**Pacific Advanced Civil Engineering, Inc., "Santa Clara River and Tributaries Drainage Analysis: Newhall Ranch Resource Management & Development Plan, Major Tributary Watersheds" (December 2008; 2008B)**

## Santa Clara River and Tributaries Drainage Analysis

# Newhall Ranch Resource Management & Development Plan Major Tributary Watersheds

**December 2008**

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# 1 Introduction

## 1.1 General Background

The following technical investigation provides a detailed and focused evaluation of the existing hydrologic and hydraulic characteristics of the Chiquito Canyon, San Martinez Grande Canyon, Potrero Canyon, Long Canyon, and Lion Canyon watersheds and floodplains within the Newhall Ranch development area (Figures 1.1-1.5 and Figures 1.6-1.10). Each watershed is described below. The existing floodplains of each tributary generally consist of natural alluvial creek systems that extend upstream from the canyon mouths at the Santa Clara River to the Newhall Ranch boundary. Adjacent development along the canyons within the Newhall Ranch will potentially modify the hydrologic response of the watersheds through changes in the runoff and reduction in the sediment supply from the developed areas. Several alternative flood protection systems have been formulated as part of the adjacent development along the creek system that involve different hydraulic elements which include: (1) bank protection or buried revetment, (2) excavation or grading of a modified channel system, (3) channelization, (4) invert grade control or grade stabilization of the streambed, (5) bridge crossings or culvert modifications, and (6) modification of the streambed profile and floodplain geometry. The proposed flood control systems are intended to provide long-term erosion protection from lateral migration of the stream bank and flood protection for the adjacent proposed development areas. These modifications to the stream system may result in adjustment to the hydraulic operation of the floodplain and changes to the stream mechanics. The intent of this analysis is to characterize the existing environment as a basis for the evaluation of impacts resulting from the (1) hydrologic modifications of the watershed from single hypothetical storm events, and (2) changes in the floodplain hydraulic operation.

## 1.2 Study Objectives

The primary objective of this report is to develop the technical engineering analysis to assess and quantify the existing floodplain hydraulics within the proposed Newhall Ranch development area. The intent is to provide a comprehensive characterization of the existing tributary channel systems. This report provides preliminary technical analysis for (1) watershed mapping and characterization, (2) regional hydrologic modeling, (3) floodplain hydraulics and mapping, (4) characterization of representative hydraulic parameters, (5) two dimensional mapping of the horizontal velocity distribution within the floodplain, and (7) assessment of existing stream stability through sediment transport capacities. The objectives of the floodplain and watershed assessment for the proposed development project include the following:

1. Quantify the hydrologic parameters that are representative of the watershed characteristics.
2. Determine the runoff from the watershed for the existing land use conditions associated with different storm return periods.
3. Development of hydraulic models of the existing floodplain.
4. Assessment of the streambed stability through determination of the sediment transport capacities within different reaches of the floodplain.
5. Quantitative floodplain mapping to assess floodplain area and horizontal distribution of velocity within the floodplain.

A variety of engineering analysis and tasks were associated with both the different aspects of the watershed hydrology and floodplain hydraulics. A technical framework was developed to guide the analysis of the system. These major task areas of study reflected the various objectives of the study and included the following:

1. <u>Watershed delineation and parameter estimation</u> – Determine regional watershed limits and interior sub-basin delineations based on surface drainage patterns. Utilize watershed mapping data to determine characteristic hydrologic parameters representative of loss rates, area, geometry, and runoff timing functions.

2. Watershed hydrology modeling – Application of synthetic runoff procedures to determine effective runoff from the watershed for the "existing" condition. Develop synthetic rainfall-runoff models to evaluate the watershed response

3. Floodplain field investigations – Perform field reconnaissance of the existing watershed conditions as well as ground photo survey along the entire existing creek system within the Newhall Ranch boundary.

4. Baseline digital floodplain cross section geometry – Layout appropriate spacing and location of cross sections to establish the representative channel geometry. Digitally develop extremely accurate cross section coordinate points using topographic digital terrain models (DTM) and CAD subroutines suitable for hydraulic model format. Adjust cross section data to include horizontal variation of roughness and other attributes.

5. Baseline HEC-RAS hydraulic model – Prepare floodplain model in HEC-RAS based on the digital geometry and existing condition flow rates. Evaluation is based on single storm event and steady flow conditions

6. Digital floodplain boundary BOSS-RMS – Detailed water surface profile analysis using BOSS-RMS to delineate the digital floodplain boundary.

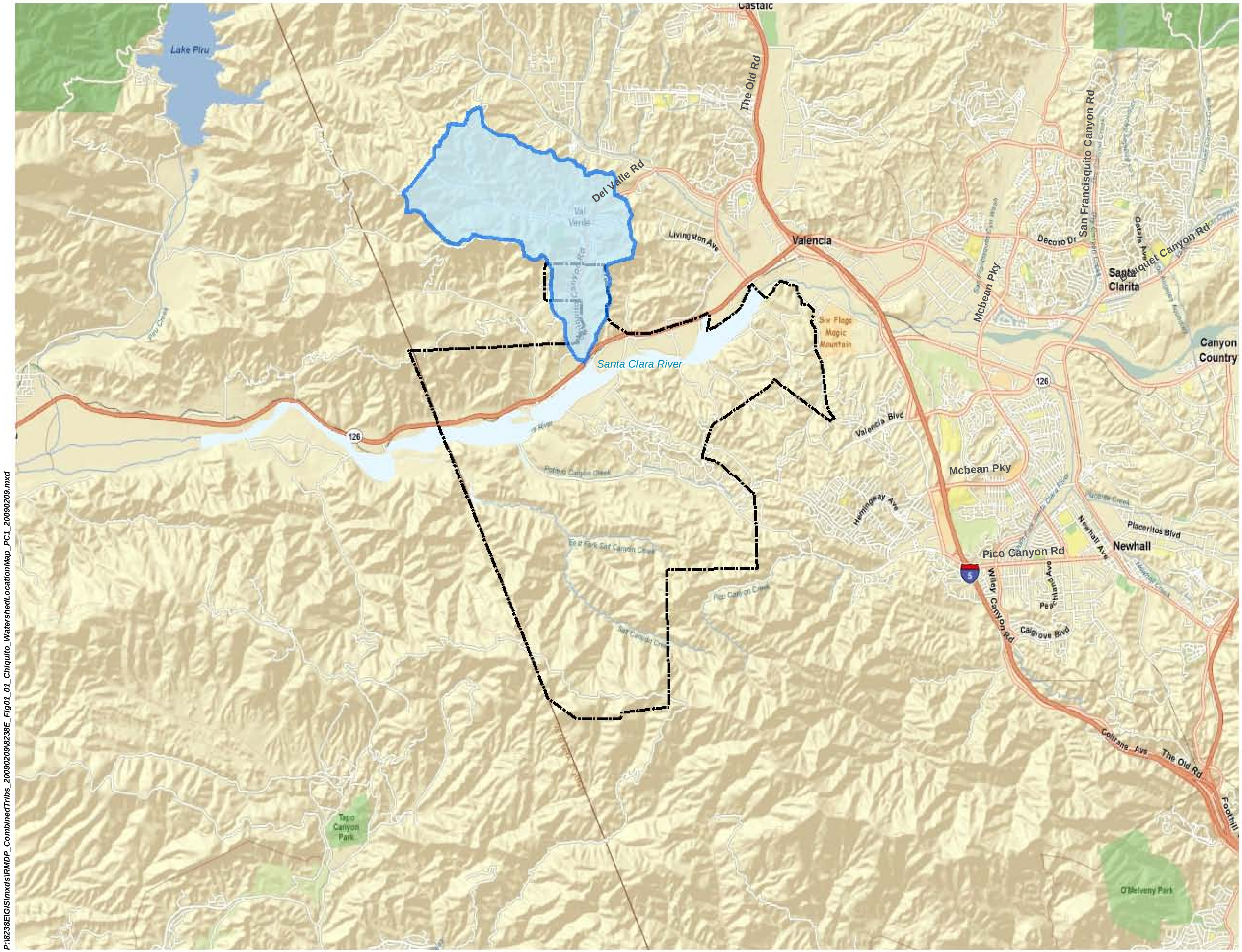
7. Velocity distribution modeling – Determine the horizontal velocity distribution for each cross section within HEC-RAS and determine the coordinate points for mapping purposes.

8. Velocity distribution mapping – Prepare the velocity distribution coordinates points in a format suitable for importing into CAD/GIS mapping software and utilize contour generating program to develop contours of equal velocity. Manually adjust computer mapping of velocity distribution to interpret unusual conditions and incorrect interpolations generated by the computer.

9. Floodplain reach characterization and parameter estimation – Prepare an assessment of the hydraulic parameters and evaluate the statistics. Develop the velocity distribution mapping for the existing condition which includes determining the coordinates for each cross section the velocity distribution, creating input format of data points into CAD/GIS, contour generation, and manipulation of the contours to address computer interpolations and incorrect assessments.

10. Sediment transport capacity analysis – Prepare steady state sediment transport capacity analysis through dividing the channel system into different reaches and comparing the capacity within each reach. The analysis involves determining the average hydraulic properties for each reach and then applying the appropriate sediment transport relationship to each grain size fraction.

11. GIS Mapping Floodplain Mapping and Parameter Statistics – Develop GIS mapping of all the floodplain mapping including the floodplain boundaries and velocity distribution so that the statistics can be accurately quantified as part of the impact assessment.




Newhall Ranch Company

L E G E N D

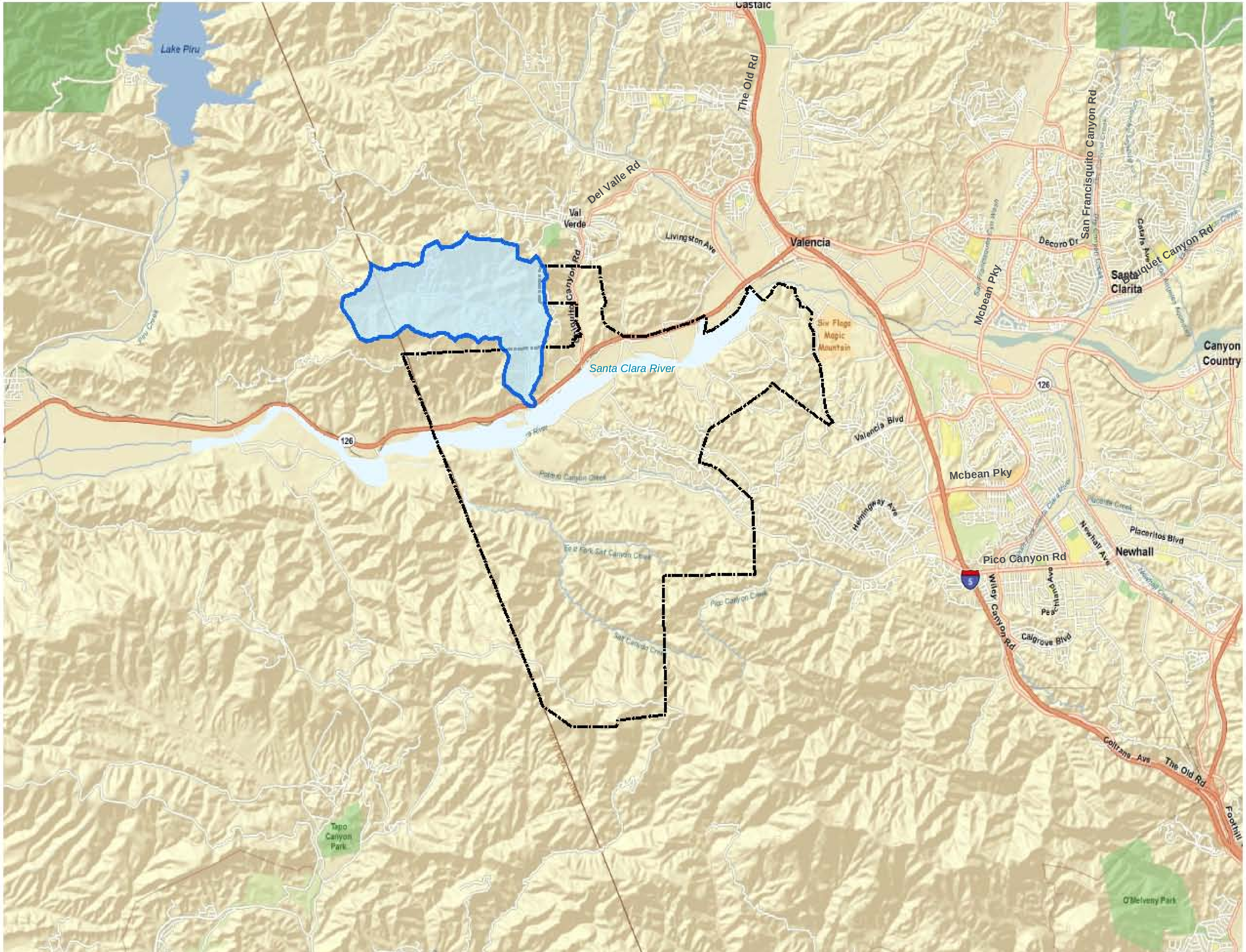
Newhall Ranch Specific Plan Boundary

Chiquito Canyon Watershed

| Feet | 0 | 1,750 | 3,500 | 7,000 |
|---|---|---|---|---|
| Meters | 0 | 525 | 1,050 | 2,100 |

Figure 1.1

**WATERSHED LOCATION MAP**
**CHIQUITO CANYON**




Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

San Martinez Grande Watershed

Feet
0 1,750 3,500 7,000

Meters
0 525 1,050 2,100

Figure 1.2

**WATERSHED LOCATION MAP**
**SAN MARTINEZ GRANDE**

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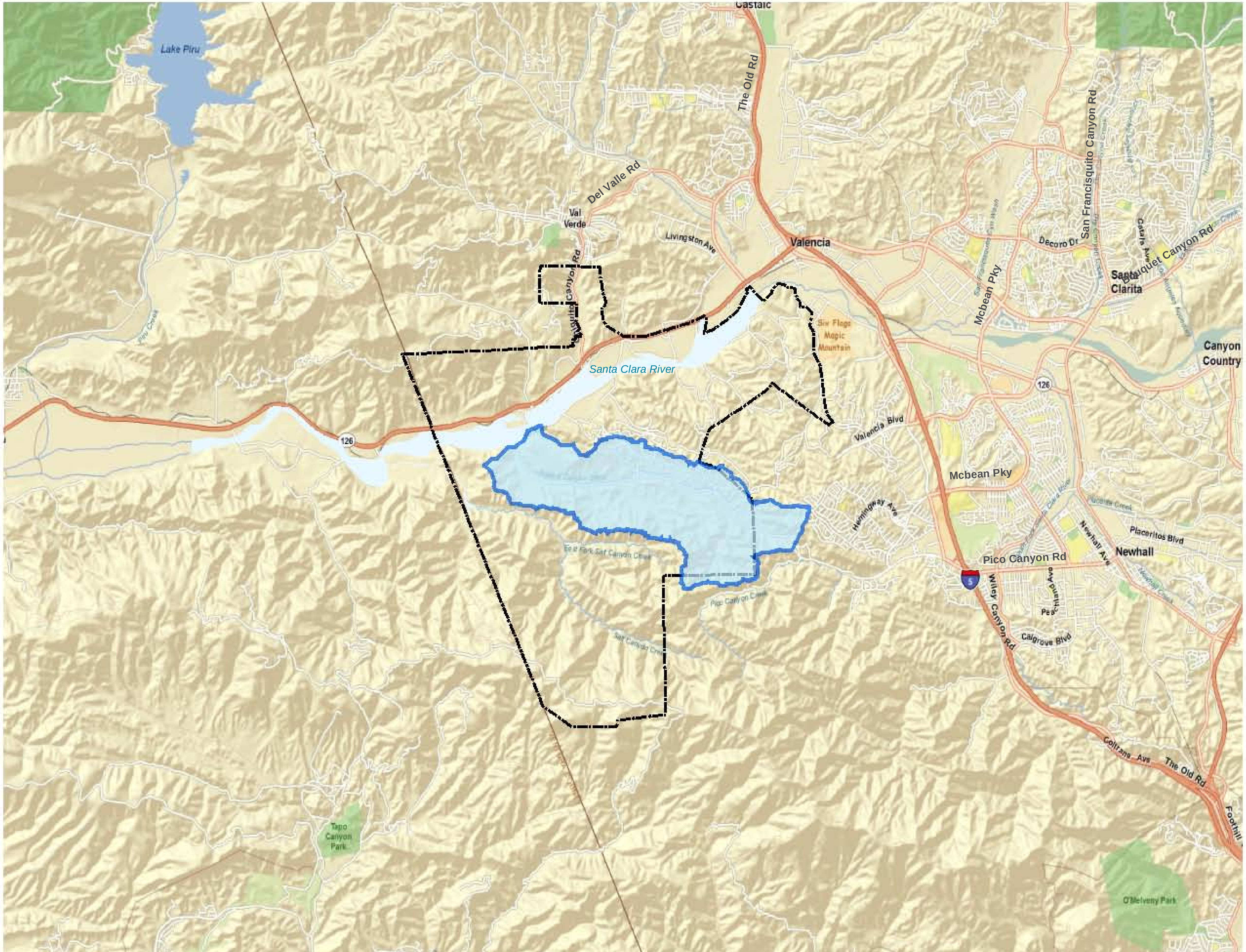


Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Potrero Canyon Watershed

Feet

0 1,750 3,500 7,000

Meters

0 525 1,050 2,100

Figure 1.3

**WATERSHED LOCATION MAP**
**POTRERO CANYON**

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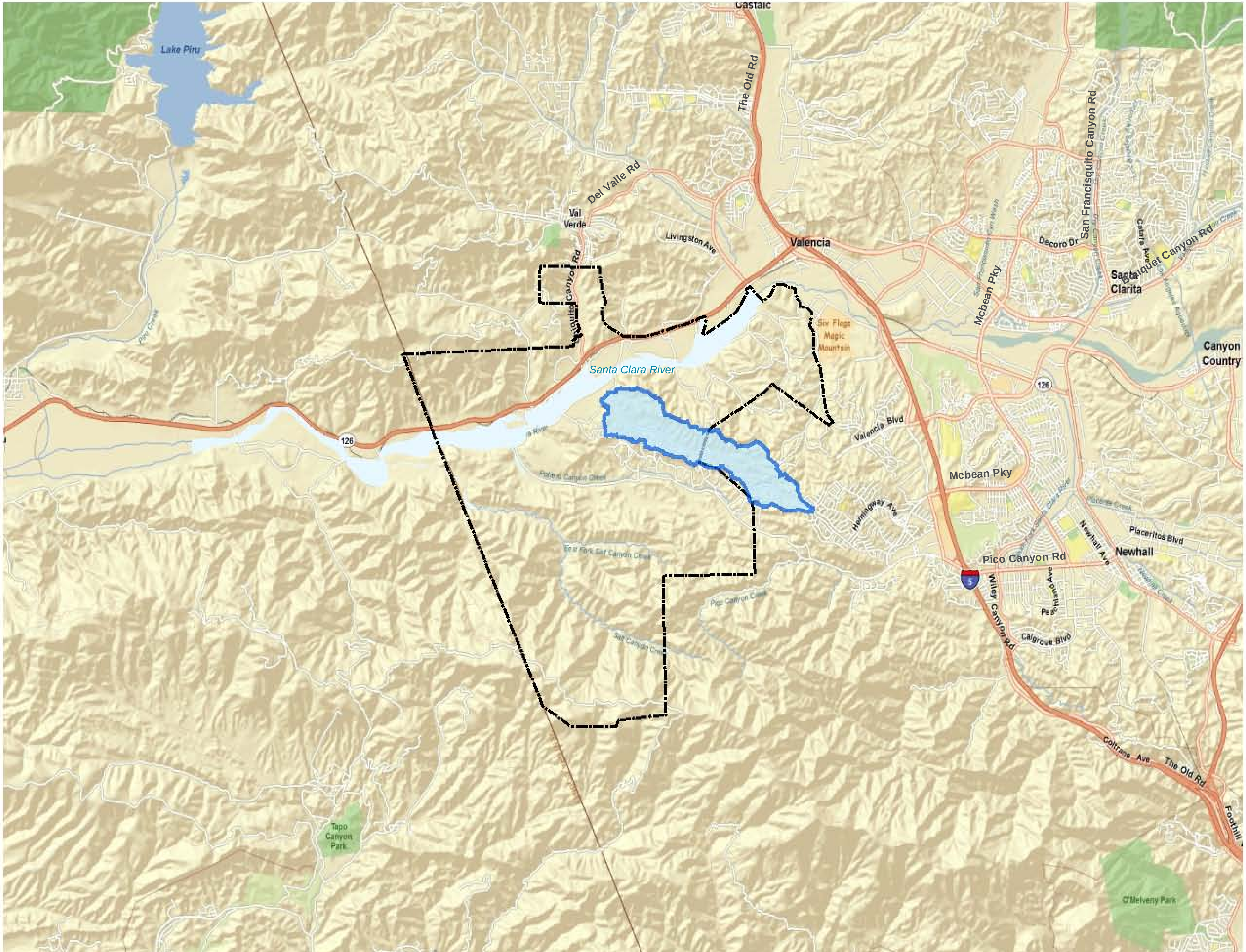


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Newhall Ranch Company

LEGEND

Newhall Ranch Specific Plan Boundary

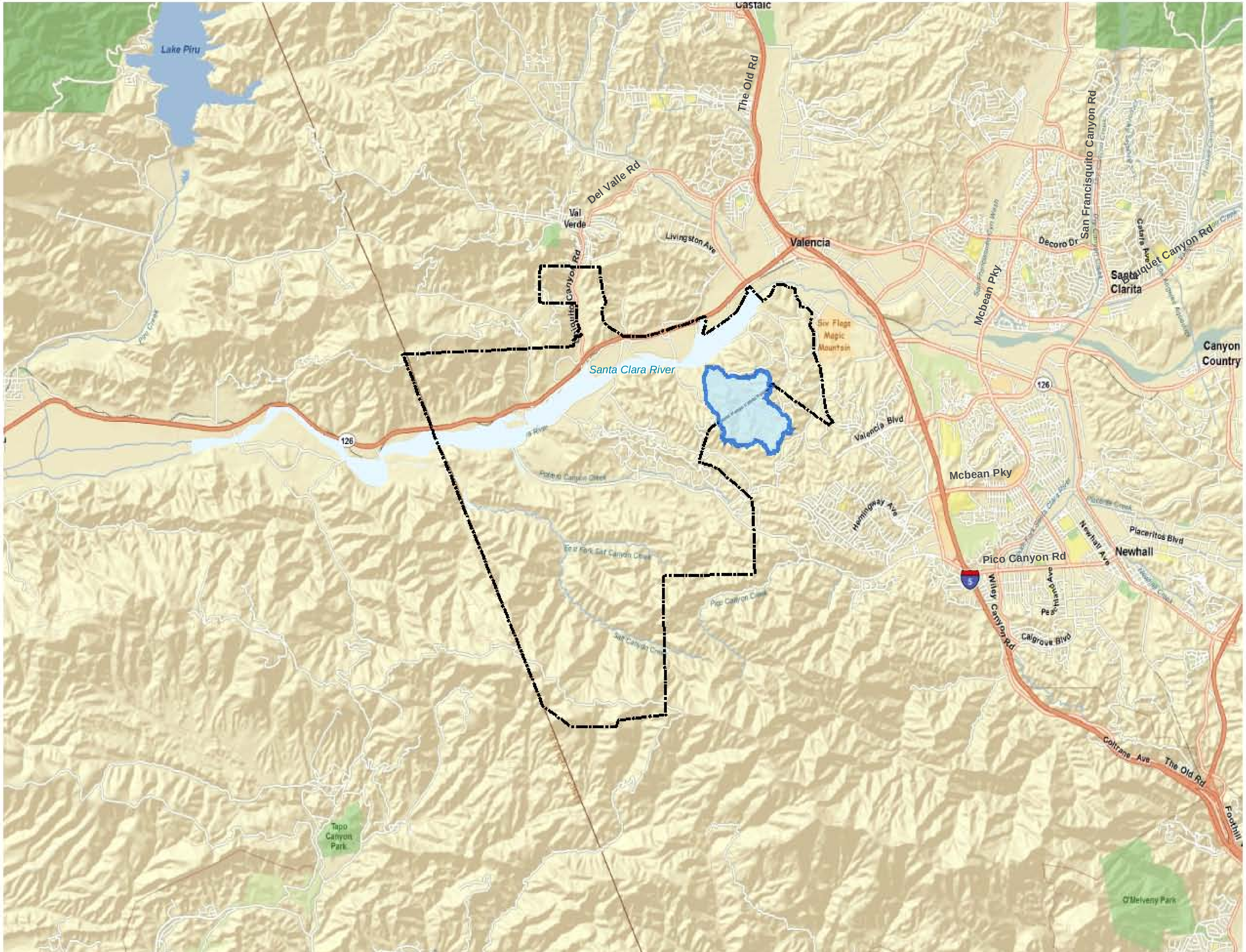
Long Canyon Watershed

Feet: 0, 1,750, 3,500, 7,000

Meters: 0, 525, 1,050, 2,100

Figure 1.4

**WATERSHED LOCATION MAP**
**LONG CANYON**




Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Lion Canyon Watershed

| Feet | 0 | 1,750 | 3,500 | 7,000 |
|---|---|---|---|---|
| Meters | 0 | 525 | 1,050 | 2,100 |

Figure 1.5

**WATERSHED LOCATION MAP**
**LION CANYON**

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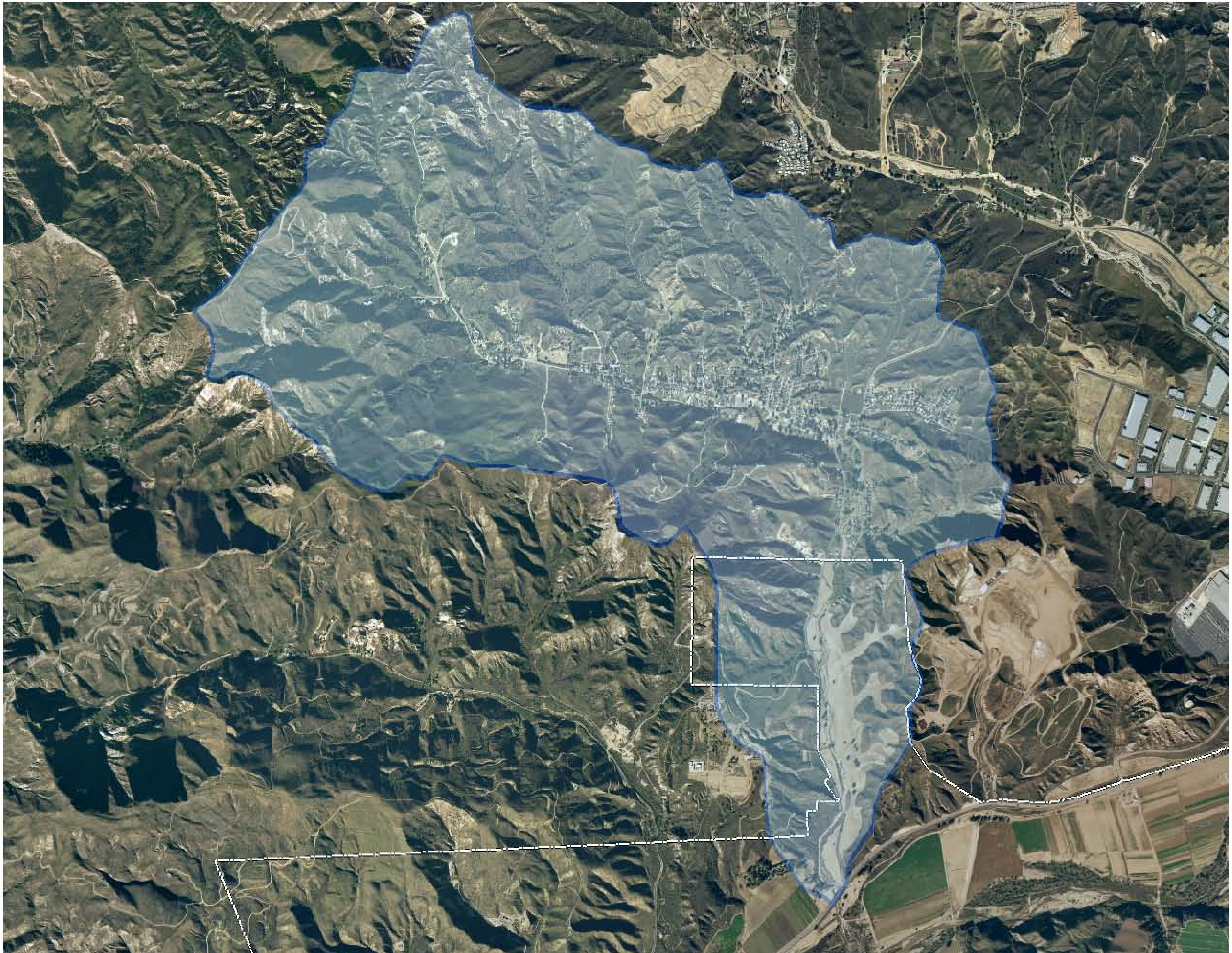

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Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

Watershed

Existing 100 Year Floodplain Boundary

Feet

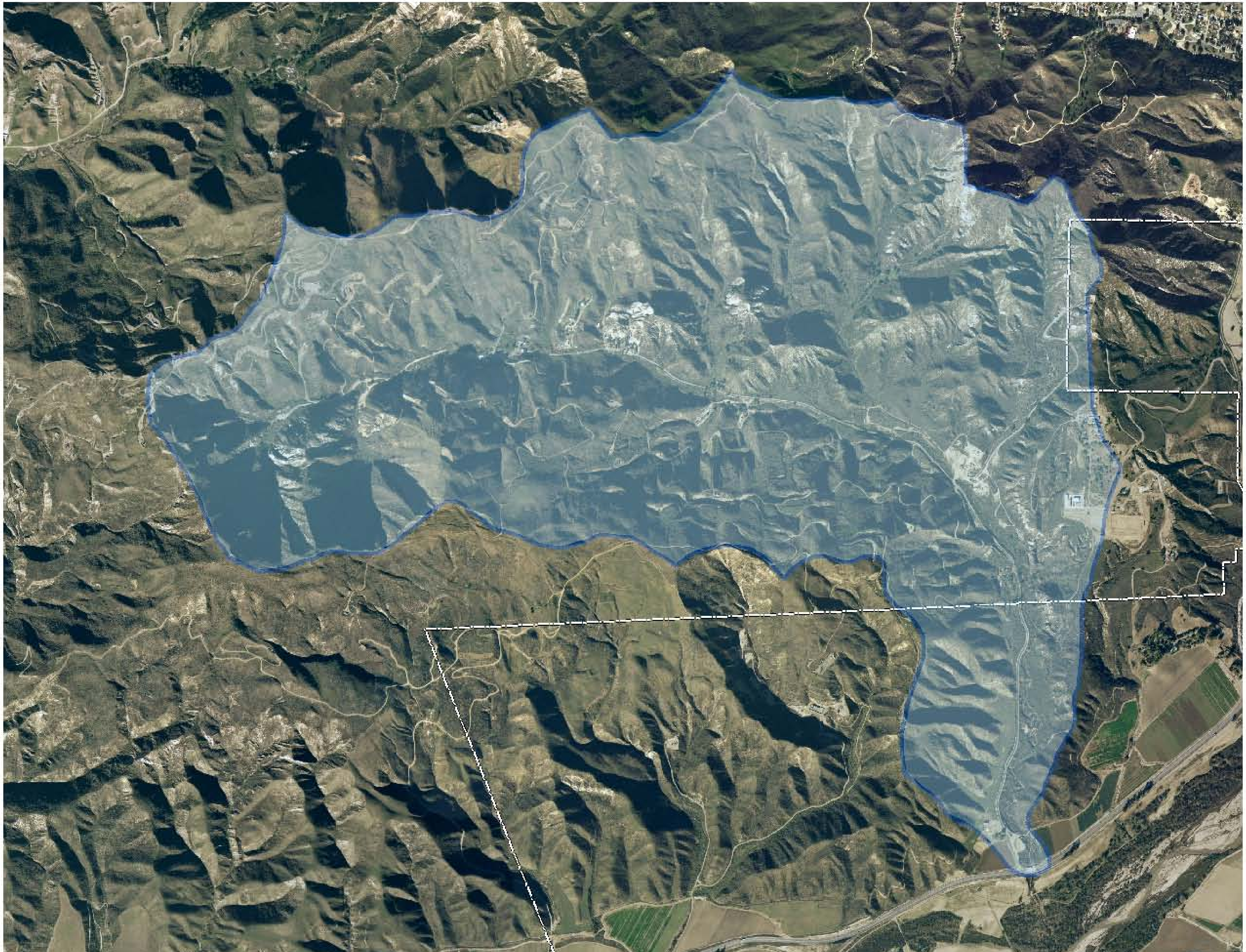
0 500 1,000 2,000

Meters

0 150 300 600

Figure 1.6

**WATERSHED BOUNDARY WITH EXISTING 100 YEAR FLOODPLAIN CHIQUITO CANYON**



Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Watershed

Existing 100 Year Floodplain Boundary

Feet

0 375 750 1,500

Meters

0 112.5 225 450

Figure 1.7

**WATERSHED BOUNDARY WITH EXISTING 100 YEAR FLOODPLAIN SAN MARTINEZ GRANDE**

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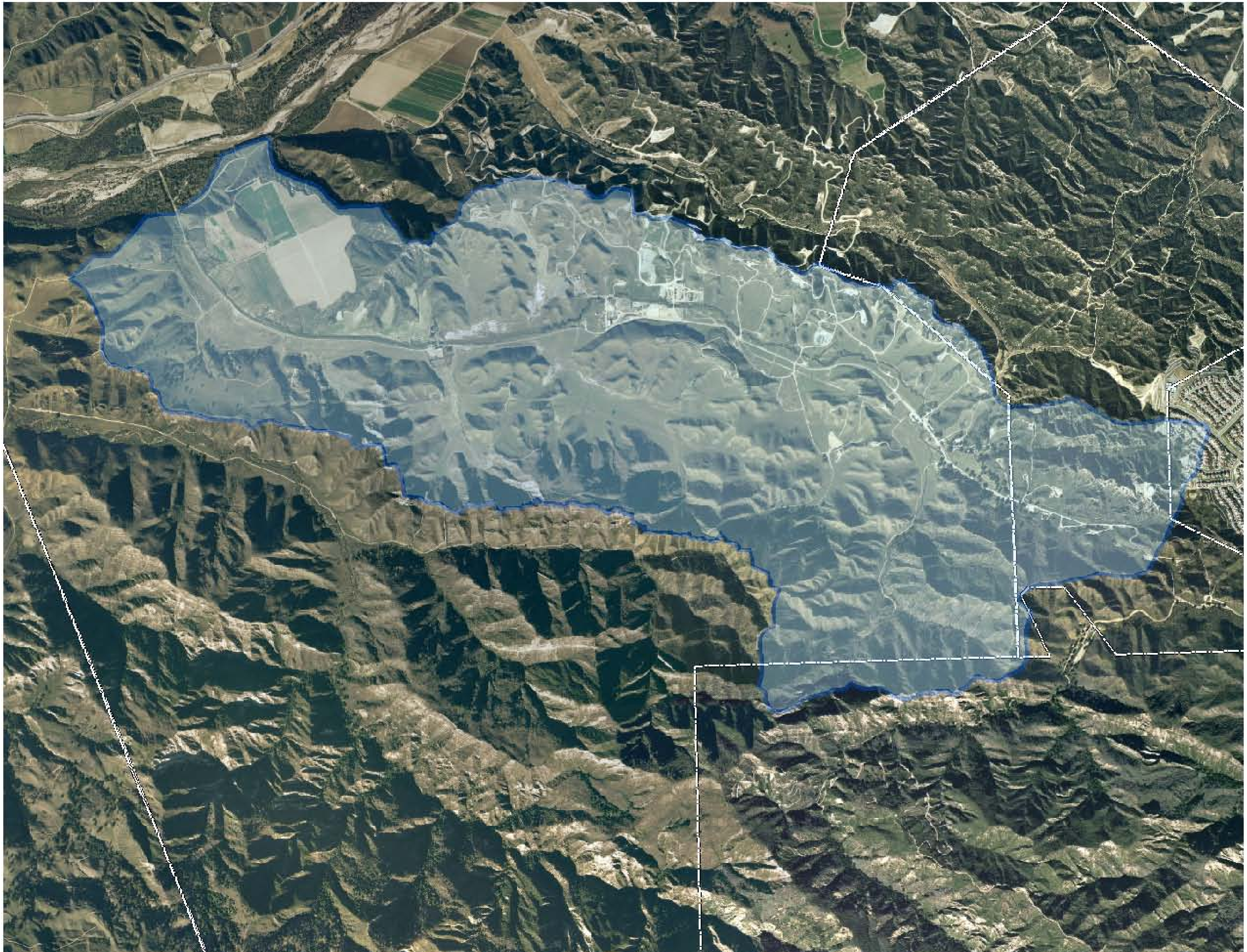

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Watershed

Existing 100 Year Floodplain Boundary



Figure 1.8

**WATERSHED BOUNDARY WITH EXISTING 100 YEAR FLOODPLAIN POTRERO CANYON**

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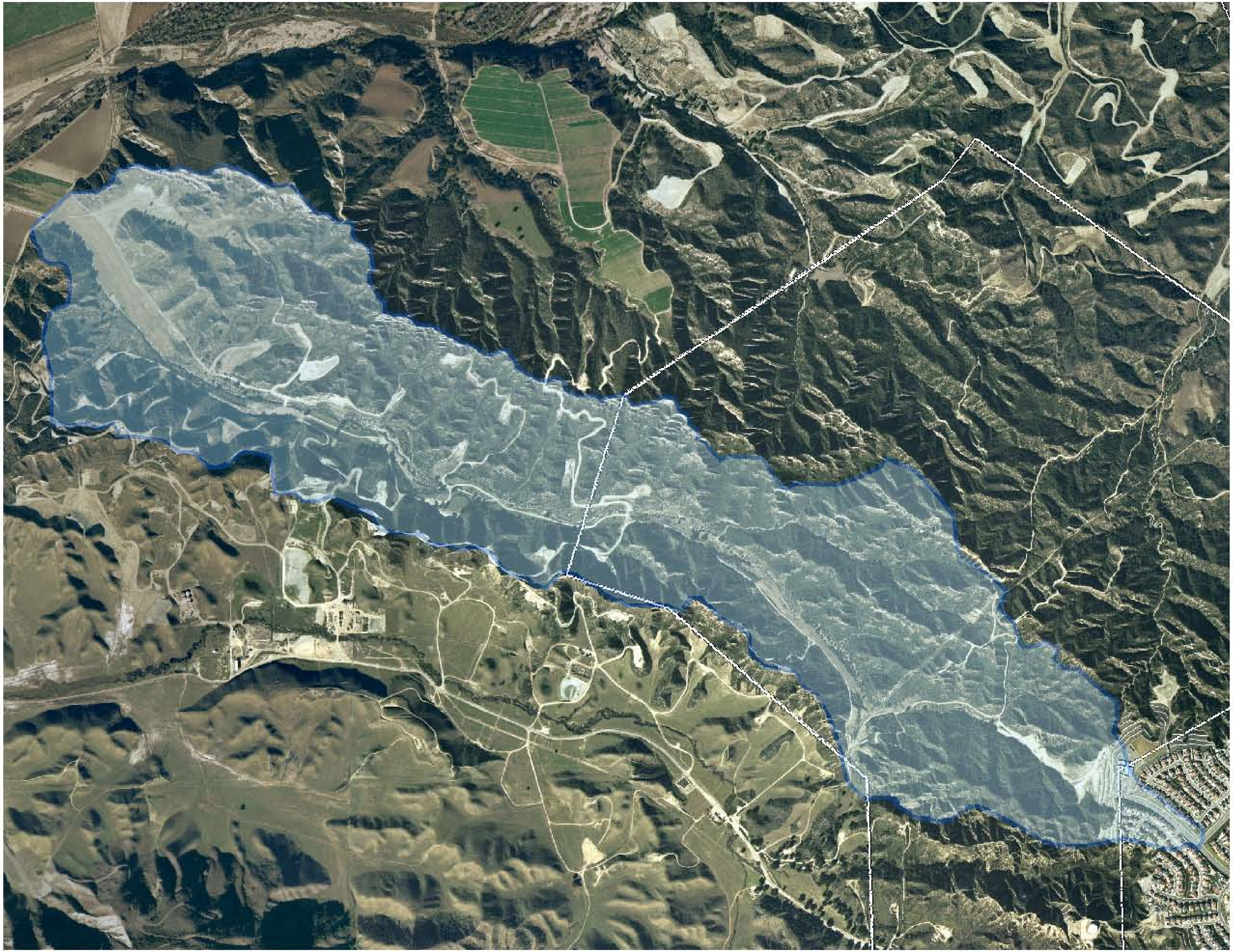

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Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

Watershed

Existing 100 Year Floodplain Boundary

0 312.5 625 1,250 Feet

0 95 190 380 Meters

Figure 1.9

**WATERSHED BOUNDARY WITH EXISTING 100 YEAR FLOODPLAIN LONG CANYON**

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Watershed

Existing 100 Year Floodplain Boundary

Feet: 0 187.5 375 750

Meters: 0 57.5 115 230

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Figure 1.10

**WATERSHED BOUNDARY WITH EXISTING 100 YEAR FLOODPLAIN LION CANYON**

# 2 Existing Watersheds and Floodplains

## 2.1 Existing Watershed Description and Characteristics

### *2.1.1 Chiquito Canyon*

The 4.8 square mile (3,053 acre) Chiquito Canyon watershed is a tributary to the northern bank of the Santa Clara River within the Newhall Ranch (Figure 2.1). Approximately 490 acres of Chiquito Canyon, or only 16% of the watershed area, is located within the Newhall Ranch property boundary, with the majority being upstream or offsite. The creek from the headwaters flows in a general west to east direction while the remaining lower portion of the creek flows in a north to south direction, similar in alignment to Grande Canyon and joining the Santa Clara River floodplain valley. The overall watershed boundary develops a shape such that a larger portion of the drainage area is tributary in the upstream portion watershed, with a maximum width of 8,300 feet, and tapers down towards the mouth of the canyon, with an average width of 2,800 feet. The shape of the watershed is important since that influences when runoff reaches the outlet. Although the watershed is relatively long, the large width in the upper portion of the watershed will result in delivering more runoff in shorter amount of time, increasing the peak discharges observed at the outlet. The distance from the upper headwaters to the canyon mouth is approximately 28,318 feet with an average overall slope of 0.031. The major natural main stem drainage course within the watershed has an average slope in the lower reaches of the watershed through the Newhall Ranch property of approximately 0.025. The majority of the Chiquito Canyon watershed is characterized by both rugged and steeply developed foothills that have numerous smaller tributary canyons that dissect the watershed, connecting to the narrow alluvial valley associated with the main stem creek. Approximately 90% or more of the watershed consists of the rugged foothill topography with the remainder being the narrow valley floor. The topography for the watershed varies from a maximum elevation of 1800 in the headwaters to a low elevation of 925 near the mouth of the canyon at the Santa Clara River valley. Generally, the soils in the watershed are characterized as silty clay loams from both the Castaic and Saugus formations. Also, the soils within the Chiquito Canyon watershed can be predominately classified as being in hydrologic soil group C (higher runoff potential) with exception of areas adjacent to the main stem creek that are type A (lower runoff potential) and Type B in the lower reaches. The associated vegetative cover within the watershed varies, but primarily consists of native grasses, chaparral, scrub oak, and sage brush. Detailed hydrologic modeling has been performed to evaluate the baseline existing watershed conditions and the results of the peak discharges are discussed in the Section on *Hydrology*.

**Table 2.1 –** Chiquito: Existing Watershed Characteristics

| | |
|---|---|
| Total Drainage Area | 3,053 acres (4.8 square miles) |
| Length of Watershed | 28,318 feet |
| Maximum Elevation Difference | 875 |
| Average Slope | 0.031 |
| Physical Topography Description | Rugged Foothill |
| Primary Hydrologic Soil Group | C |

### *2.1.2 San Martinez Grande Canyon*

The 3.3 square mile (2,111 acre) San Martinez Grande Canyon watershed is a tributary to the northern bank of the Santa Clara River within the Newhall Ranch (Figure 2.2). Approximately 200 acres of San Martinez Grande Canyon or only 10% of the watershed area is located within the Newhall Ranch property boundary, with the majority being upstream or offsite. The creek from the headwaters flows in a general west to east direction while the remaining lower portion of the creek flows in a north to south direction, similar in alignment to Chiquito Canyon and joining the Santa Clara River floodplain valley. The shape of the drainage creates a dogleg type appearance. The overall watershed boundary develops a shape such that a larger portion of the drainage area is tributary in the mid portion watershed since the width of the watershed narrows in either the upstream and downstream tails of the watershed while the central portion of the watershed widens to approximately 6,800 feet in width. The shape of the watershed is important since that influences when runoff reaches the outlet. Although the watershed is relatively long, the large width in the central portion of the watershed will result in delivering more runoff in shorter amount of time, increasing the peak discharges observed at the outlet. The distance from the upper headwaters to the canyon mouth is approximately 20,000 feet with an average overall slope of 0.059. The major natural main stem drainage course within the watershed has an average slope in the lower reaches of the watershed through the Newhall Ranch property of approximately 0.022. The majority of the San Martinez Grande Canyon watershed is characterized by both rugged and steeply developed foothills that have numerous smaller tributary canyons that dissect the watershed, connecting to the narrow alluvial valley associated with the main stem creek. Approximately 90% or more of the watershed consists of the rugged foothill topography with the remainder being the narrow valley floor. The topography for the watershed varies from a maximum elevation of 2062 in the headwaters to a low elevation of 890 near the mouth of the canyon at the Santa Clara River valley. Generally, the soils in the watershed are characterized as silty clay loams from both the Castaic and Saugus formations. Also, the soils within the San Martinez Grande Canyon watershed can be predominately classified as being in hydrologic soil group C (higher runoff potential) with exception of areas adjacent to the main stem creek that are soil group A (lower runoff potential) and soil group B in the lower reaches. The associated vegetative cover within the watershed varies, but primarily consists of native grasses, chaparral, scrub oak, and sagebrush. There are no major flood control improvements or dams within the watershed, other than several road culvert/bridge crossings such as the SR 126, which would influence the watershed response to rainfall events. Detailed hydrologic modeling has been performed to evaluate the baseline existing watershed conditions and the results of the peak discharges are discussed in the Section on *Hydrology*.

**Table 2.2 -** San Martinez Grande: Existing Watershed Characteristics

| | |
|---|---|
| Total Drainage Area | 2,111 acres (3.3 square miles) |
| Length of Watershed | 20,000 feet |
| Maximum Elevation Difference | 1172 |
| Average Slope | 0.059 |
| Physical Topography Description | Rugged Foothill |
| Primary Hydrologic Soil Group | C |

### *2.1.3* *Potrero Canyon*

The 4.6 square mile (2,938 acre) Potrero Canyon watershed is a tributary to the southern bank of the Santa Clara River within the Newhall Ranch (Figure 2.3). The creek flows in a general west to east direction, similar in alignment to Long Canyon and joining the Santa Clara River floodplain valley. The overall watershed boundary has a fairly uniform width, with an upstream maximum width of approximately 8,600 and a minimum of 5,400 feet downstream. A significant portion of this wide region is in the south-western section near the upstream end of the creek. The shape of the watershed is important since that influences when runoff reaches the outlet. Although the watershed is relatively long, the greater width throughout the central portion of the watershed will result in a higher amount of runoff during a shorter period of time, increasing the peak discharges observed at the outlet. The distance from the upper headwaters to the canyon mouth is approximately 24,139 feet with an average overall slope of 0.033. The major natural main stem drainage course within the watershed has an average slope in the lower reaches of the watershed through the Newhall Ranch property of approximately 0.024. The majority of the Potrero Canyon watershed is characterized by both rugged and steeply developed foothills that have numerous smaller tributary canyons that dissect the watershed, connecting to the narrow alluvial valley associated with the main stem creek. Approximately 90% of the watershed consists of the rugged foothill topography with the remainder being the narrow valley floor. The topography for the watershed varies from a maximum elevation of 1675 in the headwaters to a low elevation of 870 near the mouth of the canyon at the Santa Clara River valley. Generally, the soils in the watershed are characterized as silty clay loams from both the Castiac and Saugus formations. Also, the soils within the Potrero Canyon watershed can be predominately classified as being in hydrologic soil group C (higher runoff potential) with exception of areas adjacent to the main stem creek that are type A (lower runoff potential) and Type B in the lower reaches. The associated vegetative cover within the watershed varies, but primarily consists of native grasses, chaparral, scrub oak, and sage brush. There are no major flood control improvements or dams within the watershed, other than several road culvert/bridge crossings that would influence the watershed response to rainfall events. Detailed hydrologic modeling has been performed to evaluate the baseline existing watershed conditions and the results of the peak discharges are discussed in the Section on *Hydrology*.

**Table 2.3** – Potrero: Existing Watershed Characteristics

| | |
|---|---|
| Total Drainage Area | 2,938 acres (4.6 square miles) |
| Length of Watershed | 24,139 |
| Maximum Elevation Difference | 805 |
| Average Slope | 0.033 |
| Physical Topography Description | Rugged Foothill |
| Primary Hydrologic Soil Group | C |

### *2.1.4 Long Canyon*

The 1.5 square mile (982 acre) Long Canyon watershed is a tributary to the southern bank of the Santa Clara River within the Newhall Ranch (Figure 2.4). Approximately 450 acres of Long Canyon or 50% of the watershed area is located within the Newhall Ranch property boundary, with the majority being upstream or offsite. The creek from the headwaters flows in a general west to east. The watershed boundary has a shape that is rather uniform in width throughout the mid-section at approximately 2,500 ft. The boundary then gradually widens at both the upstream and downstream ends to approximately 3,750 ft. The shape of the watershed is important since that influences when runoff reaches the outlet. Although the watershed is relatively long, the large width in the central portion of the watershed will result in delivering more runoff in shorter amount of time, increasing the peak discharges observed at the outlet. The distance from the upper headwaters to the canyon mouth is approximately 18,350 feet with an average overall slope of 0.052. The major natural main stem drainage course within the watershed has an average slope in the lower reaches of the watershed through the Newhall Ranch property of approximately 0.11. The majority of the Long Canyon watershed is characterized by both rugged and steeply developed foothills that have numerous smaller tributary canyons that dissect the watershed, connecting to the narrow alluvial valley associated with the main stem creek. Approximately 85% or more of the watershed consists of the rugged foothill topography with the remainder being the narrow valley floor. The topography for the watershed varies from a maximum elevation of 2600 ft in the headwaters to a low elevation of 930 ft near the mouth of the canyon at the Santa Clara River valley. Generally, the soils in the watershed are characterized as silty clay loams from both the Castaic and Saugus formations. Also, the soils within the Long Canyon watershed can be predominately classified as being in hydrologic soil group C (higher runoff potential) with exception of areas adjacent to the main stem creek that are soil group A (lower runoff potential) and soil group B in the lower reaches. The associated vegetative cover within the watershed varies, but primarily consists of native grasses, chaparral, scrub oak, and sage brush. There are no major flood control improvements or dams within the watershed. Detailed hydrologic modeling has been performed to evaluate the baseline existing watershed conditions and the results of the peak discharges are discussed in the Section on *Hydrology*.

**Table 2.4 –** Long: Existing Watershed Characteristics

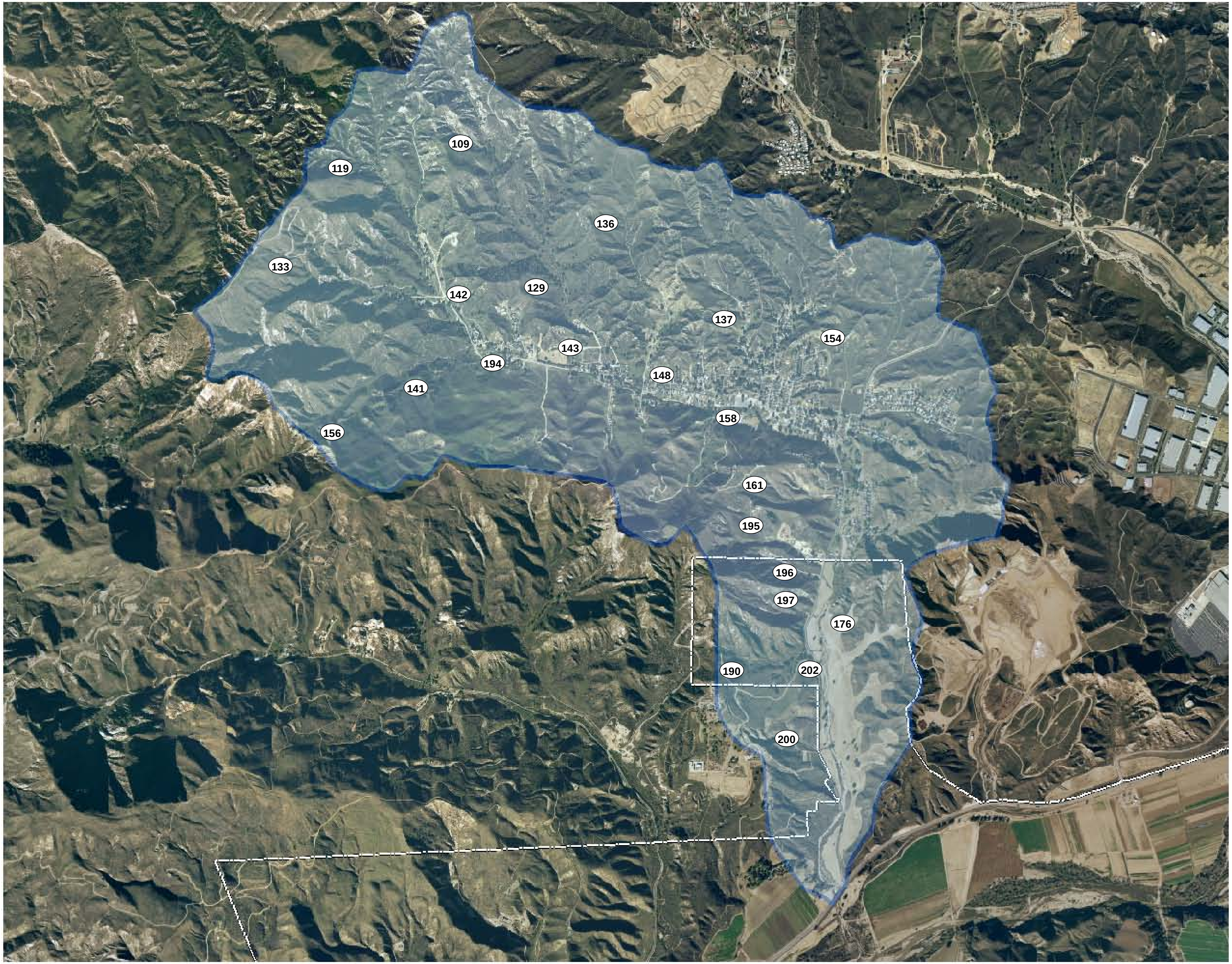
| | |
|---|---|
| Total Drainage Area | 982 acres (1.5 square miles) |
| Length of Watershed | 18,350 feet |
| Maximum Elevation Difference | 1670 |
| Average Slope | 0.052 |
| Physical Topography Description | Rugged Foothill |
| Primary Hydrologic Soil Group | C |

### *2.1.5 Lion Canyon*

The 0.95 square mile (608 acres) Lion Canyon watershed is a tributary to the southern bank of the Santa Clara River within the Newhall Ranch (Figure 2.5). The creek from the headwaters flows in a general southwest to northeast direction, joining the Santa Clara River floodplain valley. The overall watershed boundary develops a diamond shape such that a larger portion of the drainage area is tributary in the mid portion watershed since the width of the watershed narrows in either the upstream and downstream tails of the watershed while the central portion of the watershed widens to approximately 5,600 feet in width. The shape of the watershed is important since that influences when runoff reaches the outlet. Although the watershed is relatively long, the large width in the central portion of the watershed will result in delivering more runoff in shorter amount of time, increasing the peak discharges observed at the outlet. The distance from the upper headwaters to the canyon mouth is approximately 7,900 feet with an average overall slope of 0.057. The major natural main stem drainage course within the watershed has an average slope in the lower reaches of the watershed through the Newhall Ranch property of approximately 0.049. The majority of the Lion Canyon watershed is characterized by both rugged and steeply developed foothills that have numerous smaller tributary canyons that dissect the watershed, connecting to the narrow alluvial valley associated with the main stem creek. Approximately 90% or more of the watershed consists of the rugged foothill topography with the remainder being the narrow valley floor. The topography for the watershed varies from a maximum elevation of 1400 in the headwaters to a low elevation of 946 near the mouth of the canyon at the Santa Clara River valley. Generally, the soils in the watershed are characterized as silty clay loams from both the Castaic and Saugus formations. Also, the soils within the Lion Canyon watershed can be predominately classified as being in hydrologic soil group C (higher runoff potential) with exception of areas adjacent to the main stem creek that are type A (lower runoff potential) and Type B in the lower reaches. The associated vegetative cover within the watershed varies, but primarily consists of native grasses, chaparral, scrub oak, and sage brush. There are no major flood control improvements or dams within the watershed, other than several road culvert/bridge crossings such as the SR 126, that would influence the watershed response to rainfall events. Detailed hydrologic modeling has been performed to evaluate the baseline existing watershed conditions and the results of the peak discharges are discussed in the Section on *Hydrology*.

