent flows of lesser peak and duration. The natural habitats in these areas are lost until the channels re-stabilize, either by natural means or assisted through maintenance/conservation programs.

- **Habitat Restoration:**

  As was noted for several of the other project management measures, habitat, or the potential for habitat, will be lost. Habitat is an important natural resource which must be encouraged and protected. Habitat restoration projects conserve existing natural, currently unprotected, habitat or encourage and create habitat where this natural resource has been lost or destroyed by natural processes or human encroachment. In addition, identified habitat restoration projects can act as "mitigation banks", allowing other unrelated projects (outside the area), which would result in a taking, to purchase credits within the defined Kern Lake Basin Habitat Areas.

Identification of Conceptual Plans:

The ideal project will;

- Minimize the amount of sediment requiring mitigation (channel stabilization),

- Remove excessive sediment entrained in the flood waters so as to minimize adverse downstream impacts (sediment mitigation),
- Modulate the flows so as to minimize the size of downstream facilities (Volume mitigation, detention),
- Minimize the volumes that downstream properties will receive and turn the flood waters into a valuable resource through ground water recharge (volume mitigation, retention)
- Convey the flood waters safely past farming operations, public infrastructure, commercial, and residential development,
- Protect and enhance the natural habitat.

The projects identified in this report framework this idealized "project" on a basin wide basis. There is a practical realty that the area requiring the construction of a channel may not have the highest need for habitat conservation, or the best ground water recharge potential. However, the best locations for these facilities exist within the basin and should be pursued simultaneously with the channelization project. The prioritization of each of these aspects has not been determined by the CRMP at this time since these determinations require technical review beyond the individual abilities of the CRMP members.

CHAPTER V - PROJECT DESCRIPTIONS

44 interrelated projects have been identified for further evaluation and consideration.

Table 5, *"Project Index"*, lists these projects.

Figure 1, "*Kern Lake CRMP Project Master Plan*", provides a location map of the proposed projects.

Figure 2, "*Kern Lake CRMP: Project Connectivity Schematic*", details the relational connectivity of these projects, and graphically demonstrates the potential complexity of the solution to the Kern Lake Basin flooding problem. The connectivity schematic traces the path of flood water from the mouth of the watershed through intercepting flood control facilities ending at the Kern Lake Bed.

Table 6, "*Project Connectivity*", tabularizes the relationships of each project to other projects or watersheds. The table specifically identifies the upstream watershed or project(s) that contributes flood waters to the listed project, and the downstream project(s) to which flow is sent.

Table 7, "*Project Function*", specifies the intended "Primary", "Secondary", and "Tertiary" functions of each project. These functions are listed as:

- *Channel Stabilization*: The project targets natural streams which are subject to rapid scour and can be stabilized.
- *Flow Conveyance*: The project channelizes water either in a costructed channel or via a defined floodway.
- *Habitat*: The project provides mitigation for lost habitat area.
- *Sediment Mitigation*: The project will affect removal of sediment from the flood waters.
- *Volume Mitigation*: The project will decrease the volume of flood waters transported to downstream properties.
- *Warning*: The project will provide early warning of impending flooding.

Table 8, "Project Attributes", provides a reference of the approximate project sizes. The table also identifies the region of the Kern Lake Basin that the project will directly benefit. These areas are:

- Arvin: These projects will provide flood protection to the area surrounding the City of Arvin. The flood sources are Caliente Creek, Little Sycamore Creek, Sycamore Creek, and Comanche Creek.
- General: These projects are impacted by several watersheds and provide mitigation for an aspect of the flood waters not provided by upstream facilities.
- Lamont: These projects provide flood protection to the communities of Lamont and Weedpatch, as well as the surrounding area. The flood source is Caliente Creek.
- Southeast Streams: These projects mitigate flows from the following streams:

  Tejon Creek
  El Paso Creek
  Tunis Creek

- Southern Streams: These projects mitigate flows from the following streams:

  Pastoria Creek
  Grapevine Creek
  Tecuya Creek
  Salt Creek
  Pleito Creek
  Pleitito Creek
  San Emigdio Creek

Table 9, "*Project Studies Required*", Each project requires additional analysis or design, this table details these needs. The table delineates six (6) catagories of analysis or design, and the status of this study. These catagories are:

- *Preliminary Design*: Has a design detailing the projects function been prepared?
- *Hydrologic Design*: Has the water hydrology been studied?
- *Sediment Analysis*: Has a determination been made as to the sediment yeild anticipated from the watershed?
- *Habitat Impact Study*: Has the impact of this project upon the natural habitat been analyzed?
- *Quantity Estimate*: Has a detailed quantity estimate been prepared?
- *Final Design*: Has a final design for the project, ready for construction, been prepared?

The following descriptions detail the identified projects and include a project location map for reference.

Cost estimates have been prepared for many of these projects. It must be understood that the cost estimates are based upon conceptual project formulations and not upon preliminary designs derived from feasibility and technical studies. As such these costs estimates are good for comparitive analysis (i.e. which projects cost more) but may be either grossly under or over estimates of the final project cost.

The projects described in this section are conceptual solutions and have not been reviewed or discussed with the effected land owners. Such discussions are appropriate during the feasibility and environmental review phases of this plan development.

Table 5: Project Index

Project No.	*Project Name*
1	Caliente Creek Flood Warning System
2	Caliente Creek Habitat Mitigation Project
3	Caliente Creek Ground Water Recharge Project
4	Lamont Drainfield Improvements
5	Lamont Channel (Easterly Extension)
6	Lamont Channel
7	Panama Road Ditch Improvements
8	North Lamont Channel
9	Weedpatch Channel
10	Vineland Road Dam/Recharge Basin
11	Tejon/El Paso Creek Groundwater Recharge Basin
12	Tejon Creek Dam and Reservoir
13	Pastoria Creek Ground Water Recharge Basin
14	Grapevine Ground Water Recharge Basin
15	Pleito Creek Ground Water Recharge Basin
16	San Emigdio Creek Groundwater Recharge Basin
17	Sycamore Creek Watershed Restoration Project
18	Little Sycamore Creek Watershed Restoration Project
19	Comanche Creek Watershed Restoration Project
20	Tejon Creek Watershed Resoration Project
21	El Paso Creek Watershed Restoration Project
22	Tunis Creek Watershed Restoration Project
23	Pastoria Creek Watershed Restoration Project
24	Grapevine Creek Watershed Restoration Project
25	Tecuya Creek Watershed Restoration Project
26	Salt Creek Watershed Restoration Project
27	Pleito Creek Watershed Restoration Project

Project No.	*Project Name*
28	Pleitito Creek Watershed Restoration Project
29	San Emigdio Creek Watershed Restoration Project
30	Rancho Drive Floodway
31	David Road Floodway
32	Tejon Creek Floodway
33	Herring Road Floodway
34	Adobe Road Floodway
35	Millux Road Floodway
36	Rock Pile Road Floodway
37	Towerline Road Floodway
38	Millux Lake Detention Basin
39	Herring Lake Detention Basin
40	Lamont Channel (Southerly Extension)
41	Eastside Canal Enlargement
42	New Rim Ditch Conveyance Enhancement
43	LeGray to Tecuya Creek Bypass
44	Tecuya Creek Ground Water Recharge Basin

FIGURE 1

KERN LAKE CRMP: PROJECT MASTER PLAN

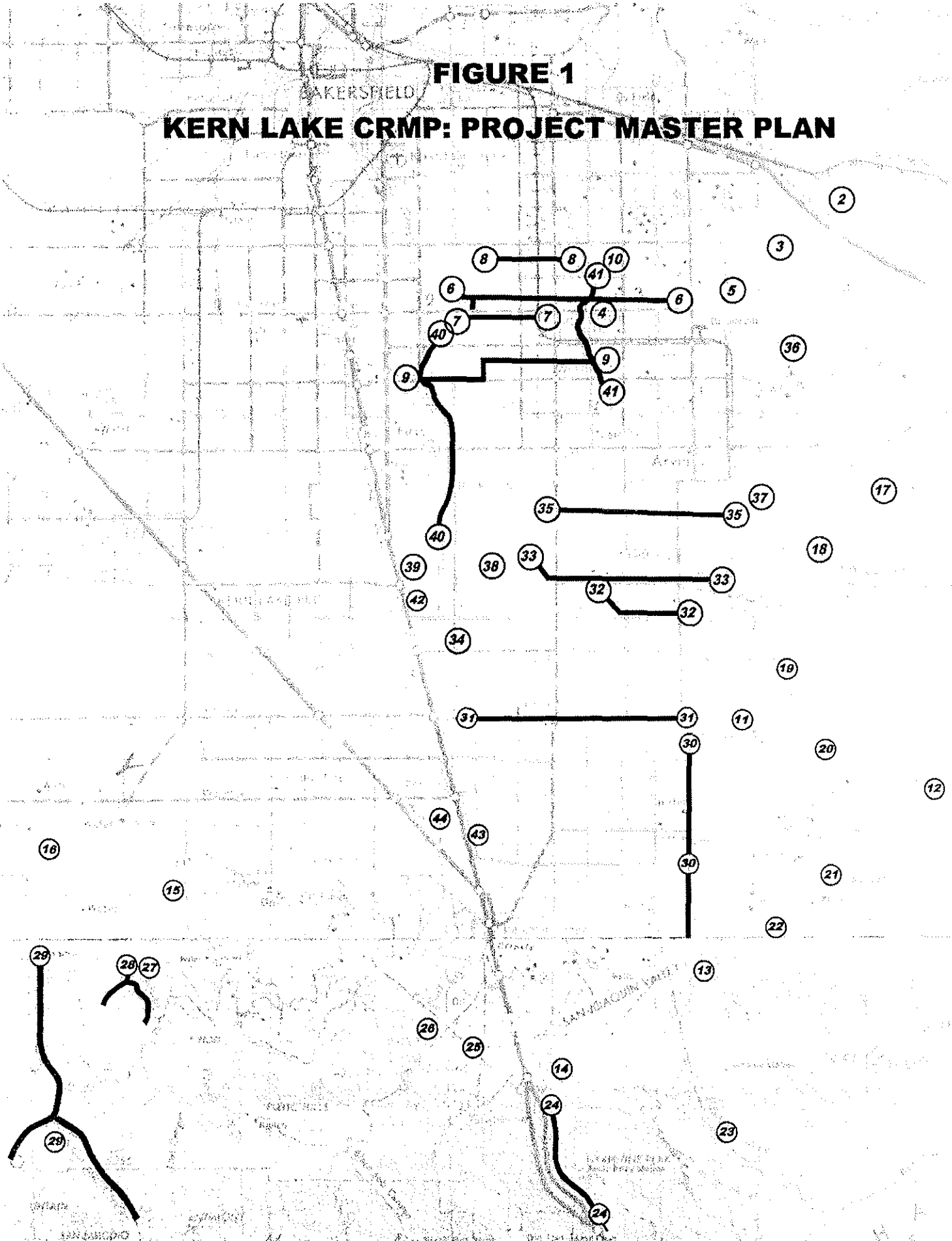

Figure 2: Kern Lake CRMP - Project Connectivity Schematic

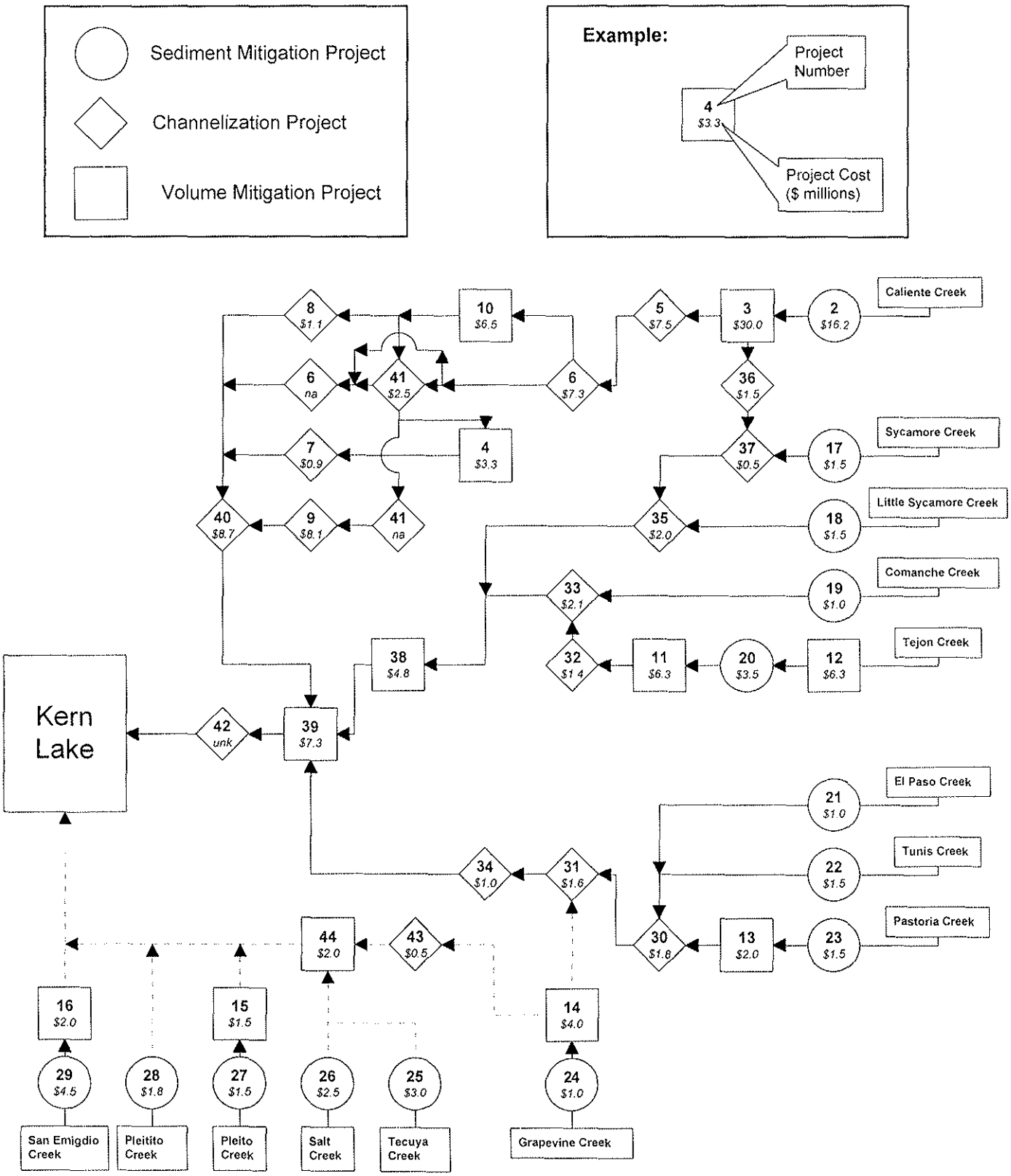

Table 6: Project Connectivity

Project No.	*Project Name*	*Upstream Watershed*	*Upstream Project*	*Down Stream Project*
1	Caliente Creek Flood Warning System			
2	Caliente Creek Habitat Mitigation Project	Caliente		3,5,36
3	Caliente Creek Ground Water Recharge Project		2	5,36
4	Lamont Drainfield Improvements	Caliente		7
5	Lamont Channel (Easterly Extension)		2,3	6
6	Lamont Channel		5	10,40
7	Panama Road Ditch Improvements		4	40
8	North Lamont Channel		10	40
9	Weedpatch Channel	Caliente		40
10	Vineland Road Dam/Recharge Basin		6	8
11	Tejon/El Paso Creek Groundwater Recharge Basin		20	32
12	Tejon Creek Dam and Reservoir	Tejon		20
13	Pastoria Creek Ground Water Recharge Basin		23	30
14	Grapevine Ground Water Recharge Basin		24	
15	Pleito Creek Ground Water Recharge Basin		27	
16	San Emigdio Creek Groundwater Recharge Basin		29	
17	Sycamore Creek Watershed Restoration Project	Sycamore		37
18	Little Sycamore Creek Watershed Restoration Project	Little Sycamore		38

Project No.	*Project Name*	*Upstream Watershed*	*Upstream Project*	*Down Stream Project*
19	Comanche Creek Watershed Restoration Project	Comanche		33
20	Tejon Creek Watershed Resoration Project		12	11
21	El Paso Creek Watershed Restoration Project	El Paso		30
22	Tunis Creek Watershed Restoration Project	Tunis		30
23	Pastoria Creek Watershed Restoration Project	Pastoria		13
24	Grapevine Creek Watershed Restoration Project	Grapevine		14
25	Tecuya Creek Watershed Restoration Project	Tecuya		44
26	Salt Creek Watershed Restoration Project	Salt		
27	Pleito Creek Watershed Restoration Project	Pleito		15
28	Pleitito Creek Watershed Restoration Project	Pleitito		
29	San Emigdio Creek Watershed Restoration Project	San Emigdio		16
30	Rancho Drive Floodway		13,21,22	31
31	David Road Floodway		30	34
32	Tejon Creek Floodway		11	33
33	Herring Road Floodway		19, 32	38
34	Adobe Road Floodway		31	39
35	Millux Road Floodway		18,37	38
36	Rock Pile Road Floodway	Caliente		37
37	Towerline Road Floodway		17,36	38
38	Millux Lake Detention Basin		33, 35	39

Project No.	*Project Name*	*Upstream Watershed*	*Upstream Project*	*Down Stream Project*
39	Herring Lake Detention Basin		34,38,40	42
40	Lamont Channel (Southerly Extension)		6,7,8,9	39
41	Eastside Canal Enlargement		10,6,4	9
42	Rim Ditch Conveyance Enhancement		38,39	
43	LeGray to Tecuya Creek Bypass			44
44	Tecuya Creek Ground Water Recharge Basin	Tecuya	25,43	

Table 7: Project Function

Project No.	*Project Name*	*Primary Function*	*Secondary Function*	*Tertiary Function*
1	Caliente Creek Flood Warning System	Warning		
2	Caliente Creek Habitat Mitigation Project	Sediment Mitigation	Habitat	Volume Mitigation
3	Caliente Creek Ground Water Recharge Project	Volume Mitigation	Sediment Mitigation	
4	Lamont Drainfield Improvements	Volume Mitigation	Sediment Mitigation	
5	Lamont Channel (Easterly Extension)	Flow Conveyance		
6	Lamont Channel	Flow Conveyance		
7	Panama Road Ditch Improvements	Flow Conveyance		
8	North Lamont Channel	Flow Conveyance	Volume Mitigation	
9	Weedpatch Channel	Flow Conveyance		
10	Vineland Road Dam/Recharge Basin	Volume Mitigation	Sediment Mitigation	
11	Tejon/El Paso Creek Groundwater Recharge Basin	Volume Mitigation		
12	Tejon Creek Dam and Reservoir	Volume Mitigation		
13	Pastoria Creek Ground Water Recharge Basin	Volume Mitigation		
14	Grapevine Ground Water Recharge Basin	Volume Mitigation		
15	Pleito Creek Ground Water Recharge Basin	Volume Mitigation		
16	San Emigdio Creek Groundwater Recharge Basin	Volume Mitigation		
17	Sycamore Creek Watershed Restoration Project	Sediment Mitigation	Channel Stabilization	Habitat
18	Little Sycamore Creek Watershed Restoration Project	Sediment Mitigation	Channel Stabilization	Habitat
19	Comanche Creek Watershed Restoration Project	Sediment Mitigation	Channel Stabilization	Habitat
20	Tejon Creek Watershed Resoration Project	Sediment Mitigation	Channel Stabilization	Habitat
21	El Paso Creek Watershed Restoration Project	Sediment Mitigation	Channel Stabilization	Habitat

Project No.	*Project Name*	*Primary Function*	*Secondary Function*	*Tertiary Function*
22	Tunis Creek Watershed Restoration Project	Sediment Mitigation	Channel Stabilization	Habitat
23	Pastoria Creek Watershed Restoration Project	Sediment Mitigation	Channel Stabilization	Habitat
24	Grapevine Creek Watershed Restoration Project	Sediment Mitigation	Channel Stabilization	Habitat
25	Tecuya Creek Watershed Restoration Project	Sediment Mitigation	Channel Stabilization	Habitat
26	Salt Creek Watershed Restoration Project	Sediment Mitigation	Channel Stabilization	Habitat
27	Pleito Creek Watershed Restoration Project	Sediment Mitigation	Channel Stabilization	Habitat
28	Pleitito Creek Watershed Restoration Project	Sediment Mitigation	Channel Stabilization	Habitat
29	San Emigdio Creek Watershed Restoration Project	Sediment Mitigation	Channel Stabilization	Habitat
30	Rancho Drive Floodway	Flow Conveyance		
31	David Road Floodway	Flow Conveyance		
32	Tejon Creek Floodway	Flow Conveyance		
33	Herring Road Floodway	Flow Conveyance		
34	Adobe Road Floodway	Flow Conveyance		
35	Millux Road Floodway	Flow Conveyance		
36	Rock Pile Road Floodway	Flow Conveyance		
37	Towerline Road Floodway	Flow Conveyance		
38	Millux Lake Detention Basin	Volume Mitigation	Habitat	
39	Herring Lake Detention Basin	Volume Mitigation	Habitat	
40	Lamont Channel (Southerly Extension)	Flow Conveyance		
41	East Side Canal Enlargement	Flow Conveyance		
42	New Rim Ditch Conveyance Enhancement	Flow Conveyance		
43	LeGray to Tecuya Creek Bypass	Flow Conveyance		
44	Tecuya Creek Ground Water Recharge Basin	Volume Mitigation		

Table 8: Project Attributes

Project No.	*Cost Estimate*	*Peak Conveyance (cfs)*	*Volume Mitigated (Acre-Ft)*	*Sediment Mitigated (Acre-Ft)*	*Project Length (Miles)*	*Project Area (Acres)*	*Impacted Area*
1	$170,000.00				0	0	Lamont
2	$16,200,000.00			3400	0	1500	Lamont
3	$30,000,000.00		6000		0	1500	Lamont
4	$3,300,000.00		450	100	0	45	Lamont
5	$7,500,000.00	3000			4.5	0	Lamont
6	$7,250,000.00	3000			8	0	Lamont
7	$900,000.00	100			2.5	0	Lamont
8	$1,100,000.00	50	20		2	5	Lamont
9	$8,100,000.00	250	500		5.5	85	Lamont
10	$6,500,000.00		650		0	160	Lamont
11	$6,250,000.00				0	160	Southeast Streams
12	$6,250,000.00				0	160	Southeast Streams
13	$2,000,000.00				0	80	Southern Streams
14	$4,000,000.00				0	160	Southern Streams
15	$1,500,000.00				0	60	Southern Streams
16	$2,000,000.00				0	80	Southern Streams

Project No.	*Cost Estimate*	*Peak Conveyance (cfs)*	*Volume Mitigated (Acre-Ft)*	*Sediment Mitigated (Acre-Ft)*	*Project Length (Miles)*	*Project Area (Acres)*	*Impacted Area*
17	$1,500,000.00				6	0	Arvin
18	$1,500,000.00				6	0	Arvin
19	$1,000,000.00				4	0	Arvin
20	$3,500,000.00				14	0	Southeast Streams
21	$1,000,000.00				4	0	Southeast Streams
22	$1,500,000.00				6	0	Southeast Streams
23	$1,500,000.00				6	0	Southern Streams
24	$1,000,000.00				4	0	Southern Streams
25	$3,000,000.00				12	0	Southern Streams
26	$2,500,000.00				10	0	Southern Streams
27	$1,500,000.00				6	0	Southern Streams
28	$1,800,000.00				7	0	Southern Streams
29	$4,500,000.00				18	0	Southern Streams
30	$1,800,000.00				7	0	Southeast Streams
31	$1,600,000.00				6.5	0	Southeast Streams
32	$1,400,000.00				5.5	0	Southeast Streams
33	$2,100,000.00				9	0	Southeast Streams
34	$1,000,000.00				4	0	Southeast Streams

Project No.	*Cost Estimate*	*Peak Conveyance (cfs)*	*Volume Mitigated (Acre-Ft)*	*Sediment Mitigated (Acre-Ft)*	*Project Length (Miles)*	*Project Area (Acres)*	*Impacted Area*
35	$2,000,000.00				8	0	Arvin
36	$1,500,000.00				6	0	Arvin
37	$500,000.00				1.5	0	Arvin
38	$4,800,000.00		1000		0	320	General
39	$7,300,000.00		2500		0	640	General
40	$8,700,000.00				5.5	0	Lamont
41	$2,500,000.00				8	0	Lamont
42	$0.00	500			0.5	0	General
43	$500,000.00	150			0.5	0	Southern Streams
44	$2,000,000.00		1200		0	300	Southern Streams

Table 9: Project Studies Required

Project No.	*Prelim Design Required*	*Prelim Design Existing*	*Hydrologic Design Required*	*Hydrologic Design Existing*	*Sediment Analysis Required*	*Sediment Analysis Existing*	*Habitat Impact Study Required*	*Habitat Impact Study Existing*	*Quantity Estimate Required*	*Quantity Estimate Existing*	*Final Design Required*	*Final Design Existing*
1	☑	☑	☐	☐	☐	☐	☐	☐	☑	☑	☑	☐
2	☑	☐	☑	☑	☑	☑	☑	☐	☑	☐	☑	☐
3	☑	☐	☑	☑	☑	☑	☑	☐	☑	☐	☑	☐
4	☑	☑	☐	☐	☐	☐	☐	☐	☑	☑	☑	☑
5	☑	☐	☑	☑	☑	☐	☑	☐	☑	☐	☑	☐
6	☑	☐	☑	☑	☐	☐	☑	☐	☑	☐	☑	☐
7	☑	☐	☐	☐	☐	☐	☐	☐	☑	☐	☑	☐
8	☑	☑	☐	☐	☐	☐	☑	☐	☑	☐	☑	☐
9	☑	☐	☐	☐	☐	☐	☑	☐	☑	☐	☑	☐
10	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐
11	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐
12	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐
13	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐
14	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐
15	☑	☐	☑		☑	☐	☑	☐	☑	☐	☑	☐
16	☑	☐	☑		☑	☐	☑	☐	☑	☐	☑	☐
17	☑	☐	☑		☑	☐	☑	☐	☑	☐	☑	☐

Project No.	*Prelim Design Required*	*Prelim Design Existing*	*Hydrologic Design Required*	*Hydrologic Design Existing*	*Sediment Analysis Required*	*Sediment Analysis Existing*	*Habitat Impact Study Required*	*Habitat Impact Study Existing*	*Quantity Estimate Required*	*Quantity Estimate Existing*	*Final Design Required*	*Final Design Existing*
18	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐
19	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐
20	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐
21	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐
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23	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐
24	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐
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28	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐
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32	☑	☐	☐	☐	☐	☐	☐	☐	☑	☐	☑	☐
33	☑	☐	☐	☐	☐	☐	☐	☐	☑	☐	☑	☐
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35	☑	☐	☐	☐	☐	☐	☐	☐	☑		☑	☐
36	☑	☐	☐	☐	☐	☐	☐	☐	☑	☐	☑	☐
37	☑	☐	☐	☐	☐	☐	☐	☐	☑		☑	☐

Project No.	*Prelim Design Required*	*Prelim Design Existing*	*Hydrologic Design Required*	*Hydrologic Design Existing*	*Sediment Analysis Required*	*Sediment Analysis Existing*	*Habitat Impact Study Required*	*Habitat Impact Study Existing*	*Quantity Estimate Required*	*Quantity Estimate Existing*	*Final Design Required*	*Final Design Existing*
38	☑	☐	☑	☐	☐	☐	☑	☐	☑	☐	☑	☐
39	☑	☐	☑	☐	☐	☐	☑	☐	☑	☐	☑	☐
40	☑	☐	☐	☑	☐	☐	☐	☐	☑	☐	☑	☐
41	☑	☐	☐	☐	☐	☐	☑	☐	☑	☐	☑	☐
42	☑	☐	☑	☐	☐	☐	☐	☐	☑	☐	☑	☐
43	☑	☐	☑	☐	☑	☐	☐	☐	☑	☐	☑	☐
44	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐	☑	☐

Project #1

Caliente Creek Flood Warning System

A. Project Operation

In order to facilitate potential orderly evacuation, flood fight, and future facility operation, an improved flood warning system is currently being installed in the Caliente watershed (inclusive of Walker Basin, Caliente, and Tehachapi Creeks). This system includes 20 rain gauges and 5 stream gauges, replacing the existing system of 6 rain and/stream gauges. It is anticipated that this higher density network will provide up to 24 hours of early warning, by monitoring rainfall intensify, and will be able to track and quantify the impacts of thunderstorms impacting the watershed (a capability the old system did not have).

B. Project Costs

The State of California has funded $170,000 of this project. An additional ~ $12,000 Community Development Block Grant (CDBG) monies, and ~$13,500 from the Tehachapi - Cummings Water Storage District are being used.

C. Project Benefits:

In 1997 an audit of the existing Caliente Creek Alert Flood Warning system was performed. This audit identified the project benefit of a fully functional flood warning system to be ~$600,000, total over the life of the project.

D. Project Justification

Flood warning is a cost effective means of informing the public of impending disaster. Without a warning system most residents or emergency personnel would not know of the flood threat until flooding was actively occurring (this was the case during the 1983 flood).

E. Environmental Effects

The flood warning system is a series of non-invasive observation stations. They are intended to blend into the background.

F. Floodplain Effects

None

Project #2

Caliente Creek Habitat Mitigation Project

A. **Project Operation**

The ~ 1500 acres located between Highway 58 and Bena Road would be removed from their existing agricultural production, re-graded, and planted with native trees, shrubs, and brush. The purpose of this "Naturalization" is four fold;

First; Force a slowing and energy dissipation of flows crossing this Alluvial plain. This area has been identified as a "supply reach" for sediment by the USACE. By slowing the water, and by stabilizing the upper soil strata with tree and brush roots the transport of sediment from this area can be minimized.

Second; Increase sediment deposition. The flows emanating from Caliente and Walker Basin Creeks are heavily laden with sediment during large flood events before they reach this sediment transport zone. Lower energy , slower moving flows will deposit sediment over this channel reach.

Third, Increase volume losses. The USACE analysis of the reach of the Caliente Creek channel indicated surface infiltration rate of from 6" to 2" per hour. If the ground actually drained at this rate, 9,000 to 3,000 cfs of flow would be absorbed by this reach. It is anticipated that the actual, prolonged rate will be 1/10th this surface rate. Thus if water is spread over this 1,500 acres, from 300 to 900 cfs will be absorbed. The absorption rate of this reach will be enhanced by the evapo-transpiration of the trees and brush, as well as the positive root system impacts upon deep infiltration.

Fourth, Reclaim this 1,500 acre area as natural habitat. Minor intervention will be required of this naturalized area. Re-introduction of native species into this site will help maintain a diverse population in the region.

B. **Project Costs**

Caliente: Habitat Restoration and Sediment Stabilization Project
Cost Estimate (Preliminary)

Item	Unit	Quantity	Cost per Unit	Cost per Item
Landscape Earthwork	CY	2,420,000	$ 4.50	$ 10,890,000
Land Aquisition	Acre	1,500	$ 1,500	$ 2,250,000
			Sub-Total	**$ 13,140,000**
Preliminary Design				$ 250,000
EIR				$ 100,000
Final Design				$ 100,000
Administration		5%		$ 657,000
Contingency		15%		$ 1,971,000
			Total	**$ 16,218,000**

Annualized maintenance is estimate to be $96,000.

C. Project Benefits

The project benefits were detailed in the "Project Operations" Section. To Reiterate;

1) Reduce scour and sediment generation from this area
2) Force deposition, sediment removal
3) Volumetric losses from flood flows, ground water recharge
4) Habitat reclamation

D. Project Justification

Beyond the benefits previously described, this project is an integral mitigation of sediment and habitat for other, downstream projects.

E. Environmental Effects

"Sediment Starved" flows leaving this site will be more erosive on downstream channel reaches. Mitigation along the "Sand Ridge" will be critical. This may require grade stabilization structures to be constructed periodically within the critical reach areas.

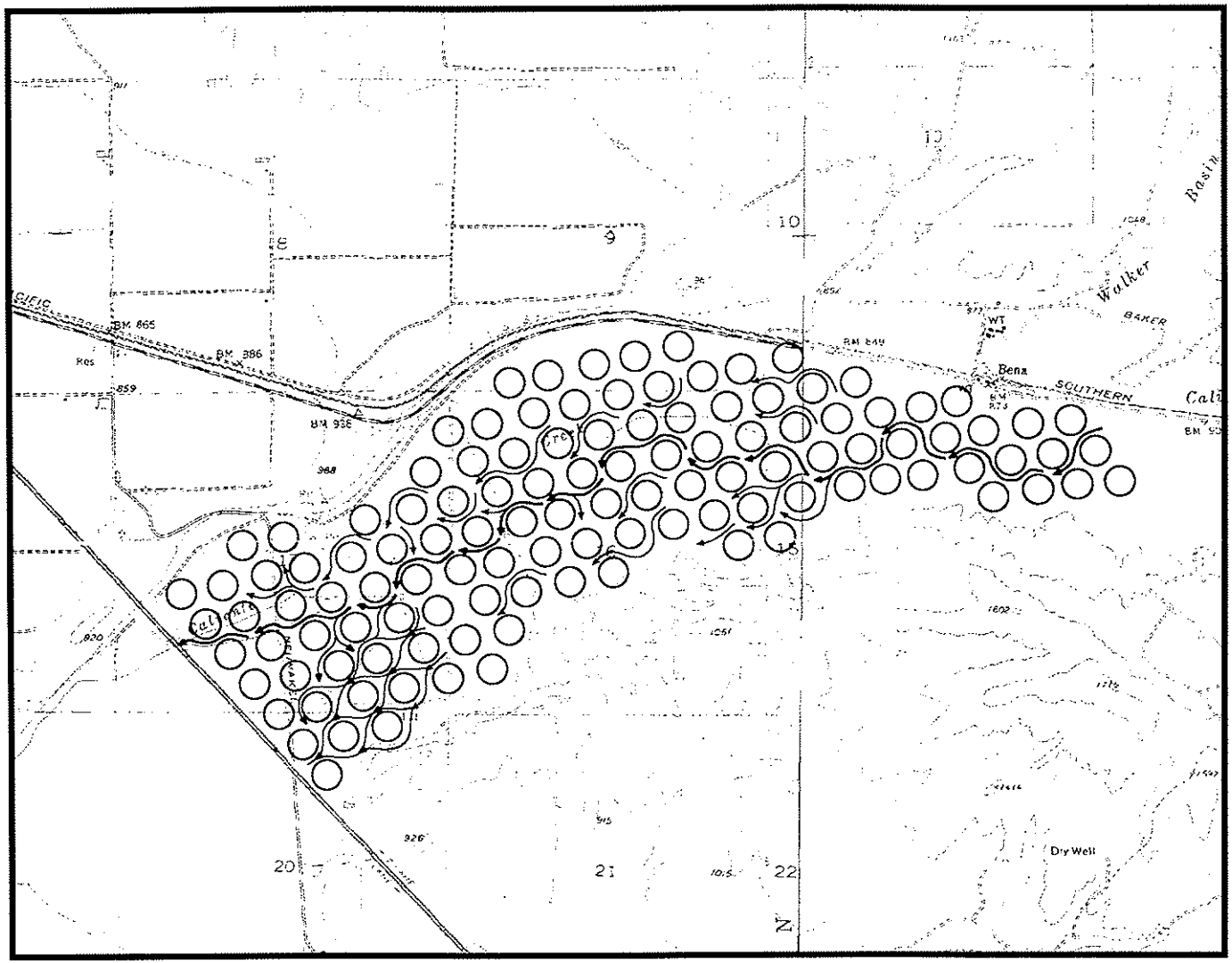
Sediment buildup upstream of Highway 58 may be accelerated significantly due to the lack of sediment being removed from this reach, while sediment replenishment continues, a sediment removal zone may be placed in the area approximately 500 feet upstream of Highway 58.

F. Floodplain Effects

If long duration absorption rates (0.2" to 0.6" per hour) and spreading impacts are correct, the peak flow from the estimate 100 year flood will be reduced from 27,000 cfs down to ~ 26,500 cfs, not a significant impact. However, the duration of flooding would be significantly reduced, and the volume of flood waters reaching the Kern Lake Bed would be reduced by as much as 1,000 acre-feet per day of flooding.

In addition the flow absorption would reduce the occurrence of flooding downstream of Highway 58 by more than 50% (i.e. less than half of the flood events now passing under Highway 58 would occur after this project).

CALIENTE CREEK HABITAT MITIGATION PROJECT



PROJECT 2

Project #3

Caliente Creek Ground Water Recharge Project

A. Project Operation

The approximately 1,500 acres between the "Tamarisk Treeline" and Highway 58 would be regraded into a series of 6' high retention dams. Flows passing under Highway 58, either at the Caliente Bridge or at the Nuemarkel underpass would be shunted, (via side weirs) into storage basins. This area has been identified by the USACE as having from 2" to 6" per hour infiltration rate. This 1,500 acres could, if these estimates can be used for long durations of flow, absorb from 3,000 to 9,000 cfs during a flood event. This rate of infiltration is unlikely for long durations. With proper site preparation (3 ft deep ripping) long duration infiltration may reach 0.5 inches per hour or ~750 cfs removed from the flow. If no infiltration (or very slow infiltration) were assumed the facilities will be able to confine 6,000 acre-foot of volume.

B. Project Costs

Caliente: Ground Water Re-Charge Project
Cost Estimate (Preliminary)

Item	Unit	Quantity	Cost per Unit	Cost per Item
Recharge Cell:				
Levee Construction	LF	4,500	$ 40.00	$ 180,000
Land Aquisition	Acre	30	$ 1,500	$ 45,000
Routing Weirs (2 per Cell): X 2				
Weir Gates	LF	200	$ 50	$ 10,000
Weir Structure (Concrete)	CY	100	$ 300	$ 30,000
Spillway (Rip-Rap)	CY	600	$ 60	$ 36,000
			Sub-Total	**$ 377,000**
Total Cells in Recharge Basin	EA	60	$ 377,000	$ 22,620,000
Intake Structure under State Highway 58				
Intake (Struct Concrete)	CY	100	$ 300	$ 30,000
2-72" RCP	LF	600	$ 160	$ 96,000
Outlet (Rip-Rap)	CY	200	$ 60	$ 12,000
Preliminary Design				$ 100,000
EIR				$ 100,000
Final Design				$ 100,000
			Sub-Total	**$ 23,058,000**
Administration		10%		$ 2,305,800
Contingency	43	20%		$ 4,611,600
			Total	**$ 29,975,400**

The estimated annualized maintenance cost of this project will be $41,000.

C. Projects Benefits

This project is primarily focused at mitigating runoff volume. A minimum of 6,000 acre-ft. would be kept from reaching the downstream floodplains and the Kern Lake Bed. Peak flows could be reduced by 750 cfs (or more).

In addition the side-weir structures would act as grade stabilization structures, protecting the "Sand Ridge from land slide failures resulting from flows undermining the slopes. This 1,500 acres would no longer be a sediment source.

D. Project Justification

This project mitigates volumetric impacts to downstream properties resulting from other proposed channelization projects. In addition this project stores, for future use, runoff from Caliente Creek in the ground water basin.