**Table 2.5 –** Lion: Existing Watershed Characteristics

| | |
|---|---|
| Total Drainage Area | 608 acres (0.95 square miles) |
| Length of Watershed | 8,200 feet |
| Maximum Elevation Difference | 1400 |
| Average Slope | 0.057 |
| Physical Topography Description | Rugged Foothill |
| Primary Hydrologic Soil Group | C |




Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

Main Channel

Streams

Watershed Boundary

Sub-Watersheds

109 Sub-Watersheds ID

Feet: 0 500 1,000 2,000

Meters: 0 150 300 600

Figure 2.1

**WATERSHED BOUNDARY ON AERIAL PHOTOGRAPH CHIQUITO CANYON**

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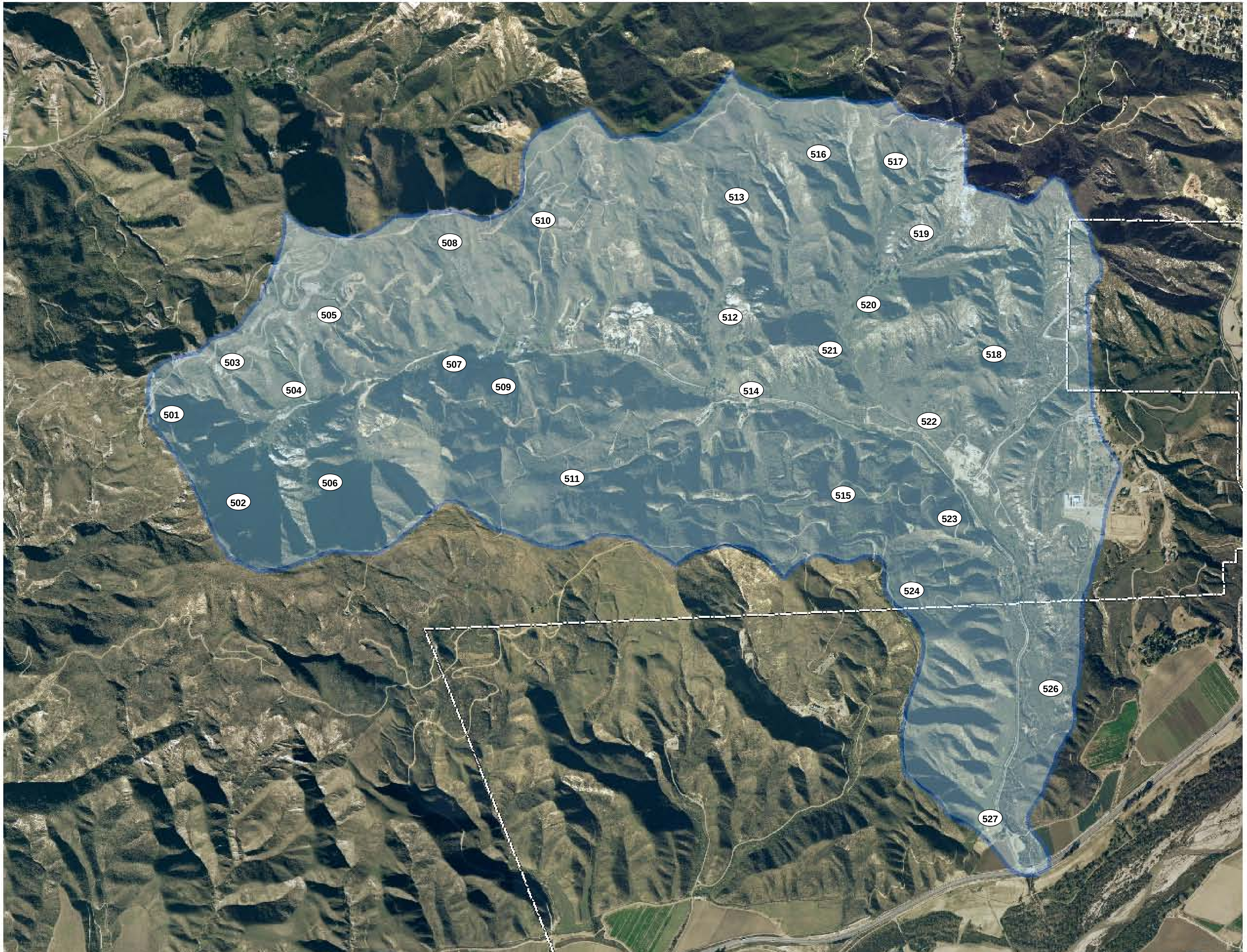


Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

Main Channel

Streams

Watershed Boundary

Sub-Watersheds

1A Sub-Watersheds ID

Feet: 0 375 750 1,500

Meters: 0 112.5 225 450

Figure 2.2

**WATERSHED BOUNDARY ON AERIAL PHOTOGRAPH SAN MARTINEZ GRANDE**

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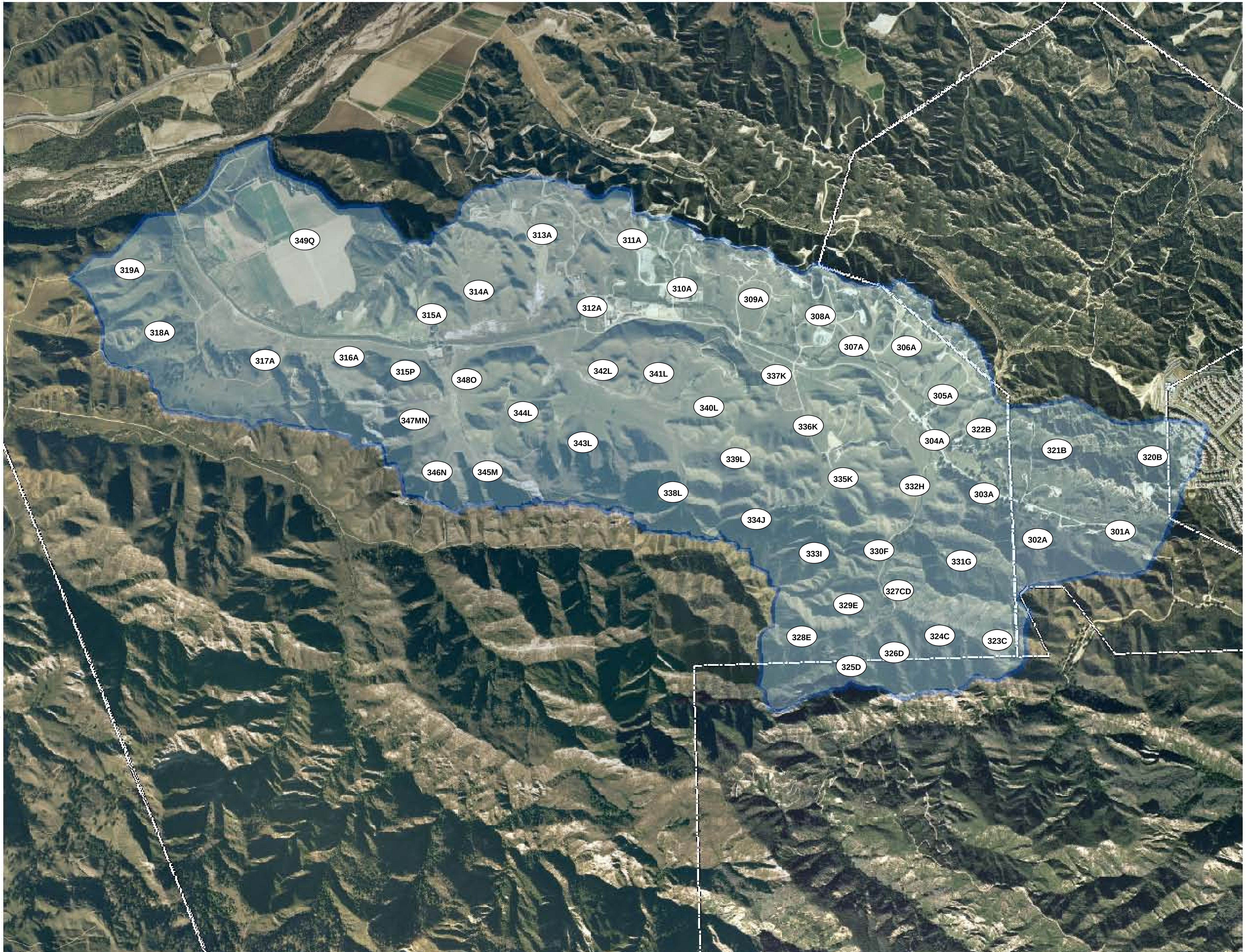


Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Main Channel

Streams

Watershed Boundary

Sub-Watersheds

301A Sub-Watersheds ID

Feet

0 500 1,000 2,000

Meters

0 150 300 600

Figure 2.3

# WATERSHED BOUNDARY ON AERIAL PHOTOGRAPH POTRERO CANYON

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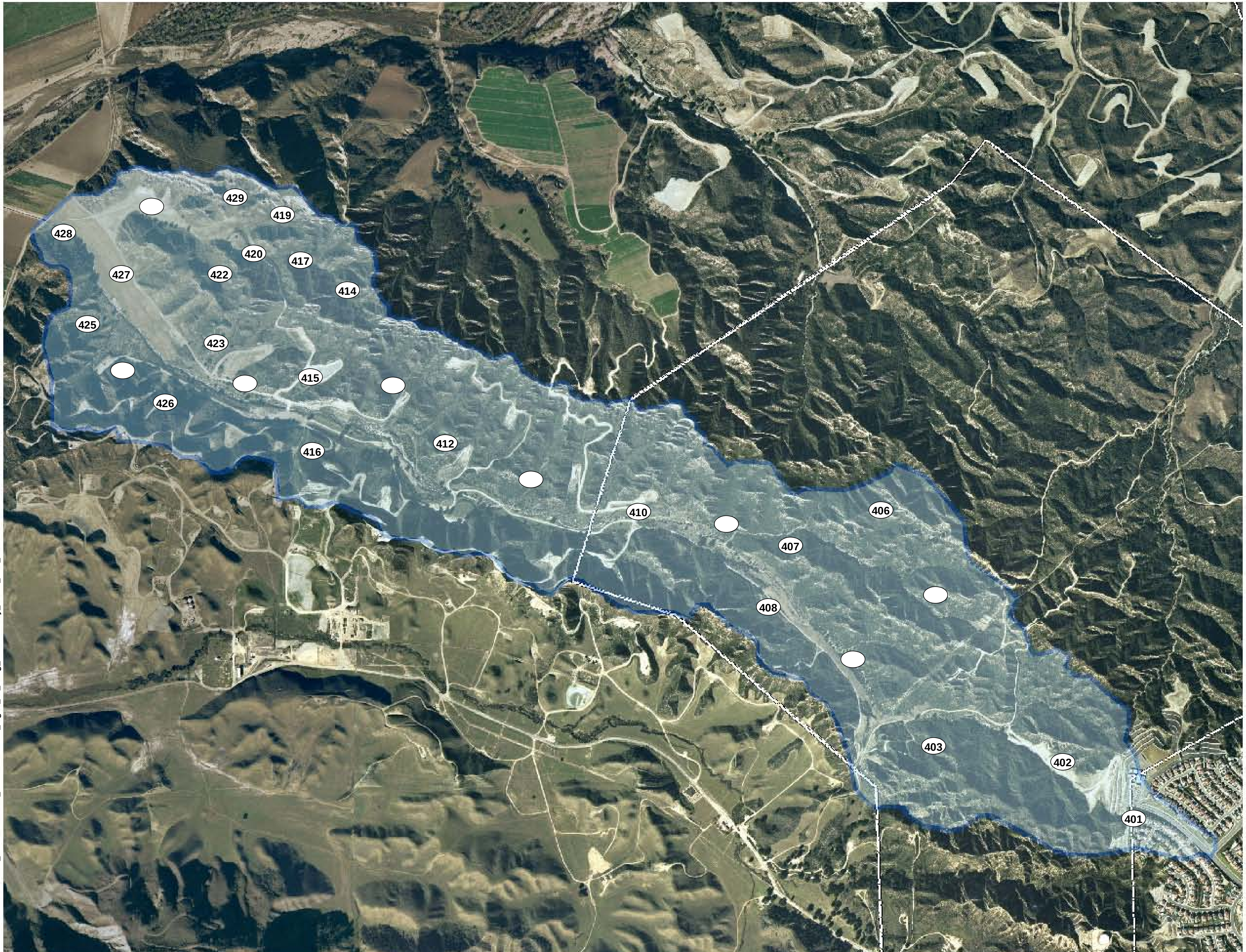



Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Main Channel

Streams

Watershed Boundary

Sub-Watersheds

401 Sub-Watersheds ID

Feet

0 312.5 625 1,250

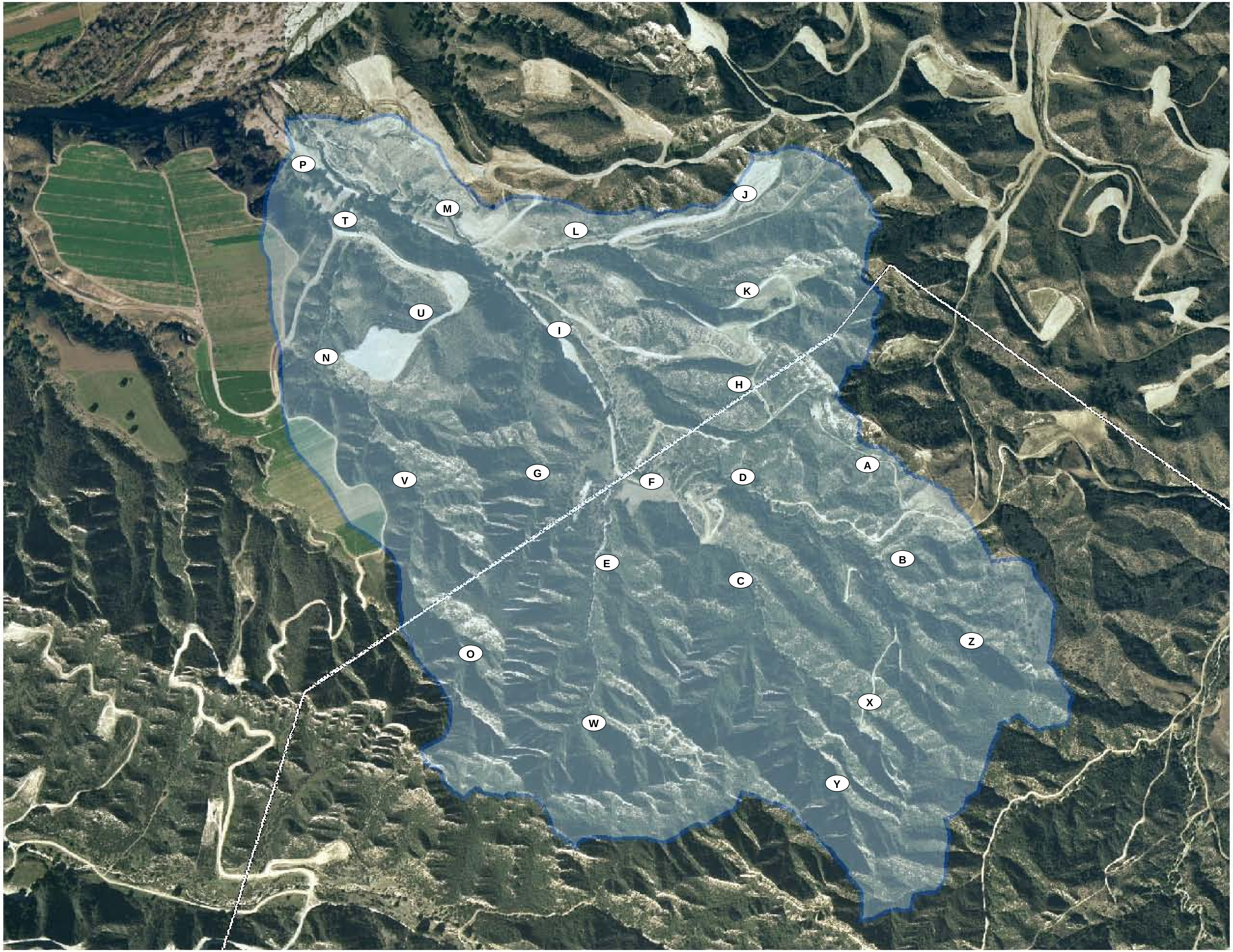
Meters

0 95 190 380

Figure 2.4

**WATERSHED BOUNDARY ON AERIAL PHOTOGRAPH LONG CANYON**

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig02_04_Long_WSBoundary_Aerial_PC1_20090209.mxd




Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Main Channel

Streams

Watershed Boundary

Sub-Watersheds

A Sub-Watersheds ID

Feet

0 187.5 375 750

Meters

0 57.5 115 230

Figure 2.5

**WATERSHED BOUNDARY ON AERIAL PHOTOGRAPH LION CANYON**

*P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig02_05_Lion_WSBoundary_Aerial_PC1_20090209.mxd*

## 2.2 Overview of Existing Tributary Geomorphology

### *2.2.1 Chiquito Canyon*

Chiquito Canyon enters the project area in a confined reach with very high, unstable banks (Image 449, 449b included in Attachment A). Further downstream it exits its confined canyon and enters a long reach that is dominated by a series of large alluvial fans on the east bank (Images 450a through 452c included in Attachment A). These fans are supplying abundant sand to the creek and the channel has formed low banks in the toe of the fan that have little erosion resistance, in part due to the arable land use and lack of woody vegetation. As a result this reach is aggrading and widening. Further downstream (Images 453 through 453b included in Attachment A) the channel becomes slightly confined as it cuts through former terraces, leaving abandoned terraces on the banks that are actively eroded on outside bends. The channel however appears to be aggrading within this setting. Towards the downstream end of the tributary (Images 454 and beyond included in Attachment A) the channel remains slightly confined and has been modified by a series of bridges, culverts and artificial channel sections. In places these appear to cause local backwaters and sediment deposition (e.g. Image 453-4b included in Attachment A). Downstream of the transportation corridor the channel enters the alluvial fan of Chiquito Canyon near its confluence with the Santa Clara River. The channel is leveed and has aggraded strongly, to the point where the channel is higher than the surrounding fan surface. There is a high potential for the channel to avulse at this point.

### *2.2.2 San Martinez Grande Canyon*

Grande Canyon combines a series of reaches alternating between unconfined stable reaches with small inset floodplains and confined, slightly incised and unstable conditions with actively eroding outside bends. The upper reach has a well defined and relatively stable bankfull channel that contains the 5-year flow adjacent to a small inset floodplain (Images 345a-b included in Attachment B). Downstream the channel is more confined and many outside bends are actively eroding into relict floodplain terraces, creating steep and failing banks (Images 354c, 346a, 346b, 346-7a, 346-7b included in Attachment B). Downstream of this reach the valley opens up and we again encounter more stable conditions (Images 347a, 347b included in Attachment B) with small floodplains that persist towards the downstream end of the channel (Image 348b, 348c included in Attachment B).

### *2.2.3 Potrero Canyon*

Potrero Canyon has steep headwaters with incised, erosive channels (Image 1 included in Attachment C) that deliver a lot of coarse sediment to a downstream braided reach (Images 2-7 included in Attachment C). The downstream reach (Images 8-10 included in Attachment C) is aggradational, with a reach where aggradation has induced channel avulsion (Image 8b included in Attachment C). There is a short reach where the channel is confined against the valley side and is deeply incised with highly unstable banks (Image 11 included in Attachment C). The channel then becomes more stable, though again with some fluctuations between slightly erosive and aggradational sub reaches (Images 12, 23, 22 included in Attachment C). The channel then has a long and unusual reach of alkaline meadow much of which takes the form of a swale rather than a channel (Images 20, 19, 18c included in Attachment C). Towards the downstream end the channel becomes increasingly well defined, culminating in an unstable nickpoint that is migrating headwards. The channel transitions sharply into a steep, incised section with several nickpoints (Image 17c included in Attachment C) before emptying into the Santa Clara River.

### *2.2.4 Long Canyon*

Long Canyon is characterized by a very steep, unstable headwaters reach (outside the project area) that becomes more stable downstream. Most of the canyon is then stable to moderately stable with some sections of wide floodplain, before passing though a culvert and into a constructed earth channel that conveys it to the Santa Clara River. The upstream headwaters reaches (Images 243a and 242a included in Attachment D) are deeply incised and highly unstable, with actively eroding channels. Downstream the channel becomes somewhat more stable but remains slightly confined (Images 242d and c included in Attachment D) and has nickpoints (Image us_242d included in Attachment D) that demonstrate channel incision. The channel passes through a slightly incised but undersized reach (Images 241c and b included in Attachment D) before entering a slightly aggrading section (Images 240a and b included in Attachment D). The channel then enters a confined reach (Images 239 included in Attachment D) with actively eroding relict terraces on the outside bend before emerging into another stable, unconfined reach with an extensive active floodplain (Images 238 included in Attachment D). Downstream the channel becomes slightly incised, potentially due to the presence of the nearby road (Images 237 included in Attachment D) (increasing runoff and providing a constriction) but still has access to a low floodplain on one side. Further downstream the channel becomes more stable (Images 236 included in Attachment D) though with eroding outside bends where the channel has migrated against relict terraces (Images 235 included in Attachment D). The channel passes through a short, slightly incised reach (Images 234 included in Attachment D) before widening and slightly aggrading (Images 233, 232 included in Attachment D). Downstream the channel becomes slightly confined with a higher floodplain, but still overall relatively stable conditions (Images 231 included in Attachment D). Below this point the creek enters a constructed trapezoidal flood channel that conveys it to the Santa Clara River.

#### *2.2.5 Lion Canyon*

Lion Canyon has steep headwaters (above the project boundary) that supply large amounts of sediment into the aggrading upper reach producing an undersized channel (Images 1-6 included in Attachment E) with local erosion on outside bends. Primarily aggradational conditions continue downstream producing a well connected and vegetated floodplain (Images 7-9 included in Attachment E). This incorporates a reach with mature oaks (Images 10-13 included in Attachment E) and an additional aggraded reach with a well connected floodplain downstream (Image 14 included in Attachment E). There is a very sharp transition from aggrading to deeply incised, eroding conditions at the road crossing, which acts as a grade control protecting the upper reaches from incision. The source of the incision is likely uncontrolled drainage from the unimproved road surface. Downstream of the grade control is a 12 foot high nickpoint (Image 15 included in Attachment E) and a reach of deeply incised channel with some failing banks (Images 16 and 17 included in Attachment E near to more mature oaks). This reach opens up into a wider section (Images 18-20 included in Attachment E) that has historically experienced incision into what appears to be material derived from the right hillside (identified by the geotechnical assessment as a former quarry spoil deposit). This material has constrained the channel and deflected it over to the left bank terrace where it is actively eroding and causing slab failures (Image 19 included in Attachment E). Despite the longer-term appearance of the incision (e.g. abandoned floodplain terraces), the bed in this reach appears to have recently aggraded (evidenced by very shallow channel and “buried” appearance of channel features, e.g. Image 20 included in Attachment E). Downstream the channel remains historically incised with erosion on the outside bends but with local bed aggradation and the formation of a small new floodplain on the inner bends (Images 21-22 included in Attachment E). The right valley side looking downstream is undercut by the creek, creating a high unstable slope. This reach culminates in an 8 foot high nickpoint which suggests that the channel is now eroding the bed sediment deposited in the 2004-05 floods.

### 2.3 Existing Floodplain Description and General Characteristics

#### *2.3.1 Chiquito Canyon*

The lower Chiquito Canyon creek extends approximately 8,200 feet upstream from the canyon mouth at the Santa Clara River valley to the Newhall Ranch boundary. The geomorphology of the active creek reflects a more highly variable and sinuous alignment that reflects the influence of the physical and topographic features. The floodplain is generally entirely contained within the active creek banks and there is little overbank flow. The changes in creek geometry and form may indicate influences from the upper watershed that affect the sediment delivery. The changes in channel geometry are also reflected in coincidental variations of the streambed slope. The slope variations are generally higher in the contractions of the channel geometry and flatter in the expansion areas, upstream and downstream. The average streambed slope of the channel indicated by the topographic data is approximately 0.025. Detailed hydraulic modeling of the existing floodplain was performed and indicated that a major portion of the Chiquito Canyon floodplain was hydraulically “steep” (Froude numbers greater than a value of 1.0. A brief description of the hydraulic operation of this 8,200 foot length floodplain for Chiquito Canyon from the downstream canyon mouth to the upstream Newhall Ranch boundary includes the following: (1) just upstream of the mouth of the canyon, about 560 feet, the floodplain contracts, increasing velocities, (2) continuing upstream into the canyon mouth the creek geometry expands, stabilizing the velocities, (3) continuing still through the canyon mouth feature the creeks passes through several additional contractions and large expansion zones which is also indicative of the riparian vegetation occurring in the expansion zones, (4) the velocities in the contractions can range of 12 to 16 fps while the expansion areas are in the 6 fps range, (6) the mid portion of the floodplain significantly widens which reflects the limited channel depth or incision and the wider alluvial floodplain deposits that appear to have occurred from a significant contraction in the channel geometry influencing the floodplain hydraulic operation, (7) the upstream portion of the floodplain then again narrows indicated by the high velocities experienced. The hydraulic characteristics of the 100-year floodplain generated by the hydraulic modeling indicates that (1) the average depth is approximately 3.8 feet, ranging from 9.5 feet to 1.6 feet, (2) the average velocity is approximately 11.9 fps, ranging from 22 fps to 5 fps, and the width of the floodplain water surface averages 194 feet, ranging from 549 feet to 36 feet consistent with the various channel constrictions. Higher velocities generally occur within the contracted and incised portions of the floodplain and lower velocities within expansion areas and flatter longitudinal streambed slopes. Along the fringes of the floodplain lower velocities occur while the higher velocities are in the deeper portions of a channel section.

#### *2.3.2 San Martinez Grande Canyon*

The lower San Martinez Grande Canyon creek extends approximately 4,800 feet upstream from the canyon mouth at the Santa Clara River valley to the Newhall Ranch boundary. The geomorphology of the active creek reflects a more highly variable and sinuous alignment that reflects the influence of the physical and topographic features. There is also a much greater variation of the active channel geometry (i.e. width and depth) along this relatively short reach of channel. The active portion of the creek is more deeply incised below the canyon valley floor. The floodplain is generally entirely contained within the active creek banks and there is little overbank flow. The changes in creek geometry and form may indicate influences from the upper watershed that affect the sediment delivery. The changes in channel geometry are also reflected in coincidental variations of the streambed slope. The slope variations are generally higher in the contractions of the channel geometry and flatter in the expansion areas, upstream and downstream. The average streambed slope of the channel indicated by the topographic data is approximately 0.022. The average slopes ranges from 0.08 in the contraction to 0.005. The upstream 500 feet has a less defined active channel and a much wider canyon floor that reflects depositional area, also the increased floodplain vegetation within this zone. The only manmade structure that influences the hydraulic operation is the roadway culvert crossing for SR 126, but this appears to have sufficient hydraulic capacity with minimal effects to the floodplain. Detailed hydraulic modeling of the existing floodplain was performed and indicated that approximately 50% of the lower reach of the San Martinez Grande Canyon floodplain was hydraulically “steep” (Froude numbers greater than a value of 1.0) while the remainder of the canyon, primarily the upper portion to the Newhall Ranch boundary was hydraulically a ”mild” channel. The hydraulics also indicated a several locations the influence of the contraction in the channel geometry which controlled the hydraulics upstream and downstream of these locations. A brief description of the hydraulic operation of this 4,800 foot length floodplain for San Martinez Canyon from the downstream canyon mouth to the upstream Newhall Ranch boundary includes the following: (1) the immediate downstream portion of floodplain near the canyon mouth to the Santa Clara River is associated with a more prismatic earthen section that connects to the SR 126 roadway crossing and velocities downstream of the bridge increase from its influence, (2) upstream of the bridge crossing the channel significantly widens in a large incised erosion feature that reduces the velocities, (3) continuing upstream into the canyon mouth the creek geometry contract and the velocities accelerate in this area along with the streambed slopes being steeper, (4) continuing still through the canyon mouth feature the creeks passes through several additional contractions and large expansion zones which is also indicative of the riparian vegetation occurring in the expansion zones, (5) the velocities in the contractions can range of 12 to 16 fps while the expansion areas are in the 6 fps range, (6) continuing through the mid portion of the canyon the channel is fairly incised with the velocities averaging from 9 to 12 fps and encountering some variation in the channel geometry, (7) the upstream 500 to 800 feet of floodplain significantly widens which reflects the limited channel depth or incision and the wider alluvial floodplain deposits that appear to have occurred from a significant contraction in the channel geometry influencing the upstream floodplain hydraulic operation. The hydraulic characteristics of the 100-year floodplain generated by the hydraulic modeling indicates that (1) the average depth is approximately 6.4 feet, ranging from 15 feet to 2.9 feet, (2) the average velocity is approximately 8.9 fps, ranging form 19 fps to 2.2 fps, and the width of the floodplain water surface averages 110 feet, ranging from 220 feet to 42 feet consistent with the various channel constrictions. Higher velocities generally occur within the contracted and incised portions of the floodplain and lower velocities within expansion areas and flatter longitudinal streambed slopes. Along the fringes of the floodplain lower velocities occur while the higher velocities are in the deeper portions of a channel section.

### *2.3.3 Potrero Canyon*

The lower Potrero Canyon creek extends approximately 18,270 feet upstream from the canyon mouth at the Santa Clara River valley to the Newhall Ranch boundary. The geomorphology of the active creek reflects a more highly variable and sinuous alignment that reflects the influence of the physical and topographic features. There is also a steady variation of the active channel geometry (ie. width and depth) along this relatively short reach of channel, with the active portion of the creek being more deeply incised below the canyon valley floor. The floodplain is generally entirely contained within the active creek banks and there is little overbank flow. The changes in creek geometry and form may indicate influences from the upper watershed that affect the sediment delivery. The changes in channel geometry are also reflected in coincidental variations of the streambed slope. The slope variations are generally higher in the contractions of the channel geometry and flatter in the expansion areas, upstream and downstream. The average streambed slope of the channel indicated by the topographic data is approximately 0.024. The average slopes ranges from 0.055 in the contraction to 0.011. The upstream 500 feet has a less defined active channel and a much wider canyon floor that reflects depositional area, also the increased floodplain vegetation within this zone. Detailed hydraulic modeling of the existing floodplain was performed and indicated that approximately 40% of the lower reach of the Potrero Canyon floodplain was hydraulically "steep" (Froude numbers greater than a value of 1.0) while the remainder of the canyon, primarily the upper portion to the Newhall Ranch boundary was hydraulically a "mild" channel. The hydraulics also indicated at several locations the influence of the contraction in the channel geometry which controlled the hydraulics upstream and downstream of these locations. A brief description of the hydraulic operation of this 18,270 foot length floodplain for Potrero Canyon from the downstream canyon mouth to the upstream Newhall Ranch boundary includes the following: (1) the immediate downstream portion of floodplain near the canyon mouth to the Santa Clara River is associated with a more prismatic earthen section that connects to the SR 126 roadway crossing and velocities downstream of the bridge increase from its influence, (2) upstream of the bridge crossing, the channel significantly widens into a large incised erosion feature that reduces water velocity, (3) continuing upstream into the canyon mouth the creek geometry contracts, increasing both velocities and streambed slopes in this area, (4) continuing still, the creek passes through several additional contractions as well as large expansion zones which are indicative of the riparian vegetation occurring throughout the expansion zones, (5) the velocities in the contractions can range of 7 to 10 fps while the expansion areas are around 4 fps, (6) continuing through the mid portion of the canyon the channel is fairly incised with the velocities averaging from 6 to 9 fps and again encountering some variation in geometry, (7) the upstream 1000 to 1300 feet of floodplain significantly widens which reflects the limited channel depth or incision and the wider alluvial floodplain deposits that appear to have occurred from a significant contraction in the channel geometry influencing the upstream floodplain hydraulic operation. The characteristics of the 100-year floodplain generated by the hydraulic modeling indicate that, (1) the average depth is approximately 3.1 feet, ranging from 6.6 feet to 0.7 feet, (2) the average velocity is approximately 5.9 fps, ranging form 11.2 fps to 2.2 fps, and the width of the floodplain water surface averages 330 feet, ranging from 950 feet to 50 feet consistent with the various channel constrictions. Higher velocities generally occur within the contracted and incised portions of the floodplain and lower velocities within expansion areas and flatter longitudinal streambed slopes. Along the fringes of the floodplain lower velocities occur while the higher velocities are in the deeper portions of a channel section.

### *2.3.4 Long Canyon*

The lower Long Canyon creek extends approximately 8,350 feet upstream from the canyon mouth at the Santa Clara River valley to the Newhall Ranch boundary. The geomorphology of the active creek reflects a more highly variable and sinuous alignment that reflects the influence of the physical and topographic features. There is also a much greater variation of the active channel geometry (ie. width and depth) along this relatively short reach of channel. The active portion of the creek is more deeply incised below the canyon valley floor then flattens and widens near the creek outlet. The floodplain is generally entirely contained within the active creek banks and there is little overbank flow. The changes in creek geometry and form may indicate influences from the upper watershed that affect the sediment delivery. The changes in channel geometry are also reflected in coincidental variations of the streambed slope. The slope variations are generally higher in the contractions of the channel geometry and flatter in the expansion areas, upstream and downstream. The average streambed slope of the channel indicated by the topographic data is approximately 0.052. The average slopes ranges from 0.1 in the contraction to 0.05. The upstream 500 feet has a less defined active channel and a much wider canyon floor that reflects depositional area, also the increased floodplain vegetation within this zone. Detailed hydraulic modeling of the existing floodplain was performed and indicated that approximately 80% of the lower reach of the Long Canyon floodplain was hydraulically “steep” (Froude numbers greater than a value of 1.0) while the remainder of the canyon, primarily the upper portion to the Newhall Ranch boundary was hydraulically a ”mild” channel. The hydraulics also indicated at several locations the influence of the contraction in the channel geometry which controlled the hydraulics upstream and downstream of these locations. A brief description of the hydraulic operation of this 8,350 foot length floodplain for Long Canyon from the downstream canyon mouth to the upstream Newhall Ranch boundary includes the following: (1) the immediate downstream portion of floodplain near the canyon mouth to the Santa Clara River is a rather flat, broad, depositional section (2) upstream, the channel begins to contract, developing an incised erosion feature that increases the velocities along with the streambed slopes becoming steeper, (3) continuing still through the canyon mouth feature the creek passes through several additional contractions and expansion zones which is also indicative of the riparian vegetation occurring in the expansion zones, (4) the velocities in the contractions can range from 10 to 16 fps while the expansion areas are in the 6 fps range, (5) continuing through the mid portion of the canyon the channel is fairly incised with the velocities averaging from 8 to 12 fps and encountering some variation in the channel geometry, (6) the upstream 1000 to 1200 feet of floodplain significantly widens which reflects the limited channel depth or incision and the wider alluvial floodplain deposits that appear to have occurred from a significant contraction in the channel geometry influencing the upstream floodplain hydraulic operation. The hydraulic characteristics of the 100-year floodplain generated by the hydraulic modeling indicates that (1) the average depth is approximately 2.4 feet, ranging from 6.5 feet to 0.7 feet, (2) the average velocity is approximately 7.8 fps, ranging from 17 fps to 3.5 fps, and the width of the floodplain water surface averages 140 feet, ranging from 420 feet to 30 feet consistent with the various channel constrictions. Higher velocities generally occur within the contracted and incised portions of the floodplain and lower velocities within expansion areas and flatter longitudinal streambed slopes. Along the fringes of the floodplain lower velocities occur while the higher velocities are in the deeper portions of a channel section.

#### *2.3.5* *<u>Lion Canyon</u>*

The lower Lion Canyon creek extends approximately 5,400 feet upstream from the canyon mouth at the Santa Clara River valley to the Newhall Ranch boundary. The geomorphology of the active creek reflects a more highly variable and sinuous alignment that reflects the influence of the physical and topographic features. There is also a much greater variation of the active channel geometry (ie. width and depth) along this relatively short reach of channel. The active portion of the creek is more deeply incised below the canyon valley floor. The floodplain is generally entirely contained within the active creek banks and there is little overbank flow. The changes in creek geometry and form may indicate influences from the upper watershed that affect the sediment delivery. The changes in channel geometry are also reflected in coincidental variations of the streambed slope. The slope variations are generally higher in the contractions of the channel geometry and flatter in the expansion areas, upstream and downstream. The average streambed slope of the channel indicated by the topographic data is approximately 0.049. The upstream 500 feet has a less defined active channel and a much wider canyon floor that reflects depositional area, also the increased floodplain vegetation within this zone. Detailed hydraulic modeling of the existing floodplain was performed and indicated that approximately 50% of the lower reach of the Lion Canyon floodplain was hydraulically “steep” (Froude numbers greater than a value of 1.0) while the remainder of the canyon, primarily the upper portion to the Newhall Ranch boundary was hydraulically a ”mild” channel. The hydraulics also indicated a several locations the influence of the contraction in the channel geometry which controlled the hydraulics upstream and downstream of these locations. A brief description of the hydraulic operation of this 5,400 foot length floodplain for Lion Canyon from the downstream canyon mouth to the upstream Newhall Ranch boundary includes the following: (1) the immediate downstream portion of floodplain near the canyon mouth to the Santa Clara River is associated with a more prismatic earthen, (2) the channel maintains a uniform width up to 2,150 feet from the mouth of the canyon, (3) continuing upstream into the canyon mouth the creek geometry expand and the velocities decrease in this area, (4) continuing still through the canyon mouth feature the creeks passes through several additional contractions zones, (5) the velocities in the contractions can range of 5 to 7 fps while the expansion areas are in the 3 to 5 fps range. The hydraulic characteristics of the 100-year floodplain generated by the hydraulic modeling indicates that (1) the average depth is approximately 1.6 feet, ranging from 3.9 feet to 0.3 feet, (2) the average velocity is approximately 5.7 fps, ranging form 9.2 fps to 2.1 fps, and the width of the floodplain water surface averages 58 feet, ranging from 166 feet to 21 feet consistent with the various channel constrictions. Higher velocities generally occur within the contracted and incised portions of the floodplain and lower velocities within expansion areas and flatter longitudinal streambed slopes. Along the fringes of the floodplain lower velocities occur while the higher velocities are in the deeper portions of a channel section.

## 2.4 Existing FEMA Flood Hazard Mapping

The Federal Emergency Management Agency (FEMA) has developed published Flood Insurance Rate Maps (FIRM) identifying flood hazards associated with a base flood that has a 1-percent probability (100-year return period) of being equaled or exceeded in any given year. This mapping is available for selected creeks and rivers in the County of Los Angeles since it is a participant in the National Flood Insurance Program (NFIP) that is administered by FEMA. Communities participating in the NFIP must adopt and enforce minimum floodplain management standards, including identification of flood hazards and flood risks. In addition, the published flood hazard information is available in Geographic Information System (GIS) format which is referred to a Q3 data because of the 3 data type provided (100-year, 500-year, and floodway data). However, the level of accuracy of the floodplain mapping performed for the flood hazards studies does not provide accurate results of the floodplain boundaries because (1) the mapping was done at a regional level and does not include the study of smaller local effects and disturbances along the fringe of the floodplain, (2) the cross section spacing used in the hydraulic model was generally performed at large intervals so it tends to miss changes along a highly variable creek system, (3) many flood hazards studies involve using “approximate” methods and only provide preliminary estimates of the floodplain, (4) flood hazards studies use the “existing” 100-year flowrate at the time of the study which may change with development, (5) the accuracy of the topography used in the analysis may not be to the level which obtains all the local topographic variations along the floodplain fringe and the topography was generally performed at a regional mapping level.

### *2.4.1 Chiquito Canyon*

Chiquito Canyon floodplain does have a published FEMA 100-year floodplain which extends from the downstream confluence with the Santa Clara River to just several hundred feet upstream beyond the Newhall Ranch property boundary. The original published mapping illustrated in the 1996 Q3 data was updated in a Letter of Map Revision (LOMR) prepared Sikand Engineering Associates in 1998 based on more detailed floodplain hydraulic mapping and more accurate topographic information. The floodplain maps associated with the approved LOMR were digitized in order to obtain digital mapping information (Figure 2.6-2.20).

### *2.4.2 San Martinez Grande Canyon*

San Martinez Grande Canyon floodplain does have a published FEMA 100-year floodplain which extends from the downstream confluence with the Santa Clara River to just several hundred feet upstream beyond the Newhall Ranch property boundary. The original published mapping illustrated in the 1996 Q3 data was updated in a Letter of Map Revision (LOMR) prepared by Sikand Engineering Associates in 1998 based on more detailed floodplain hydraulic mapping and more accurate topographic information. The floodplain maps associated with the approved LOMR were digitized in order to obtain digital mapping information.

The County of Los Angeles has also published floodplain studies for different stream and river systems within the County which includes San Martinez Grande. The County has generated the "Capital" floodplain and floodway boundaries on published "ML" maps (Miscellaneous Maps) for approximately 17,500 feet of San Martinez Grande, or upstream to the Ventura County line within the canyon. The capital floodplain and floodway is illustrated on ML-748, which was generated in October 1986 and adopted by the County Board of Supervisors in January 1990. The capital flood flow used by the County of Los Angeles is different from the adopted FEMA 100-year flowrate because of the methodology and rainfall which results in the capital flood generally being much larger than the FEMA flowrate. The capital flood flow identified in the 1990 ML maps indicated a value of 6,700 cfs and the floodplain was analyzed with a Manning's roughness coefficient of n=0.06. Another important difference is that FEMA only published a 100-year floodplain boundary and did not develop a published floodway which was only produced by the County mapping.

#### *2.4.3 Potrero Canyon*

Potrero Canyon floodplain does have a published FEMA 100-year floodplain which extends from the downstream confluence with the Santa Clara River to just a few hundred feet. The original published mapping illustrated in the 1996 Q3 data was updated in a Letter of Map Revision (LOMR) prepared by Sikand Engineering Associates in 1998 based on more detailed floodplain hydraulic mapping and more accurate topographic information. The floodplain maps associated with the approved LOMR were digitized in order to obtain digital mapping information.

#### *2.4.4 Long Canyon*

Currently, the Long Canyon floodplain does not have a published FEMA 100-year floodplain. However, a FEMA floodplain generation is anticipated pending further development within the local Long Canyon watershed.

#### *2.4.5 Lion Canyon*

Like Long Canyon, the Lion Canyon floodplain does not currently have a published FEMA 100-year floodplain. However, like Long, FEMA floodplain generation is anticipated pending further development within the local Lion Canyon watershed.

Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

Existing 100 Year Floodplain Boundary

Feet

0 175 350 700

Meters

0 50 100 200

Figure 2.6

**WATERSHED BOUNDARY WITH EXISTING 100 YEAR FLOODPLAIN CHIQUITO CANYON**

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P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig02_07_Grande_Ex100YrFloodplain_PC1_20090209.mxd

Newhall Ranch Company

L E G E N D

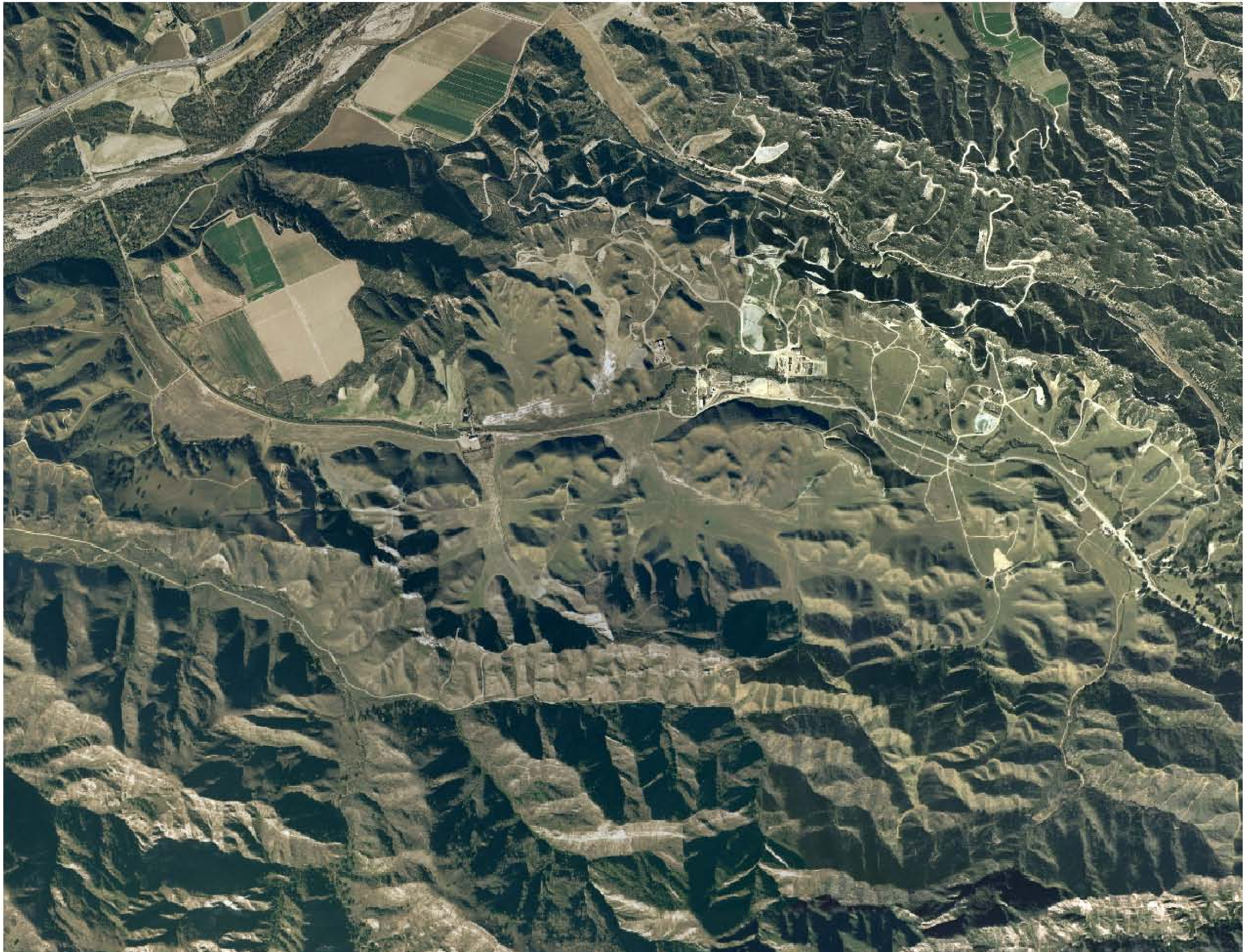
Newhall Ranch Specific Plan Boundary

Existing 100 Year Floodplain Boundary

Feet
0 125 250 500
Meters
0 40 80 160

Figure 2.7

**WATERSHED BOUNDARY WITH EXISTING 100 YEAR FLOODPLAIN SAN MARTINEZ GRANDE**



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Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

Existing 100 Year Floodplain Boundary

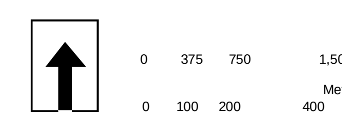



Figure 2.8

**WATERSHED BOUNDARY WITH EXISTING 100 YEAR FLOODPLAIN POTRERO CANYON**

Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

Existing 100 Year Floodplain Boundary

Feet
0 200 400 800
Meters
0 50 100 200

Figure 2.9

**WATERSHED BOUNDARY WITH EXISTING 100 YEAR FLOODPLAIN LONG CANYON**

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig02_09_Long_Ex100YrFloodplain_PC1_20090209.mxd

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Existing 100 Year Floodplain Boundary

Feet

0 125 250 500

Meters

0 40 80 160

Figure 2.10

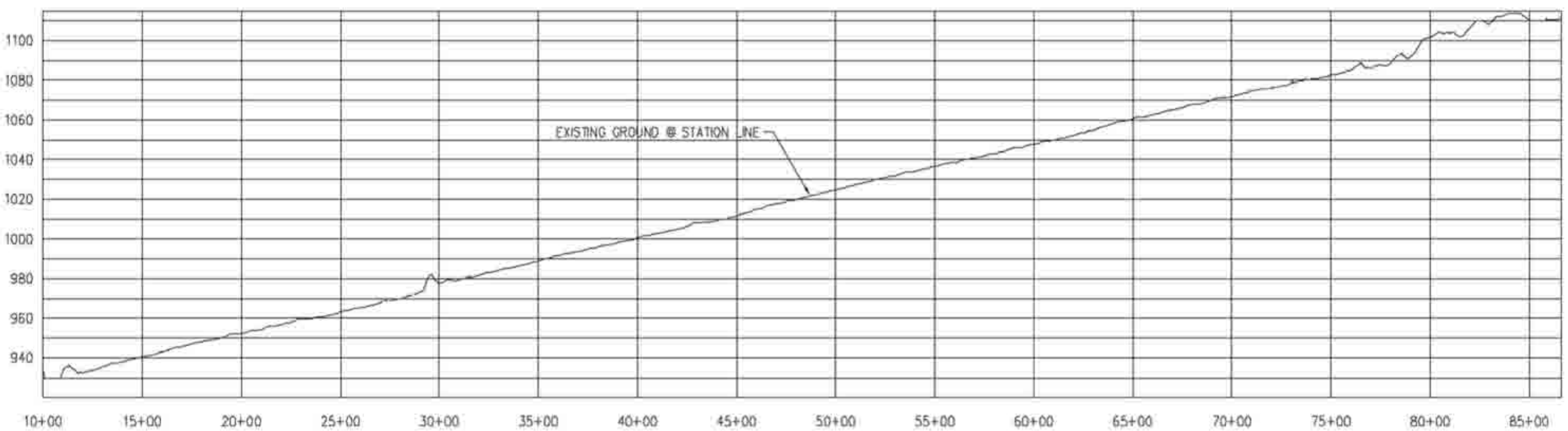
**WATERSHED BOUNDARY WITH EXISTING 100 YEAR FLOODPLAIN LION CANYON**

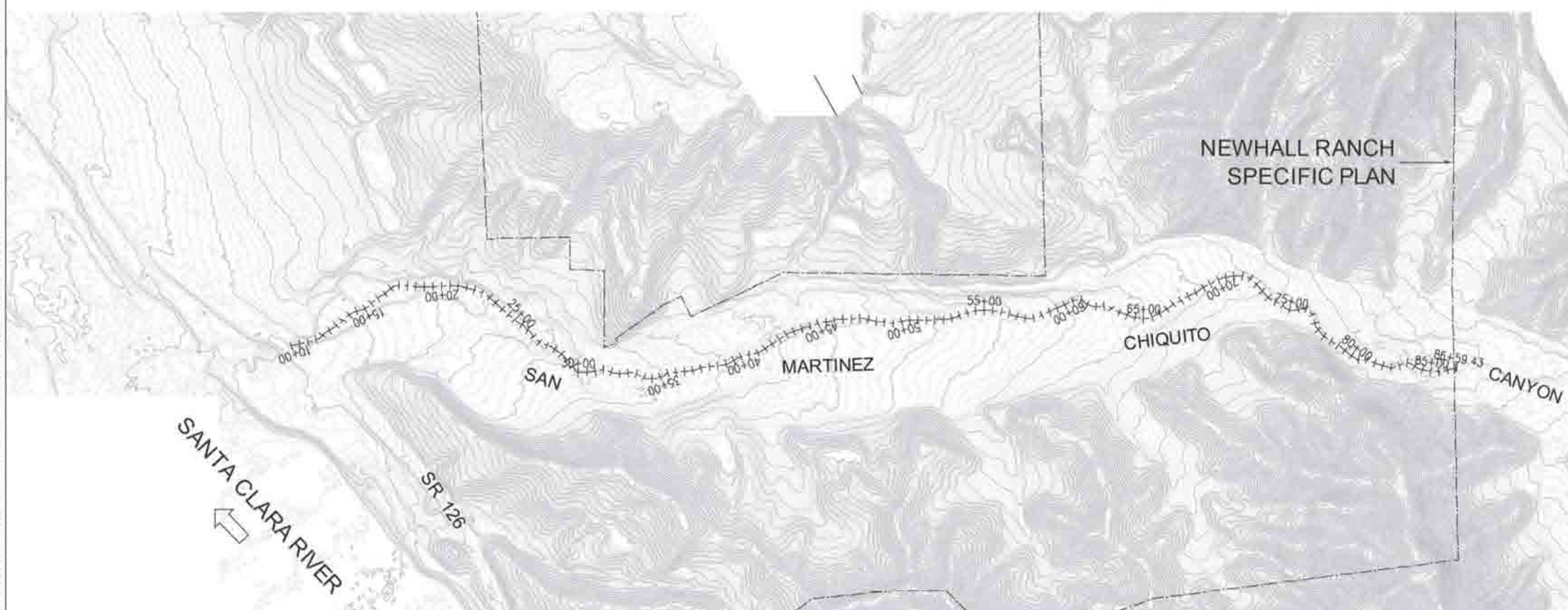
P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig02_10_Lion_Ex100YrFloodplain_PC1_20090209.mxd

NEWHALL RANCH
Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary



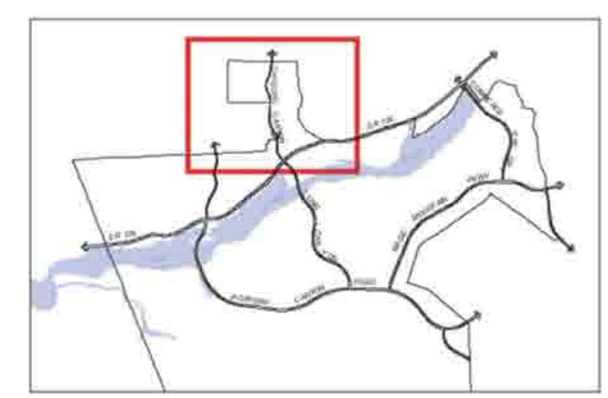
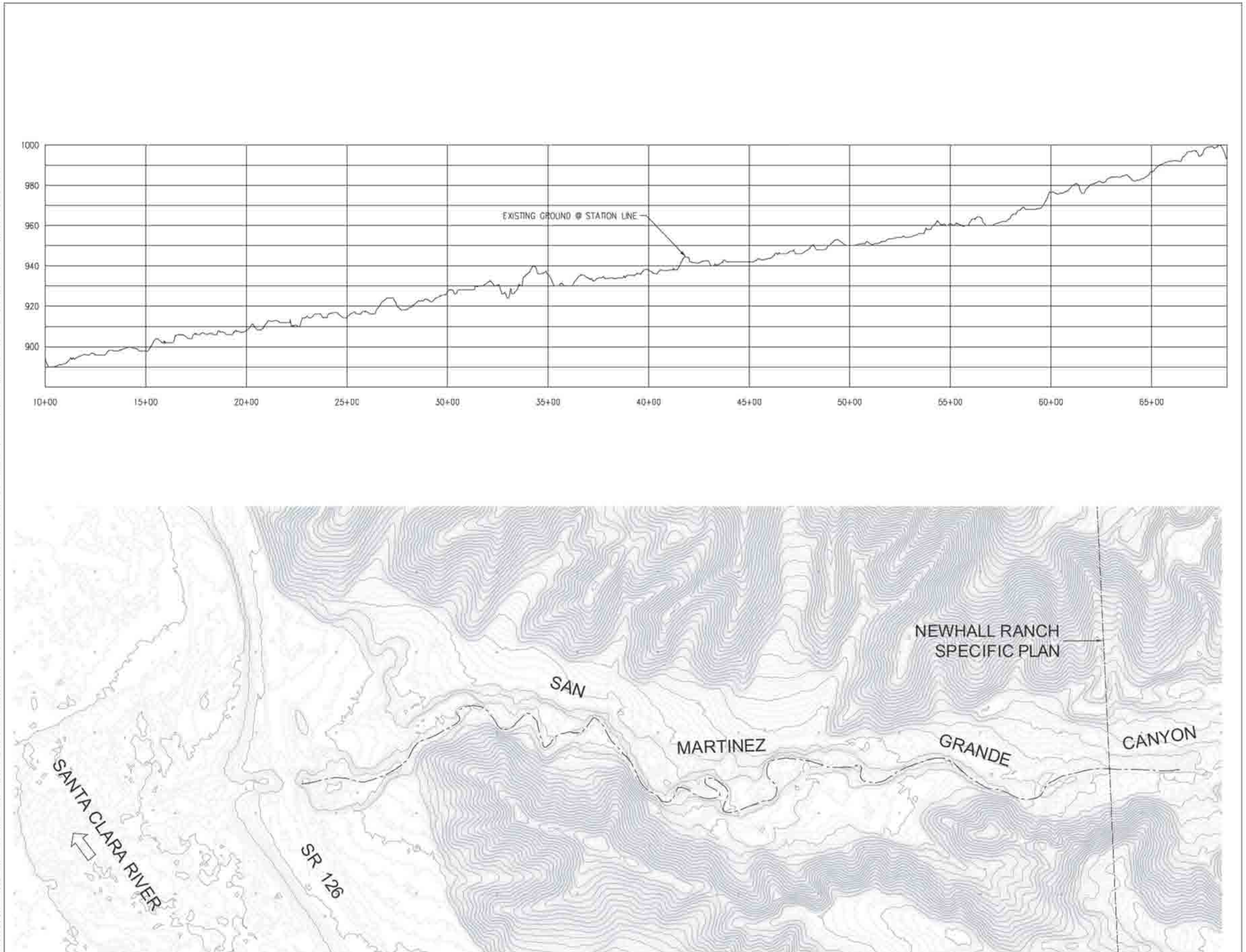



Figure 2.11
**EXISTING CONDITION PLAN AND PROFILE SAN MARTINEZ CHIQUITO**

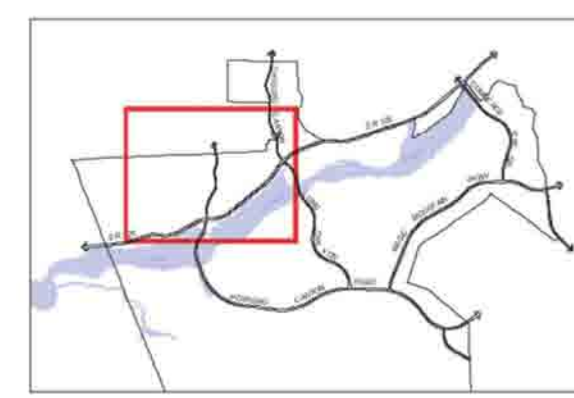
P:\7104E\Engineering\7104-41 (Chiquito)\Report figures\7104E FIG 2-3 CHIQUITO (EXISTING CONDITION PLAN & PROFILE).dwg - Tab Layout1 By: ddrann on Mar. 04, 2009 at 05:39 pm




NEWHALL RANCH
Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary



0 125 250 500 Feet

PACE

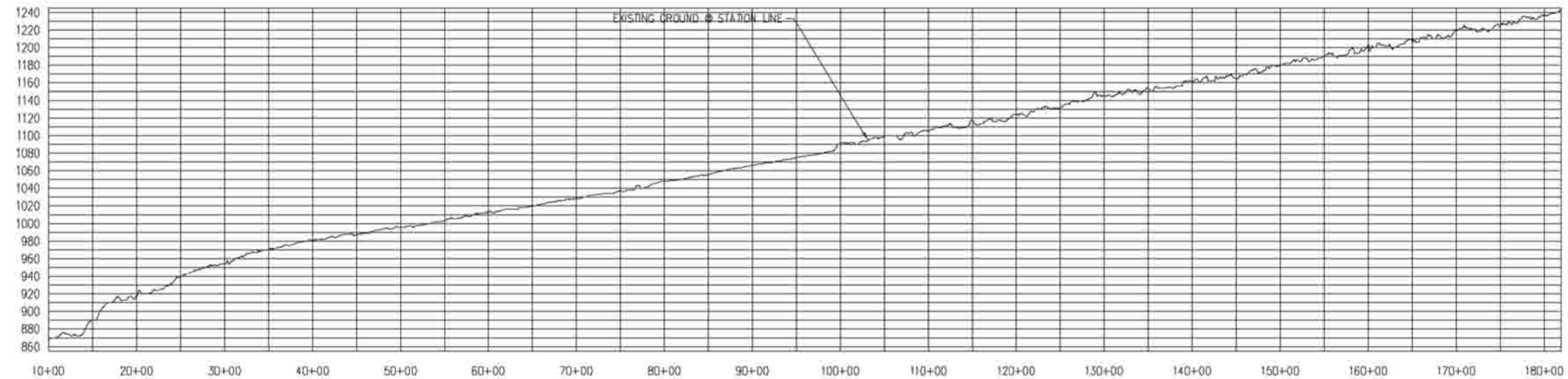
Figure 2.12
**EXISTING CONDITION PLAN AND PROFILE SAN MARTINEZ GRANDE**

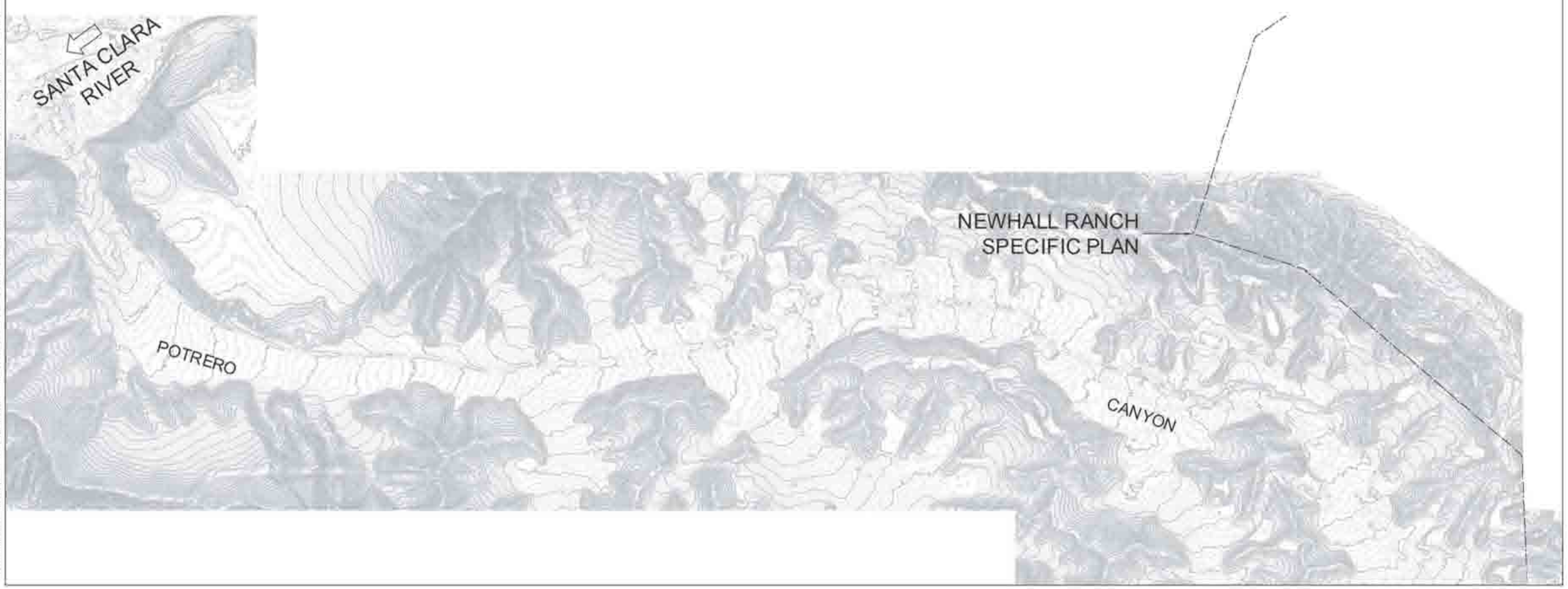
P:\7104E\Engineering\7104-51 (Grande)\Report Figures\7104E FIG 2-3 GRANDE (EXISTING CONDITION PLAN & PROFILE).dwg - Tab: Layout1 By: ddrohn on Mar. 04, 2009 at 04:49 pm

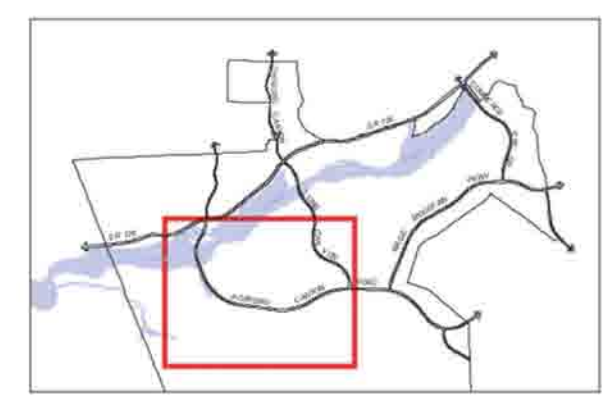
NEWHALL RANCH
Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary



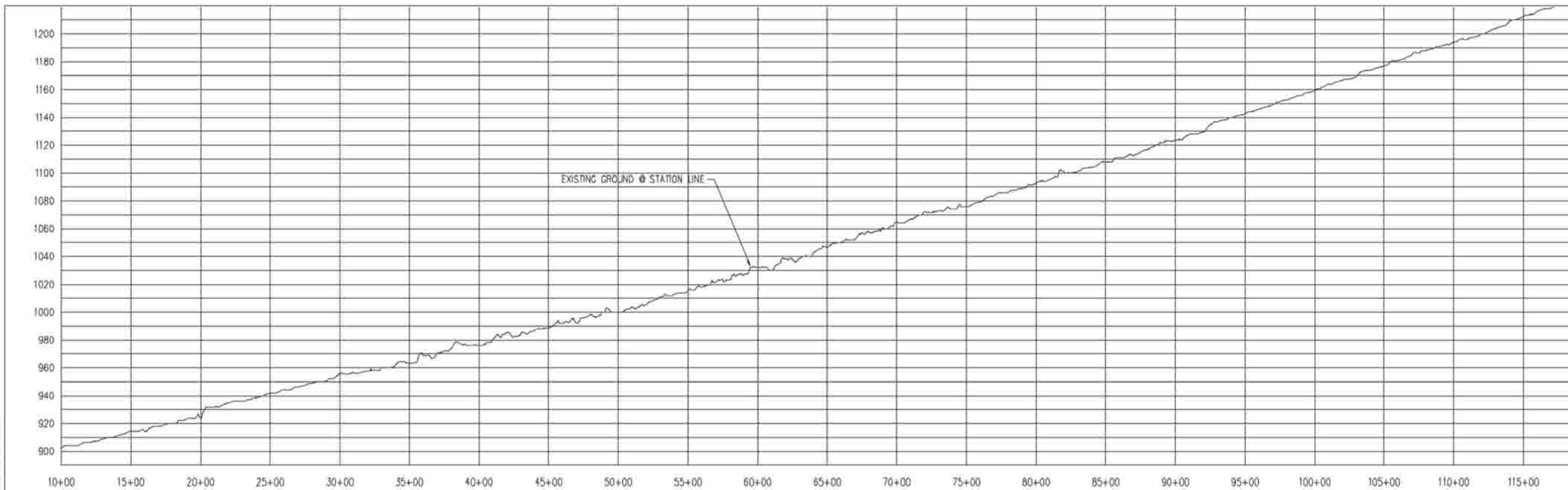



Feet
0 375 750 1500

PACE

Figure 2.13
**EXISTING CONDITION PLAN AND PROFILE POTRERO CANYON**

P:\7104E\Engineering\7104-21 (Potrero)\Report Figures\7104E FIG 2-3 POTRERO (EXISTING CONDITION PLAN & PROFILE).dwg - Tab: Layout1 By: ddrahn on Mar. 04, 2009 at 05:15 pm

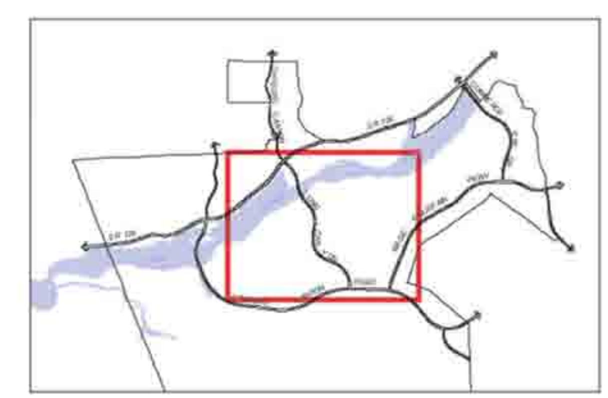




NEWHALL RANCH
Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

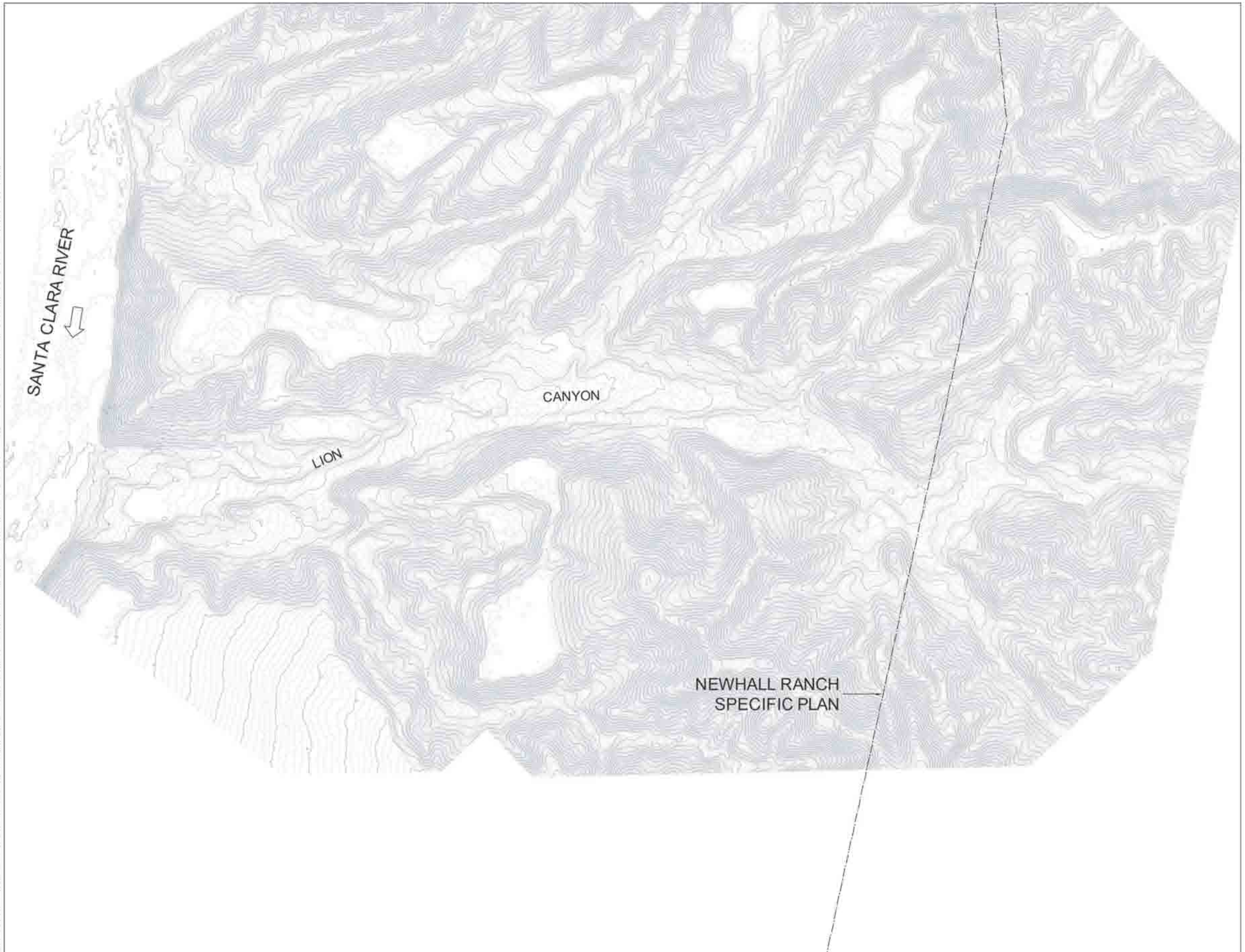


Feet
0 200 400 800

PACE

Figure 2.14
**EXISTING CONDITION**
**PLAN AND PROFILE**
**LONG CANYON**

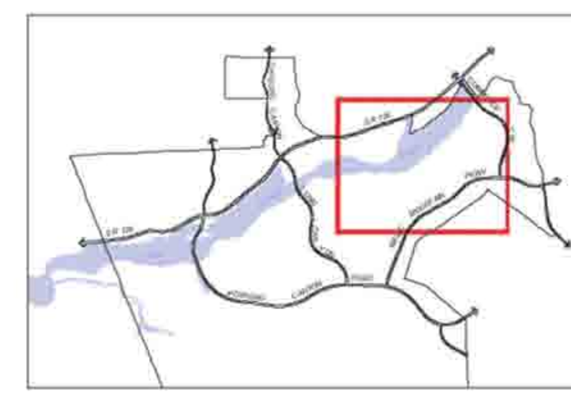
P:\7104E\Engineering\7104-31 (Long)\Report Figures\7104E FIG 2-3 LONG (EXISTING CONDITION PLAN & PROFILE).dwg - Tab: Layout1 By: ddrahn on Mar 04, 2009 at 05:23 pm




NEWHALL RANCH
Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary



0 125 250 500 Feet

PACE

Figure 2.15
**EXISTING CONDITION PLAN**
**LION CANYON**

P:\7104E\Engineering\7104-XX (LionCanyon)\Report Figures\7104E FIG 2-3 LION (EXISTING CONDITION PLAN & PROFILE).dwg - Tab Layout1 By: ddrahn on Mar. 04, 2009 at 05:35 pm



Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

Mapped FEMA 100 Year Flood Hazard Zone



Figure 2.16

**MAPPED FEMA 100 YEAR FLOOD HAZARD ZONE CHIQUITO CANYON**

Newhall Ranch Company

**LEGEND**

Newhall Ranch Specific Plan Boundary

Mapped FEMA 100 Year Flood Hazard Zone

Feet
0 175 350 700
Meters
0 50 100 200

Figure 2.17

**WATERSHED BOUNDARY WITH EXISTING 100 YEAR FLOODPLAIN SAN MARTINEZ GRANDE**

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig02_17_Grande_FEMAFloodplain_PC1_20090227.mxd

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig02_18_Potrero_FEMAFloodplain_PC1_20090227.mxd

Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

Mapped FEMA 100 Year Flood Hazard Zone

Feet

0 375 750 1,500

Meters

0 100 200 400

Figure 2.18

**MAPPED FEMA 100 YEAR FLOOD HAZARD ZONE POTRERO CANYON**

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Mapped FEMA 100 Year Flood Hazard Zone

Feet
0 200 400 800

Meters
0 50 100 200

Figure 2.19

**MAPPED FEMA 100 YEAR FLOOD HAZARD ZONE LONG CANYON**

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig02_19_Long_FEMAFloodplain_PC1_20090227.mxd

Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

Mapped FEMA 100 Year Flood Hazard Zone



Figure 2.20

**MAPPED FEMA 100 YEAR FLOOD HAZARD ZONE LION CANYON**

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig02_20_Lion_FEMAFloodplain_PC1_20090227.mxd

# 3 Watershed Hydrology

## 3.1 Hydrology Analysis Procedures

A rainfall-runoff model was utilized to analyze the five regional tributary watersheds as part of this technical analysis since there is not available stream gage data for measured flow information. The focus of the study was to estimate the hydrologic response of each watershed from a single hypothetical rainfall event utilizing synthetic procedures to estimate or quantify the response. The Army Corps of Engineers (ACOE) HEC-1 flood hydrograph model was utilized as the modeling program to perform all the rainfall-runoff analysis or transformation of rainfall excess into surface runoff. The watershed input parameters and results were compared to previous studies as part of the verification/validation process, which included recent studies by Geosyntec and URS.