E. Environmental Effects

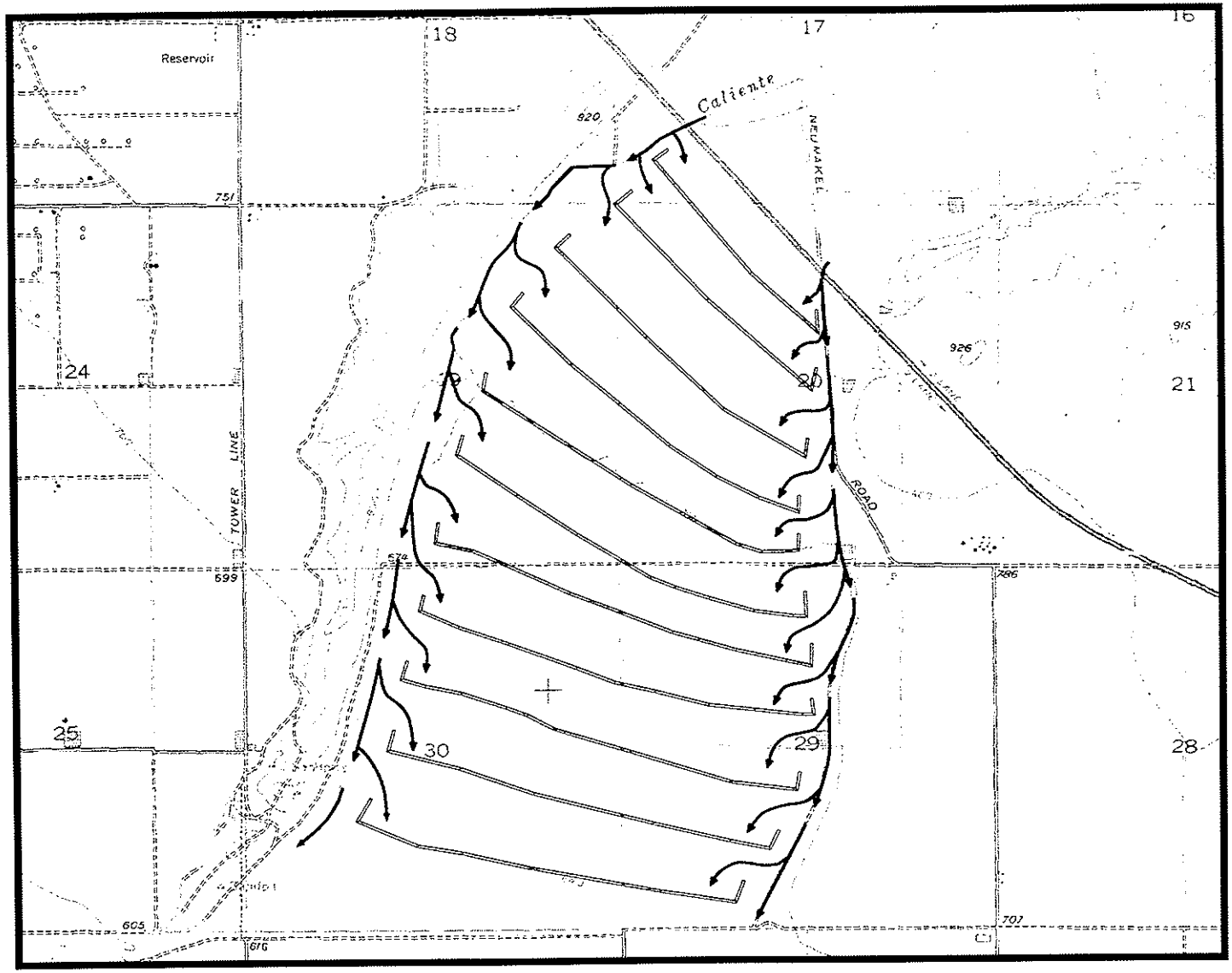
~1,500 acres of farmland will be removed from production. Naturalization of this area will not be permitted so that enhanced ground water recharge and short term storage can be sustained.

The stabilization of the channel located along the toe of the sand ridge will help protect the native species resident on the Sand Ridge.

F. Floodplain Effects

This project will lower flood flow volumes, peak flow rates, and modulate sediment transport from this reach. The downstream floodplain will receive significantly lower occurance of flooding and flood related damages as a result.

CALIENTE CREEK GROUND WATER RECHARGE PROJECT



PROJECT 3

Project #4

Lamont Drainfield Improvements

A. Project Operation

This project consists of constructing a new sump on the east side of the East Side Canal just north of Panama Road. This will be ~ three times the capacity of the current sumps.

These facilities would be used as emergency volume regulation and sediment storage. Flows exceeding the detention capacity and outflow design capacity of the Eastside Sump would be shunted into the main storage basin of the new facility. Flows moving westerly on Panama Road, east of Lamont, would be intercepted in the frontage area of the new facility where sediment deposition would occur prior to traveling onto and into the Eastside Sump.

Emergency flow connections will be made to Kern Delta's Eastside Canal. These connections will be used when extremely high volumes in the canal are posing the risk of catastrophic failure. The flood waters within the canal would be released directly into the main storage basin of this new facility.

In the majority of years the main storage basin can be used as a community recreational facility, with the frontage area used as a parking lot.

B. Project Costs

Lamont Drainfield Improvements

(Work Remaining)

Cost Estimate (Preliminary)

Item	Unit	Quantity	Cost per Unit	Cost per Item
Clearing and Grubbing	LS			$ 36,000
Develop Water Supply	LS			$ 16,000
Excavation	CY	546,000	$ 4.50	$ 2,457,000
Spillway & Gate to Eastside Canal	LS			$ 100,000
			Sub-Total	**$ 2,609,000**
Engineering & Construction		10%		$ 260,900
Administration		10%		$ 260,900
Contingency		5%		$ 130,450
			Total	**$ 3,261,250**

C. Project Benefits:

Upon completion the project will be able to mitigate flows up to 325 cfs, for up to 24 hours, and 100 cfs continuously. These sediment laden currently follow Panama Road into the town of Lamont where the sediment is deposited upon the roadways and private properties proximate to Panama Road. The sediment basins are designed to be shallow (maximum 4' depth of sediment) to allow for continuous sediment removal. This will prevent the existing bypass system from becoming choked with sediment, with a secession of function after one or two flow events.

A 450 acre-ft surge basin, capable of receiving 225 cfs for a 24 hour period is linked to the existing system. Flows exceeding the 100 cfs capacity of the existing bypass system will be truncated with the peak being temporally detained within the basin. An emergency release will be constructed into the Eastside Canal to allow for a rapid draining of the canal. This will provide additional time for the emergency evacuation of residents in case of imminent canal breach.

In dry years this basin can be used for community recreation.

D. Project Justification

Relatively small, sediment laden flows choke the existing system, limiting its functionality. This facility will mitigate these adverse impacts, increasing the capability and reliability of the bypass system.

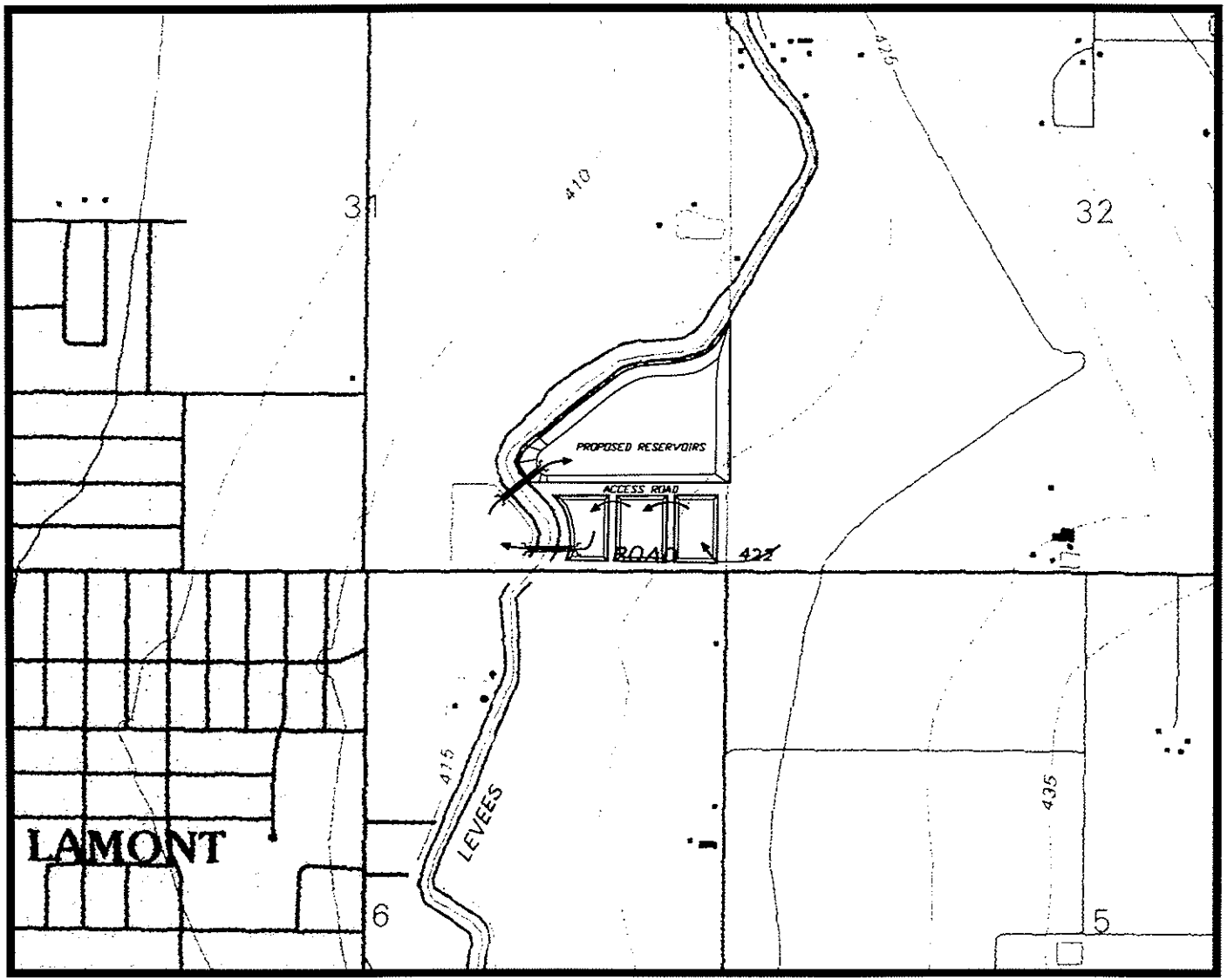
E. Environmental Effects

There are no environmental effects.

F. Floodplain Effects

This project will mitigate ~450 acre-ft of volume during moderate to heavy flood events.

LAMONT DRAINFIELD IMPROVEMENTS



PROJECT 4

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Project #5

Lamont Channel (Easterly Extension)

A. Project Operation

This project would extend the "Lamont Channel" easterly from the Arvin-Edison Canal to Caliente Creek Ground Water Recharge Project. It would also include the acquisition of flowage easements over adjacent farm lands to allow for higher peak flows from Caliente Creek to temporarily expand, flooding these farm properties, and then be drained back into the Lamont Channel.

By constructing this channel and providing a surge capacity, over a 24 hour period 1,500 acre-ft of flood volume can be temporarily detained.

B. Project Costs

Lamont Channel: Expansion

Cost Estimate (Preliminary)

Item	Unit	Quantity	Cost per Unit	Cost per Item
Land Aquisition				
Flowage Easements	Acre	640	$ 5,600	$ 3,584,000
Channel	Acre	60	$ 7,000	$ 420,000
Channel Excavation	CY	240,000	$ 4.50	$ 1,080,000
Roadway Undercrossings	Each	2	$250,000	$ 500,000
			Sub-Total	**$ 5,584,000**
Preliminary Design				$ 100,000
EIR				$ 100,000
Final Design				$ 50,000
Administration		10%		$ 558,400
Contingency		20%		$ 1,116,800
			Total	**$ 7,509,200**

C. Project Benefits:

This project provides peak flow and volume mitigation. The volume mitigation, through infiltration losses, will compensate for the lack of normal spreading resulting from the Lamont Channel. The attenuation effects of the 640 acre spreading grounds will reduce and modulate the peak flows following this path.

D. Project Justification

The proposed upstream projects, Caliente Creek Habitat Mitigation Project and the Caliente Creek Ground Water Recharge Project, will slow, cleanse, and modulate the flows leaving Caliente Creek. This project will further stabilize the flows and focus the flood waters toward the Lamont Channel.

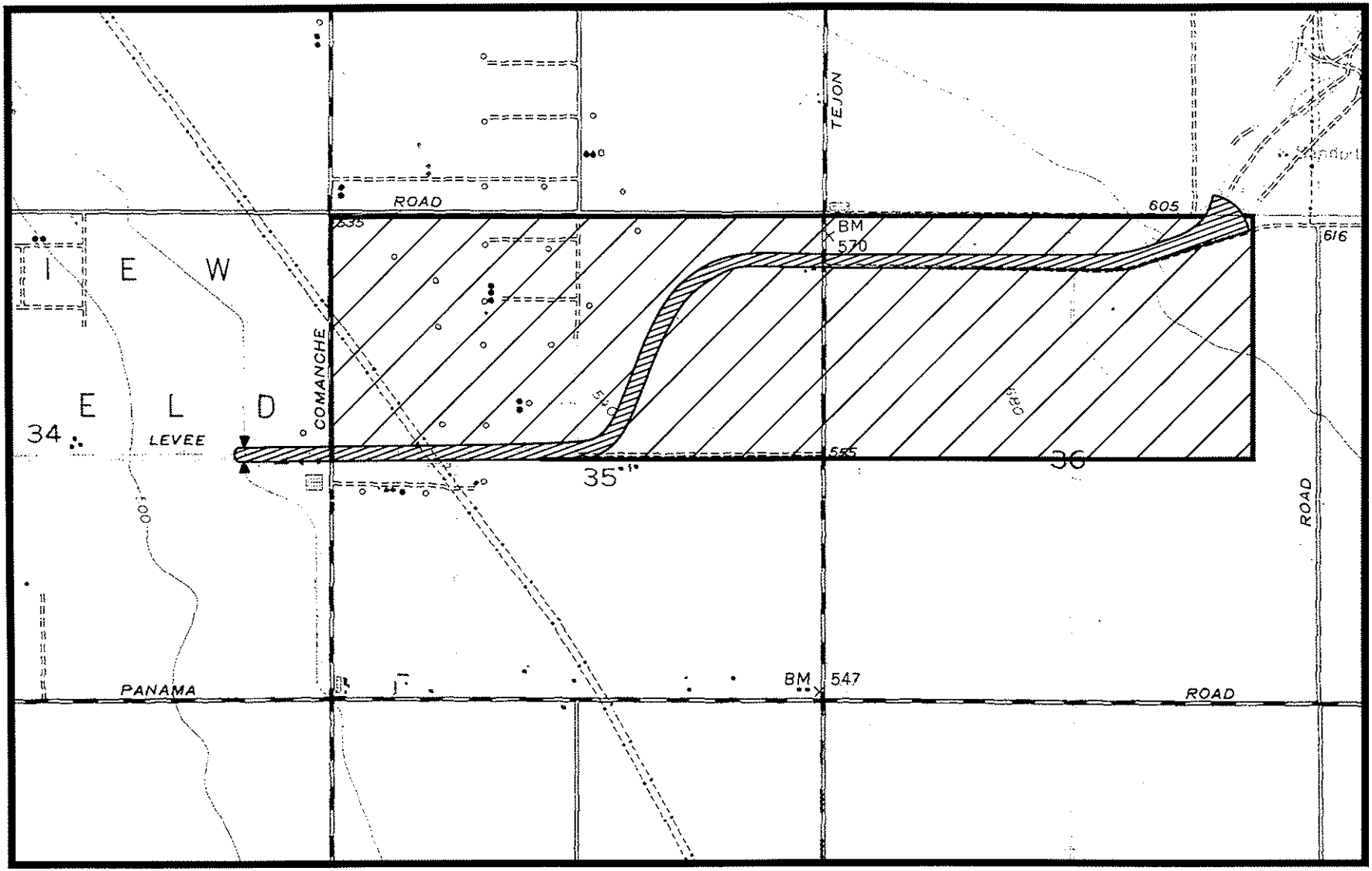
E. Environmental Effects

The lands used for detention will be usable for row crops. Tree farming in this reach may not be profitable due to the frequency of deep root zone flooding. A riparian corridor exists along the channel alignment, and will be re-introduced as part of this project

F. Floodplain Effects

This project, in effect, confines Caliente Creek to a ½ mile wide floodplain, protecting farming operations to the south. Breakout waters will still impact the intersection of Panama Road and Comanche Road, but these will be an infrequent occurrence.

LAMONT CHANNEL
(EASTERLY EXTENSION)



PROJECT 5

Project #6

Lamont Channel

A. Project Operation

This project constructs a channel with an in ground capacity of 3,000 cfs, along the McKee Road alignment, starting at Arvin-Edison Canal, traveling westerly across the Eastside Canal (with an intertie facility), crossing Edison Hwy, Weedpatch Hwy, the Railroad, Fairfax Road, finally terminating at the Arvin-Edison Intake Canal spreading grounds (approximately 7 miles of channel). The levees surrounding these spreading grounds and the outlet channel would also be upgraded.

The channel is intended to convey flood waters which currently split at Malaga Road and flow north toward the Reynold's Tract, and south towards Panama Road and the densely populated areas within Lamont. The interception at this point avoids the most heavily sediment laden reaches of the creek while providing a level of protection great enough to limit flooding of Lamont to once every 25 to 50 years.

The intertie with the Eastside Canal is intended to minimize the maintenance on the channel downstream of the Eastside Canal. The first 100 cfs would be shunted south to the Lamont Bypass System. The next 50 cfs would be shunted north to the North Lamont Channel. When constructed, the Eastside Canal Expansion would convey an additional 350 cfs south to the Weedpatch Channel.

B. Project Costs

Lamont Channel
Cost Estimate (Preliminary)

Item	Unit	Quantity	Cost per Unit	Cost per Item
Railroad Undercrossing	Each	1	$ 350,000	$ 350,000
Eastside Canal Intertie	Each	1	$ 150,000	$ 150,000
Land Aquisition	Acre	240	$ 7,000	$ 1,680,000
Channel Excavation	CY	700,000	$ 4.50	$ 3,150,000
Roadway Undercrossings	Each	3	$ 250,000	$ 750,000
			Sub-Total	**$ 6,080,000**
Preliminary Design				$ 100,000
EIR				$ 100,000
Final Design				$ 50,000
Administration		5%		$ 304,000
Contingency		10%		$ 608,000
			Total	**$ 7,242,000**

C. Project Benefits:

This project intercepts the maximum amount of flow which can be passed over the Arvin-Edison Canal syphon, without directly breaching the canal. These flood waters directly impact Lamont. The proposed channel diverts and safely moves this flow through and past the residential and commercial areas of Lamont.

D. Project Justification

This project provides primary and direct flood protection to Lamont.

E. Environmental Effects

Sediment loads in the flood waters will become unmanageable during long duration or moderate to large flood events. Sediment mitigation is required or this facility will fail during these larger events.

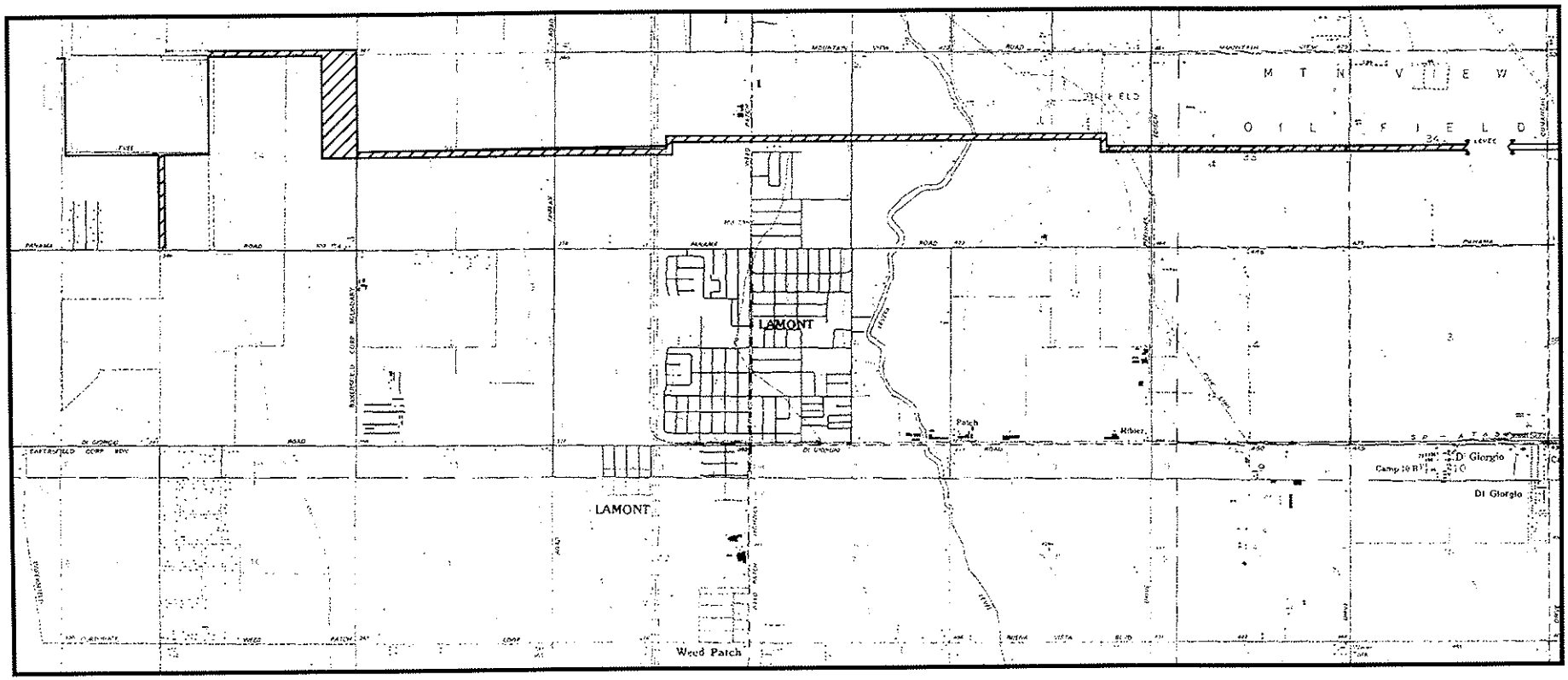
The channel bed itself will become a source of transportable sediment when clarified flows are introduced. Grade stabilization structures may become necessary.

Natural habitat will attempt to establish in the channel bed. The necessity for annual channel maintenance, such as sediment removal and levee servicing, will be incompatable with this riperian habitat. Therefore, alternate habitat mitigation should be proposed and implemented.

F. Floodplain Effects

This project will greatly reduce the area impacted by the 100-year flood and will eliminate flooding of the Lamont area accept from the most infrequent of flood events.

LAMONT CHANNEL



PROJECT 6

Project #7

Panama Road Ditch Improvements

A. Project Operation

This project consists of increasing the capacity of the existing ditch on the south side of Panama Road which currently transports the water westward from the existing westside sump.

The Lamont Bypass System currently must throttle back the flows leaving the Westside Sump so as to not endanger the residential structures west of Fairfax Road on the south side of Panama Road. The construction of this project would greatly increase the flow carrying capacity of this existing ditch and thus allow for a system wide increase in efficiency and level of flood protection .

B. Project Costs

Panama Road Ditch Improvement
Cost Estimate (Preliminary)

Item	Unit	Quantity	Cost per Unit	Cost per Item
Land Aquisition	Acre	8	$ 1,000	$ 8,000
Channel Excavation	CY	40,000	$ 4.50	$ 180,000
Channel Embankment	CY	40,000	$ 8.00	$ 320,000
Access Bridge/Culvert	Each	12	$ 15,000.00	$ 180,000
Roadway Undercrossings	Each	1	$ 50,000	$ 50,000
			Sub-Total	**$ 738,000**
Preliminary Design				$ 20,000
EIR				$ 20,000
Final Design				$ 10,000
Administration		5%		$ 36,900
Contingency		10%		$ 73,800
			Total	**$ 898,700**

C. Project Benefits:

The existing Lamont Bypass storm drain system can convey up to 100 cfs from the Eastside Sump to the Westside Sump. The outlet from the Westside Sump is limited to the capacity of the downstream road side ditch, which can convey ~50 cfs. By increasing the capacity of the downstream roadside ditch, the bypass system will be able to function longer and more efficiently.

D. Project Justification

The existing ditch is a bottle-neck which places the property owners adjacent to the ditch at risk as well as those properties dependant upon the bypass facilities.

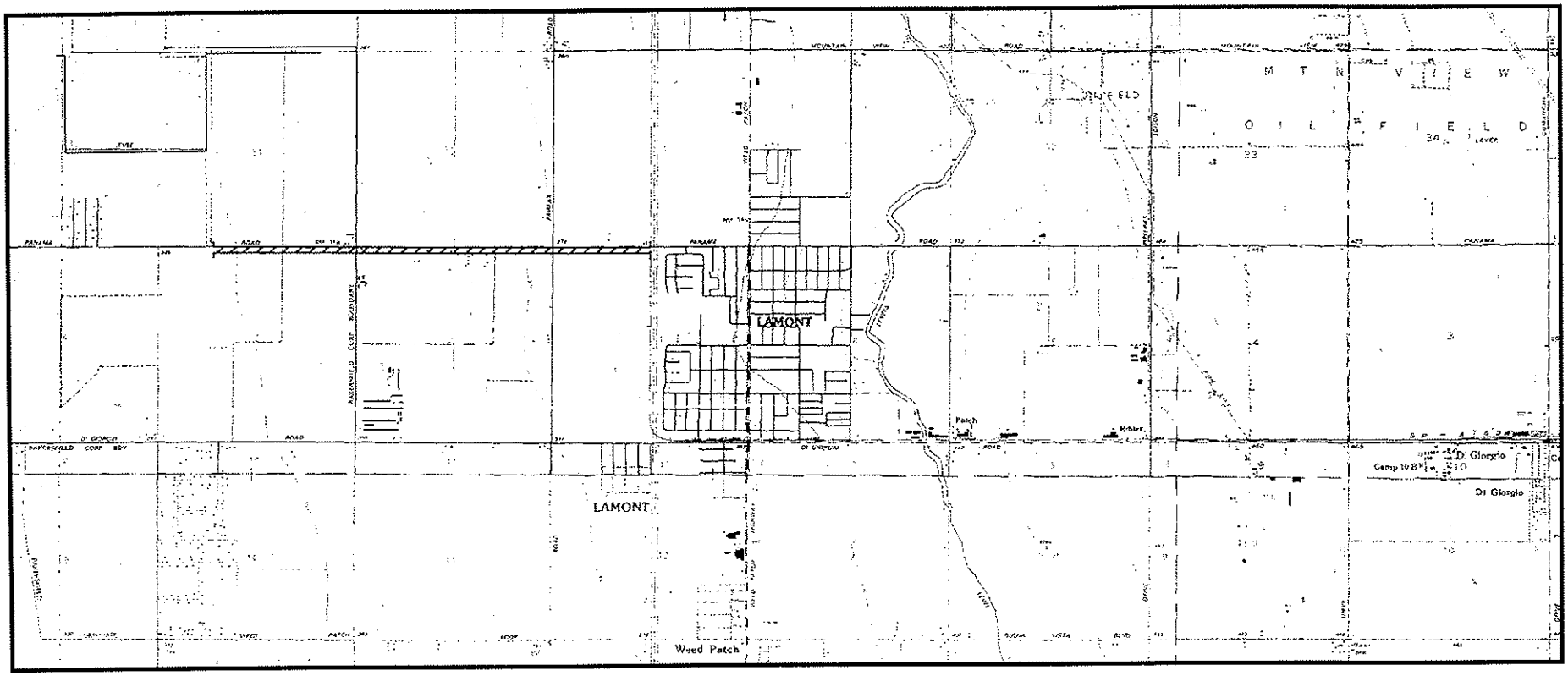
E. Environmental Effects

There are no environmental impacts.

F. Floodplain Effects

The increased capacity of this ditch will not change the floodplain. It will control the extra flow which breaks out of the Westside sump when its capacity is exceeded.

PANAMA ROAD DITCH IMPROVEMENTS



PROJECT 7

Project #8

North Lamont Channel

A. Project Operation

This proposed channel begins with a structure tied into the East Side Canal and would allow water, which currently flows through the Reynolds Tract, to be carried along the northern boundary of the tract, under the San Joaquin railroad tracks, westerly to Fairfax Road, under Fairfax, westerly along the dairy access road, terminating at the westerly edge of the dairies. The connection at the East Side Canal would also allow for a rapid, controlled emptying of the canal instead of an uncontrolled breach, which has occurred in the past.

This facility will eliminate the current, distressful, level of nuisance flows which flood the Reynold's Tract and adjacent properties. Flood flows which would, under extreme events, overtop the Eastside Canal, will continue to be a potential problem for the northern area of Lamont.

B. Project Costs

North Lamont Channel
Cost Estimate (Preliminary)

Item	Unit	Quantity	Cost per Unit	Cost per Item
Railroad Undercrossing	Each	1	$ 75,000	$ 75,000
Land Aquisition	Acre	25	$ 5,000	$ 125,000
Channel Excavation	CY	9,000	$ 2.50	$ 22,500
48" RCP, RGJ	LF	3,900	$ 88.00	$ 343,200
Roadway Undercrossings	Each	1	$ 50,000	$ 50,000
Sump Excavation	CY	100,000	$ 2.50	$ 250,000
			Sub-Total	**$ 865,700**
Preliminary Design				$ 25,000
EIR				$ 25,000
Final Design				$ 10,000
Administration		5%		$ 43,285
Contingency		10%		$ 86,570
			Total	**$ 1,055,555**

C. Project Benefits:

Most flooding which impacts the Reynolds Tract originates from waters passing through the 36" culvert under the East Side Canal. This project will fully mitigate these flows and protect the residents of the Reynolds Tract from this nuisance flooding.

D. Project Justification

The Reynolds Tract receives frequent and severe nuisance flooding from the east. This project mitigates this problem.

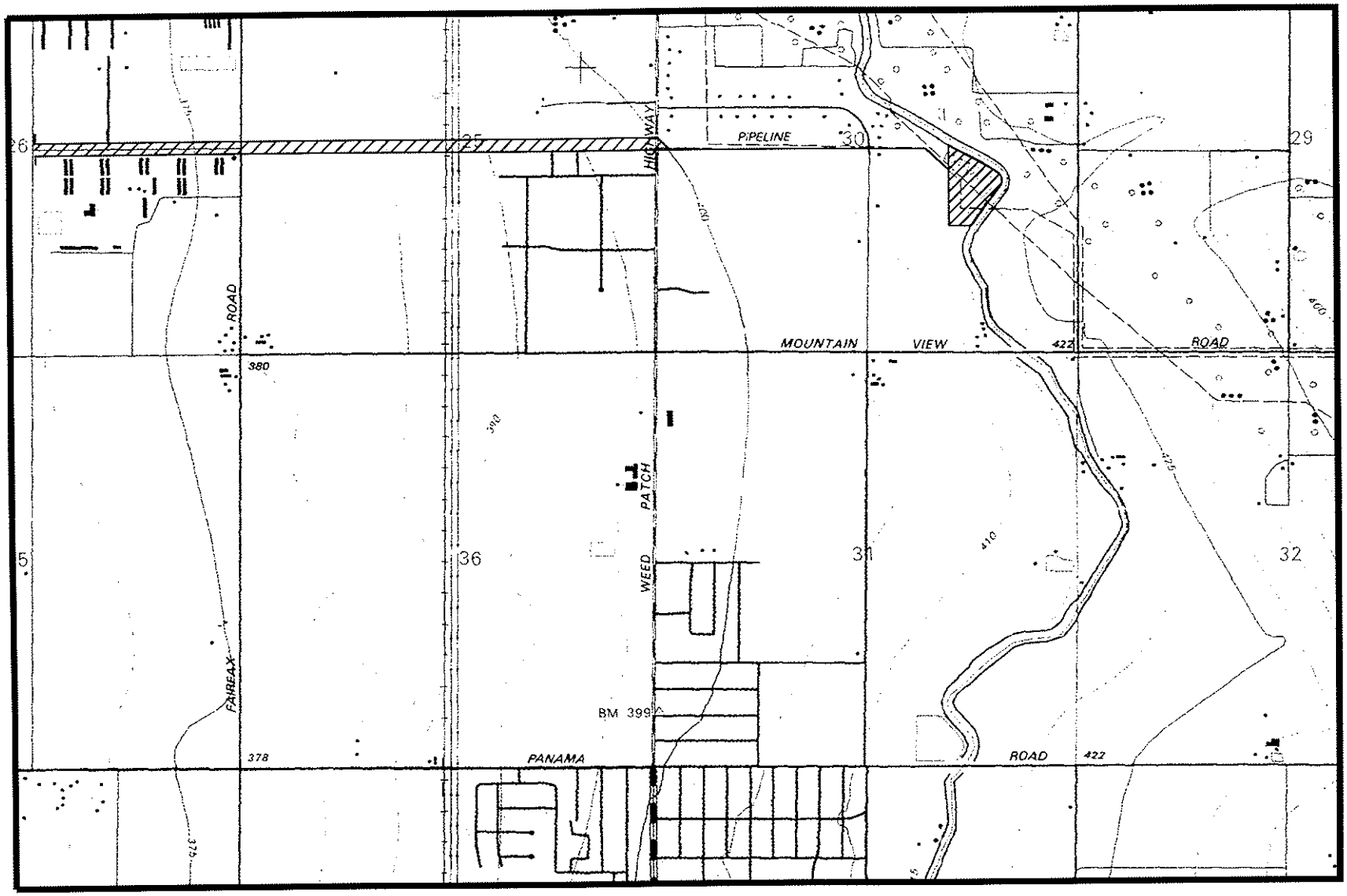
E. Environmental Effects

Currently, these flood waters flow through dairies west of Fairfax in an uncontrolled manner. This project will mitigate this public health threat.

F. Floodplain Effects

This project mitigates frequent, nuisance flooding and will have limited (if any) impact upon the 100 year flood.

NORTH LAMONT CHANNEL



PROJECT 8

Project #9

Weedpatch Channel

A. Project Operation

This project would construct five (5) miles of channel originating at the Eastside Canal (approximately one-half mile south of Di Giorgio Road) westerly to two miles west of Weedpatch Highway (jogging around the County offices) then south crossing Buena Vista Road then west to the natural flow path of Caliente Creek. Along its path three retention basins, designed for volumetric mitigation for downstream properties, will be constructed.

The greatest risk of disastrous flooding in Lamont lies with a catastrophic failure of the Eastside Canal. This project will provide a flow release for flood waters entering the Eastside Canal north of Di Giorgio Road. Currently these flood waters escape the canal at the Di Giorgio syphon, flooding residential properties south of Di Giorgio Road and west of Weedpatch Highway.

B. Project Costs

Weedpatch Channel
Cost Estimate (Preliminary)

Item	Unit	Quantity	Cost per Unit	Cost per Item
Land Aquisition				
Detention Basin #1	Acre	15	$ 4,000	$ 60,000
Detention Basin #2	Acre	15	$ 4,000	$ 60,000
Detention Basin #3	Acre	54	$ 4,000	$ 216,000
Channel	Acre	95	$ 4,000	$ 380,000
Excavation				
Detention Basin #1	CY	120,000	$ 4.50	$ 540,000
Detention Basin #2	CY	120,000	$ 4.50	$ 540,000
Detention Basin #3	CY	500,000	$ 4.50	$ 2,250,000
Channel	CY	200,000	$ 4.50	$ 900,000
Roadway Undercrossings				
Weedpatch Hwy	Each	1	$ 200,000	$ 200,000
Fairfax Road	Each	1	$ 150,000	$ 150,000
Buena Vista Road	Each	1	$ 150,000	$ 150,000
Flow Control Structures				
Eastside Canal	Each	1	$ 150,000	$ 150,000
Detention Basin #1	Each	1	$ 100,000	$ 100,000
Detention Basin #2	Each	1	$ 100,000	$ 100,000
Detention Basin #3	Each	1	$ 100,000	$ 100,000
Outlet	Each	1	$ 150,000	$ 150,000
			Sub-Total	**$ 6,046,000**
Preliminary Design				$ 100,000
EIR				$ 100,000
Final Design				$ 50,000
Administration		10%		$ 604,600
Contingency		20%		$ 1,209,200
			Total	**$ 8,109,800**

C. Project Benefits:

This project protects the community of Weedpatch from breakout flows from the Eastside Canal. In conjunction with the Eastside Canal Enlargement project, this facility will increase the area wide flood mitigation capability.

D. Project Justification

This project is justified in conjunction with the East Side Canal Enlargement Project. Without this improvement the proposed Channel will have only limited function.

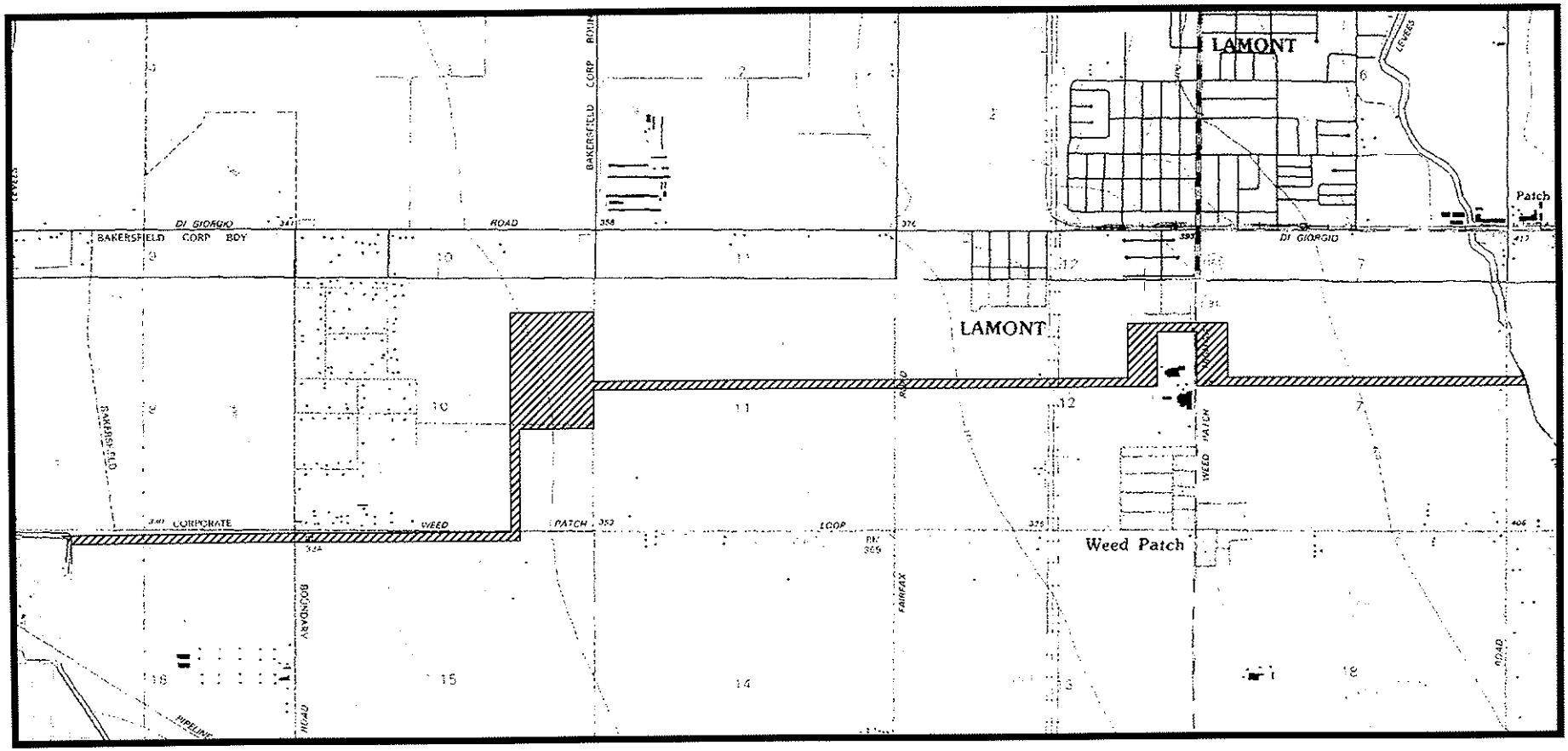
E. Environmental Effects

Habitat mitigation will need to be employed in conjunction with this project.