### *3.1.1 HEC-1 Watershed Model*

The HEC-1 Flood Hydrograph Package developed by the ACOE, calculates hydrographs from single storm events for watershed basins of all levels of complexities and was adopted for this study to provide the precipitation-runoff modeling. This program was selected because (1) multiple options or hydrologic procedures available internally, (2) wide acceptability, (3) familiarity by the local agencies in using the program, and (4) utilized on other local and regional watersheds within the area. The program also offers several hydrologic procedures including loss rates and rainfall excess transformation that are more physically based and representative of actual surface runoff processes. The physical processes are transformed into a “link-node” model in which the hydrologic process occurs at a calculation node and these processes within the watershed are linked together by hydraulic connections.

HEC-1 requires that each sub-basin within the watersheds be composed for three different elements and include precipitation, loss rate, and hydrograph process. These three elements are the basin building blocks of the watershed model.

## 3.2 Input Data and Watershed Parameters

Use of HEC-1 for rainfall-runoff modeling requires (1) sub-basin delineation, (2) precipitation data, (3) runoff and routing parameters and, (4) loss rate or infiltration abstraction estimates.

### *3.2.1 Rainfall / Precipitation*

Synthetic rainfall data used in the hydrologic modeling was obtained from two sources which includes: (1) *NOAA Atlas No. 2 – Precipitation Frequency Atlas of the Western United States* (1973) and (2) published statistical rainfall gage data from the State of California indicated in the *Rainfall Analysis for Drainage Design – Volume 1 – Short Duration Precipitation Frequency Data* (1976) as well electronic updated values of this publication obtained through the retired state hydrologist Jim Goodrich (2002). This data was combined to develop the required rainfall amounts at the different durations within a maximum of a 24-hour period for the six return periods investigated. Synthetic storm rainfall was utilized to simulate an average storm of a given magnitude associated with a specific statistical probability or return period. The synthetic rainfall was utilized rather than historical data since a single storm event was being evaluated and was considered representative with rainfall of any duration within the 24-hour period of that particular probability. A hypothetical rainfall distribution was applied within HEC-1 that utilized a balanced distribution, or centering, of the rainfall increments equally for each interval within the twenty-four hour period.

**Table 3.1 -** Hypothetical Statistical Rainfall Data

| Return Period | 5 minute | 15 minute | 60 minute | 2 hour | 3 hour | 6 hour | 12 hour | 24 hour |
|---|---|---|---|---|---|---|---|---|
| 2-year | 0.2 | 0.39 | 0.68 | 1.0 | 1.25 | 1.8 | 2.45 | 3.1 |
| 5-year | 0.25 | 0.49 | 0.85 | 1.24 | 1.55 | 2.35 | 3.31 | 4.28 |
| 10-year | 0.28 | 0.54 | 0.95 | 1.40 | 1.75 | 2.80 | 4.00 | 5.2 |
| 20-year | 0.34 | 0.67 | 1.17 | 1.63 | 2.07 | 3.12 | 4.57 | 6.01 |
| 50-year | 0.40 | 0.78 | 1.38 | 1.89 | 2.41 | 3.63 | 5.40 | 7.16 |
| 100-year | 0.45 | 0.89 | 1.56 | 2.1 | 2.7 | 4.0 | 6.0 | 8.0 |

#### *3.2.2 Unit Hydrograph and Hydrologic Routing Procedure*

The “Kinematic Wave” procedure was utilized within HEC-1 to transform the rainfall excess and is an alternative procedure to the conventional unit hydrograph process. The parameters of this model are developed from physical characteristics of each basin, and equations of motion are used to simulate the movement of water through each of the systems. Parameters such as catchment length and area, roughness, slope and channel geometry are used to define the flow of water conceptually over basin surfaces, into stream channels, and through the channel network of the basin. The surface features of the basin are represented with two basic types of elements: (1) overland flow, and (2) channel flow. One or two overland-flow elements are combined with one or two channel-flow elements to represent the processes occurring within a sub-basin. The entire watershed basin is modeled by linking the various sub-basins together in a network. The “kinematic wave” procedure is the closest option within HEC-1 that approximates the procedures in the SWMM model which is more of a hydrodynamic model.

The three basic elements for HEC-1 that are required to apply the kinematic wave procedure to a model the runoff processes within a sub-basin include: (1) one or two typical overland flow planes, (2) a typical collector channel within the sub-basin that collects the overland flow, and (3) a main channel the intercepts the collector channel and also conveys flow from the upstream to downstream end of the mainstem channel traversing the sub-basin. The overland-flow plane is a rectangular plan of unit width in which some of the rain falling on the plan is lost to infiltration. The remaining rainfall excess flows over the surface and runs off into the collector channel. The flow length, $L_{o,}$ has the greatest influence on the response of the overland flow element. It is generally considered the maximum length of the path taken by a representative water drop in traveling to the collector channel where it first becomes streamflow. These lengths were determined for the existing conditions by evaluating the smaller collector streams near the headwaters of each sub-basin and averaging these lengths from the ridgelines to the smallest collector channels. The slope is the representative slope that the surface water takes following the path from the ridgeline to the collector stream or channel. Roughness coefficients for sheet flow surface were estimated from standard tables and are much different from standard hydraulic roughness values. The natural overland flow path roughness was estimated at a value of 0.24 while the natural main or collector channels were given a value of 0.04 more representative of the natural canyon floodplains. The developed condition overland flow roughness value and lengths were modified from these values based on typical urban residential development assumptions. A summary of the estimated “kinematic wave” parameters developed from the measured mapping data for each of the sub-basins within the Chiquito watershed are summarized in the table in the section *Sub-basin Delineation*.

#### *3.2.3 Infiltration / Loss Rate / Impervious Cover*

Hydrologic classification of soils have been developed by the US Soil Conservation Service (formerly the SCS and now the NRCS) and mapping of soils types is available indicating the relative amount of infiltration potential from the soils (Figures 3.1-3.5). The general defined classification of soils includes four types, ranging from type “A” which is very permeable, representing more of a sandy soil, to a type “D” which is more impermeable representing clayey type systems. Generally, the soils in the watershed are characterized as silty clay loams from both the Castiac and Saugus formations. The soil mapping overlay of the watershed boundaries indicates that the soils within the Chiquito, San Martinez Grande, Potrero, Long, and Lion Canyon watersheds can be predominately classified as being in hydrologic soil group C (higher runoff potential) with exception of areas adjacent to the main stem creeks that are type A (lower runoff potential) and Type B in the lower reaches of each watershed.

The “exponential” loss rate was utilized as the abstraction function within the HEC-1 model to simulate the soil infiltration. Although this is an empirical method, its form better reflects the physical processes involved in rainfall loss. The loss rate is a function of rainfall intensity and accumulated loss or soil moisture storage. This loss rate function was similar to that utilized in recent watershed studies and models prepared by URS/Geosyntec in the Chiquito, San Martinez Grande, Potrero, Long, and Lion Canyon watersheds. In addition, the numerical parameters were the same as the studies done for each canyon since these had been studied in more detail by URS/Geosyntec in order to validate their use. Utilizing the exponential loss rate requires inputting the following information: (1) initial starting value for the loss rate and a value of 0.50 in/hr was used for the Grande and Long tributaries, while Lion, Chiquito and Potrero tributaries used 0.76 in/hr, (2) rate of change of the loss rate parameter, (3) exponent of the precipitation for the loss rate function and a value of 0.4 was used. The 100-year existing model reflects these values.

### 3.3 Watershed and Sub-basin Delineation

Watershed mapping was performed using the USGS topographic data since the more current and increased accuracy aerial mapping performed on the Newhall Ranch only covers approximately 16 percent of the Chiquito Canyon watershed, 10 percent of the San Martinez Grande Canyon watershed, and 50 percent of the Long Canyon watershed. The physical topographic features and ridgelines were used to establish the each of the five major regional watershed boundaries. The regional watershed boundary was then subdivided into multiple sub-basins (39 sub-basins in Chiquito Canyon, 27 sub-basins in San Martinez Grande Canyon, 50 sub-basins in Potrero Canyon, 29 sub-basins in Long Canyon, and 23 sub-basins in Lion Canyon) to facilitate the modeling process and establish appropriate delineation of the interior watershed areas (Figures 3.6-3.10). The sub-basins generally corresponded to smaller individual drainage systems based on the drainage patterns. The sub-basins were located based on the smaller tributary stream systems, confluences or streams, drainage area size, and anticipated development or ownerships. The sub-basin delineation also allows studying the local land-use changes within the regional watershed but analyzed on a local sub-basin level. The sub-basin sizes were limited based on the physical topographic constraints created by the small tributary natural drainage systems and attempting to maintain relatively similar sub-basin tributary area amounts. The general sub-basin delineation for each canyon follows:

- Chiquito Canyon sub-basins have an average size of 0.12 square miles, with the smallest sub-basin at approximately 0.11 squire miles and the largest at 0.367 squire miles;
- San Martinez Grande Canyon sub-basins are within the 0.1 to 0.2 square miles size, with the smallest sub-basin area at approximately 0.035 square miles and the largest at 0.269 square miles;
- Potrero Canyon sub-basins are within the 0.12 to 0.07 square miles size, with the smallest sub-basin area at approximately 0.002 square miles and the largest at 0.334 square miles;
- Long Canyon sub-basins are within the 0.07 to 0.1 square miles size, with the smallest sub-basin area at approximately 0.014 square miles and the largest at 0.134 square miles; and
- Lion Canyon sub-basins have an average size of about 0.040 square miles, with the smallest sub-basin area at approximately 0.005 square miles and the largest at 0.103 square miles.

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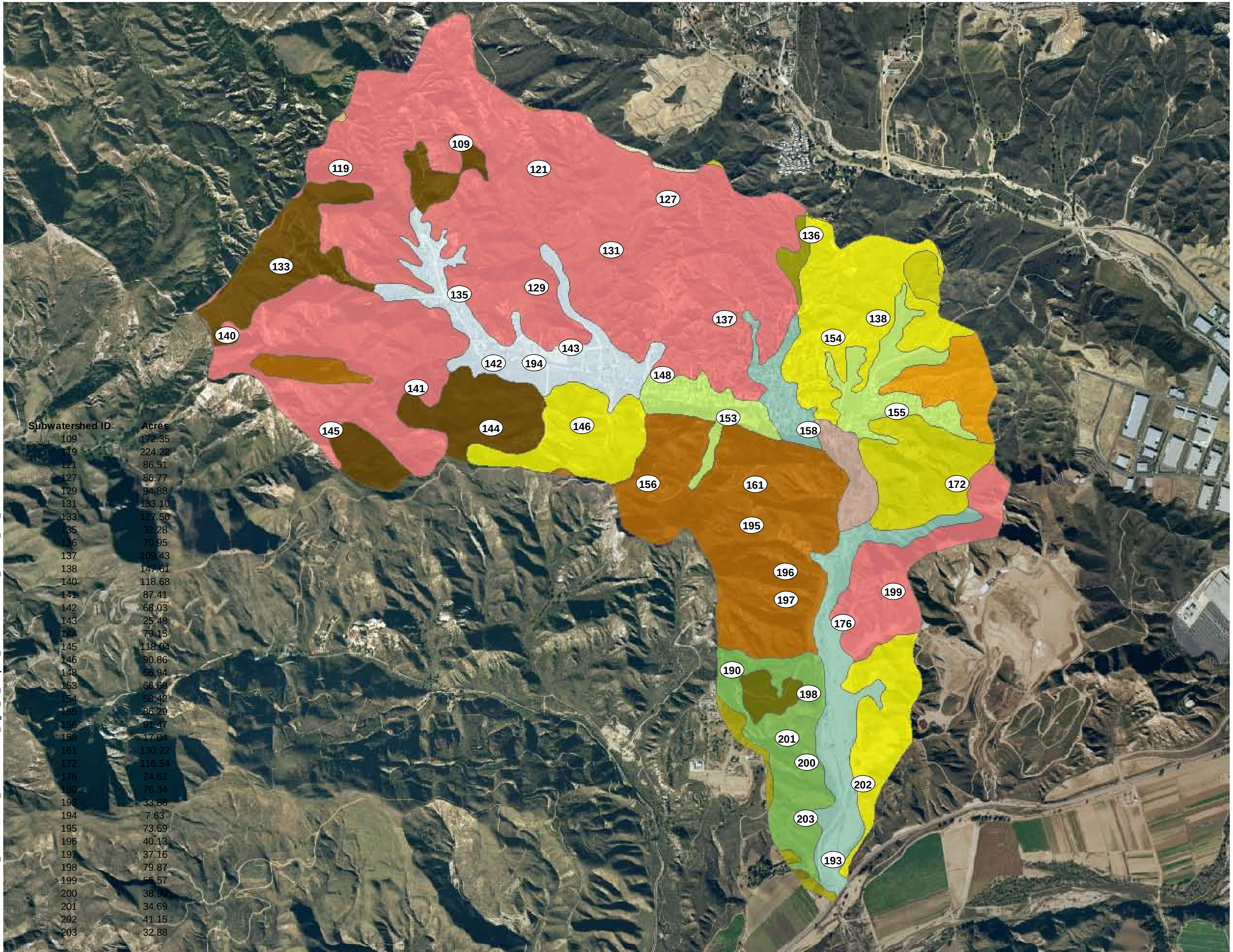



| Subwatershed ID | Acres |
|---|---|
| 109 | 172.35 |
| 119 | 224.22 |
| 121 | 86.51 |
| 127 | 86.77 |
| 129 | 94.88 |
| 131 | 133.10 |
| 133 | 127.56 |
| 135 | 32.28 |
| 136 | 70.95 |
| 137 | 109.43 |
| 138 | 147.61 |
| 140 | 118.68 |
| 141 | 87.41 |
| 142 | 68.03 |
| 143 | 25.48 |
| 144 | 79.15 |
| 145 | 118.04 |
| 146 | 90.86 |
| 148 | 56.94 |
| 153 | 66.68 |
| 154 | 58.42 |
| 155 | 86.29 |
| 156 | 91.47 |
| 158 | 17.04 |
| 161 | 130.22 |
| 172 | 116.54 |
| 176 | 24.62 |
| 190 | 76.34 |
| 193 | 33.88 |
| 194 | 7.63 |
| 195 | 73.59 |
| 196 | 40.13 |
| 197 | 37.16 |
| 198 | 79.87 |
| 199 | 55.57 |
| 200 | 38.90 |
| 201 | 34.69 |
| 202 | 41.15 |
| 203 | 32.88 |

Newhall Ranch Company

L E G E N D

Main Channel

Streams

Newhall Ranch Specific Plan Boundary

Sub-Watersheds

109 Sub-Watersheds ID

**Soil Types**

Castaic-Balcom silty clay looms, 15 to 30 percent slopes

Castaic and Saugus soils, 30 to 65 percent slopes, severely eroded

Castaic-Balcom silty clay looms, 30 to 50 percent slopes, eroded

Castaic-Balcom silty clay looms, 50 to 65 percent slopes, eroded

Castaic-Bolcom silty clay looms, 30 to 50 percent slopes

Hanford sandy loam, 2 to 9 percent slopes

Metz loamy sand, 2 to 9 percent slopes

Saugus loam, 15 to 30 percent slopes

Saugus loam, 30 to 50 percent slopes

Saugus loam, 30 to 50 percent slopes, eroded

Sorrento loam, 2 to 5 percent slopes

Terrace escarpments

Yolo loam, 2 to 9 percent slopes

Zamora loam, 2 to 9 percent slopes

Zamora loam, 9 to 15 percent slopes

Feet

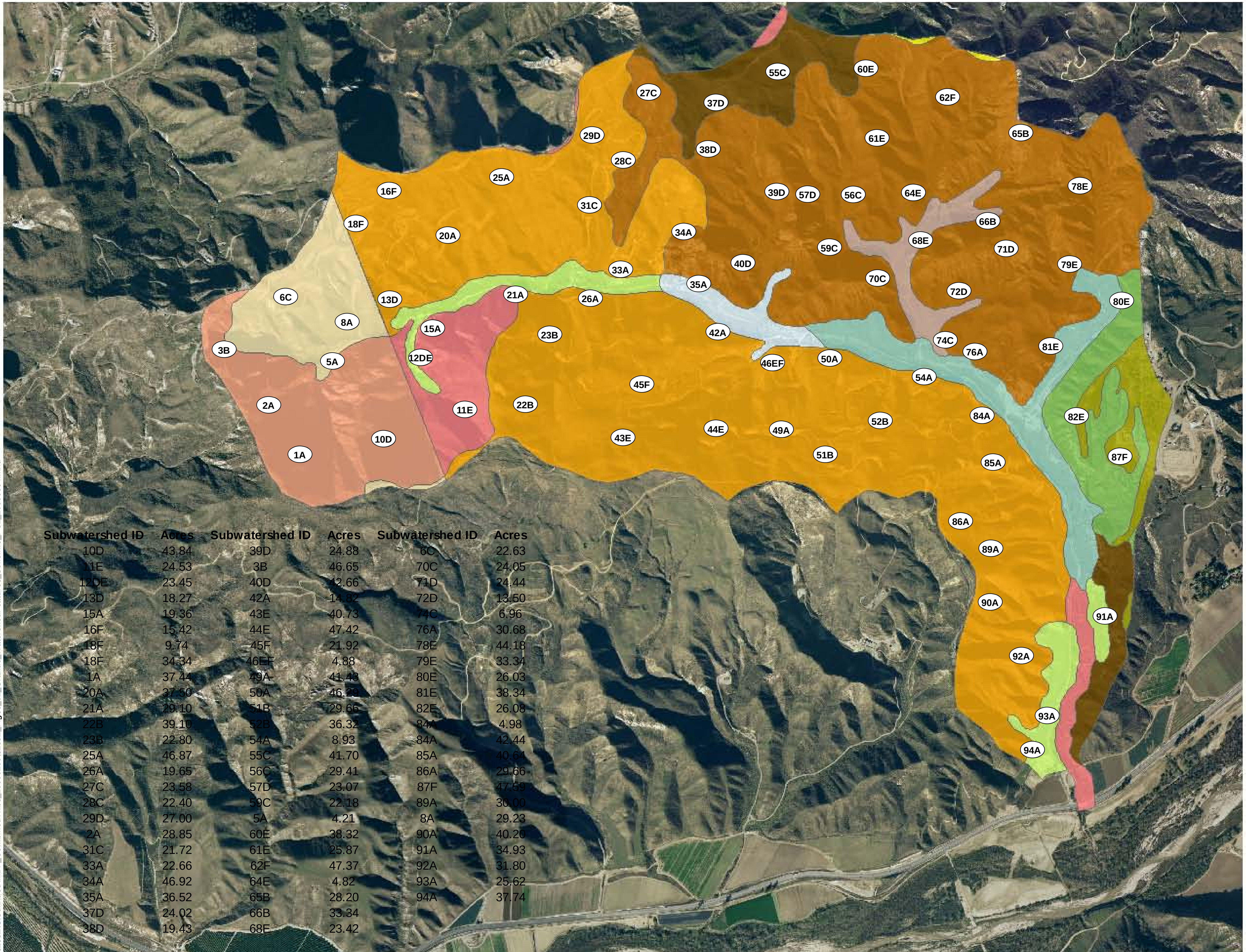
0 500 1,000 2,000

Meters

0 150 300 600

Figure 3.1

**WATERSHED FEATURES WITH SOILS INFORMATION CHIQUITO CANYON**




| Subwatershed ID | Acres | Subwatershed ID | Acres | Subwatershed ID | Acres |
|---|---|---|---|---|---|
| 10D | 43.84 | 39D | 24.88 | 6C | 22.63 |
| 11E | 24.53 | 3B | 46.65 | 70C | 24.05 |
| 12DE | 23.45 | 40D | 42.66 | 71D | 24.44 |
| 13D | 18.27 | 42A | 14.82 | 72D | 13.50 |
| 15A | 19.36 | 43E | 40.73 | 74C | 6.96 |
| 16F | 15.42 | 44E | 47.42 | 76A | 30.68 |
| 18F | 9.74 | 45F | 21.92 | 78E | 44.18 |
| 18F | 34.34 | 46EF | 4.88 | 79E | 33.34 |
| 1A | 37.44 | 49A | 41.43 | 80E | 26.03 |
| 20A | 37.50 | 50A | 46.29 | 81E | 38.34 |
| 21A | 29.10 | 51B | 29.66 | 82E | 26.08 |
| 22B | 39.10 | 52B | 36.32 | 84A | 4.98 |
| 23B | 22.80 | 54A | 8.93 | 84A | 42.44 |
| 25A | 46.87 | 55C | 41.70 | 85A | 40.64 |
| 26A | 19.65 | 56C | 29.41 | 86A | 29.66 |
| 27C | 23.58 | 57D | 23.07 | 87F | 47.59 |
| 28C | 22.40 | 59C | 22.18 | 89A | 30.00 |
| 29D | 27.00 | 5A | 4.21 | 8A | 29.23 |
| 2A | 28.85 | 60E | 38.32 | 90A | 40.20 |
| 31C | 21.72 | 61E | 25.87 | 91A | 34.93 |
| 33A | 22.66 | 62F | 47.37 | 92A | 31.80 |
| 34A | 46.92 | 64E | 4.82 | 93A | 25.62 |
| 35A | 36.52 | 65B | 28.20 | 94A | 37.74 |
| 37D | 24.02 | 66B | 33.34 | | |
| 38D | 19.43 | 68E | 23.42 | | |

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Newhall Ranch Company

**L E G E N D**

Main Channel

Streams

Newhall Ranch Specific Plan Boundary

Sub-Watersheds

**1A** Sub-Watersheds ID

**Soil Types**

Castaic and Saugus soils, 30 to 75 percent slopes, eroded

Castaic and Saugus soils, 30 to 65 percent slopes, severely eroded

Castaic-Balcom silty clay looms, 30 to 50 percent slopes, eroded

Castaic-Balcom silty clay looms, 50 to 65 percent slopes, eroded

Castaic-Bolcom silty clay looms, 30 to 50 percent slopes

Castaic-Balcom complex, 30 to 50 percent slopes, eroded

Hanford sandy loam, 2 to 9 percent slopes

Metz loamy sand, 2 to 9 percent slopes

Sorrento loam, 2 to 5 percent slopes

Terrace escarpments

Yolo loam, 0 to 2 percent slopes

Yolo loam, 2 to 9 percent slopes

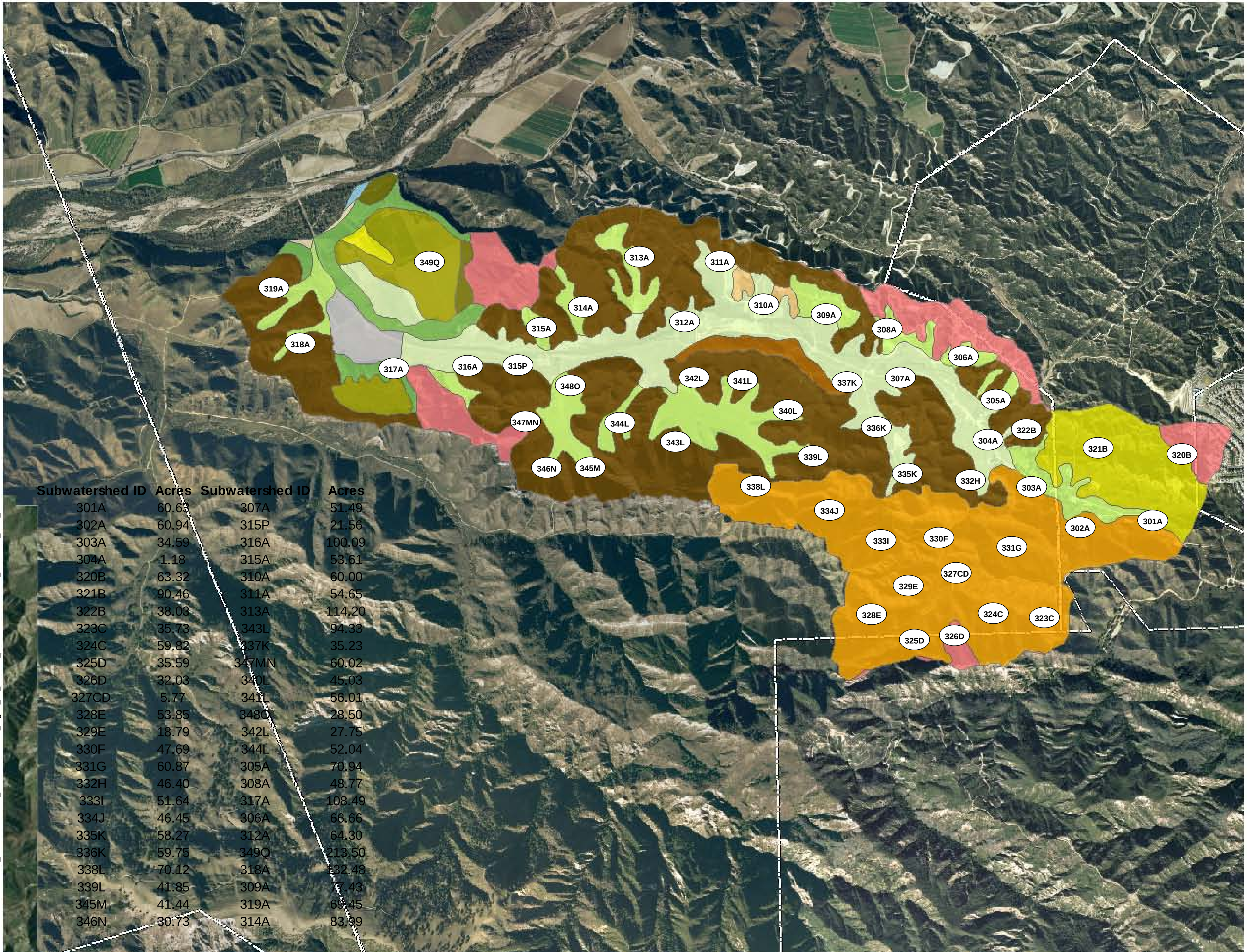
Zamora loam, 2 to 9 percent slopes

Feet: 0 375 750 1,500

Meters: 0 112.5 225 450

Figure 3.2

**WATERSHED FEATURES WITH SOILS INFORMATION SAN MARTINEZ GRANDE**




| Subwatershed ID | Acres | Subwatershed ID | Acres |
|---|---|---|---|
| 301A | 60.63 | 307A | 51.49 |
| 302A | 60.94 | 315P | 21.56 |
| 303A | 34.59 | 316A | 100.09 |
| 304A | 1.18 | 315A | 53.61 |
| 320B | 63.32 | 310A | 60.00 |
| 321B | 90.46 | 311A | 54.65 |
| 322B | 38.03 | 313A | 114.20 |
| 323C | 35.73 | 343L | 94.33 |
| 324C | 59.82 | 337K | 35.23 |
| 325D | 35.59 | 347MN | 60.02 |
| 326D | 32.03 | 340L | 45.03 |
| 327CD | 5.77 | 341L | 56.01 |
| 328E | 53.85 | 348O | 28.50 |
| 329E | 18.79 | 342L | 27.75 |
| 330F | 47.69 | 344L | 52.04 |
| 331G | 60.87 | 305A | 70.94 |
| 332H | 46.40 | 308A | 48.77 |
| 333I | 51.64 | 317A | 108.49 |
| 334J | 46.45 | 306A | 66.66 |
| 335K | 58.27 | 312A | 64.30 |
| 336K | 59.75 | 349Q | 213.50 |
| 338L | 70.12 | 318A | 132.48 |
| 339L | 41.85 | 309A | 77.43 |
| 345M | 41.44 | 319A | 69.45 |
| 346N | 30.73 | 314A | 83.99 |

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Newhall Ranch Company

**L E G E N D**

Main Channel

Streams

Newhall Ranch Specific Plan Boundary

Sub-Watersheds

**301A** Sub-Watersheds ID

**Soil Types**

Castaic-Balcom silty clay looms, 15 to 30 percent slopes

Castaic and Saugus soils, 30 to 65 percent slopes, severely eroded

Castaic-Balcom silty clay looms, 30 to 50 percent slopes, eroded

Castaic-Balcom silty clay looms, 50 to 65 percent slopes, eroded

Castaic-Bolcom silty clay looms, 30 to 50 percent slopes

Chino loam

Riverwash

Sandy alluvial land

Saugus loam, 30 to 50 percent slopes

Saugus loam, 30 to 50 percent slopes, eroded

Terrace escarpments

Yolo loam, 0 to 2 percent slopes

Yolo loam, 2 to 9 percent slopes

Zamora loam, 2 to 9 percent slopes

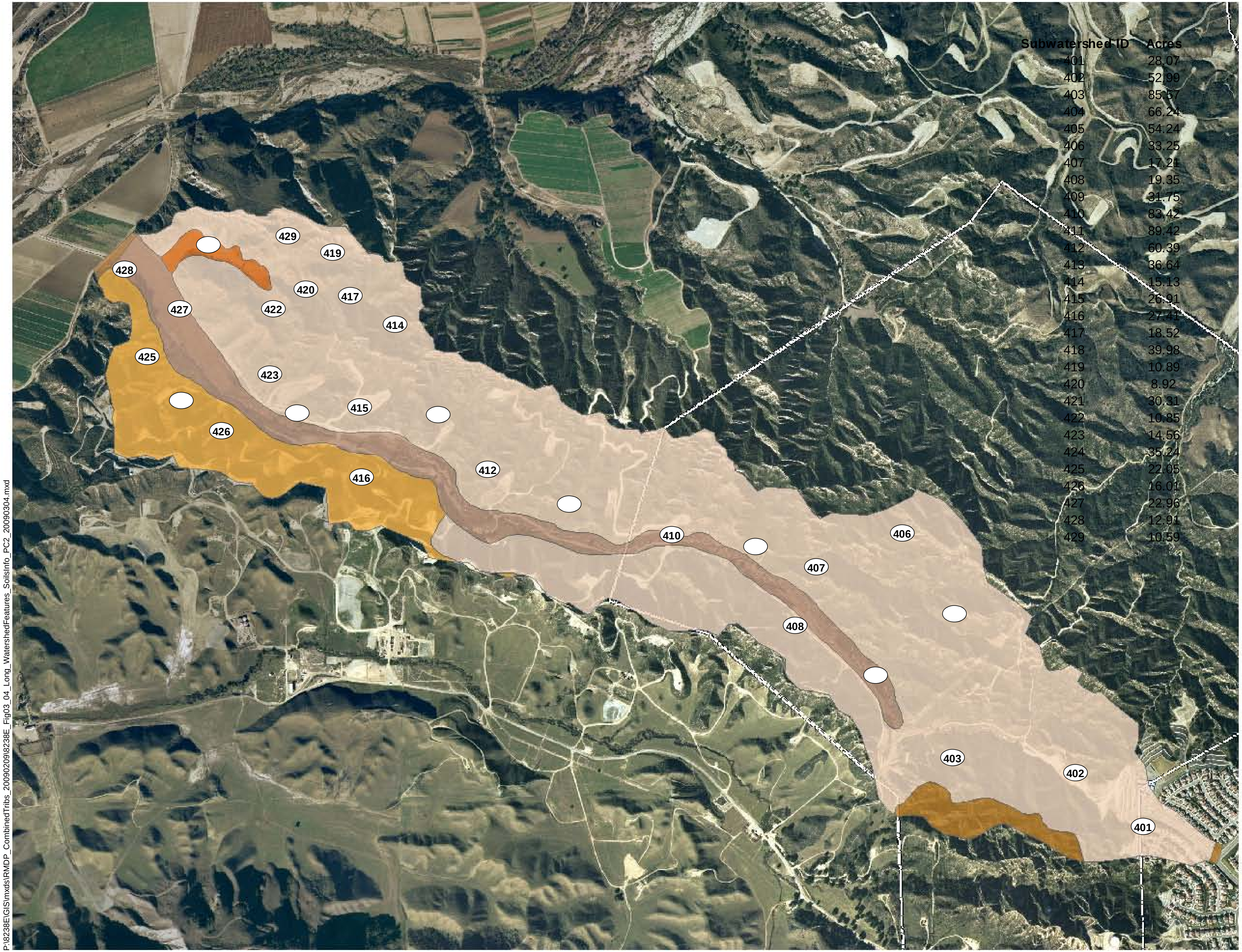
Zamora loam, 9 to 15 percent slopes

Feet: 0 500 1,000 2,000

Meters: 0 150 300 600

Figure 3.3

**WATERSHED FEATURES WITH SOILS INFORMATION POTRERO CANYON**




| Subwatershed ID | Acres |
|---|---|
| 401 | 28.07 |
| 402 | 52.99 |
| 403 | 85.57 |
| 404 | 66.24 |
| 405 | 54.24 |
| 406 | 33.25 |
| 407 | 17.21 |
| 408 | 19.35 |
| 409 | 31.75 |
| 410 | 83.42 |
| 411 | 89.42 |
| 412 | 60.39 |
| 413 | 36.64 |
| 414 | 15.13 |
| 415 | 26.91 |
| 416 | 27.41 |
| 417 | 18.52 |
| 418 | 39.98 |
| 419 | 10.89 |
| 420 | 8.92 |
| 421 | 30.31 |
| 422 | 10.85 |
| 423 | 14.56 |
| 424 | 35.24 |
| 425 | 22.05 |
| 426 | 16.01 |
| 427 | 22.96 |
| 428 | 12.91 |
| 429 | 10.59 |

Newhall Ranch Company

**L E G E N D**

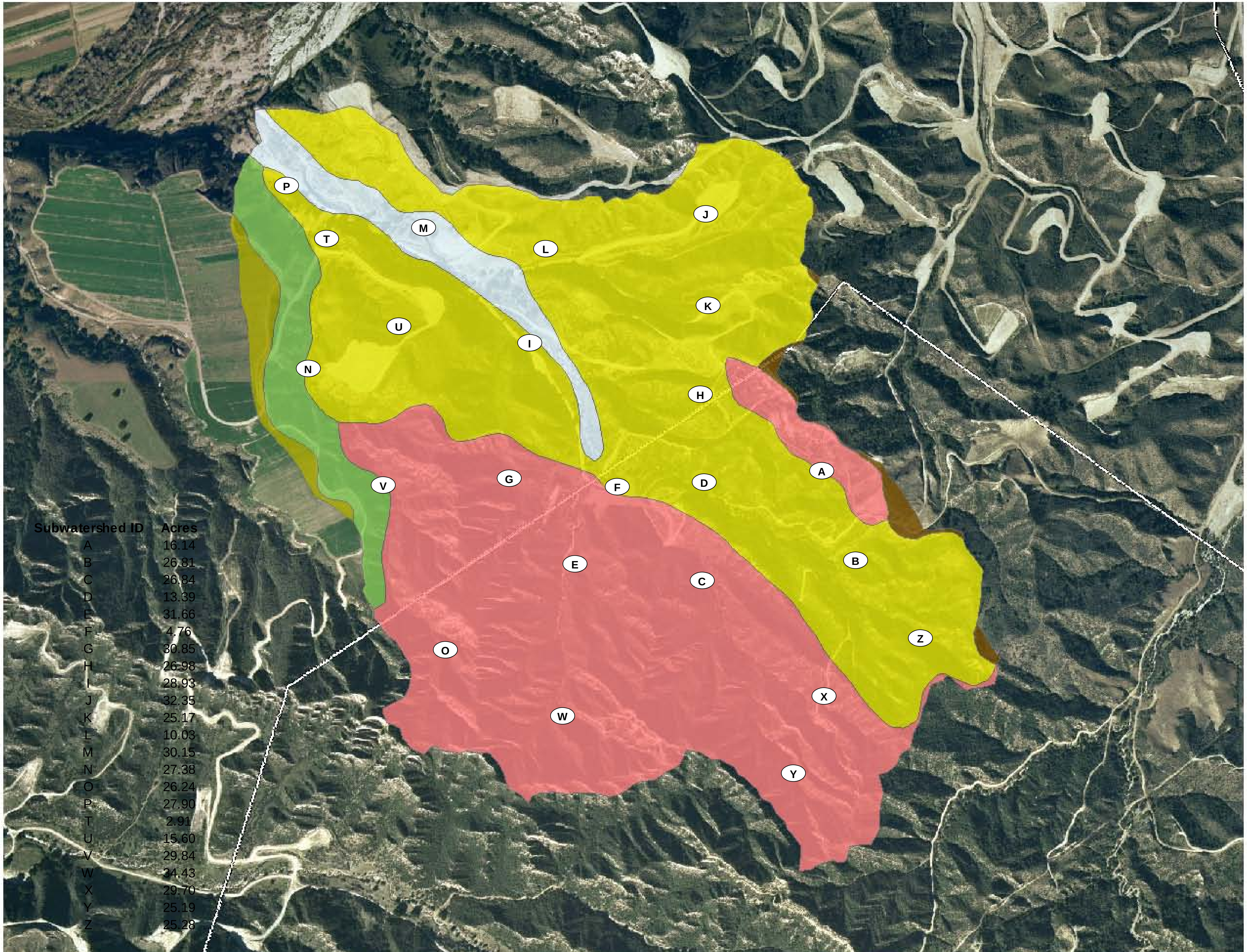
Main Channel
Streams
Newhall Ranch Specific Plan Boundary
Sub-Watersheds
401 Sub-Watersheds ID
CmF
CnG3
MfC
ScF2
SsB
YoC
ZaD

Feet: 0 325 650 1,300
Meters: 0 100 200 400

Figure 3.4

**WATERSHED FEATURES WITH SOILS INFORMATION LONG CANYON**

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig03_04_Long_WatershedFeatures_SoilsInfo_PC2_20090304.mxd




| Subwatershed ID | Acres |
|---|---|
| A | 16.14 |
| B | 26.81 |
| C | 26.84 |
| D | 13.39 |
| E | 31.66 |
| F | 4.76 |
| G | 30.85 |
| H | 26.98 |
| I | 28.93 |
| J | 32.35 |
| K | 25.17 |
| L | 10.03 |
| M | 30.15 |
| N | 27.38 |
| O | 26.24 |
| P | 27.90 |
| T | 2.91 |
| U | 15.60 |
| V | 29.84 |
| W | 34.43 |
| X | 29.70 |
| Y | 25.19 |
| Z | 25.28 |

Newhall Ranch Company

**L E G E N D**

Main Channel

Streams

Newhall Ranch Specific Plan Boundary

Sub-Watersheds

A Sub-Watersheds ID

**Soil Types**

Castaic and Saugus soils, 30 to 65 percent slopes, severely eroded

Castaic-Bolcom silty clay looms, 30 to 50 percent slopes

Metz loamy sand, 2 to 9 percent slopes

Saugus loam, 30 to 50 percent slopes, eroded

Terrace escarpments

Zamora loam, 2 to 9 percent slopes

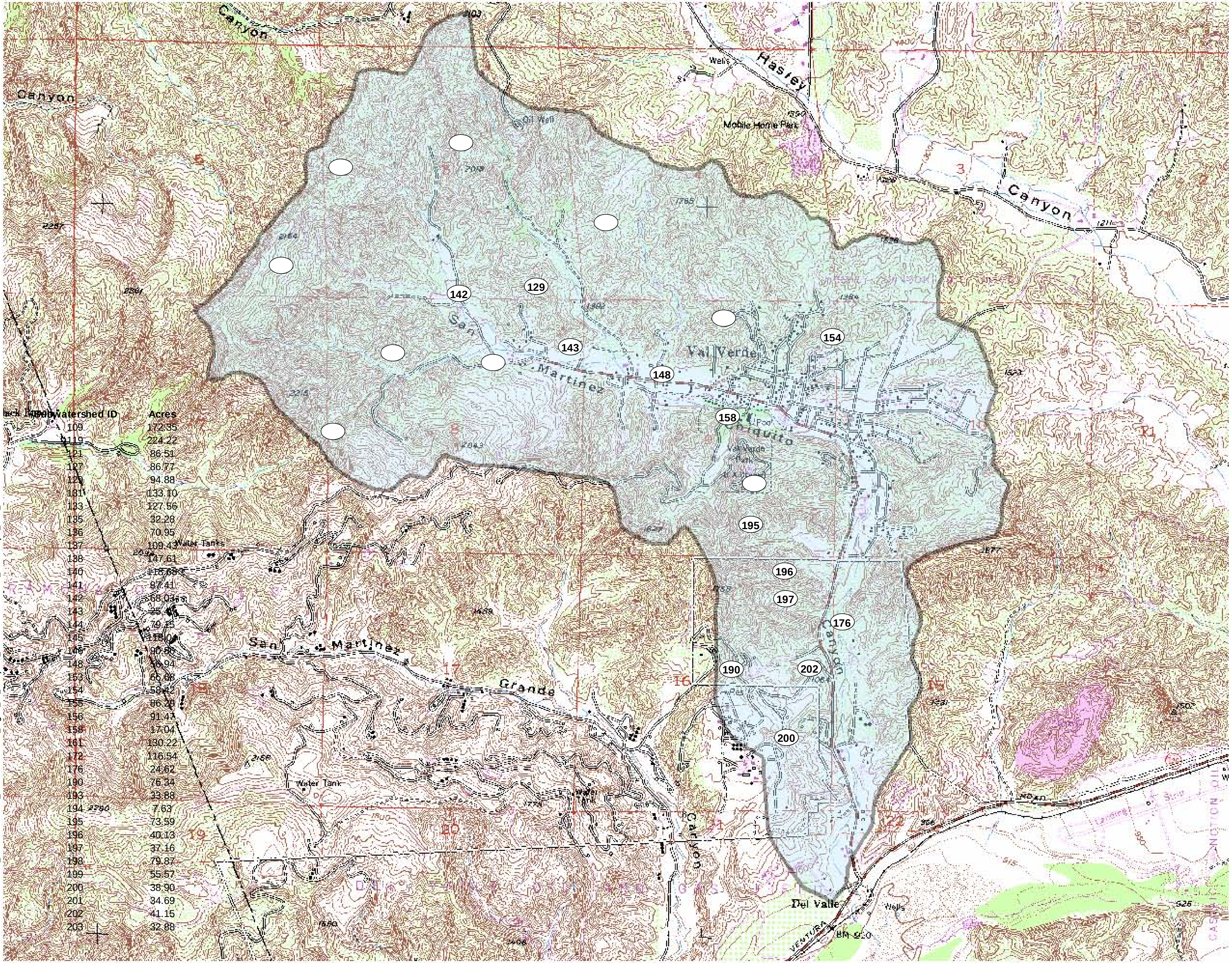
Feet: 0 200 400 800

Meters: 0 60 120 240

Figure 3.5

**WATERSHED FEATURES WITH SOILS INFORMATION LION CANYON**

FILE: \\pacefs01\projects\8238E\GIS\mxds\watershed_mxds\8238E_lion_watershed_soils_pc032305.mxd




| Subwatershed ID | Acres |
|---|---|
| 109 | 172.35 |
| 119 | 224.22 |
| 121 | 86.51 |
| 127 | 86.77 |
| 129 | 94.88 |
| 131 | 133.10 |
| 133 | 127.56 |
| 135 | 32.28 |
| 136 | 70.95 |
| 137 | 109.43 |
| 138 | 147.61 |
| 140 | 118.68 |
| 141 | 87.41 |
| 142 | 68.03 |
| 143 | 25.48 |
| 144 | 79.15 |
| 145 | 118.04 |
| 146 | 90.86 |
| 148 | 56.94 |
| 153 | 66.68 |
| 154 | 58.42 |
| 155 | 86.29 |
| 156 | 91.47 |
| 158 | 17.04 |
| 161 | 130.22 |
| 172 | 116.54 |
| 176 | 24.62 |
| 190 | 76.34 |
| 193 | 33.88 |
| 194 | 7.63 |
| 195 | 73.59 |
| 196 | 40.13 |
| 197 | 37.16 |
| 198 | 79.87 |
| 199 | 55.57 |
| 200 | 38.90 |
| 201 | 34.69 |
| 202 | 41.15 |
| 203 | 32.88 |

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Newhall Ranch Company

LEGEND

Newhall Ranch Specific Plan Boundary

Main Channel

Streams

Sub-Watersheds

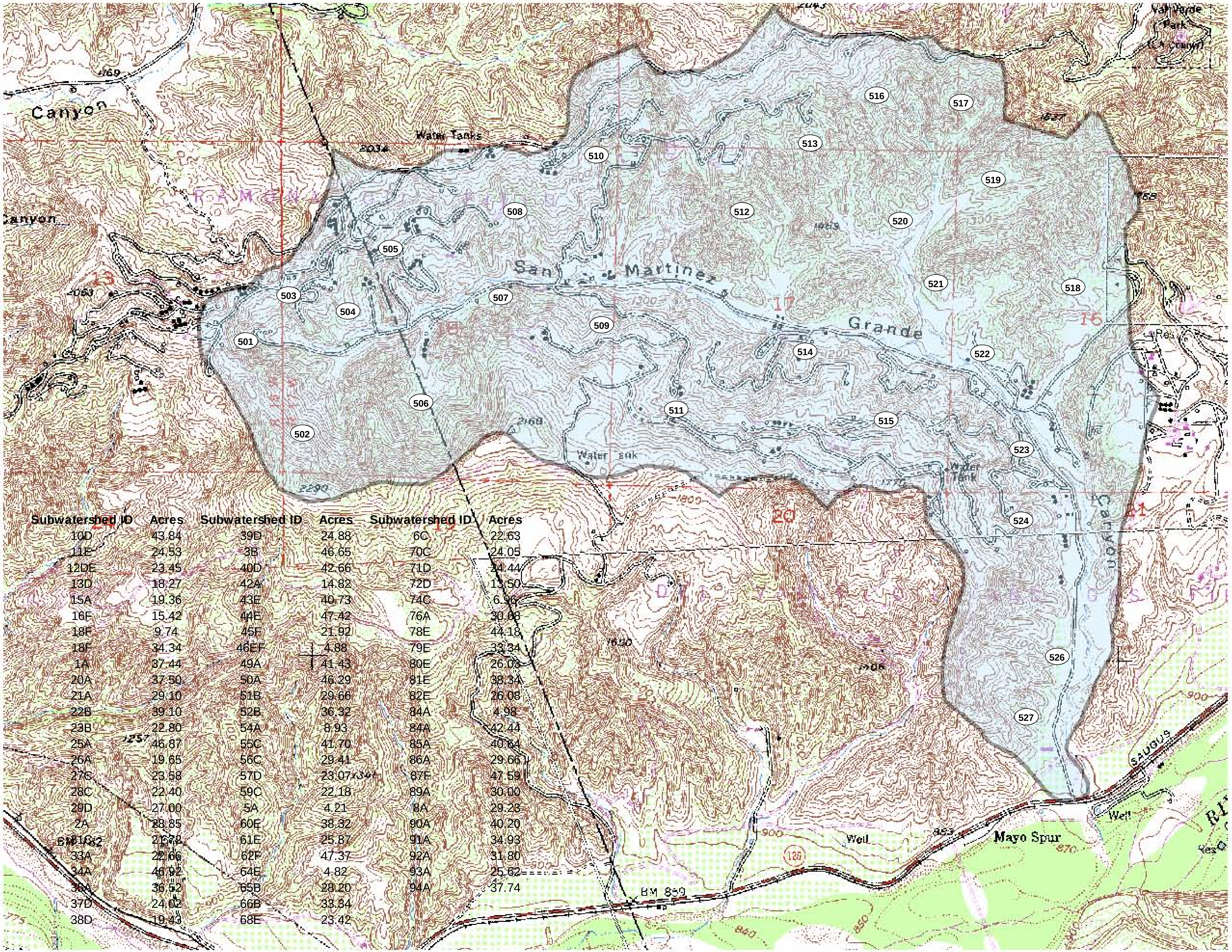
1A Sub-Watersheds ID

Feet: 0 500 1,000 2,000

Meters: 0 150 300 600

Figure 3.6

**WATERSHED FEATURES WITH USGS TOPOGRAPHY CHIQUITO CANYON**




| Subwatershed ID | Acres | Subwatershed ID | Acres | Subwatershed ID | Acres |
|---|---|---|---|---|---|
| 10D | 43.84 | 39D | 24.88 | 6C | 22.63 |
| 11E | 24.53 | 3B | 46.65 | 70C | 24.05 |
| 12DE | 23.45 | 40D | 42.66 | 71D | 24.44 |
| 13D | 18.27 | 42A | 14.82 | 72D | 13.50 |
| 15A | 19.36 | 43E | 40.73 | 74C | 6.96 |
| 16F | 15.42 | 44E | 47.42 | 76A | 30.68 |
| 18F | 9.74 | 45F | 21.92 | 78E | 44.18 |
| 18F | 34.34 | 46EF | 4.88 | 79E | 33.34 |
| 1A | 37.44 | 49A | 41.43 | 80E | 26.03 |
| 20A | 37.50 | 50A | 46.29 | 81E | 38.34 |
| 21A | 29.10 | 51B | 29.66 | 82E | 26.08 |
| 22B | 39.10 | 52B | 36.32 | 84A | 4.98 |
| 23B | 22.80 | 54A | 8.93 | 84A | 42.44 |
| 25A | 46.87 | 55C | 41.70 | 85A | 40.64 |
| 26A | 19.65 | 56C | 29.41 | 86A | 29.66 |
| 27C | 23.58 | 57D | 23.07 | 87F | 47.59 |
| 28C | 22.40 | 59C | 22.18 | 89A | 30.00 |
| 29D | 27.00 | 5A | 4.21 | 8A | 29.23 |
| 2A | 28.85 | 60E | 38.32 | 90A | 40.20 |
| 31C | 21.72 | 61E | 25.87 | 91A | 34.93 |
| 33A | 22.66 | 62F | 47.37 | 92A | 31.80 |
| 34A | 46.92 | 64E | 4.82 | 93A | 25.62 |
| 35A | 36.52 | 65B | 28.20 | 94A | 37.74 |
| 37D | 24.02 | 66B | 33.34 | | |
| 38D | 19.43 | 68E | 23.42 | | |

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Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

Main Channel

Streams

Sub-Watersheds

1A Sub-Watersheds ID

Feet

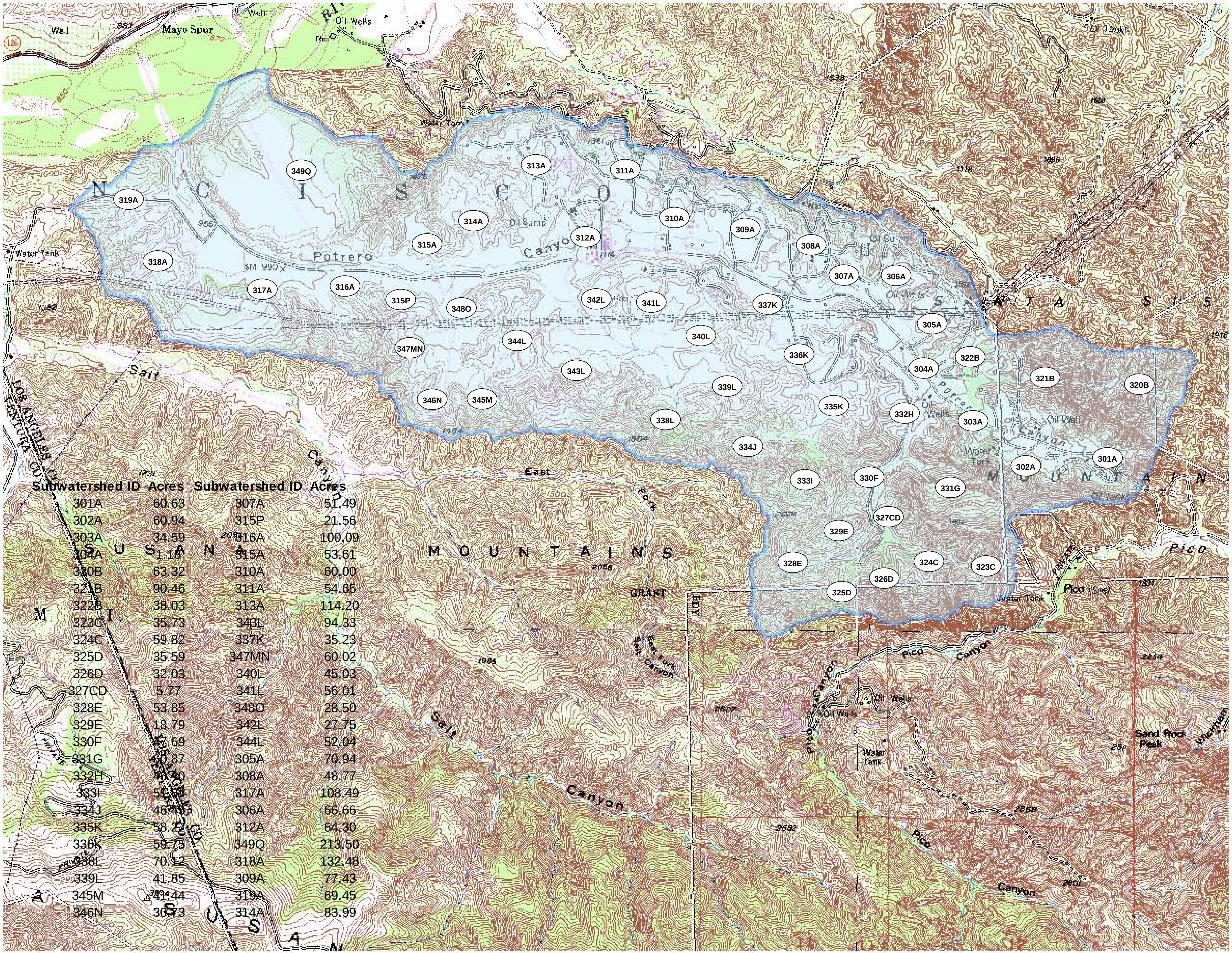
0 375 750 1,500

Meters

0 112.5 225 450

Figure 3.7

**WATERSHED FEATURES WITH USGS TOPOGRAPHY SAN MARTINEZ GRANDE**




| Subwatershed ID | Acres | Subwatershed ID | Acres |
|---|---|---|---|
| 301A | 60.63 | 307A | 51.49 |
| 302A | 60.94 | 315P | 21.56 |
| 303A | 34.59 | 316A | 100.09 |
| 304A | 1.18 | 315A | 53.61 |
| 320B | 63.32 | 310A | 60.00 |
| 321B | 90.46 | 311A | 54.65 |
| 322B | 38.03 | 313A | 114.20 |
| 323C | 35.73 | 343L | 94.33 |
| 324C | 59.82 | 337K | 35.23 |
| 325D | 35.59 | 347MN | 60.02 |
| 326D | 32.03 | 340L | 45.03 |
| 327CD | 5.77 | 341L | 56.01 |
| 328E | 53.85 | 348O | 28.50 |
| 329E | 18.79 | 342L | 27.75 |
| 330F | 47.69 | 344L | 52.04 |
| 331G | 60.87 | 305A | 70.94 |
| 332H | 46.40 | 308A | 48.77 |
| 333I | 51.64 | 317A | 108.49 |
| 334J | 46.45 | 306A | 66.66 |
| 335K | 58.27 | 312A | 64.30 |
| 336K | 59.75 | 349Q | 213.50 |
| 338L | 70.12 | 318A | 132.48 |
| 339L | 41.85 | 309A | 77.43 |
| 345M | 41.44 | 319A | 69.45 |
| 346N | 30.73 | 314A | 83.99 |