F. Floodplain Effects

This project will have only marginal impact upon the floodplain limits. During moderate flood events this project will provide additional capacity for flood diversion.

WEEDPATCH CHANNEL



PROJECT 9

Project #10

Vineland Road Dam/Recharge Basin

A. Project Operation

Vineland Road makes an ~12 ft dip as it crosses the northerly channelization of Caliente Creek upstream of the Eastside Canal. This "dip" would be removed with Vineland Road following a hilltop to hilltop vertical alignment. The resulting roadway would act as a dam for flow following this northerly split from Caliente Creek.

This facility will have approximately 650 acre-ft of storage capacity. It will be linked to the North Lamont Channel, with a discharge capacity of ~50 cfs. In addition a tie-in will be made to the Eastside Canal so that waters stored behind the dam can be used for irrigation or distribution to downstream facilities.

B. Project Costs

Vineland Road Dam/Recharge Basin

Cost Estimate (Preliminary)

Item	Unit	Quantity	Cost per Unit	Cost per Item
Dam Construction	CY	400,000	$ 10.00	$ 4,000,000
Spillway	EA	1	$ 250,000	$ 250,000
Eastside Canal Tie-in	EA	1	$ 250,000	$ 250,000
Land Aquisition	Acre	100	$ 5,000	$ 500,000
			Sub-Total	**$ 5,000,000**
Preliminary Design				$ 250,000
EIR				$ 100,000
Final Design				$ 100,000
Administration		5%		$ 250,000
Contingency		15%		$ 750,000
			Total	**$ 6,450,000**

C. Project Benefits:

The northerly split flow from Caliente Creek which floods this area can, and has historically, cause(d) a catastrophic failure of the Eastside Canal in this reach. By controlling ~650 acre-ft of volume the potential for failure and serious harm to life and property down stream is greatly diminished.

D. Project Justification

This project will provide additional volume mitigation for the Lamont Channel and for the North Lamont Channel. The project will provide significant flood protection to downstream properties.

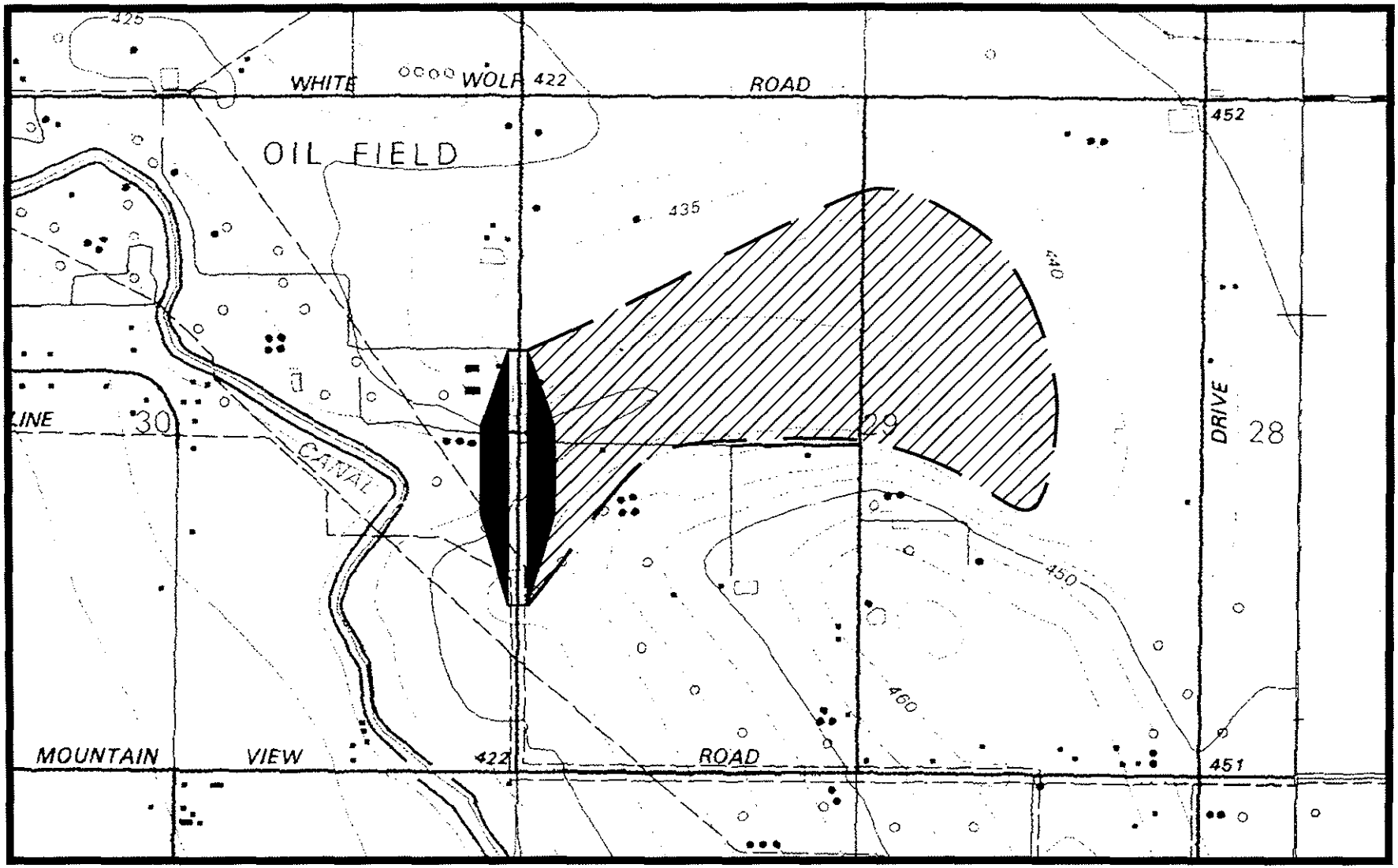
E. Environmental Effects

The area covered by the dam "reservoir" is currently under row crop cultivation. This function can be continued in non-flood years. There will be habitat mitigation required.

F. Floodplain Effects

This facility may provide 100-yr flood protection for downstream properties, additional feasibility analysis is required.

VINELAND ROAD DAM / RECHARGE BASIN



PROJECT 10

Project #11

Tejon/El Paso Creek Groundwater Recharge Basin

A. Project Operation

This facility takes water controlled and discharged from the Tejon Creek Dam and Reservoir. The deep sandy alluvium will be used to recharge the ground water basin for future use.

B. Project Costs

The KCWA estimated the cost of this project, in conjunction with the Tejon Dam and Reservoir, to be $1,900,000, in 1975. Current cost of these projects would be $6,250,000.

C. Project Benefits:

This project would provide ~50 year protection from flood waters originating from El Paso Creek and Tejon Creeks.

D. Project Justification

This project mitigates increased runoff volume and peak that may result from the channelization of flows proposed by other projects.

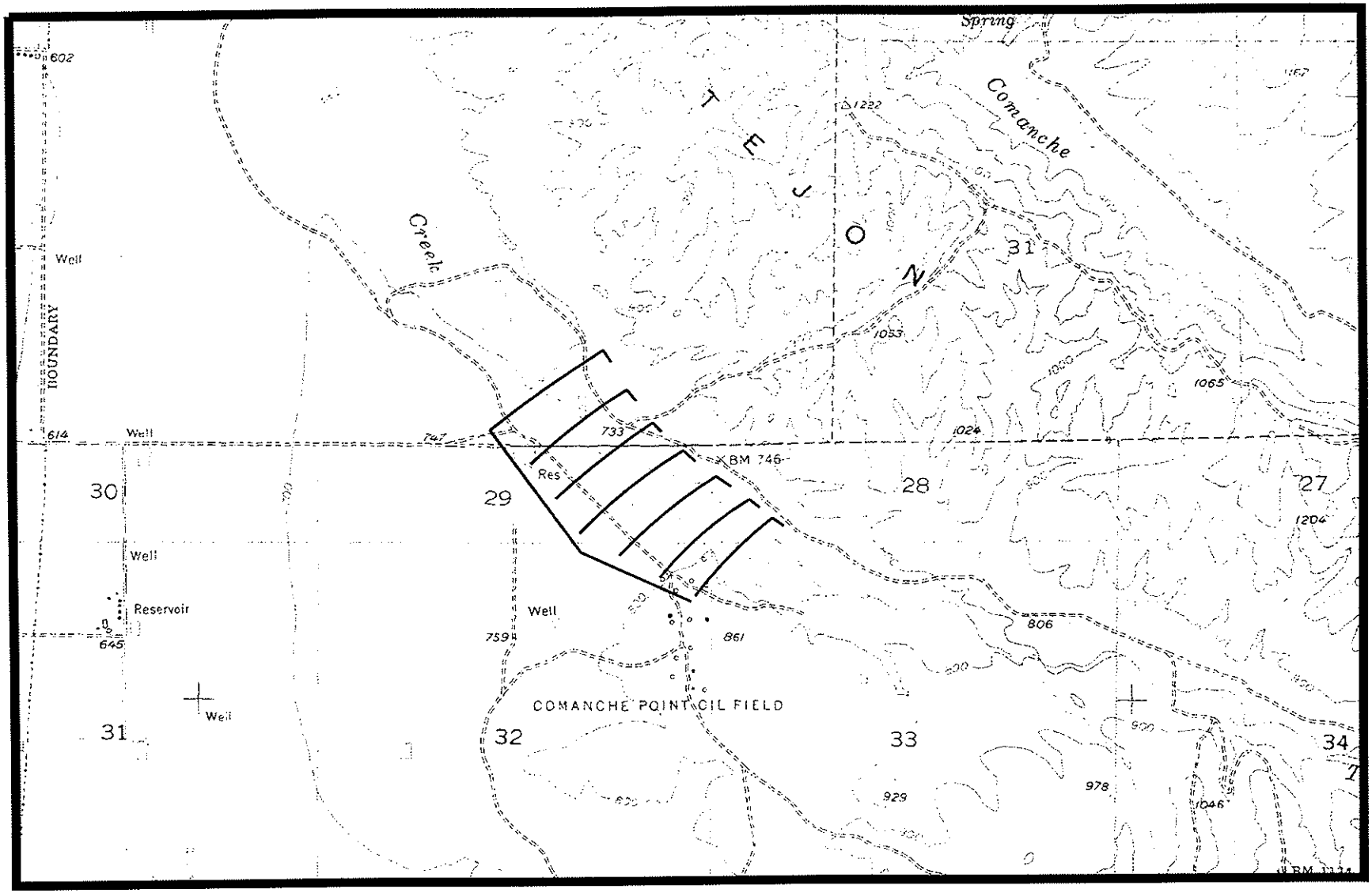
E. Environmental Effects

This project could be used as habitat mitigation, further research into this function should be pursued. Typically, a ground water recharge facility will require significant maintenance which is not conducive to the establishment of native habitat. Habitat mitigation will be required.

F. Floodplain Effects

This project, in conjunction with the Tejon Creek Dam and downstream channelization will control flooding originating in Tejon Creek.

TEJON / EL PASO CREEK GROUND WATER RECHARGE BASIN



PROJECT 11

Project #12

Tejon Creek Dam and Reservoir

A. Project Operation

This project proposes a dam and reservoir. Flows from this dam will be delivered to the Tejon/El Paso Creek Groundwater Recharge Basin.

B. Project Costs

This project in conjunction with the Tejon/El Paso Creek Groundwater Recharge Basin will cost an estimated $6,250,000.

C. Project Benefits:

The dam and reservoir will provide ~50 year flood protection to down stream properties.

D. Project Justification

This project will provide volumetric mitigation and peak flow mitigation for other proposed channelization projects.

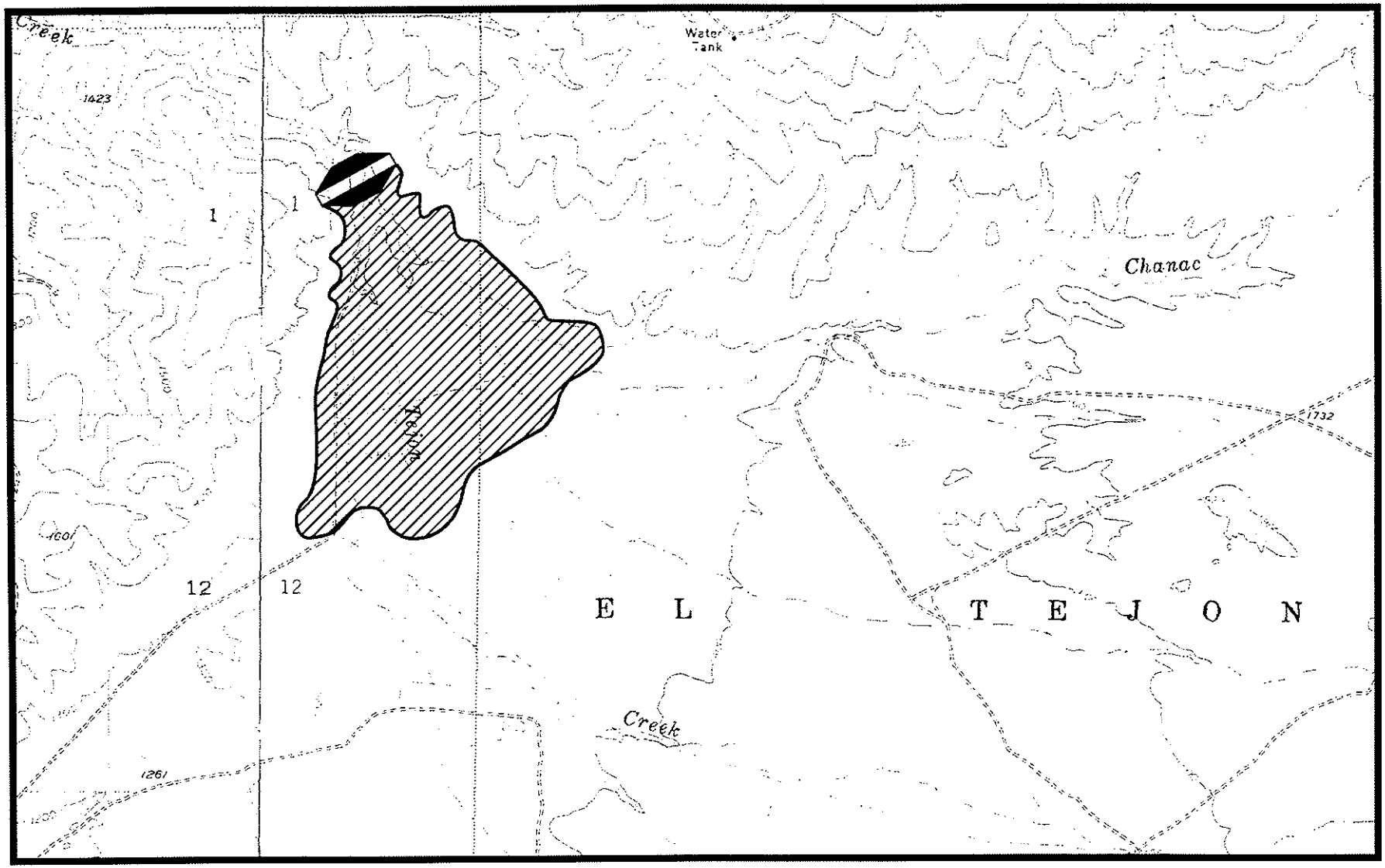
E. Environmental Effects

Unknown at this time.

F. Floodplain Effects

This project in conjunction with other proposed downstream facilities will provide significant flood relief.

TEJON CREEK DAM AND RESERVOIR



PROJECT 12

Project #13

Pastoria Creek Ground Water Recharge Basin

A. Project Operation

Runoff waters, originating from Pastoria Creek will be intercepted and spread into groundwater recharge facilities.

B. Project Costs

This project has been estimated to cost $2,000,000. This estimate should not be used for budgetary purposes, but should only be used for comparison.

C. Project Benefits:

This project provides volumetric mitigation for other channelization projects.

D. Project Justification

Water is a valuable resource in this region. During wet years it needs to be stored for dry year usage. Ground water recharge is the best means to meet this need.

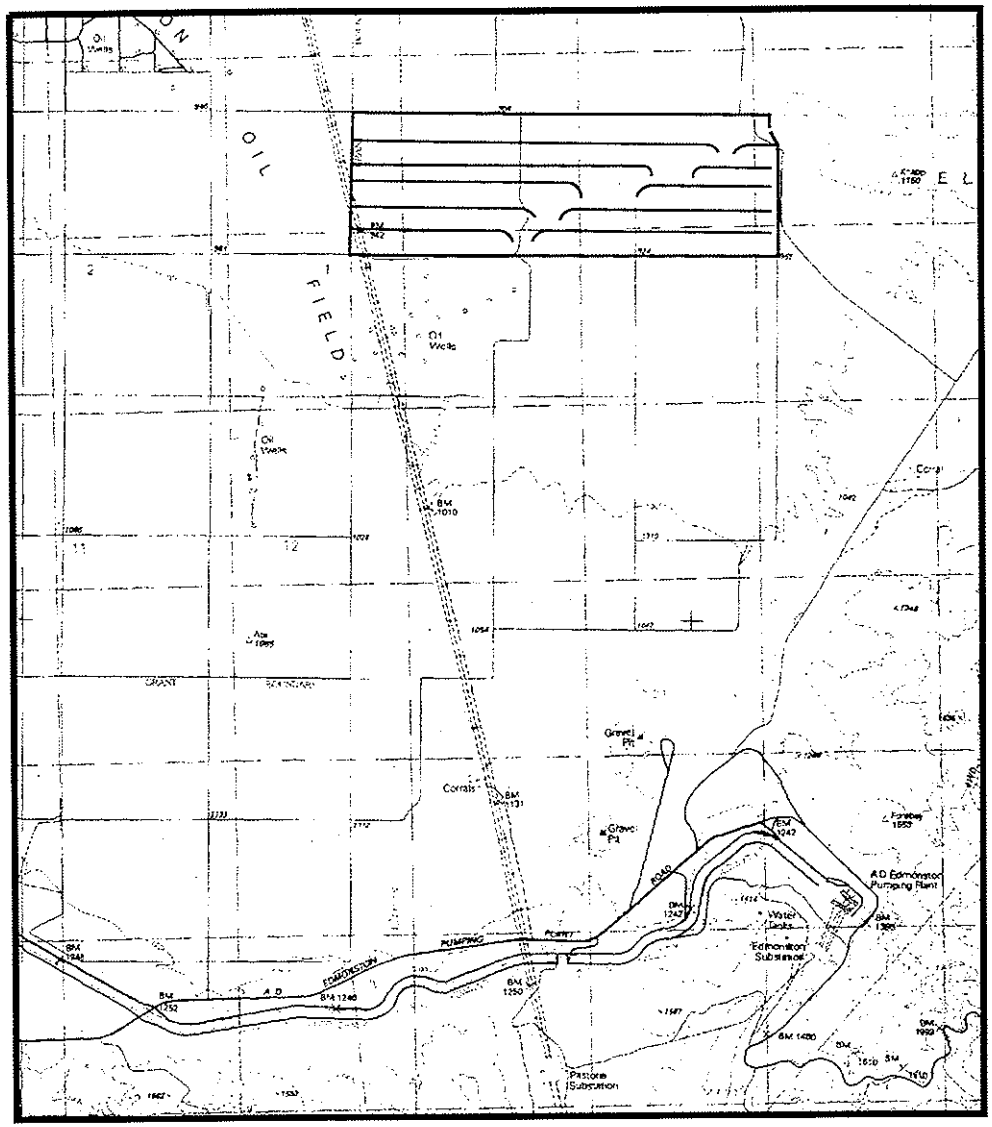
E. Environmental Effects

This project could be used as habitat mitigation, further research into this function should be pursued. Typically, a ground water recharge facility will require significant maintenance which is not conducive to the establishment of native habitat. Habitat mitigation will be required.

F. Floodplain Effects

Through mitigating volume this project makes possible the construction of channelization projects which will limit the extent and degree of flooding.

PASTORIA CREEK GROUND WATER RECHARGE BASIN



PROJECT 13

Project #14

Grapevine Creek Ground Water Recharge Basin

A. Project Operation

Runoff waters, originating from Grapevine Creek will be intercepted and spread into groundwater recharge facilities.

B. Project Costs

This project has been estimated to cost $4,000,000. This estimate should not be used for budgetary purposes, but should only be used for comparison.

C. Project Benefits:

This project provides volumetric mitigation for other channelization projects.

D. Project Justification

Water is a valuable resource in this region. During wet years it needs to be stored for dry year usage. Ground water recharge is the best means to meet this need.

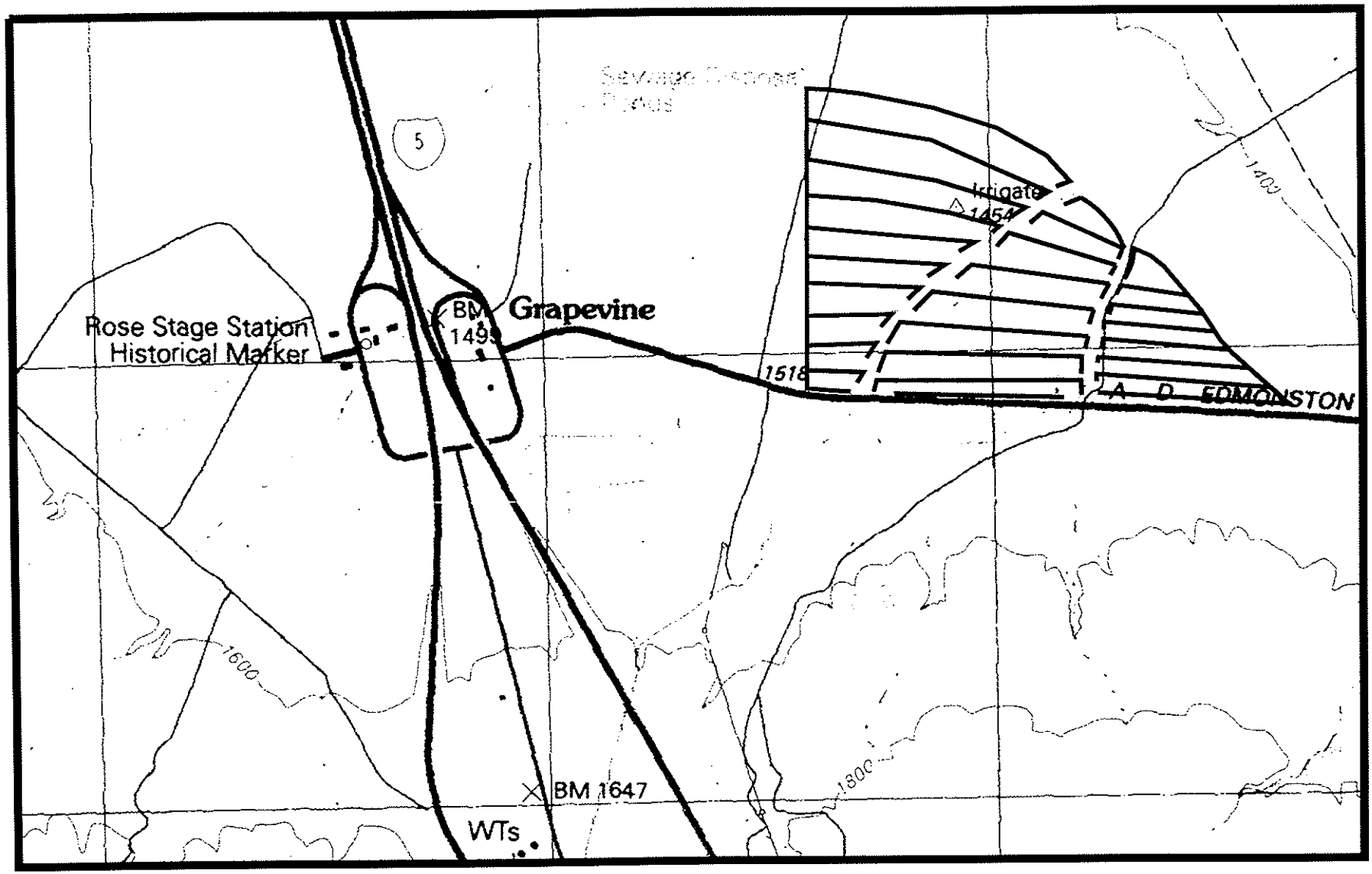
E. Environmental Effects

This project could be used as habitat mitigation, further research into this function should be pursued. Typically, a ground water recharge facility will require significant maintenance which is not conducive to the establishment of native habitat. Habitat mitigation will be required.

F. Floodplain Effects

Through mitigating volume this project makes possible the construction of channelization projects which will limit the extent and degree of flooding.

GRAPEVINE GROUND WATER RECHARGE BASIN



PROJECT 14

Project #15

Pleito Creek Ground Water Recharge Basin

A. Project Operation

Runoff waters, originating from Pleito Creek will be intercepted and spread into groundwater recharge facilities.

B. Project Costs

This project has been estimated to cost $1,500,000. This estimate should not be used for budgetary purposes, but should only be used for comparison.

C. Project Benefits:

This project provides volumetric mitigation for other channelization projects.

D. Project Justification

Water is a valuable resource in this region. During wet years it needs to be stored for dry year usage. Ground water recharge is the best means to meet this need.

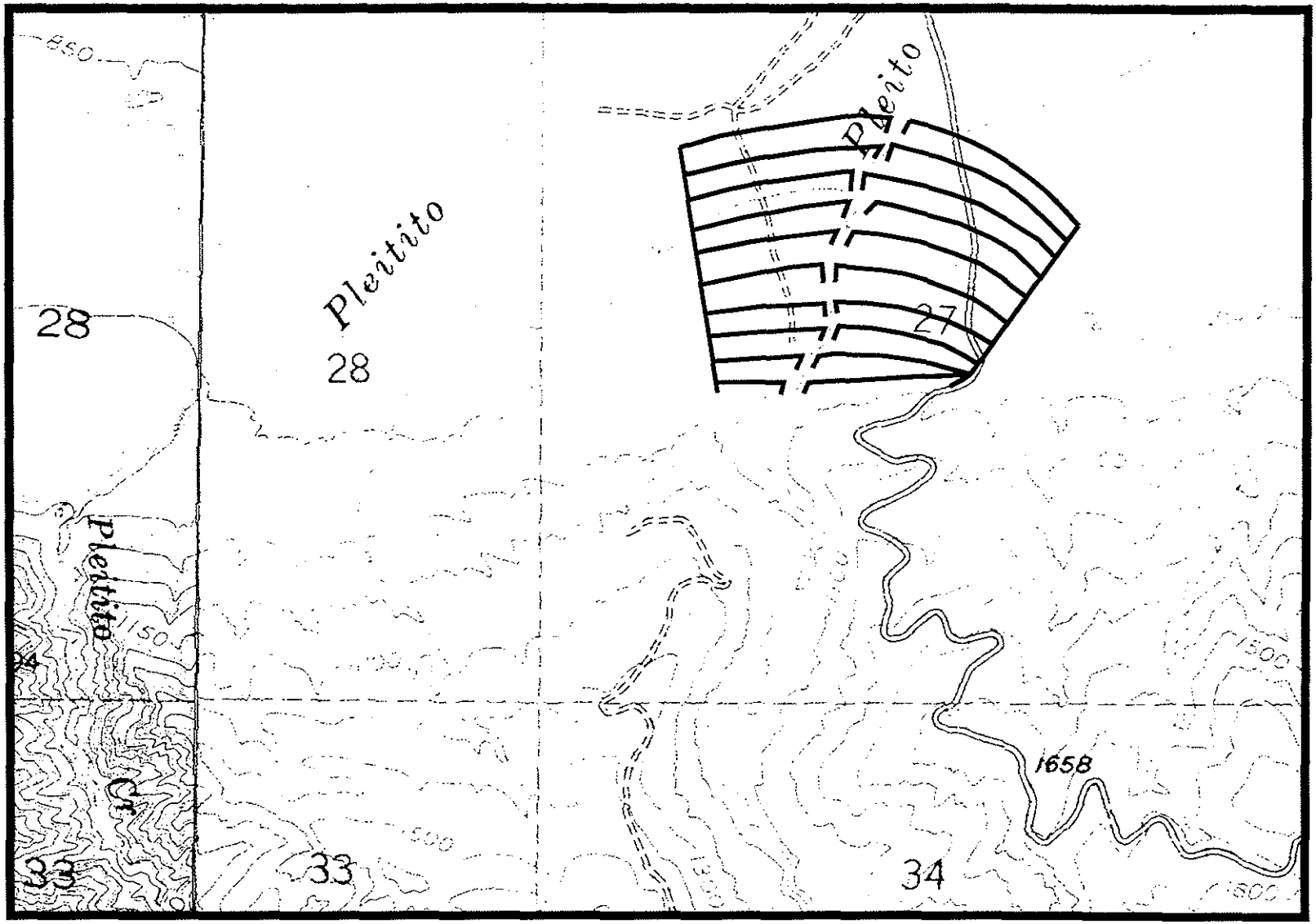
E. Environmental Effects

This project could be used as habitat mitigation, further research into this function should be pursued. Typically, a ground water recharge facility will require significant maintenance which is not conducive to the establishment of native habitat. Habitat mitigation will be required.

F. Floodplain Effects

Through mitigating volume this project makes possible the construction of channelization projects which will limit the extent and degree of flooding.

PLEITO CREEK GROUND WATER RECHARGE BASIN



PROJECT 15

Project #16

San Emigdio Creek Ground Water Recharge Basin

A. Project Operation

Runoff waters, originating from San Emigdio Creek will be intercepted and spread into groundwater recharge facilities.

B. Project Costs

This project has been estimated to cost $2,000,000. This estimate should not be used for budgetary purposes, but should only be used for comparison.

C. Project Benefits:

This project provides volumetric mitigation for other channelization projects.

D. Project Justification

Water is a valuable resource in this region. During wet years it needs to be stored for dry year usage. Ground water recharge is the best means to meet this need.

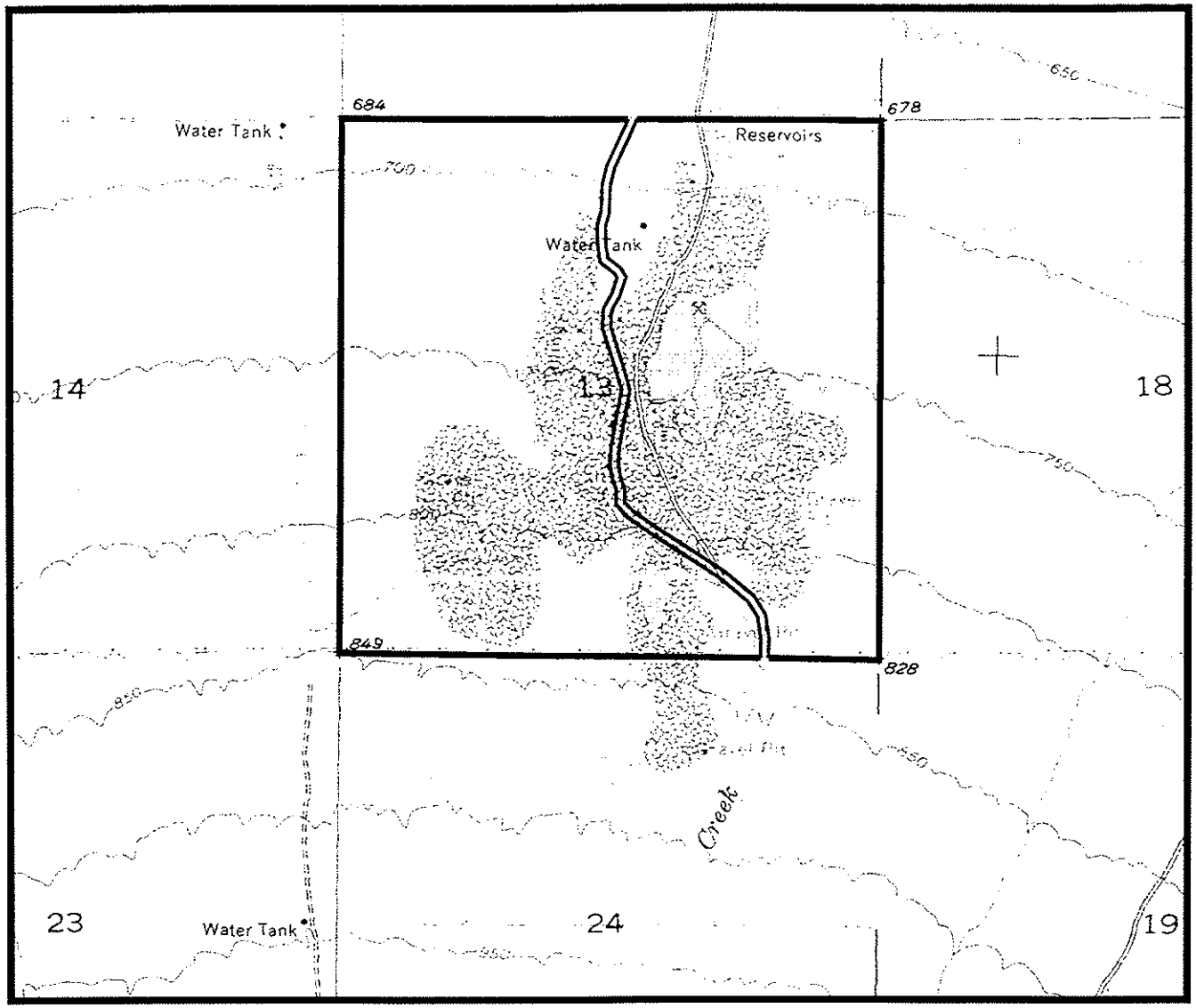
E. Environmental Effects

This project could be used as habitat mitigation, further research into this function should be pursued. Typically, a ground water recharge facility will require significant maintenance which is not conducive to the establishment of native habitat. Habitat mitigation will be required.

F. Floodplain Effects

Through mitigating volume this project makes possible the construction of channelization projects which will limit the extent and degree of flooding.

SAN EMIGDIO CREEK GROUND WATER RECHARGE BASIN



PROJECT 16

Project #17

Sycamore Creek Watershed Restoration Project

A. Project Operation

Critical, damaged reaches of the channel will be identified and grade stabilization structures will be constructed.

From an engineering standpoint the purpose of this project is to stabilize the channel embankments in the watersheds so that rapid degradation and large scale mass wasting in the upper and intermediate watershed does not occur. This will allow for the construction and operation of sediment basins and channels downstream.

The natural riparian environment is typically devastated by rapid erosion of the channel beds. Recovery of these environs under natural conditions is very slow. This project will assist in the recovery of this habitat.

B. Project Costs

The Natural Resources Conservation Service (NRCS) can assist in the determination of appropriate channel stabilization measures. The California Conservation Corps (CCC) can be used for the construction of the recommended facilities. The final riparian corridors will be incorporated into the appropriate Habitat Conservation Plan (HCP). The actual costs are not known at this time, however an estimate of $250,000 per channel mile for easement and improvements has been made. Six miles of improvements, at a total cost of **$1,500,000** have been estimated.

C. Project Benefits:

The project will limit the potential for mass wasting events which would damage or destroy other downstream flood control facilities, as well as destroy the natural riparian environments established within, and adjacent to, the Creek bed in the intermediate and upper watershed.

D. Project Justification

The unstable channel reached within the intermediate and upper watershed are a significant source of sediment to the downstream floodplain. These areas are also riparian corridors whose natural and beneficial values can be enhanced and protected. This project will not stop erosion, it is intended to limit the potential mass wasting, which is a significant problem for both human and natural environments.

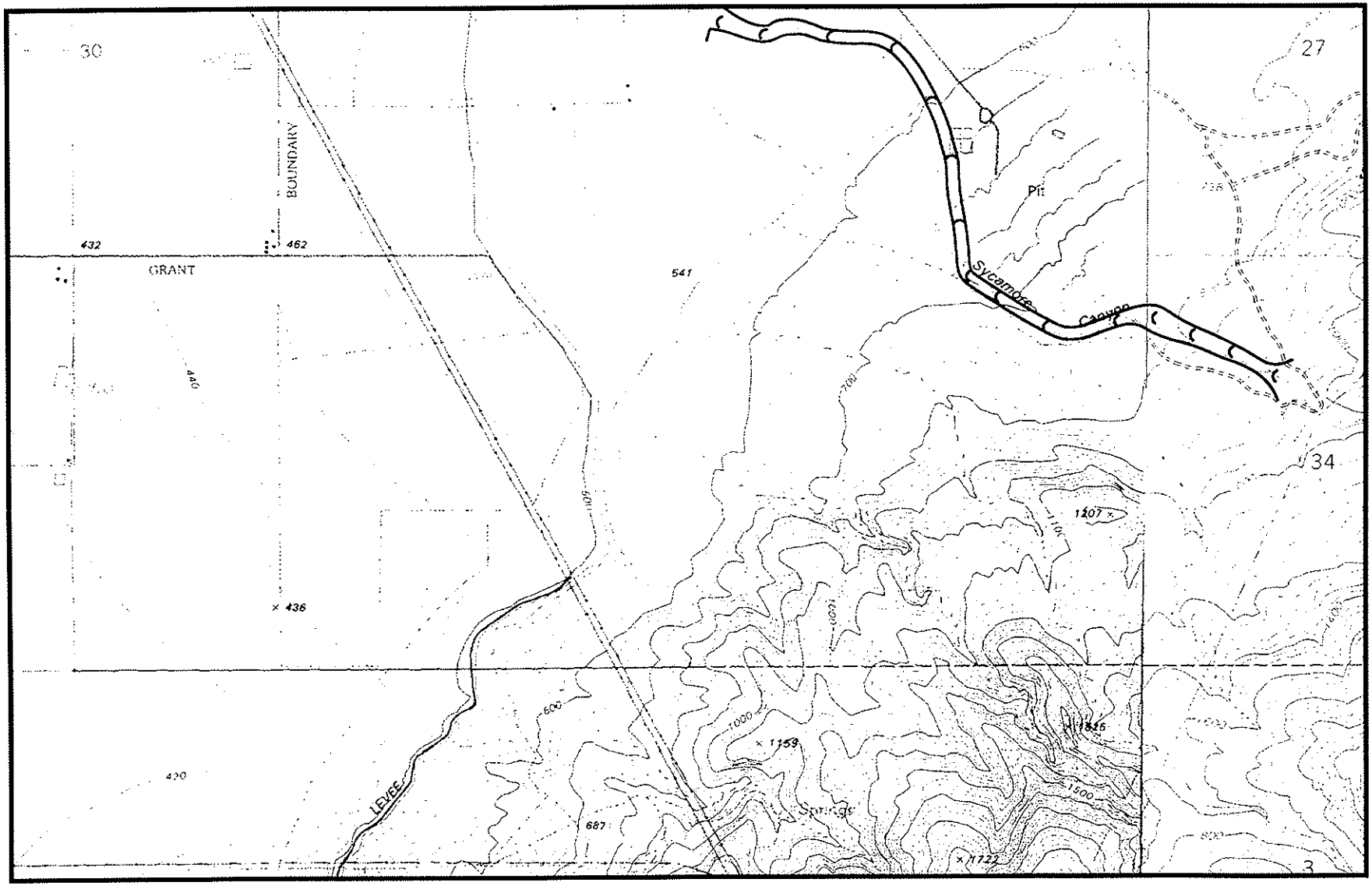
E. Environmental Effects

The project will promote the establishment of stable riparian corridors on the intermediate and upper channel reaches by identifying unstable channel reaches and constructing grade stabilization structures which will stay further rapid channel degradation and potential hillside under-cutting, which lead to mass wasting events (landslides).

F. Floodplain Effects

By limiting the potential for mass wasting and rapid channel degradation in upstream channel reaches, flood control structures can be constructed and maintained more efficiently and at lower cost. The natural hydraulics or hydrology of the floodplain will be unaffected by this project.

SYCAMORE CREEK WATERSHED RESTORATION PROJECT



PROJECT 17

Project #18

Little Sycamore Creek Watershed Restoration Project

A. Project Operation

Critical, damaged reaches of the channel will be identified and grade stabilization structures will be constructed.

From an engineering standpoint the purpose of this project is to stabilize the channel embankments in the watersheds so that rapid degradation and large scale mass wasting in the upper and intermediate watershed does not occur. This will allow for the construction and operation of sediment basins and channels downstream.

The natural riparian environment is typically devastated by rapid erosion of the channel beds. Recovery of these environs under natural conditions is very slow. This project will assist in the recovery of this habitat.

B. Project Costs

The Natural Resources Conservation Service (NRCS) can assist in the determination of appropriate channel stabilization measures. The California Conservation Corps (CCC) can be used for the construction of the recommended facilities. The final riparian corridors will be incorporated into the appropriate Habitat Conservation Plan (HCP). The actual costs are not known at this time, however an estimate of $250,000 per channel mile for easement and improvements has been made. 6 miles of improvements, at a total cost of **$1,500,000** have been estimated.

C. Project Benefits:

The project will limit the potential for mass wasting events which would damage or destroy other downstream flood control facilities, as well as destroy the natural riparian environments established within, and adjacent to, the Creek bed in the intermediate and upper watershed.

D. Project Justification

The unstable channel reached within the intermediate and upper watershed are a significant source of sediment to the downstream floodplain. These areas are also riparian corridors whose natural and beneficial values can be enhanced and protected. This project will not stop erosion, it is intended to limit the potential mass wasting, which is a significant problem for both human and natural environments.

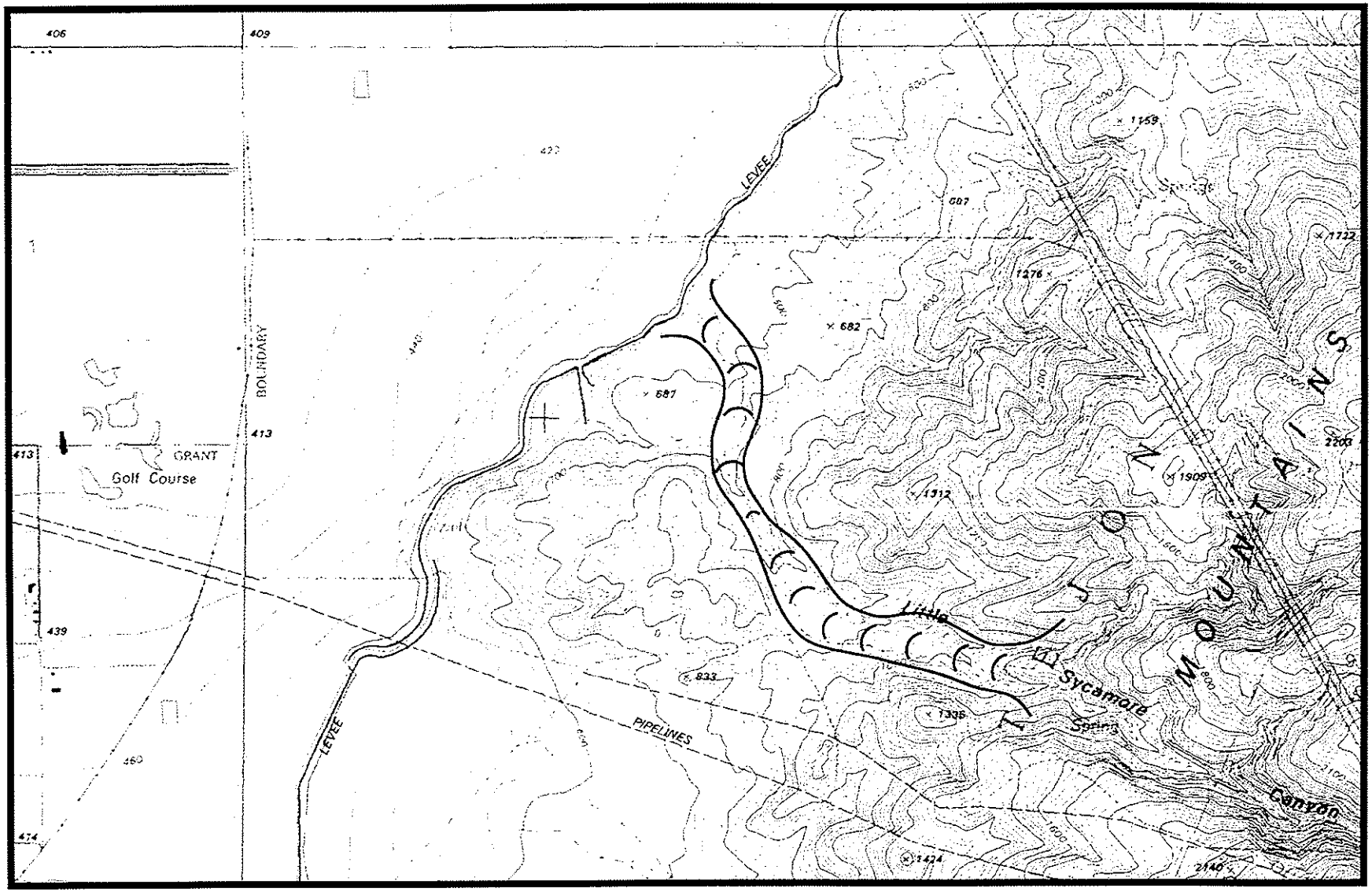
E. Environmental Effects

The project will promote the establishment of stable riparian corridors on the intermediate and upper channel reaches by identifying unstable channel reaches and constructing grade stabilization structures which will stay further rapid channel degradation and potential hillside under-cutting, which lead to mass wasting events (landslides).

F. Floodplain Effects

By limiting the potential for mass wasting and rapid channel degradation in upstream channel reaches, flood control structures can be constructed and maintained more efficiently and at lower cost. The natural hydraulics or hydrology of the floodplain will be unaffected by this project.

LITTLE SYCAMORE CREEK WATERSHED RESTORATION PROJECT



PROJECT 18

Project #19

Comanche Creek Watershed Restoration Project

A. Project Operation

Critical, damaged reaches of the channel will be identified and grade stabilization structures will be constructed.

From an engineering standpoint the purpose of this project is to stabilize the channel embankments in the watersheds so that rapid degradation and large scale mass wasting in the upper and intermediate watershed does not occur. This will allow for the construction and operation of sediment basins and channels downstream.

The natural riparian environment is typically devastated by rapid erosion of the channel beds. Recovery of these environs under natural conditions is very slow. This project will assist in the recovery of this habitat.

B. Project Costs

The Natural Resources Conservation Service (NRCS) can assist in the determination of appropriate channel stabilization measures. The California Conservation Corps (CCC) can be used for the construction of the recommended facilities. The final riparian corridors will be incorporated into the appropriate Habitat Conservation Plan (HCP). The actual costs are not known at this time, however an estimate of $250,000 per channel mile for easement and improvements has been made. 4 miles of improvements, at a total cost of **$1,000,000** have been estimated.

C. Project Benefits:

The project will limit the potential for mass wasting events which would damage or destroy other downstream flood control facilities, as well as destroy the natural riparian environments established within, and adjacent to, the Creek bed in the intermediate and upper watershed.

D. Project Justification

The unstable channel reached within the intermediate and upper watershed are a significant source of sediment to the downstream floodplain. These areas are also riparian corridors whose natural and beneficial values can be enhanced and protected. This project will not stop erosion, it is intended to limit the potential mass wasting, which is a significant problem for both human and natural environments.

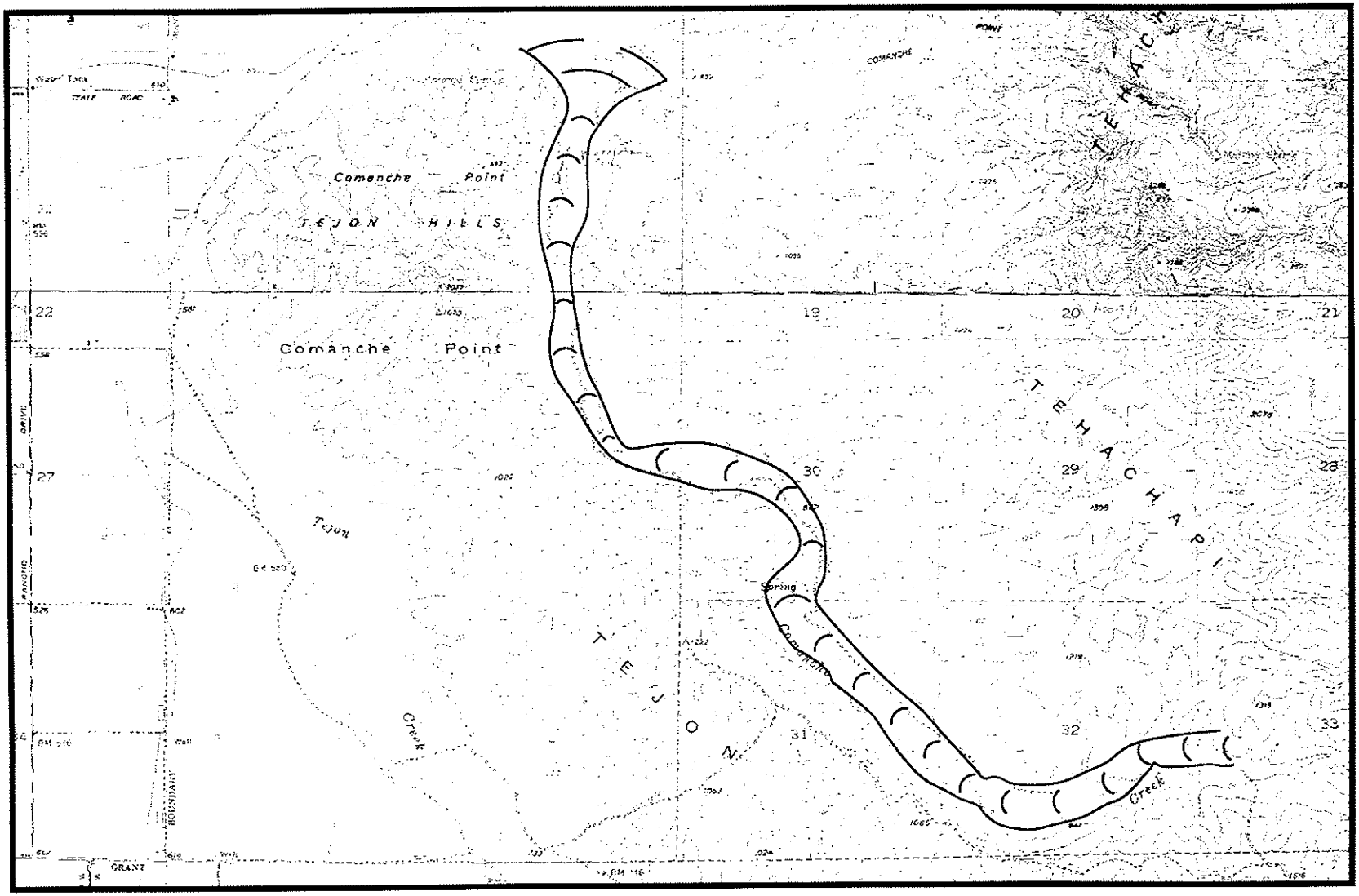
E. Environmental Effects

The project will promote the establishment of stable riparian corridors on the intermediate and upper channel reaches by identifying unstable channel reaches and constructing grade stabilization structures which will stay further rapid channel degradation and potential hillside under-cutting, which lead to mass wasting events (landslides).

F. Floodplain Effects

By limiting the potential for mass wasting and rapid channel degradation in upstream channel reaches, flood control structures can be constructed and maintained more efficiently and at lower cost. The natural hydraulics or hydrology of the floodplain will be unaffected by this project.

COMANCHE CREEK WATERSHED RESTORATION PROJECT



PROJECT 19

Project #20

Tejon Creek Watershed Restoration Project

A. Project Operation

Critical, damaged reaches of the channel will be identified and grade stabilization structures will be constructed.

From an engineering standpoint the purpose of this project is to stabilize the channel embankments in the watersheds so that rapid degradation and large scale mass wasting in the upper and intermediate watershed does not occur. This will allow for the construction and operation of sediment basins and channels downstream.

The natural riparian environment is typically devastated by rapid erosion of the channel beds. Recovery of these environs under natural conditions is very slow. This project will assist in the recovery of this habitat.

B. Project Costs

The Natural Resources Conservation Service (NRCS) can assist in the determination of appropriate channel stabilization measures. The California Conservation Corps (CCC) can be used for the construction of the recommended facilities. The final riparian corridors will be incorporated into the appropriate Habitat Conservation Plan (HCP). The actual costs are not known at this time, however an estimate of $250,000 per channel mile for easement and improvements has been made. 14 miles of improvement, at a total cost of **$3,500,000** have been estimated.

C. Project Benefits:

The project will limit the potential for mass wasting events which would damage or destroy other downstream flood control facilities, as well as destroy the natural riparian environments established within, and adjacent to, the Creek bed in the intermediate and upper watershed.

D. Project Justification

The unstable channel reached within the intermediate and upper watershed are a significant source of sediment to the downstream floodplain. These areas are also riparian corridors whose natural and beneficial values can be enhanced and protected. This project will not stop erosion, it is intended to limit the potential mass wasting, which is a significant problem for both human and natural environments.

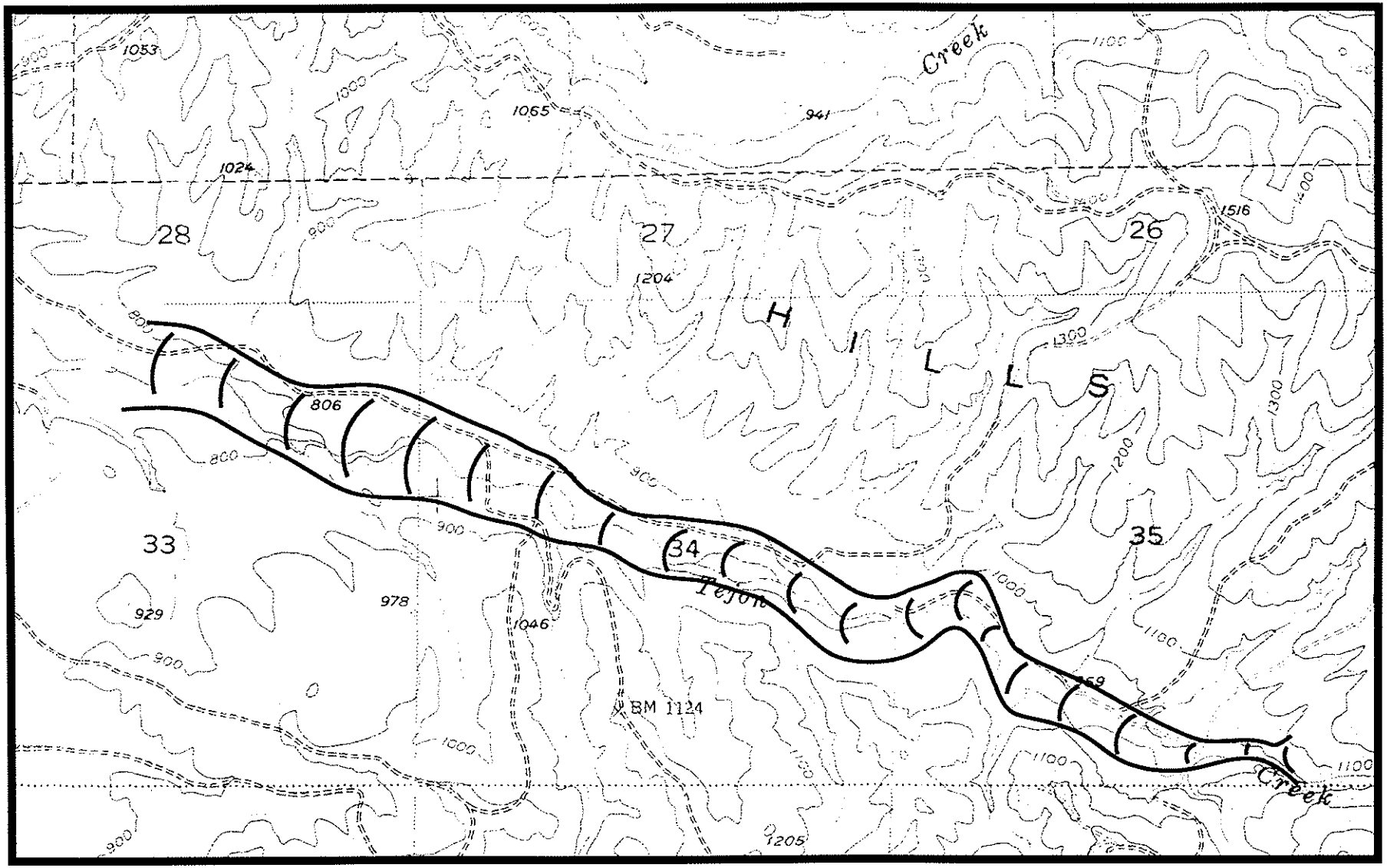
E. Environmental Effects

The project will promote the establishment of stable riparian corridors on the intermediate and upper channel reaches by identifying unstable channel reaches and constructing grade stabilization structures which will stay further rapid channel degradation and potential hillside under-cutting, which lead to mass wasting events (landslides).

F. Floodplain Effects

By limiting the potential for mass wasting and rapid channel degradation in upstream channel reaches, flood control structures can be constructed and maintained more efficiently and at lower cost. The natural hydraulics or hydrology of the floodplain will be unaffected by this project.

TEJON CREEK WATERSHED RESTORATION PROJECT



PROJECT 20

Project #21

El Paso Creek Watershed Restoration Project

A. Project Operation

Critical, damaged reaches of the channel will be identified and grade stabilization structures will be constructed.

From an engineering standpoint the purpose of this project is to stabilize the channel embankments in the watersheds so that rapid degradation and large scale mass wasting in the upper and intermediate watershed does not occur. This will allow for the construction and operation of sediment basins and channels downstream.

The natural riparian environment is typically devastated by rapid erosion of the channel beds. Recovery of these environs under natural conditions is very slow. This project will assist in the recovery of this habitat.

B. Project Costs

The Natural Resources Conservation Service (NRCS) can assist in the determination of appropriate channel stabilization measures. The California Conservation Corps (CCC) can be used for the construction of the recommended facilities. The final riparian corridors will be incorporated into the appropriate Habitat Conservation Plan (HCP). The actual costs are not known at this time, however an estimate of $250,000 per channel mile for easement and improvements has been made. 4 miles of improvement, at a total cost of **$1,000,000** have been estimated.

C. Project Benefits:

The project will limit the potential for mass wasting events which would damage or destroy other downstream flood control facilities, as well as destroy the natural riparian environments established within, and adjacent to, the Creek bed in the intermediate and upper watershed.

D. Project Justification

The unstable channel reached within the intermediate and upper watershed are a significant source of sediment to the downstream floodplain. These areas are also riparian corridors whose natural and beneficial values can be enhanced and protected. This project will not stop erosion, it is intended to limit the potential mass wasting, which is a significant problem for both human and natural environments.

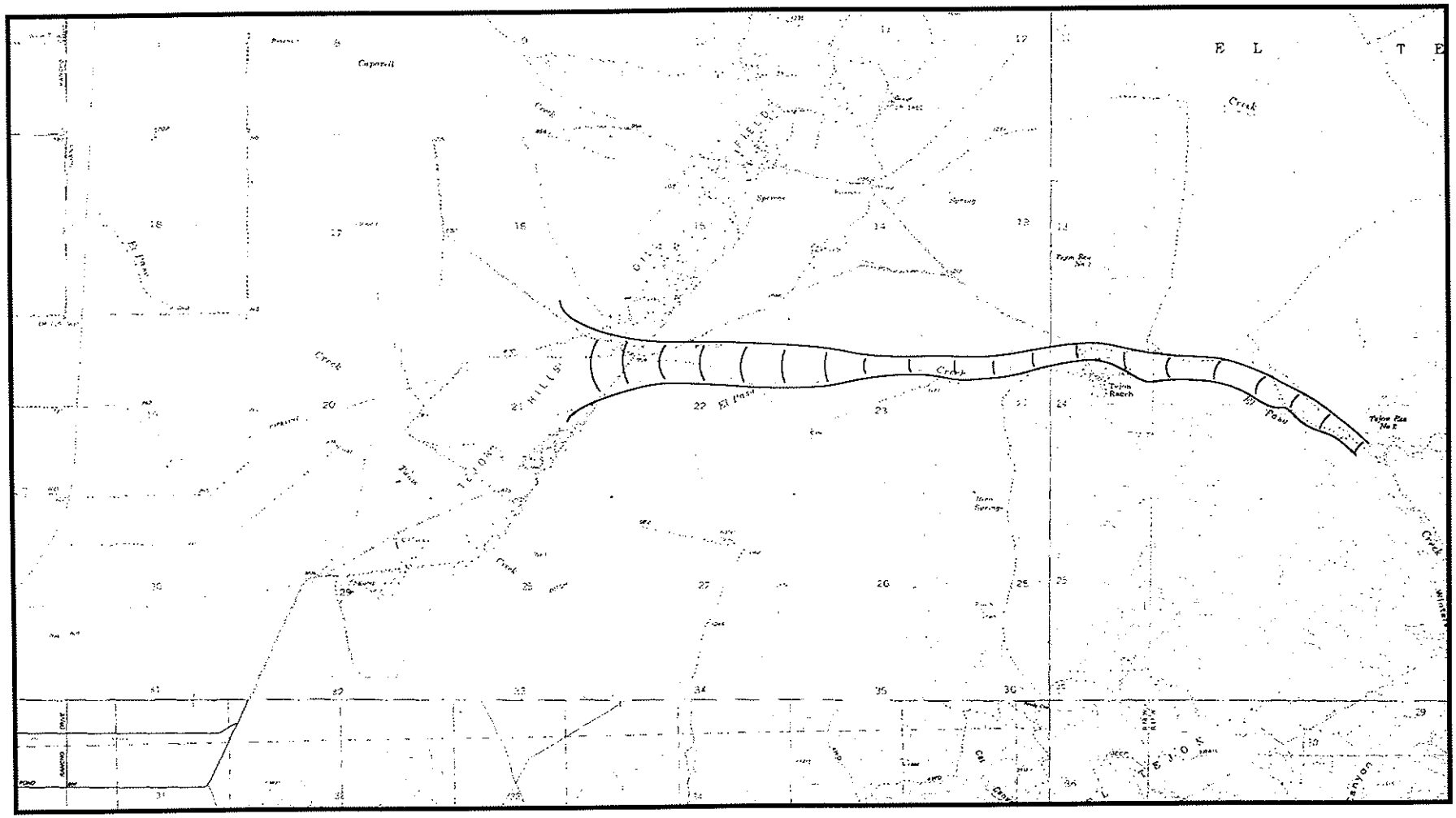
E. Environmental Effects

The project will promote the establishment of stable riparian corridors on the intermediate and upper channel reaches by identifying unstable channel reaches and constructing grade stabilization structures which will stay further rapid channel degradation and potential hillside under-cutting, which lead to mass wasting events (landslides).

F. Floodplain Effects

By limiting the potential for mass wasting and rapid channel degradation in upstream channel reaches, flood control structures can be constructed and maintained more efficiently and at lower cost. The natural hydraulics or hydrology of the floodplain will be unaffected by this project.

EL PASO CREEK WATERSHED RESTORATION PROJECT



PROJECT 21

Project #22

Tunis Creek Watershed Restoration Project

A. Project Operation

Critical, damaged reaches of the channel will be identified and grade stabilization structures will be constructed.

From an engineering standpoint the purpose of this project is to stabilize the channel embankments in the watersheds so that rapid degradation and large scale mass wasting in the upper and intermediate watershed does not occur. This will allow for the construction and operation of sediment basins and channels downstream.

The natural riparian environment is typically devastated by rapid erosion of the channel beds. Recovery of these environs under natural conditions is very slow. This project will assist in the recovery of this habitat.

B. Project Costs

The Natural Resources Conservation Service (NRCS) can assist in the determination of appropriate channel stabilization measures. The California Conservation Corps (CCC) can be used for the construction of the recommended facilities. The final riparian corridors will be incorporated into the appropriate Habitat Conservation Plan (HCP). The actual costs are not known at this time, however an estimate of $250,000 per channel mile for easement and improvements has been made. 6 miles of improvement, at a total cost of **$1,500,000** have been estimated.

C. Project Benefits:

The project will limit the potential for mass wasting events which would damage or destroy other downstream flood control facilities, as well as destroy the natural riparian environments established within, and adjacent to, the Creek bed in the intermediate and upper watershed.

D. Project Justification

The unstable channel reached within the intermediate and upper watershed are a significant source of sediment to the downstream floodplain. These areas are also riparian corridors whose natural and beneficial values can be enhanced and protected. This project will not stop erosion, it is intended to limit the potential mass wasting, which is a significant problem for both human and natural environments.

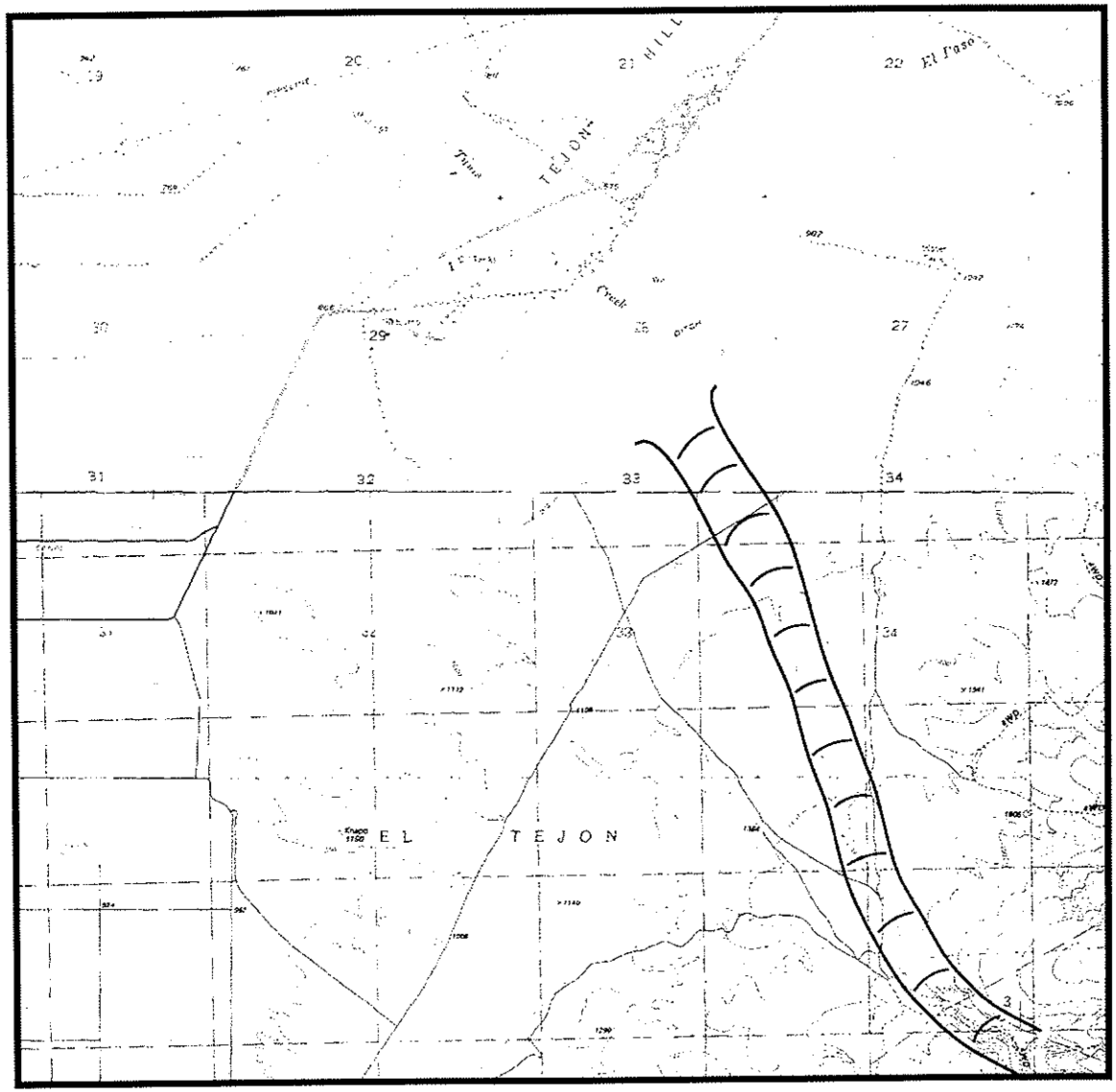
E. Environmental Effects

The project will promote the establishment of stable riparian corridors on the intermediate and upper channel reaches by identifying unstable channel reaches and constructing grade stabilization structures which will stay further rapid channel degradation and potential hillside under-cutting, which lead to mass wasting events (landslides).

F. Floodplain Effects

By limiting the potential for mass wasting and rapid channel degradation in upstream channel reaches, flood control structures can be constructed and maintained more efficiently and at lower cost. The natural hydraulics or hydrology of the floodplain will be unaffected by this project.

TUNIS CREEK WATERSHED RESTORATION PROJECT



PROJECT 22

Project #23

Pastoria Creek Watershed Restoration Project

A. Project Operation

Critical, damaged reaches of the channel will be identified and grade stabilization structures will be constructed.

From an engineering standpoint the purpose of this project is to stabilize the channel embankments in the watersheds so that rapid degradation and large scale mass wasting in the upper and intermediate watershed does not occur. This will allow for the construction and operation of sediment basins and channels downstream.

The natural riparian environment is typically devastated by rapid erosion of the channel beds. Recovery of these environs under natural conditions is very slow. This project will assist in the recovery of this habitat.

B. Project Costs

The Natural Resources Conservation Service (NRCS) can assist in the determination of appropriate channel stabilization measures. The California Conservation Corps (CCC) can be used for the construction of the recommended facilities. The final riparian corridors will be incorporated into the appropriate Habitat Conservation Plan (HCP). The actual costs are not known at this time, however an estimate of $250,000 per channel mile for easement and improvements has been made. 6 miles of improvement, at a total cost of **$1,500,000** have been estimated.

C. Project Benefits:

The project will limit the potential for mass wasting events which would damage or destroy other downstream flood control facilities, as well as destroy the natural riparian environments established within, and adjacent to, the Creek bed in the intermediate and upper watershed.

D. Project Justification

The unstable channel reached within the intermediate and upper watershed are a significant source of sediment to the downstream floodplain. These areas are also riparian corridors whose natural and beneficial values can be enhanced and protected. This project will not stop erosion, it is intended to limit the potential mass wasting, which is a significant problem for both human and natural environments.

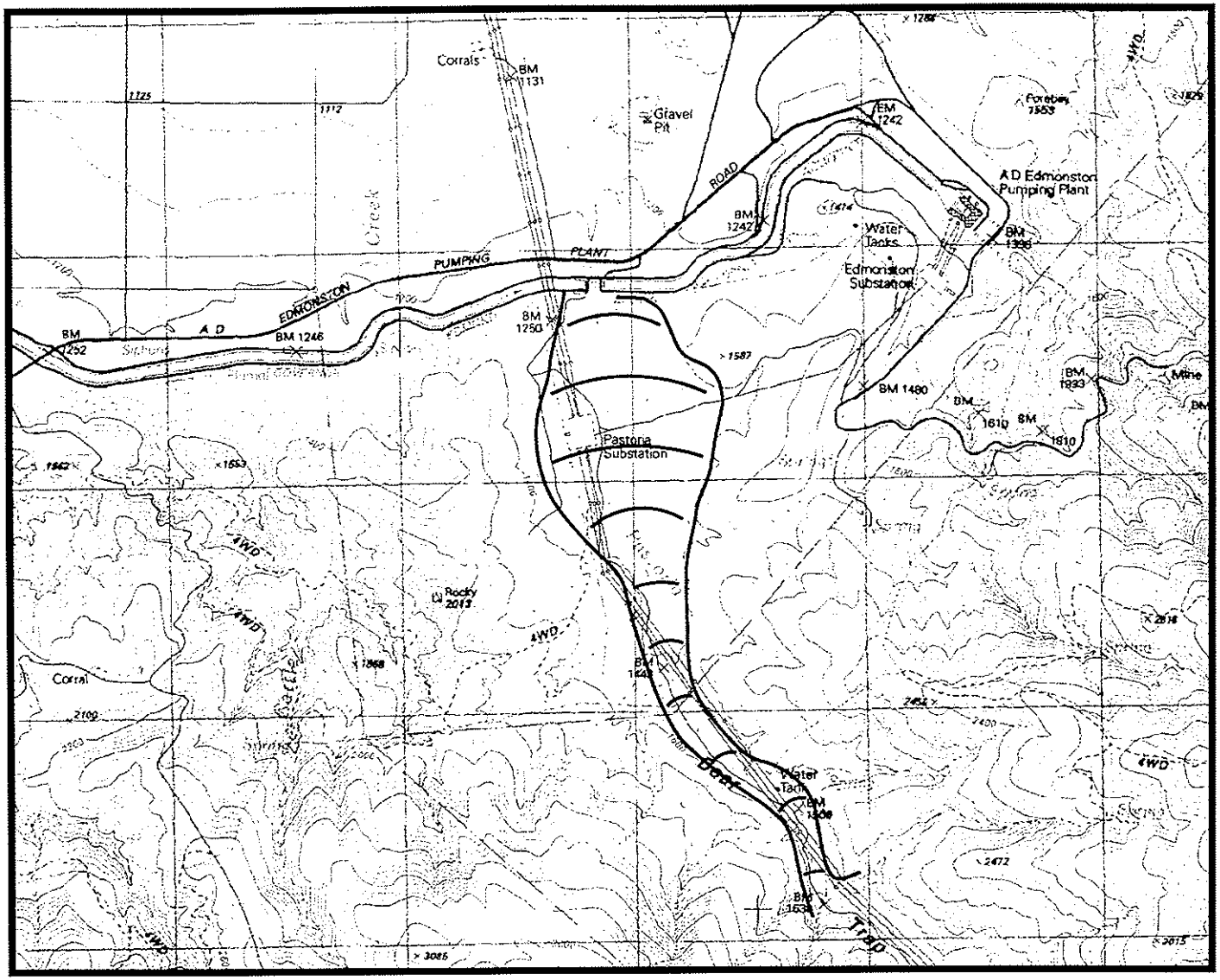
E. Environmental Effects

The project will promote the establishment of stable riparian corridors on the intermediate and upper channel reaches by identifying unstable channel reaches and constructing grade stabilization structures which will stay further rapid channel degradation and potential hillside under-cutting, which lead to mass wasting events (landslides).

F. Floodplain Effects

By limiting the potential for mass wasting and rapid channel degradation in upstream channel reaches, flood control structures can be constructed and maintained more efficiently and at lower cost. The natural hydraulics or hydrology of the floodplain will be unaffected by this project.

PASTORIA CREEK WATERSHED RESTORATION PROJECT



PROJECT 23

Project #24

Grapevine Creek Watershed Restoration Project

A. Project Operation

Critical, damaged reaches of the channel will be identified and grade stabilization structures will be constructed.

From an engineering standpoint the purpose of this project is to stabilize the channel embankments in the watersheds so that rapid degradation and large scale mass wasting in the upper and intermediate watershed does not occur. This will allow for the construction and operation of sediment basins and channels downstream.

The natural riparian environment is typically devastated by rapid erosion of the channel beds. Recovery of these environs under natural conditions is very slow. This project will assist in the recovery of this habitat.

B. Project Costs

The Natural Resources Conservation Service (NRCS) can assist in the determination of appropriate channel stabilization measures. The California Conservation Corps (CCC) can be used for the construction of the recommended facilities. The final riparian corridors will be incorporated into the appropriate Habitat Conservation Plan (HCP). The actual costs are not known at this time, however an estimate of $250,000 per channel mile for easement and improvements has been made. 4 miles of improvement, at a total cost of **$1,000,000** have been estimated.

C. Project Benefits:

The project will limit the potential for mass wasting events which would damage or destroy other downstream flood control facilities, as well as destroy the natural riparian environments established within, and adjacent to, the Creek bed in the intermediate and upper watershed.

D. Project Justification

The unstable channel reached within the intermediate and upper watershed are a significant source of sediment to the downstream floodplain. These areas are also riparian corridors whose natural and beneficial values can be enhanced and protected. This project will not stop erosion, it is intended to limit the potential mass wasting, which is a significant problem for both human and natural environments.

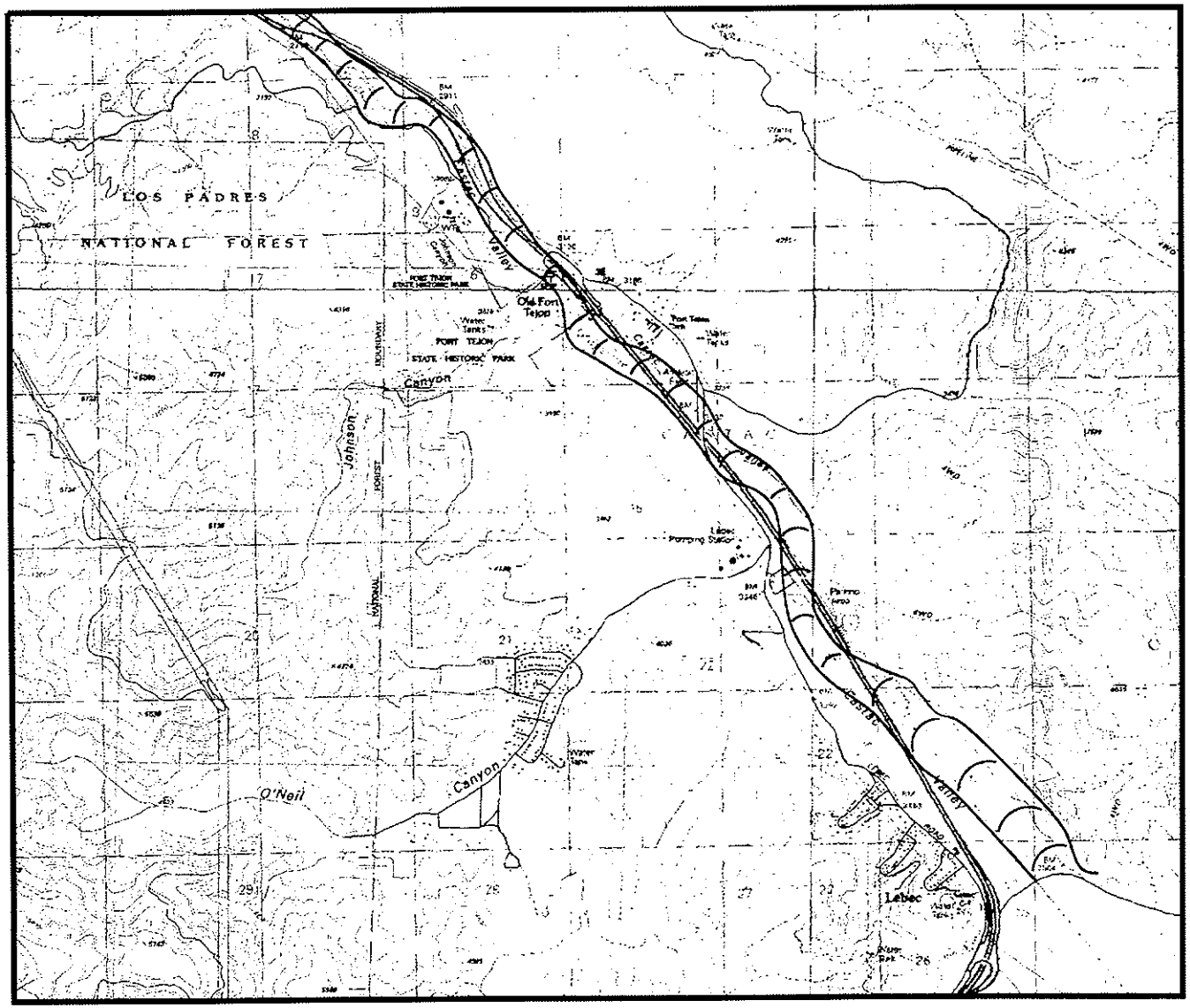
E. Environmental Effects

The project will promote the establishment of stable riparian corridors on the intermediate and upper channel reaches by identifying unstable channel reaches and constructing grade stabilization structures which will stay further rapid channel degradation and potential hillside under-cutting, which lead to mass wasting events (landslides).