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig03_08_Potrero_WatershedFeatures_USGSTopo_PC1_20090227.mxd

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Sub-Watersheds

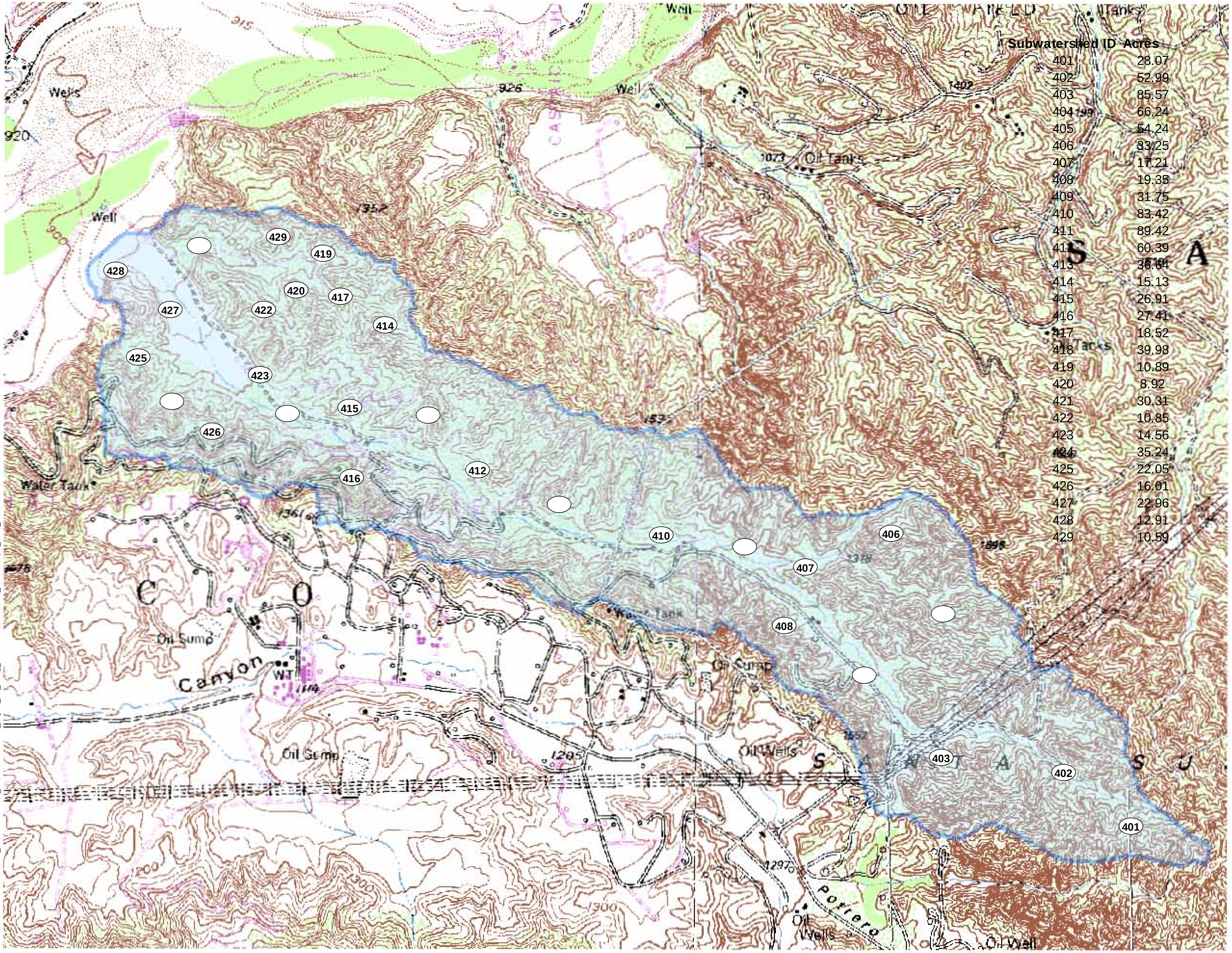
1A Sub-Watersheds ID

Feet: 0 500 1,000 2,000

Meters: 0 150 300 600

Figure 3.8

**WATERSHED FEATURES WITH USGS TOPOGRAPHY POTRERO CANYON**




| Subwatershed ID | Acres |
|---|---|
| 401 | 28.07 |
| 402 | 52.99 |
| 403 | 85.57 |
| 404 | 66.24 |
| 405 | 54.24 |
| 406 | 33.25 |
| 407 | 17.21 |
| 408 | 19.35 |
| 409 | 31.75 |
| 410 | 83.42 |
| 411 | 89.42 |
| 412 | 60.39 |
| 413 | 36.64 |
| 414 | 15.13 |
| 415 | 26.91 |
| 416 | 27.41 |
| 417 | 18.52 |
| 418 | 39.98 |
| 419 | 10.89 |
| 420 | 8.92 |
| 421 | 30.31 |
| 422 | 10.85 |
| 423 | 14.56 |
| 424 | 35.24 |
| 425 | 22.05 |
| 426 | 16.01 |
| 427 | 22.96 |
| 428 | 12.91 |
| 429 | 10.59 |

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Sub-Watersheds

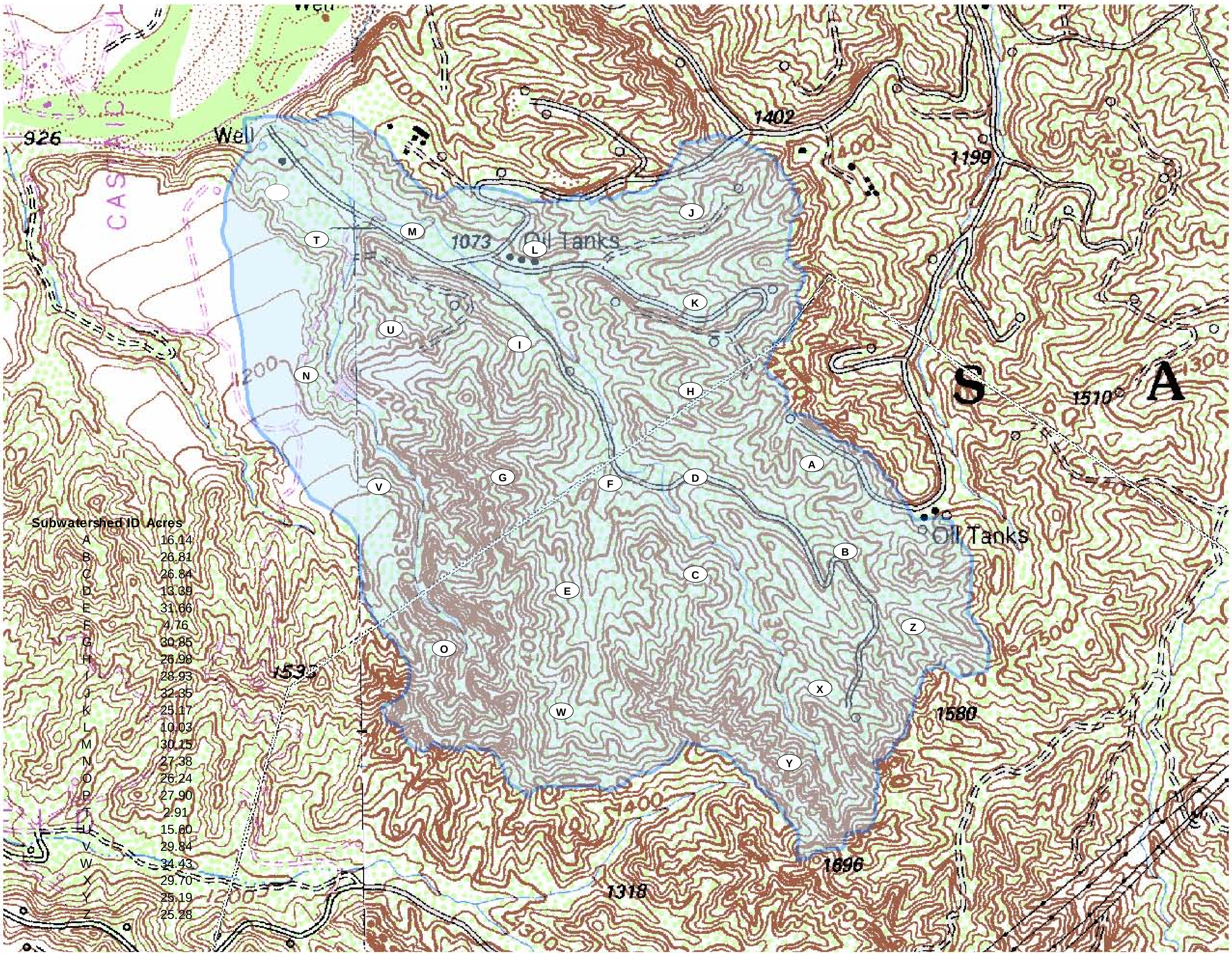
**1A** Sub-Watersheds ID

Feet
0 325 650 1,300
Meters
0 100 200 400

Figure 3.9

**WATERSHED FEATURES WITH USGS TOPOGRAPHY LONG CANYON**

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig03_09_Long_WatershedFeatures_USGSTopo_PC1_20090227.mxd




| Subwatershed ID | Acres |
|---|---|
| A | 16.14 |
| B | 26.81 |
| C | 26.84 |
| D | 13.39 |
| E | 31.66 |
| F | 4.76 |
| G | 30.85 |
| H | 26.98 |
| I | 28.93 |
| J | 32.35 |
| K | 25.17 |
| L | 10.03 |
| M | 30.15 |
| N | 27.38 |
| O | 26.24 |
| P | 27.90 |
| T | 2.91 |
| U | 15.60 |
| V | 29.84 |
| W | 34.43 |
| X | 29.70 |
| Y | 25.19 |
| Z | 25.28 |

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig03_10_Lion_WatershedFeatures_USGSTopo_PC1_20090227.mxd

Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

Sub-Watersheds

1A Sub-Watersheds ID

Feet
0 200 400 800
Meters
0 60 120 240

Figure 3.10

**WATERSHED FEATURES WITH USGS TOPOGRAPHY LION CANYON**

Once the local sub-basin boundaries had been delineated then the physical parameters representative of each area could be measured or estimated depending on the parameters required. The measured parameters included: (1) tributary area within each sub-basin boundary, (2) representative length of the overland flow planes and slope, (3) length of the main channel or collector channel and slope. The values of the measured or estimated parameters used for each of the sub-basins in each of the five watersheds are summarized in the following tables.

**Table 3.2** – Chiquito Canyon: Summary of Watershed Sub-basin Parameters

| Sub-basin | Area (sq.mi.) | Overland Flow Element | | | Collector/Main Channel Element | | |
|---|---|---|---|---|---|---|---|
| | | Length (ft) | Slope | Roughness Coeff. | Length (ft) | Slope | Roughness Coeff. |
| 109 | 0.275 | 800 | 0.33 | 0.24 | 4571 | 0.07 | 0.04 |
| 119 | 0.367 | 1000 | 0.28 | 0.24 | 4538 | 0.06 | 0.04 |
| 121 | 0.134 | 800 | 0.30 | 0.24 | 2281 | 0.06 | 0.04 |
| 127 | 0.134 | 800 | 0.16 | 0.24 | 1997 | 0.04 | 0.04 |
| 129 | 0.144 | 600 | 0.24 | 0.24 | 3312 | 0.04 | 0.04 |
| 131 | 0.204 | 700 | 0.25 | 0.24 | 4614 | 0.05 | 0.04 |
| 133 | 0.210 | 1200 | 0.36 | 0.24 | 3595 | 0.05 | 0.04 |
| 135 | 0.050 | 500 | 0.24 | 0.24 | 1443 | 0.04 | 0.04 |
| 136 | 0.109 | 800 | 0.16 | 0.24 | 1997 | 0.04 | 0.04 |
| 137 | 0.168 | 1500 | 0.19 | 0.24 | 2961 | 0.04 | 0.04 |
| 138 | 0.225 | 1200 | 0.17 | 0.24 | 3272 | 0.03 | 0.04 |
| 140 | 0.190 | 900 | 0.43 | 0.24 | 3276 | 0.06 | 0.04 |
| 141 | 0.134 | 1200 | 0.33 | 0.24 | 2677 | 0.04 | 0.04 |
| 142 | 0.105 | 1500 | 0.26 | 0.24 | 1436 | 0.04 | 0.04 |
| 143 | 0.041 | 500 | 0.17 | 0.24 | 1477 | 0.03 | 0.04 |
| 144 | 0.116 | 1000 | 0.35 | 0.24 | 2248 | 0.08 | 0.04 |
| 145 | 0.185 | 1000 | 0.47 | 0.24 | 2232 | 0.06 | 0.04 |
| 146 | 0.140 | 2000 | 0.37 | 0.24 | 1004 | 0.02 | 0.04 |
| 148 | 0.088 | 1000 | 0.21 | 0.24 | 1396 | 0.02 | 0.04 |
| 153 | 0.100 | 700 | 0.21 | 0.24 | 2146 | 0.03 | 0.04 |
| 154 | 0.089 | 2000 | 0.13 | 0.24 | 1085 | 0.02 | 0.04 |
| 155 | 0.124 | 700 | 0.16 | 0.24 | 1755 | 0.04 | 0.04 |
| 156 | 0.144 | 800 | 0.42 | 0.24 | 2597 | 0.04 | 0.04 |
| 158 | 0.026 | 600 | 0.23 | 0.24 | 473 | 0.00 | 0.04 |
| 161 | 0.198 | 1200 | 0.24 | 0.24 | 2643 | 0.03 | 0.04 |
| 172 | 0.180 | 800 | 0.35 | 0.24 | 3107 | 0.05 | 0.04 |
| 176 | 0.038 | 1000 | 0.22 | 0.24 | 825 | 0.03 | 0.04 |
| 190 | 0.131 | 1000 | 0.24 | 0.24 | 2193 | 0.05 | 0.04 |
| 193 | 0.060 | 800 | 0.14 | 0.24 | 1330 | 0.02 | 0.04 |
| 194 | 0.011 | 500 | 0.12 | 0.24 | 98 | 0.00 | 0.04 |
| 195 | 0.177 | 2500 | 0.32 | 0.24 | 669 | 0.01 | 0.04 |
| 196 | 0.061 | 1200 | 0.33 | 0.24 | 710 | 0.03 | 0.04 |
| 197 | 0.059 | 1800 | 0.36 | 0.24 | 531 | 0.03 | 0.04 |
| 198 | 0.116 | 1500 | 0.20 | 0.24 | 1176 | 0.03 | 0.04 |
| 199 | 0.076 | 2000 | 0.24 | 0.24 | 237 | 0.03 | 0.04 |
| 200 | 0.053 | 1200 | 0.18 | 0.24 | 433 | 0.03 | 0.04 |
| 201 | 0.056 | 1300 | 0.18 | 0.24 | 710 | 0.02 | 0.04 |
| 202 | 0.060 | 1000 | 0.21 | 0.24 | 1200 | 0.02 | 0.04 |
| 203 | 0.051 | 1200 | 0.21 | 0.24 | 375 | 0.02 | 0.04 |

**Table 3.3 –** San Martinez Grande Canyon:  Summary of Watershed Sub-basin Parameters

| Sub-basin | Area (sq.mi.) | Overland Flow Element | | | Collector/Main Channel Element | | |
|---|---|---|---|---|---|---|---|
| | | Length (ft) | Slope | Roughness Coeff. | Length (ft) | Slope | Roughness Coeff. |
| 501 | 0.076 | 680 | 0.09 | 0.24 | 1792 | 0.12 | 0.04 |
| 502 | 0.106 | 800 | 0.39 | 0.24 | 2125 | 0.24 | 0.04 |
| 503 | 0.035 | 780 | 0.27 | 0.24 | 943 | 0.2 | 0.04 |
| 504 | 0.06 | 900 | 0.23 | 0.24 | 1291 | 0.04 | 0.04 |
| 505 | 0.147 | 1470 | 0.37 | 0.24 | 1058 | 0.04 | 0.04 |
| 506 | 0.146 | 720 | 0.24 | 0.24 | 2138 | 0.16 | 0.04 |
| 507 | 0.126 | 1140 | 0.28 | 0.24 | 1474 | 0.03 | 0.04 |
| 508 | 0.092 | 1230 | 0.2 | 0.24 | 864 | 0.04 | 0.04 |
| 509 | 0.234 | 1370 | 0.2 | 0.24 | 1615 | 0.30 | 0.04 |
| 510 | 0.165 | 1030 | 0.14 | 0.24 | 1892 | 0.14 | 0.04 |
| 511 | 0.179 | 1000 | 0.22 | 0.24 | 2377 | 0.18 | 0.04 |
| 512 | 0.193 | 2320 | 0.17 | 0.24 | 1068 | 0.04 | 0.04 |
| 513 | 0.19 | 1450 | 0.22 | 0.24 | 2911 | 0.12 | 0.04 |
| 514 | 0.117 | 1110 | 0.33 | 0.24 | 1576 | 0.02 | 0.04 |
| 515 | 0.196 | 1140 | 0.19 | 0.24 | 1794 | 0.02 | 0.04 |
| 516 | 0.096 | 1740 | 0.2 | 0.24 | 2133 | 0.11 | 0.04 |
| 517 | 0.079 | 640 | 0.36 | 0.24 | 2169 | 0.10 | 0.04 |
| 518 | 0.269 | 1480 | 0.18 | 0.24 | 4186 | 0.05 | 0.04 |
| 519 | 0.093 | 1100 | 0.24 | 0.24 | 1997 | 0.11 | 0.04 |
| 520 | 0.040 | 840 | 0.23 | 0.24 | 883 | 0.04 | 0.04 |
| 521 | 0.103 | 1310 | 0.13 | 0.24 | 2191 | 0.03 | 0.04 |
| 522 | 0.06 | 1160 | 0.20 | 0.24 | 1098 | 0.02 | 0.04 |
| 523 | 0.071 | 1140 | 0.23 | 0.24 | 1238 | 0.02 | 0.04 |
| 524 | 0.163 | 1130 | 0.16 | 0.2 | 1690 | 0.02 | 0.04 |
| 525 | 0.061 | 1270 | 0.14 | 0.18 | 672 | 0.02 | 0.04 |
| 526 | 0.104 | 1420 | 0.15 | 0.17 | 1543 | 0.02 | 0.04 |
| 527 | 0.099 | 1430 | 0.17 | 0.18 | 1923 | 0.02 | 0.04 |

**Table 3.4** – Potrero Canyon:  Summary of Watershed Sub-basin Parameters

| Sub-basin | Area (sq.mi.) | Overland Flow Element | | | Collector/Main Channel Element | | |
|---|---|---|---|---|---|---|---|
| | | Length (ft) | Slope | Roughness Coeff. | Length (ft) | Slope | Roughness Coeff. |
| 301A | 0.095 | 760 | 0.27 | 0.24 | 1705 | 0.12 | 0.04 |
| 302A | 0.095 | 896 | 0.14 | 0.24 | 1495 | 0.06 | 0.04 |
| 303A | 0.054 | 1006 | 0.11 | 0.24 | 1897 | 0.04 | 0.04 |
| 304A | 0.002 | 226 | 0.02 | 0.24 | 226 | 0.02 | 0.04 |
| 305A | 0.111 | 1251 | 0.07 | 0.24 | 1118 | 0.02 | 0.04 |
| 306A | 0.104 | 1614 | 0.08 | 0.24 | 1102 | 0.03 | 0.04 |
| 307A | 0.080 | 1315 | 0.09 | 0.24 | 1175 | 0.02 | 0.04 |
| 308A | 0.076 | 1214 | 0.06 | 0.24 | 1287 | 0.02 | 0.04 |
| 309A | 0.121 | 1496 | 0.05 | 0.24 | 1142 | 0.03 | 0.04 |
| 310A | 0.094 | 776 | 0.02 | 0.24 | 1361 | 0.02 | 0.04 |
| 311A | 0.085 | 1750 | 0.07 | 0.24 | 447 | 0.02 | 0.04 |
| 312A | 0.100 | 894 | 0.06 | 0.24 | 1979 | 0.02 | 0.04 |
| 313A | 0.178 | 2025 | 0.03 | 0.24 | 221 | 0.04 | 0.04 |
| 314A | 0.131 | 1656 | 0.07 | 0.24 | 1226 | 0.02 | 0.04 |
| 315A | 0.084 | 1233 | 0.08 | 0.24 | 1357 | 0.02 | 0.04 |
| 315P | 0.034 | 770 | 0.08 | 0.24 | 351 | 0.01 | 0.04 |
| 316A | 0.156 | 1919 | 0.09 | 0.24 | 1516 | 0.02 | 0.04 |
| 317A | 0.170 | 1625 | 0.08 | 0.24 | 1436 | 0.02 | 0.04 |
| 318A | 0.207 | 3363 | 0.08 | 0.24 | 2024 | 0.03 | 0.04 |
| 319A | 0.109 | 1217 | 0.14 | 0.24 | 725 | 0.06 | 0.04 |
| 320B | 0.099 | 694 | 0.19 | 0.24 | 5414 | 0.03 | 0.04 |

| Sub-basin | Area (sq.mi.) | Overland Flow Element | | | Collector/Main Channel Element | | |
|---|---|---|---|---|---|---|---|
| | | Length (ft) | Slope | Roughness Coeff. | Length (ft) | Slope | Roughness Coeff. |
| 321B | 0.141 | 503 | 0.41 | 0.24 | 2189 | 0.04 | 0.04 |
| 322B | 0.059 | 632 | 0.10 | 0.24 | 1372 | 0.04 | 0.04 |
| 323C | 0.056 | 477 | 0.32 | 0.24 | 692 | 0.31 | 0.04 |
| 324C | 0.093 | 555 | 0.26 | 0.24 | 1728 | 0.07 | 0.04 |
| 325D | 0.056 | 278 | 0.30 | 0.24 | 2447 | 0.24 | 0.04 |
| 326D | 0.050 | 1115 | 0.27 | 0.24 | 920 | 0.07 | 0.04 |
| 327CD | 0.009 | 517 | 0.26 | 0.24 | 415 | 0.05 | 0.04 |
| 328E | 0.084 | 566 | 0.22 | 0.24 | 1818 | 0.11 | 0.04 |
| 329E | 0.029 | 715 | 0.26 | 0.24 | 889 | 0.07 | 0.04 |
| 330F | 0.075 | 542 | 0.15 | 0.24 | 1527 | 0.05 | 0.04 |
| 331G | 0.095 | 1040 | 0.14 | 0.24 | 2369 | 0.00 | 0.04 |
| 332H | 0.072 | 760 | 0.12 | 0.24 | 1710 | 0.03 | 0.04 |
| 333I | 0.081 | 494 | 0.28 | 0.24 | 2647 | 0.20 | 0.04 |
| 334J | 0.073 | 1106 | 0.27 | 0.24 | 1754 | 0.08 | 0.04 |
| 335K | 0.091 | 909 | 0.10 | 0.24 | 834 | 0.05 | 0.04 |
| 336K | 0.094 | 1259 | 0.05 | 0.24 | 1364 | 0.36 | 0.04 |
| 337K | 0.055 | 914 | 0.10 | 0.24 | 1721 | 0.02 | 0.04 |
| 338L | 0.110 | 1132 | 0.16 | 0.24 | 1978 | 0.13 | 0.04 |
| 339L | 0.065 | 667 | 0.14 | 0.24 | 1789 | 0.05 | 0.04 |
| 340L | 0.070 | 1889 | 0.05 | 0.24 | 730 | 0.04 | 0.04 |
| 341L | 0.088 | 1662 | 0.04 | 0.24 | 622 | 0.04 | 0.04 |
| 342L | 0.043 | 822 | 0.09 | 0.24 | 1590 | 0.03 | 0.04 |
| 343L | 0.147 | 1012 | 0.08 | 0.24 | 2596 | 0.08 | 0.04 |
| 344L | 0.081 | 2397 | 0.04 | 0.24 | 717 | 0.01 | 0.04 |
| 345M | 0.065 | 714 | 0.18 | 0.24 | 2081 | 0.12 | 0.04 |
| 346N | 0.048 | 679 | 0.10 | 0.24 | 1520 | 0.07 | 0.04 |
| 347MN | 0.094 | 1671 | 0.13 | 0.24 | 350 | 0.04 | 0.04 |
| 348O | 0.045 | 641 | 0.07 | 0.24 | 1626 | 0.03 | 0.04 |
| 349Q | 0.334 | 1971 | 0.11 | 0.24 | 1974 | 0.10 | 0.04 |

**Table 3.5 –** Long Canyon Summary of Watershed Sub-basin Parameters

| Sub-basin | Area (sq.mi.) | Overland Flow Element | | | Collector/Main Channel Element | | |
|---|---|---|---|---|---|---|---|
| | | Length (ft) | Slope | Roughness Coeff. | Length (ft) | Slope | Roughness Coeff. |
| 401 | 0.044 | 420 | 0.18 | 0.24 | 1632 | 0.12 | 0.04 |
| 402 | 0.083 | 960 | 0.19 | 0.24 | 859 | 0.07 | 0.04 |
| 403 | 0.134 | 970 | 0.18 | 0.24 | 2525 | 0.04 | 0.04 |
| 405 | 0.085 | 1240 | 0.14 | 0.24 | 1273 | 0.03 | 0.04 |
| 408 | 0.030 | 550 | 0.15 | 0.24 | 1022 | 0.04 | 0.04 |
| 404 | 0.103 | 1030 | 0.16 | 0.24 | 2495 | 0.09 | 0.04 |
| 406 | 0.052 | 570 | 0.21 | 0.24 | 1563 | 0.08 | 0.04 |
| 407 | 0.027 | 690 | 0.18 | 0.24 | 1093 | 0.06 | 0.04 |
| 409 | 0.050 | 660 | 0.18 | 0.24 | 853 | 0.04 | 0.04 |
| 410 | 0.130 | 1230 | 0.13 | 0.24 | 560 | 0.04 | 0.04 |
| 411 | 0.140 | 1110 | 0.10 | 0.24 | 1608 | 0. 03 | 0.04 |
| 412 | 0.094 | 1110 | 0.11 | 0.24 | 1109 | 0.04 | 0.04 |
| 413 | 0.057 | 1000 | 0.15 | 0.24 | 742 | 0.03 | 0.04 |
| 416 | 0.043 | 1030 | 0.14 | 0.24 | 863 | 0.03 | 0.04 |
| 415 | 0.042 | 640 | 0.11 | 0.24 | 411 | 0.01 | 0.04 |
| 418 | 0.062 | 640 | 0.15 | 0.24 | 569 | 0.04 | 0.04 |
| 423 | 0.023 | 660 | 0.13 | 0.24 | 526 | 0.03 | 0.04 |

| Sub-basin | Area (sq.mi.) | Overland Flow Element | | | Collector/Main Channel Element | | |
|---|---|---|---|---|---|---|---|
| | | Length (ft) | Slope | Roughness Coeff. | Length (ft) | Slope | Roughness Coeff. |
| 426 | 0.025 | 880 | 0.11 | 0.24 | 234 | 0.56 | 0.04 |
| 424 | 0.055 | 1150 | 0.13 | 0.24 | 450 | 0.02 | 0.04 |
| 425 | 0.034 | 980 | 0.08 | 0.24 | 204 | 0.03 | 0.04 |
| 427 | 0.036 | 650 | 0.12 | 0.24 | 1068 | 0.03 | 0.04 |
| 414 | 0.024 | 710 | 0.19 | 0.24 | 891 | 0.17 | 0.04 |
| 417 | 0.029 | 330 | 0.26 | 0.24 | 778 | 0.08 | 0.04 |
| 420 | 0.014 | 300 | 0.27 | 0.24 | 602 | 0.04 | 0.04 |
| 419 | 0.017 | 230 | 0.16 | 0.24 | 830 | 0.17 | 0.04 |
| 429 | 0.025 | 410 | 0.15 | 0.24 | 517 | 0.07 | 0.04 |
| 422 | 0.017 | 250 | 0.22 | 0.24 | 1025 | 0.11 | 0.04 |
| 421 | 0.064 | 410 | 0.16 | 0.24 | 2172 | 0.05 | 0.04 |
| 428 | 0.020 | 580 | 0.22 | 0.24 | 620 | 0.04 | 0.04 |

**Table 3.6 –** Lion Canyon:  Summary of Watershed Sub-basin Parameters

| Sub-basin | Area (sq.mi.) | Overland Flow Element | | | Collector/Main Channel Element | | |
|---|---|---|---|---|---|---|---|
| | | Length (ft) | Slope | Roughness Coeff. | Length (ft) | Slope | Roughness Coeff. |
| A | 0.025 | 1238 | 0.2 | 0.24 | 858 | 0.12 | 0.04 |
| B | 0.081 | 2515 | 0.12 | 0.24 | 2010 | 0.07 | 0.04 |
| C | 0.042 | 2401 | 0.04 | 0.24 | 1508 | 0.05 | 0.04 |
| D | 0.021 | 1162 | 0.19 | 0.24 | 1126 | 0.06 | 0.04 |
| E | 0.103 | 3230 | 0.13 | 0.24 | 2790 | 0.08 | 0.04 |
| F | 0.007 | 886 | 0.23 | 0.24 | 467 | 0.05 | 0.04 |
| G | 0.048 | 2372 | 0.17 | 0.24 | 704 | 0.04 | 0.04 |
| H | 0.042 | 2135 | 0.18 | 0.24 | 1702 | 0.1 | 0.04 |
| I | 0.045 | 1838 | 0.17 | 0.24 | 1151 | 0.04 | 0.04 |
| J | 0.051 | 1933 | 0.16 | 0.24 | 1631 | 0.1 | 0.04 |
| K | 0.039 | 2061 | 0.17 | 0.24 | 1678 | 0.1 | 0.04 |
| L | 0.016 | 1384 | 0.19 | 0.24 | 1013 | 0.07 | 0.04 |
| M | 0.046 | 2382 | 0.12 | 0.24 | 1550 | 0.05 | 0.04 |
| N | 0.043 | 1546 | 0.17 | 0.24 | 1461 | 0.06 | 0.04 |
| O | 0.041 | 2796 | 0.13 | 0.24 | 1550 | 0.05 | 0.04 |
| P | 0.044 | 2017 | 0.12 | 0.24 | 994 | 0.05 | 0.04 |
| T | 0.005 | 678 | 0.22 | 0.24 | 532 | 0.22 | 0.04 |
| U | 0.024 | 1576 | 0.21 | 0.24 | 832 | 0.1 | 0.04 |
| V | 0.047 | 2151 | 0.18 | 0.24 | 1082 | 0.07 | 0.04 |
| W | 0.054 | 1711 | 0.19 | 0.24 | 1270 | 0.1 | 0.04 |
| X | 0.046 | 1987 | 0.2 | 0.24 | 535 | 0.07 | 0.04 |
| Y | 0.039 | 1890 | 0.22 | 0.24 | 1221 | 0.1 | 0.04 |
| Z | 0.04 | 1207 | 0.23 | 0.24 | 814 | 0.1 | 0.04 |
| A | 0.025 | 1238 | 0.2 | 0.24 | 858 | 0.12 | 0.04 |
| B | 0.081 | 2515 | 0.12 | 0.24 | 2010 | 0.07 | 0.04 |
| C | 0.042 | 2401 | 0.04 | 0.24 | 1508 | 0.05 | 0.04 |

## 3.4 Watershed Analysis Results

The results of the watershed hydrologic modeling are summarized in each of the following sub-sections including tables and figures reflecting the six storm return period (2- through 100-year), and both the developed and existing watershed land use conditions. These tables reflect the peak discharges at various concentration points within the watersheds and a numbered sequential from the upstream headwaters of each watershed. The hydrologic modeling reflects conservative estimates of the watershed response associated with a single hypothetical rainfall event and it is not intended to reproduce historical storm events or historical time series.

### *3.4.1 Chiquito Canyon*

**Table 3.5** – Chiquito Canyon Hydrology HEC-1 Results

| Node / Conc. Point | Total Drainage Area (sq.mi.) | "Existing" Condition Peak Flow (cfs) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 100-Year | 50-Year | 20-Year | 10-Year | 5-Year | 2-year |
| 119 | 0.367 | 427 | 339 | 251 | 111 | 45 | 18 |
| 135 | 0.050 | 711 | 572 | 422 | 182 | 76 | 31 |
| 142 | 0.105 | 1423 | 1146 | 846 | 375 | 158 | 60 |
| 143 | 0.041 | 1595 | 1286 | 944 | 427 | 181 | 69 |
| 148 | 0.088 | 2751 | 2225 | 1637 | 747 | 322 | 124 |
| 153 | 0.100 | 3004 | 2423 | 1789 | 832 | 360 | 140 |
| 158 | 0.026 | 3434 | 2761 | 2054 | 948 | 409 | 159 |
| 161 | 0.198 | 3917 | 3140 | 2378 | 1074 | 459 | 180 |
| 176 | 0.038 | 4205 | 3453 | 2590 | 1156 | 504 | 196 |
| 193 | 0.177 | 4663 | 3768 | 2785 | 1252 | 545 | 216 |
| 195 | 0.061 | 4178 | 3352 | 2537 | 1144 | 490 | 192 |
| 196 | 0.059 | 4199 | 3396 | 2563 | 1153 | 497 | 194 |
| 197 | 0.116 | 4219 | 3431 | 2583 | 1157 | 501 | 195 |
| 198 | 0.076 | 4482 | 3663 | 2723 | 1209 | 528 | 206 |
| 199 | 0.053 | 4389 | 3600 | 2697 | 1199 | 523 | 203 |
| 200 | 0.056 | 4564 | 3718 | 2741 | 1228 | 532 | 209 |
| 201 | 0.060 | 4526 | 3688 | 2727 | 1218 | 529 | 207 |
| 202 | 0.051 | 4603 | 3737 | 2734 | 1239 | 535 | 211 |
| 203 | 0.177 | 4641 | 3764 | 2755 | 1247 | 539 | 213 |

Note: Light green shaded areas indicate concentration points within the Newhall Ranch.

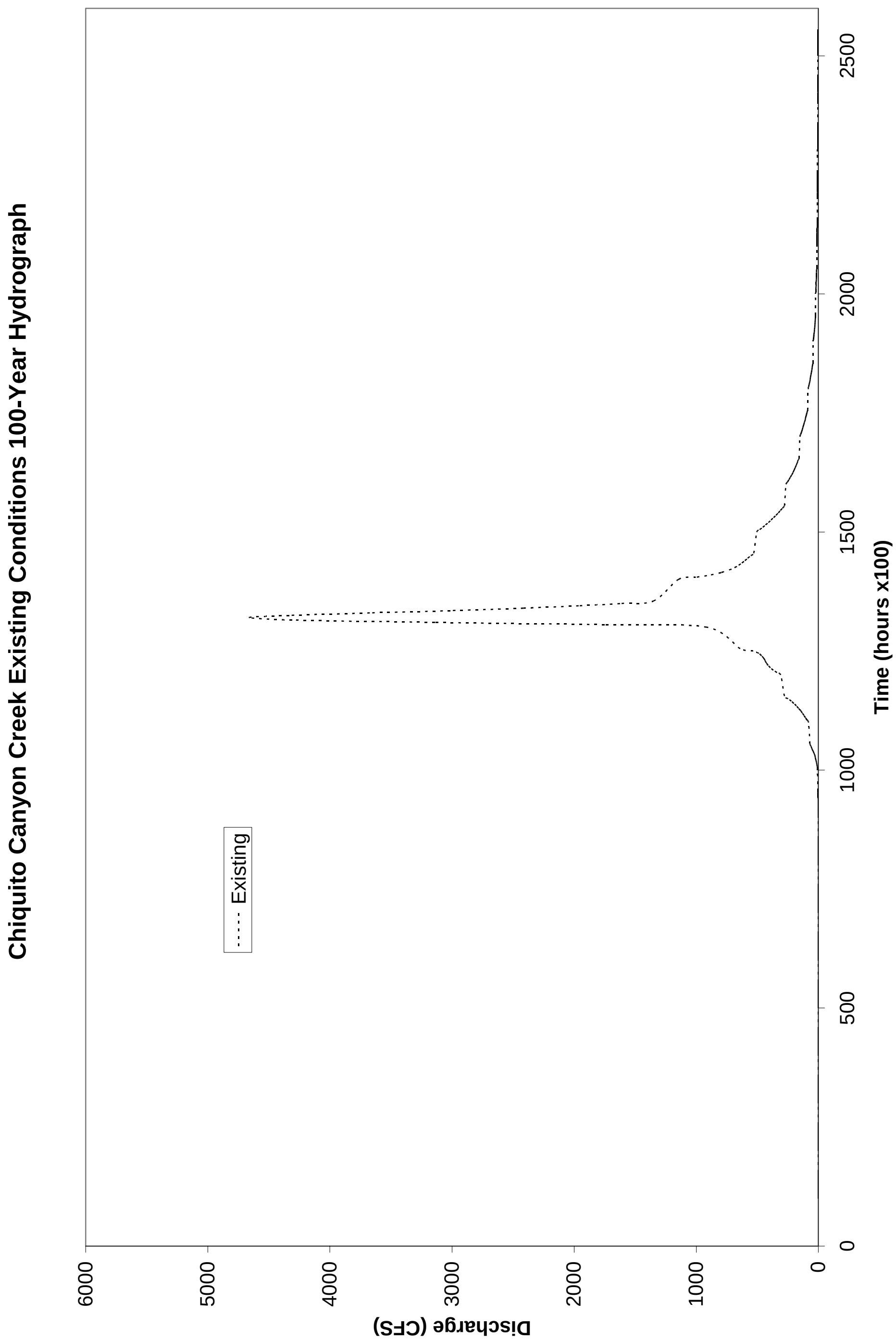



**Figure 3.11 –** Chiquito Canyon 100-Year Runoff Hydrograph Existing Conditions

### *3.4.2 San Martinez Grande Canyon*

**Table 3.8 -** San Martinez Grande Hydrology HEC-1 Results

| Node / Conc. Point | Total Drainage Area (sq.mi.) | "Existing" Condition Peak Flow (cfs) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 100-Year | 50-Year | 20-Year | 10-Year | 5-Year | 2-Year |
| 503 | 0.22 | 280 | 223 | 165 | 78 | 33 | 12 |
| 506 | 0.42 | 553 | 441 | 331 | 159 | 67 | 26 |
| 508 | 0.79 | 890 | 724 | 538 | 243 | 102 | 39 |
| 509 | 1.19 | 12451 | 997 | 727 | 316 | 134 | 50 |
| 511 | 1.56 | 1541 | 1252 | 899 | 385 | 161 | 61 |
| 514 | 1.68 | 1651 | 1309 | 968 | 418 | 175 | 66 |
| 521 | 2.47 | 2369 | 1884 | 1392 | 589 | 247 | 94 |
| 522 | 2.53 | 2390 | 1929 | 522 | 597 | 252 | 95 |
| 523 | 2.87 | 2633 | 2152 | 1564 | 655 | 276 | 105 |
| 524 | 3.04 | 2796 | 2255 | 1623 | 687 | 289 | 109 |
| 525 | 3.10 | 2840 | 2285 | 1646 | 696 | 292 | 111 |
| 526 | 3.20 | 2905 | 2324 | 1690 | 707 | 299 | 113 |
| 527 | 3.30 | 2951 | 2346 | 1727 | 709 | 304 | 116 |

Note: Light green shaded areas indicate concentration points within the Newhall Ranch. Node 527 is located at the 126 Freeway junction with the Santa Clara River and the Newhall Ranch property boundary is located between Nodes 523 and 524.

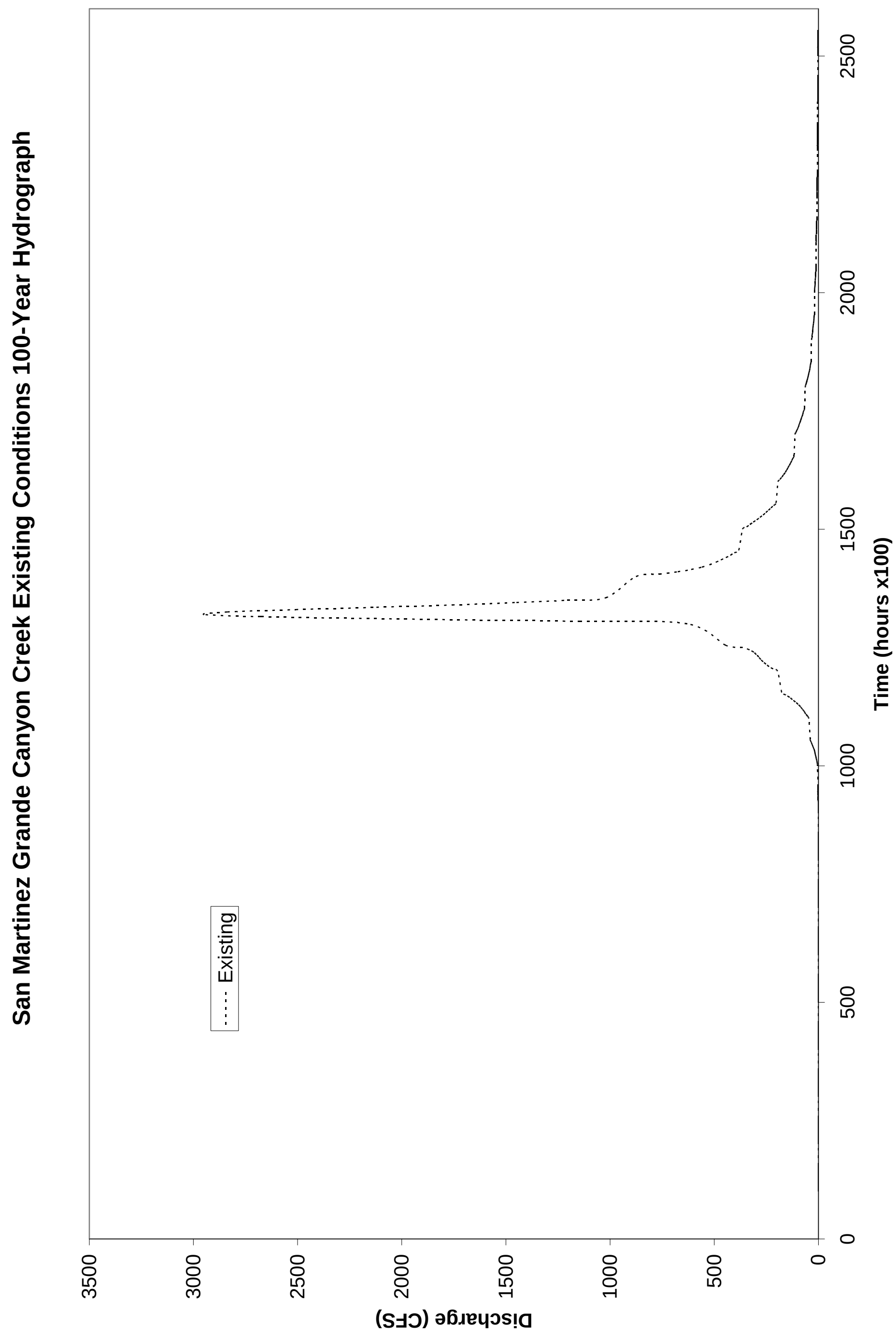



**Figure 3.12 –** San Martinez Grande Canyon 100-Year Runoff Hydrograph Existing Conditions

### 3.4.3 *Potrero Canyon*

**Table 3.6 -** Potrero Canyon Hydrology HEC-1 Results

| Node / Conc. Point | Total Drainage Area (sq.mi.) | "Existing" Condition Peak Flow (cfs) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 100-Year | 50-Year | 20-Year | 10-Year | 5-Year | 2-Year |
| 301A | 0.095 | ------------ | ------------ | ------------ | ------------ | ------------ | ------------ |
| 302A | 0.095 | ------------ | ------------ | ------------ | ------------ | ------------ | ------------ |
| 303A | 0.054 | 282 | 228 | 168 | 74 | 31 | 13 |
| 304A | 0.002 | 1363 | 1115 | 851 | 400 | 183 | 70 |
| 305A | 0.111 | 1424 | 1164 | 877 | 412 | 183 | 72 |
| 306A | 0.104 | 1479 | 1202 | 887 | 419 | 187 | 73 |
| 307A | 0.080 | 1521 | 1227 | 891 | 422 | 190 | 74 |
| 308A | 0.076 | 1543 | 1234 | 911 | 420 | 189 | 75 |
| 309A | 0.121 | 1942 | 1548 | 1144 | 519 | 231 | 92 |
| 310A | 0.094 | 1955 | 1588 | 1166 | 527 | 234 | 93 |
| 311A | 0.085 | 1991 | 1619 | 1183 | 532 | 236 | 94 |
| 312A | 0.100 | 2070 | 1669 | 1199 | 534 | 238 | 95 |
| 314A | 0.178 | 2604 | 2064 | 1473 | 641 | 281 | 111 |
| 315A | 0.131 | 2639 | 2081 | 1501 | 648 | 283 | 112 |
| 315P | 0.084 | 2883 | 2276 | 1640 | 707 | 307 | 121 |
| 316A | 0.156 | 2935 | 2315 | 1672 | 712 | 312 | 123 |
| 317A | 0.170 | 2991 | 2389 | 1706 | 723 | 317 | 124 |
| 318A | 0.207 | 3045 | 2429 | 1708 | 732 | 317 | 126 |
| 319A | 0.109 | 3309 | 2619 | 1853 | 764 | 337 | 133 |

Note: Light green shaded areas indicate concentration points within the Newhall Ranch.

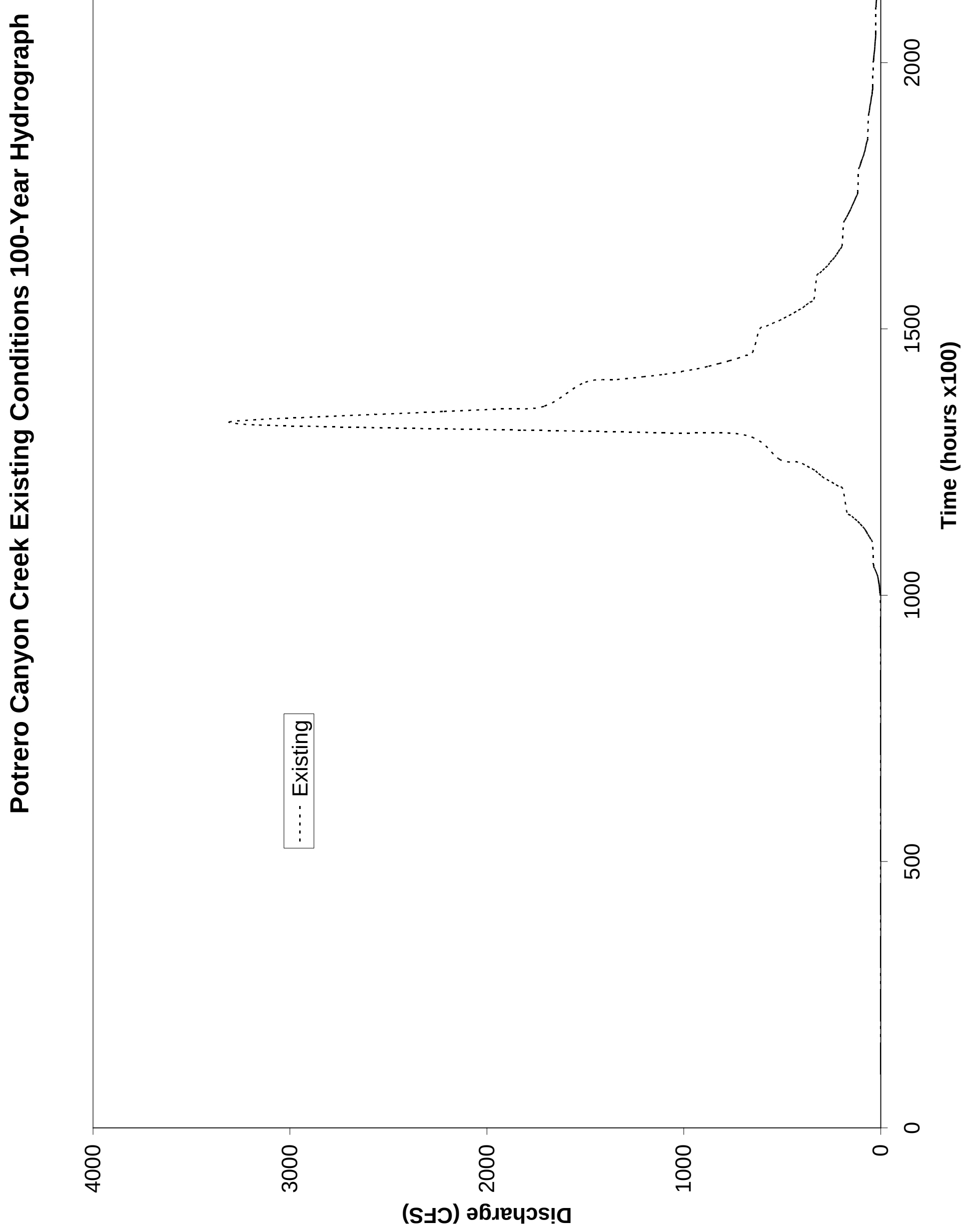



**Figure 3.13 –** Potrero Canyon 100-Year Runoff Hydrograph Existing Conditions

### *3.4.4 Long Canyon*

**Table 3.7 -** Long Canyon Hydrology HEC-1 Results

| Node / Conc. Point | Total Drainage Area (sq.mi.) | "Existing" Condition Peak Flow (cfs) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 100-Year | 50-Year | 20-Year | 10-Year | 5-Year | 2-Year |
| 401 | 0.044 | 72 | 60 | 47 | 24 | 11 | 4 |
| 402 | 0.083 | 161 | 128 | 96 | 45 | 20 | 8 |
| 403 | 0.134 | 298 | 241 | 180 | 79 | 34 | 13 |
| 405 | 0.085 | 369 | 299 | 216 | 93 | 40 | 15 |
| 408 | 0.030 | 401 | 328 | 235 | 103 | 45 | 17 |
| 409 | 0.050 | 663 | 544 | 395 | 175 | 75 | 30 |
| 410 | 0.13 | 763 | 609 | 445 | 195 | 84 | 33 |
| 411 | 0.14 | 862 | 686 | 510 | 218 | 94 | 36 |
| 412 | 0.094 | 927 | 749 | 553 | 234 | 100 | 39 |
| 413 | 0.057 | 975 | 793 | 582 | 245 | 105 | 41 |
| 416 | 0.024 | 1014 | 822 | 601 | 252 | 108 | 42 |
| 415 | 0.042 | 1051 | 854 | 624 | 264 | 114 | 44 |
| 418 | 0.043 | 1103 | 898 | 662 | 281 | 122 | 48 |
| 423 | 0.029 | 1123 | 915 | 672 | 287 | 124 | 49 |
| 426 | 0.062 | 1145 | 933 | 686 | 292 | 127 | 50 |
| 424 | 0.017 | 1192 | 969 | 709 | 303 | 131 | 51 |
| 425 | 0.014 | 1220 | 990 | 723 | 309 | 133 | 52 |
| 427 | 0.064 | 1253 | 1013 | 738 | 318 | 137 | 54 |
| 428 | 0.02 | 1455 | 25 | 862 | 367 | 159 | 62 |

Note: Light green shaded areas indicate concentration points within the Newhall Ranch. Node 428 is located at the junction with the Santa Clara River and the Newhall Ranch property boundary is located between Nodes 409 and 410.

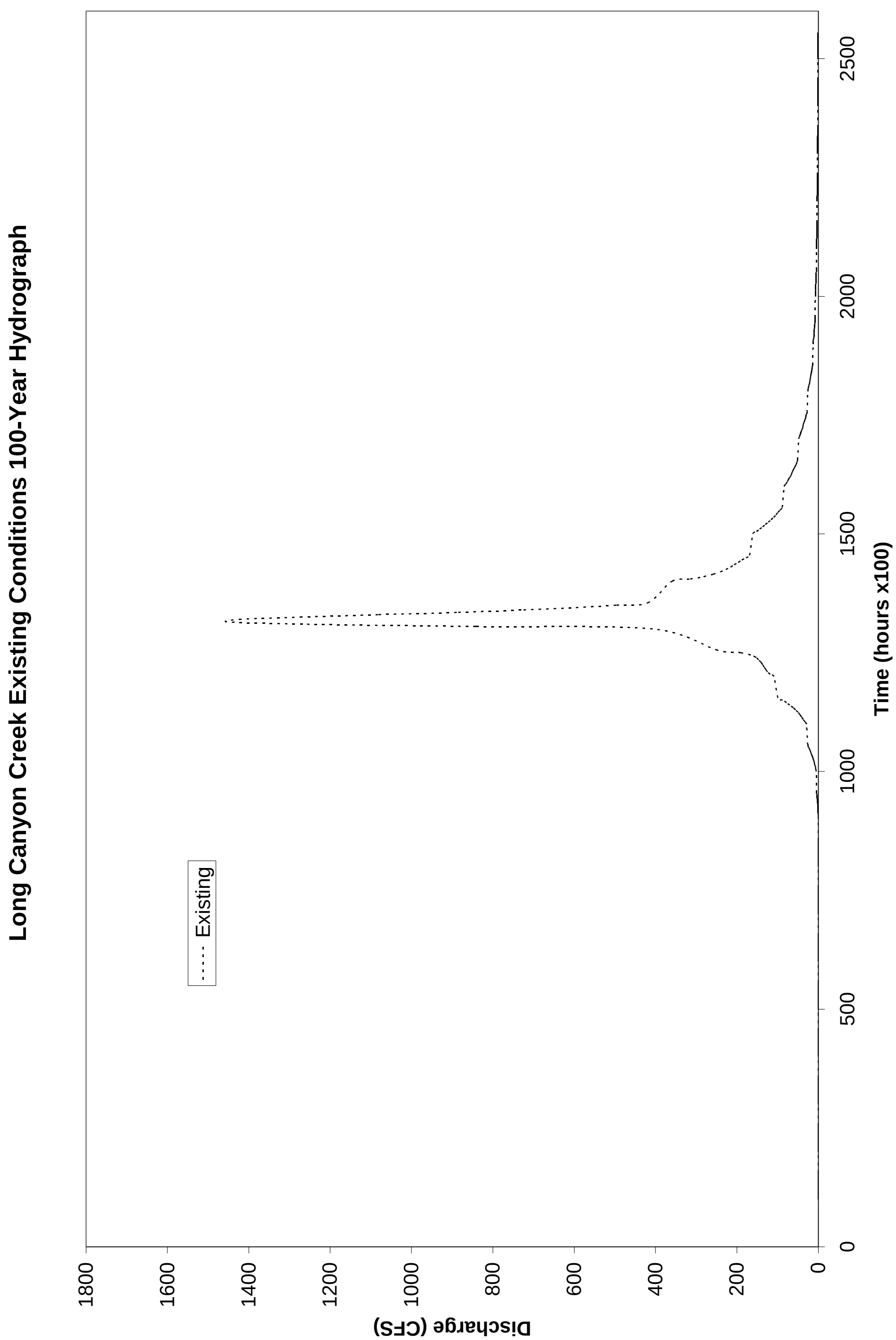



**Figure 3.14** – Long Canyon 100-Year Runoff Hydrograph Existing Conditions

### *3.4.5 Lion Canyon*

**Table 3.8 -** Lion Canyon Hydrology HEC-1 Results

| Node / Conc. Point | Total Drainage Area (sq.mi.) | "Existing" Condition Peak Flow (cfs) | | | | | |
|---|---|---|---|---|---|---|---|
| | | 100-Year | 50-Year | 20-Year | 10-Year | 5-Year | 2-Year |
| Y | 0.039 | 30 | 24 | 17 | 6 | 2 | 1 |
| X | 0.046 | 64 | 50 | 34 | 13 | 6 | 3 |
| C | 0.042 | 78 | 61 | 41 | 15 | 7 | 3 |
| F | 0.007 | 208 | 161 | 110 | 43 | 18 | 7 |
| G | 0.048 | 323 | 246 | 168 | 64 | 26 | 10 |
| I | 0.045 | 381 | 293 | 199 | 75 | 31 | 12 |
| M | 0.046 | 477 | 370 | 250 | 93 | 38 | 15 |
| P | 0.044 | 608 | 474 | 321 | 119 | 49 | 19 |

Note: Light green shaded areas indicate concentration points within the Newhall Ranch.

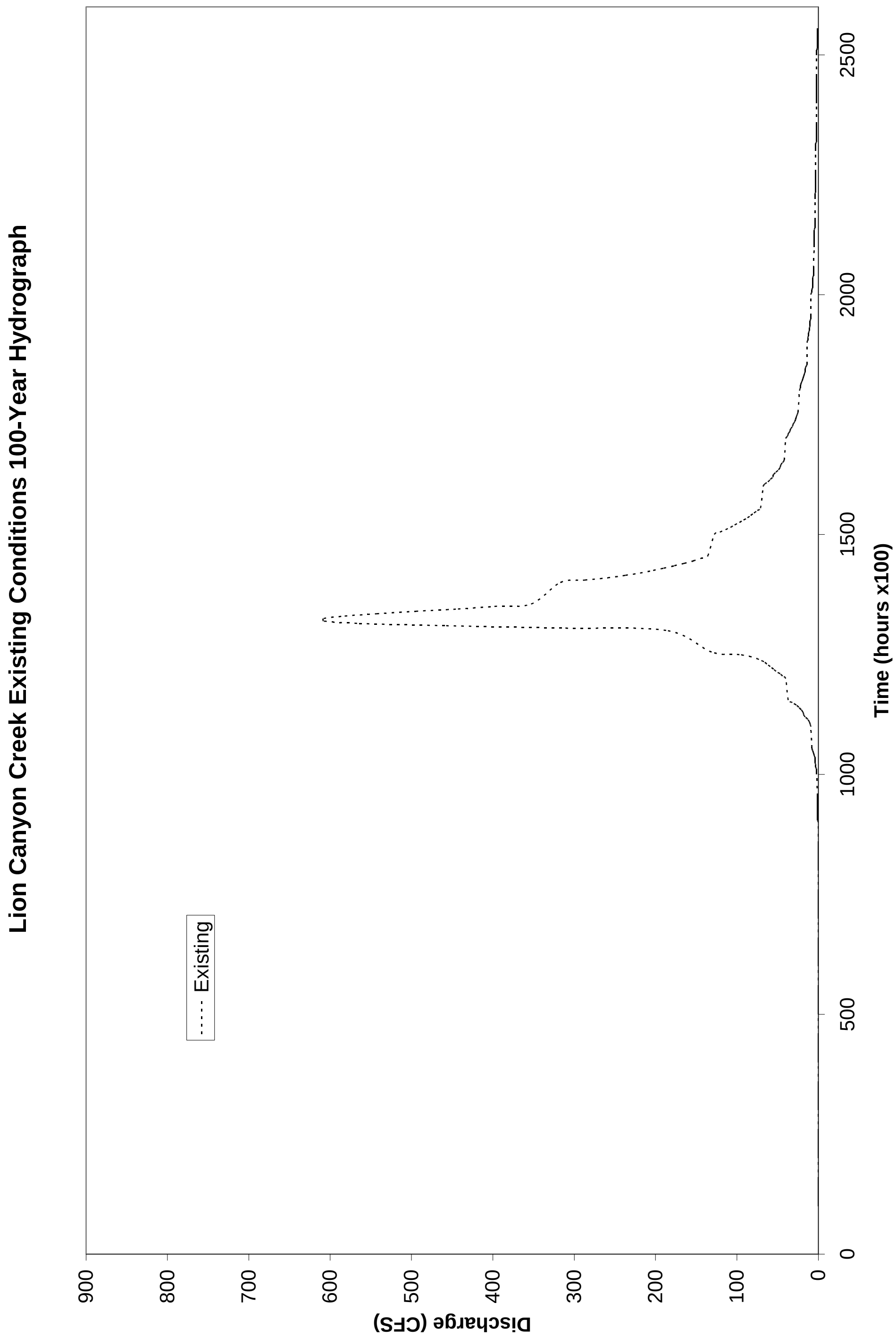



**Figure 3.15 –** Lion Canyon 100-Year Runoff Hydrograph Existing Conditions

# 4 Floodplain Hydraulics

## 4.1 Floodplain Hydraulic Analysis Procedures

Detailed water surface profile models were developed to analyze the hydraulics representative of the different channel systems and establish the "baseline" floodplain for the natural river system. The hydraulic models provide an accurate estimate of the actual flow depths and variation of different hydraulic parameters for a specific flowrate or steady state conditions using basic hydraulic principles. A specialized technique was developed to illustrate one of the more critical hydraulic characteristic parameters, velocity, in a two-dimension format, providing a map of the floodplain area that shows horizontal variations of velocity. The results allow quantifying the total area of different "iso-velocity" contours or areas of similar velocity for the existing floodplain conditions. This two dimensional analysis and application of the conventional hydraulic parameters from the water surface profile models provide an accurate assessment of the floodplain hydraulic operation. Detailed calculated data for over 80 hydraulic parameters characteristic of each individual cross section are available as output from the computations performed by the HEC-RAS model. The general procedures used in the hydraulic model formation and associated hydraulic analyses included the following tasks:

1. <u>Existing natural floodplain digital cross section geometry</u> – Channel hydraulics are calculated at representative cross section locations along the river system and these cross sections are described by their physical geometry using data point or coordinates. The cross sections are located at regular interval spacing and were located digitally on the topographic mapping. CAD routines would determine the coordinates for the points along the cross section and export the data in a HEC-2 format file. The HEC-2 format file was converted into a HEC-RAS file. The HEC-RAS was corrected to include the required lengths along the channel and overbanks, as well as locating the main channel bank station markers.
2. <u>Existing variable roughness values</u> – Horizontal variation of the roughness within the natural floodplain cross section was estimated from field ground photos and from color aerial photographs of the floodplain. The distribution of roughness within the cross section was input into the HEC-RAS model.
3. <u>Digital floodplain boundary determination</u> – The floodplain boundary was analyzed in BOSS-RMS which can provide a digital floodplain boundary mapped in CAD. This particular element was important for the velocity distribution mapping process.
4. <u>Cross section velocity distribution</u> – Each individual cross section velocity distribution was computed within HEC-RAS and the data output.
5. <u>Velocity distribution coordinates</u> – The coordinates of the horizontal velocity variation within each cross section was determined based on the individual velocity distribution plots within HEC-RAS. Each data point coordinate included an "x" and "y" value as well as magnitude of velocity.
6. <u>Import floodplain boundary and velocity distribution into CAD/GIS</u> – The coordinate files were imported in the CAD civil mapping package for Land Development Desktop which can develop topographic contour maps from digital coordinates. The digital floodplain boundary was required to set a boundary for the topographic map generation and a zero velocity boundary.
7. <u>Velocity distribution map preparation</u> – The velocity distribution contour mapping was generated within the Land Development Desktop (LDD) GIS software, however, the data had to be manipulated for input.
8. <u>Adjustment of mapping uncertainties</u> – The results of the CAD generated map of velocity contours had to be inspected because the program would make many interpolations which were not correct. These anomalies were adjusted manually through interpreting the original HEC-RAS output and the horizontal mapping information. These adjustments included modification of the digital floodplain boundary which would sometimes create islands of water or cutoff small fringes in the floodplain.

## 4.2 HEC- RAS (River Analysis System) Hydraulic Model

The US Army Corps of Engineers (ACOE) HEC-RAS (River Analysis System version 3.1.2) water surface profile model was used to analyze the existing natural creek floodplain for variations in different hydraulic characteristic parameters. HEC-RAS is a rigid boundary hydraulic model that assumes the channel bed or invert does not fluctuate although all the floodplain systems considered are actually fluvial systems with moveable alluvial streambeds. A preliminary sediment transport analysis was performed to assess the sediment transport capacity of different reaches of the floodplain as an indicator or relative stream stability and is described in more detail in *Section 6 – Stream Stability and Floodplain Operation*. The HEC-RAS model is a comprehensive program that is intended for calculating water surface profile hydraulics for steady/unsteady and gradually varied flow in natural and manmade channels. It is the primary tool used in the industry to evaluate the hydraulics of floodplain and floodplain mapping studies. The steady flow component is the process used for the current study and is capable of modeling subcritical, supercritical, and mixed flow rater surface profile regimes. The basic computational procedure is based on the solution of the one dimensional energy equation. Energy losses are evaluated by friction and contraction / expansion. The momentum equation is utilized in situations where the water surface profile is rapidly varied. The effects of various obstructions such as bridges and structures within the floodplain may be considered in the computation. HEC-RAS and current mapping programs allow detailed cross section geometry to be obtained directly from digital topographic mapping which enhances the level of accuracy in describing the floodplain characteristics.

## 4.3 Hydraulic Model Assumptions and Parameters

The following guidelines, input data sources, and assumptions were used to develop the various hydraulic analyses with the HEC-RAS model:

- <u>Channel Cross Section Data</u>: The data describing the channel cross section geometry was obtained digitally from digital terrain models of topographic data representing the natural existing creek system. Cross sections were digitally oriented on the electronic mapping by BOSS-RMS exporting the data to HEC data and the distances between cross sections adjusted, channel bank marker stations determined, and the horizontal variation of the Manning's roughness coefficients determined.

- <u>Rigid Boundary Model</u>: HEC-RAS is a rigid boundary hydraulic model which assumes that the channel does not move or erode, but will remain with a fixed geometry. However, the channel is an alluvial stream system which is subject to both vertical and horizontal variation of the channel geometry. This assumption of a fixed bed is sufficient to assess the changes in the hydraulic parameters for different channel conditions and comparison purposes of the hydraulic operation.

- <u>Cross Section Interval Spacing</u>: The cross sections were oriented to the perpendicular to the anticipated direction of flow and were spaced approximately 200 to 300 feet apart. Shorter intervals were used when there were unusual variations in the geometry which should be included and would not be representative of averaging between the normally spaced sections.

- <u>Channel Roughness</u>: Proper selection of the Manning roughness coefficient is one of the more critical and subjective elements describing the hydraulics. The selection of the appropriate Manning's roughness coefficient was performed based on (1) field observation and inspection of the existing floodplain conditions, (2) color aerial photographs, (3) field ground photographs of representative locations along the natural creek corridor, (4) comparison to published guidelines for roughness selection based on similar ground photographs corresponding to representative cross sections, and (5) calculation of the Manning's coefficient within the floodplain based on the application of Cowan's additive procedure (Chow, 1959) of five different parameters that include a base value, surface irregularities, variations in shape, obstructions, vegetation, and meandering. The Manning's roughness coefficient was varied horizontally within the cross section based on vegetative patterns and density.

- Flow Regime: The hydraulic analyses were performed in a “mixed flow” regime which allows both subcritical and supercritical flow conditions to occur. This would reflect the actual conditions that would naturally occur in the hydraulic system.
- Starting Water Surface Elevations: Starting water surface elevations are required as boundary conditions at both the upstream and downstream limits of the model since the hydraulics were being analyzed in a “mixed flow” regime. The initial upstream depth was based on a “normal depth” or slope-area method, utilizing the natural upstream slope of the existing streambed beyond the study limits. The corresponding maximum water surface at the junction of the Santa Clara River was used as the downstream boundary conditions.
- Study Limits: The hydraulic model extended approximately 500 feet upstream of the Newhall Ranch property boundary for the Chiquito, San Martinez Grande, Long and Lion watersheds and 20,400 feet upstream of the Santa Clara River for the Potrero watershed in order to evaluate hydraulic effects beyond the project boundary.
- Channel Invert Elevations: The vertical elevations of the streambed or minimum elevation within each cross section reflected the profile for the existing natural streambed.
- Flowrates – Multi-Discharge Analysis: An evaluation of the hydraulic effects and characteristics from various flood frequencies or storm return periods was developed through a multi-discharge analysis of six different discharges reflecting return periods developed from the HEC-1 analysis of the 2- through 100-year events. The analysis was performed for “steady flow” conditions reflecting the maximum discharge or single point on the flood hydrograph. Variation of the flowrates occurred along the channel to reflect change in the total drainage area and the junction of smaller tributary streams.

### 4.4 Channel Hydraulic Conditions Modeled

A variety of floodplain hydraulic models were developed using both HEC-RAS and HEC-RMS. The HEC-RMS model is a proprietary version of HEC-RAS published by Boss International and was specified used because of its capabilities of digitally mapping the floodplain boundary which HEC-RAS cannot provide. Five different floodplain models were developed reflecting the five different floodplain geometries which include (1) natural or existing baseline conditions, (2) avoidance alternative, (3) proposed project, (4) alternative No. 2, and (5) alternative No. 3. All of these alternatives were analyzed for the six different flowrates corresponding to the six different return periods.

Existing Natural Canyon Floodplain – The natural topography within the each of the five tributary watersheds was used to develop the floodplain boundaries for the 2-, 5-, 10-, 20-, 50- and 100-year return periods for this condition. The following parameters were used for each tributary:

- For Chiquito Canyon, about 41 cross-sections were cut along the length of the reach, approximately 100 feet apart on average. The 100-year floodplain reaches a maximum top width of about 549 feet and about 194 feet on average. A minimum top width of 36 feet can be seen about 560 upstream of the mouth of the canyon.
- For San Martinez Grande Canyon, about 39 cross-sections were cut along the length of the reach, approximately 100 feet apart on average. The 100-year floodplain reaches a maximum top width of about 200 feet and about 110 feet on average. A culvert exists about 50 feet upstream of the Santa Clara River giving a minimum top width of 25 feet.
- For Potrero Canyon, about 93 cross-sections were cut along the length of the reach, approximately 100 feet apart on average. The 100-year floodplain reaches a maximum top width of about 952 feet and about 329 feet on average. Major contraction occurs upstream of the canyon giving a minimum top width of approximately 50 feet.
- For Long Canyon, a subcritical flow condition occurs in majority of the canyon, except in areas where drastic changes in the channel invert are evident. Maximum depths range from approximately 3 feet to 7 feet from 2- through 100-year events.

- For Lion Canyon, about 30 cross-sections were cut along the length of the reach, approximately 200 feet apart on average. The 100-year floodplain reaches a maximum top width of about 166 feet and about 58 feet on average. Contractions occur upstream of the canyon giving a minimum top width of approximately 21 feet.

## 4.5 Results of Floodplain Hydraulic Analysis

Selected results from the floodplain hydraulic analyses for each of the five different channel systems investigated are included in summary tables and figures in the following sections. Detailed water surface information, including water surface profiles is available in the *Technical Appendix*. Additional information of other hydraulic parameters at each cross section along the floodplain model is also contained in the models and was used to develop the information for the summary tables. The summary results have been provided in the following format to assist in characterizing the hydraulic operation of the floodplain which include: (1) summary table for select hydraulic parameters using channel length weighted values, (2) hydraulic characteristics at five representative cross sections at different location along the channel, (3) plot of velocity variation along the channel profile, (4) water surface profile plot of the existing floodplain, (5) velocity distribution mapping of the existing floodplain, and (6) statistics associated with the velocity mapping indicating the quantity of area for each velocity increment within the floodplain.

### *4.5.1 Definition of Representative Hydraulic Parameters*

The following are general definitions of some of the commonly used hydraulic parameters that are useful in characterizing the hydraulic operation of a channel system and these parameters have been estimated for the assessment of the existing floodplain conditions.

Maximum channel flow depth – The difference between the lowest point in the cross section and the water surface elevation.

Friction slope – Value of the energy gradient and is a strong indicator of conveyance related through the Section Factor (Z).

Average velocity – This represents the flowrate divided by the total cross section flow area. The average velocity of the cross section does not indicate the variation of velocity that generally occurs between the main channel and the overbanks or in locations of higher or lower roughness values varying across the section.

Channel average velocity – The flowrate in the portion of the floodplain defined to be the main channel or excluding the right and left overbank areas. The flowrate in the main channel is divided by the

Flow area – The amount of area perpendicular to the direction of flow and within the cross section that the water is flowing.

Top width – Distance from one side of the channel to the other at the edge of the floodplain.

Shear Stress – Hydraulic radius multiplied by the friction slope and unit weight of water where the hydraulic radius in the flow area divided by the depth.

Stream Power – Shear stress multiplied by the velocity. This parameter is the strongest indicator of erosion thresholds or sediment transport when compared to shear stress and velocity alone.

### 4.5.2 *Estimated Average Floodplain Hydraulic Parameters*

**Table 4.1** – Summary of Channel Average Hydraulic Parameters

| Channel | Return Interval (years) | Max. Flow Depth (ft) | Average Velocity (fps) | Friction Slope | Flow Area (sq. ft.) | Top Width (ft) | Total Shear (psf) |
|---|---|---|---|---|---|---|---|
| Chiquito | 2 | 3.00 | 5.33 | 0.0247 | 47.25 | 88.33 | 1.81 |
| Chiquito | 5 | 4.13 | 6.76 | 0.0240 | 91.16 | 104.82 | 2.02 |
| Chiquito | 10 | 5.05 | 8.48 | 0.0230 | 162.31 | 128.02 | 2.55 |
| Chiquito | 20 | 6.73 | 10.46 | 0.0230 | 285.93 | 158.19 | 3.18 |
| Chiquito | 50 | 7.70 | 11.27 | 0.0228 | 353.21 | 173.18 | 3.43 |
| Chiquito | 100 | 9.51 | 11.86 | 0.0225 | 411.19 | 194.47 | 3.58 |
| San Martinez Grande | 2 | 6.40 | 3.67 | 0.016 | 47.91 | 43.2 | 1.78 |
| San Martinez Grande | 5 | 7.73 | 5.07 | 0.018 | 84.79 | 52.74 | 2.57 |
| San Martinez Grande | 10 | 9.61 | 6.26 | 0.018 | 153.95 | 69.94 | 3.00 |
| San Martinez Grande | 20 | 12.46 | 7.65 | 0.019 | 290.83 | 95.82 | 3.91 |
| San Martinez Grande | 50 | 13.91 | 8.34 | 0.019 | 365.91 | 103.43 | 4.50 |
| San Martinez Grande | 100 | 15.00 | 8.86 | 0.019 | 431.04 | 109.72 | 4.93 |
| Potrero | 2 | 1.90 | 2.69 | 0.0218 | 44.42 | 117.40 | 0.90 |
| Potrero | 5 | 3.02 | 3.54 | 0.0213 | 85.04 | 141.77 | 1.33 |
| Potrero | 10 | 4.02 | 4.40 | 0.0210 | 151.94 | 190.33 | 1.75 |
| Potrero | 20 | 5.67 | 5.27 | 0.0217 | 284.60 | 269.39 | 2.27 |
| Potrero | 50 | 6.12 | 5.64 | 0.0214 | 360.03 | 298.19 | 2.37 |
| Potrero | 100 | 6.63 | 5.88 | 0.0212 | 426.46 | 328.62 | 2.51 |
| Long | 2 | 2.88 | 3.42 | 0.03 | 17.25 | 70.08 | 1.14 |
| Long | 5 | 3.57 | 4.44 | 0.03 | 30.69 | 76.47 | 1.29 |
| Long | 10 | 4.46 | 5.68 | 0.03 | 56.09 | 95.78 | 1.89 |
| Long | 20 | 5.72 | 6.91 | 0.03 | 103.00 | 122.38 | 2.31 |
| Long | 50 | 6.28 | 7.37 | 0.03 | 129.19 | 131.96 | 2.57 |
| Long | 100 | 6.68 | 7.77 | 0.03 | 150.73 | 139.93 | 2.78 |
| Lion | 2 | 0.71 | 1.97 | 0.0449 | 5.90 | 39.00 | 0.65 |
| Lion | 5 | 1.12 | 2.70 | 0.0437 | 10.52 | 40.16 | 1.00 |
| Lion | 10 | 1.79 | 3.56 | 0.0413 | 19.42 | 44.85 | 1.50 |
| Lion | 20 | 2.86 | 4.77 | 0.0391 | 37.98 | 51.42 | 2.27 |
| Lion | 50 | 2.98 | 5.19 | 0.0385 | 47.19 | 54.32 | 2.57 |
| Lion | 100 | 3.93 | 5.71 | 0.0374 | 60.18 | 58.08 | 2.93 |

## 4.6 Floodplain Velocity Distribution Analysis

**Table 4.2** – Chiquito Canyon Floodplain Velocity Distribution Statistics

| Velocity Increment (fps) | Existing (ac) | | | | | |
|---|---|---|---|---|---|---|
| | 2-Year | 5-Year | 10-Year | 20-Year | 50-Year | 100-Year |
| 0-2 | 1.9 | 1.3 | 1.5 | 1.0 | 1.2 | 1.2 |
| 3-4 | 8.8 | 4.6 | 3.5 | 4.3 | 3.5 | 3.5 |
| 5-6 | 5.6 | 8.9 | 5.7 | 4.9 | 5.1 | 5.1 |
| 7-8 | 1.1 | 4.8 | 8.5 | 5.4 | 5.4 | 5.4 |
| 9-10 | 0.2 | 0.9 | 3.9 | 7.8 | 7.0 | 7.0 |
| 11-12 | 0.0 | 0.1 | 1.2 | 4.3 | 6.3 | 6.3 |
| 13-15 | 0.0 | 0.1 | 0.5 | 2.7 | 4.0 | 4.0 |
| 16-18 | 0.0 | 0.0 | 0.2 | 0.7 | 1.2 | 1.2 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.2 | 0.4 | 0.4 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Table 4.3** – San Martinez Grande Canyon Floodplain Velocity Distribution Statistics

| Velocity Increment (fps) | Existing (ac) | | | | | |
|---|---|---|---|---|---|---|
| | 2-Year | 5-Year | 10-Year | 20-Year | 50-Year | 100-Year |
| 0-2 | 1.9 | 1.7 | 2.4 | 1.8 | 2.2 | 2.0 |
| 3-4 | 2.7 | 2.9 | 2.5 | 3.6 | 3.9 | 3.9 |
| 5-6 | 0.6 | 1.5 | 2.0 | 2.5 | 2.5 | 2.6 |
| 7-8 | 0.1 | 0.4 | 1.1 | 1.6 | 1.7 | 1.8 |
| 9-10 | 0.0 | 0.1 | 0.6 | 1.3 | 1.2 | 1.5 |
| 11-12 | 0.0 | 0.0 | 0.3 | 0.6 | 0.6 | 0.7 |
| 13-15 | 0.0 | 0.0 | 0.0 | 0.5 | 0.5 | 0.6 |
| 16-18 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

**Table 4.4** – Potrero Canyon Floodplain Velocity Distribution Statistics

| Velocity Increment (fps) | Existing (ac) | | | | | |
|---|---|---|---|---|---|---|
| | 2-Year | 5-Year | 10-Year | 20-Year | 50-Year | 100-Year |
| 0-2 | 34.81 | 31.94 | 30.65 | 36.48 | 34.19 | 36.81 |
| 3-4 | 15.22 | 30.96 | 43.33 | 49.35 | 56.20 | 59.24 |
| 5-6 | 0.90 | 4.73 | 12.93 | 31.84 | 32.53 | 36.55 |
| 7-8 | 0.04 | 0.40 | 2.03 | 6.80 | 14.84 | 21.12 |
| 9-10 | 0.00 | 0.03 | 0.21 | 1.40 | 2.61 | 3.61 |
| 11-12 | 0.00 | 0.00 | 0.02 | 0.24 | 0.50 | 0.81 |
| 13-15 | 0.00 | 0.00 | 0.00 | 0.05 | 0.15 | 0.21 |
| 16-18 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.05 |
| 19-21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 22-24 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 25-27 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 28-30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 31-39 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

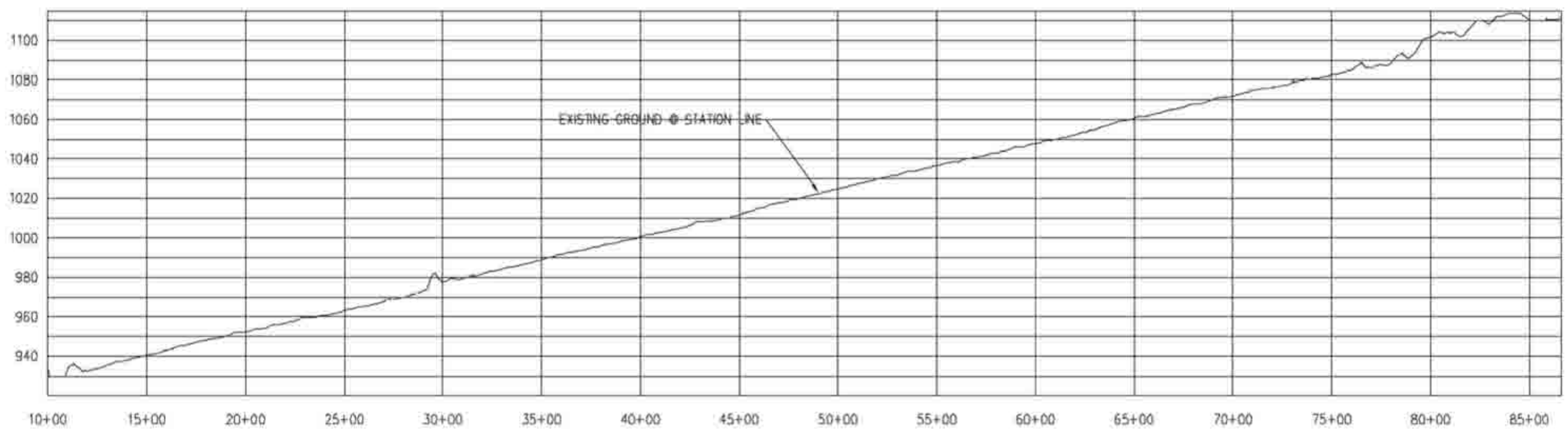
**Table 4.5** – Long Canyon Floodplain Velocity Distribution Statistics

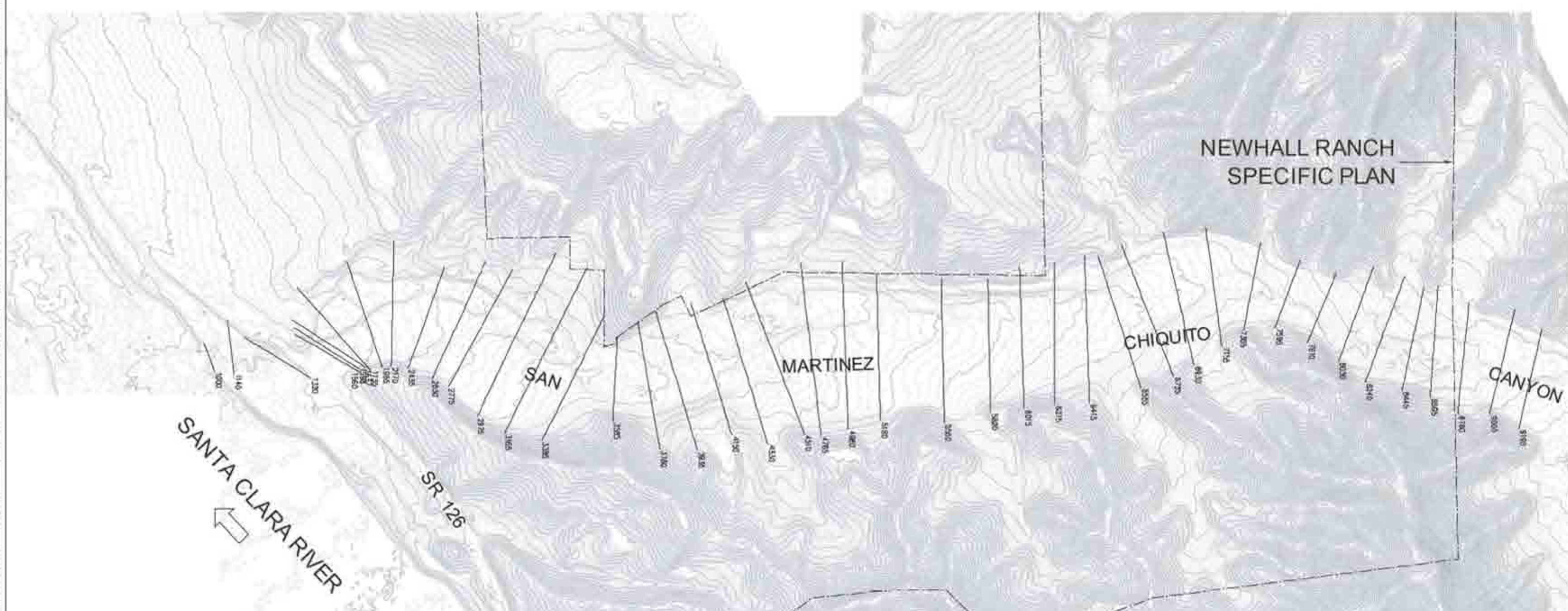
| Velocity Increment (fps) | Existing (ac) | | | | | |
|---|---|---|---|---|---|---|
| | 2-Year | 5-Year | 10-Year | 20-Year | 50-Year | 100-Year |
| 0-2 | 5.20 | 2.13 | 3.16 | 0.00 | 1.68 | 1.06 |
| 3-4 | 4.95 | 8.33 | 9.16 | 0.00 | 9.22 | 6.51 |
| 5-6 | 0.21 | 1.87 | 4.05 | 0.00 | 8.98 | 11.24 |
| 7-8 | 0.05 | 0.19 | 0.95 | 0.00 | 3.59 | 4.83 |
| 9-10 | 0.00 | 0.06 | 0.18 | 0.00 | 1.68 | 2.20 |
| 11-12 | 0.00 | 0.00 | 0.08 | 0.00 | 0.40 | 0.63 |
| 13-15 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.23 |
| 16-18 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 19-21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 22-24 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 25-27 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 28-30 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 31-39 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

**Table 4.6** – Lion Canyon Floodplain Velocity Distribution Statistics

| Velocity Increment (fps) | Existing (ac) | | | | | |
|---|---|---|---|---|---|---|
| | 2-Year | 5-Year | 10-Year | 20-Year | 50-Year | 100-Year |
| 0-2 | 9.6 | 7.8 | 5.0 | 9.6 | 1.3 | 1.2 |
| 3-4 | 1.4 | 3.0 | 4.8 | 1.4 | 7.7 | 7.0 |
| 5-6 | 0.1 | 0.3 | 1.1 | 0.1 | 2.9 | 3.8 |
| 7-8 | 0.0 | 0.0 | 0.2 | 0.0 | 0.5 | 0.8 |
| 9-10 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 |
| 11-12 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 13-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

P:\7104E\Engineering\7104-41 (Chiquito)\Report Figures\7104E FIG 5-1 CHIQUITO WORKMAP EXISTING CONDITION PLAN & PROFILE.dwg - Tab Layout1 By: darann on Mar. 04, 2009 at 05:38 pm




NEWHALL RANCH
Newhall Ranch Company

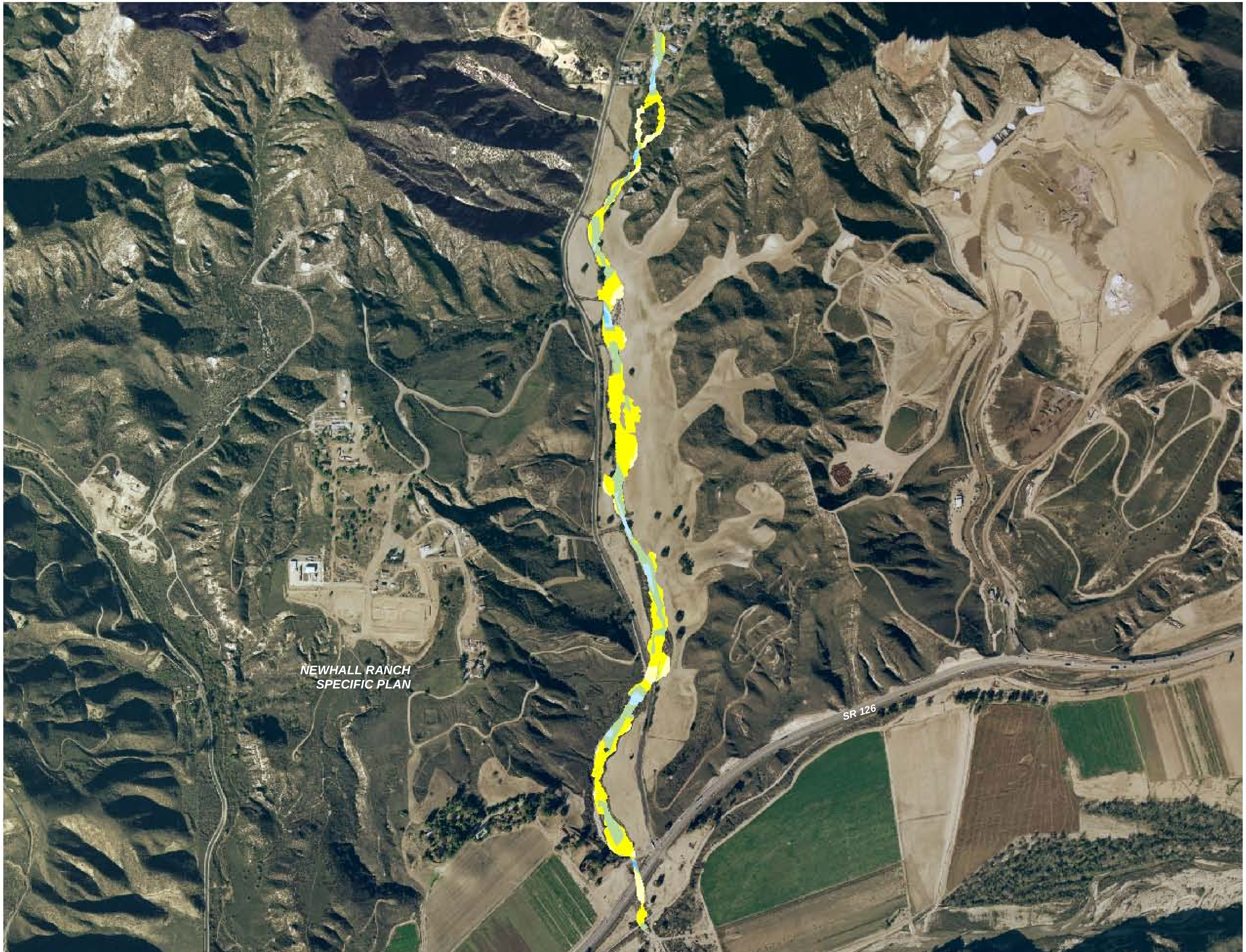
L E G E N D

Newhall Ranch Specific Plan Boundary

0 200 400 800 Feet

PACE

Figure 4.1
**EXISTING CONDITION WORKMAP SAN MARTINEZ CHIQUITO**



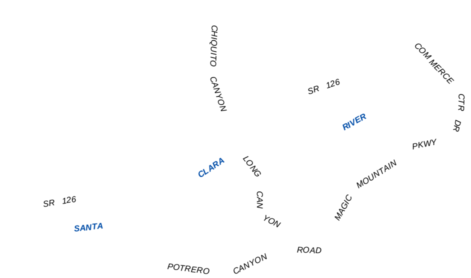

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39



Feet
0 250 500 1,000
Meters
0 60 120 240

Figure 4.2

**EXISTING VELOCITIES**
**2 YEAR FLOOD EVENT**
**CHIQUITO CANYON**

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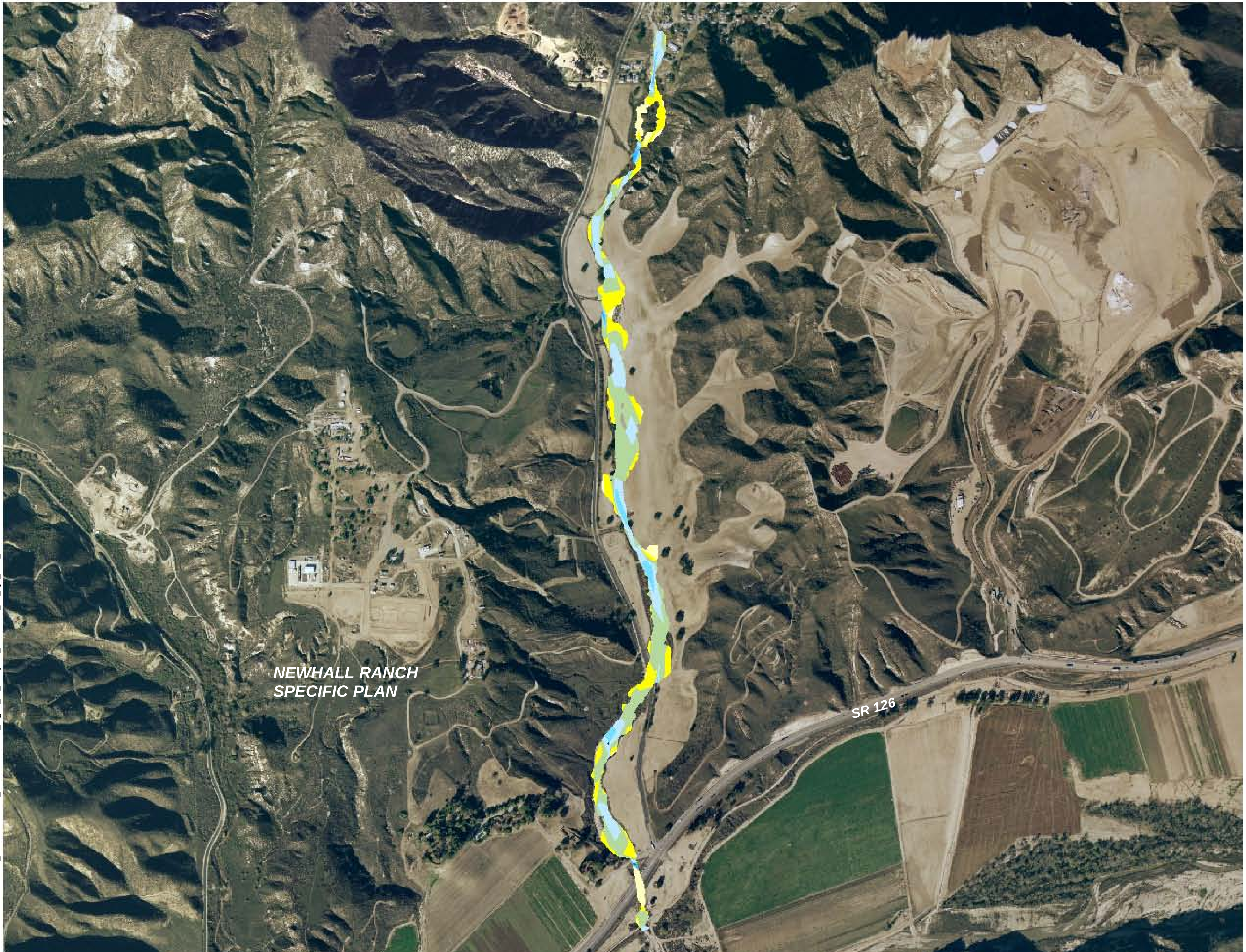


Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39

CHIQUITO CANYON
SR 126
COMMERCE CTR DR
RIVER
PKWY
CLARA
LONG CANYON
MAGIC MOUNTAIN
SR 126
SANTA
ROAD
POTRERO CANYON

Feet
0 250 500 1,000
Meters
0 60 120 240

Figure 4.3

**EXISTING VELOCITIES**
**5 YEAR FLOOD EVENT**
**CHIQUITO CANYON**

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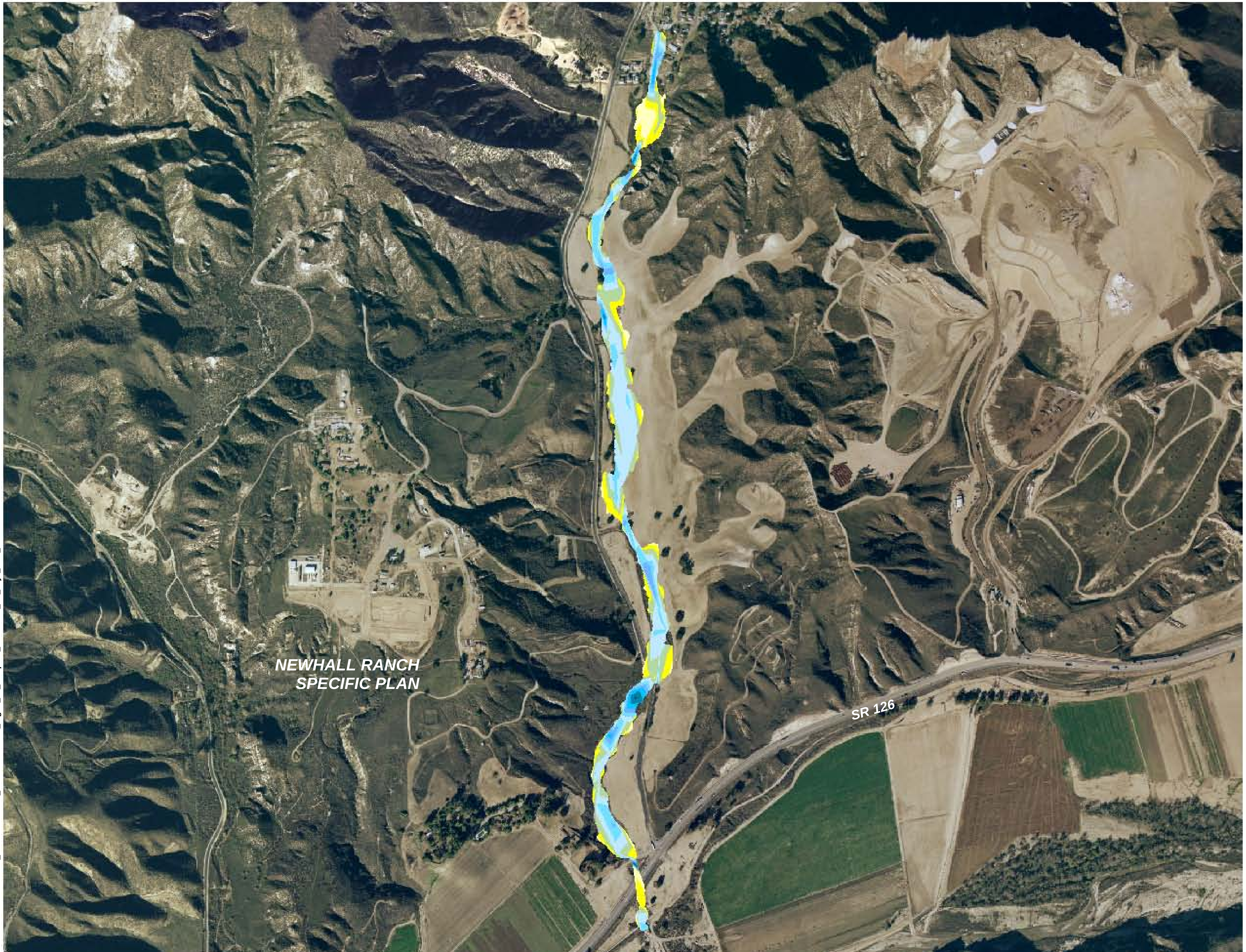


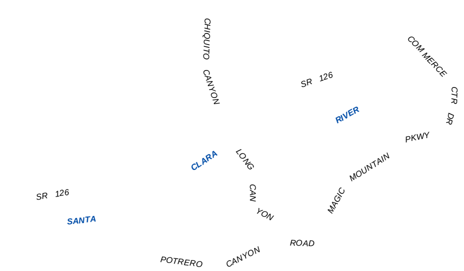

Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39



Feet: 0 250 500 1,000

Meters: 0 60 120 240

Figure 4.4

**EXISTING VELOCITIES**
**10 YEAR FLOOD EVENT**
**CHIQUITO CANYON**

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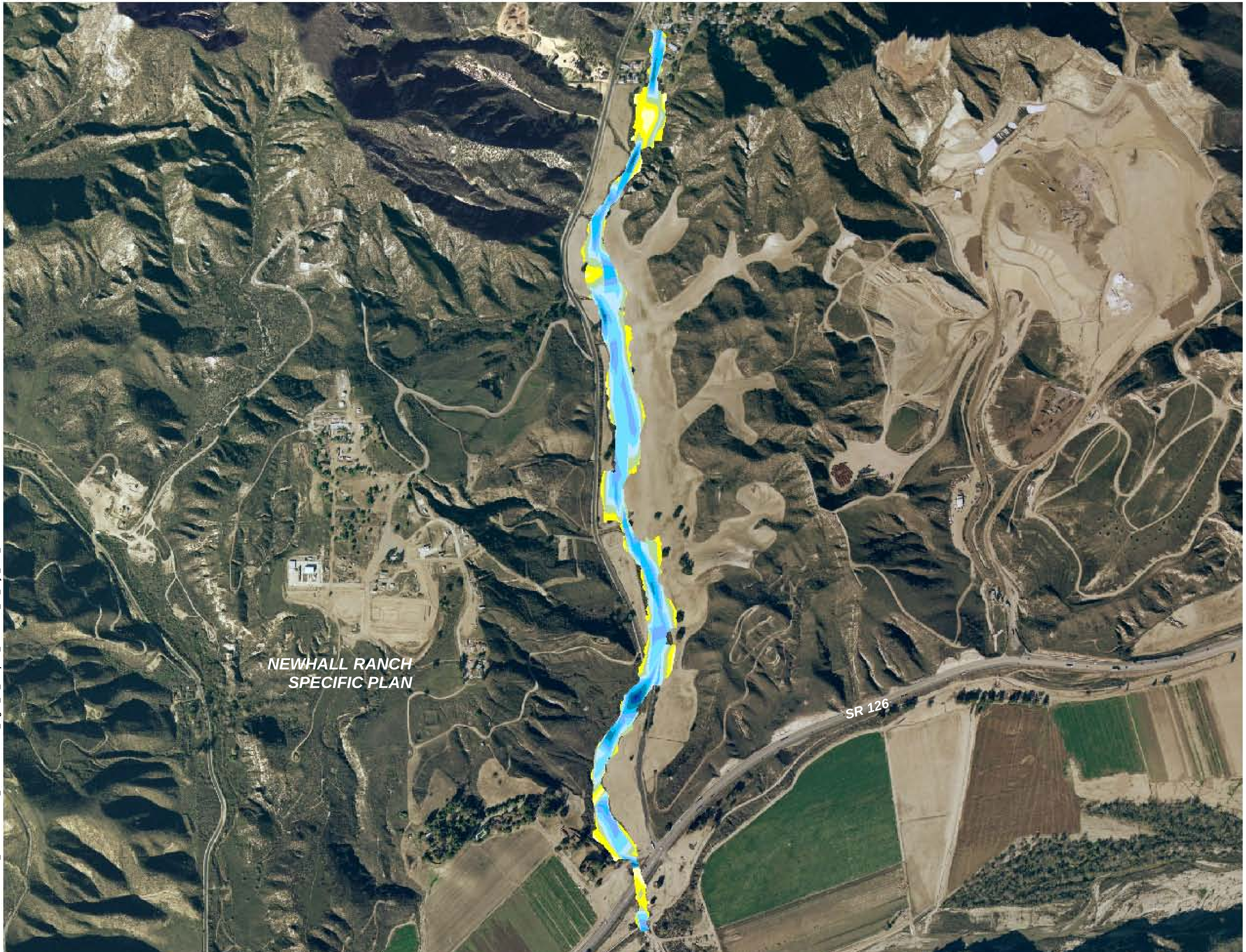


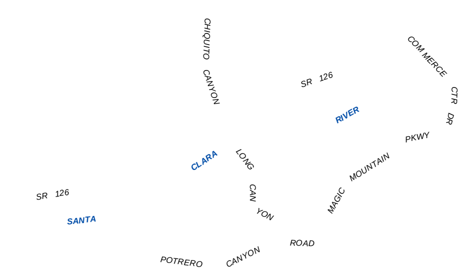

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39



Feet: 0 250 500 1,000

Meters: 0 60 120 240

Figure 4.5

**EXISTING VELOCITIES**
**20 YEAR FLOOD EVENT**
**CHIQUITO CANYON**

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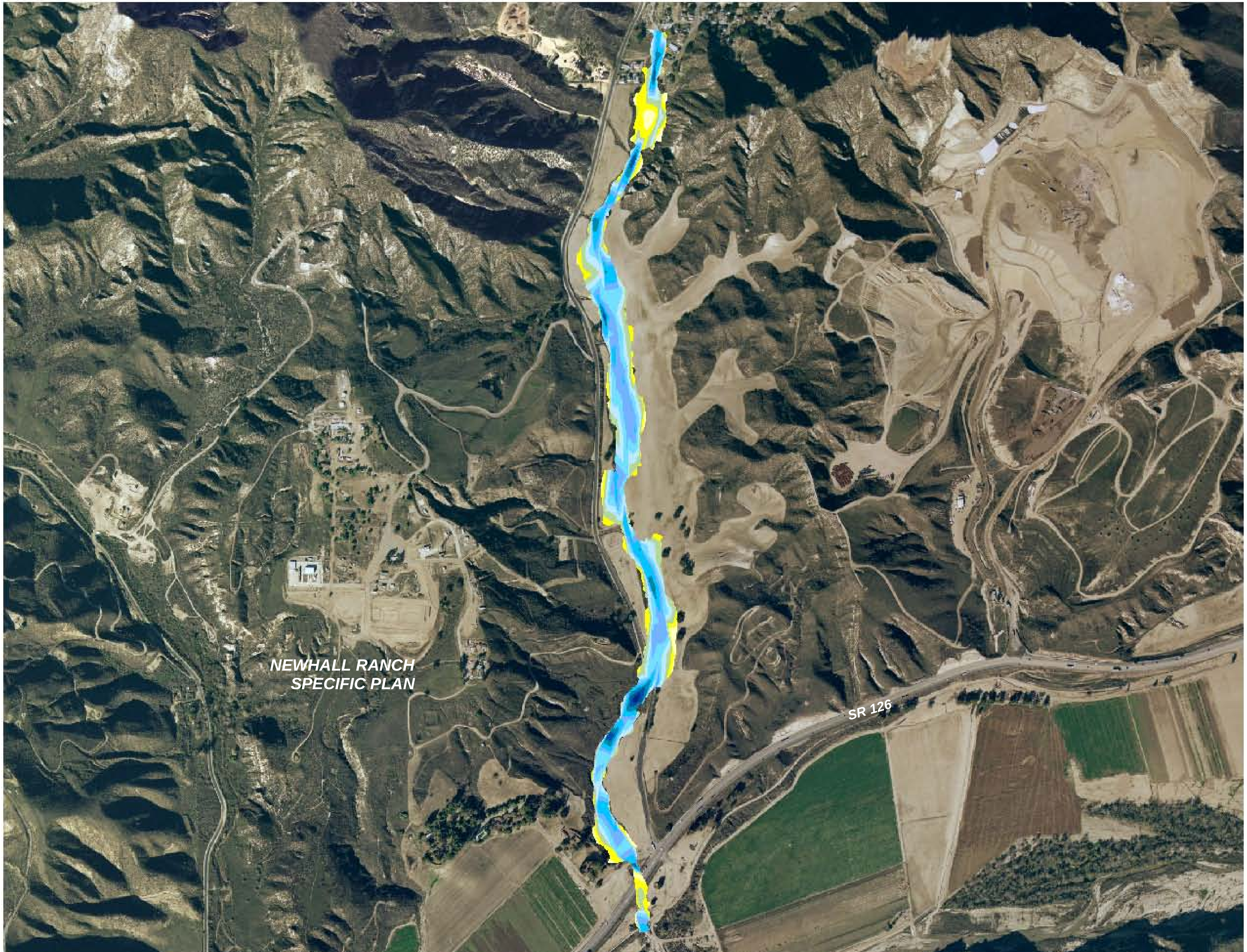


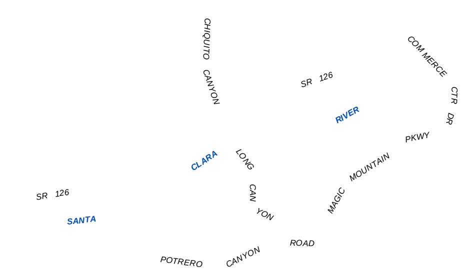

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

- 0 - 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 15
- 16 - 18
- 19 - 21
- 22 - 24
- 25 - 27
- 28 - 30
- 31 - 39




Feet: 0, 250, 500, 1,000

Meters: 0, 60, 120, 240

Figure 4.6

**EXISTING VELOCITIES**
**50 YEAR FLOOD EVENT**
**CHIQUITO CANYON**

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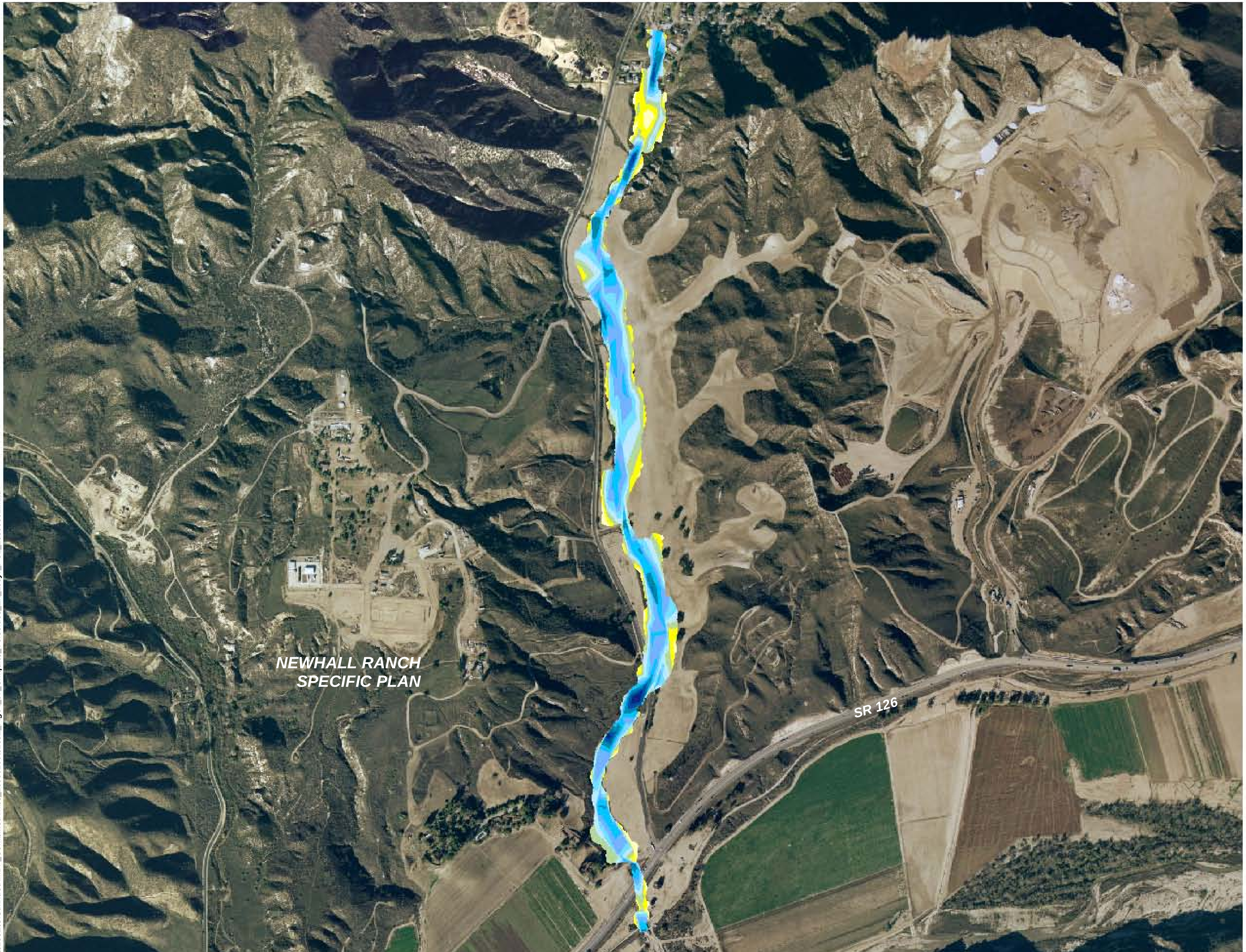


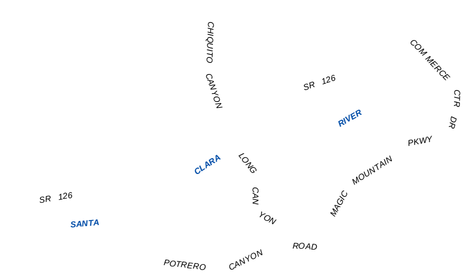

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

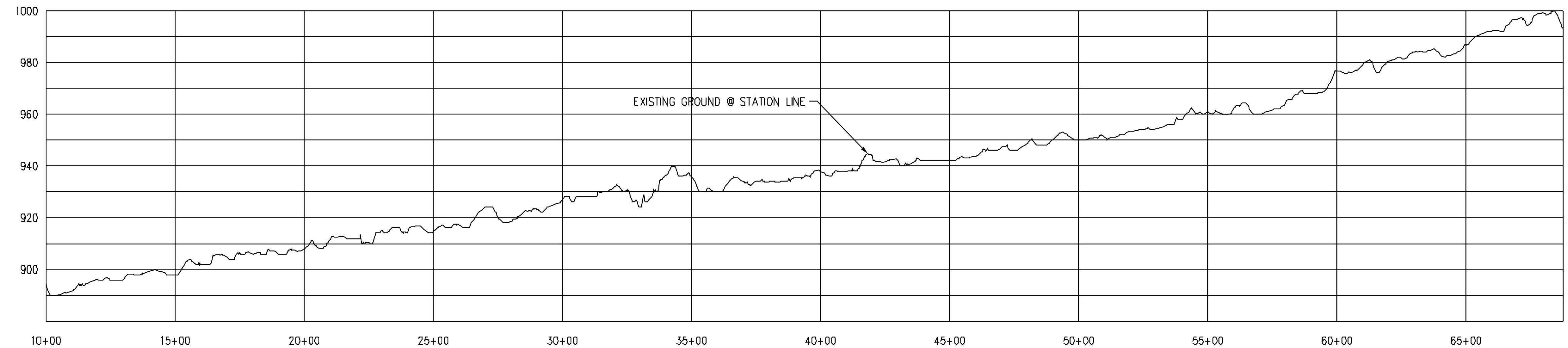
0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39

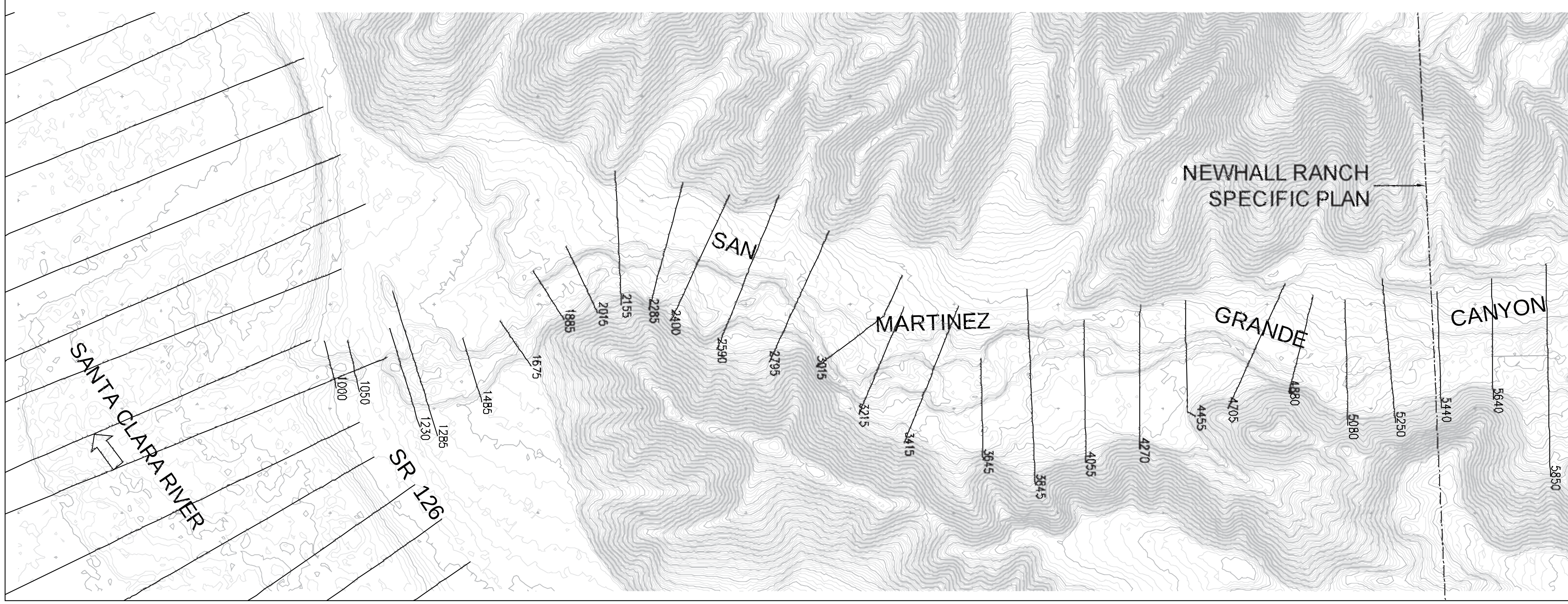



Feet
0 250 500 1,000
Meters
0 60 120 240

Figure 4.7
**EXISTING VELOCITIES**
**100 YEAR FLOOD EVENT**
**CHIQUITO CANYON**

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig04_07_Chiquito_Velocities_Ex_100yr_PC1_20090302.mxd

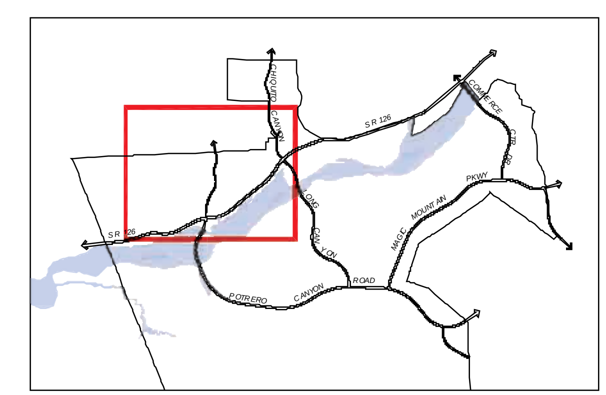



NEWHALL RANCH
Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary



0 125 250 500
Feet

PACE

Figure 4.8
**EXISTING CONDITION WORK MAP SAN MARTINEZ GRANDE**

P:\7104E\Engineering\7104-51 (Grande)\Report Figures\7104E FIG 5-1 GRANDE (WORKMAP EXISTING CONDITION PLAN & PROFILE).dwg - Tab: Layout1 By: ddrahn on Mar. 04, 2009 at 04:49 pm

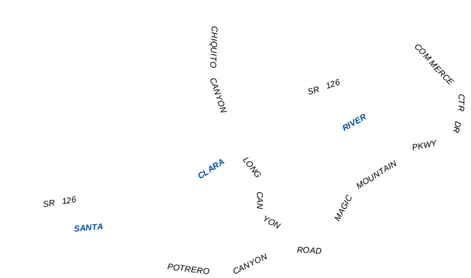

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39



Feet
0 125 250 500
Meters
0 40 80 160

Figure 4.9

**EXISTING VELOCITIES**
**2 YEAR FLOOD EVENT**
**SAN MARTINEZ GRANDE**

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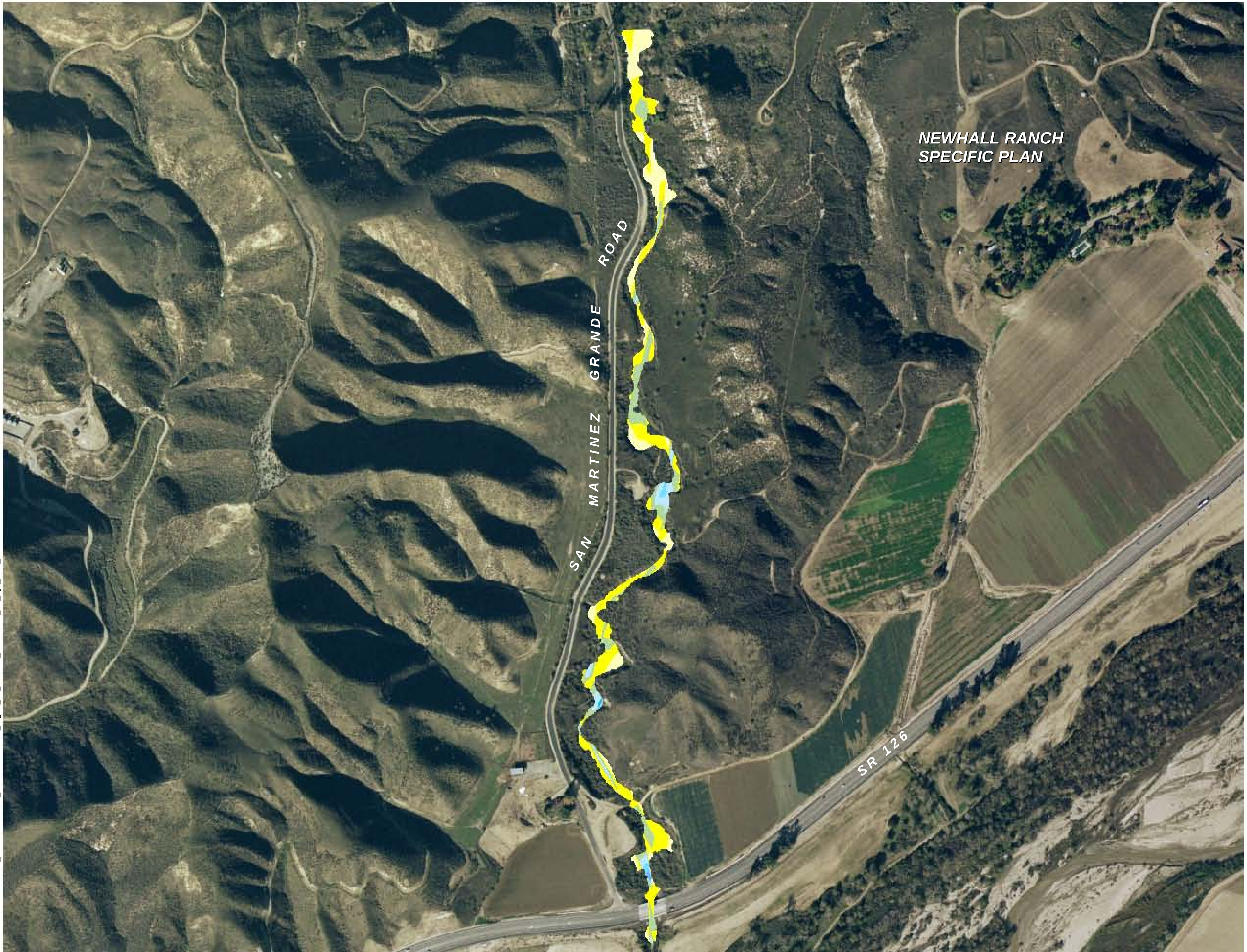


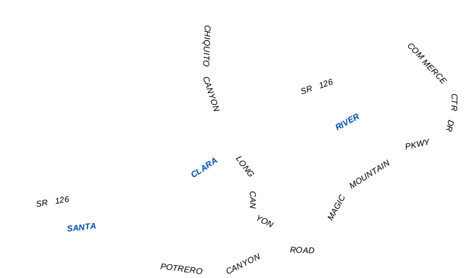

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39




Feet
0 125 250 500
Meters
0 37.5 75 150

Figure 4.10

**EXISTING VELOCITIES**
**5 YEAR FLOOD EVENT**
**SAN MARTINEZ GRANDE**

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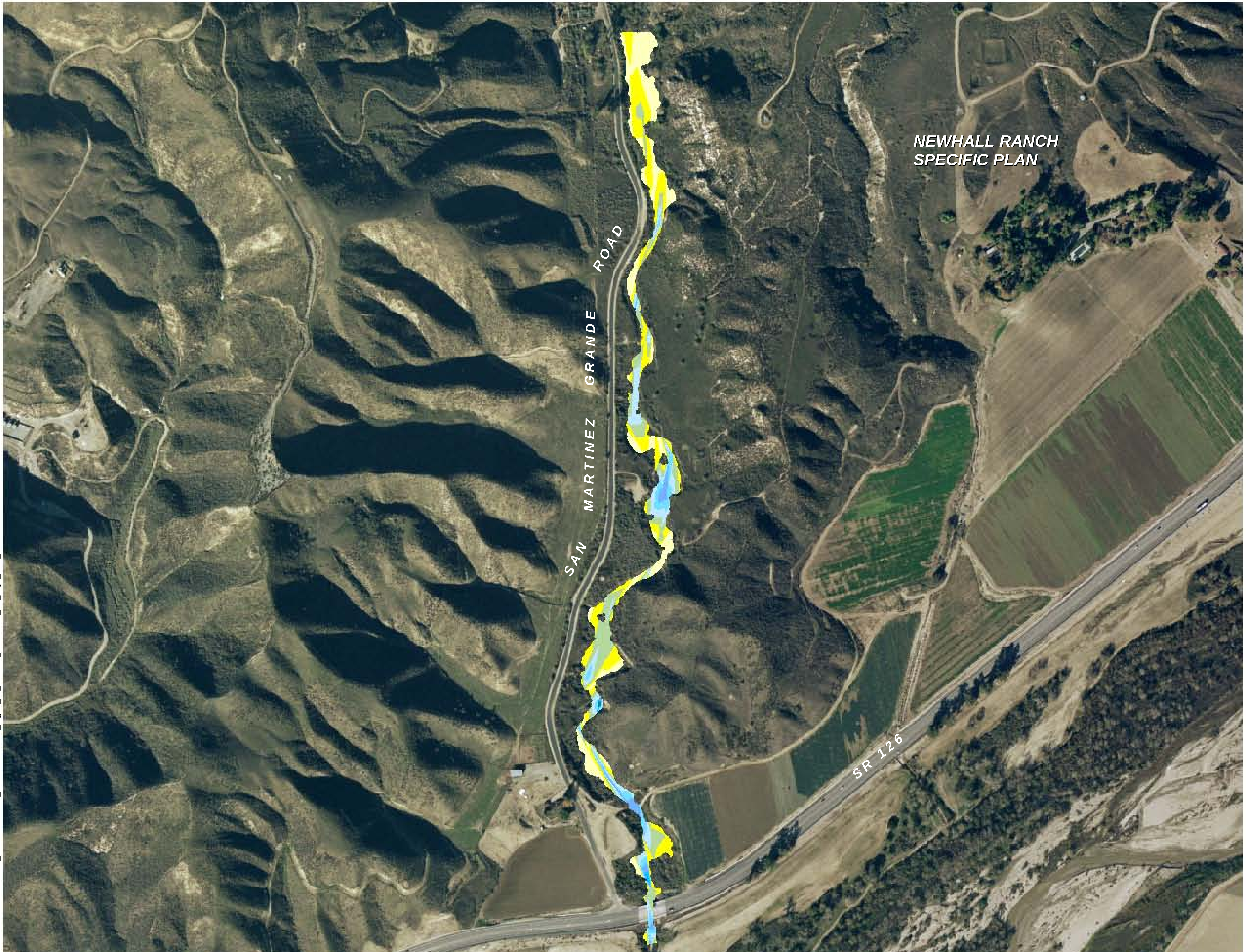