F. Floodplain Effects

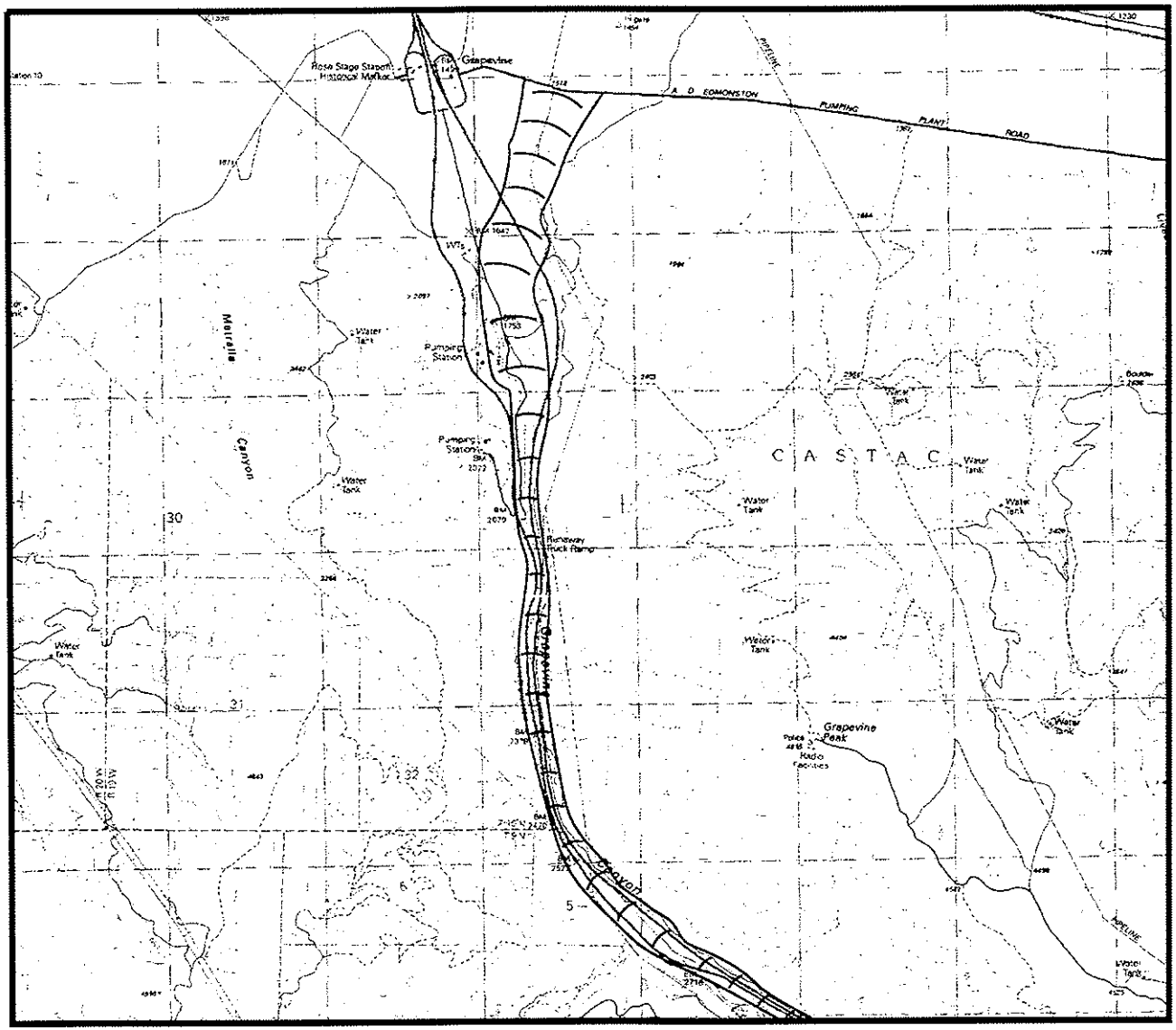
By limiting the potential for mass wasting and rapid channel degradation in upstream channel reaches, flood control structures can be constructed and maintained more efficiently and at lower cost. The natural hydraulics or hydrology of the floodplain will be unaffected by this project.

GRAPEVINE CREEK WATERSHED RESTORATION PROJECT



PROJECT 24A

GRAPEVINE CREEK WATERSHED RESTORATION PROJECT



PROJECT 24B

Project #25

Tecuya Creek Watershed Restoration Project

A. Project Operation

Critical, damaged reaches of the channel will be identified and grade stabilization structures will be constructed.

From an engineering standpoint the purpose of this project is to stabilize the channel embankments in the watersheds so that rapid degradation and large scale mass wasting in the upper and intermediate watershed does not occur. This will allow for the construction and operation of sediment basins and channels downstream.

The natural riparian environment is typically devastated by rapid erosion of the channel beds. Recovery of these environs under natural conditions is very slow. This project will assist in the recovery of this habitat.

B. Project Costs

The Natural Resources Conservation Service (NRCS) can assist in the determination of appropriate channel stabilization measures. The California Conservation Corps (CCC) can be used for the construction of the recommended facilities. The final riparian corridors will be incorporated into the appropriate Habitat Conservation Plan (HCP). The actual costs are not known at this time, however an estimate of $250,000 per channel mile for easement and improvements has been made. 12 miles of improvement, at a total cost of **$3,000,000** have been estimated.

C. Project Benefits:

The project will limit the potential for mass wasting events which would damage or destroy other downstream flood control facilities, as well as destroy the natural riparian environments established within, and adjacent to, the Creek bed in the intermediate and upper watershed.

D. Project Justification

The unstable channel reached within the intermediate and upper watershed are a significant source of sediment to the downstream floodplain. These areas are also riparian corridors whose natural and beneficial values can be enhanced and protected. This project will not stop erosion, it is intended to limit the potential mass wasting, which is a significant problem for both human and natural environments.

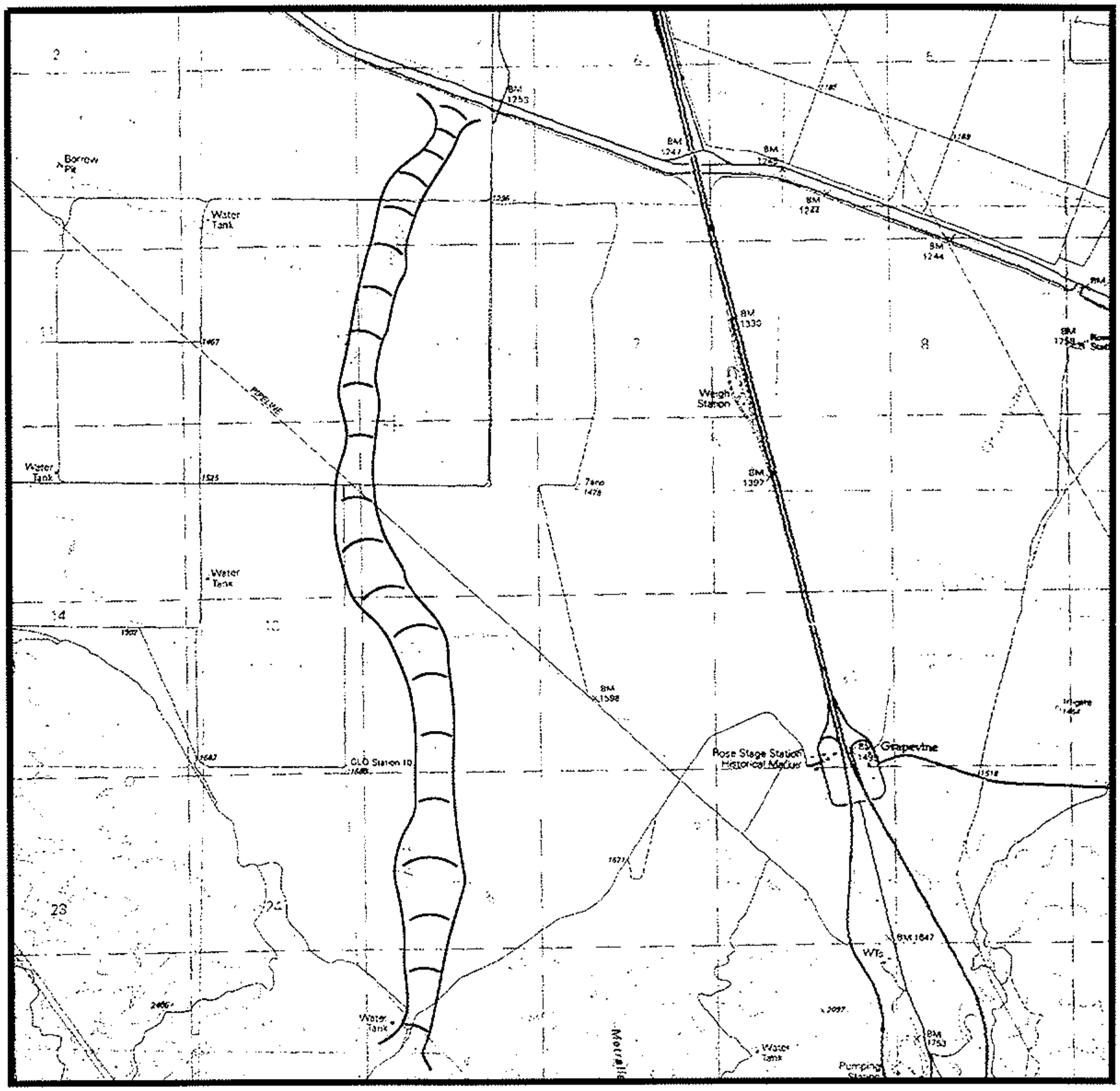
E. Environmental Effects

The project will promote the establishment of stable riparian corridors on the intermediate and upper channel reaches by identifying unstable channel reaches and constructing grade stabilization structures which will stay further rapid channel degradation and potential hillside under-cutting, which lead to mass wasting events (landslides).

F. Floodplain Effects

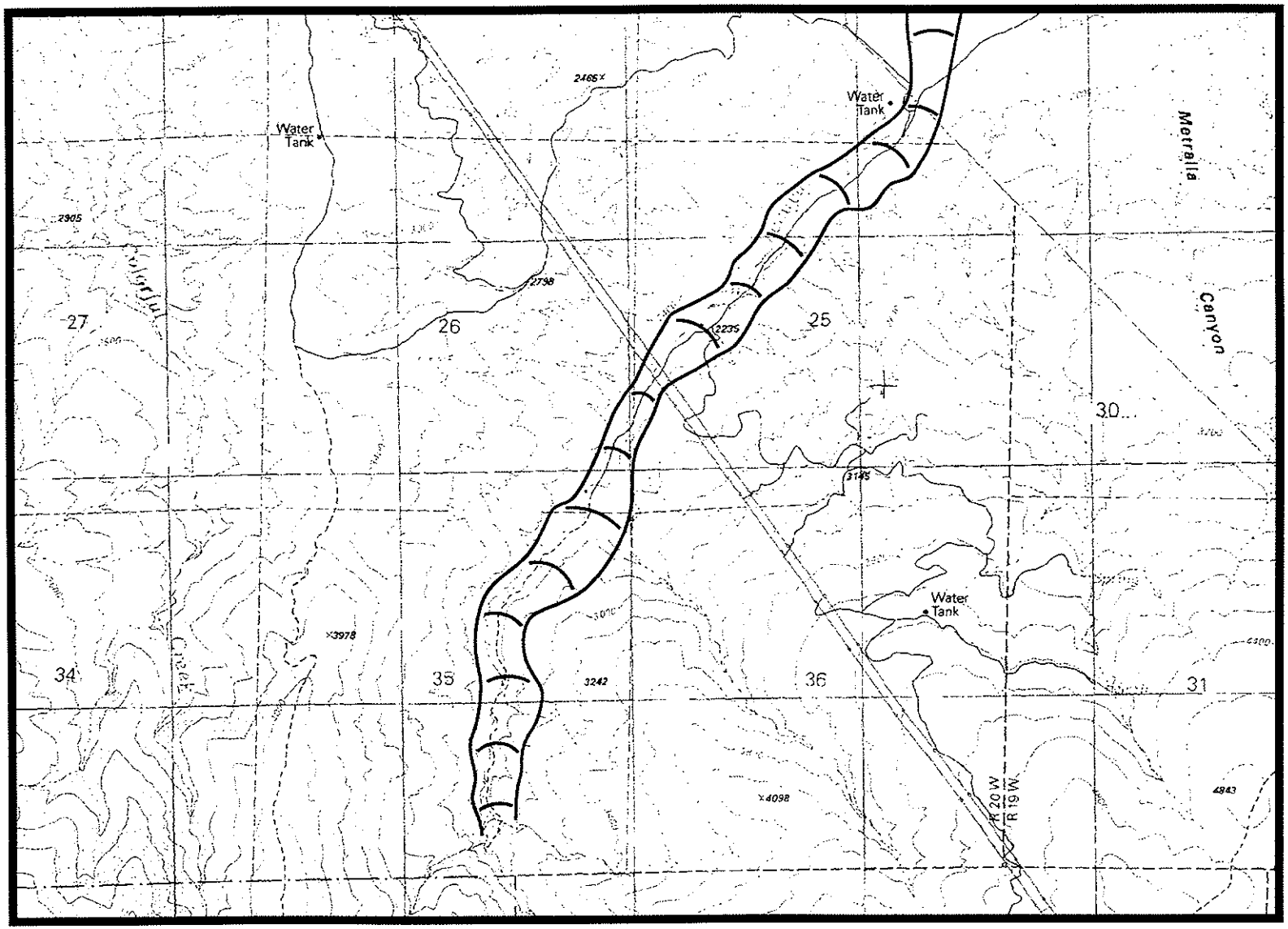
By limiting the potential for mass wasting and rapid channel degradation in upstream channel reaches, flood control structures can be constructed and maintained more efficiently and at lower cost. The natural hydraulics or hydrology of the floodplain will be unaffected by this project.

TECUYA CREEK WATERSHED RESTORATION PROJECT



PROJECT 25A

TECUYA CREEK WATERSHED RESTORATION PROJECT



PROJECT 25B

Project #26

Salt Creek Watershed Restoration Project

A. Project Operation

Critical, damaged reaches of the channel will be identified and grade stabilization structures will be constructed.

From an engineering standpoint the purpose of this project is to stabilize the channel embankments in the watersheds so that rapid degradation and large scale mass wasting in the upper and intermediate watershed does not occur. This will allow for the construction and operation of sediment basins and channels downstream.

The natural riparian environment is typically devastated by rapid erosion of the channel beds. Recovery of these environs under natural conditions is very slow. This project will assist in the recovery of this habitat.

B. Project Costs

The Natural Resources Conservation Service (NRCS) can assist in the determination of appropriate channel stabilization measures. The California Conservation Corps (CCC) can be used for the construction of the recommended facilities. The final riparian corridors will be incorporated into the appropriate Habitat Conservation Plan (HCP). The actual costs are not known at this time, however an estimate of $250,000 per channel mile for easement and improvements has been made. 10 miles of improvement, at a total cost of **$2,500,000** have been estimated.

C. Project Benefits:

The project will limit the potential for mass wasting events which would damage or destroy other downstream flood control facilities, as well as destroy the natural riparian environments established within, and adjacent to, the Creek bed in the intermediate and upper watershed.

D. Project Justification

The unstable channel reached within the intermediate and upper watershed are a significant source of sediment to the downstream floodplain. These areas are also riparian corridors whose natural and beneficial values can be enhanced and protected. This project will not stop erosion, it is intended to limit the potential mass wasting, which is a significant problem for both human and natural environments.

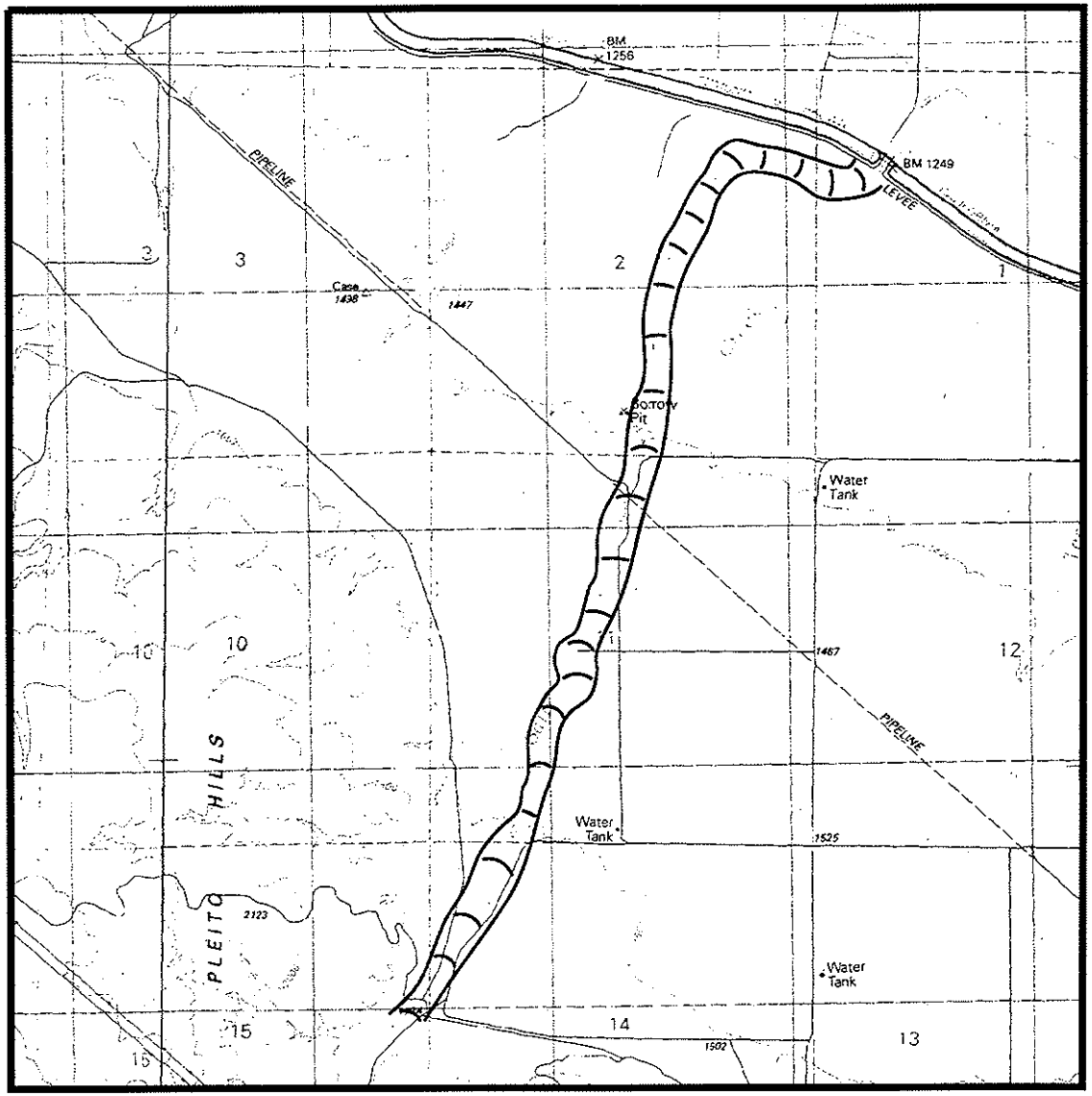
E. Environmental Effects

The project will promote the establishment of stable riparian corridors on the intermediate and upper channel reaches by identifying unstable channel reaches and constructing grade stabilization structures which will stay further rapid channel degradation and potential hillside under-cutting, which lead to mass wasting events (landslides).

F. Floodplain Effects

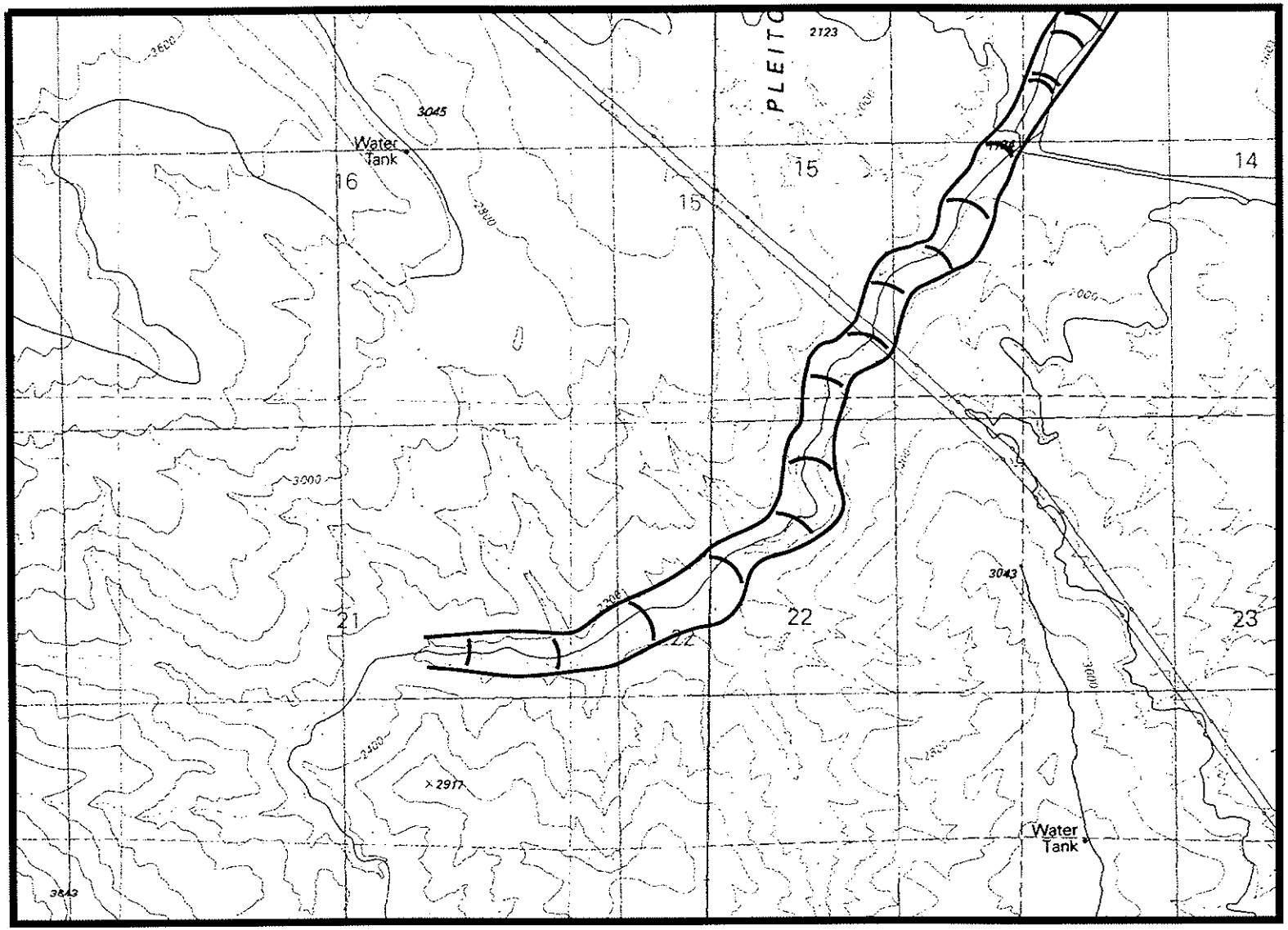
By limiting the potential for mass wasting and rapid channel degradation in upstream channel reaches, flood control structures can be constructed and maintained more efficiently and at lower cost. The natural hydraulics or hydrology of the floodplain will be unaffected by this project.

SALT CREEK WATERSHED RESTORATION PROJECT



PROJECT 26A

SALT CREEK WATERSHED RESTORATION PROJECT



PROJECT 26B

Project #27

Pleito Creek Watershed Restoration Project

A. Project Operation

Critical, damaged reaches of the channel will be identified and grade stabilization structures will be constructed.

From an engineering standpoint the purpose of this project is to stabilize the channel embankments in the watersheds so that rapid degradation and large scale mass wasting in the upper and intermediate watershed does not occur. This will allow for the construction and operation of sediment basins and channels downstream.

The natural riparian environment is typically devastated by rapid erosion of the channel beds. Recovery of these environs under natural conditions is very slow. This project will assist in the recovery of this habitat.

B. Project Costs

The Natural Resources Conservation Service (NRCS) can assist in the determination of appropriate channel stabilization measures. The California Conservation Corps (CCC) can be used for the construction of the recommended facilities. The final riparian corridors will be incorporated into the appropriate Habitat Conservation Plan (HCP). The actual costs are not known at this time, however an estimate of $250,000 per channel mile for easement and improvements has been made. 6 miles of improvement, at a total cost of **$1,500,000** have been estimated.

C. Project Benefits:

The project will limit the potential for mass wasting events which would damage or destroy other downstream flood control facilities, as well as destroy the natural riparian environments established within, and adjacent to, the Creek bed in the intermediate and upper watershed.

D. Project Justification

The unstable channel reached within the intermediate and upper watershed are a significant source of sediment to the downstream floodplain. These areas are also riparian corridors whose natural and beneficial values can be enhanced and protected. This project will not stop erosion, it is intended to limit the potential mass wasting, which is a significant problem for both human and natural environments.

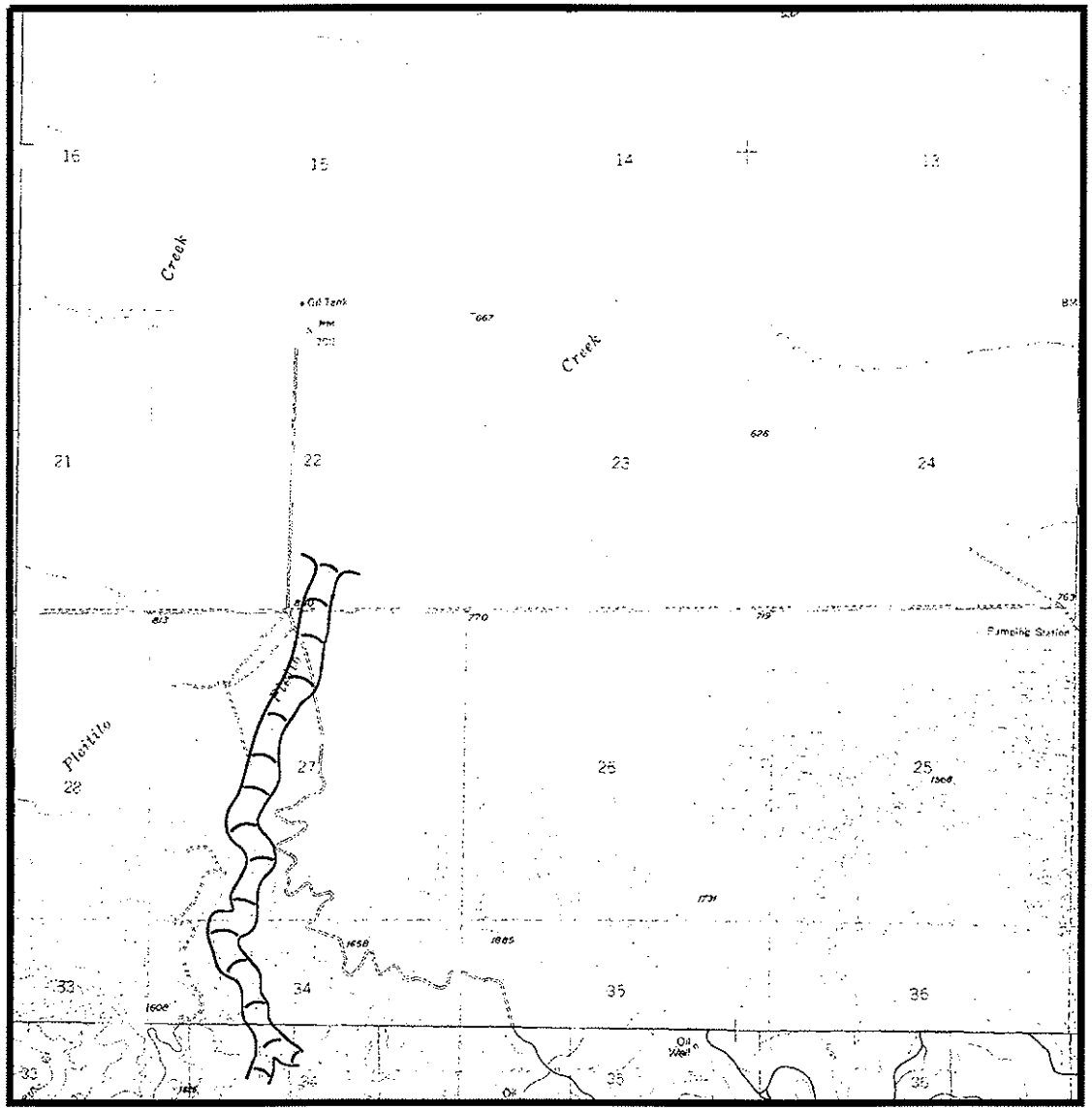
E. Environmental Effects

The project will promote the establishment of stable riparian corridors on the intermediate and upper channel reaches by identifying unstable channel reaches and constructing grade stabilization structures which will stay further rapid channel degradation and potential hillside under-cutting, which lead to mass wasting events (landslides).

F. Floodplain Effects

By limiting the potential for mass wasting and rapid channel degradation in upstream channel reaches, flood control structures can be constructed and maintained more efficiently and at lower cost. The natural hydraulics or hydrology of the floodplain will be unaffected by this project.

PLEITO CREEK WATERSHED RESTORATION PROJECT



PROJECT 27

Project #28

Pleitito Creek Watershed Restoration Project

A. Project Operation

Critical, damaged reaches of the channel will be identified and grade stabilization structures will be constructed.

From an engineering standpoint the purpose of this project is to stabilize the channel embankments in the watersheds so that rapid degradation and large scale mass wasting in the upper and intermediate watershed does not occur. This will allow for the construction and operation of sediment basins and channels downstream.

The natural riparian environment is typically devastated by rapid erosion of the channel beds. Recovery of these environs under natural conditions is very slow. This project will assist in the recovery of this habitat.

B. Project Costs

The Natural Resources Conservation Service (NRCS) can assist in the determination of appropriate channel stabilization measures. The California Conservation Corps (CCC) can be used for the construction of the recommended facilities. The final riparian corridors will be incorporated into the appropriate Habitat Conservation Plan (HCP). The actual costs are not known at this time, however an estimate of $250,000 per channel mile for easement and improvements has been made. 7 miles of improvement, at a total cost of **$1,750,000** have been estimated.

C. Project Benefits:

The project will limit the potential for mass wasting events which would damage or destroy other downstream flood control facilities, as well as destroy the natural riparian environments established within, and adjacent to, the Creek bed in the intermediate and upper watershed.

D. Project Justification

The unstable channel reached within the intermediate and upper watershed are a significant source of sediment to the downstream floodplain. These areas are also riparian corridors whose natural and beneficial values can be enhanced and protected. This project will not stop erosion, it is intended to limit the potential mass wasting, which is a significant problem for both human and natural environments.

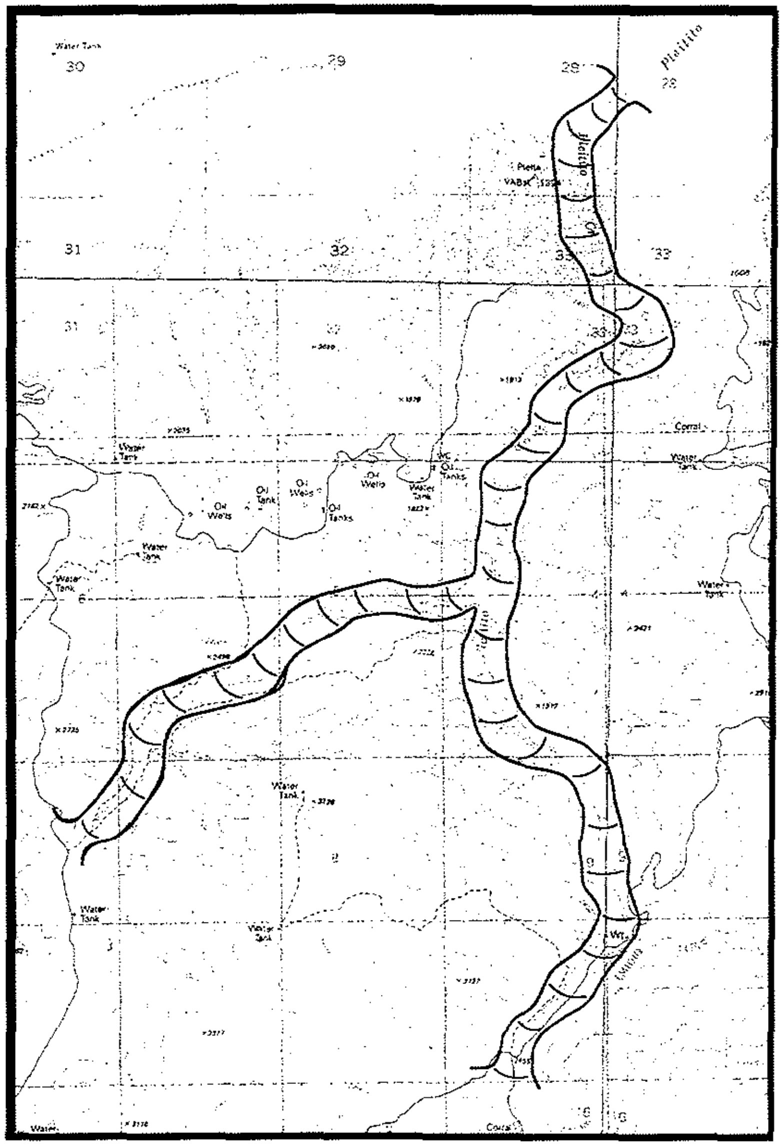
E. Environmental Effects

The project will promote the establishment of stable riparian corridors on the intermediate and upper channel reaches by identifying unstable channel reaches and constructing grade stabilization structures which will stay further rapid channel degradation and potential hillside under-cutting, which lead to mass wasting events (landslides).

F. Floodplain Effects

By limiting the potential for mass wasting and rapid channel degradation in upstream channel reaches, flood control structures can be constructed and maintained more efficiently and at lower cost. The natural hydraulics or hydrology of the floodplain will be unaffected by this project.

PLEITITO CREEK WATERSHED RESTORATION PROJECT



PROJECT 28

Project #29

San Emigdio Creek Watershed Restoration Project

A. Project Operation

Critical, damaged reaches of the channel will be identified and grade stabilization structures will be constructed.

From an engineering standpoint the purpose of this project is to stabilize the channel embankments in the watersheds so that rapid degradation and large scale mass wasting in the upper and intermediate watershed does not occur. This will allow for the construction and operation of sediment basins and channels downstream.

The natural riparian environment is typically devastated by rapid erosion of the channel beds. Recovery of these environs under natural conditions is very slow. This project will assist in the recovery of this habitat.

B. Project Costs

The Natural Resources Conservation Service (NRCS) can assist in the determination of appropriate channel stabilization measures. The California Conservation Corps (CCC) can be used for the construction of the recommended facilities. The final riparian corridors will be incorporated into the appropriate Habitat Conservation Plan (HCP). The actual costs are not known at this time, however an estimate of $250,000 per channel mile for easement and improvements has been made. 18 miles of improvement, at a total cost of **$4,500,000** have been estimated.

C. Project Benefits:

The project will limit the potential for mass wasting events which would damage or destroy other downstream flood control facilities, as well as destroy the natural riparian environments established within, and adjacent to, the Creek bed in the intermediate and upper watershed.

D. Project Justification

The unstable channel reached within the intermediate and upper watershed are a significant source of sediment to the downstream floodplain. These areas are also riparian corridors whose natural and beneficial values can be enhanced and protected. This project will not stop erosion, it is intended to limit the potential mass wasting, which is a significant problem for both human and natural environments.

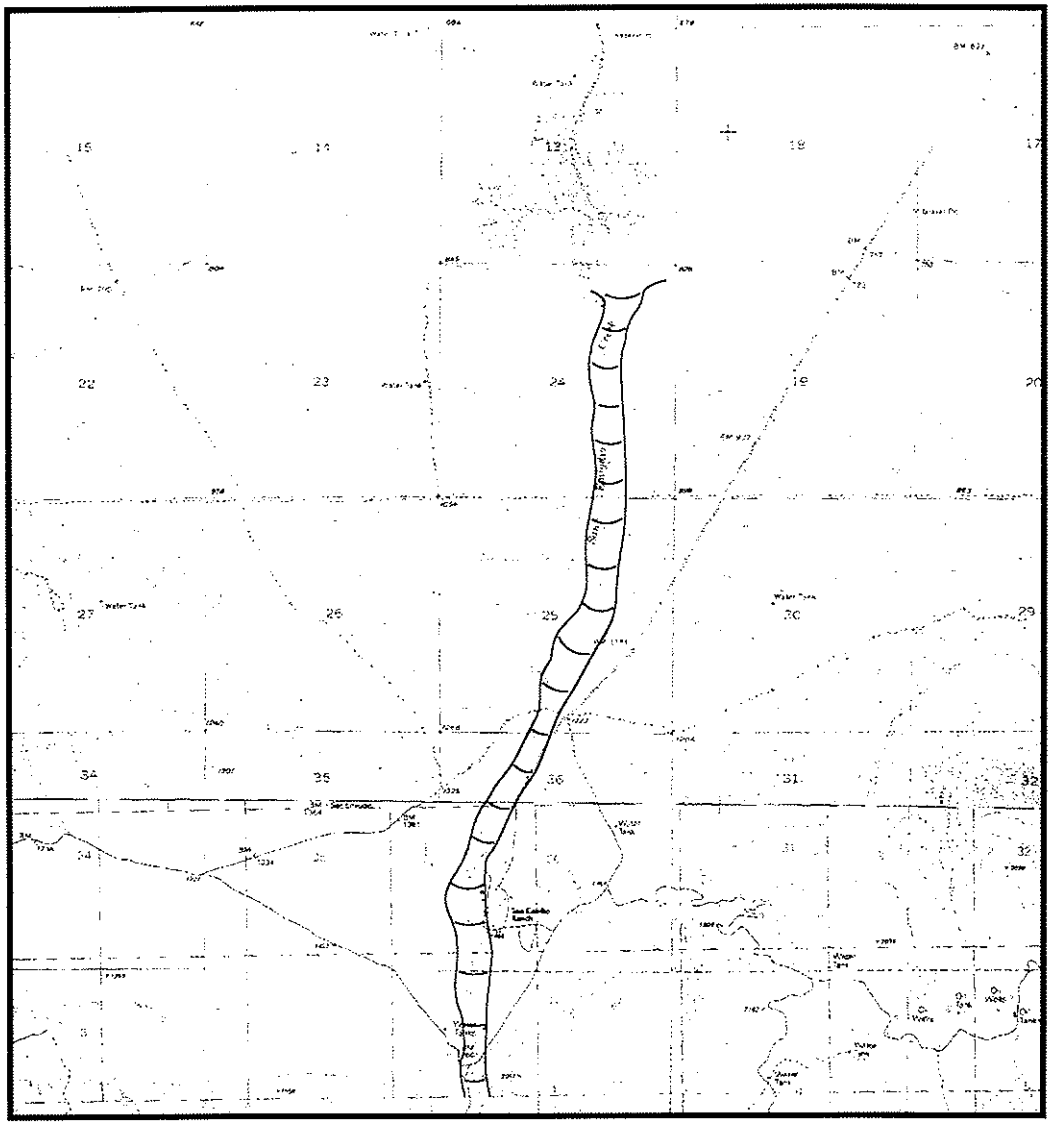
E. Environmental Effects

The project will promote the establishment of stable riparian corridors on the intermediate and upper channel reaches by identifying unstable channel reaches and constructing grade stabilization structures which will stay further rapid channel degradation and potential hillside under-cutting, which lead to mass wasting events (landslides).