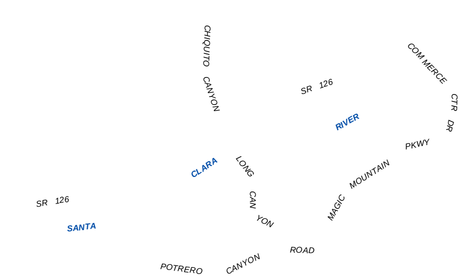

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39

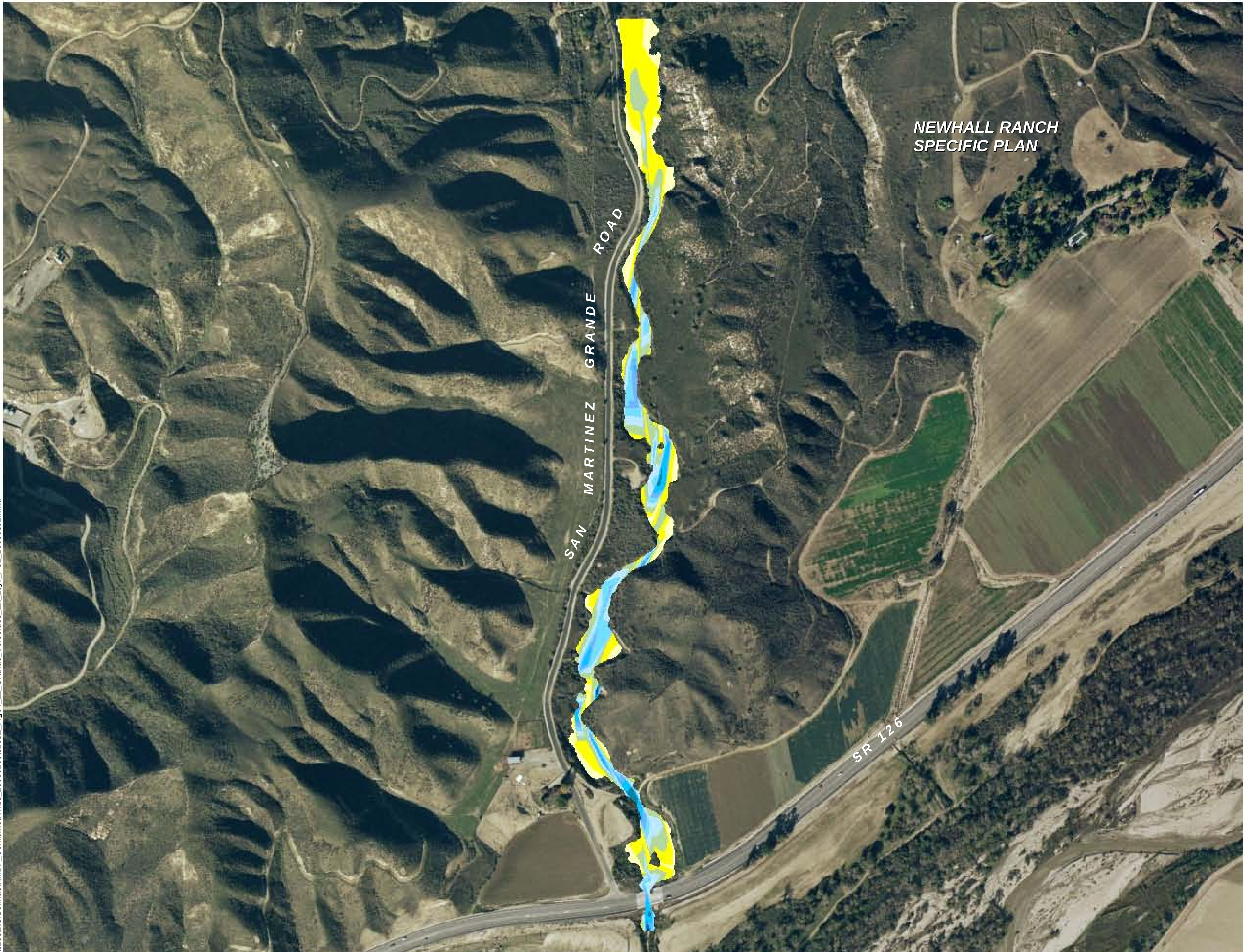



Feet
0 125 250 500
Meters
0 37.5 75 150

Figure 4.11

**EXISTING VELOCITIES**
**10 YEAR FLOOD EVENT**
**SAN MARTINEZ GRANDE**

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig04_11_Grande_Velocities_Ex_10yr_PC1_20090302.mxd




Newhall Ranch Company

LEGEND

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39

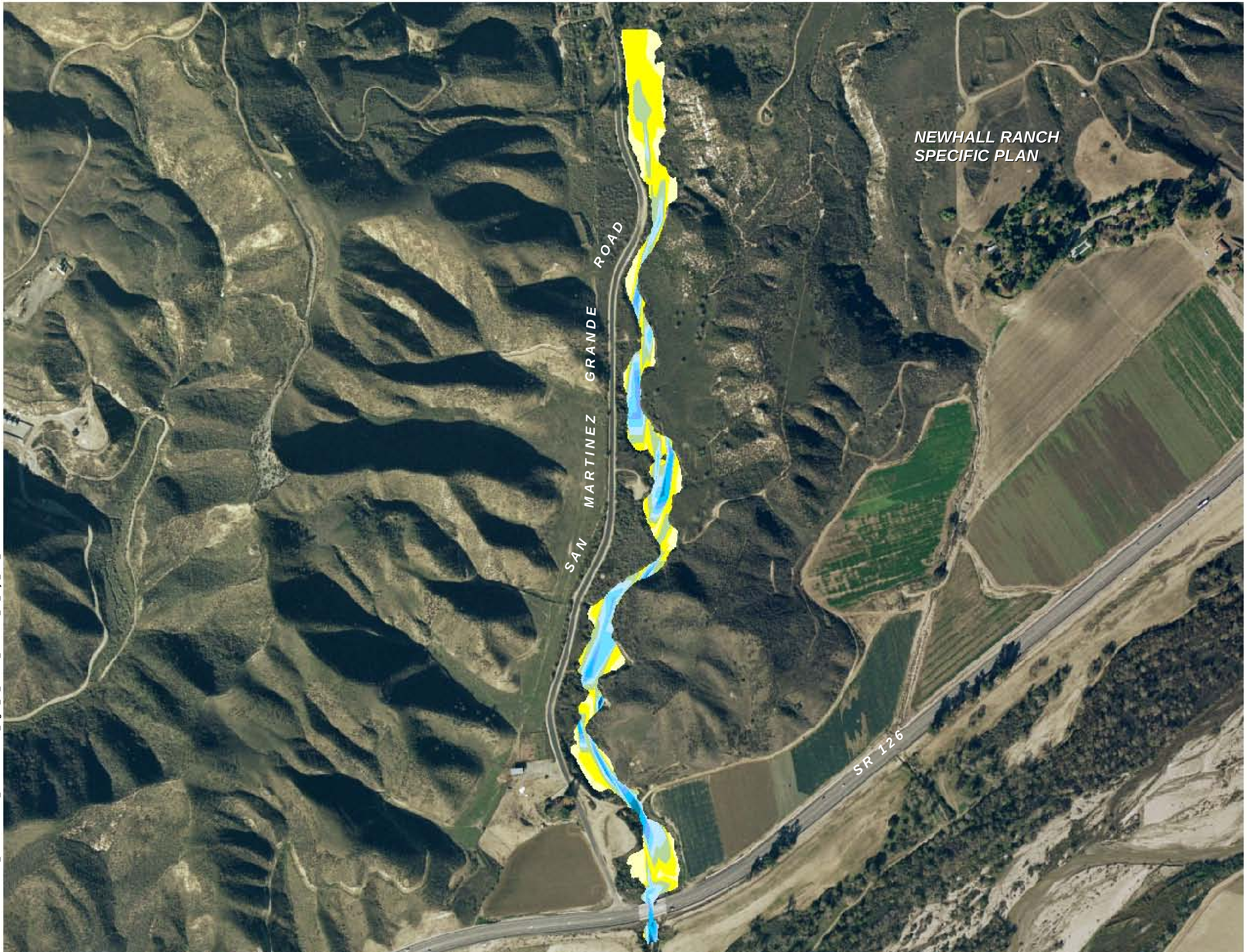
CHIQUITO CANYON
SR 126
COM MERCE CTR DR
RIVER
PKWY
CLARA
LONG CAN YON
MAGIC MOUNTAIN
SR 126
SANTA
POTRERO CANYON
ROAD

Feet
0 125 250 500
Meters
0 37.5 75 150

Figure 4.12

**EXISTING VELOCITIES**
**20 YEAR FLOOD EVENT**
**SAN MARTINEZ GRANDE**

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig04_12_Grande_Velocities_Ex_20yr_PC1_20090302.mxd



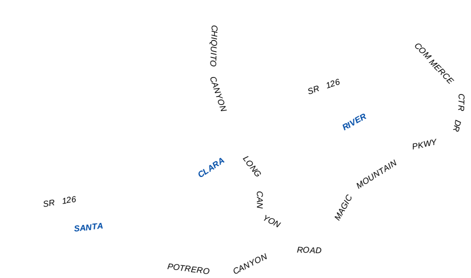

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39

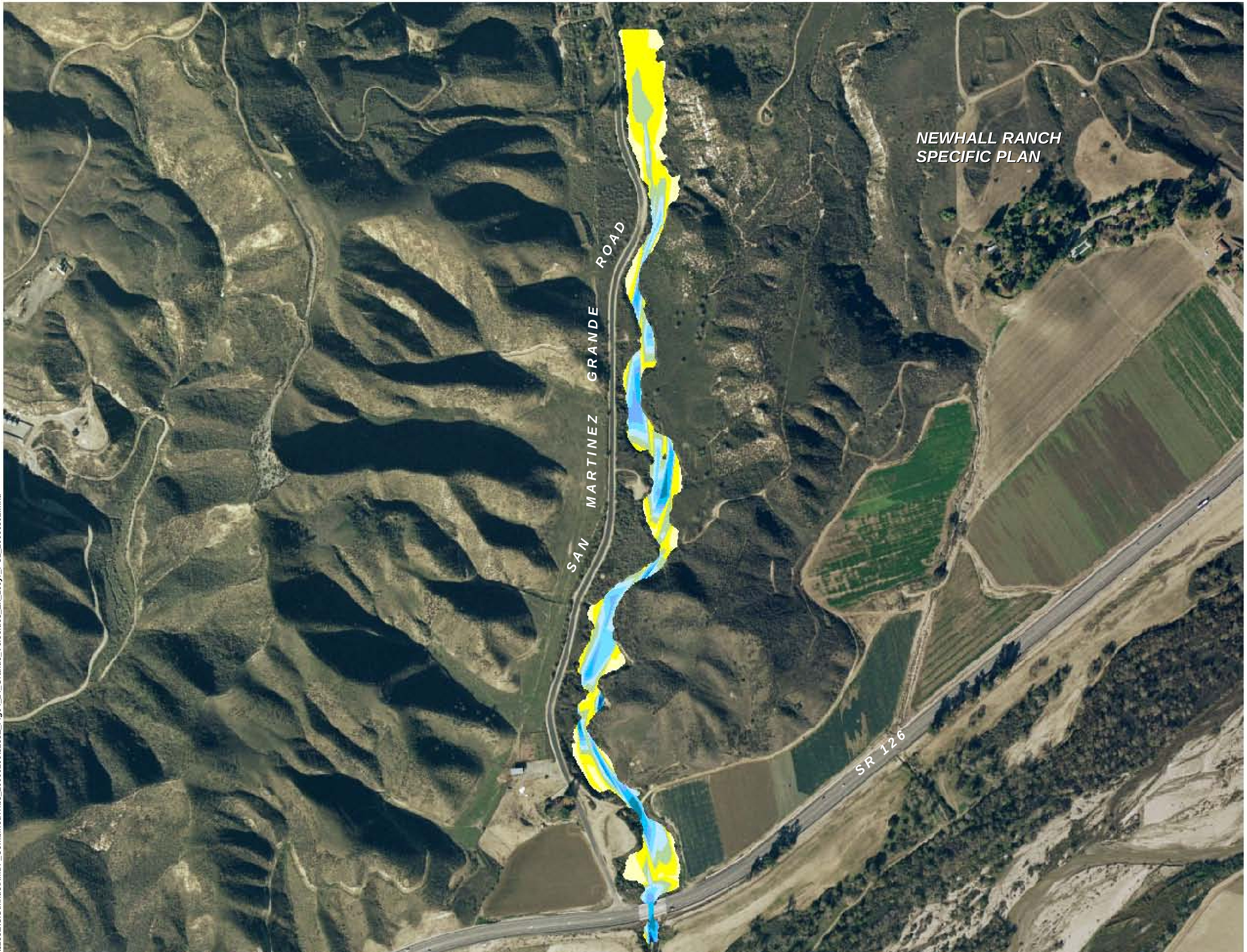


0 125 250 500 Feet
0 37.5 75 150 Meters

Figure 4.13

**EXISTING VELOCITIES**
**50 YEAR FLOOD EVENT**
**SAN MARTINEZ GRANDE**

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig04_13_Grande_Velocities_Ex_50yr_PC1_20090302.mxd



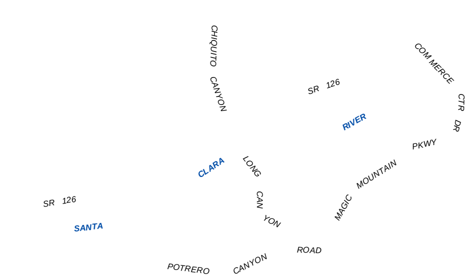

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39




Feet: 0 125 250 500

Meters: 0 37.5 75 150

Figure 4.14

**EXISTING VELOCITIES**
**100 YEAR FLOOD EVENT**
**SAN MARTINEZ GRANDE**

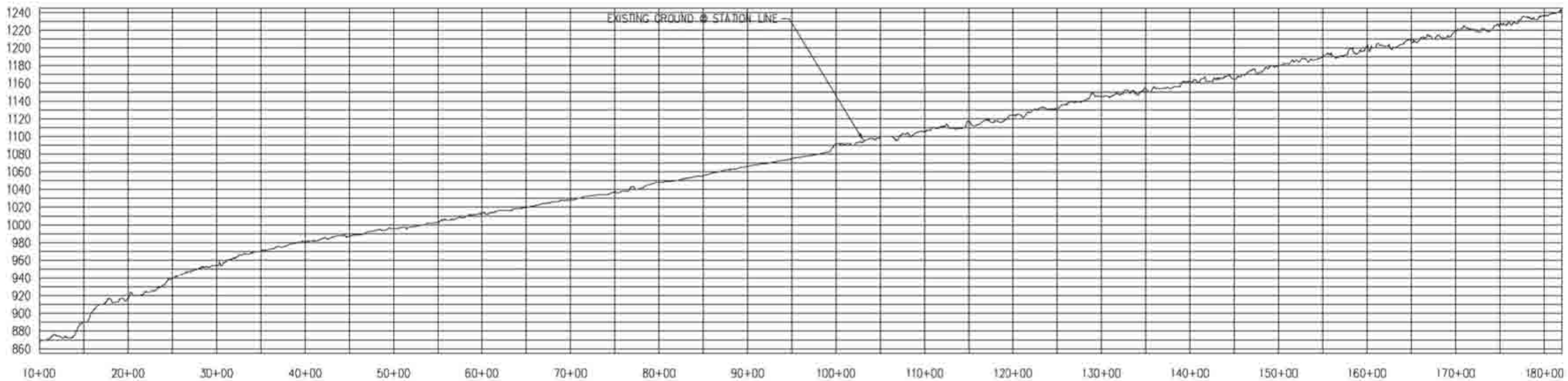
P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig04_14_Grande_Velocities_Ex_100yr_PC1_20090302.mxd

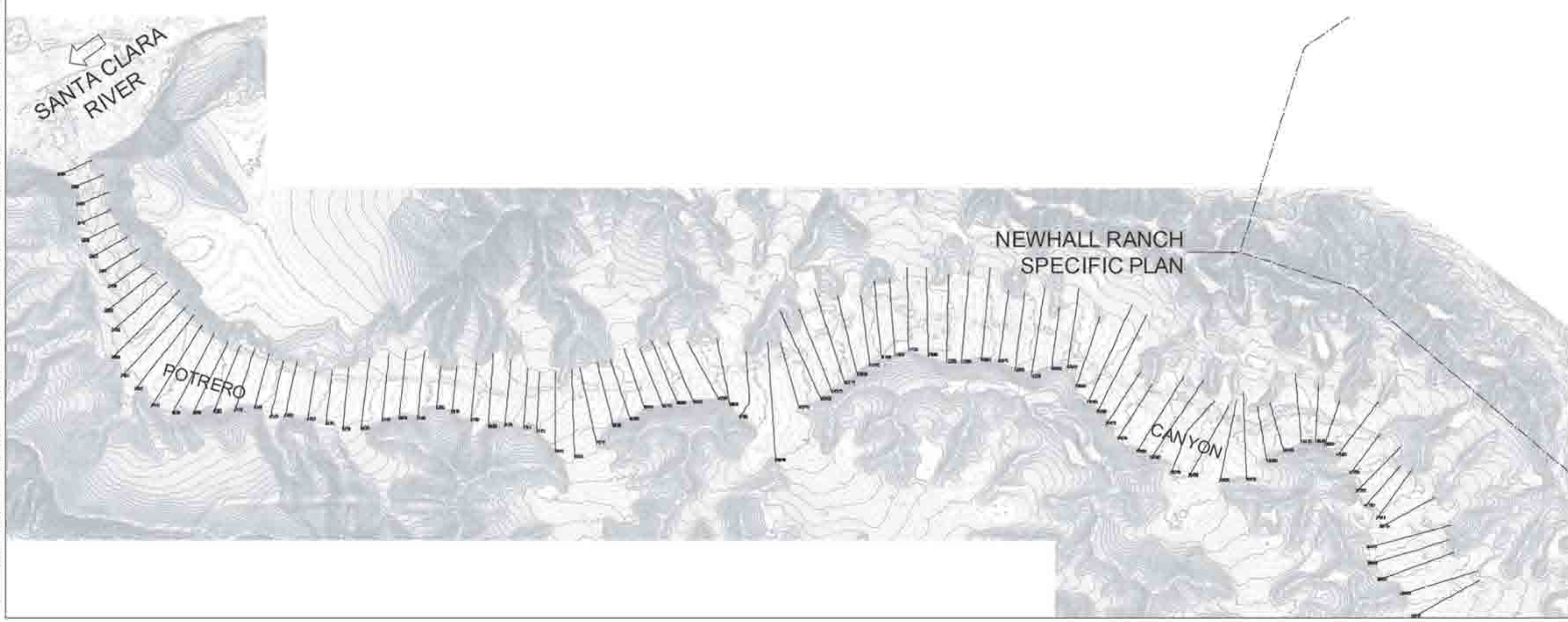
P:\1104E\Engineering\1104-21 (Potrero)\Report Figures\1104E FIG 5-1 POTRERO (WORKMAP EXISTING CONDITION PLAN & PROFILE).dwg - Tab: Layout1 By: ddrahn on Mar. 04, 2009 at 05:18 pm

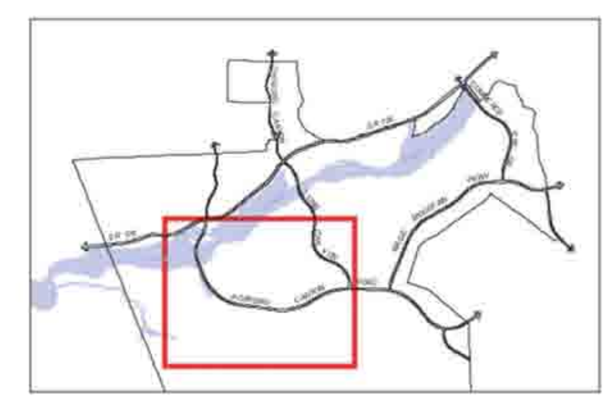
NEWHALL RANCH
Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary



0 375 750 1500 Feet

PACE

Figure 4.15

**EXISTING CONDITION WORKMAP POTRERO CANYON**

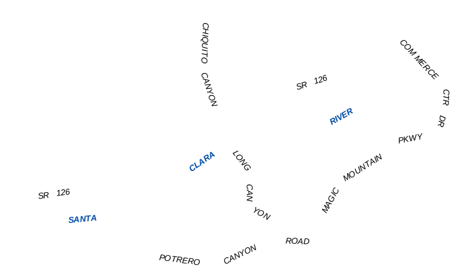

Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39




Feet
0 350 700 1,400
Meters
0 100 200 400

Figure 4.16
**EXISTING VELOCITIES**
**2 YEAR FLOOD EVENT**
**POTRERO CANYON**

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig04_16_Potrero_Velocities_Ex_2yr_PC1_20090302.mxd


P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig04_17_Potrero_Velocities_Ex_5yr_PC1_20090302.mxd

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39

CHIQUITO CANYON
SR 126
COM MERCE CTR DR
RIVER
PKWY
CLARA
LONG CANYON
MAGIC MOUNTAIN
SR 126
SANTA
ROAD
POTRERO CANYON

Feet
0 350 700 1,400
Meters
0 100 200 400

Figure 4.17

# EXISTING VELOCITIES 5 YEAR FLOOD EVENT POTRERO CANYON

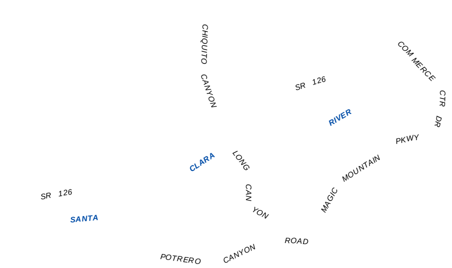

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39




Feet
0 350 700 1,400
Meters
0 100 200 400

Figure 4.18
**EXISTING VELOCITIES**
**10 YEAR FLOOD EVENT**
**POTRERO CANYON**

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig04_18_Potrero_Velocities_Ex_10yr_PC1_20090302.mxd


P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig04_19_Potrero_Velocities_Ex_20yr_PC1_20090302.mxd

Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2

3 - 4

5 - 6

7 - 8

9 - 10

11 - 12

13 - 15

16 - 18

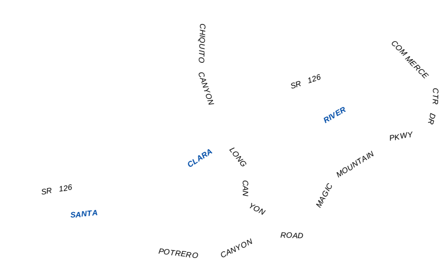
19 - 21

22 - 24

25 - 27

28 - 30

31 - 39



Feet

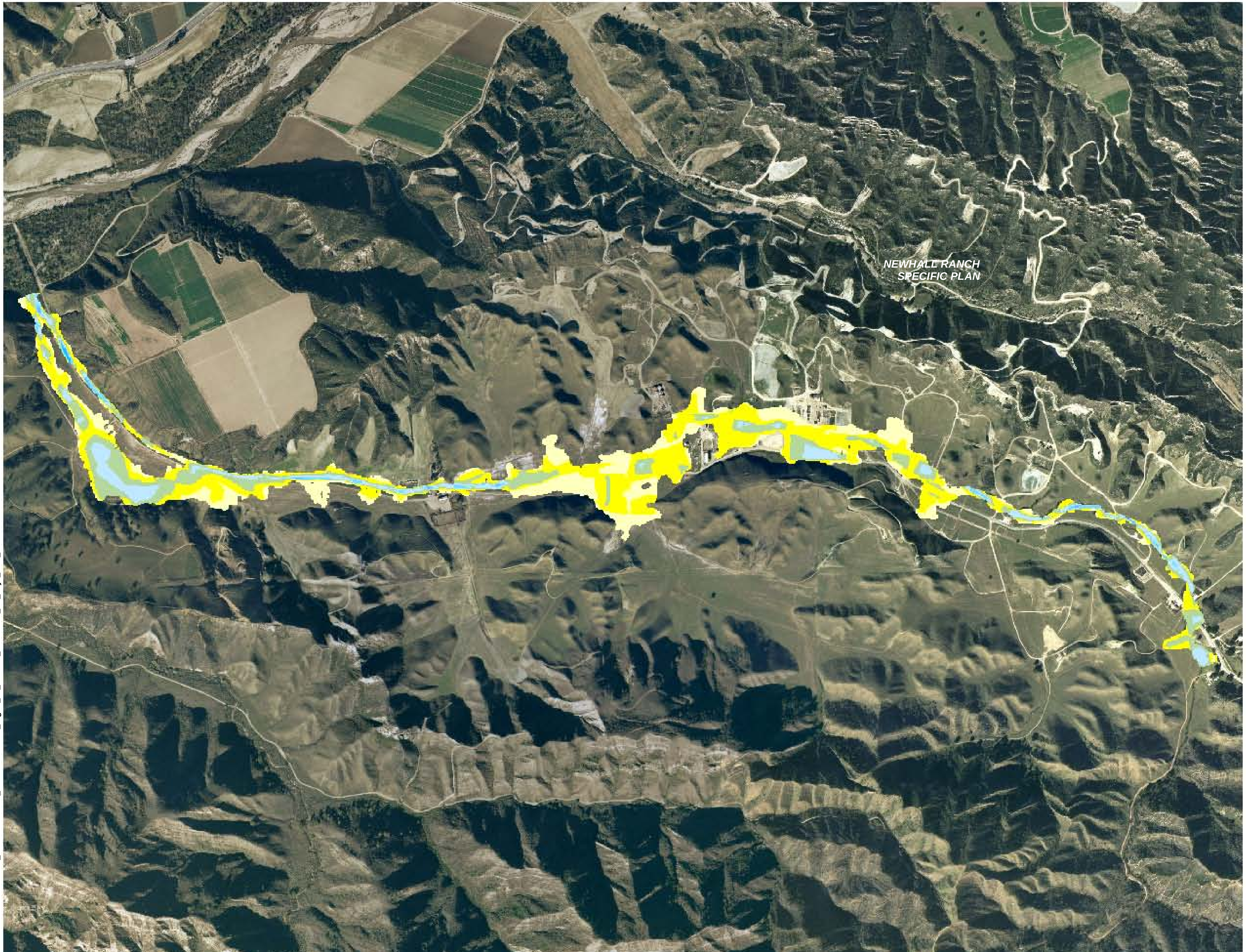
0 350 700 1,400

Meters

0 100 200 400

Figure 4.19

**EXISTING VELOCITIES**
**20 YEAR FLOOD EVENT**
**POTRERO CANYON**



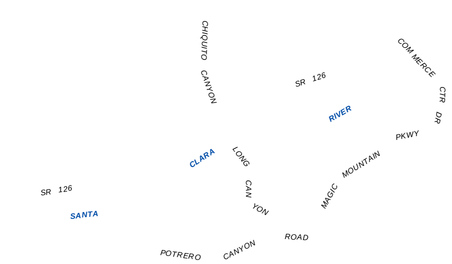

Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39

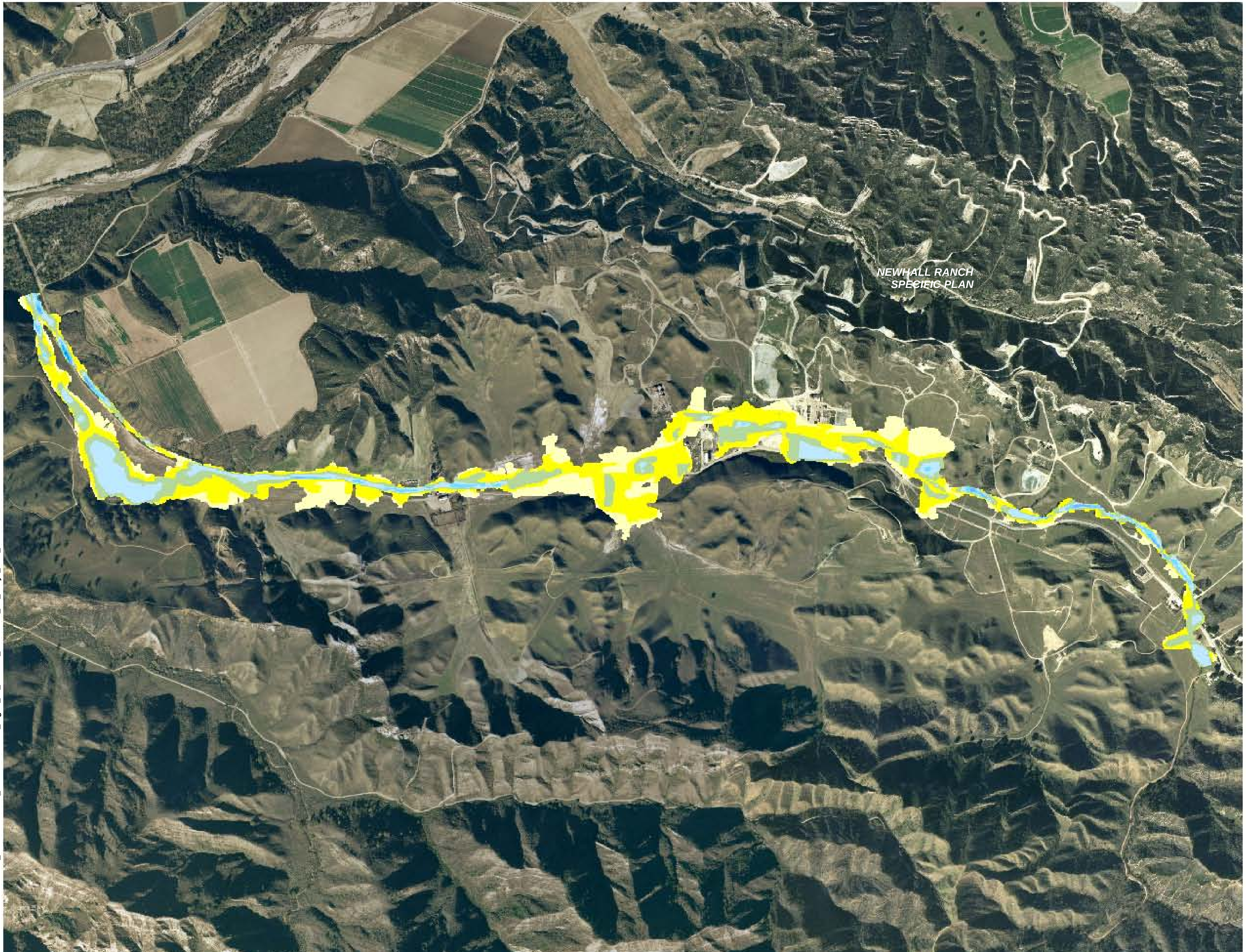


Feet: 0, 350, 700, 1,400
Meters: 0, 100, 200, 400

Figure 4.20

**EXISTING VELOCITIES**
**50 YEAR FLOOD EVENT**
**POTRERO CANYON**

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig04_20_Potrero_Velocities_Ex_50yr_PC1_20090302.mxd



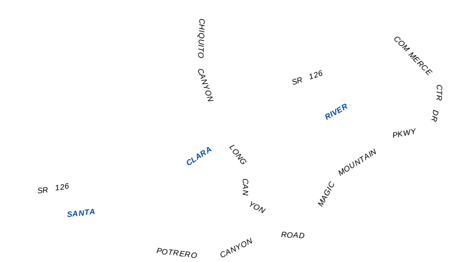

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

- 0 - 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 15
- 16 - 18
- 19 - 21
- 22 - 24
- 25 - 27
- 28 - 30
- 31 - 39



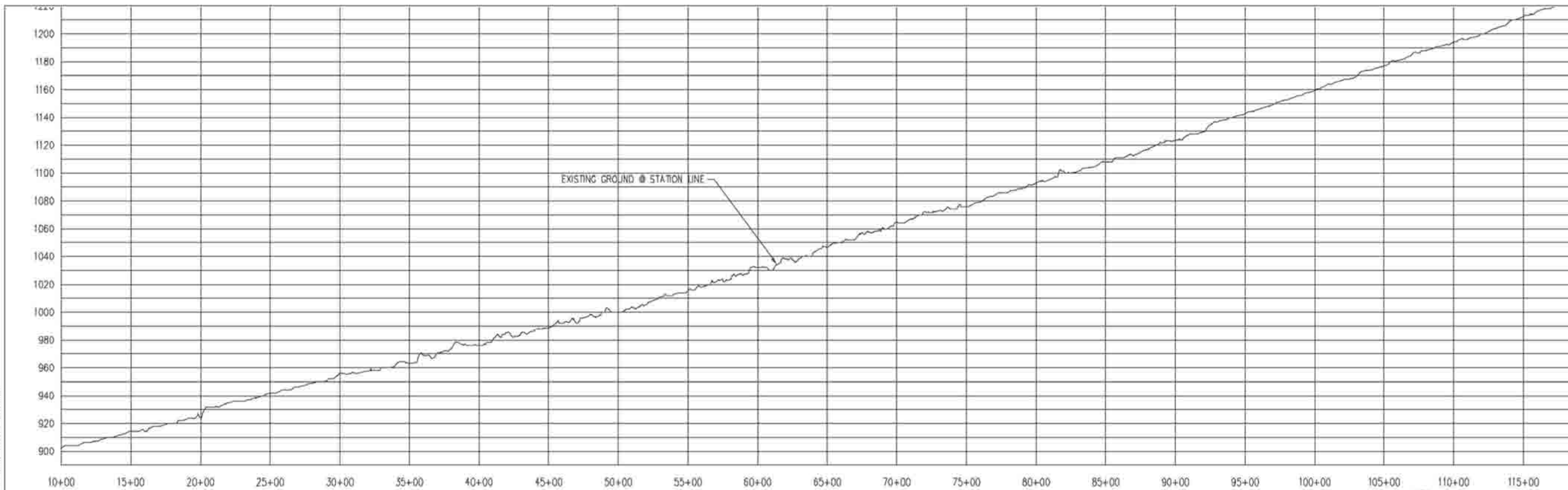
Feet: 0, 350, 700, 1,400

Meters: 0, 100, 200, 400

Figure 4.21

**EXISTING VELOCITIES**
**100 YEAR FLOOD EVENT**
**POTRERO CANYON**

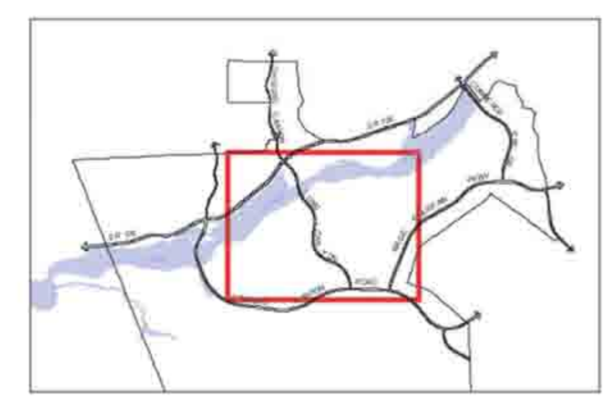
P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig04_21_Potrero_Velocities_Ex_100yr_PC1_20090302.mxd




NEWHALL RANCH
Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

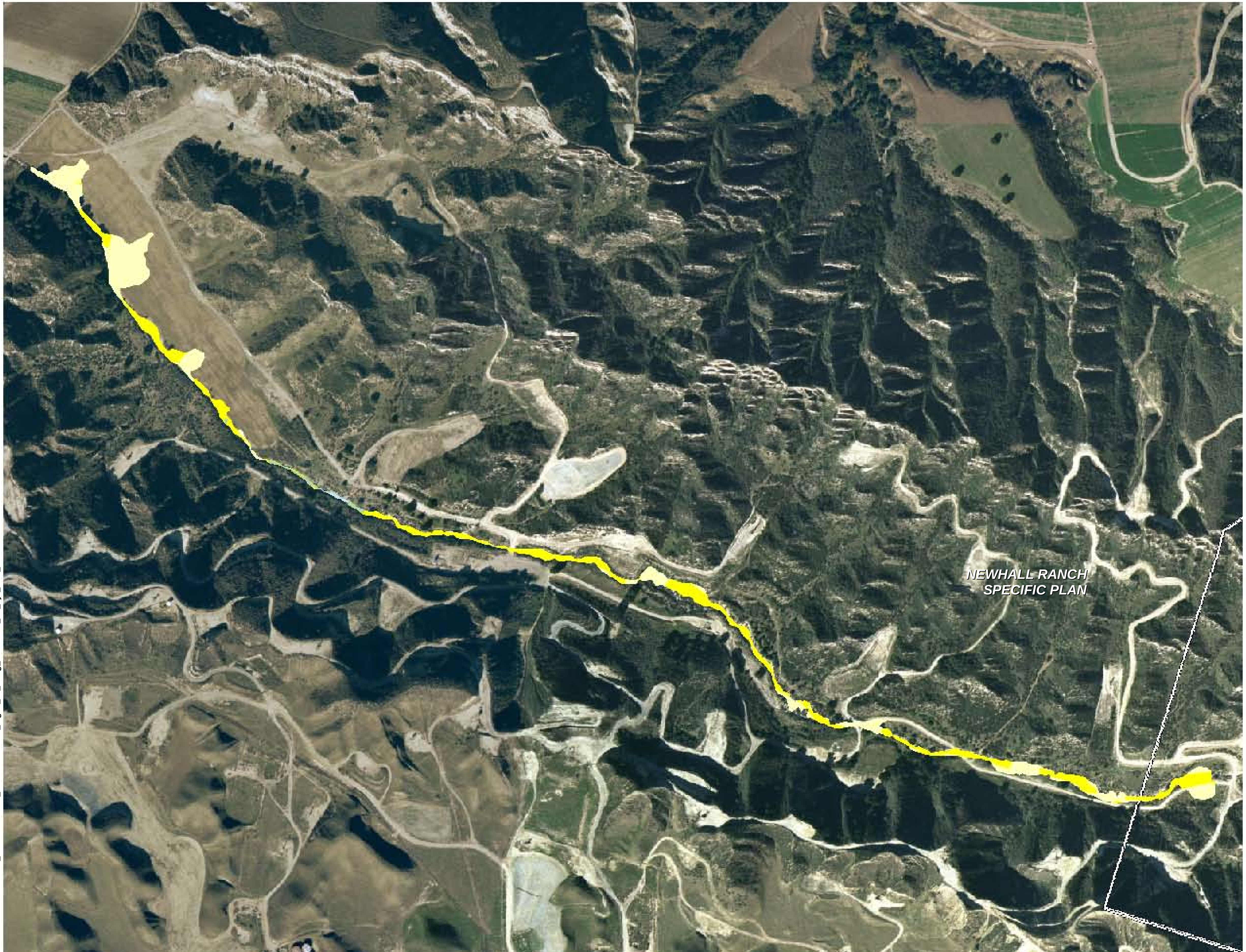
0 200 400 800 Feet

PACE

Figure 4.22

**EXISTING CONDITION WORKMAP LONG CANYON**

P:\7104E\Engineering\7104-31 (Long)\Report Figures\7104E FIG 5-1 LONG (WORKMAP EXISTING CONDITION PLAN & PROFILE).dwg - Tab: Layout1 By: ddrahn on Mar. 04, 2009 at 05:25 pm




P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig04_23_Long_Velocities_Ex_2yr_PC1_20090302.mxd

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

- 0 - 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 15
- 16 - 18
- 19 - 21
- 22 - 24
- 25 - 27
- 28 - 30
- 31 - 39

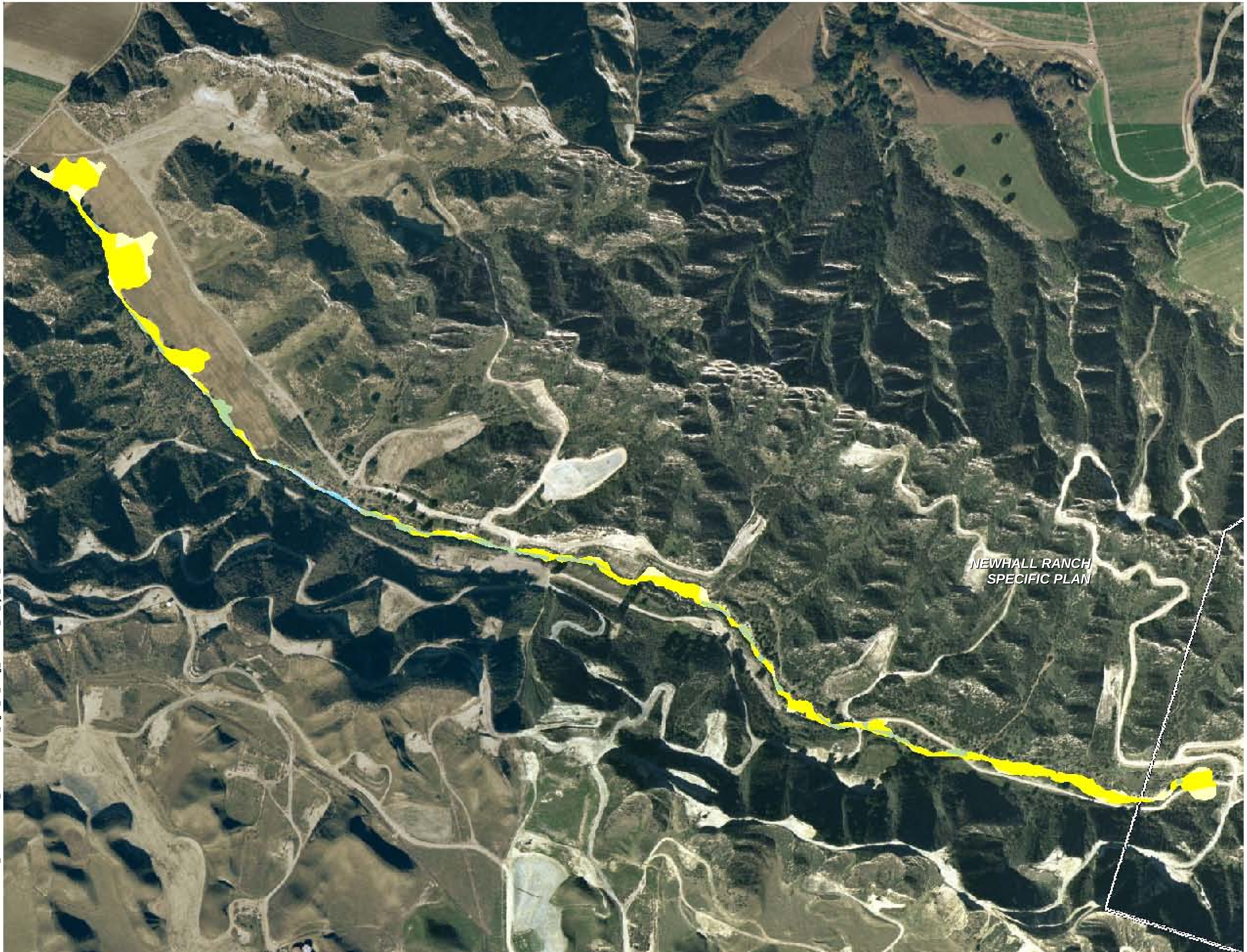
CHIQUITO CANYON
SR 126
COMMERCE CTR DR
RIVER
PKWY
CLARA
LONG CANYON
MAGIC MOUNTAIN
SR 126
SANTA
ROAD
POTRERO CANYON

Feet: 0 150 300 600

Meters: 0 45 90 180

Figure 4.23

**EXISTING VELOCITIES**
**2 YEAR FLOOD EVENT**
**LONG CANYON**




Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2

3 - 4

5 - 6

7 - 8

9 - 10

11 - 12

13 - 15

16 - 18

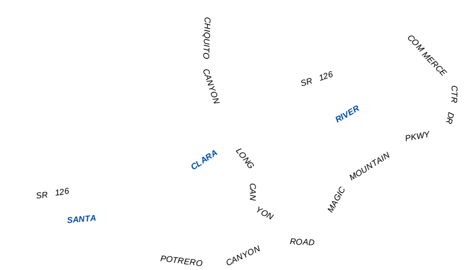
19 - 21

22 - 24

25 - 27

28 - 30

31 - 39




Feet: 0, 150, 300, 600

Meters: 0, 45, 90, 180

Figure 4.24

**EXISTING VELOCITIES**
**5 YEAR FLOOD EVENT**
**LONG CANYON**

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig04_24_Long_Velocities_Ex_5yr_PC1_20090302.mxd

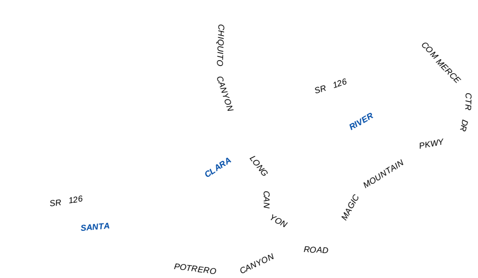

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

- 0 - 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 15
- 16 - 18
- 19 - 21
- 22 - 24
- 25 - 27
- 28 - 30
- 31 - 39

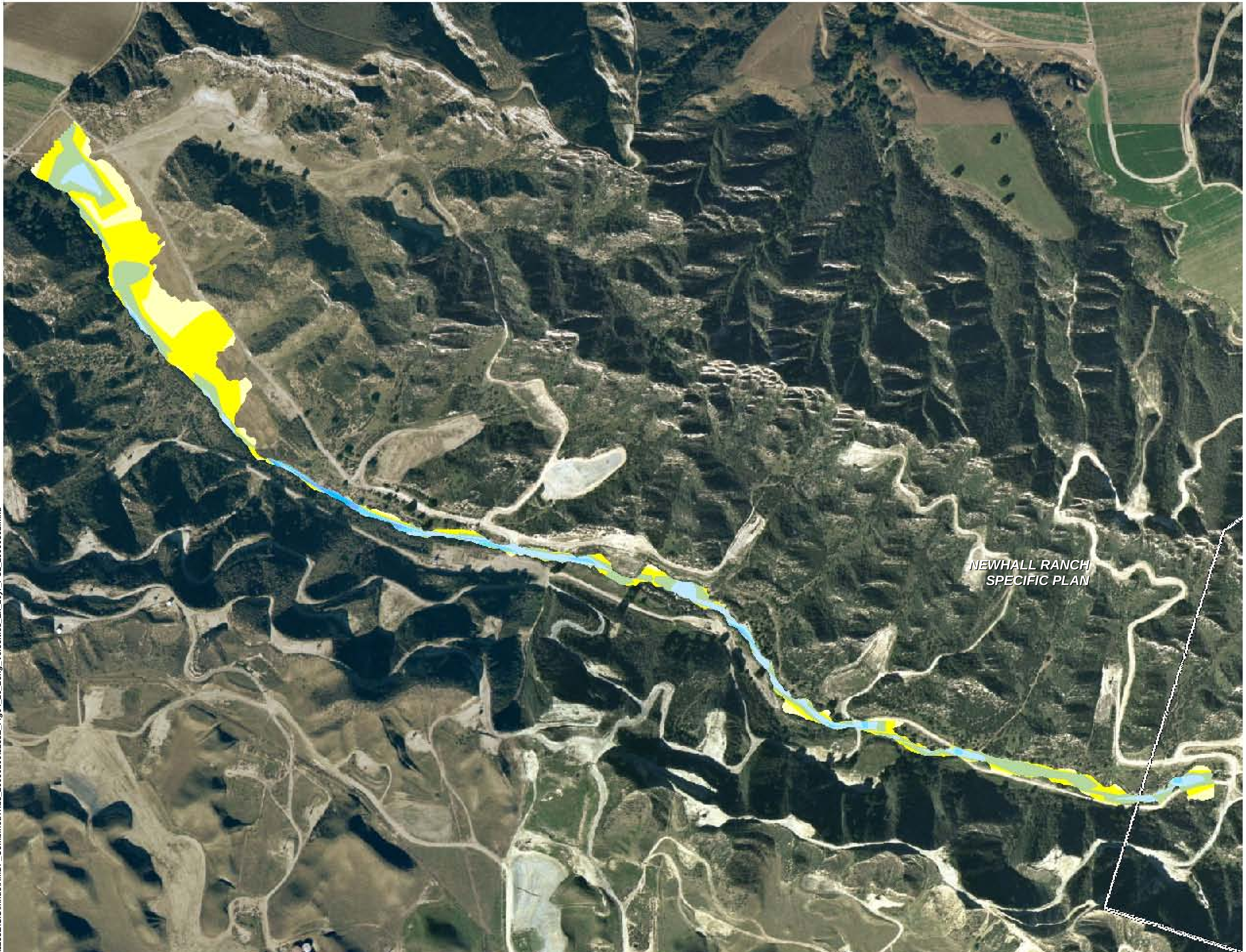



Feet
0 150 300 600
Meters
0 45 90 180

Figure 4.25

**EXISTING VELOCITIES**
**10 YEAR FLOOD EVENT**
**LONG CANYON**

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig04_25_Long_Velocities_Ex_10yr_PC1_20090302.mxd



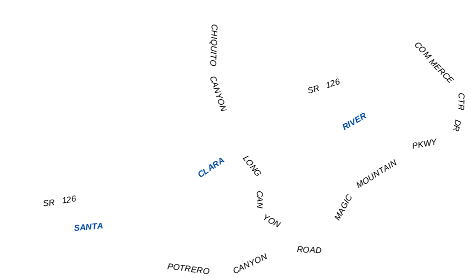

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39

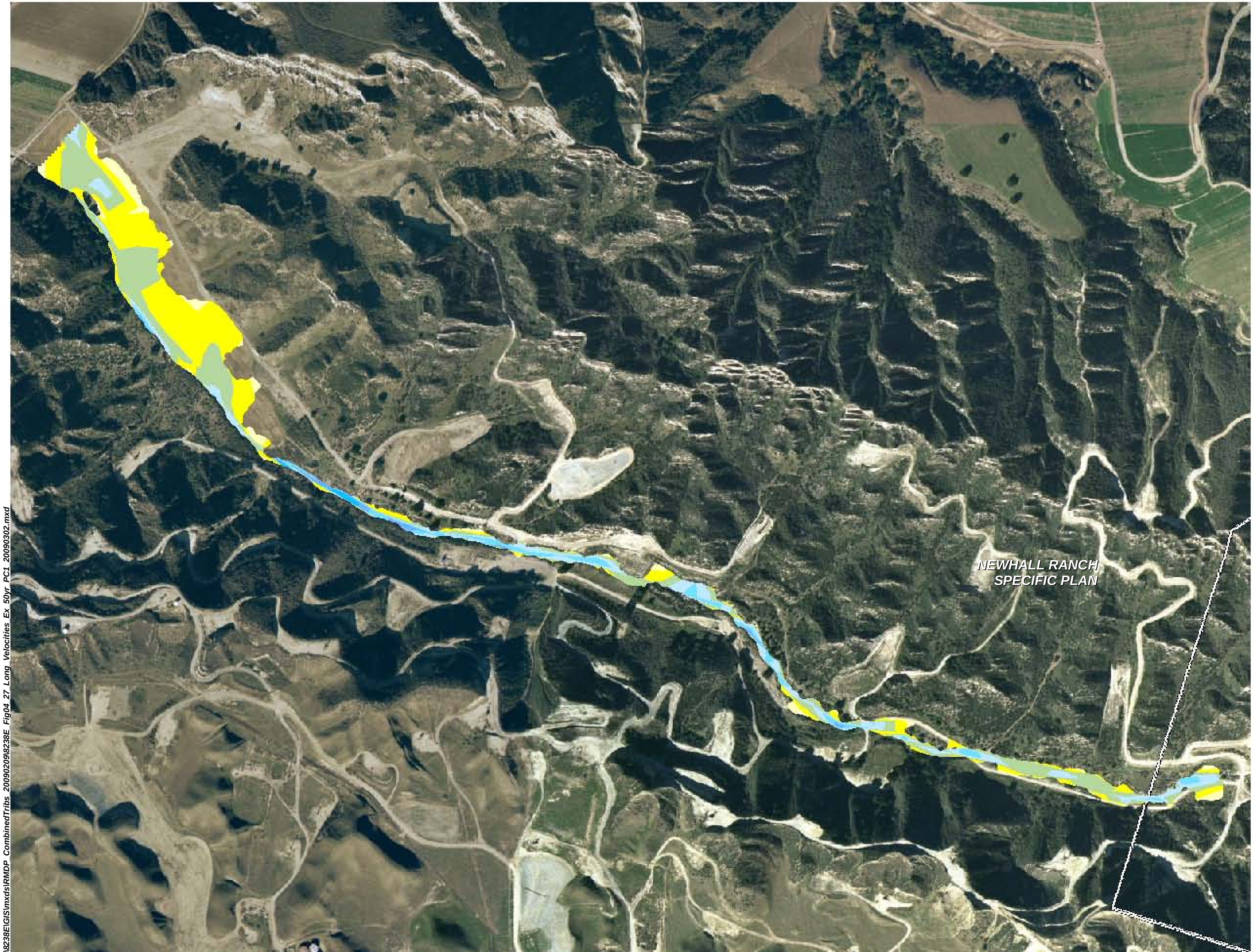



Feet: 0 150 300 600
Meters: 0 45 90 180

Figure 4.26

**EXISTING VELOCITIES**
**20 YEAR FLOOD EVENT**
**LONG CANYON**

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig04_26_Long_Velocities_Ex_20yr_PC1_20090302.mxd



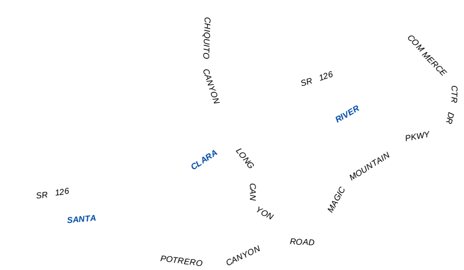

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39

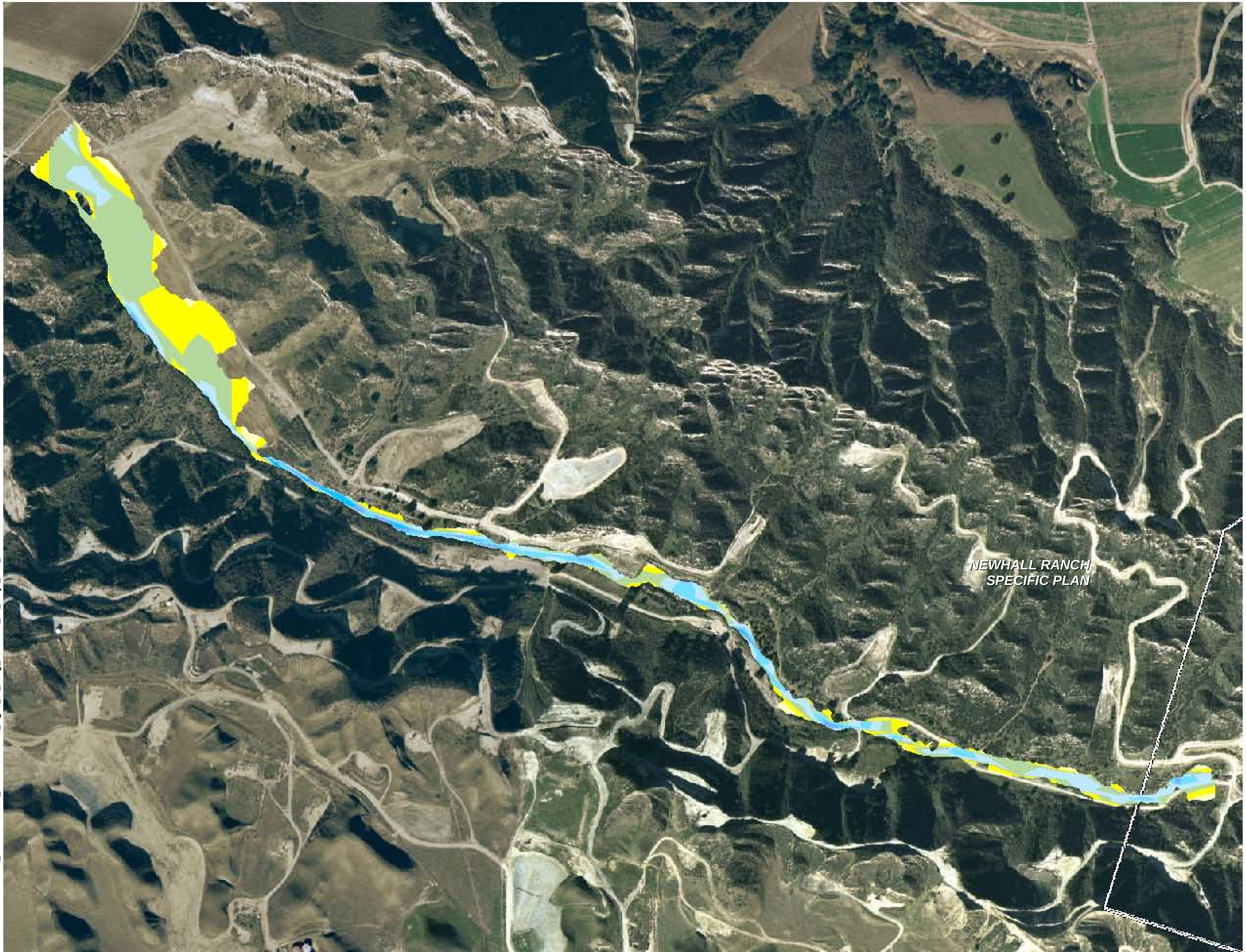



Feet
0 150 300 600
Meters
0 45 90 180

Figure 4.27

**EXISTING VELOCITIES**
**50 YEAR FLOOD EVENT**
**LONG CANYON**

P:\8238E\GIS\mxds\RMDP CombinedTribs 20090209\8238E Fig04 27 Long Velocities Ex 50yr PC1 20090302.mxd



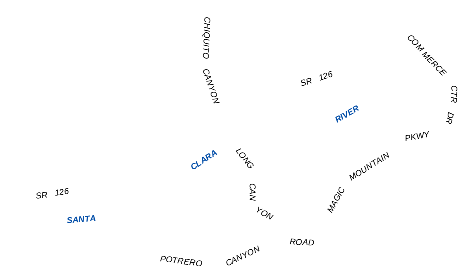

Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39




Feet
0 150 300 600
Meters
0 45 90 180

Figure 4.28

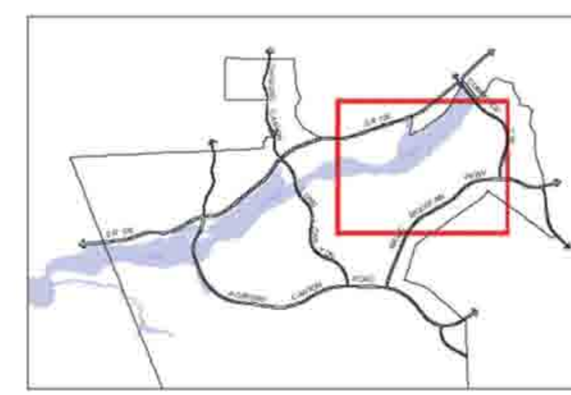
**EXISTING VELOCITIES**
**100 YEAR FLOOD EVENT**
**LONG CANYON**

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig04_28_Long_Velocities_Ex_100yr_PC1_20090302.mxd