F. Floodplain Effects

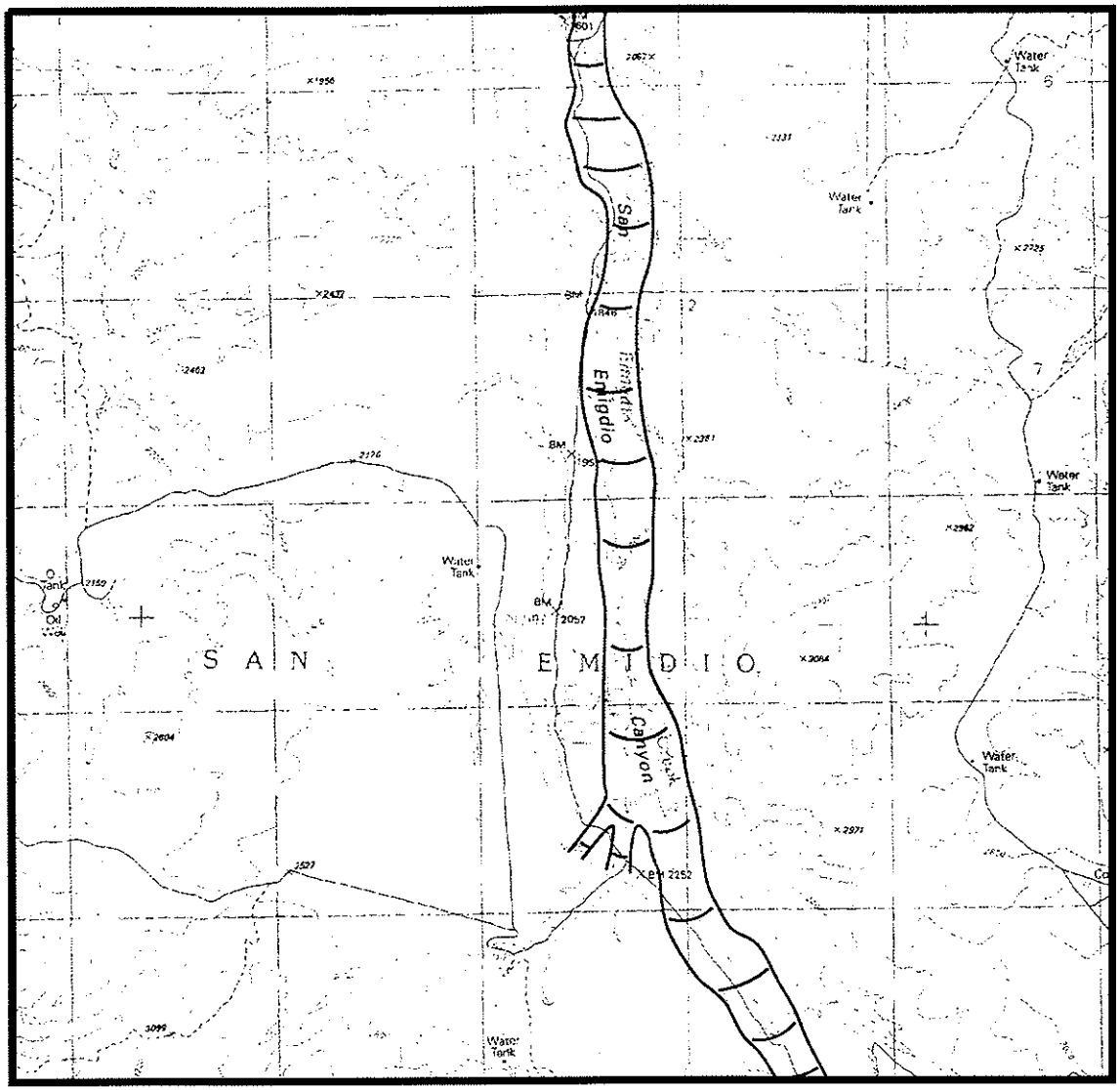
By limiting the potential for mass wasting and rapid channel degradation in upstream channel reaches, flood control structures can be constructed and maintained more efficiently and at lower cost. The natural hydraulics or hydrology of the floodplain will be unaffected by this project.

SAN EMIGDIO CREEK WATERSHED RESTORATION PROJECT



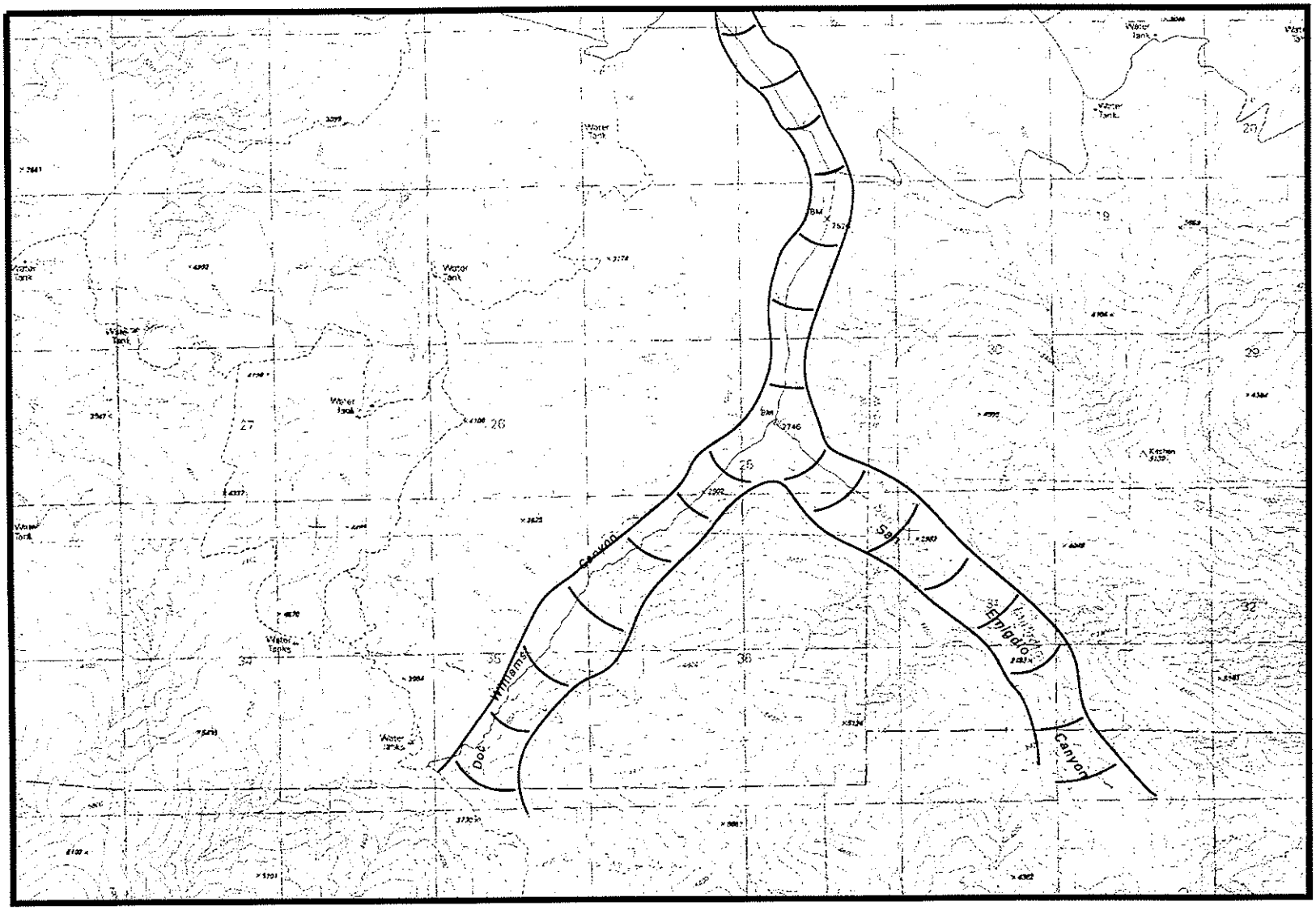
PROJECT 29A

SAN EMIGDIO CREEK WATERSHED RESTORATION PROJECT



PROJECT 29B

SAN EMIGDIO CREEK WATERSHED RESTORATION PROJECT



PROJECT 29C

Project #30

Rancho Drive Floodway

A. Project Operation

This project establishes a non-encroachable (no levees, canal, or other flow obstructions) path for flood waters originating from Pastoria Creek, as well as Tunis and El Paso creeks. This floodway follows the current path of flood waters and will encompass an area roughly 300 ft wide by 7 miles in length. The down stream terminus of this floodway will be the David Road Floodway

B. Project Costs

Easements, valued at 80% of the full land cost, will be acquired from property owners along the length of the floodway. This will cost ~$250,000 per mile, for 7 miles, or a total cost of ~$1,800,000.

C. Project Benefits:

The existence of a floodway allows for full encroachment and flood protection (i.e. levees) of adjacent properties. Currently the practice of placement of levees in the floodplain to protect crop land is in violation of the Floodplain Management Ordinance.

D. Project Justification

Uncontrolled obstruction and channelization of flood waters into the county roadways endangers the traveling public, destroys the public road system, increases the peak flow, volume and sediment transported to downstream properties. This levee construction is a violation of the County's Floodplain Management Ordinance.

The economy of this region is dependant upon the production of farm products. Without protection, flooding would devastate this production.

This project, along with the other floodway projects creates a compromise. Floodways wide enough to reasonably convey the flood waters without serious damage, at known locations, will be purchased. These corridors can still be farmed, however the areas farmed within the easements can not be protected. The areas outside the easement may be fully protected with as large of levee as the farmer feels necessary. This will result in some loss of production capacity of the region without destroying the public infrastrature.

E. Environmental Effects

There are no environmental impacts.

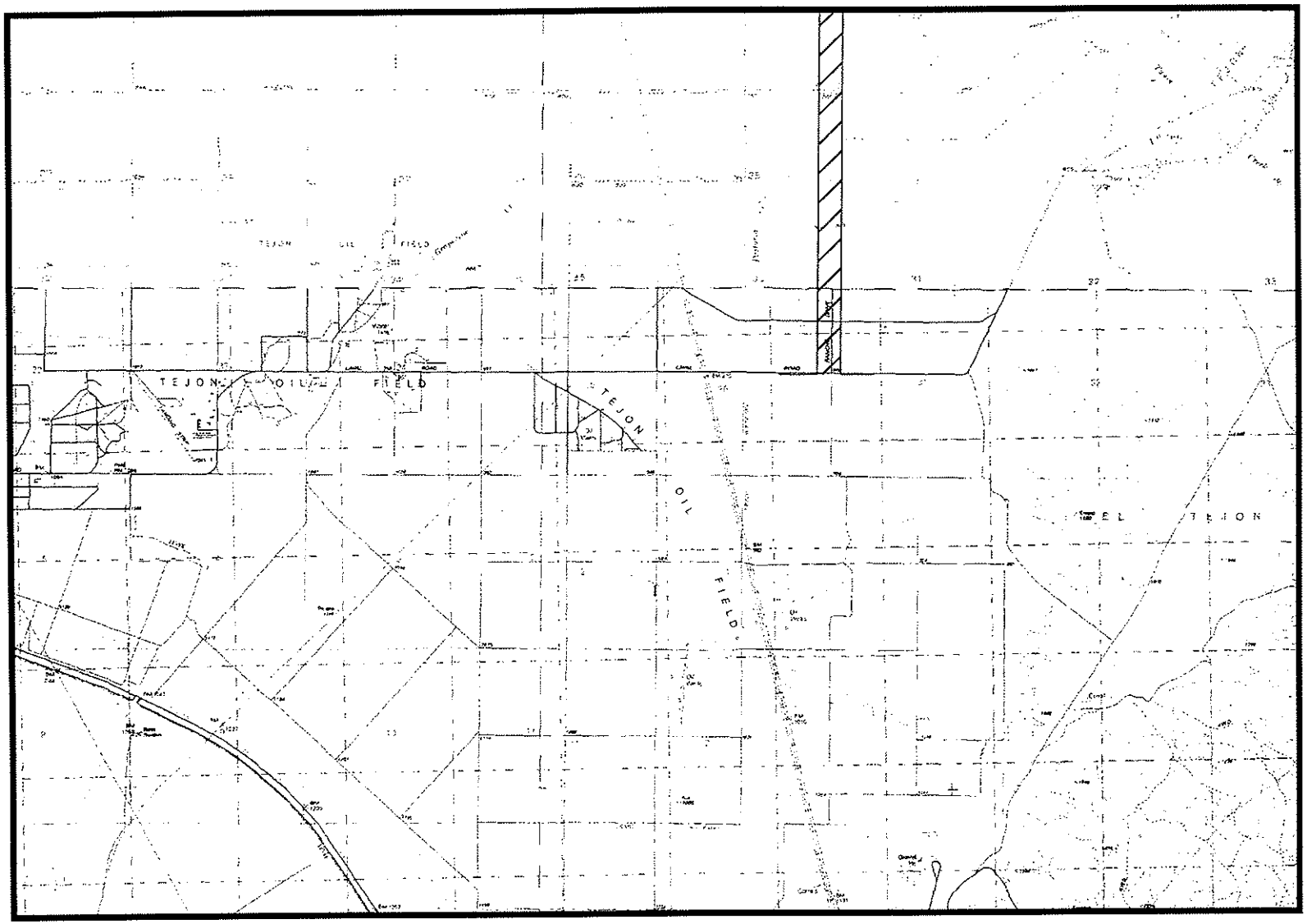
F. Floodplain Effects

Currently, individual farming operations are proliferating the use of levees to encroach the flood waters in to narrow roadway corridors. The use of wider (300' minimum) floodway corridors will increase the peak and volume received by downstream properties as compared to a natural, unobstructed condition, but these wider corridors will lessen the impacts that the existing, un-regulated condition currently has.

RANCHO DRIVE FLOODWAY

PROJECT 30A

RANCHO DRIVE FLOODWAY



PROJECT 30B

Project #31

David Road Floodway

A. Project Operation

This project establishes a non-encroachable (no levees, canal, or other flow obstructions) path for flood waters conveyed by the Rancho Road Floodway. This floodway follows the current path of flood waters and will encompass an area roughly 300 ft wide by 6.5 miles in length. The down stream terminus of this floodway will be the Adobe Road Floodway

B. Project Costs

Easements, valued at 80% of the full land cost, will be acquired from property owners along the length of the floodway. This will cost ~$250,000 per mile, for 6.5 miles, or a total cost of ~$1,600,000.

C. Project Benefits:

The existence of a floodway allows for full encroachment and flood protection (i.e. levees) of adjacent properties. Currently the practice of placement of levees in the floodplain to protect crop land is in violation of the Floodplain Management Ordinance.

D. Project Justification

Uncontrolled obstruction and channelization of flood waters into the county roadways endangers the traveling public, destroys the public road system, increases the peak flow, volume and sediment transported to downstream properties. This levee construction is a violation of the County's Floodplain Management Ordinance.

The economy of this region is dependant upon the production of farm products. Without protection, flooding would devastate this production.

This project, along with the other floodway projects creates a compromise. Floodways wide enough to reasonably convey the flood waters without serious damage, at known locations, will be purchased. These corridors can still be farmed, however the areas farmed within the easements can not be protected. The areas outside the easement may be fully protected with as large of levee as the farmer feels necessary. This will result in some loss of production capacity of the region without destroying the public infrastrature.

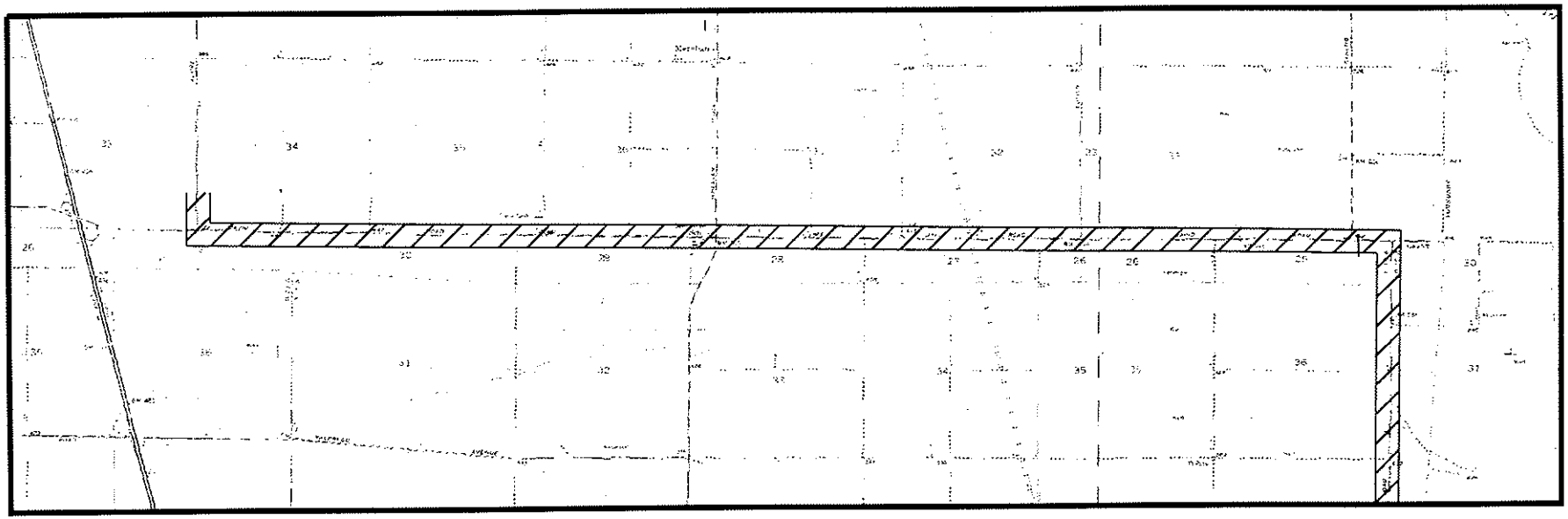
E. Environmental Effects

There are no environmental impacts.

F. Floodplain Effects

Currently, individual farming operations are proliferating the use of levees to encroach the flood waters in to narrow roadway corridors. The use of wider (300' minimum) floodway corridors will increase the peak and volume received by downstream properties as compared to a natural, unobstructed condition, but these wider corridors will lessen the impacts that the existing, un-regulated condition currently has.

DAVID ROAD FLOODWAY



PROJECT 31

Project #32

Tejon Creek Floodway

A. Project Operation

This project establishes a non-encroachable (no levees, canal, or other flow obstructions) path for flood waters originating in Tejon Creek. This floodway follows the current path of flood waters and will encompass an area roughly 300 ft wide by 5.5 miles in length. The down stream terminus of this floodway will be the Herring Road Floodway

B. Project Costs

Easements, valued at 80% of the full land cost, will be acquired from property owners along the length of the floodway. This will cost ~$250,000 per mile, for 5.5 miles, or a total cost of ~$1,400,000.

C. Project Benefits:

The existence of a floodway allows for full encroachment and flood protection (i.e. levees) of adjacent properties. Currently the practice of placement of levees in the floodplain to protect crop land is in violation of the Floodplain Management Ordinance.

D. Project Justification

Uncontrolled obstruction and channelization of flood waters into the county roadways endangers the traveling public, destroys the public road system, increases the peak flow, volume and sediment transported to downstream properties. This levee construction is a violation of the County's Floodplain Management Ordinance.

The economy of this region is dependant upon the production of farm products. Without protection, flooding would devastate this production.

This project, along with the other floodway projects creates a compromise. Floodways wide enough to reasonably convey the flood waters without serious damage, at known locations, will be purchased. These corridors can still be farmed, however the areas farmed within the easements can not be protected. The areas outside the easement may be fully protected with as large of levee as the farmer feels necessary. This will result in some loss of production capacity of the region without destroying the public infrastrature.

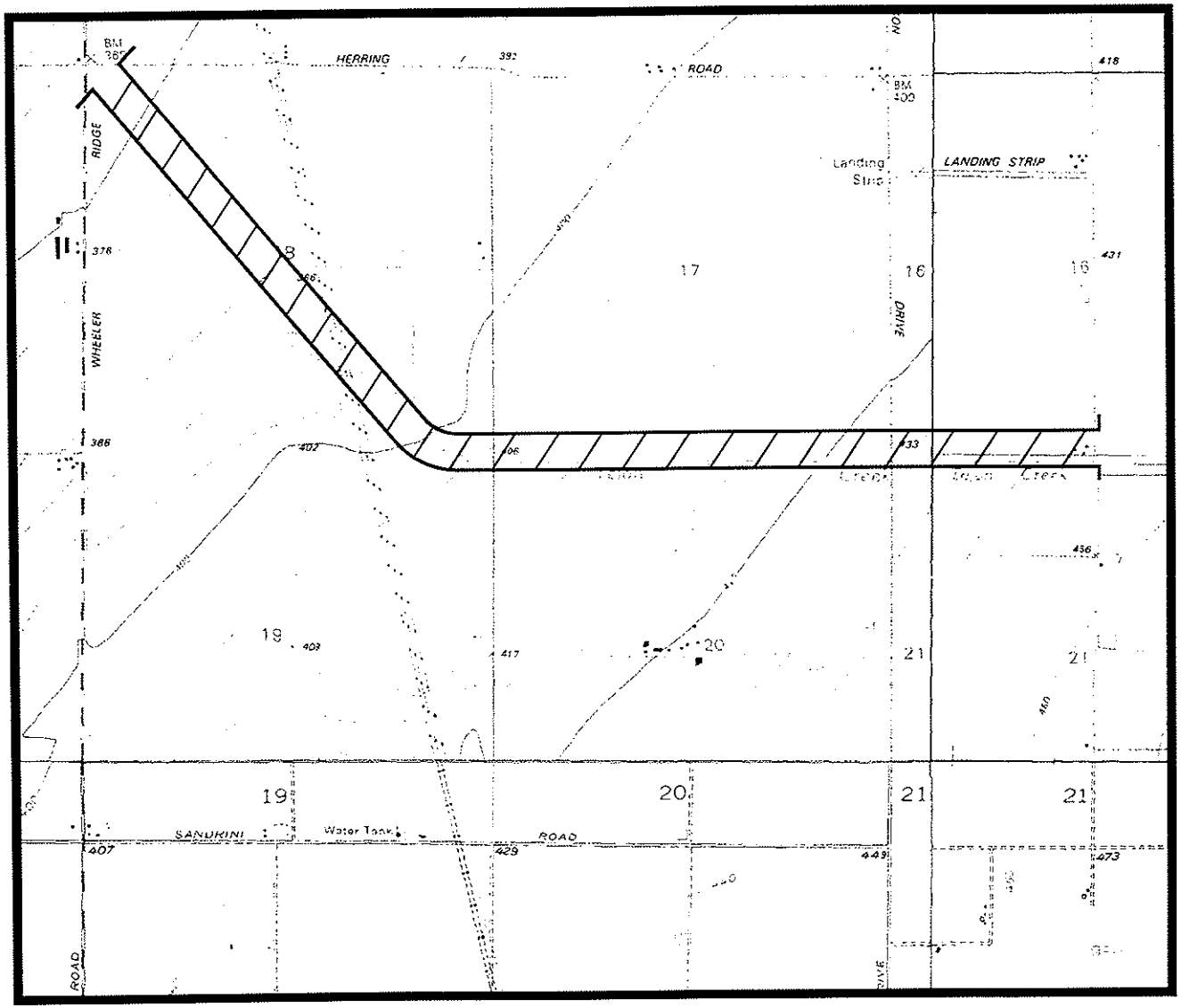
E. Environmental Effects

There are no environmental impacts.

F. Floodplain Effects

Currently, individual farming operations are proliferating the use of levees to encroach the flood waters in to narrow roadway corridors. The use of wider (300' minimum) floodway corridors will increase the peak and volume received by downstream properties as compared to a natural, unobstructed condition, but these wider corridors will lessen the impacts that the existing, un-regulated condition currently has.

TEJON CREEK FLOODWAY



PROJECT 32

Project #33

Herring Road Floodway

A. Project Operation

This project establishes a non-encroachable (no levees, canal, or other flow obstructions) path for flood waters originating in Comanche Creek and conveyed via the Tejon Creek Floodway. This floodway follows the current path of flood waters and will encompass an area roughly 300 ft wide by 5.5 miles in length. The down stream terminus of this floodway will be the Herring Lake Detention Basin.

B. Project Costs

Easements, valued at 80% of the full land cost, will be acquired from property owners along the length of the floodway. This will cost ~$250,000 per mile, for 9 miles, or a total cost of ~$2,100,000.

C. Project Benefits:

The existence of a floodway allows for full encroachment and flood protection (i.e. levees) of adjacent properties. Currently the practice of placement of levees in the floodplain to protect crop land is in violation of the Floodplain Management Ordinance.

D. Project Justification

Uncontrolled obstruction and channelization of flood waters into the county roadways endangers the traveling public, destroys the public road system, increases the peak flow, volume and sediment transported to downstream properties. This levee construction is a violation of the County's Floodplain Management Ordinance.

The economy of this region is dependant upon the production of farm products. Without protection, flooding would devastate this production.

This project, along with the other floodway projects creates a compromise. Floodways wide enough to reasonably convey the flood waters without serious damage, at known locations, will be purchased. These corridors can still be farmed, however the areas farmed within the easements can not be protected. The areas outside the easement may be fully protected with as large of levee as the farmer feels necessary. This will result in some loss of production capacity of the region without destroying the public infrastrature.

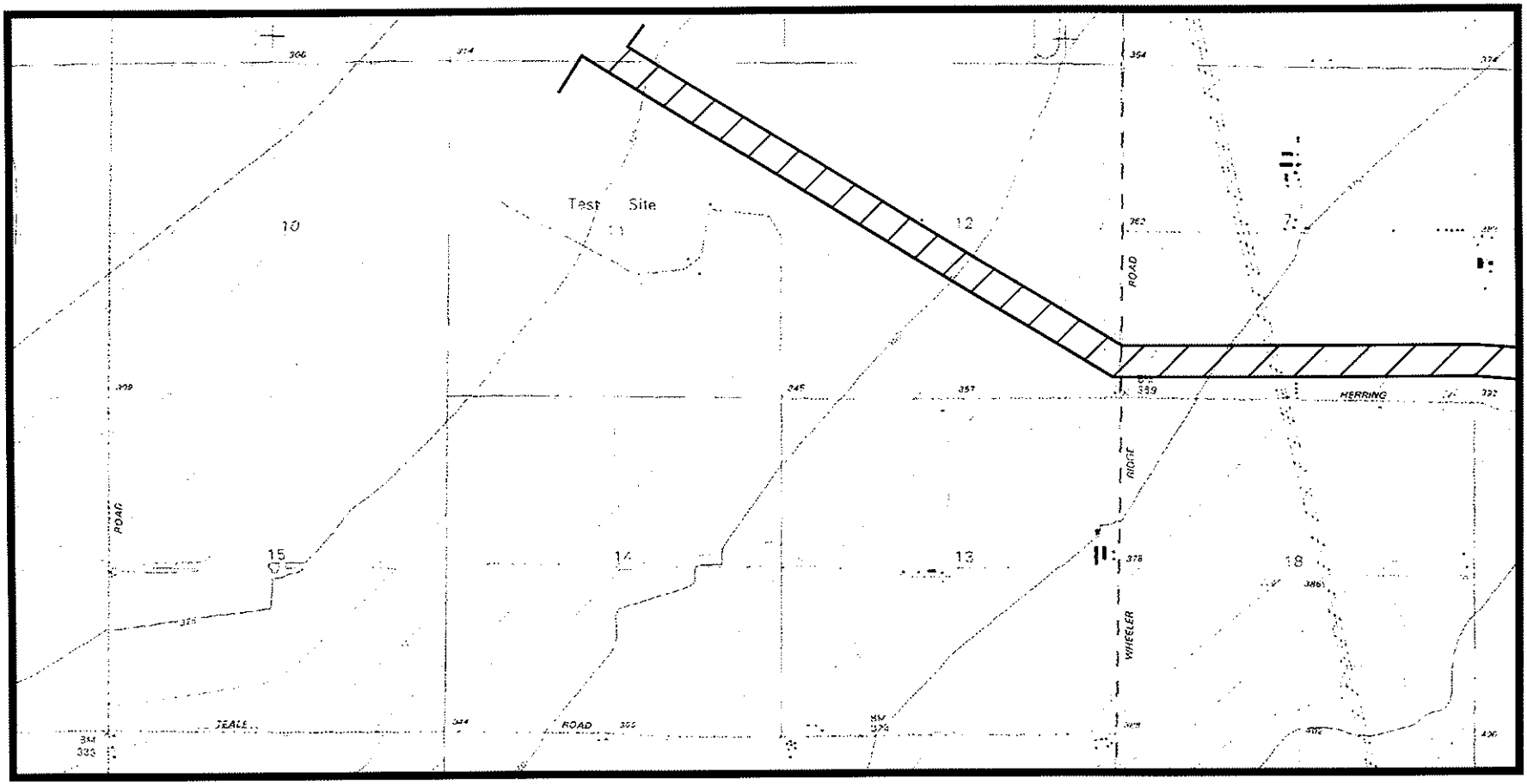
E. Environmental Effects

There are no environmental impacts.

F. Floodplain Effects

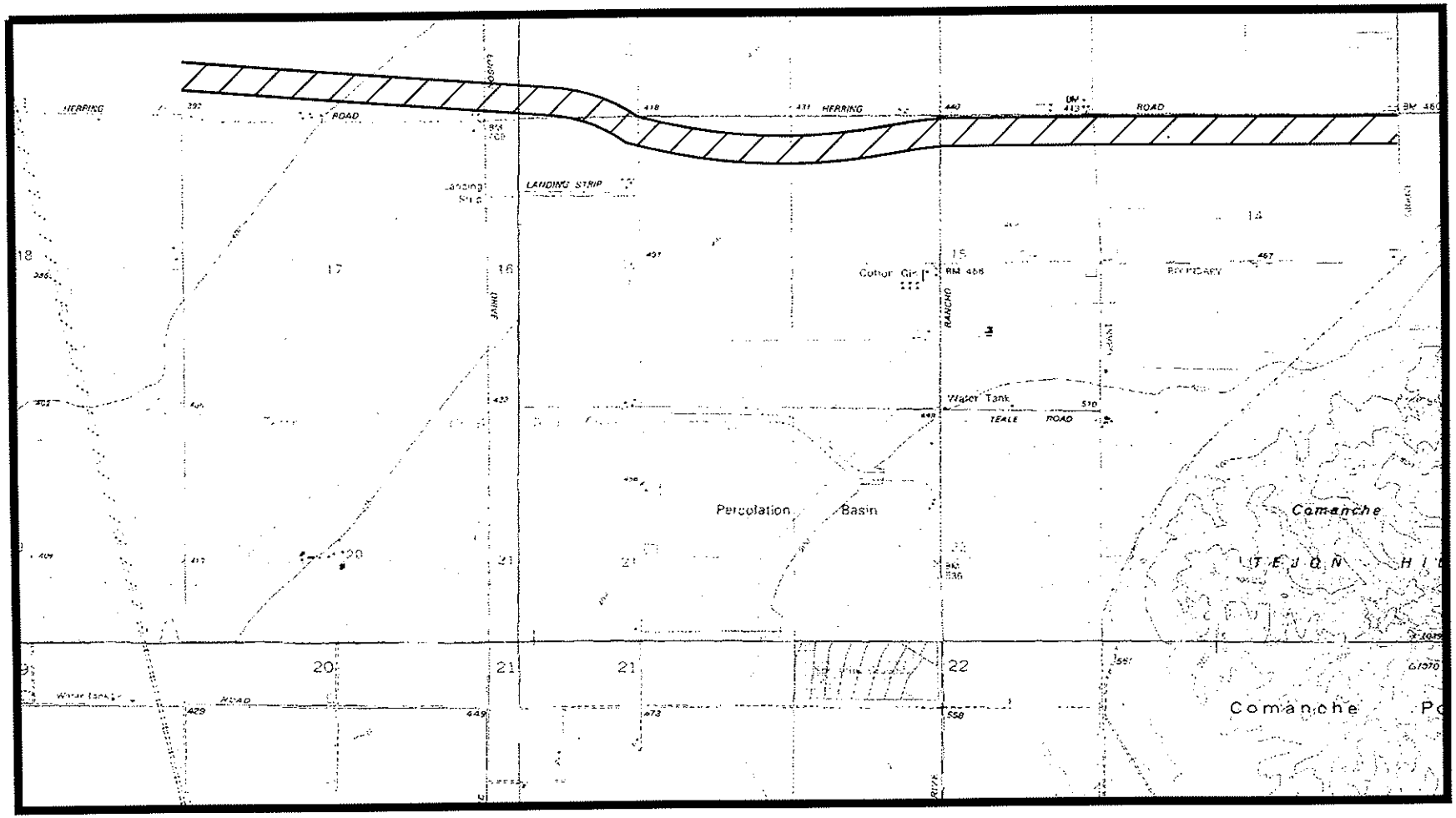
Currently, individual farming operations are proliferating the use of levees to encroach the flood waters in to narrow roadway corridors. The use of wider (300' minimum) floodway corridors will increase the peak and volume received by downstream properties as compared to a natural, unobstructed condition, but these wider corridors will lessen the impacts that the existing, un-regulated condition currently has.

HERRING ROAD FLOODWAY



PROJECT 33A

HERRING ROAD FLOODWAY



PROJECT 33B

Project #34

Adobe Road Floodway

A. Project Operation

This project establishes a non-encroachable (no levees, canal, or other flow obstructions) path for flood waters conveyed by the David Road Floodway. This floodway follows the current path of flood waters and will encompass an area roughly 300 ft wide by 4 miles in length. The down stream terminus of this floodway will be the Herring Lake Detention Basin.

B. Project Costs

Easements, valued at 80% of the full land cost, will be acquired from property owners along the length of the floodway. This will cost ~$250,000 per mile, for 4 miles, or a total cost of ~$1,000,000.

C. Project Benefits:

The existence of a floodway allows for full encroachment and flood protection (i.e. levees) of adjacent properties. Currently the practice of placement of levees in the floodplain to protect crop land is in violation of the Floodplain Management Ordinance.

D. Project Justification

Uncontrolled obstruction and channelization of flood waters into the county roadways endangers the traveling public, destroys the public road system, increases the peak flow, volume and sediment transported to downstream properties. This levee construction is a violation of the County's Floodplain Management Ordinance.

The economy of this region is dependant upon the production of farm products. Without protection, flooding would devastate this production.

This project, along with the other floodway projects creates a compromise. Floodways wide enough to reasonably convey the flood waters without serious damage, at known locations, will be purchased. These corridors can still be farmed, however the areas farmed within the easements can not be protected. The areas outside the easement may be fully protected with as large of levee as the farmer feels necessary. This will result in some loss of production capacity of the region without destroying the public infrastrature.

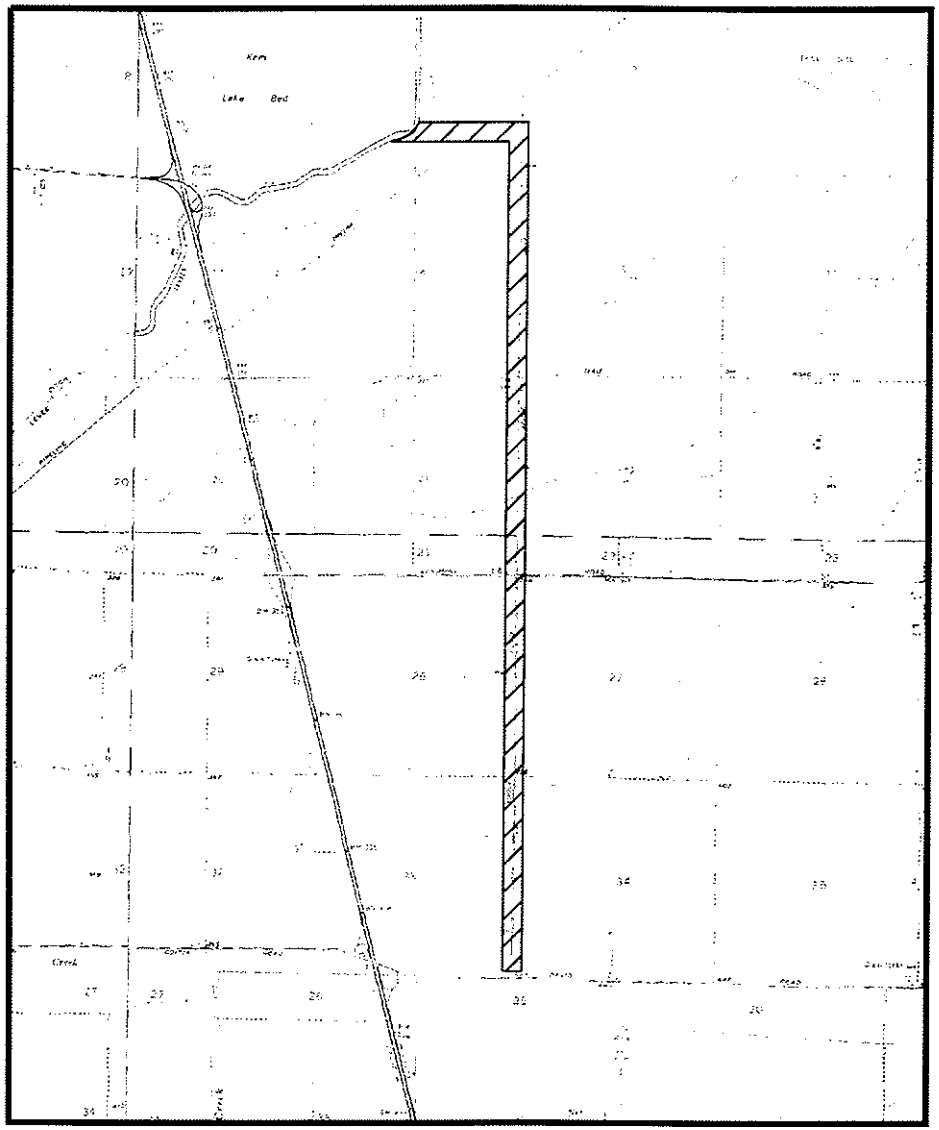
E. Environmental Effects

There are no environmental impacts.

F. Floodplain Effects

Currently, individual farming operations are proliferating the use of levees to encroach the flood waters in to narrow roadway corridors. The use of wider (300' minimum) floodway corridors will increase the peak and volume received by downstream properties as compared to a natural, unobstructed condition, but these wider corridors will lessen the impacts that the existing, un-regulated condition currently has.

ADOBE ROAD FLOODWAY



PROJECT 34

Project #35

Millux Road Floodway

A. Project Operation

This project establishes a non-encroachable (no levees, canal, or other flow obstructions) path for flood waters originating in Little Sycamore Creek, and convey via the Towerline Road Floodway. This floodway follows the current path of flood waters and will encompass an area roughly 300 ft wide by 8 miles in length. The down stream terminus of this floodway will be the Millux Lake Detention Basin.

B. Project Costs

Easements, valued at 80% of the full land cost, will be acquired from property owners along the length of the floodway. This will cost ~$250,000 per mile, for 8 miles, or a total cost of ~$2,000,000.

C. Project Benefits:

The existence of a floodway allows for full encroachment and flood protection (i.e. levees) of adjacent properties. Currently the practice of placement of levees in the floodplain to protect crop land is in violation of the Floodplain Management Ordinance.

D. Project Justification

Uncontrolled obstruction and channelization of flood waters into the county roadways endangers the traveling public, destroys the public road system, increases the peak flow, volume and sediment transported to downstream properties. This levee construction is a violation of the County's Floodplain Management Ordinance.