NEWHALL RANCH
Newhall Ranch Company

L E G E N D

Newhall Ranch Specific Plan Boundary

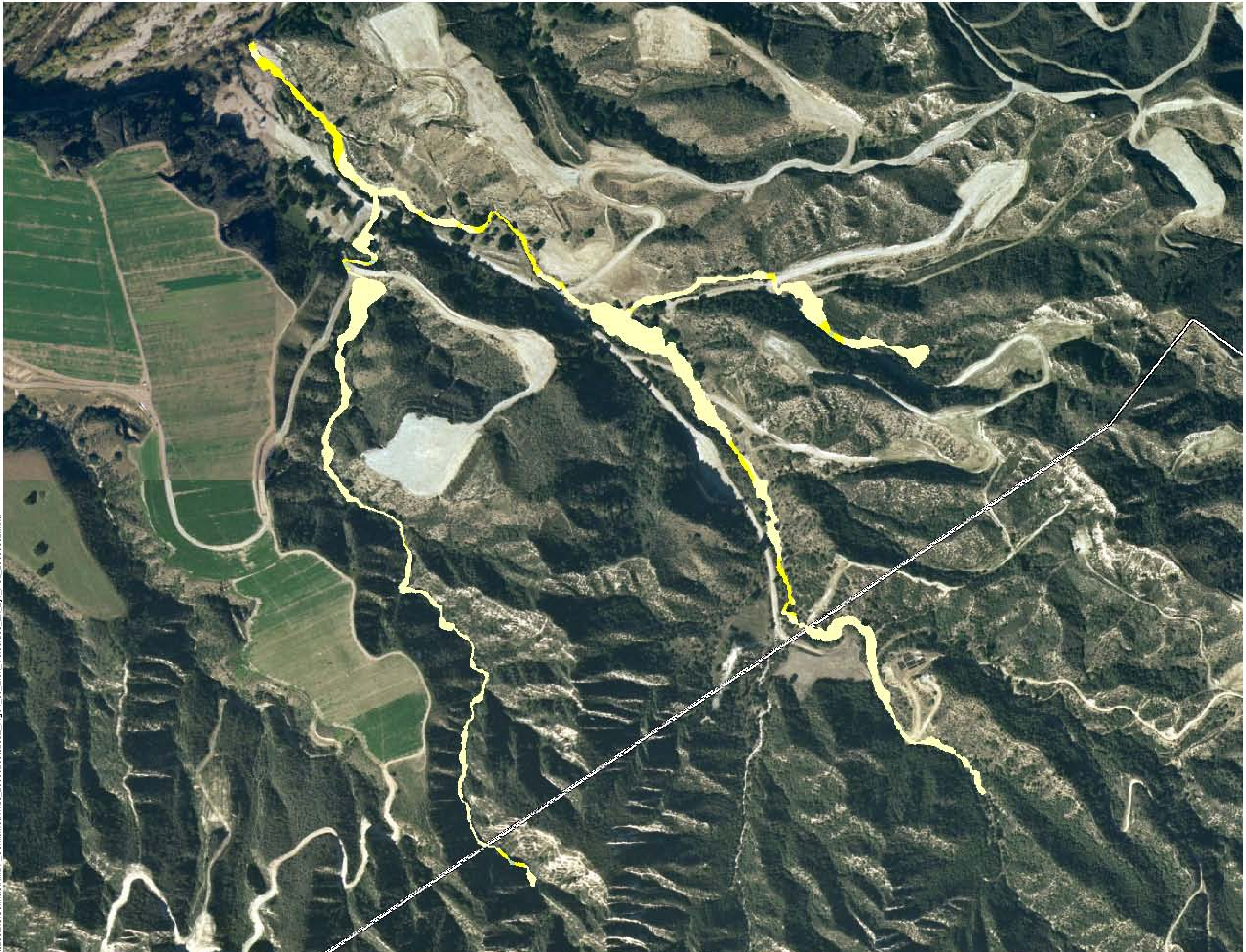


0 125 250 500 Feet

PACE

Figure 4.29
**EXISTING CONDITION WORKMAP LION CANYON**

P:\7104E\Engineering\7104-XX (LionCanyon)\Report Figures\7104E FIG 5-1 LION (WORKMAP EXISTING CONDITION PLAN & PROFILE).dwg - Tab: Layout1 By: on Mar. 04, 2009 at 05:34 pm



P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig04_30_Lion_Velocities_Ex_2yr_PC1_20090302.mxd

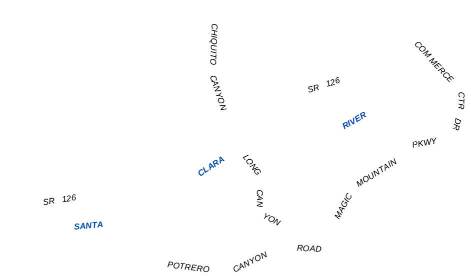
Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

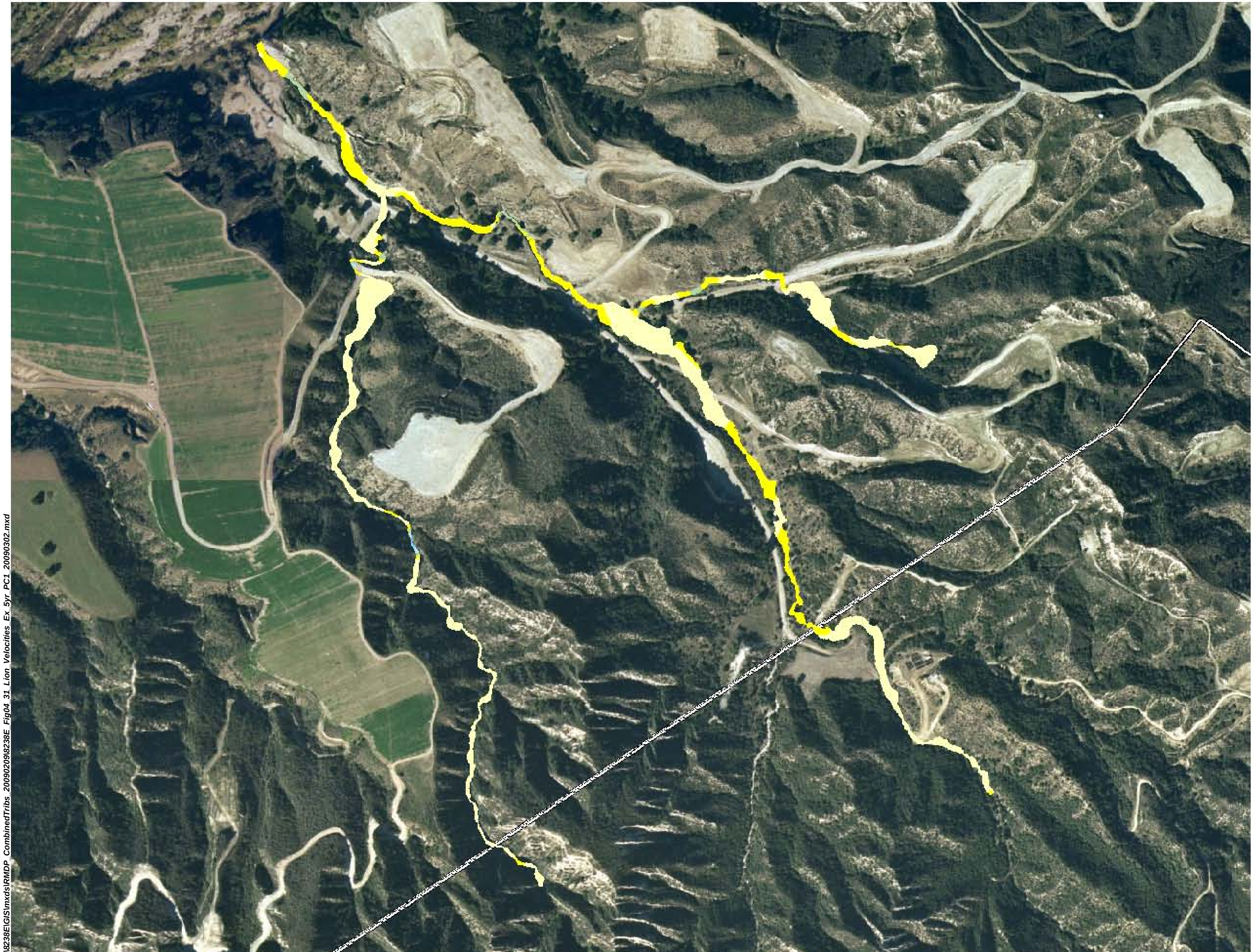
- 0 - 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- 11 - 12
- 13 - 15
- 16 - 18
- 19 - 21
- 22 - 24
- 25 - 27
- 28 - 30
- 31 - 39




Feet
0 125 250 500
Meters
0 37.5 75 150

Figure 4.30

**EXISTING VELOCITIES**
**2 YEAR FLOOD EVENT**
**LION CANYON**



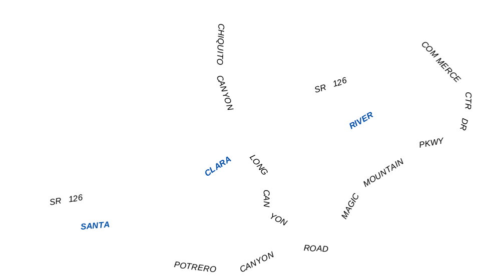
Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

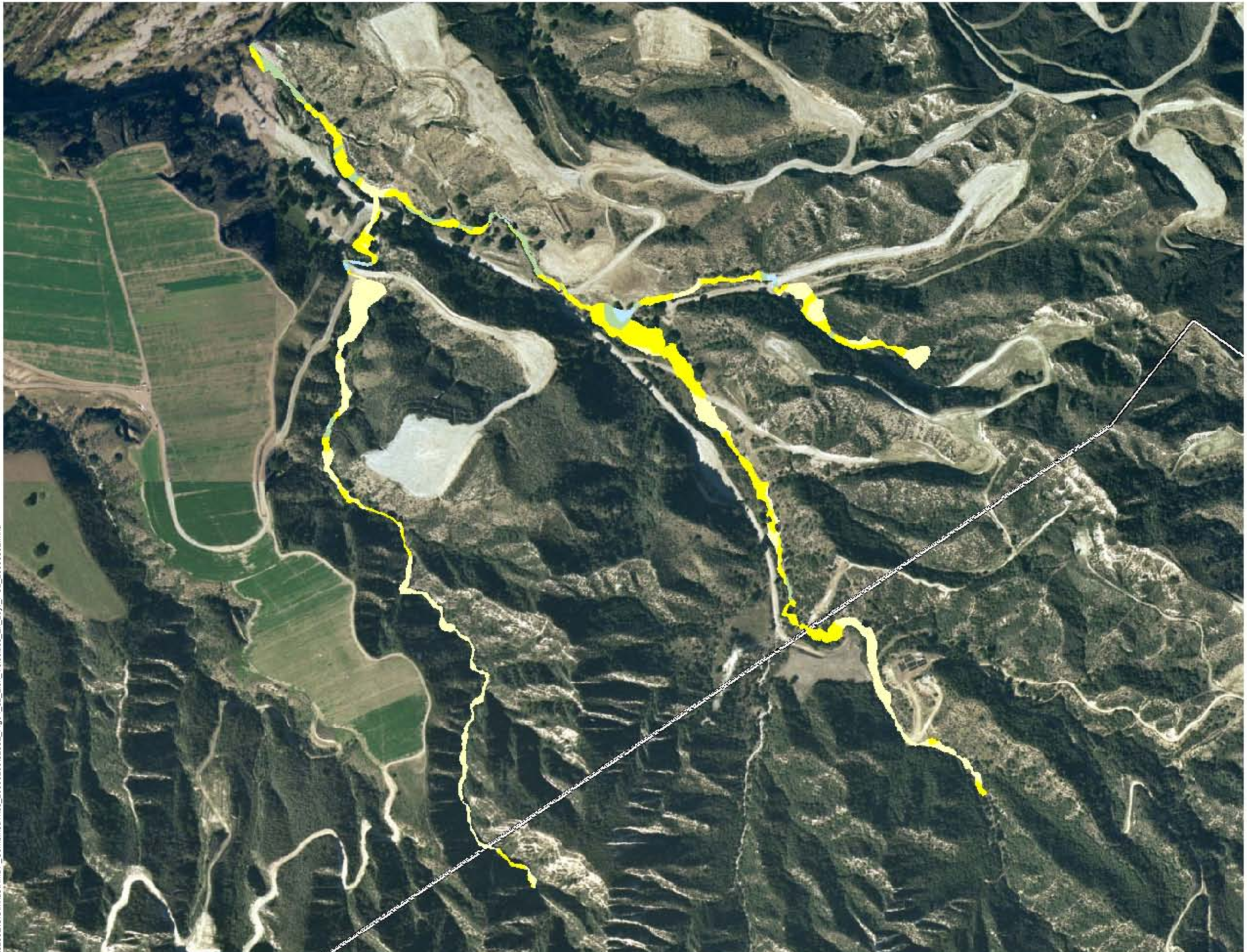
0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39




Feet
0 125 250 500
Meters
0 37.5 75 150

Figure 4.31
**EXISTING VELOCITIES**
**5 YEAR FLOOD EVENT**
**LION CANYON**

P:\8238E\GIS\mxds\RMDP_CombinedTribs_20090209\8238E_Fig04_31_Lion_Velocities_Ex_5yr_PC1_20090302.mxd



Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2

3 - 4

5 - 6

7 - 8

9 - 10

11 - 12

13 - 15

16 - 18

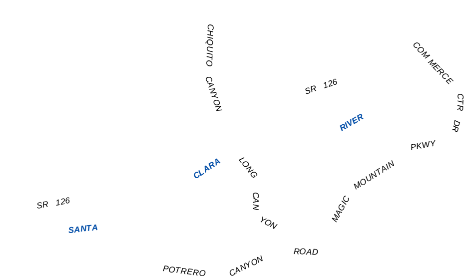
19 - 21

22 - 24

25 - 27

28 - 30

31 - 39



Feet
0 125 250 500

Meters
0 35 70 140

Figure 4.32

**EXISTING VELOCITIES**
**10 YEAR FLOOD EVENT**
**LION CANYON**

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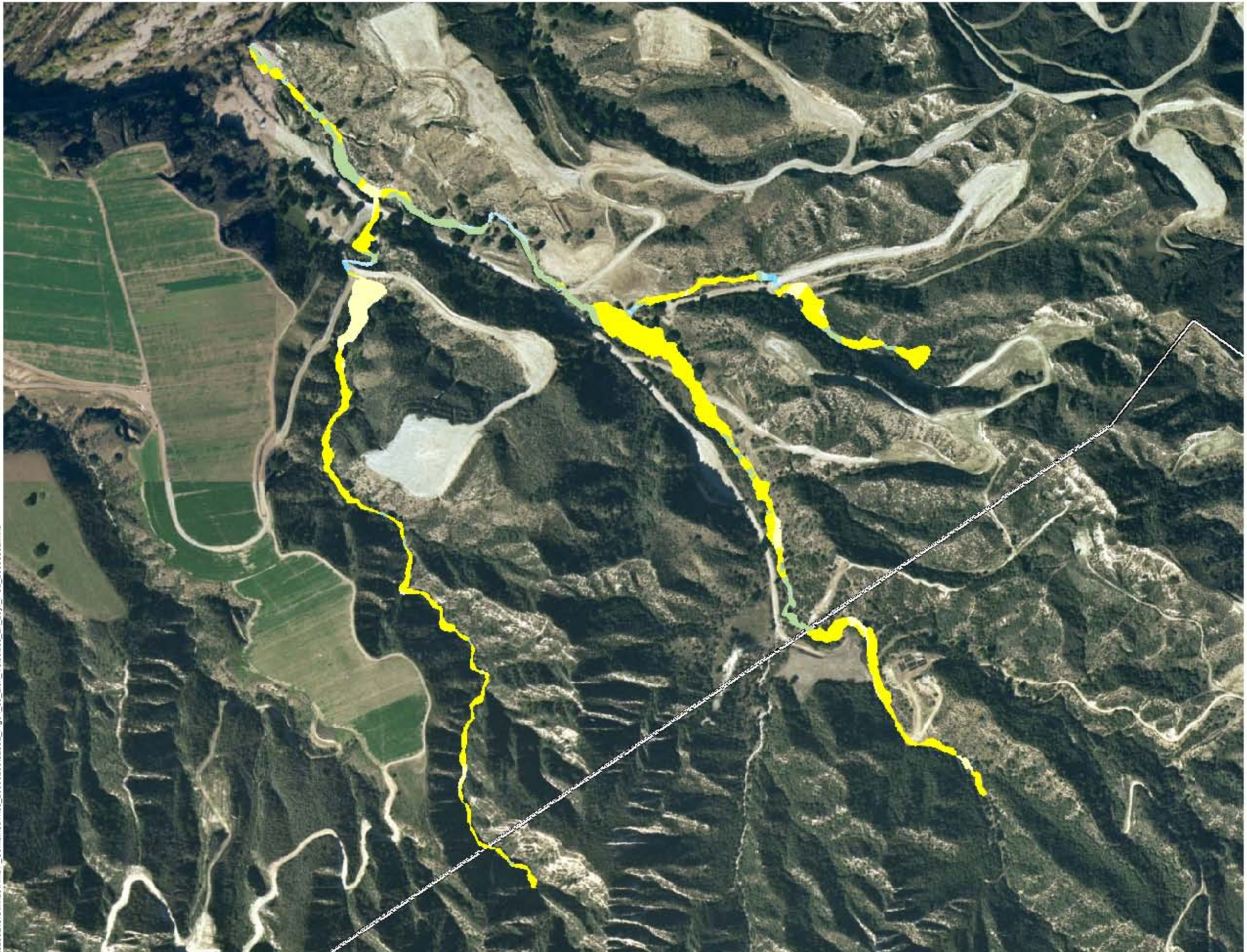


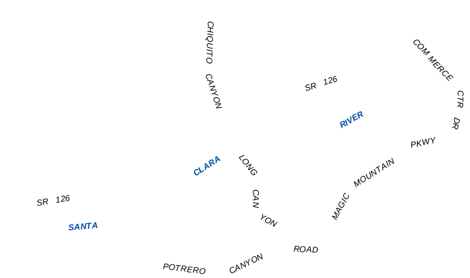
Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39




Feet
0 125 250 500
Meters
0 35 70 140

Figure 4.33

**EXISTING VELOCITIES**
**20 YEAR FLOOD EVENT**
**LION CANYON**

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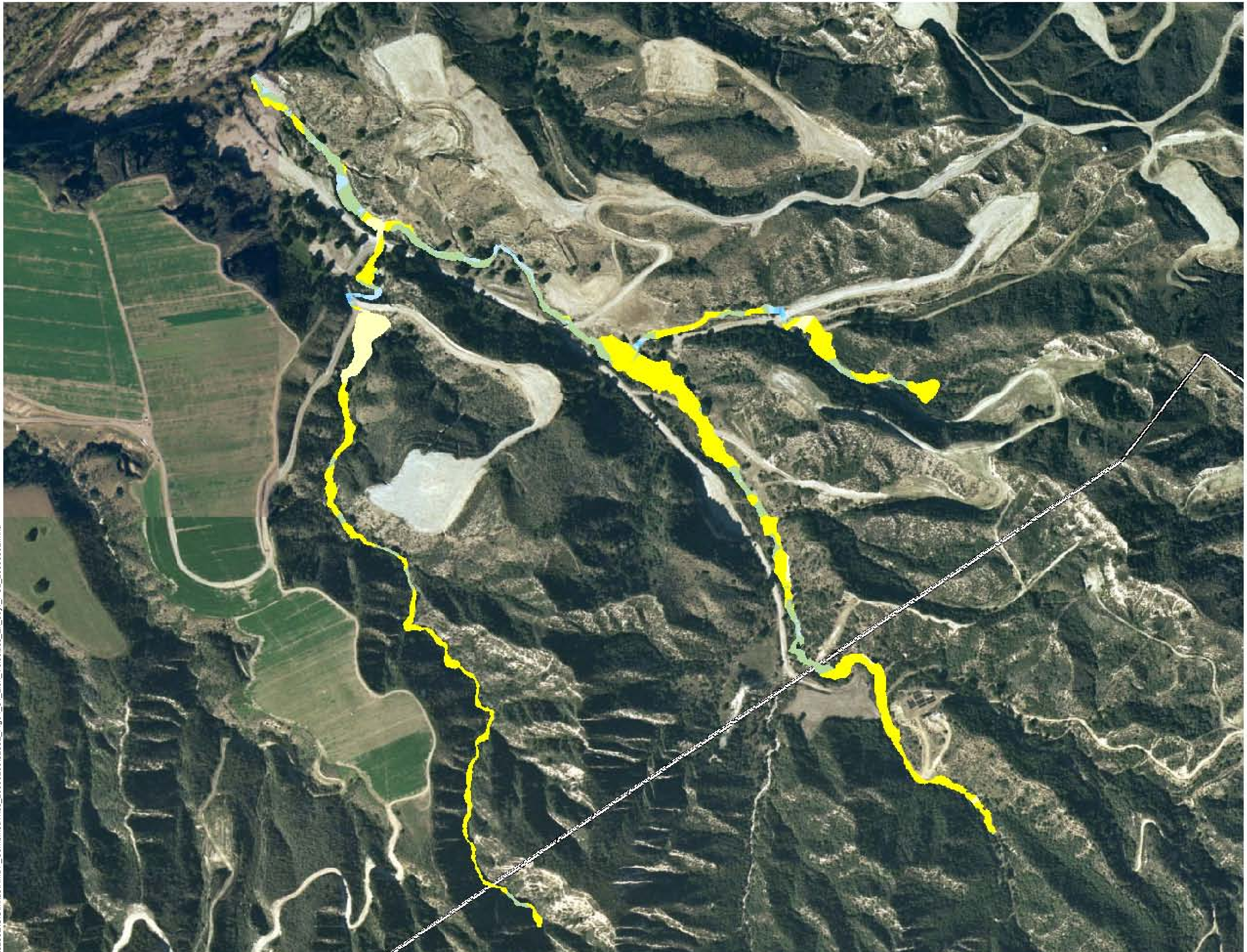


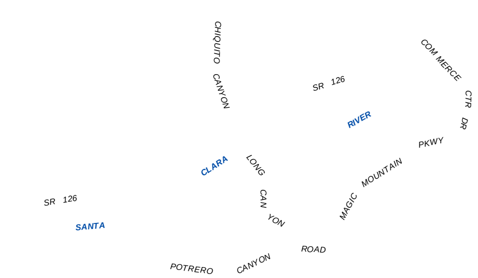
Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2
3 - 4
5 - 6
7 - 8
9 - 10
11 - 12
13 - 15
16 - 18
19 - 21
22 - 24
25 - 27
28 - 30
31 - 39




Feet
0 125 250 500
Meters
0 35 70 140

Figure 4.34

**EXISTING VELOCITIES**
**50 YEAR FLOOD EVENT**
**LION CANYON**

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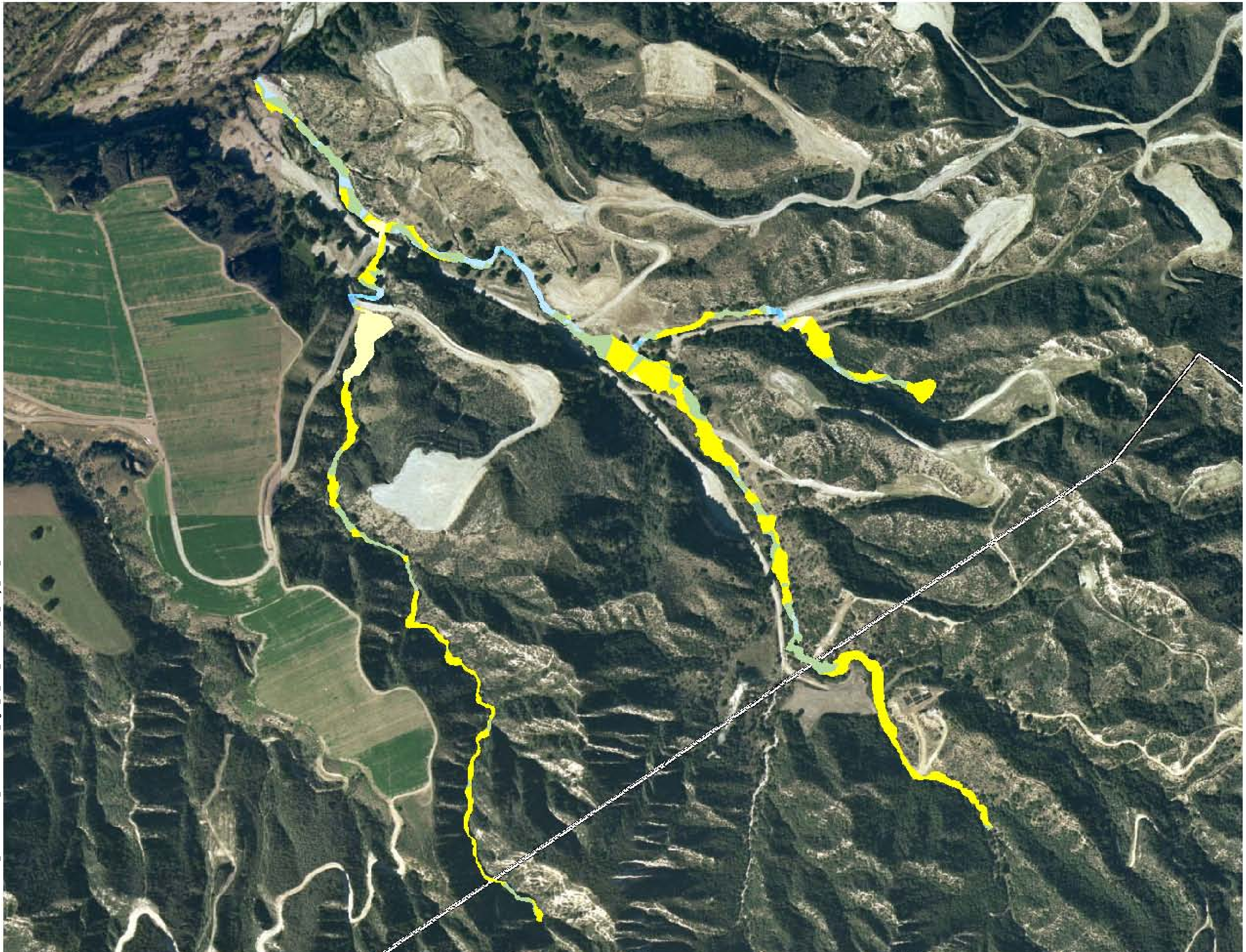

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Newhall Ranch Company

**L E G E N D**

Newhall Ranch Specific Plan Boundary

Velocity Profile (fps)

0 - 2

3 - 4

5 - 6

7 - 8

9 - 10

11 - 12

13 - 15

16 - 18

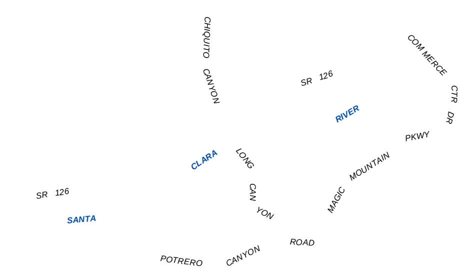
19 - 21

22 - 24

25 - 27

28 - 30

31 - 39



Feet

0 125 250 500

Meters

0 37.5 75 150

Figure 4.35

**EXISTING VELOCITIES**
**100 YEAR FLOOD EVENT**
**LION CANYON**

# 5 Stream Stability and Floodplain Operation

## 5.1 Channel Sediment Transport Analysis Approach

### *5.1.1 SAM Model*

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 SAM.SED module combines the hydraulic parameters with the bed material gradation curve to compute bed material discharge rating curves by size classification. The SAM.AID module provides the user with recommended procedures based on the best matches between hydraulic parameters and grain size gradation of the study reach with the same parameters of selected river. Calibrations based on measured data have been performed between the available procedures and selected rivers. This calibration has shown which procedures best predict the actual sediment transport capacity of a particular river. SAM.SED provides a sediment transport capacity for each discharge.

### *5.1.2 Input Data and Selection of Transport Functions*

The SAM numerical model is built upon hydraulic and fluvial components. The hydraulic components include representations of river bed characteristics including top width, side slope, hydraulic depth, bed roughness, reach length, energy grade, and discharge. The fluvial component includes representation of bed gradation as percent finer statistics and a selection of up to twenty sediment transport equations.

Hydraulic representation of the river bed is accomplished in several distinct steps. First, the HEC-RAS numerical model is converted to HEC-2 format and run to produce the Army Corps' T95 binary hydraulic simulation output file. Next, the T95 file is then read directly into SAM using the SAM model's M95 subroutine. This methodology is powerful because it ensures that data created for, and analyzed using, HEC-RAS and HEC-2 hydraulic software is fully compatible with, and implemented in, SAM fluvial analyses. Finally, sub-reaches within the model are specified and average hydraulic parameters are calculated for those sub-reaches. Sub-reaches are determined by examining the hydraulic parameters of the individual HEC-RAS cross-sections and identifying correlations between those hydraulic parameters and the longitudinal position in the channel of the individual cross-section. This process is described in detail in Section 5.2, below.

Representation of sediment grain size distribution in SAM takes the form of percent finer data obtained from sieve analysis of channel sediment grab samples. At each sample location three samples are collected and analyzed, and the average data is input into the model. All sampling and sieve analysis was conducted by Allan E. Seward Engineering Geology, Inc., and sample locations were chosen based on either the presence of recently active alluvium or the presence of adjacent/underlying older alluvium commonly incorporated into stream sediment load during major events. Environmental constraints on subsurface investigations in active drainages limited sampling locations in some instances, and in these cases the most representative, obtainable data is used.

Sediment transport equations used in all SAM modeling were chosen with the assistance of the Army Corps' SAM.AID subroutine. The SAM.AID subroutine determines the most representative transport function based on the hydraulic parameters and percent finer data for each sub-reach by comparing the data with the results of 20 peer-reviewed and widely acknowledged sediment transport studies. This case-by-case transport equation selection is more likely to provide a robust representation of channel sediment transport than choosing and individual transport equation for all reaches. Once the best transport equation matches have been determined by SAM.AID the most representative equations are run for each sub-reach. Sediment transport for each sub-reach can then be estimated by reviewing the calculations of transport from each equation, excluding any outliers, and using the median transport estimate.

## 5.2 Reach-by-Reach Channel Hydraulic Characterization

As noted in section 6.1.2, SAM modeling is based on channel sub-reaches determined by correlating hydraulic characteristics with longitudinal cross-section location. The hydraulic parameters examined are discharge, energy slope, bed slope, Froude number, top width, hydraulic velocity and flow area. Correlation values typically vary from r=0.0 to r=±0.5. In the case of the five tributary drainages, changes in discharge along the creeks dominated the other hydraulic parameters with respect to sub-reach classification. Therefore, all sub-reaches have been defined based on locations of significant discharge increases within the drainages, and correspond to reaches defined in Tables 5.2-5.5.

## 5.3 Results of Sediment Transport Analysis

**Table 5.1** – Chiquito Existing Conditions SAM Model Estimates of Transport Potential

| Sub-Reach Upstream Section No | Discharge (CFS) | Median Transport Equation | Transport (tons/day) | Transport (tons/day) | Stability |
|---|---|---|---|---|---|
| 9190 | 3917 | Yang | 128844.92 | NA | NA |
| | 1074 | Laursen-Copeland | 804192.56 | NA | NA |
| 9000 | 4147 | Laursen-Copeland | 1674485.00 | 1545640.08 | Degrade |
| | 1137 | Laursen-Copeland | 312726.53 | -491466.03 | Aggrade |
| 8445 | 4178 | Laursen-Copeland | 1501544.75 | -172940.25 | Aggrade |
| | 1144 | Laursen-Copeland | 342133.63 | 29407.1 | Degrade |
| 7595 | 4199 | Laursen-Copeland | 1864599.75 | 363055 | Degrade |
| | 1153 | Laursen-Copeland | 429458.06 | 87324.43 | Degrade |
| 7155 | 4218 | Laursen-Copeland | 2037389.38 | 172789.63 | Degrade |
| | 115 | Laursen-Copeland | 483598.22 | 54140.16 | Degrade |
| 6735 | 4205 | Laursen-Copeland | 1870280.50 | -167108.88 | Aggrade |
| | 1156 | Laursen-Copeland | 453714.53 | -29883.69 | |
| 6215 | 4389 | Laursen-Copeland | 1908495.88 | 38215.38 | Degrade |
| | 1199 | Laursen-Copeland | 506152.78 | 52438.25 | Degrade |
| 4980 | 4482 | Laursen-Copeland | 846347.38 | -1062148.5 | Aggrade |
| | 1209 | Laursen-Copeland | 191837.08 | -314315.7 | |
| 4510 | 4526 | Laursen-Copeland | 1669890.88 | 823543.5 | Degrade |
| | 1218 | Laursen-Copeland | 554889.38 | 363052.3 | Degrade |
| 3935 | 4564 | Laursen-Copeland | 1931309.5 | 261418.62 | Degrade |
| | 1228 | Laursen-Copeland | 414582.28 | -140307.1 | Aggrade |
| 3165 | 4603 | Laursen-Copeland | 2072274.63 | 140965.13 | Degrade |
| | 1239 | Laursen-Copeland | 531083.25 | 116500.97 | Degrade |
| 2630 | 4641 | Laursen-Copeland | 1738055.8 | -334218.83 | Aggrade |
| | 1247 | Laursen-Copeland | 456944.59 | -74138.66 | |
| 1560 | 4663 | Laursen-Copeland | 247662.47 | -1490393.33 | Aggrade |
| | 1252 | Ackers-White | 24952.03 | -431992.56 | |

**Table 5.2 –** San Martinez Grande Canyon Existing Conditions SAM Model Estimates of Transport Potential

| Sub-Reach Upstream Section No. | Discharge (CFS) | Median Transport Equation | Potential Transport (tons/day) | Transport (tons/day) | Stability |
|---|---|---|---|---|---|
| 5850 | 2653 | Laursen-Copeland | 1062558 | NA | NA |
| | 655 | Laursen-Copeland | 132509 | NA | NA |
| 4980 | 2796 | Laursen-Copeland | 1155397 | 92839 | Degrade |
| | 687 | Laursen-Copeland | 203384 | 70875 | |
| 4362 | 2840 | Laursen-Copeland | 126559 | -1028838 | Aggrade |
| | 696 | Laursen-Copeland | 19919 | -183465 | |
| 2905 | 2905 | Laursen-Copeland | 523534 | 396975 | Degrade |
| | 707 | Laursen-Copeland | 96797 | 76878 | |
| 1050 | 2951 | Laursen-Copeland | 1097482 | 573948 | Degrade |
| | 719 | Laursen-Copeland | 222004 | 125207 | |

**Table 5.3** – Potrero Canyon Existing Conditions SAM Model Estimates of Transport

| Sub-Reach Upstream Section No. | Discharge (CFS) | Median Transport Equation | Transport (tons/day) | Δ Transport (tons/day) | Stability |
|---|---|---|---|---|---|
| 19270 | 1335 | Ackers-White | 1410890.63 | NA | NA |
| | 393 | Ackers-White | 222140.67 | NA | NA |
| 19095 | 1335 | Ackers-White | 224352.98 | -1186537.7 | Aggrade |
| | 393 | Ackers-White | 19554.45 | -202586.22 | |
| 17915 | 1403 | Ackers-White | 841989.81 | 617636.83 | Degrade |
| | 404 | Ackers-White | 117538.77 | 97984.32 | |
| 16820 | 1457 | Laursen-Copeland | 842762.31 | 772.5 | Degrade |
| | 411 | Ackers-White | 124808.85 | 7270.08 | |
| 15655 | 1497 | Ackers-White | 77840.09 | -764922.22 | Aggrade |
| | 414 | Ackers-White | 24940.24 | -99868.61 | |
| 14425 | 1519 | Ackers-White | 222064.30 | 144224.21 | Degrade |
| | 412 | Ackers-White | 27968.70 | 3028.46 | |
| 13420 | 1915 | Ackers-White | 491276.97 | 269212.67 | Degrade |
| | 512 | Ackers-White | 57493.26 | 29524.56 | |
| 11980 | 1932 | Ackers-White | 488148.53 | -3128.44 | Aggrade |
| | 519 | Ackers-White | 165166.41 | 107673.15 | Degrade |
| 11555 | 1977 | Ackers-White | 197281.13 | -290867.4 | Aggrade |
| | 524 | Ackers-White | 6054.56 | -159111.85 | |
| 9780 | 2052 | Ackers-White | 33566413 | 33369131.9 | Degrade |
| | 526 | Ackers-White | 92267.9 | 86213.34 | |
| 8365 | 2586 | Ackers-White | 1262616.38 | -32303797 | Aggrade |
| | 634 | Ackers-White | 215179.45 | 122911.55 | Degrade |
| 7125 | 2619 | Ackers-White | 1775680.88 | 513064.5 | Degrade |
| | 641 | Ackers-White | 204807.34 | -10372.11 | Aggrade |
| 6730 | 2862 | Ackers-White | 522737.53 | -1252943.4 | Aggrade |
| | 700 | Ackers-White | 290205.97 | 85398.63 | Degrade |
| 5310 | 2913 | Ackers-White | 880623.4 | 357885.87 | Degrade |

| Sub-Reach Upstream Section No. | Discharge (CFS) | Median Transport Equation | Transport (tons/day) | ∆ Transport (tons/day) | Stability |
|---|---|---|---|---|---|
| | 705 | Ackers-White | 25215.71 | -264990.26 | Aggrade |
| 3830 | 2968 | Ackers-White | 2643335.5 | 1762712.1 | Degrade |
| | 717 | Ackers-White | 426914.03 | 401698.32 | |
| 1610 | 3031 | Ackers-White | 1808221.63 | -835113.87 | Aggrade |
| | 725 | Ackers-White | 123336.78 | -303577.25 | |
| 1000 | 3303 | Laursen-Copeland | 1967993.25 | 159771.62 | Degrade |
| | 775 | Laursen-Copeland | 300732.19 | 177395.41 | |

**Table 5.4** – Long Canyon Existing Conditions SAM Model Estimates of Transport

| Sub-Reach Upstream Section No. | Discharge (CFS) | Median Transport Equation | Transport (tons/day) | ∆ Transport (tons/day) | Stability |
|---|---|---|---|---|---|
| 9600 | 663 | Ackers-White | 241598.73 | NA | NA |
| | 175 | Ackers-White | 36847.83 | NA | NA |
| 8900 | 763 | Ackers-White | 332339.19 | 90740.46 | Degrade |
| | 195 | Ackers-White | 41230.65 | 4382.82 | |
| 7500 | 862 | Ackers-White | 344063.72 | 11724.53 | Degrade |
| | 218 | Ackers-White | 47915353.00 | 47874122.35 | |
| 6400 | 972 | Ackers-White | 398829.00 | 54765.28 | Degrade |
| | 234 | Ackers-White | 37721.23 | -47877631.8 | Aggrade |
| 5600 | 975 | Ackers-White | 659459.13 | 260630.13 | Degrade |
| | 245 | Ackers-White | 88346.01 | 50624.78 | |
| 5000 | 1014 | Laursen-Copeland | 699208.06 | 39748.93 | Degrade |
| | 252 | Ackers-White | 65162.20 | -23183.81 | Aggrade |
| 4700 | 1051 | Ackers-White | 469214.47 | -229993.59 | Aggrade |
| | 264 | Ackers-White | 39326.92 | -25835.28 | |
| 3900 | 1103 | Laursen-Copeland | 768771.31 | 299556.84 | Degrade |
| | 281 | Ackers-White | 164427.67 | 125100.75 | |
| 3500 | 1123 | Laursen-Copeland | 641724.13 | -127047.18 | Aggrade |
| | 287 | Ackers-White | 203324.16 | 38896.49 | Degrade |
| 3300 | 1145 | Ackers-White | 108812.54 | -532911.59 | Aggrade |
| | 292 | Ackers-White | 4808.85 | -198515.31 | |
| 2600 | 1192 | Ackers-White | 570890.81 | 462078.27 | Degrade |
| | 303 | Ackers-White | 93209.45 | 88400.6 | |
| 2400 | 1220 | Ackers-White | 252360.06 | -318530.75 | Aggrade |
| | 309 | Ackers-White | 3525.15 | -89684.3 | |
| 1400 | 1442 | Ackers-White | 469548.03 | 217187.97 | Degrade |
| | 363 | Ackers-White | 40545.71 | 37020.56 | |
| 1100 | 1455 | Ackers-White | 388097.38 | -81450.65 | Aggrade |
| | 367 | Ackers-White | 2096.19 | -38449.52 | |

**Table 5.5 –** Lion Canyon Existing Conditions SAM Model Estimates of Transport

| Sub-Reach Upstream Section No. | Discharge (CFS) | Median Transport Equation | Potential Transport (tons/day) | Transport (tons/day) | Stability |
|---|---|---|---|---|---|
| 6800 | 64 | Ackers-White | 8803 | NA | NA |
| | 13 | Yang | 533 | NA | NA |
| 5800 | 202 | Ackers-White | 51330 | 42527 | Degrade |
| | 41 | Ackers-White | 3149 | 2616 | |
| 5200 | 294 | Ackers-White | 114547 | 63217 | Degrade |
| | 58 | Ackers-White | 10606 | 7457 | |
| 4600 | 351 | Ackers-White | 59694 | -54853 | Aggrade |
| | 69 | Ackers-White | 3128 | -7478 | |
| 3400 | 456 | Ackers-White | 165304 | 105610 | Degrade |
| | 90 | Ackers-White | 12520 | 9392 | |
| 2000 | 584 | Ackers-White | 237531 | 72227 | Degrade |
| | 115 | Ackers-White | 15600 | 3080 | |
| 1050 | 608 | Laursen-Copeland | 2111832 | 1874301 | Degrade |
| | 119 | Laursen-Copeland | 452634 | 437034 | |

## 5.4 Discussion of Stream Stability and Long-Term Trends

Stream stability can be examined based on the change in potential transport between channel sub-reaches. Sub-reaches are readily determined from changes in hydraulic parameters, and frequently the most significant hydraulic parameter in terms of impact on stream stability is discharge (volume per unit time). If a channel sub-reach has equal potential transport both entering and exiting the reach then the sub-reach is said to be in equilibrium. Frequently, however, channel sub-reaches are either in an aggrading or degrading condition. For the purposes of this study, aggrading reaches are those whereby the potential transport entering the reach (the potential transport of the sub-reach upstream of that under immediate consideration) is higher than the potential transport leaving the sub-reach (the potential transport of the sub-reach under immediate consideration). In degrading sub-reaches the opposite is true and potential transport entering the reach is lower than that leaving the sub-reach. While it would appear that downstream sub-reaches would be degrading constantly because discharge generally increases in downstream sub-reaches, in turn increasing the transport potential as one moves downstream, other factors such as hydraulic depth, mean sub-reach velocity, hydraulic top width, and bed slope contribute significantly to potential transport.

To determine stability and long-term trends in each of the five tributaries, the 100- and 10-year discharge was calculated for each of the channel sub reaches. Transport equations chosen for modeling was based on output of the SAM.AID subroutine, as noted above, and potential transport was estimated based on the median potential transport. For the five tributary drainages, Yang, Laursen-Copeland or Ackers-White equations represented the median values in every case modeled. The results of the simulations are shown in Tables 5.2-5.5, above. In general, the existing condition bed stability are similar is predominately in a degrading condition.

## 5.5 Floodplain Outlet and Inlet Operation

Generally, outlets and inlets to the channel include the upstream channel entrance, the confluence with the River and any inlets which occur along the channel length. There are no existing diversions away from the channels. Inlets and outlets have a direct influence on the hydraulics, and thus sediment capacity, of the channel. The upstream channel inlet is generally in a natural state. The channel confluence with the River will largely be controlled by the aggradation or degradation in the River, as well as episodic River hydraulic events in the form of backwater effects. Along-stream inlets are considered in the modeling as changes to discharge.

# Chiquito Canyon Floodplain Area

| Flood Frequency | Existing (AC) | Proposed (AC) | Delta (AC) | Delta (%) | Alt 2 (AC) | Delta (AC) | Delta (%) | Alt 3 (AC) | Delta (AC) | Delta (%) | Avoidance (AC) | Delta (AC) | Delta (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 Year | 17.5 | 11.8 | -5.8 | -0.3 | 19.3 | 1.8 | 0.1 | 13.7 | -3.8 | -0.2 | 17.2 | -0.3 | 0.0 |
| 5 Year | 20.6 | 12.4 | -8.2 | -0.4 | 20.4 | -0.2 | 0.0 | 14.9 | -5.7 | -0.3 | 20.3 | -0.3 | 0.0 |
| 10 Year | 25.2 | 13.6 | -11.6 | -0.5 | 21.7 | -3.4 | -0.1 | 16.3 | -8.9 | -0.4 | 24.4 | -0.7 | 0.0 |
| 20 Year | 31.4 | 14.8 | -16.6 | -0.5 | 23.3 | -8.1 | -0.3 | 18.4 | -13.0 | -0.4 | 30.4 | -1.0 | 0.0 |
| 50 Year | 34.4 | 15.4 | -18.9 | -0.6 | 24.2 | -10.1 | -0.3 | 19.5 | -14.8 | -0.4 | 33.3 | -1.1 | 0.0 |
| 100 Year | 36.7 | 16.0 | -20.8 | -0.6 | 25.0 | -11.7 | -0.3 | 20.8 | -15.9 | -0.4 | 37.4 | 0.7 | 0.0 |

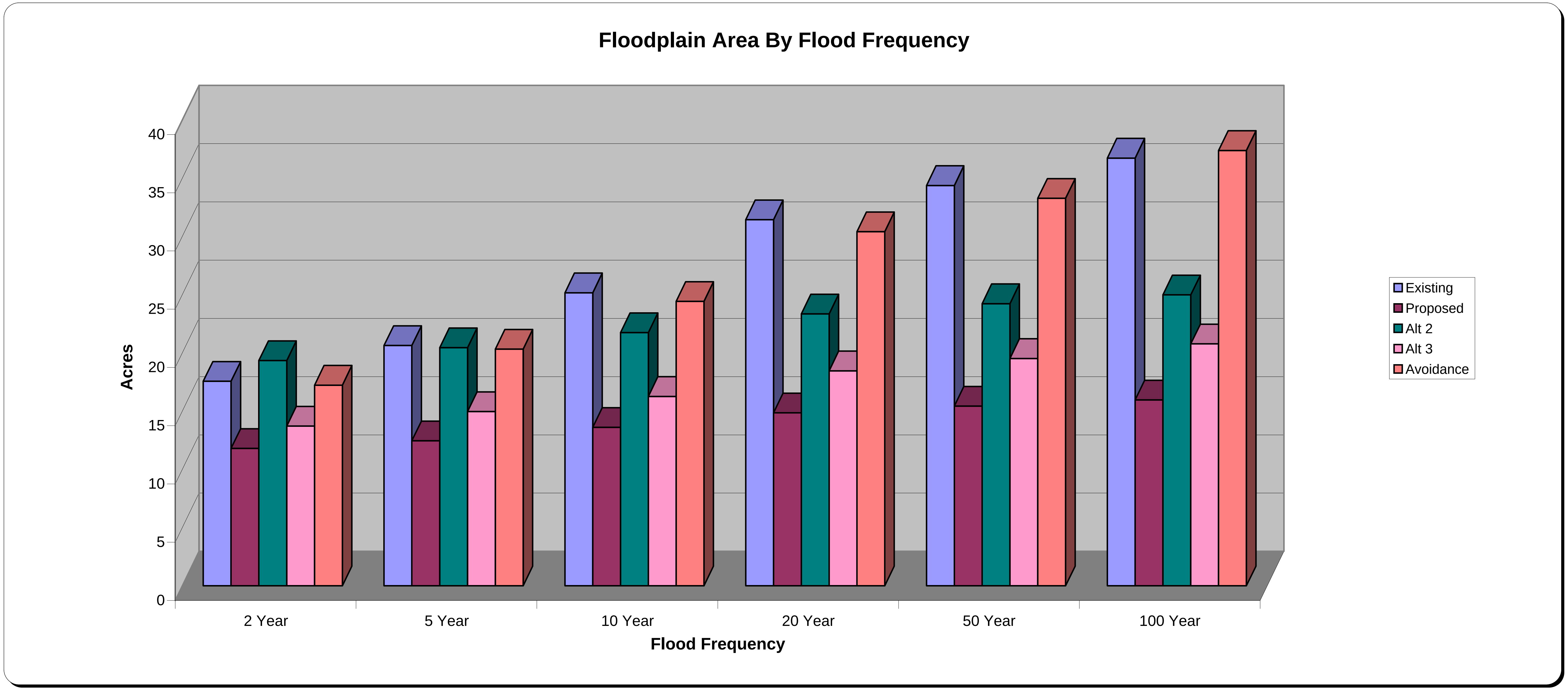



**Figure 5.1**
**Chiquito Canyon Floodplain Area Summary**

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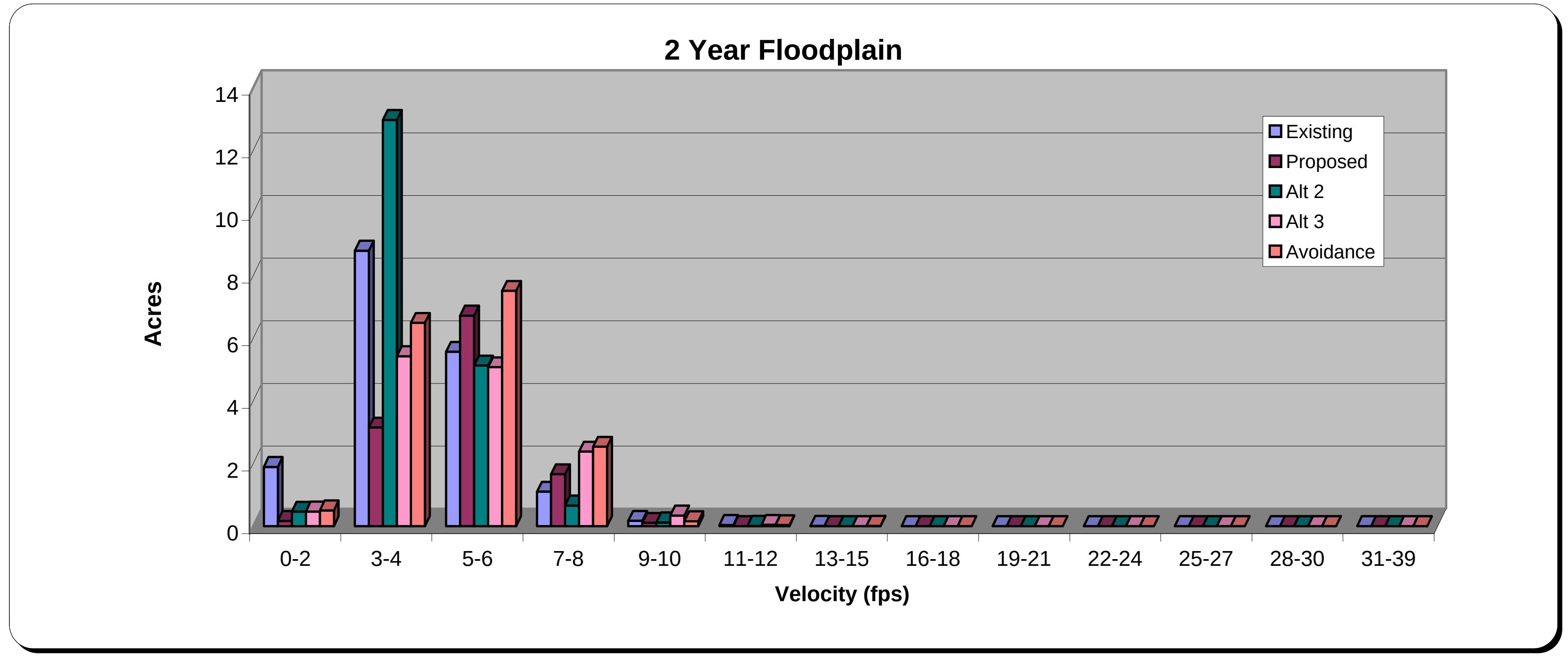
## Chiquito Canyon Floodplain Area by Velocity Distribution

| Velocity Profile (fps) | 2 Year | | | | |
|---|---|---|---|---|---|
| | Existing | Proposed | Alt 2 | Alt 3 | Avoidance |
| 0-2 | 1.9 | 0.2 | 0.5 | 0.5 | 0.5 |
| 3-4 | 8.8 | 3.1 | 13.0 | 5.4 | 6.5 |
| 5-6 | 5.6 | 6.7 | 5.1 | 5.1 | 7.5 |
| 7-8 | 1.1 | 1.7 | 0.7 | 2.4 | 2.5 |
| 9-10 | 0.2 | 0.1 | 0.1 | 0.3 | 0.2 |
| 11-12 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 13-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 16-18 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **17.5** | **11.8** | **19.3** | **13.7** | **17.2** |




| Velocity Profile (fps) | 5 Year | | | | |
|---|---|---|---|---|---|
| | Existing | Proposed | Alt 2 | Alt 3 | Avoidance |
| 0-2 | 1.3 | 0.1 | 0.1 | 0.4 | 0.9 |
| 3-4 | 4.6 | 0.8 | 0.5 | 2.5 | 2.3 |
| 5-6 | 8.9 | 3.1 | 5.1 | 5.3 | 10.3 |
| 7-8 | 4.8 | 5.7 | 9.0 | 3.8 | 5.0 |
| 9-10 | 0.9 | 2.3 | 3.9 | 2.3 | 1.2 |
| 11-12 | 0.1 | 0.4 | 1.3 | 0.6 | 0.4 |
| 13-15 | 0.1 | 0.0 | 0.4 | 0.1 | 0.2 |
| 16-18 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **20.6** | **12.4** | **20.4** | **14.9** | **20.3** |

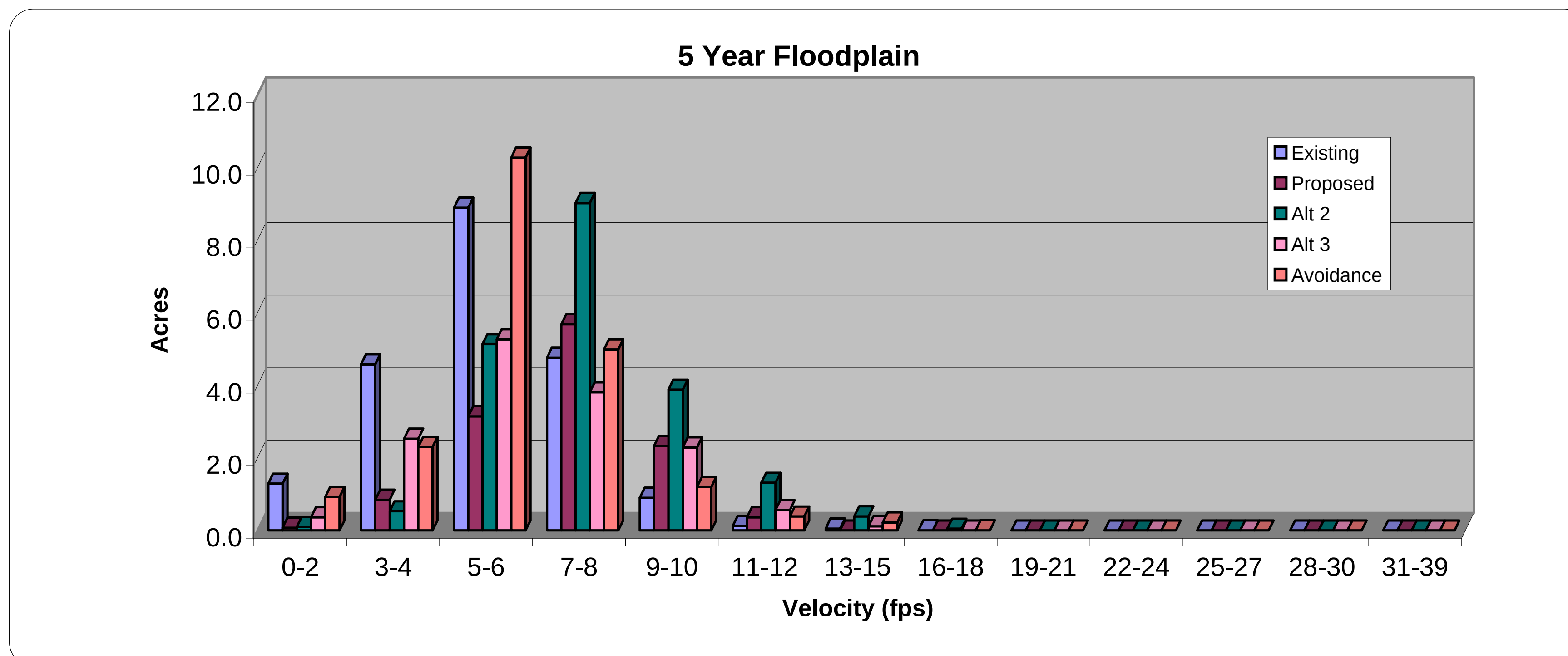
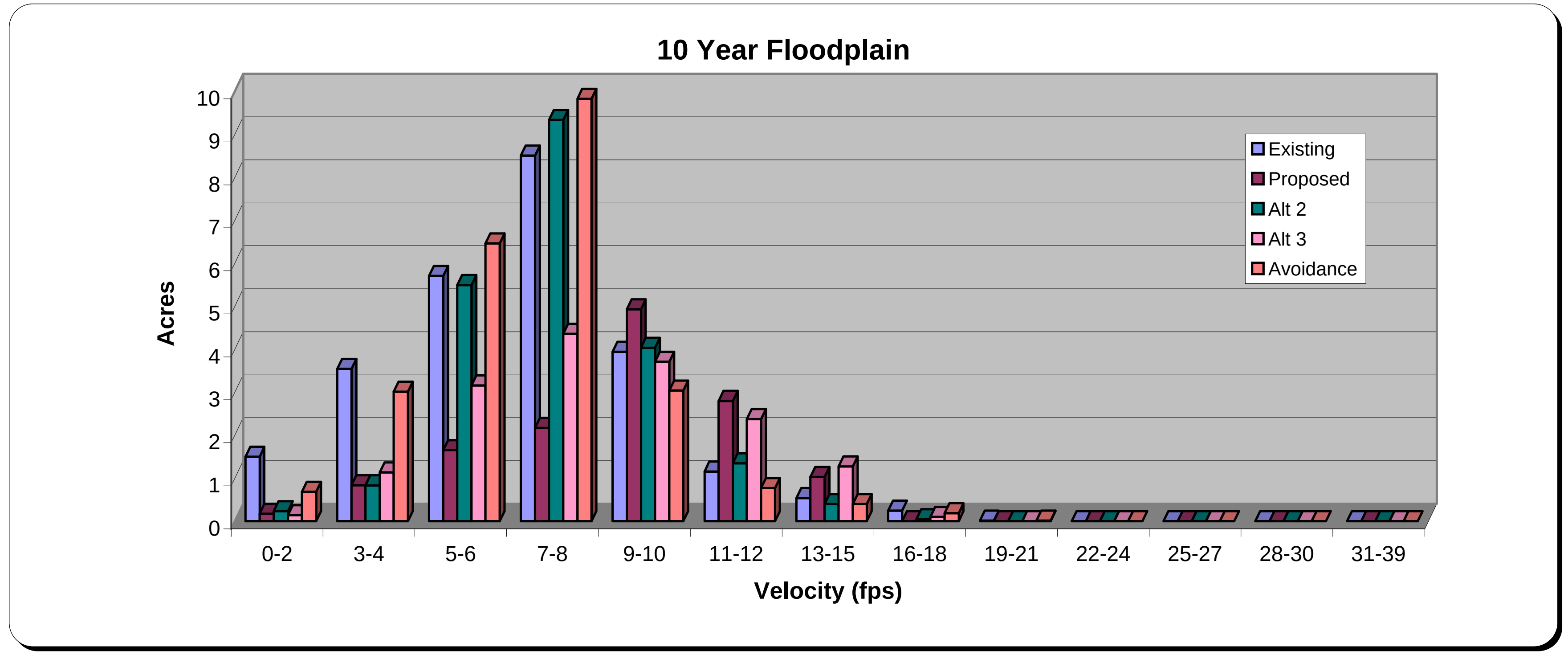



**Figure 5.2**
**Chiquito Canyon Floodplain Area by Velocity Distribution**

P:\8238E\GIS\tables\RMDP_CombinedTribs_20090209\RMDP_CombinedTribs_FPAndVel_PC3_20090302 - Chiquito Fig 5.2

# Chiquito Canyon Floodplain Area by Velocity Distribution

| Velocity Profile (fps) | 10 Year | | | | |
|---|---|---|---|---|---|
| | Existing | Proposed | Alt 2 | Alt 3 | Avoidance |
| 0-2 | 1.5 | 0.2 | 0.2 | 0.1 | 0.7 |
| 3-4 | 3.5 | 0.8 | 0.8 | 1.1 | 3.0 |
| 5-6 | 5.7 | 1.7 | 5.5 | 3.2 | 6.5 |
| 7-8 | 8.5 | 2.2 | 9.3 | 4.4 | 9.8 |
| 9-10 | 3.9 | 4.9 | 4.0 | 3.7 | 3.0 |
| 11-12 | 1.2 | 2.8 | 1.3 | 2.4 | 0.8 |
| 13-15 | 0.5 | 1.0 | 0.4 | 1.3 | 0.4 |
| 16-18 | 0.2 | 0.0 | 0.0 | 0.1 | 0.2 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **25.2** | **13.6** | **21.7** | **16.3** | **24.4** |




| Velocity Profile (fps) | 20 Year | | | | |
|---|---|---|---|---|---|
| | Existing | Proposed | Alt 2 | Alt 3 | Avoidance |
| 0-2 | 1.0 | 0.1 | 0.3 | 0.2 | 0.5 |
| 3-4 | 4.3 | 0.7 | 0.8 | 1.2 | 3.7 |
| 5-6 | 4.9 | 1.7 | 1.7 | 1.8 | 5.9 |
| 7-8 | 5.4 | 1.3 | 4.8 | 2.8 | 7.0 |
| 9-10 | 7.8 | 1.7 | 7.1 | 3.4 | 8.6 |
| 11-12 | 4.3 | 2.1 | 4.8 | 4.1 | 3.1 |
| 13-15 | 2.7 | 5.9 | 3.2 | 3.3 | 1.0 |
| 16-18 | 0.7 | 1.4 | 0.6 | 1.6 | 0.4 |
| 19-21 | 0.2 | 0.0 | 0.1 | 0.1 | 0.1 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **31.4** | **14.8** | **23.3** | **18.4** | **30.4** |