The economy of this region is dependant upon the production of farm products. Without protection, flooding would devastate this production.

This project, along with the other floodway projects creates a compromise. Floodways wide enough to reasonably convey the flood waters without serious damage, at known locations, will be purchased. These corridors can still be farmed, however the areas farmed within the easements can not be protected. The areas outside the easement may be fully protected with as large of levee as the farmer feels necessary. This will result in some loss of production capacity of the region without destroying the public infrastrature.

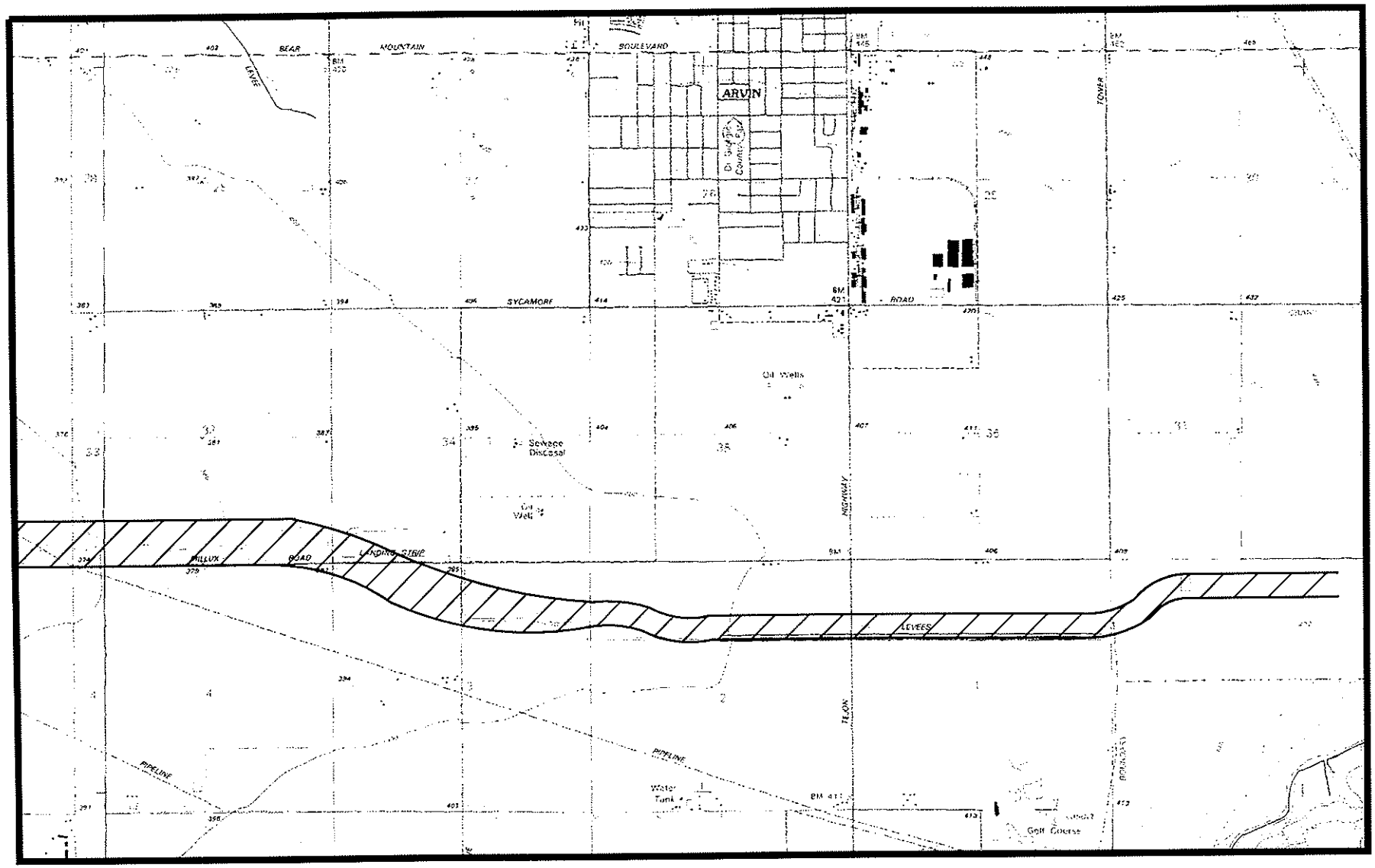
E. Environmental Effects

There are no environmental impacts.

F. Floodplain Effects

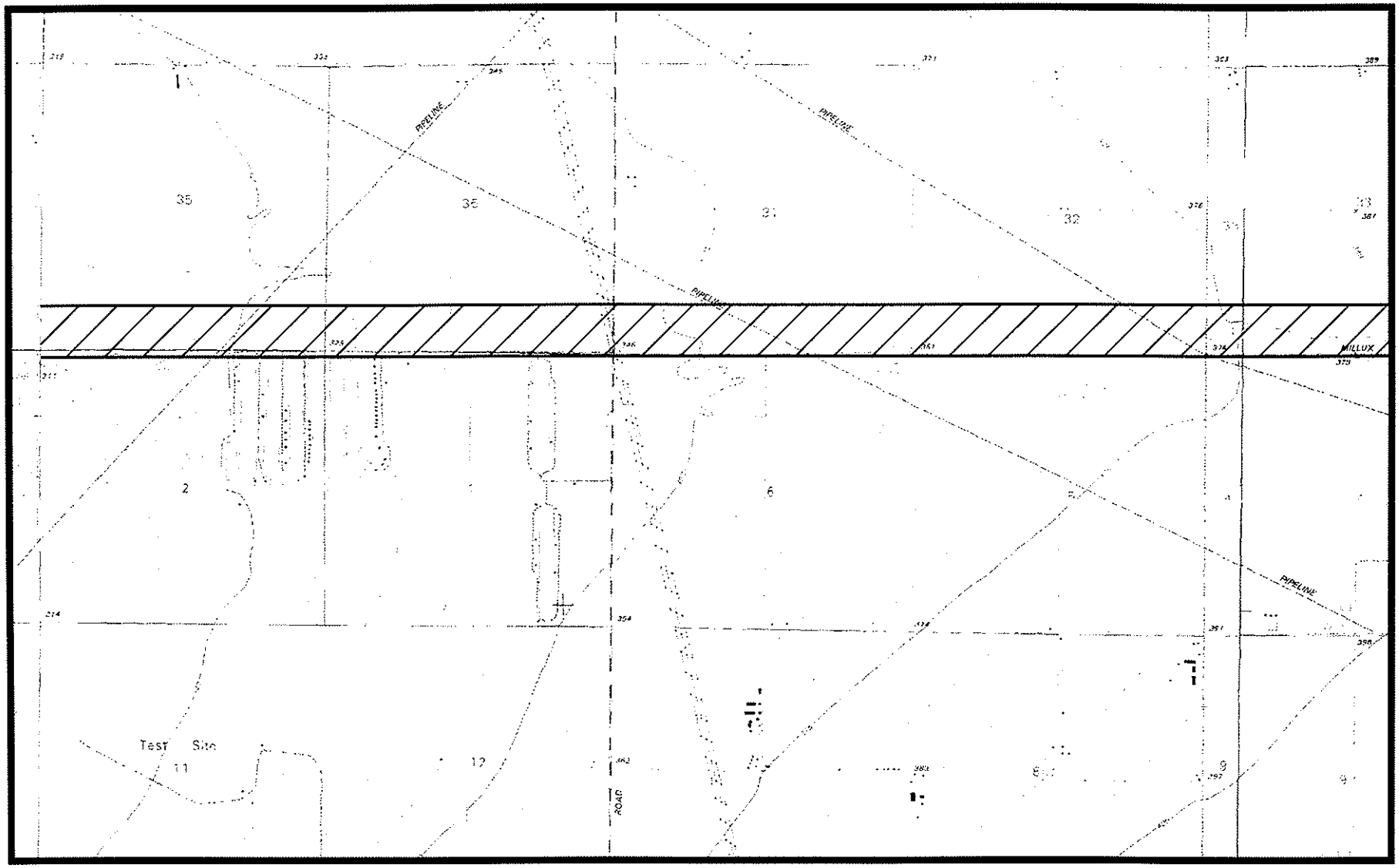
Currently, individual farming operations are proliferating the use of levees to encroach the flood waters in to narrow roadway corridors. The use of wider (300' minimum) floodway corridors will increase the peak and volume received by downstream properties as compared to a natural, unobstructed condition, but these wider corridors will lessen the impacts that the existing, un-regulated condition currently has.

MILLUX ROAD FLOODWAY



PROJECT 35A

MILLUX ROAD FLOODWAY



PROJECT 35B

Project #36

Rock Pile Road Floodway

A. Project Operation

This project establishes a non-encroachable (no levees, canal, or other flow obstructions) path for flood waters originating in Caliente Creek. This floodway follows the current path of flood waters and will encompass an area roughly 300 ft wide by 6 miles in length. The down stream terminus of this floodway will be the Towerline Road Floodway

B. Project Costs

Easements, valued at 80% of the full land cost, will be acquired from property owners along the length of the floodway. This will cost ~$250,000 per mile, for 6 miles, or a total cost of ~$1,500,000.

C. Project Benefits:

The existence of a floodway allows for full encroachment and flood protection (i.e. levees) of adjacent properties. Currently the practice of placement of levees in the floodplain to protect crop land is in violation of the Floodplain Management Ordinance.

D. Project Justification

Uncontrolled obstruction and channelization of flood waters into the county roadways endangers the traveling public, destroys the public road system, increases the peak flow, volume and sediment transported to downstream properties. This levee construction is a violation of the County's Floodplain Management Ordinance.

The economy of this region is dependant upon the production of farm products. Without protection, flooding would devastate this production.

This project, along with the other floodway projects creates a compromise. Floodways wide enough to reasonably convey the flood waters without serious damage, at known locations, will be purchased. These corridors can still be farmed, however the areas farmed within the easements can not be protected. The areas outside the easement may be fully protected with as large of levee as the farmer feels necessary. This will result in some loss of production capacity of the region without destroying the public infrastrature.

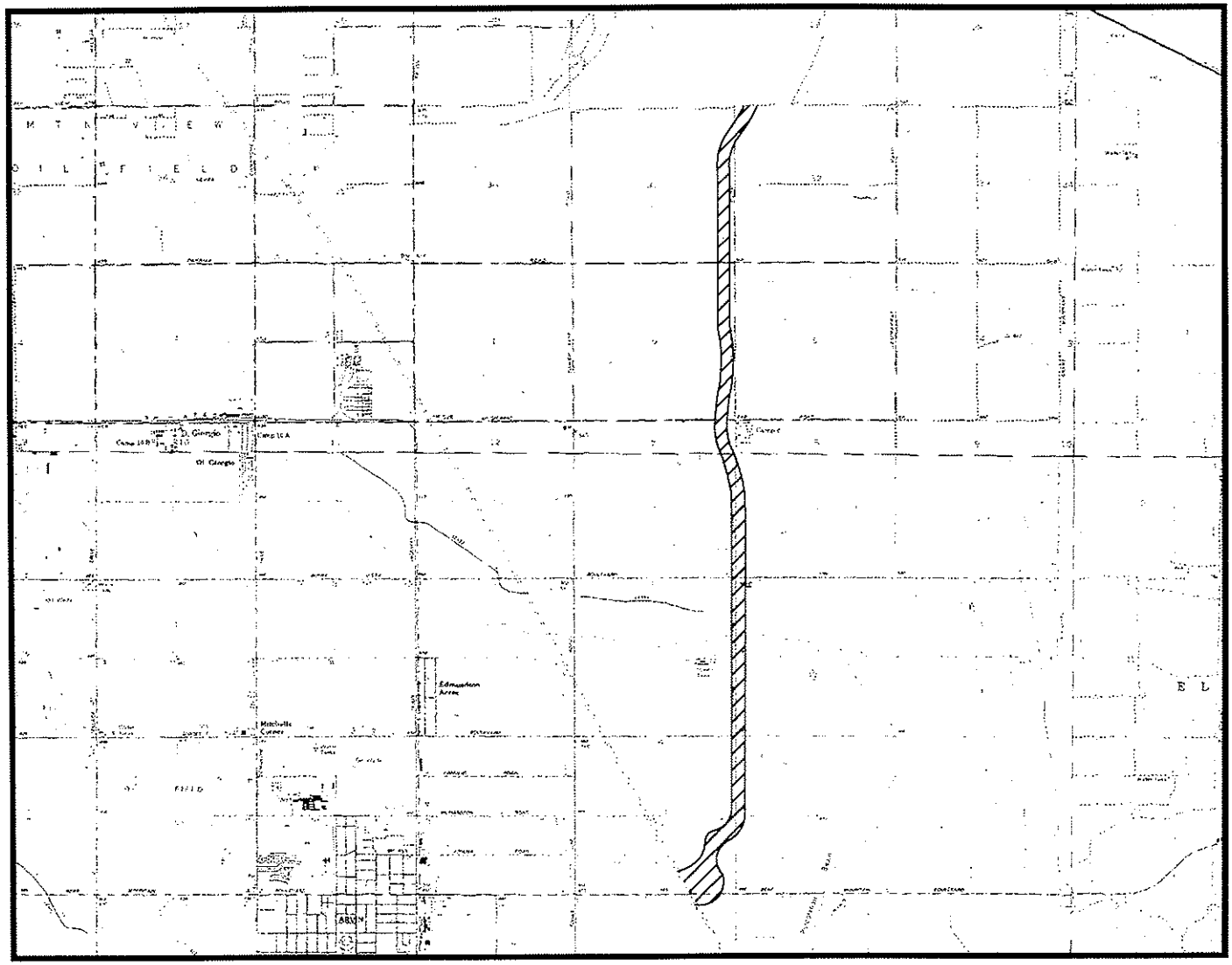
E. Environmental Effects

There are no environmental impacts.

F. Floodplain Effects

Currently, individual farming operations are proliferating the use of levees to encroach the flood waters in to narrow roadway corridors. The use of wider (300' minimum) floodway corridors will increase the peak and volume received by downstream properties as compared to a natural, unobstructed condition, but these wider corridors will lessen the impacts that the existing, un-regulated condition currently has.

ROCK PILE ROAD FLOODWAY



PROJECT 36

Project #37

Towerline Road Floodway

A. Project Operation

This project establishes a non-encroachable (no levees, canal, or other flow obstructions) path for flood waters originating in Sycamore Creek, and conveyed via the Rock Pile Road Floodway. This floodway follows the current path of flood waters and will encompass an area roughly 300 ft wide by 1.5 miles in length. The down stream terminus of this floodway will be the Millux Road Floodway.

B. Project Costs

Easements, valued at 80% of the full land cost, will be acquired from property owners along the length of the floodway. This will cost ~$300,000 per mile, for 1.5 miles, or a total cost of ~$500,000.

C. Project Benefits:

The existence of a floodway allows for full encroachment and flood protection (i.e. levees) of adjacent properties. Currently the practice of placement of levees in the floodplain to protect crop land is in violation of the Floodplain Management Ordinance.

D. Project Justification

Uncontrolled obstruction and channelization of flood waters into the county roadways endangers the traveling public, destroys the public road system, increases the peak flow, volume and sediment transported to downstream properties. This levee construction is a violation of the County's Floodplain Management Ordinance.

The economy of this region is dependant upon the production of farm products. Without protection, flooding would devastate this production.

This project, along with the other floodway projects creates a compromise. Floodways wide enough to reasonably convey the flood waters without serious damage, at known locations, will be purchased. These corridors can still be farmed, however the areas farmed within the easements can not be protected. The areas outside the easement may be fully protected with as large of levee as the farmer feels necessary. This will result in some loss of production capacity of the region without destroying the public infrastrature.

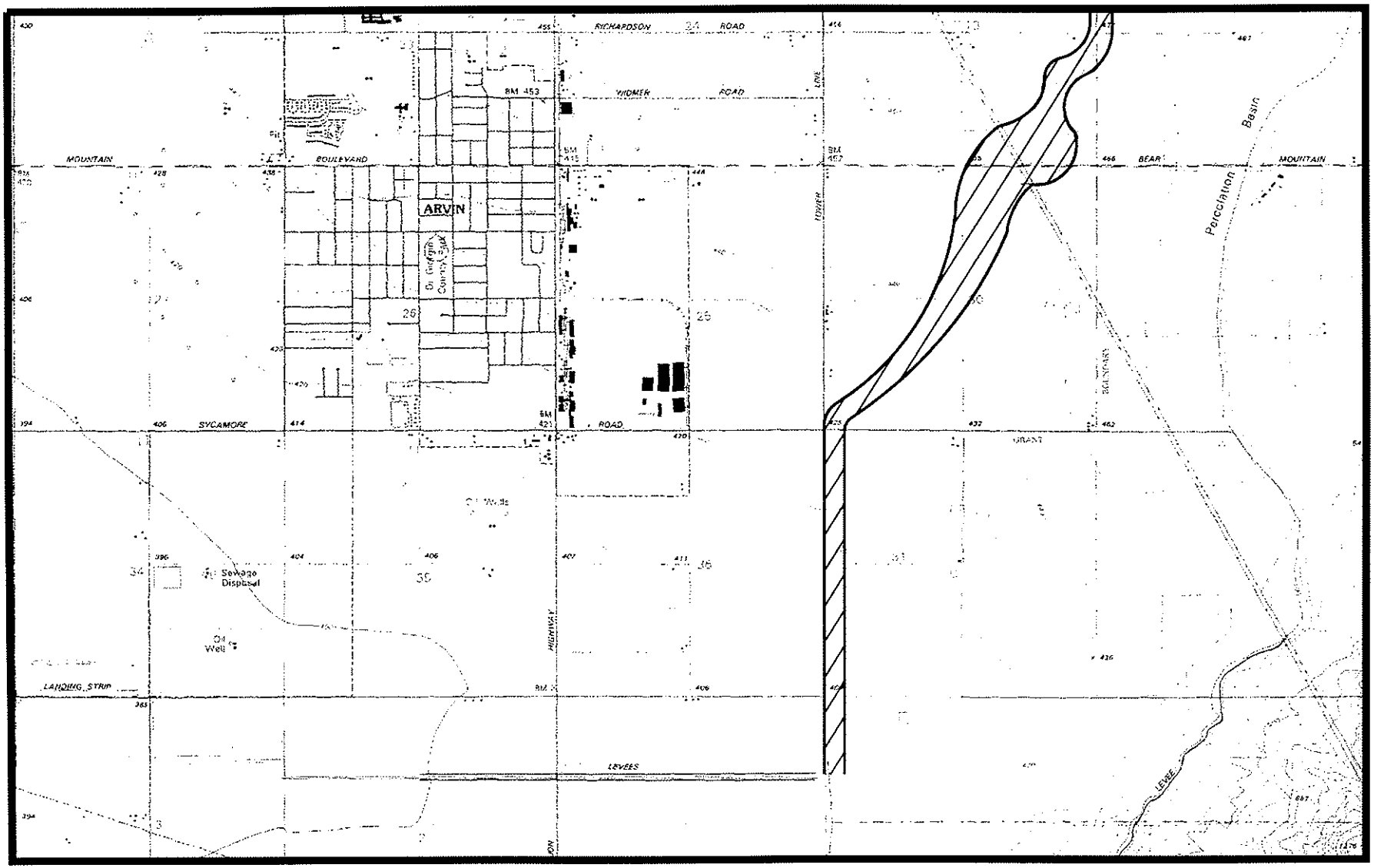
E. Environmental Effects

There are no environmental impacts.

F. Floodplain Effects

Currently, individual farming operations are proliferating the use of levees to encroach the flood waters in to narrow roadway corridors. The use of wider (300' minimum) floodway corridors will increase the peak and volume received by downstream properties as compared to a natural, unobstructed condition, but these wider corridors will lessen the impacts that the existing, un-regulated condition currently has.

TOWERLINE ROAD FLOODWAY



PROJECT 37

Project #38

Millux Lake Detention Basin

A. Project Operation

This project will construct a 1,000 acre-ft detention/retention basin. Flows will enter the facility from the **Millux Road Floodway** and will be held for irrigation purposes at a later date. Excess volume will be allowed to flow west to the **Herring Lake** facility.

B. Project Costs

Millux Lake Detention Basin

Cost Estimate (Preliminary)

Item	Unit	Quantity	Cost per Unit	Cost per Item
Levee Construction	CY	250,000	$ 10.00	$ 2,500,000
Land Aquisition	Acre	320	$ 3,500	$ 1,120,000
			Sub-Total	**$ 3,620,000**
Preliminary Design				$ 250,000
EIR				$ 100,000
Final Design				$ 100,000
Administration		5%		$ 181,000
Contingency		15%		$ 543,000
			Total	**$ 4,794,000**

C. Project Benefits:

This project mitigates volumetric impacts resulting from other channelization projects

D. Project Justification

Increased flow volumes will result from the channelization of flood waters. These volumes must be mitigated.

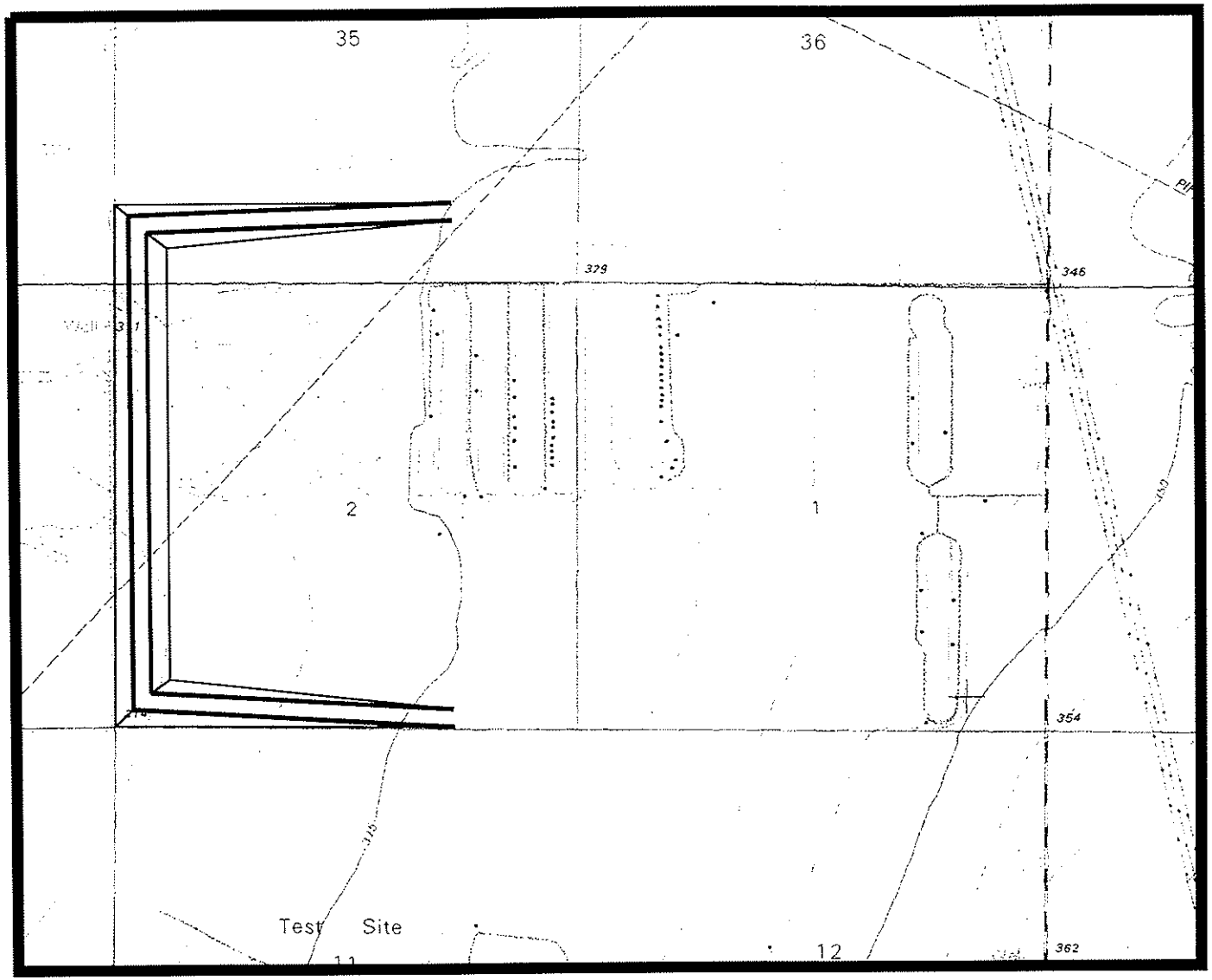
E. Environmental Effects

Due to the infrequency of flooding in this area, farming may still be viable within the area covered by this basin. Habitat mitigation may be required.

F. Floodplain Effects

The construction of this project will limit the amount and frequency of downstream flooding.

MILLUX LAKE DETENTION BASIN



PROJECT 38

Project #39

Herring Lake Detention Basin

A. Project Operation

This project will construct a 2,500 acre-ft detention/retention basin. Flows will enter the facility from the **Herring Road Floodway** and the **Lamont Channel (Southerly Extension)** and will be held for irrigation purposes at a later date. Excess volume will be allowed to flow south to the New Rim Ditch.

B. Project Costs

Herring Lake Detention Basin

Cost Estimate (Preliminary)

Item	Unit	Quantity	Cost per Unit	Cost per Item
Levee Construction	CY	250,000	$ 10.00	$ 2,500,000
Land Aquisition	Acre	640	$ 5,000	$ 3,200,000
			Sub-Total	**$ 5,700,000**
Preliminary Design				$ 250,000
EIR				$ 100,000
Final Design				$ 100,000
Administration		5%		$ 285,000
Contingency		15%		$ 855,000
			Total	**$ 7,290,000**

C. Project Benefits:

This project mitigates volumetric impacts resulting from other channelization projects

D. Project Justification

Increased flow volumes will result from the channelization of flood waters. These volumes must be mitigated.

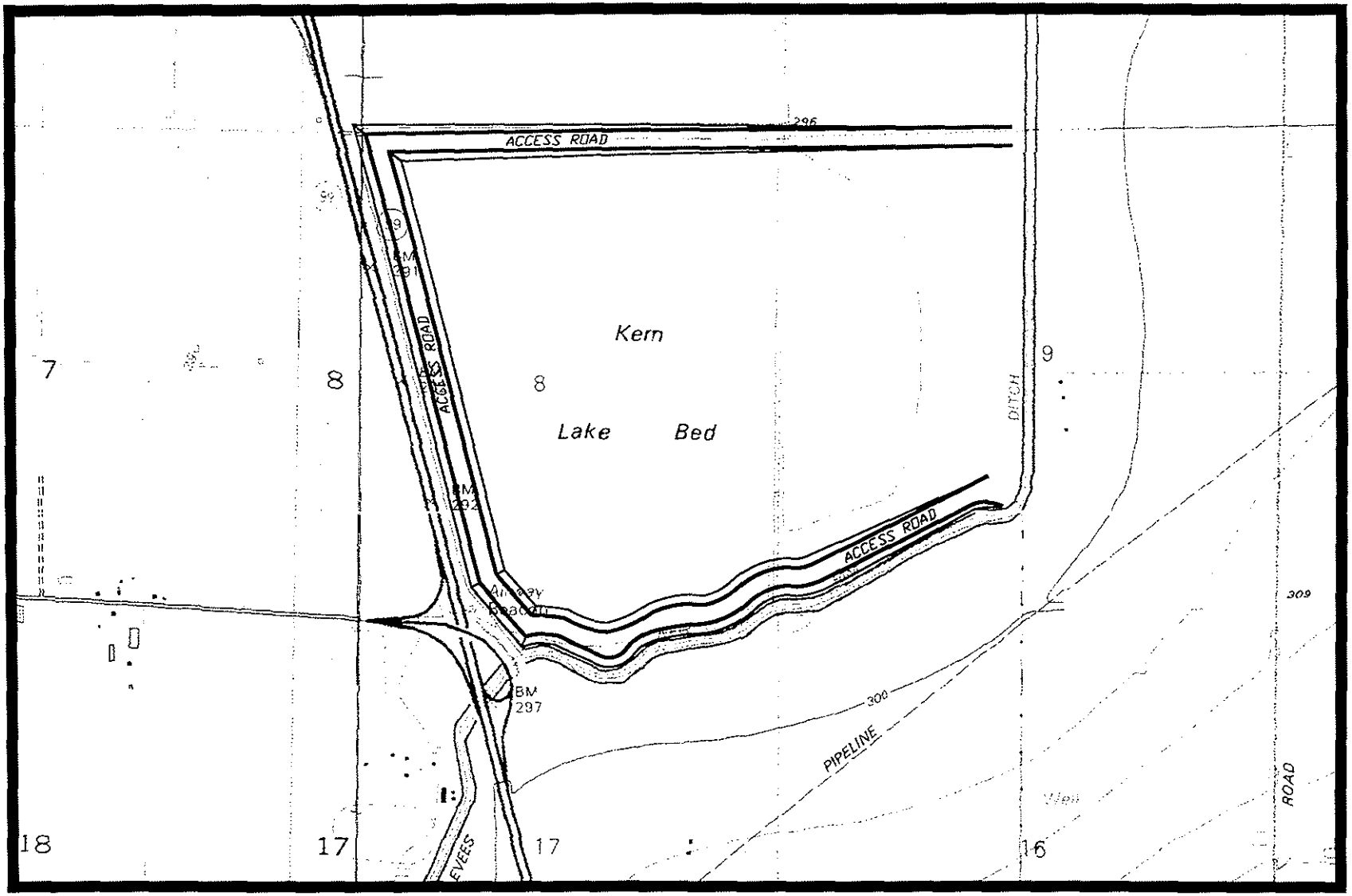
E. Environmental Effects

Due to the infrequency of flooding in this area, farming may still be viable within the area covered by this basin. Habitat mitigation may be required.

F. Floodplain Effects

The construction of this project will limit the amount and frequency of downstream flooding.

HERRING LAKE DETENTION BASIN



PROJECT 39

Project #40

Lamont Channel (Southerly Extension)

A. Project Operation

The Lamont Channel ends at the Arvin-Edison Waste Way. Upon leaving this facility flood waters will follow a natural floodplain south to the Kern Lake Bed.

The construction of a Southerly Extension will provide protection for public facilities and private properties along this flood path.

B. Project Costs

Lamont Channel (Southerly Extension)
Cost Estimate (Preliminary)

Item	Unit	Quantity	Cost per Unit	Cost per Item
Land Aquisition	Acre	350	$ 7,000	$ 2,450,000
Channel Excavation	CY	750,000	$ 4.50	$ 3,375,000
Roadway Undercrossings	Each	6	$ 250,000	$ 1,500,000
			Sub-Total	**$ 7,325,000**
Preliminary Design				$ 100,000
EIR				$ 100,000
Final Design				$ 50,000
Administration		5%		$ 366,250
Contingency		10%		$ 732,500
			Total	**$ 8,673,750**

C. Project Benefits:

The City of Bakersfield Sewer Farms are located within the floodplain downstream of the Lamont Channel. In addition 6 county and state highways are crossed by this floodplain. This channel extension would control the outflow from the Lamont Channel through these facilities.

D. Project Justification

The construction of this facility will control the flood waters, conveyed via the Lamont Channel, from Panama Road south to the Kern Lake Bed. If the Herring Lake facilities are constructed this channelization will establish a controlled ingress point to this detention basin. By controlling these flood waters associated flood damages can be minimized.

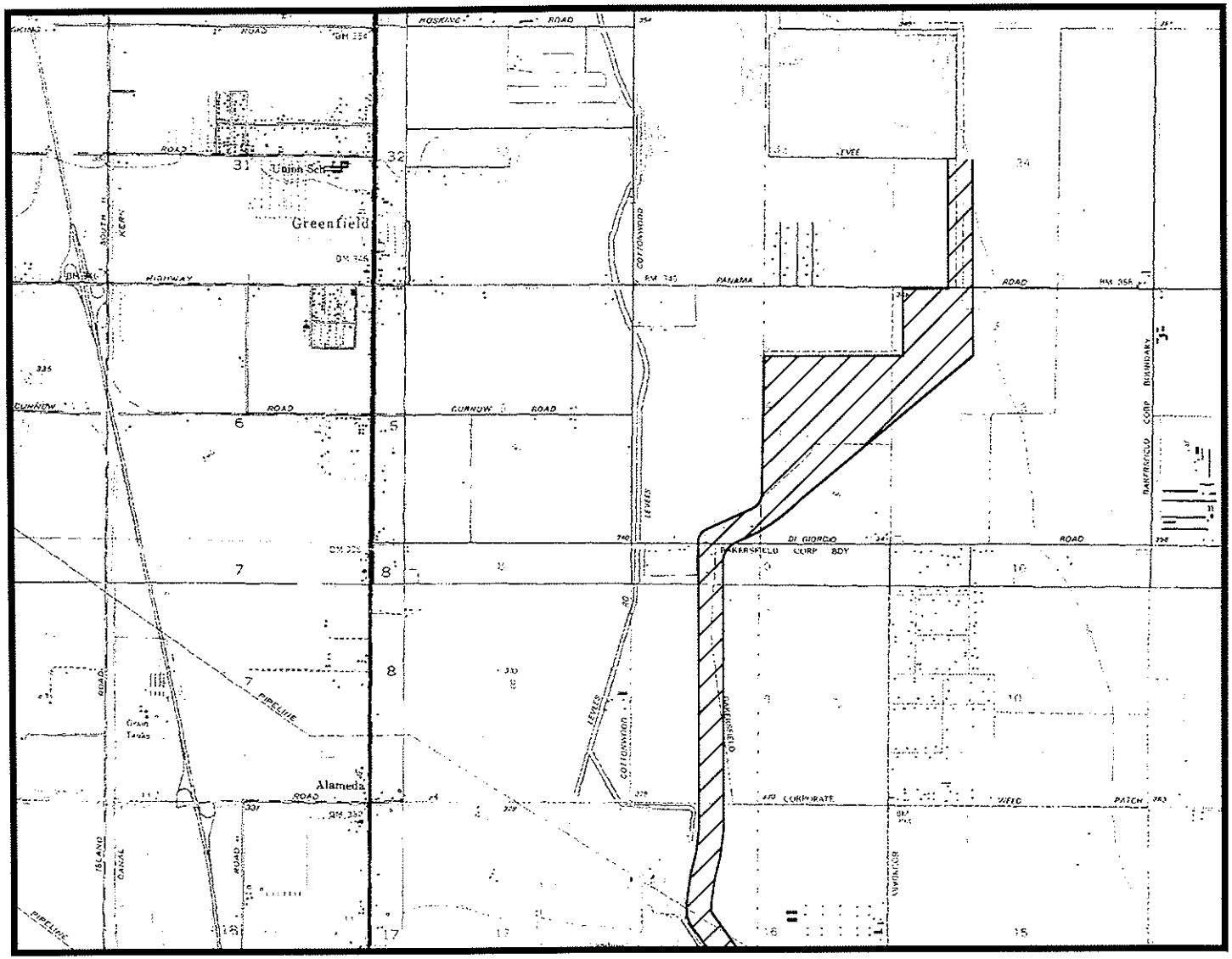
E. Environmental Effects

Peak flow rate and flood volume reaching the Kern Lake Bed will be increased. These increases will require mitigation. Habitat mitigation will be required.

F. Floodplain Effects

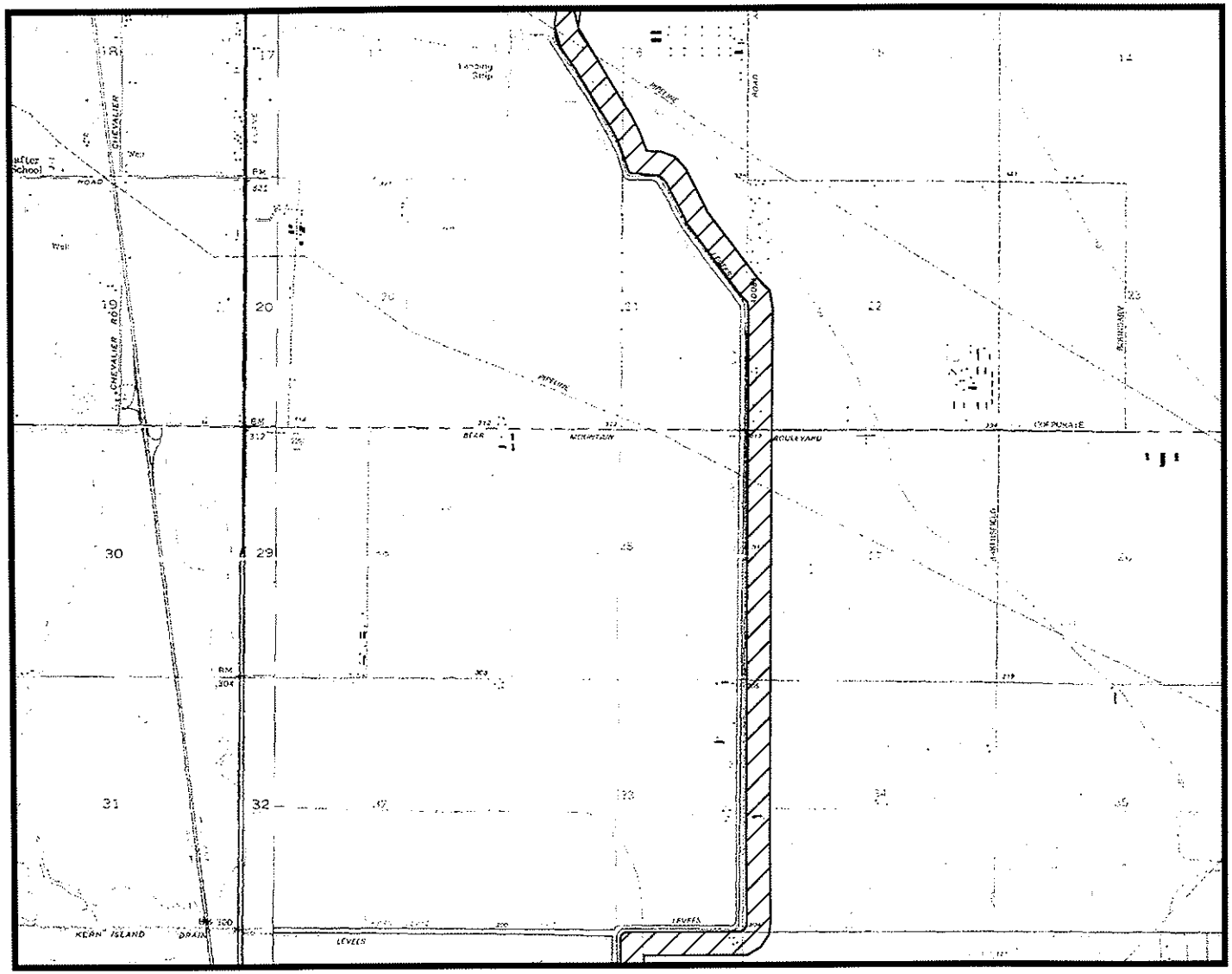
This facility will minimize the area impacted by moderate and small floods. Larger flood events will continue to impact significant areas.

LAMONT CHANNEL
(SOUTHERLY CHANNEL)



PROJECT 40A

LAMONT CHANNEL
(SOUTHERLY EXTENSION)



PROJECT 40B

Project #41

Eastside Canal Enlargement

A. Project Operation

The Eastside Canal would be widened 50 feet from the North Lamont Channel connection to the Weedpatch Channel connection.

The Eastside Canal flow capacity would be increased to 350 cfs between the **North Lamont Channel** and the **Weedpatch Channel** by this project. This expansion will allow an increase in system capacity by providing a diversion of high peak surges to the southerly, **Weedpatch Channel**.

B. Project Costs

Eastside Canal Enlargement

Cost Estimate (Preliminary)

Item	Unit	Quantity	Cost per Unit	Cost per Item
Land Aquisition				
Channel	Acre	20	$ 7,000	$ 140,000
Excavation				
Channel	CY	140,000	$ 4.50	$ 630,000
Roadway Undercrossings				
Mountain View Road	Each	1	$ 250,000	$ 250,000
Panama Road	Each	1	$ 250,000	$ 250,000
Railroad	Each	1	$ 250,000	$ 250,000
Di Giorgio Road	Each	1	$ 250,000	$ 250,000
			Sub-Total	**$ 1,770,000**
Preliminary Design				$ 50,000
EIR				$ 50,000
Final Design				$ 25,000
Administration		10%		$ 177,000
Contingency		20%		$ 354,000
			Total	**$ 2,426,000**

C. Project Benefits:

Low flows captured by the **Lamont Channel** can be intercepted and diverted to the **Lamont Drainfield** or the **Weedpatch Channel**. These facilities have lower maintenance cost and thus damages to the Lamont Channel can be avoided.

D. Project Justification

This project provides a needed connectivity between the Lamont flood control projects. By connecting these facilities the uncertainty surrounding the magnitude of flow at any specific location on the Caliente Alluvial Fan can be mitigated and excess flows diverted to facilities with unused capacity.

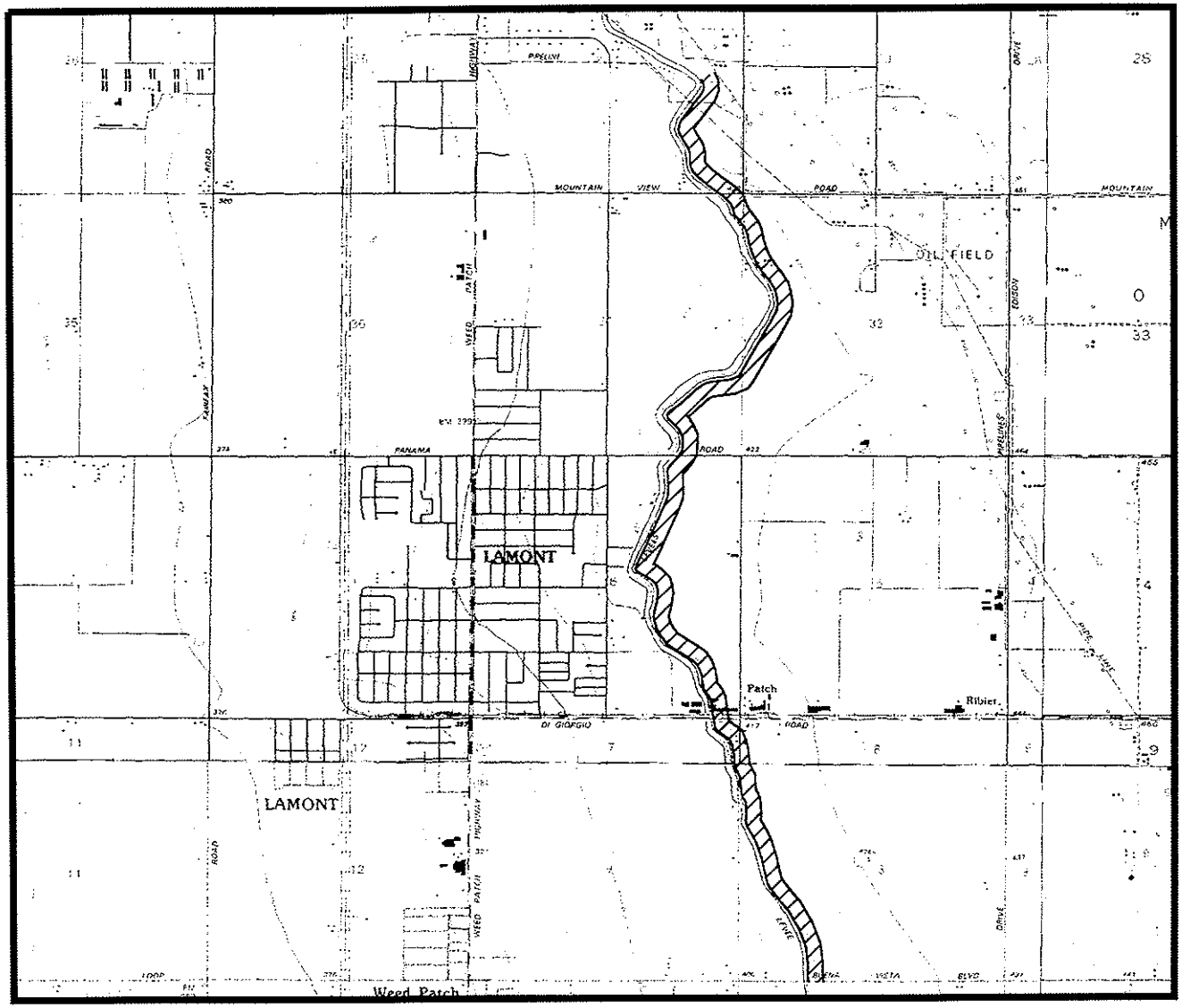
E. Environmental Effects

There would be no environmental impacts. The flows will be transported from one control facility to another.

F. Floodplain Effects

This project will have minor beneficial impacts to the floodplain downstream of the Eastside Canal, in that an additional 200 cfs can be conveyed away from Lamont.

EASTSIDE CANAL ENLARGEMENT



PROJECT 41

Project #42

New Rim Ditch Conveyance Enhancements

A. Project Operation

With the proliferation of farm protection levees, flows from upstream watersheds which have historically spread across the intervening farmlands are now funneled to the Kern Lake Bed, and the New Rim Ditch. This facility is the extension of Kern Delta's Central Branch Canal and has the capacity to convey ~250 cfs under Highway 99. During moderate flood events significantly more flow is reaching the canal reach upstream of the highway and thus this flow is increasing the potential for freeway flooding, which endangers the traveling public.

This project would double the capacity of the New Rim Ditch to convey flood waters under Highway 99. This can be accomplished by;

- Constructing a parallel culvert under the freeway,
- Boring and jacking several pipes under the freeway,
- Raising the upstream backwater.

It must be noted that merely increasing the size and/or capacity of the existing culverts under Highway 99 does not necessarily increase the conveyance capacity of the rim ditch. Additional downstream mitigations may be required.

No specific design has been determined as yet.

B. Project Costs

Additional consultation with CalTrans is required before a cost estimate can be prepared for this project.

C. Project Benefits:

This project is intended to protect the traveling public on Highway 99. By increasing the capacity of the New Rim Ditch under-crossing, higher flows can be conveyed under the freeway and thus freeway flooding will be reduced.

D. Project Justification

The potential for flooding of Highway 99 at Herring Road (New Rim Ditch) will increase, with attendant deleterious impacts, if current trends continue.

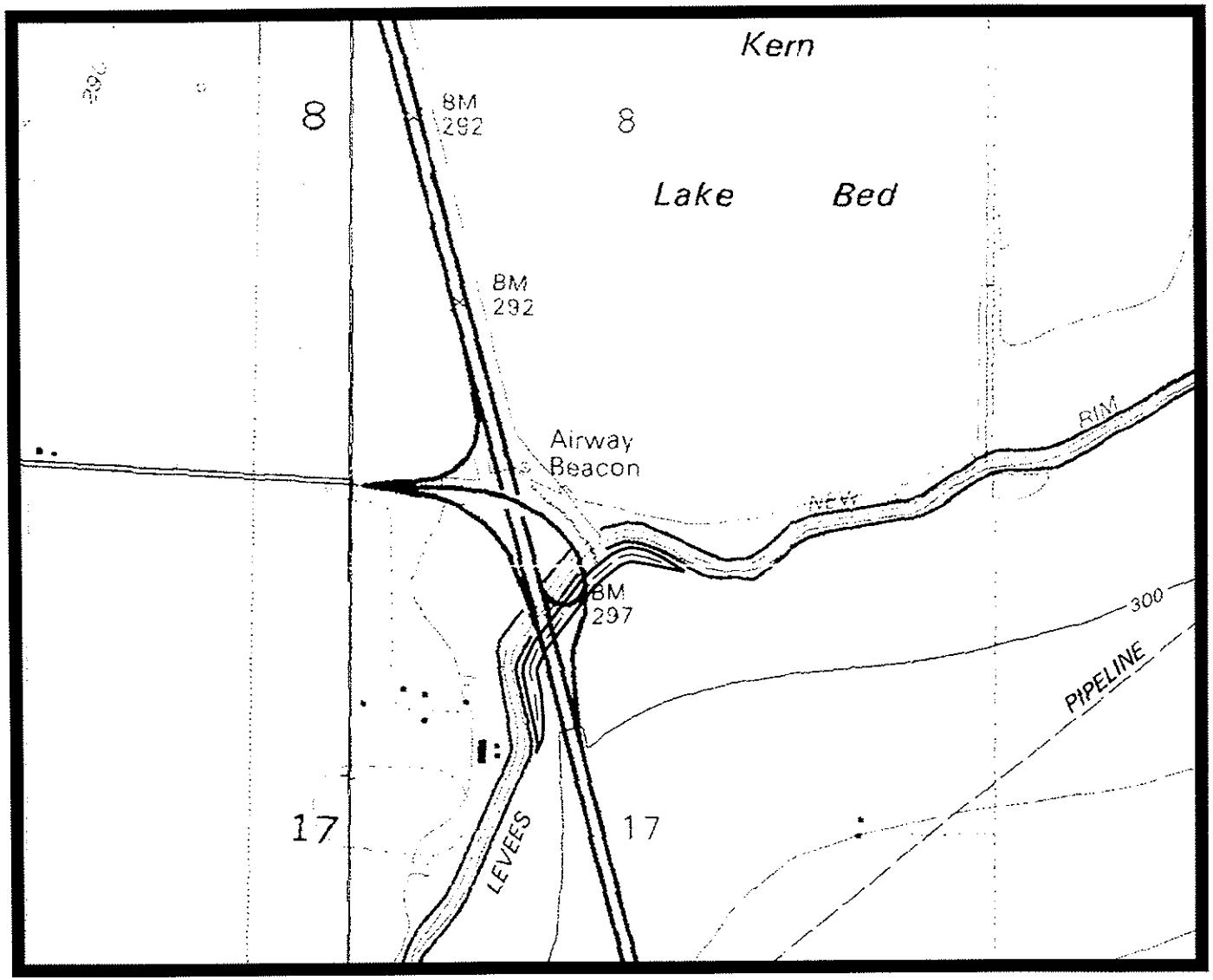
E. Environmental Effects

The downstream properties will realize greater flow and greater volume as a result of this project. These impacts must be mitigated.

F. Floodplain Effects

No effect.

NEW RIM DITCH
CONVEYANCE ENHANCEMENT



PROJECT 42

Project #43

LeGray Road to Tecuya Creek Bypass

A. Project Operation

Under current conditions runoff originating from Grapevine Creek, and the adjacent watersheds, as well as from the foothills and the upstream valley floor, converge at the intersection of Le Gray Road and the Highway 99 frontage road. These flows pose a serious risk to the traveling public on Highway 99 as well as cause serious damage to the farming operation in the area.

This project will intercept 100 cfs of this flow and pipe it under the highway to Tecuya Creek.

B. Project Costs

It is estimated this project will cost ~$500,000.

C. Project Benefits:

This project will limit the potential for Highway 99 to be flooded from this source.

D. Project Justification

This project is intended to protect the traveling public and mitigate damages resulting from uncontrolled flow at the intersection of Le Gray Road and Highway 99.

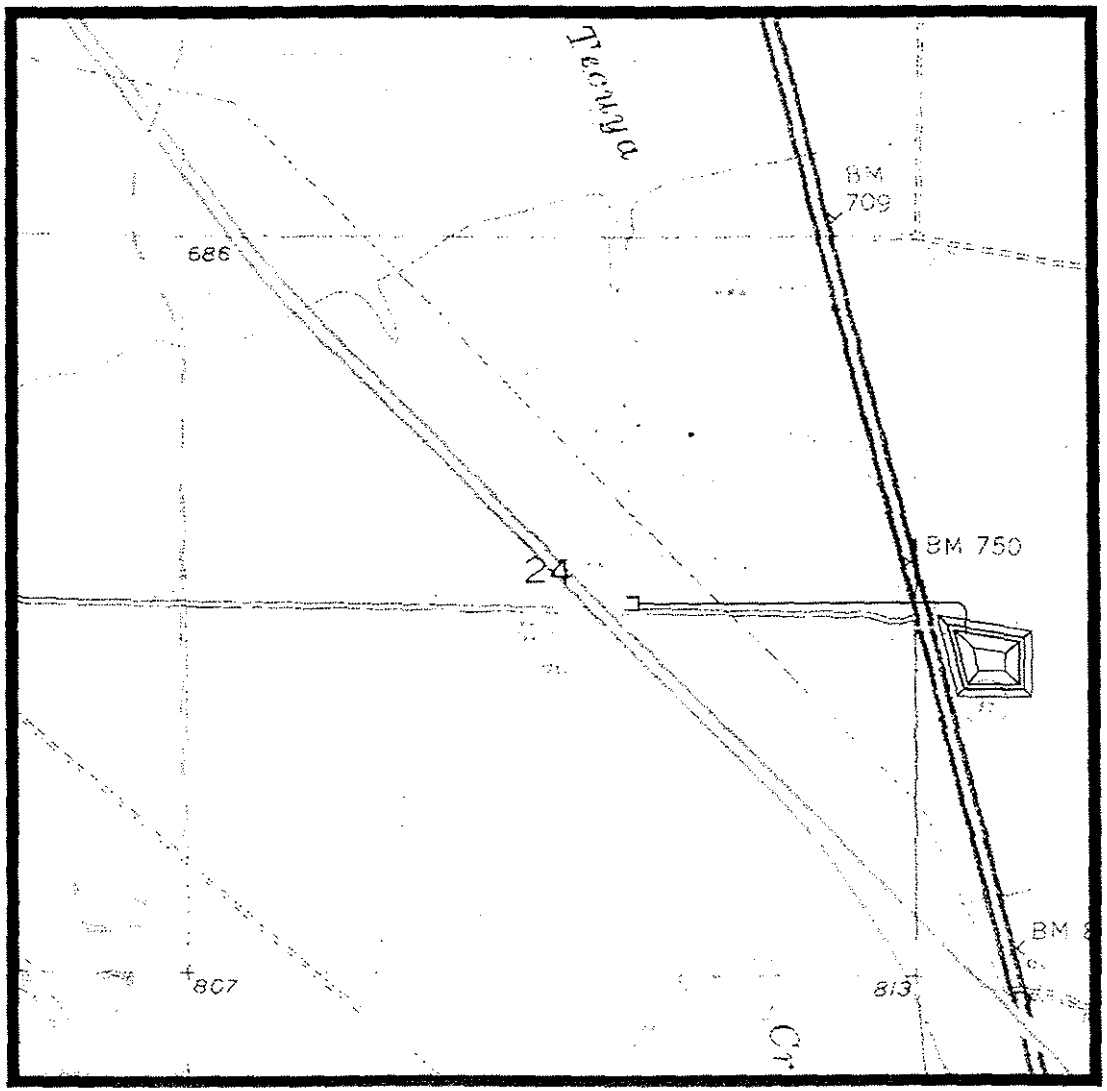
E. Environmental Effects

This project is a diversion of water which will adversely impact properties along Tecuya Creek. Mitigation will be required.

F. Floodplain Effects

No impact.

LeGRAY TO TECUYA CREEK BYPASS



PROJECT 43

Project #44

Tecuya Creek Ground Water Recharge Basin

A. Project Operation

Runoff waters, originating from Tecuya Creek will be intercepted and spread into groundwater recharge facilities.

B. Project Costs

This project has been estimated to cost $2,000,000. This estimate should not be used for budgetary purposes, but should only be used for comparison.

C. Project Benefits:

This project provides volumetric mitigation for other channelization projects.

D. Project Justification

Water is a valuable resource in this region. During wet years it needs to be stored for dry year usage. Ground water recharge is the best means to meet this need.

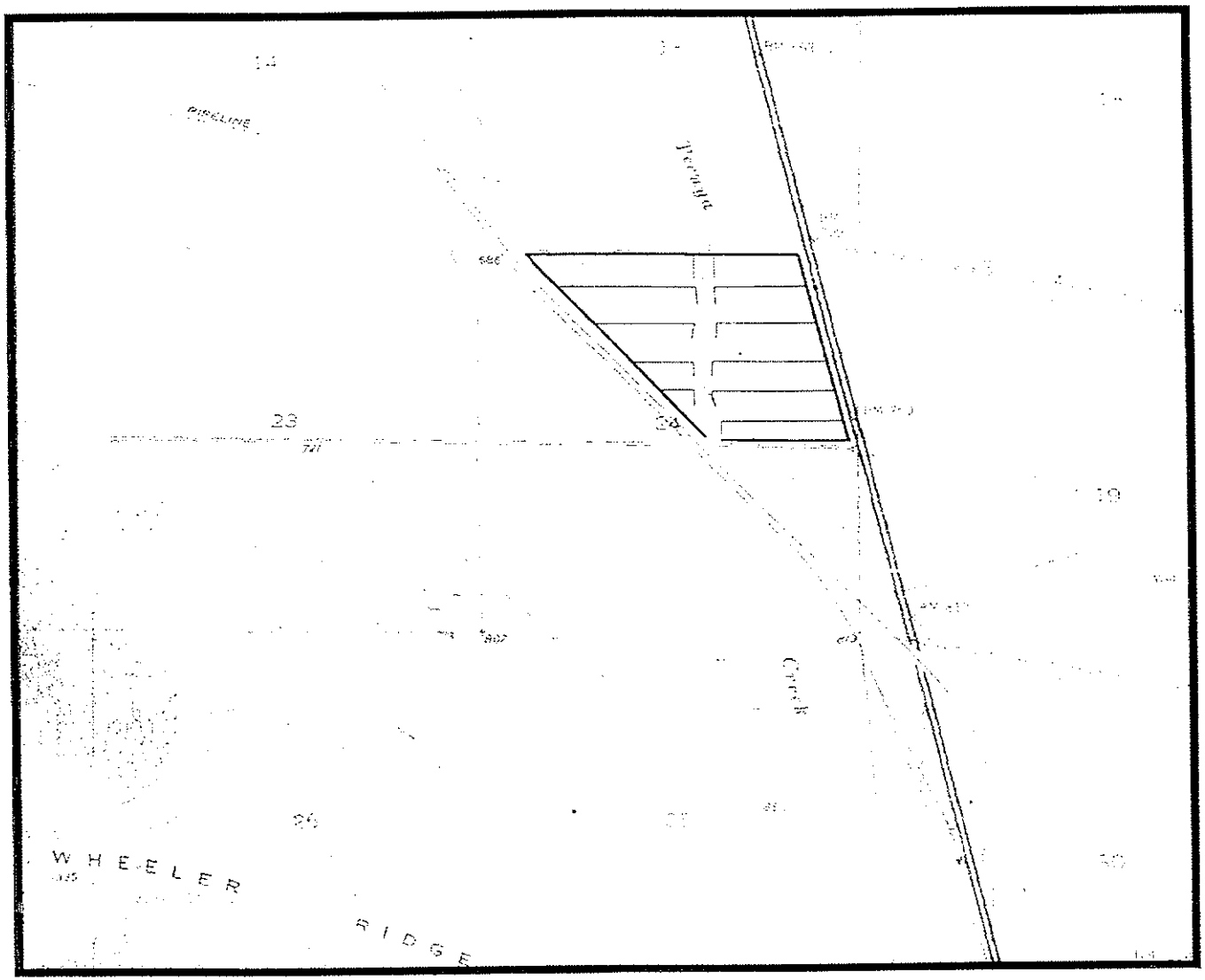
E. Environmental Effects

This project could be used as habitat mitigation, further research into this function should be pursued. Typically, a ground water recharge facility will require significant maintenance which is not conducive to the establishment of native habitat. Habitat mitigation will be required.

F. Floodplain Effects

Through mitigating volume this project makes possible the construction of channelization projects which will limit the extent and degree of flooding.

TECUYA CREEK GROUND WATER RECHARGE BASIN



PROJECT 44

CHAPTER VI: PLAN IMPLEMENTATION

Additional Studies Required:

This report is a preliminary, status report from the Kern Lake CRMP. In order to proceed with the CRMP process additional studies and investigations must be funded and undertaken. These include;

- ***Hydrologic analysis of watersheds contributory to the Kern Lake Bed.***

  J.G. Boswell Company owns and operates the farming operations within the Kern Lake Bed. They understand and accept their responsibilities to accept the "Natural" runoff which reaches the Lake Bed. They will not accept increased runoff which results from development or as a consequence of flood control projects which concentrate flood water, raising both the peak and volume which are discharged onto the lake bed (i.e. channelization project impacts).

  One of the premises of this CRMP investigation is the inter-relational balance from one watershed to another. In this case, if peak flow or volume are increased from Caliente Creek, that increase can be mitigated by lowering the peak and volumes from other watersheds, thus the net impact would be zero. In order for this concept to work, an hydrologic investigation detailing the frequency of peaks and volumes from the various watersheds is required. This analysis should be based upon consistent assumptions and evaluation procedures. The USACE is best equipped to perform this analysis. The total cost of this project could be **$500,000 with a local share of $250,000.**

- ***Hydraulic analysis of the floodplain.***

  Farm protection levees have proliferated over recent years. The impact of these facilities is known to be deleterious, but the degree of impact is unknown. An analysis of the unconfined and encroached floodplain conditions are required to evaluate the effectiveness of the proposed flood control projects, the impact of existing and anticipated developments, and the benefit areas covered by the proposed projects. It is anticipated that this analysis could cost **$750,000.** The USACE may be a source of cost share. The DWR, or the NRCS, may be a source of cost share, as well.

- ***Habitat Conservation Plan (HCP).***

  The Kern Lake Bed, and its surrounding watersheds (up to an elevation of 2000') are included in the valley floor HCP with the Northern portions covered by the Metro Bakersfield HCP. Each project constructed as part of the CRMP currently will pay into a mitigation fund for the acquisition of habitat, most likely outside of the Kern Lake Bed. As has been noted in the project descriptions, many of the proposed projects are intended to meet habitat mitigation requirements as well as act as channel stabilization or sediment mitigation. To have fees added to the cost of projects, and then have those fees expended outside the basin when they could be used within the basin, does not appear to be a wise use of local monies. The development of a Kern Lake HCP in conjunction with this CRMP would provide the information needed by the CRMP to establish wise land use and project planning. It is estimated that the development of such an HCP would cost ~ **$400,000.**

- ***Detailed evaluation and feasibility study of the Caliente Creek Habitat Mitigation Project and the Caliente Creek Ground Water Recharge Project.***

  These projects can be significant flood, sediment, and habitat mitigators. The actual effectiveness of these projects is unknown, and requires a more detailed review before public monies are expended upon land acquisition or construction. It is estimated that the studies required will cost **$500,000.** Much of this analysis can be cost shared with the USACE or NRCS.

- ***Channel Stabilization Study (Preliminary)***

  The NRCS can assist, if requested, by investigating and recommending remedial works necessary to stabilize and restore channels which have been de-stabilized by recent flooding. There is no cost for this preliminary investigation, however, supplemental studies will require funding. The cost of these studies is unknown at this time.

Financing:

The March, 2000 election saw the passage of two bond measures which can provide funding for projects delineated in this report. **Table 10**, "*Project Financing - Proposition 12*", and **Table 11**, "*Project Financing - Proposition 13*", outline the potential for financing for projects detailed in Chapter V of this report.

Proposition 12, *Safe Neighborhood Parks, Clean Water, Clean Air, and Coastal Protection Bond Act of 2000*

Several sections of this bond measure provide monies which could be used for habitat mitigation. These are;

- **Article 2, §5096.310 (L)(2)**; which provides monies for the development of soccer fields to non profit organizations for disadvantaged youths.

- **Article 2, §5096.310 (s)**; which provides funding for the California Conservation Corps to act as a labor force on conservation projects.

- **Article 2, §5096.310 (u)**; which provides funding for tree planting and maintenance for up to 3 years.

- **Article 5, §5096.350(a)(3)**; which provides funding for the restoration and acquisition of habitat.

- **Article 5, §5096.350(a)(5)**; which provides matching funds for the restoration and acquisition of habitat.

Proposition 13, *Safe Drinking Water, Clean Water, Watershed protection, and Flood Protection Act.*

- **Chapter 5, Article 2 §79033 (b)**; provides monies for flood studies. Monies specified in §79033.2 (b) may be ideally suited for the Hydrologic and Hydraulic study needs described in this CRMP report.

- **Chapter 5, Article 2.5 §79036**; provides monies for flood protection corridors. Programs specified under §79037 (b) can meet many of the proposed projects needs for land acquisition and floodway establishment. A flood study will be required to determine the width of these corridors.

- **Chapter 5, Article 4, §79056**; provides flood control subventions monies.

- **Chapter 6, Article 2, §79080(c)**; provides funding for monies specific to this CRMP'S needs for;

  (1) Reduction of chronic flooding problems or to control water velocity and volume using vegetation management or other non-structural methods.

  (2) Protect and enhance green belts and riparian and wetlands habitat.

  (3) Restore or improve habitat for aquatic or terrestrial species.

  (4) Use geographic information systems to display and manage the environmental data describing the watershed.

  (5) Prevent watershed soil erosion and sedimentation of surface waters.

  (6) Support beneficial groundwater recharge capacities.

- **Chapter 6, Article 2, §79080 (d)**; provides grants for the development of watershed management plans, up to $200,000 per plan. The Kern Lake Bed is comprised of 14 watersheds (Caliente is inclusive of Caliente, Walker Basin, and Tehachapi Creeks). Each of the watersheds could qualify individually. These watershed management plans could meet the CRMP's Hydrology, sediment, and channel stabilization study needs.

- **Chapter 8, Article 4, §79161(a)**; provides monies for ground water recharge facilities, $5,000,000 (max) per project. Several of the projects in this report meet the established criteria.

Table 10

Proposition 12

Project No.	Project Name:	Article 2			Article 5	
		5096.310 (l)(2)	5096.310 (s)	5096.310 (u)	5096.350 (a)(3)	5096.350 (a)(5)
1	Caliente Creek Flood Warning System	●				
2	Caliente Creek Habitat Mitigation Project		●	●	●	●
3	Caliente Creek Ground Water Recharge Project					
4	Lamont Drainfield Improvements					
5	Lamont Channel (Easterly Extension)					
6	Lamont Channel					
7	Panama Road Flood Flow Conveyance Enhancements					
8	North Lamont Channel					
9	Weedpatch Channel					
10	Vineland Road Dam/Recharge Basin					
11	Tejon/El Paso Creek Groundwater Recharge Basin					
12	Tejon Creek Dam and Reservoir					
13	Pastoria Creek Ground Water Recharge Basin					
14	Grapevine Ground Water Recharge Basin					
15	Pleito Creek Ground Water Recharge Basin					
16	San Emigdio Creek Groundwater Recharge Basin					
17	Sycamore Creek Watershed Restoration Project		●	●	●	●
18	Little Sycamore Creek Watershed Restoration Project		●	●	●	●
19	Comanche Creek Watershed Restoration Project		●	●	●	●
20	Tejon Creek Watershed Restoration Project		●	●	●	●
21	El Paso Creek Watershed Restoration Project		●	●	●	●
22	Tunis Creek Watershed Restoration Project		●	●	●	●
23	Pastoria Creek Watershed Restoration Project		●	●	●	●
24	Grapevine Creek Watershed Restoration Project		●	●	●	●
25	Tecuya Creek Watershed Restoration Project		●	●	●	●
26	Salt Creek Watershed Restoration Project		●	●	●	●
27	Pleito Creek Watershed Restoration Project		●	●	●	●
28	Pleitito Creek Watershed Restoration Project		●	●	●	●
29	San Emigdio Creek Watershed Restoration Project		●	●	●	●
30	Rancho Drive Floodway					
31	David Road Floodway					
32	Tejon Creek Floodway					
33	Herring Road Floodway					
34	Adobe Road Floodway					
35	Millux Road Floodway					
36	Rock Pile Road Floodway					
37	Towerline Road Floodway					
38	Millux Lake Detention Basin					
39	Herring Lake Detention Basin					
40	Lamont Channel (Southerly Extension)					
41	Eastside Canal Enlargement					
42	Rim Ditch Conveyance Enhancement					
43	LeGray Road to Tecuya Creek Bypass					
44	Tecuya Creek Ground Water Recharge Basin					

Table 11

Project No.	Project Name:	Proposition 13 Chapter 5 Article 1 79033 (b)	Article 2.5 79036	Article 4 79056	Article 2 79080 (C)	Chapter 6 Article 2 79080 (d)	Chapter 8 Article 4 79161 (a)
1	Caliente Creek Flood Warning System						
2	Caliente Creek Habitat Mitigation Project		●		●	●	●
3	Caliente Creek Ground Water Recharge Project				●		●
4	Lamont Drainfield Improvements						
5	Lamont Channel (Easterly Extension)		●				
6	Lamont Channel		●				
7	Panama Road Flood Flow Conveyance Enhancements						
8	North Lamont Channel		●				
9	Weedpatch Channel		●				
10	Vineland Road Dam/Recharge Basin		●		●		●
11	Tejon/El Paso Creek Groundwater Recharge Basin				●		●
12	Tejon Creek Dam and Reservoir		●		●		●
13	Pastoria Creek Ground Water Recharge Basin				●		●
14	Grapevine Ground Water Recharge Basin				●		●
15	Pleito Creek Ground Water Recharge Basin				●		●
16	San Emigdio Creek Groundwater Recharge Basin				●		●
17	Sycamore Creek Watershed Restoration Project				●	●	
18	Little Sycamore Creek Watershed Restoration Project				●	●	
19	Comanche Creek Watershed Restoration Project				●	●	
20	Tejon Creek Watershed Restoration Project				●	●	
21	El Paso Creek Watershed Restoration Project				●	●	
22	Tunis Creek Watershed Restoration Project				●	●	
23	Pastoria Creek Watershed Restoration Project				●	●	
24	Grapevine Creek Watershed Restoration Project				●	●	
25	Tecuya Creek Watershed Restoration Project				●	●	
26	Salt Creek Watershed Restoration Project				●	●	
27	Pleito Creek Watershed Restoration Project				●	●	
28	Pleitito Creek Watershed Restoration Project				●	●	
29	San Emigdio Creek Watershed Restoration Project				●	●	
30	Rancho Drive Floodway		●				
31	David Road Floodway		●				
32	Tejon Creek Floodway		●				
33	Herring Road Floodway		●				
34	Adobe Road Floodway		●				
35	Millux Road Floodway		●				
36	Rock Pile Road Floodway		●				
37	Towerline Road Floodway		●				
38	Millux Lake Detention Basin		●				
39	Herring Lake Detention Basin		●				
40	Lamont Channel (Southerly Extension)		●				
41	Eastside Canal Enlargement		●				
42	Rim Ditch Conveyance Enhancement		●				
43	LeGray Road to Tecuya Creek Bypass						
44	Tecuya Creek Ground Water Recharge Basin				●		●

Flood Control District

Current Responsibilities:

- The Kern County Water Agency (KCWA) as part of its establishing charter was given the authority to develop local water supplies and Flood Control.

  In its early years the KCWA actively pursued these responsibilities including administering aspects of the National Flood Insurance Program (NFIP).

  Following the passage of 1978's Proposition 13, the KCWA no longer had the public financing to continue aggressive pursuit of Flood Control. In 1985 the KCWA formally passed these responsibilities (save large projects and the Kelso Creek Levees) to Kern County via a joint Powers Agreement. In September, 1999, the KCWA notified the County of its intention to terminate this agreement.

- The Natural Resource Conservation Service (NRCS), (formally Soil Conservation Service, SCS) has established several resource conservation districts throughout the County. All are supported by local tax revenues, most are grossly under funded. These RCD's typically have specific maintenance or oversight responsibilities.

- The Lamont Storm Water District (LSWD) was formed as a local cost sharing entity for a proposed flood control project which was being formulated by the USACE. The LSWD has at times acted independently of the direction put forth by the County.

- The County of Kern has responsibility for the NFIP and flood control, though the KCWA can be called upon to act as lead agency for large projects.

  The County's budget restraints have slowly reduced the County's Floodplain Management staffing from 7 full time employees (FTE) to 2 FTE's (1 full time and 3 part time) from 1988 to present, making long range planning and project preparation difficult to perform in a timely manner.

Flood Control District Necessity:

Today, the Board of Supervisors receive numerous requests for assistance from residents, farmers, business, etc, in overcoming drainage and flood related problems. Each of these problems are given to a limited staff to prepare mitigation options. Occasionally these "problems" are sent to the KCWA for project formulation. Most projects receive conceptual design, some receive detailed study and impact review, fewer receive detailed design and Environmental review, seldom is there construction funding, and maintenance is given little forethought in the hope that monies will become available.

The existing flood control system in Kern County can best be described as dysfunctional. There is no agency solely responsible for aggressively looking for, planning for, designing, constructing and maintaining flood control facilities. Those agencies which undertake flood control projects do so reluctantly, with a narrow focus and a minimal effort due to a lack of support both internally and externally.

A Flood Control District would be directly responsible for;

- Conceptual Project Development
- Detailed feasibility analysis and Impact Review
- Detailed Design and Environmental Review

- Construction Financing
- Facility Maintenance

Responsibility and accountability are centrally located. A Flood Control District would maintain:

(1) **Focus**; One central authority with a sole purpose of Flood Control/Floodplain Management

(2) **Responsibility**; Properly designed, a Flood Control District will provide better, more efficient services to the community. Each project is directly funded by those receiving benefit.

(3) **Integral Planning**; "Piece Meal" project development is a costly means of Flood Control. Master planning, with constituent mitigation allows for "Piece Wise" development that integrates into an overall flood mitigation strategy.

(4) **Liability**: Flood Control facilities are amongst the most often litigated public infrastructure. When the County constructs a Flood Control Facility it is liable for damages resulting from its function, or perceived function. Regardless of the actual impact the facility may have had, litigation must be absorbed by the County's General Fund. A Flood Control District is a less likely target for litigation. While the County's General Fund is perceived to be a "Deep Pocket", a Flood Control District has limited resources and is thus has "shallow pockets", at best. The important point here is the fact that the County's General Fund is no longer at risk, should litigation arise.

(5) **Borrowing Authority**: A Flood Control District has the ability to borrow money from sources such as the "Infrastructure Bank" without endangering the County's borrowing ability or credit rating. Such indebtedness requires voter approval.

Formulation:

There are many models to choose from based upon various flood control districts throughout the state. The County is not limited to these choices and may choose or formulate a flood control district based upon the needs of its diverse population. One such concept is discussed below:

Conceptual Kern County Flood Control District Formulation:

Kern County covers ~ 8,500 square miles. Flood issues, and their impact mitigation can be as large as 100's of square miles (Caliente Creek) to as small as a few acres. The objective of this concept is to provide as efficient of a means to administer from a County wide prospective down to the smallest discrete element while maintaining an integral plan.

This can be accomplished by establishing a tiered structure of responsibility and accountability. These levels are discussed below:

Level (1) Initially the County Board of Supervisors would act as the Flood Control District Board of Directors.

This Board of Directors would ratify the Flood Control District's budget and oversee it's operations.

In the future, the Board of Supervisors may wish to allow a separate election of The Flood Control District Board of Directors, due to workload.

Level (2) Below the Board of Directors, an administrative team would be responsible for project financing, basin conceptual plan formulation, and administration of the County's responsibilities under the NFIP. This administrative team would be comprised of

- Engineer Manager (Civil Engineer IV or V)
- Grant Writer

In addition, the Flood Control District would initially (until the workload warranted full time employees) pay various Departments for the use of existing staff such as engineers, surveyors, accountants, draftsmen, secretaries, planners, etc.

Funding for Level (1) and Level (2) would be based upon either joint powers agreements with the County and the KCWA, or by a permanent property tax shift from these sources to the Flood Control District, (requiring no additional taxes). A minimum annual budget of ~ $300,000 is expected. The cost for some functions, such as the NFIP, can be covered via development fees (currently in place).

Level (3) Basin Advisory Committees would be established in each of the Nine Lake Basins in Kern County;

Tulare Lake
Kern Lake
Lake Isabella
Koehn Lake
Rogers Lake
Buena Vista Lake
Castac (Tejon) Lake
China Lake
Rosamond Lake

These Basin Advisory Committees (BAC) would be initially formulated upon the CRMP model. Once a conceptual plan for a basin has been developed, funding will be sought for a detailed feasibility and impact analysis from taxpayers (requiring a vote) within the basin and from outside funding sources.

Upon adoption of a funding source the BAC will be superseded by a Basin Oversight Committee. This committee will be made up of individuals recommended by the BAC, FCD Engineer Manager, and the Board Member(s) within whose district(s) the basin has coverage. The Basin Oversight Committee will have the responsibility of advise and consent of the Engineer Managers budget for expenditures within the basin, which would then be sent to the FCD Board of Directors for ratification. This maintains local control over local issues.

Level (4) The detailed feasibility analysis will identify and prioritize projects for funding. The impact review will establish property benefits for cost sharing purposes. If project maintenance funding is approved by the project benefactors then detailed design, funding and environmental review will be processed.

A "Project Advisory Committee", made up of the impacted participants will be formed to track and advise the "Basin Oversight Committee" of problems or changes required of the project. This committee will remain in force for as long as the project exists and will advise of maintenance inadequacies as they occur. This will help to maintain a local connection between the community and their investment.

Additional Responsibilities:

Within the above concept's framework lies the ability of The Flood Control District to assume, or contract with local agencies, responsibilities such as;

Floodplain Management (NFIP)
Flood Control Design
Flood Control Maintenance
Flood Control Planning (CEQA)
Drainage Design
Drainage Maintenance
Clean Water Act Compliance (NPDES)

In addition the RCD's, KCWA Improvement Districts and storm water districts could easily be incorporated into the FCD, thus eliminating fragmentation of service.

CHAPTER VII: CONCLUSIONS

The Kern Lake CRMP has developed a conceptual approach to mitigating the flooding problems impacting the communities of Lamont and Arvin. The "Concept" requires an integrated approach which mitigates sediment, peak flow rate, flow volume, and habitat for all watersheds contributing to the Kern Lake Bed.

This report has documented the progress to date of the CRMP and includes a layout of conceptual projects which require additional technical study. The conceptual plan includes 44 projects which mitigate flows from 14 watersheds. The feasibility of these projects has not been evaluated

Studies neccessary for feasibilty and environmental analysis have been outlined in Chapter VI. Further, relevant work by the CRMP will be hindered pending the start of these studies.

The CRMP still must identify resources which can be used to implement the plan. This will be performed after the plan's feasibility has been determined.

An action plan which outlines and prioritizes the implementation of projects and resources will follow the identification of resources.

Once an action plan has been established, a final plan will be submitted for approval.

A government entity with taxing powers (or a fixed source of revenue), maintenance ability, full responsibility and liability, and authority to implement this plan must be assigned. This entity could be the KCWA or the County. The liabilities associated with any of the conceptual projects could undermine the ability of these government agencies to provide their existing primary duties. A Flood Control District is ideal for these responsibilities.

CHAPTER VIII: RECOMMENDATIONS

With the passage of Proposition 13 (March 2000) there exists an opportunity for the development and construction of flood control facilities within the Kern Lake Bed area that is unparalleled in recent history.

Many of the conceptual projects, discussed in the report, are specifically designed to maximize the availability for financing through Prop.'s 12 and 13. Kern County must take advantage of this opportunity.

It is recommended that the following tasks be undertaken by the County;

- Fast track the studies outlined in Chapter VI. Much of the cost for these studies can be offset by Prop. 13, the USACE, the NRCS, or other sources.

- Work with our elected State Assemblymen and Senators to ensure that the Proposition 12 and 13 grant qualification process is "friendly" to Kern County Projects.

- Create a "Kern County Flood Control District." This will bring focus, responsibility, and central authority to flood control planning, design, construction, and maintenance. Without the establishment of the KCFCD, the County will be attempting to take upon itself responsibilities which historically (as a result of economic, liability, political, and social changes) it has been incapable of performing. Without the creation of a Flood Control District, future flood control projects will be difficult to implement, and nearly impossible to maintain.

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