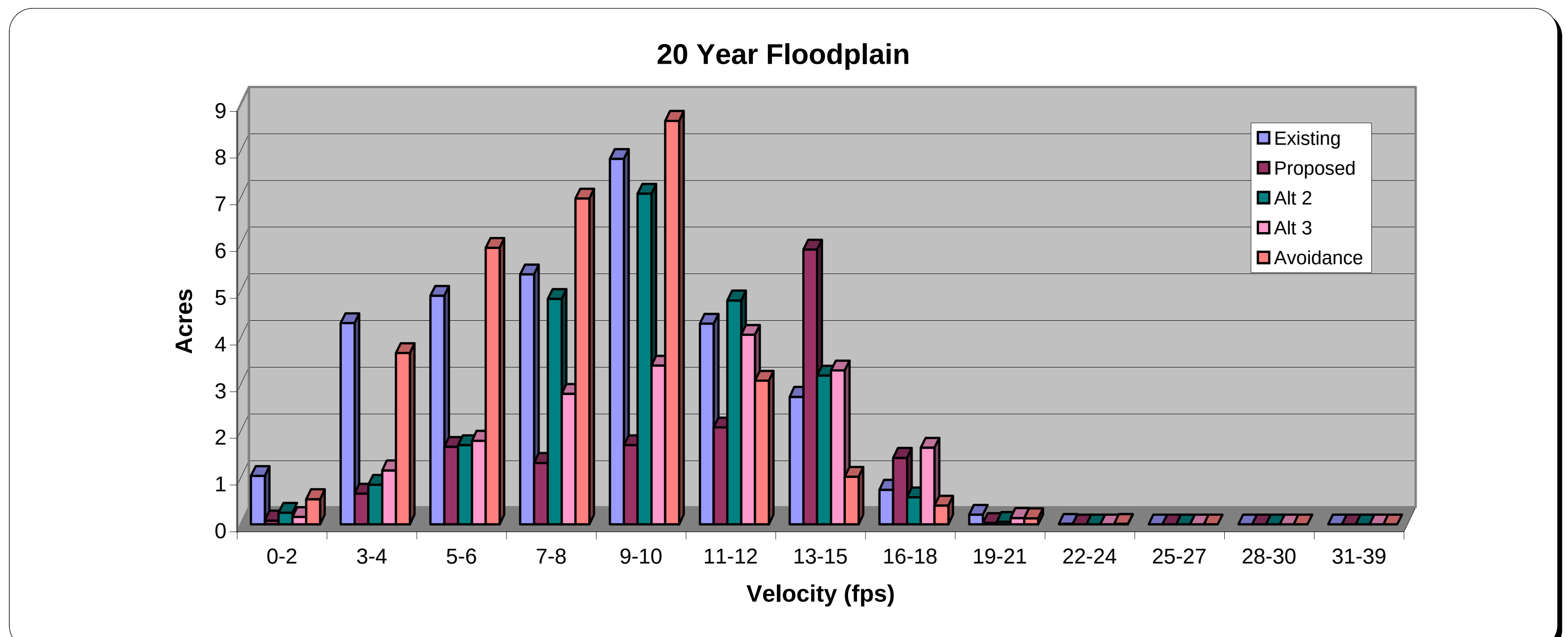
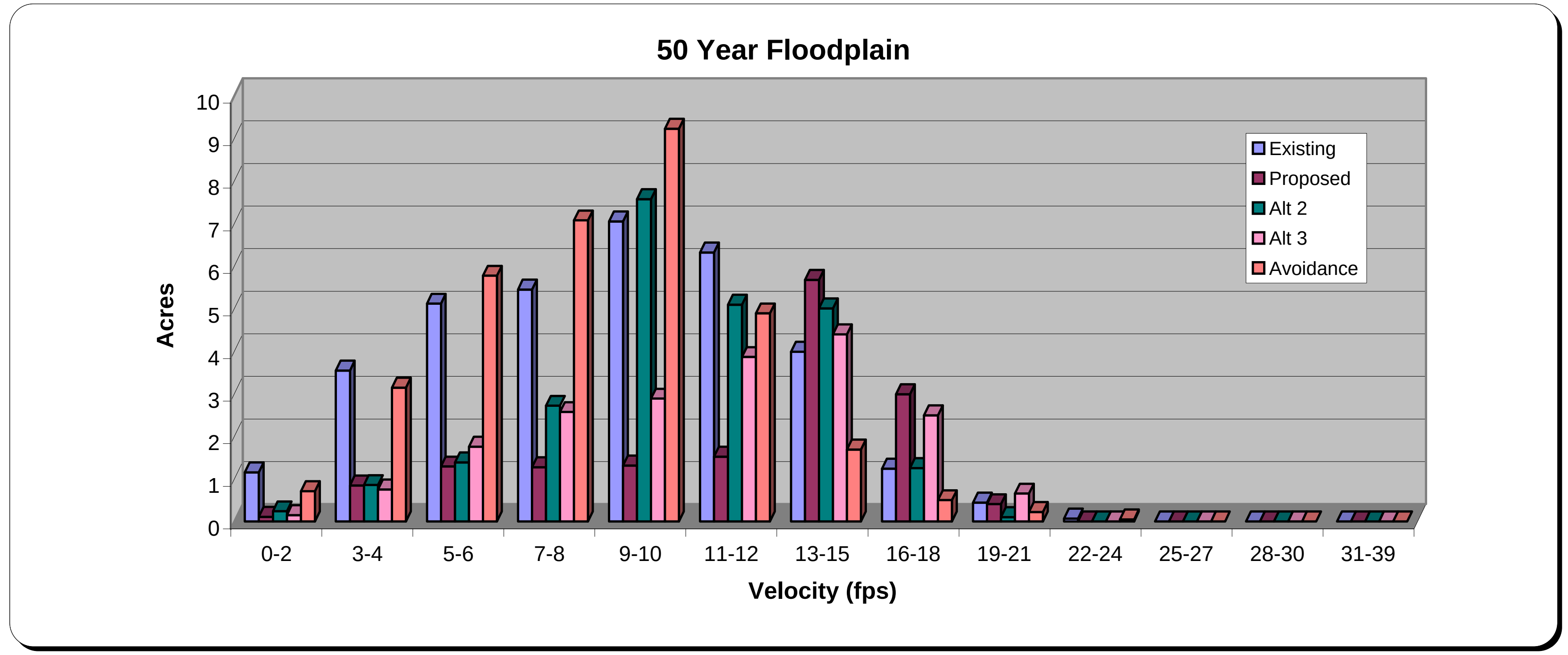



**Figure 5.3**
**Chiquito Floodplain Area by Velocity Distribution, 10-Year and 20-Year**

## Chiquito Canyon Floodplain Area by Velocity Distribution

| Velocity Profile (fps) | 50 Year | | | | |
|---|---|---|---|---|---|
| | Existing | Proposed | Alt 2 | Alt 3 | Avoidance |
| 0-2 | 1.2 | 0.1 | 0.2 | 0.1 | 0.7 |
| 3-4 | 3.5 | 0.8 | 0.9 | 0.7 | 3.1 |
| 5-6 | 5.1 | 1.3 | 1.4 | 1.8 | 5.8 |
| 7-8 | 5.4 | 1.3 | 2.7 | 2.6 | 7.1 |
| 9-10 | 7.0 | 1.3 | 7.6 | 2.9 | 9.2 |
| 11-12 | 6.3 | 1.5 | 5.1 | 3.9 | 4.9 |
| 13-15 | 4.0 | 5.7 | 5.0 | 4.4 | 1.7 |
| 16-18 | 1.2 | 3.0 | 1.3 | 2.5 | 0.5 |
| 19-21 | 0.4 | 0.4 | 0.1 | 0.7 | 0.2 |
| 22-24 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **34.4** | **15.4** | **24.2** | **19.5** | **33.3** |




| Velocity Profile (fps) | 100 Year | | | | |
|---|---|---|---|---|---|
| | Existing | Proposed | Alt 2 | Alt 3 | Avoidance |
| 0-2 | 1.1 | 0.2 | 0.2 | 0.3 | 1.3 |
| 3-4 | 3.3 | 0.7 | 0.7 | 1.0 | 4.2 |
| 5-6 | 5.2 | 1.3 | 1.7 | 1.7 | 5.7 |
| 7-8 | 5.7 | 1.4 | 2.1 | 2.3 | 6.9 |
| 9-10 | 6.3 | 1.0 | 5.7 | 2.6 | 8.4 |
| 11-12 | 7.2 | 1.6 | 6.1 | 3.5 | 6.7 |
| 13-15 | 5.2 | 3.4 | 6.0 | 5.0 | 3.1 |
| 16-18 | 1.9 | 5.2 | 2.2 | 2.9 | 0.6 |
| 19-21 | 0.6 | 1.1 | 0.3 | 1.2 | 0.3 |
| 22-24 | 0.2 | 0.0 | 0.0 | 0.1 | 0.1 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **36.7** | **16.0** | **25.0** | **20.8** | **37.4** |

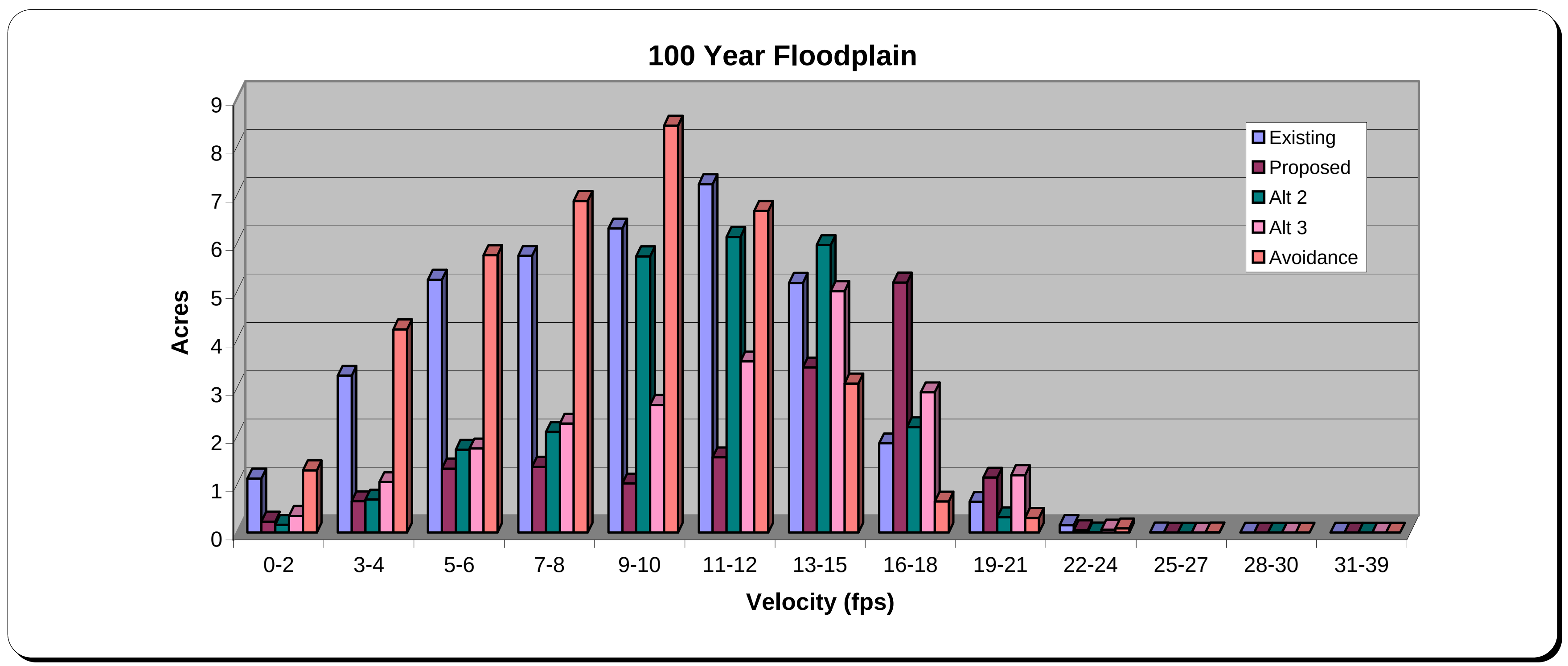





**Figure 5.4**
**Chiquito Floodplain Area by Velocity Distribution**

## San Martinez Grande Canyon Floodplain Area

| Flood Frequency | Existing (AC) | Proposed (AC) | Delta (AC) | Delta (%) | Alt 1 (AC) | Delta (AC) | Delta (%) | Alt 2 (AC) | Delta (AC) | Delta (%) | Avoidance (AC) | Delta (AC) | Delta (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 Year | 5.3 | 6.5 | 1.2 | 0.2 | 9.3 | 4.0 | 0.8 | 8.1 | 2.9 | 0.5 | 5.2 | 0.0 | 0.0 |
| 5 Year | 6.6 | 6.8 | 0.3 | 0.0 | 10.0 | 3.4 | 0.5 | 8.9 | 2.3 | 0.3 | 6.7 | 0.1 | 0.0 |
| 10 Year | 8.8 | 7.3 | -1.5 | -0.2 | 11.2 | 2.4 | 0.3 | 10.0 | 1.1 | 0.1 | 8.8 | 0.0 | 0.0 |
| 20 Year | 11.9 | 8.1 | -3.8 | -0.3 | 12.6 | 0.7 | 0.1 | 11.4 | -0.5 | 0.0 | 11.5 | -0.4 | 0.0 |
| 50 Year | 12.7 | 8.4 | -4.3 | -0.3 | 13.1 | 0.4 | 0.0 | 11.7 | -1.0 | -0.1 | 12.3 | -0.4 | 0.0 |
| 100 Year | 13.4 | 8.7 | -4.6 | -0.3 | 13.5 | 0.1 | 0.0 | 12.3 | -1.0 | -0.1 | 13.0 | -0.4 | 0.0 |

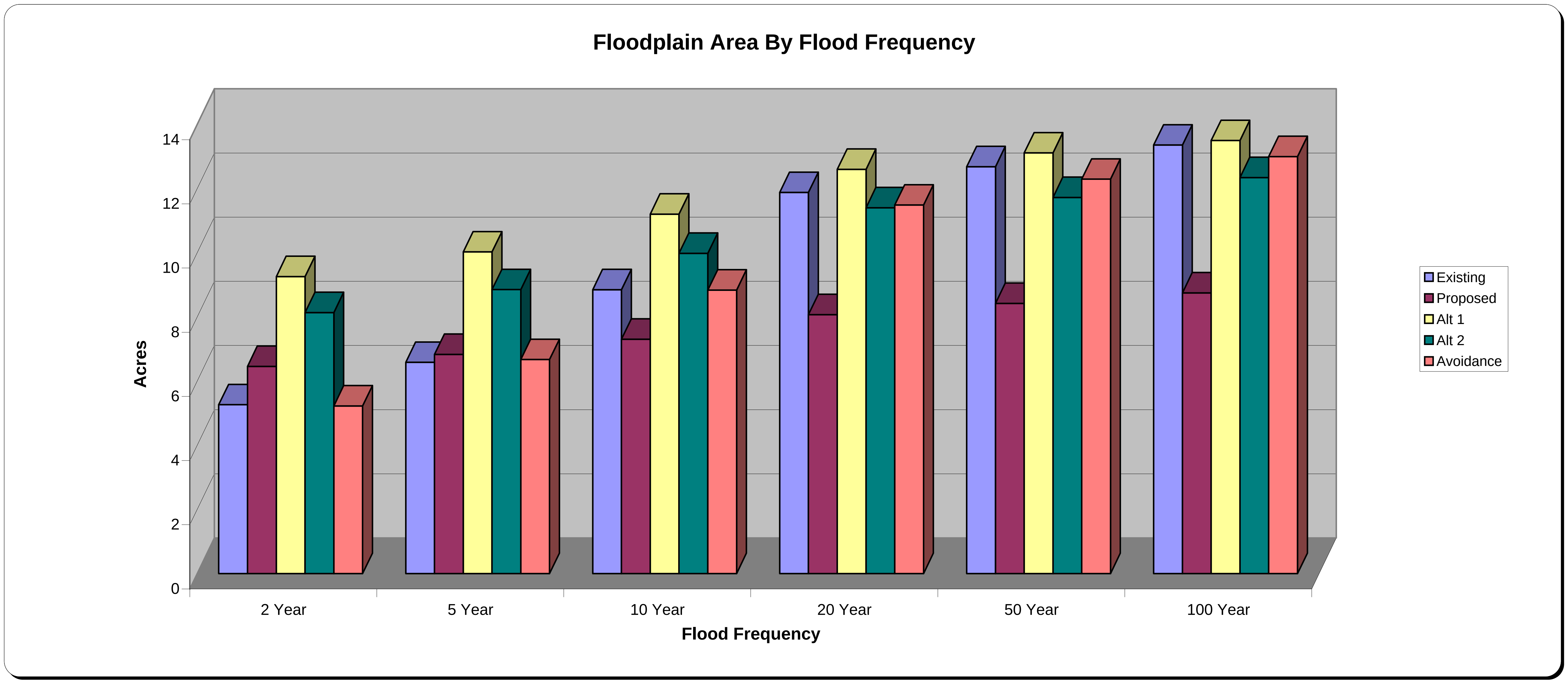



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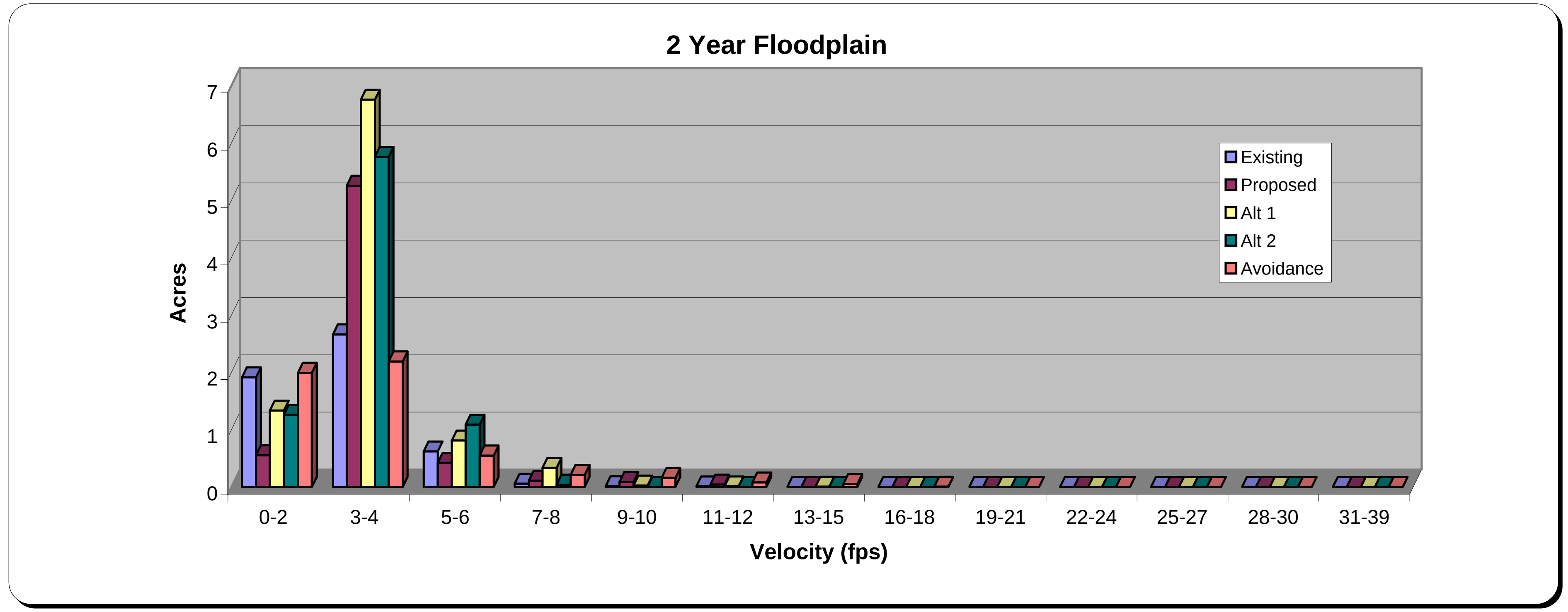
**Figure 5.5**
**San Martinez Grande Canyon Floodplain Area Summary**

# San Martinez Grande Canyon Floodplain Area by Velocity Distribution

| Velocity Profile (fps) | 2 Year | | | | |
|---|---|---|---|---|---|
| | Existing | Proposed | Alt 1 | Alt 2 | Avoidance |
| 0-2 | 1.9 | 0.6 | 1.3 | 1.3 | 2.0 |
| 3-4 | 2.7 | 5.3 | 6.8 | 5.8 | 2.2 |
| 5-6 | 0.6 | 0.4 | 0.8 | 1.1 | 0.5 |
| 7-8 | 0.1 | 0.1 | 0.3 | 0.0 | 0.2 |
| 9-10 | 0.0 | 0.1 | 0.0 | 0.0 | 0.2 |
| 11-12 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 13-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 16-18 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **5.3** | **6.5** | **9.3** | **8.1** | **5.2** |




| Velocity Profile (fps) | 5 Year | | | | |
|---|---|---|---|---|---|
| | Existing | Proposed | Alt 1 | Alt 2 | Avoidance |
| 0-2 | 1.7 | 0.1 | 1.0 | 1.3 | 1.9 |
| 3-4 | 2.9 | 1.4 | 5.4 | 4.2 | 2.5 |
| 5-6 | 1.5 | 4.7 | 2.8 | 2.4 | 1.3 |
| 7-8 | 0.4 | 0.3 | 0.8 | 0.8 | 0.4 |
| 9-10 | 0.1 | 0.1 | 0.1 | 0.1 | 0.3 |
| 11-12 | 0.0 | 0.1 | 0.0 | 0.0 | 0.2 |
| 13-15 | 0.0 | 0.1 | 0.0 | 0.0 | 0.1 |
| 16-18 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **6.6** | **6.8** | **10.0** | **8.9** | **6.7** |

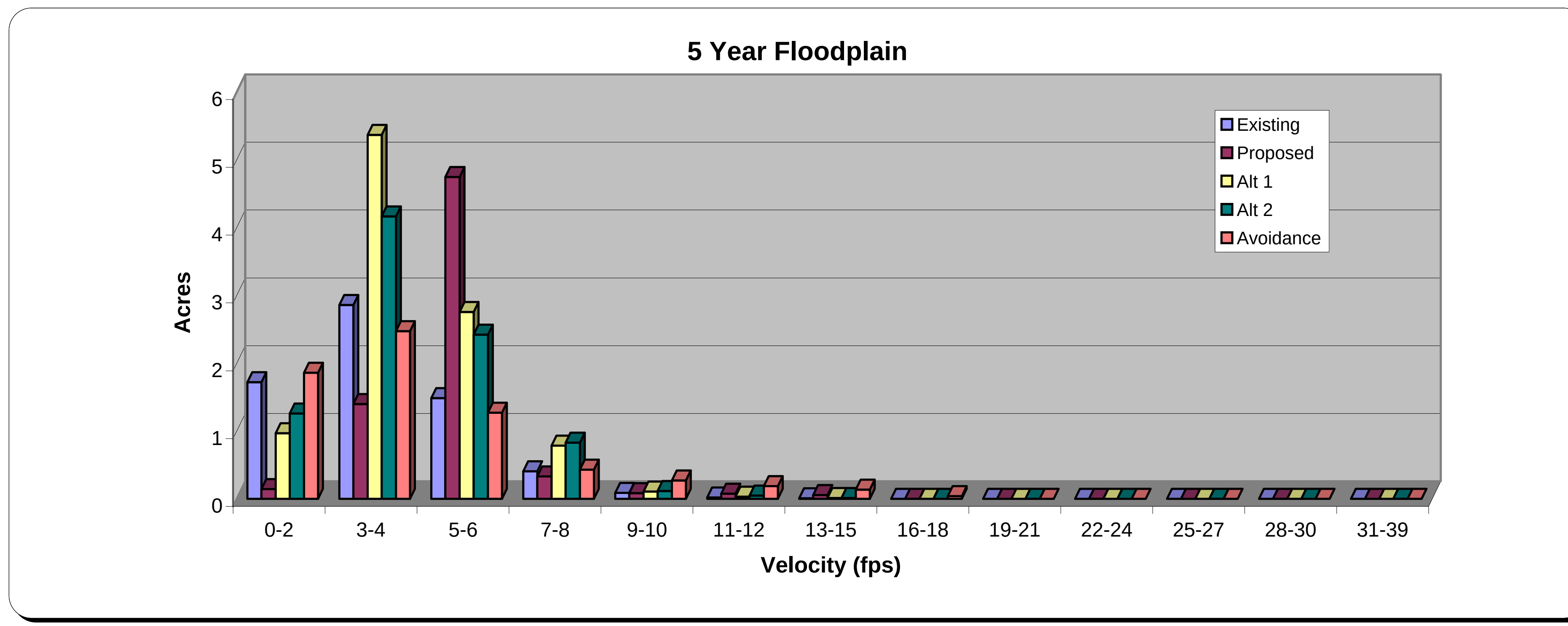
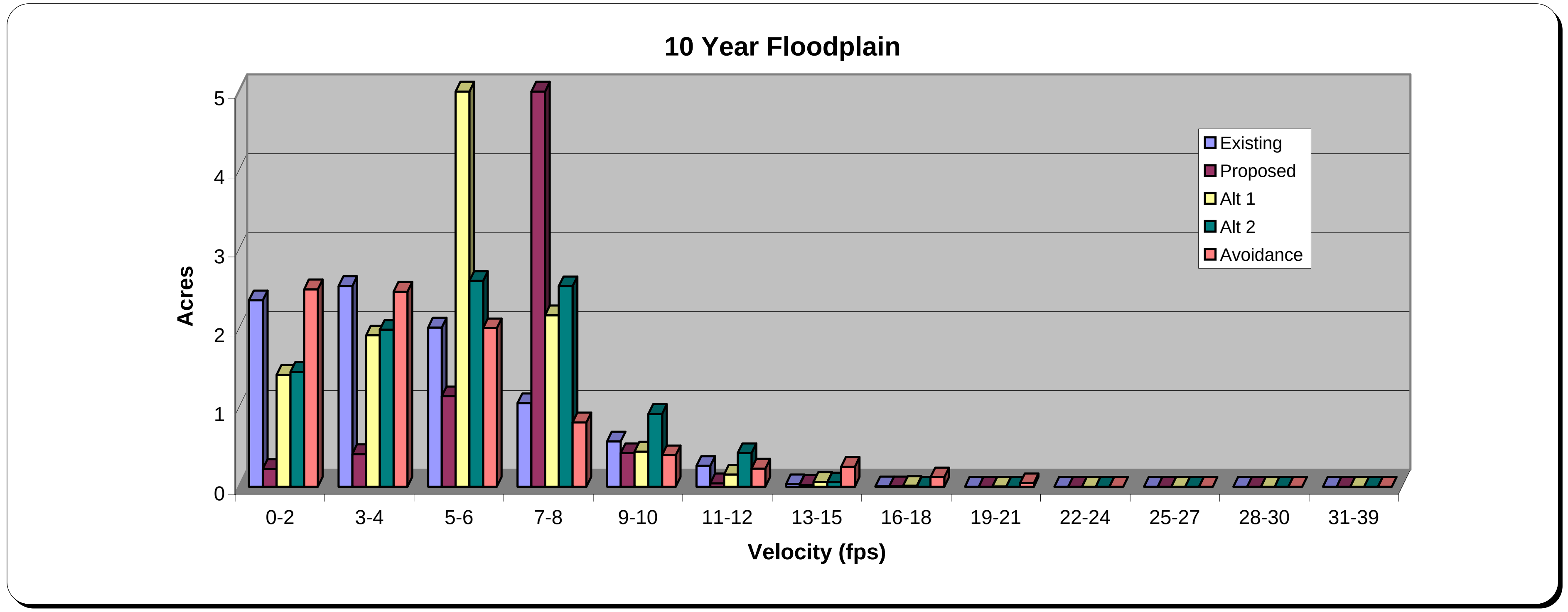



**Figure 5.6**
**San Martinez Grande Canyon Floodplain Area by Velocity Distribution**

## San Martinez Grande Canyon Floodplain Area by Velocity Distribution

| Velocity Profile (fps) | 10 Year | | | | |
|---|---|---|---|---|---|
| | Existing | Proposed | Alt 1 | Alt 2 | Avoidance |
| 0-2 | 2.4 | 0.2 | 1.4 | 1.5 | 2.5 |
| 3-4 | 2.5 | 0.4 | 1.9 | 2.0 | 2.5 |
| 5-6 | 2.0 | 1.1 | 5.0 | 2.6 | 2.0 |
| 7-8 | 1.1 | 5.0 | 2.2 | 2.5 | 0.8 |
| 9-10 | 0.6 | 0.4 | 0.4 | 0.9 | 0.4 |
| 11-12 | 0.3 | 0.0 | 0.2 | 0.4 | 0.2 |
| 13-15 | 0.0 | 0.0 | 0.1 | 0.1 | 0.3 |
| 16-18 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **8.8** | **7.3** | **11.2** | **10.0** | **8.8** |




| Velocity Profile (fps) | 20 Year | | | | |
|---|---|---|---|---|---|
| | Existing | Proposed | Alt 1 | Alt 2 | Avoidance |
| 0-2 | 1.8 | 0.3 | 1.3 | 1.2 | 2.5 |
| 3-4 | 3.6 | 0.7 | 2.1 | 2.1 | 3.1 |
| 5-6 | 2.5 | 0.7 | 2.8 | 1.6 | 2.2 |
| 7-8 | 1.6 | 1.0 | 3.4 | 1.8 | 1.4 |
| 9-10 | 1.3 | 3.6 | 1.5 | 2.4 | 0.8 |
| 11-12 | 0.6 | 1.6 | 0.9 | 1.4 | 0.7 |
| 13-15 | 0.5 | 0.2 | 0.5 | 0.8 | 0.4 |
| 16-18 | 0.1 | 0.0 | 0.0 | 0.1 | 0.2 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **11.9** | **8.1** | **12.6** | **11.4** | **11.5** |

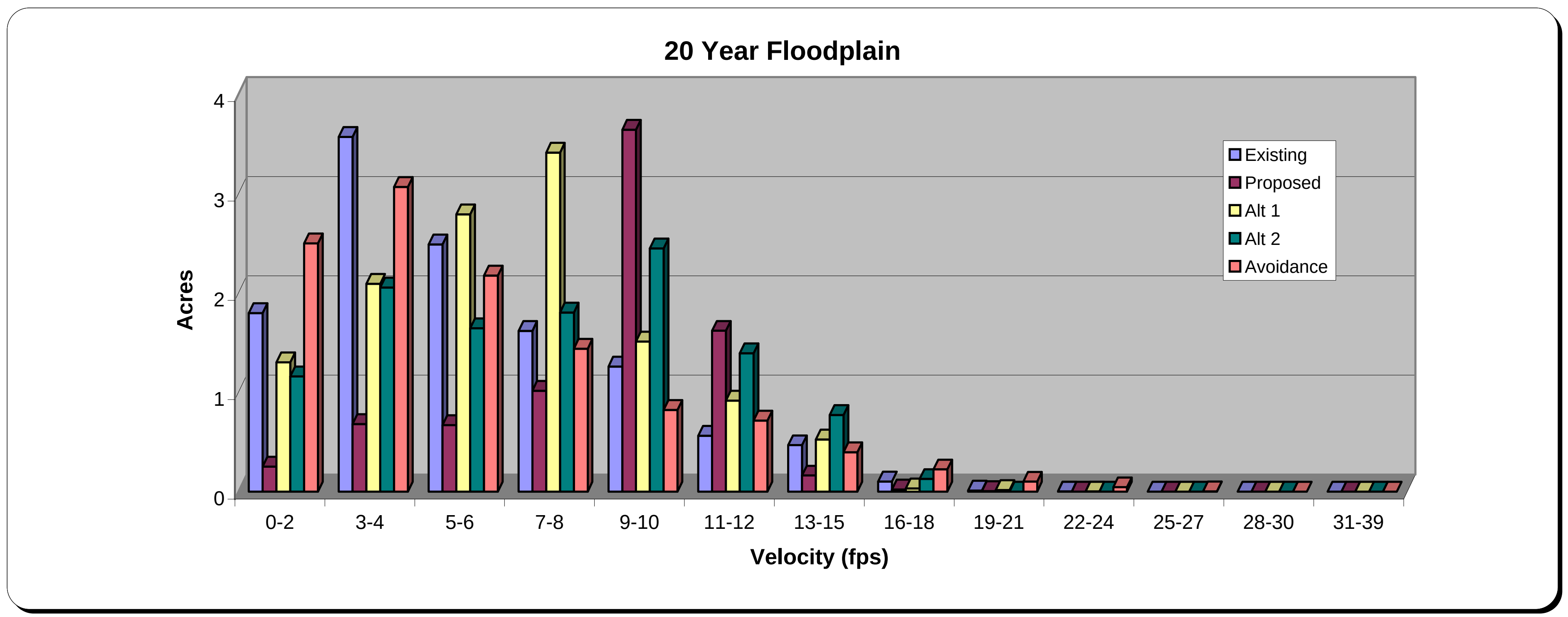
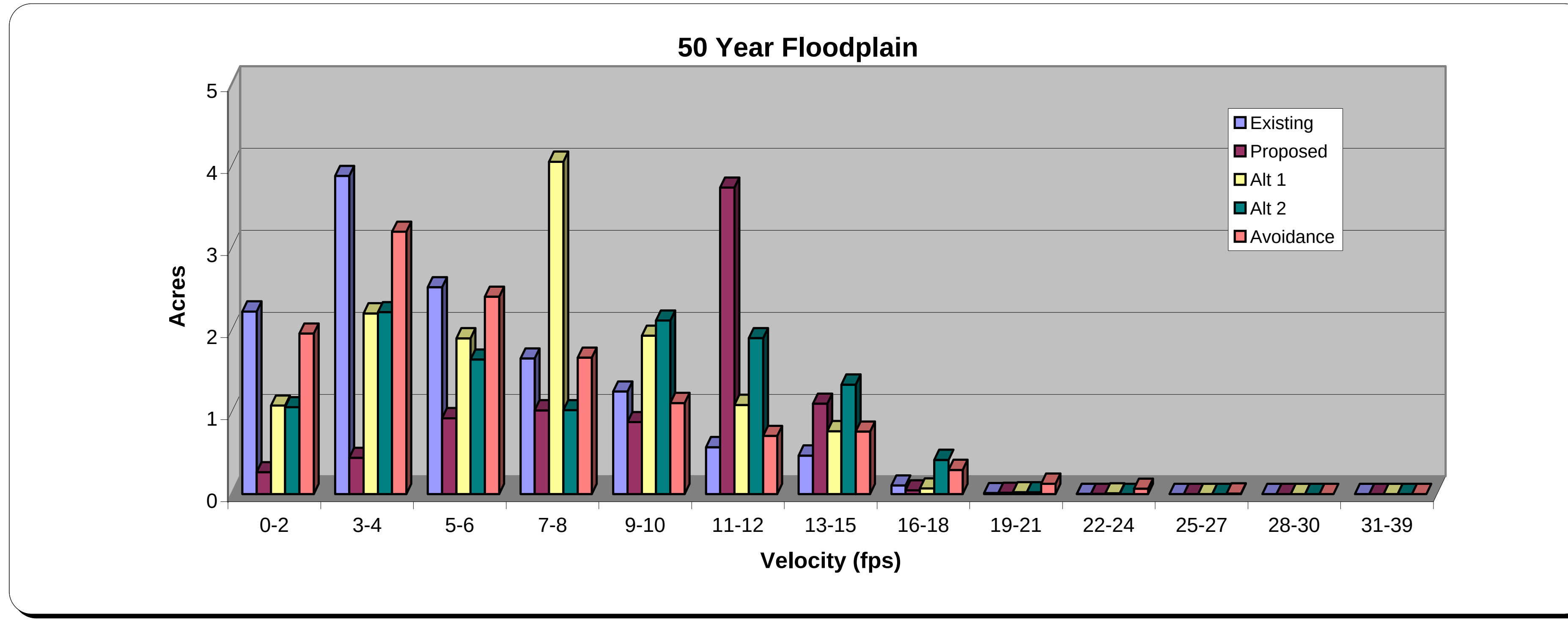



**Figure 5.7**
**San Martinez Grande Canyon Floodplain Area**
**by Velocity Distribution**

# San Martinez Grande Canyon Floodplain Area by Velocity Distribution

| Velocity Profile (fps) | 50 Year | | | | |
|---|---|---|---|---|---|
| | Existing | Proposed | Alt 1 | Alt 2 | Avoidance |
| 0-2 | 2.2 | 0.3 | 1.1 | 1.1 | 2.0 |
| 3-4 | 3.9 | 0.4 | 2.2 | 2.2 | 3.2 |
| 5-6 | 2.5 | 0.9 | 1.9 | 1.6 | 2.4 |
| 7-8 | 1.7 | 1.0 | 4.1 | 1.0 | 1.7 |
| 9-10 | 1.2 | 0.9 | 1.9 | 2.1 | 1.1 |
| 11-12 | 0.6 | 3.7 | 1.1 | 1.9 | 0.7 |
| 13-15 | 0.5 | 1.1 | 0.8 | 1.3 | 0.8 |
| 16-18 | 0.1 | 0.0 | 0.1 | 0.4 | 0.3 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **12.7** | **8.4** | **13.1** | **11.7** | **12.3** |




| Velocity Profile (fps) | 100 Year | | | | |
|---|---|---|---|---|---|
| | Existing | Proposed | Alt 1 | Alt 2 | Avoidance |
| 0-2 | 2.0 | 0.2 | 2.3 | 2.3 | 2.0 |
| 3-4 | 3.9 | 0.4 | 1.3 | 1.5 | 3.4 |
| 5-6 | 2.6 | 0.7 | 1.4 | 1.5 | 2.3 |
| 7-8 | 1.8 | 1.3 | 3.3 | 0.9 | 1.8 |
| 9-10 | 1.5 | 0.9 | 2.5 | 1.8 | 1.3 |
| 11-12 | 0.7 | 2.8 | 1.5 | 2.1 | 0.7 |
| 13-15 | 0.6 | 2.3 | 1.1 | 1.6 | 0.9 |
| 16-18 | 0.2 | 0.1 | 0.2 | 0.4 | 0.3 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **13.4** | **8.7** | **13.5** | **12.3** | **13.0** |

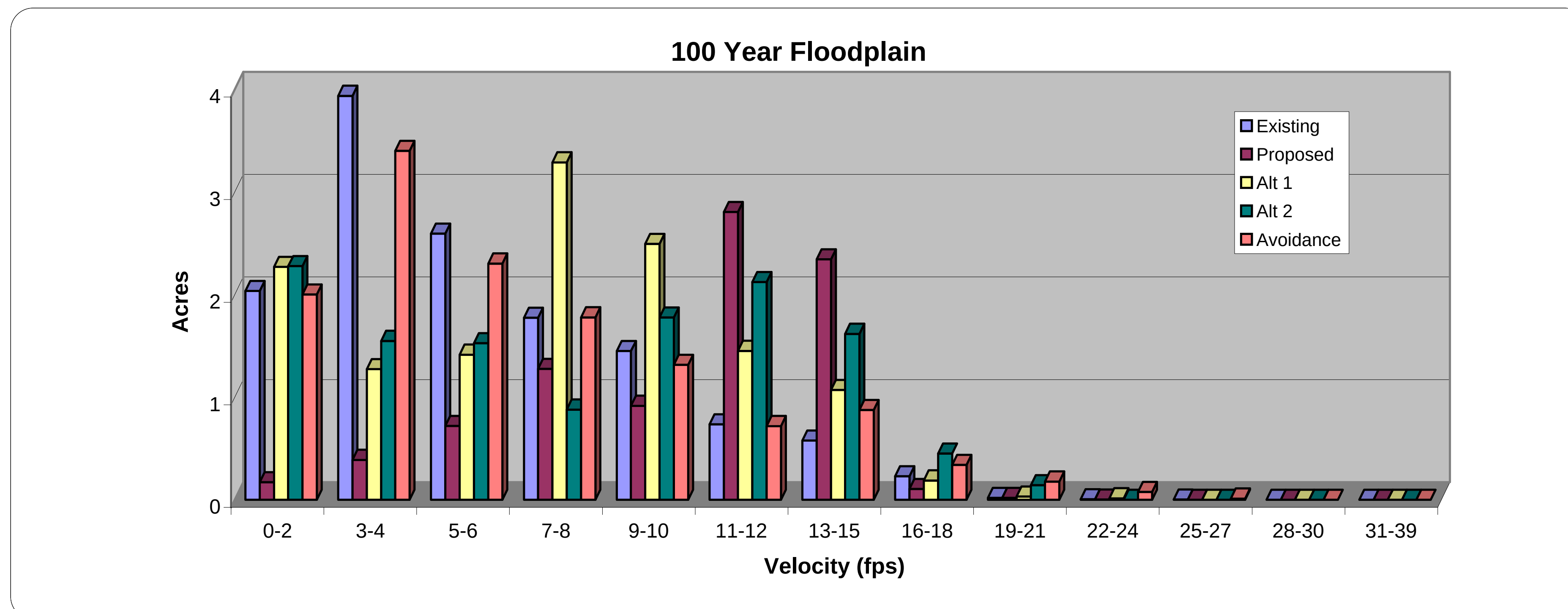



**Figure 5.8**
**San Martinez Grande Canyon Floodplain Area**
**by Velocity Distribution**

# Potrero Canyon Floodplain Area

| Flood Frequency | Existing (AC) | Proposed (AC) | Delta (AC) | Delta (%) | Alt 1 (AC) | Delta (AC) | Delta (%) | Alt 3 (AC) | Delta (AC) | Delta (%) | Alt 5 (AC) | Delta (AC) | Delta (%) | Avoidance (AC) | Delta (AC) | Delta (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 Year | 51.0 | 18.6 | -32.4 | -0.6 | 87.4 | 36.4 | 0.7 | 55.2 | 4.2 | 0.1 | 20.2 | -30.7 | -0.6 | 41.8 | -9.2 | -0.2 |
| 5 Year | 68.0 | 20.1 | -48.0 | -0.7 | 88.3 | 20.3 | 0.3 | 56.4 | -11.6 | -0.2 | 20.3 | -47.8 | -0.7 | 49.6 | -18.5 | -0.3 |
| 10 Year | 89.2 | 21.6 | -67.6 | -0.8 | 89.3 | 0.2 | 0.0 | 57.8 | -31.4 | -0.4 | 21.3 | -67.9 | -0.8 | 60.9 | -28.2 | -0.3 |
| 20 Year | 126.2 | 23.5 | -102.7 | -0.8 | 90.5 | -35.6 | -0.3 | 59.6 | -66.6 | -0.5 | 22.4 | -103.8 | -0.8 | 76.8 | -49.4 | -0.4 |
| 50 Year | 141.0 | 24.5 | -116.6 | -0.8 | 91.3 | -49.7 | -0.4 | 60.7 | -80.3 | -0.6 | 23.0 | -118.0 | -0.8 | 84.7 | -56.3 | -0.4 |
| 100 Year | 158.4 | 25.3 | -133.1 | -0.8 | 91.8 | -66.5 | -0.4 | 61.5 | -96.9 | -0.6 | 26.6 | -131.8 | -0.8 | 92.1 | -66.3 | -0.4 |

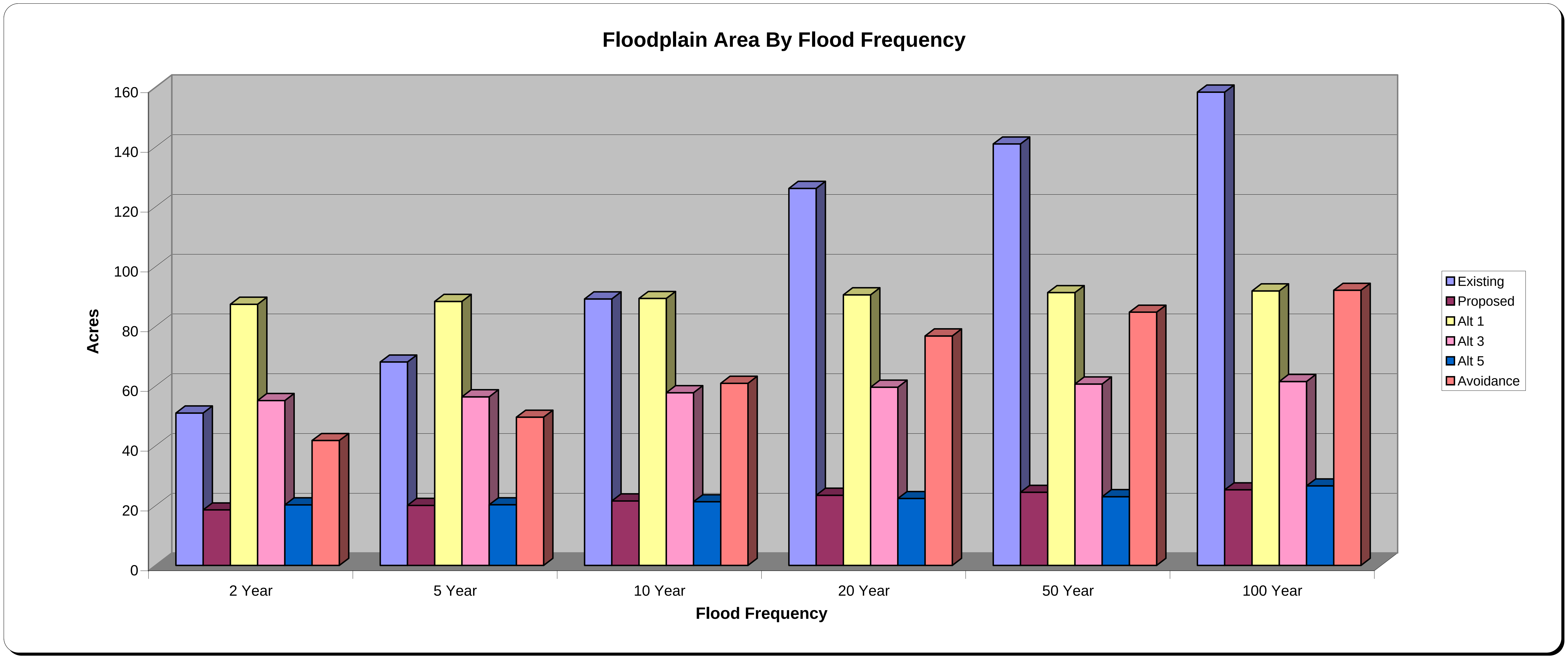



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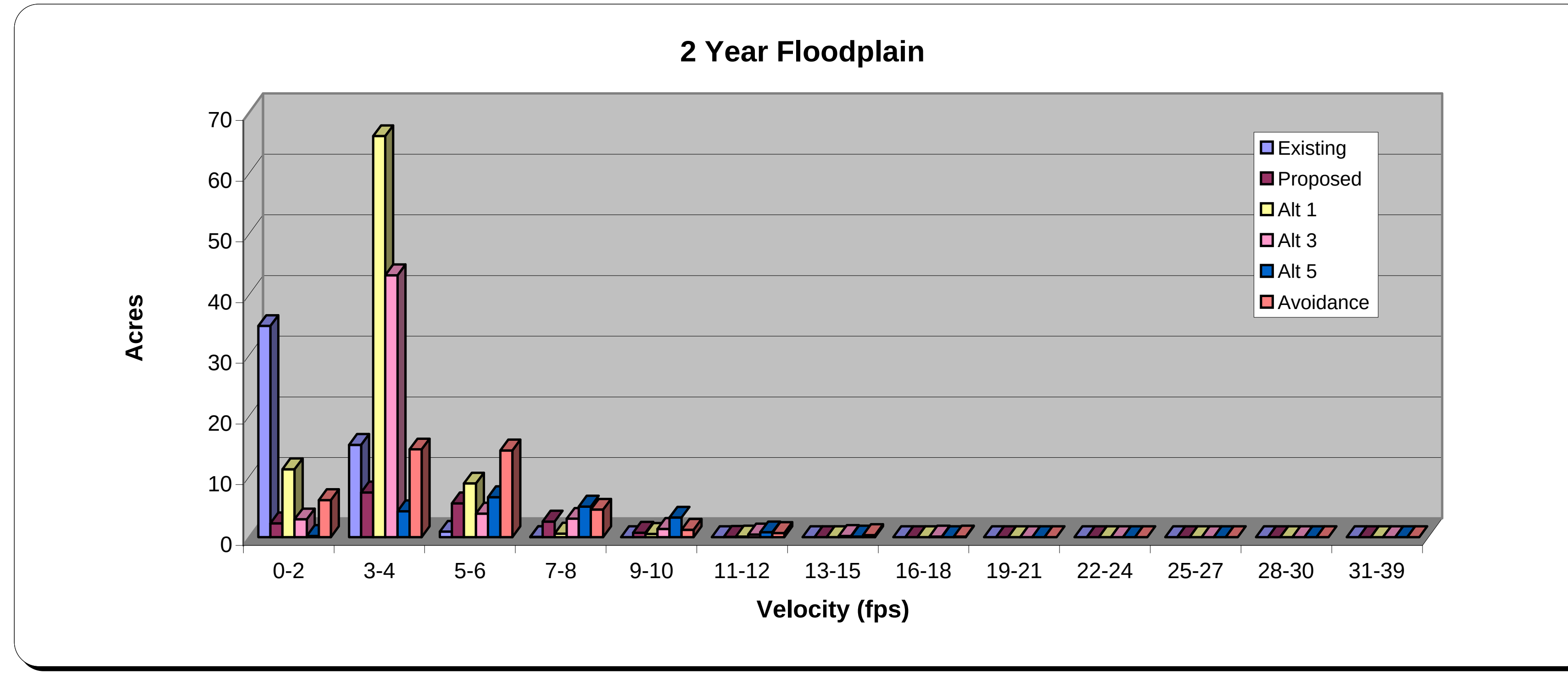
**Figure 5.9**
**Potrero Canyon Floodplain Area Summary**

# Potrero Canyon Floodplain Area by Velocity Analysis

| Velocity Profile (fps) | 2 Year | | | | | |
|---|---|---|---|---|---|---|
| | Existing | Proposed | Alt 1 | Alt 3 | Alt 5 | Avoidance |
| 0-2 | 34.8 | 2.3 | 11.2 | 2.9 | 0.2 | 6.1 |
| 3-4 | 15.2 | 7.4 | 66.1 | 43.2 | 4.3 | 14.5 |
| 5-6 | 0.9 | 5.6 | 8.9 | 3.9 | 6.6 | 14.3 |
| 7-8 | 0.0 | 2.6 | 0.6 | 3.0 | 5.1 | 4.5 |
| 9-10 | 0.0 | 0.7 | 0.5 | 1.4 | 3.2 | 1.2 |
| 11-12 | 0.0 | 0.0 | 0.1 | 0.5 | 0.8 | 0.7 |
| 13-15 | 0.0 | 0.0 | 0.0 | 0.2 | 0.1 | 0.4 |
| 16-18 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.1 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **51.0** | **18.6** | **87.4** | **55.2** | **20.2** | **41.8** |




| Velocity Profile (fps) | 5 Year | | | | | |
|---|---|---|---|---|---|---|
| | Existing | Proposed | Alt 1 | Alt 3 | Alt 5 | Avoidance |
| 0-2 | 31.9 | 0.0 | 4.0 | 0.7 | 0.2 | 5.5 |
| 3-4 | 31.0 | 0.1 | 54.2 | 36.1 | 3.7 | 16.2 |
| 5-6 | 4.7 | 7.4 | 27.0 | 13.1 | 5.9 | 13.4 |
| 7-8 | 0.4 | 6.1 | 2.1 | 2.7 | 5.1 | 9.0 |
| 9-10 | 0.0 | 4.4 | 0.5 | 2.5 | 3.6 | 3.0 |
| 11-12 | 0.0 | 1.8 | 0.4 | 0.9 | 1.4 | 1.2 |
| 13-15 | 0.0 | 0.3 | 0.1 | 0.3 | 0.4 | 1.0 |
| 16-18 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.3 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **68.0** | **20.1** | **88.3** | **56.4** | **20.3** | **49.6** |

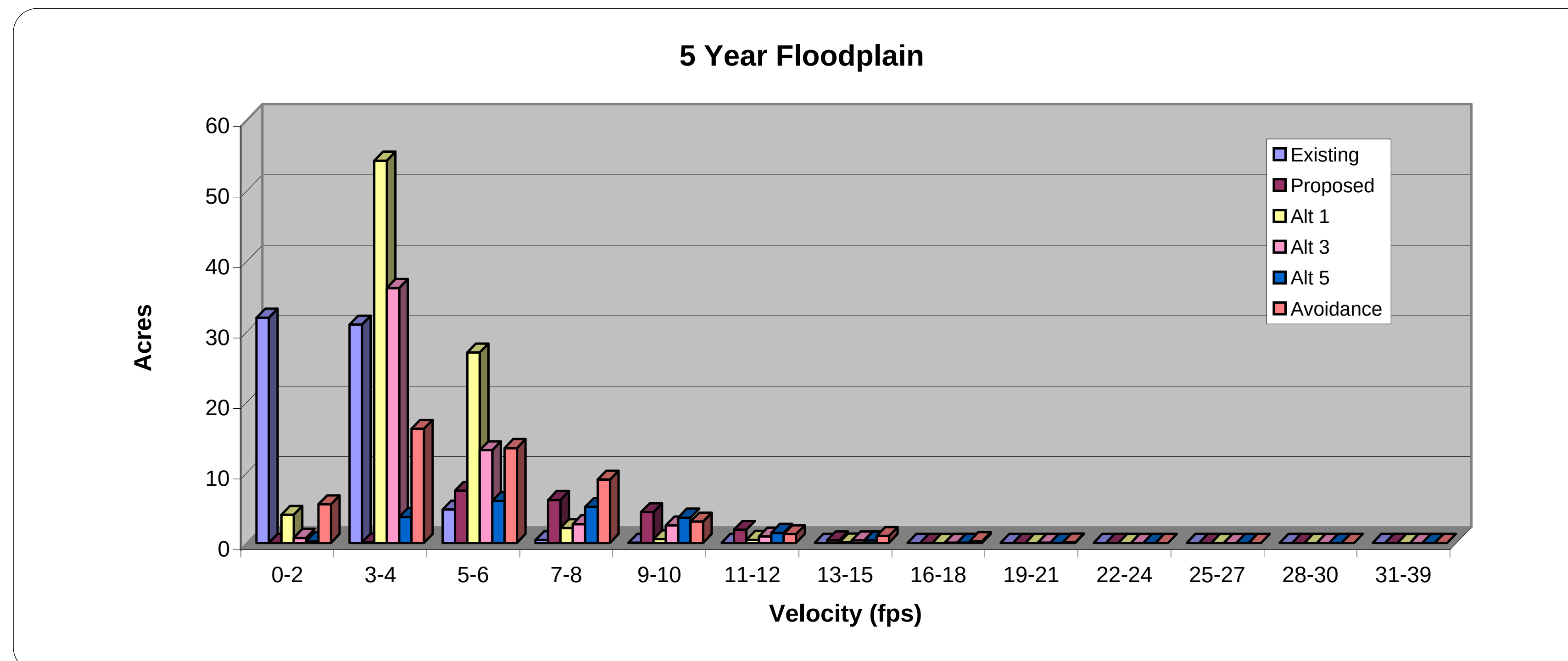
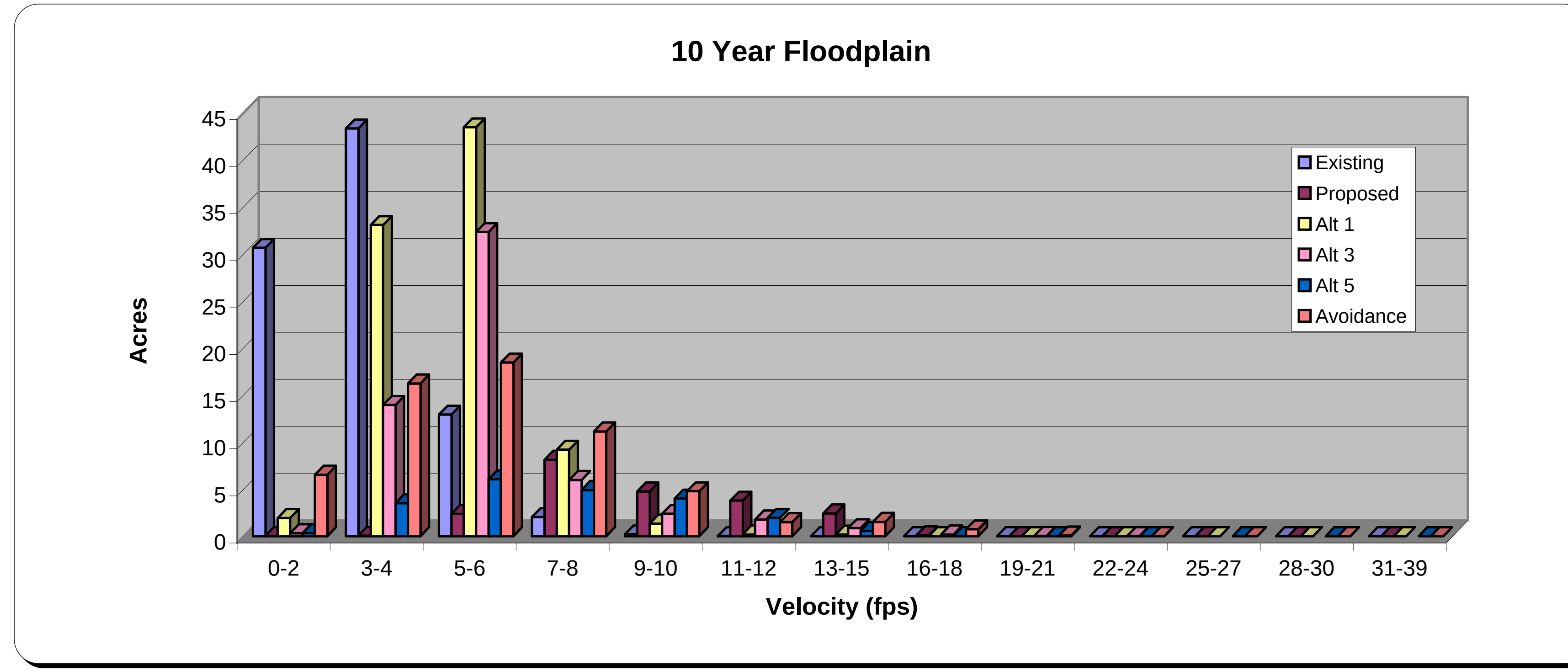



**Figure 5.10**
**Potrero Canyon Floodplain Area by Velocity Distribution**

# Potrero Canyon Floodplain Area by Velocity Analysis

| Velocity Profile (fps) | 10 Year | | | | | |
|---|---|---|---|---|---|---|
| | Existing | Proposed | Alt 1 | Alt 3 | Alt 5 | Avoidance |
| 0-2 | 30.7 | 0.0 | 1.9 | 0.3 | 0.3 | 6.5 |
| 3-4 | 43.3 | 0.0 | 33.1 | 13.9 | 3.5 | 16.2 |
| 5-6 | 12.9 | 2.4 | 43.5 | 32.3 | 6.0 | 18.5 |
| 7-8 | 2.0 | 8.1 | 9.2 | 6.0 | 4.9 | 11.1 |
| 9-10 | 0.2 | 4.8 | 1.3 | 2.4 | 4.0 | 4.8 |
| 11-12 | 0.0 | 3.8 | 0.2 | 1.8 | 1.9 | 1.5 |
| 13-15 | 0.0 | 2.4 | 0.2 | 0.9 | 0.5 | 1.5 |
| 16-18 | 0.0 | 0.1 | 0.0 | 0.2 | 0.0 | 0.7 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **89.2** | **21.6** | **89.3** | **57.8** | **21.3** | **60.9** |




| Velocity Profile (fps) | 20 Year | | | | | |
|---|---|---|---|---|---|---|
| | Existing | Proposed | Alt 1 | Alt 3 | Alt 5 | Avoidance |
| 0-2 | 36.5 | 0.0 | 0.5 | 0.2 | 0.4 | 7.5 |
| 3-4 | 49.4 | 0.0 | 15.6 | 3.8 | 3.3 | 18.1 |
| 5-6 | 31.8 | 0.4 | 41.2 | 28.4 | 5.9 | 20.0 |
| 7-8 | 6.8 | 5.1 | 23.5 | 16.8 | 4.9 | 15.2 |
| 9-10 | 1.4 | 6.6 | 8.0 | 5.1 | 4.3 | 7.8 |
| 11-12 | 0.2 | 3.5 | 1.4 | 2.1 | 2.6 | 3.6 |
| 13-15 | 0.1 | 5.7 | 0.2 | 2.4 | 0.9 | 2.7 |
| 16-18 | 0.0 | 2.1 | 0.1 | 0.7 | 0.1 | 1.4 |
| 19-21 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.6 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **126.2** | **23.5** | **90.5** | **59.6** | **22.4** | **76.8** |

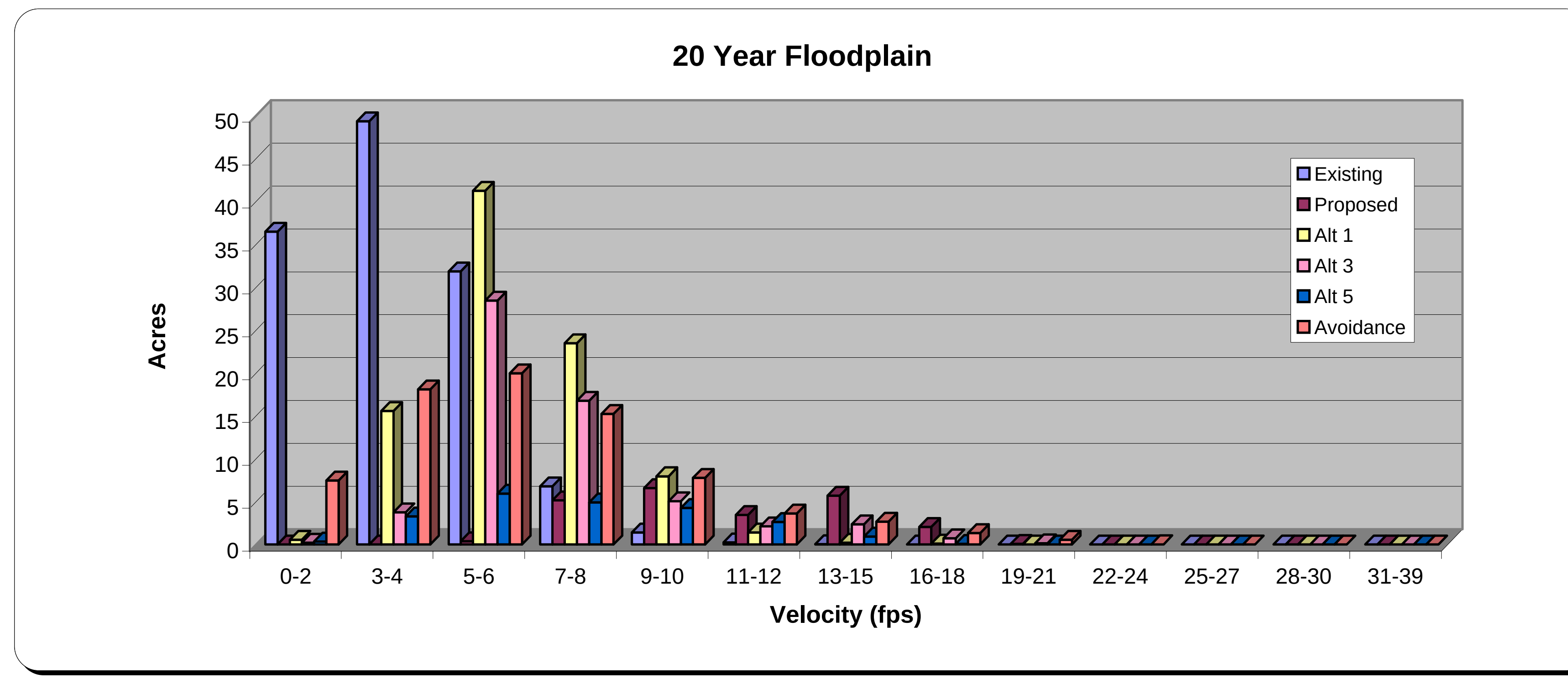



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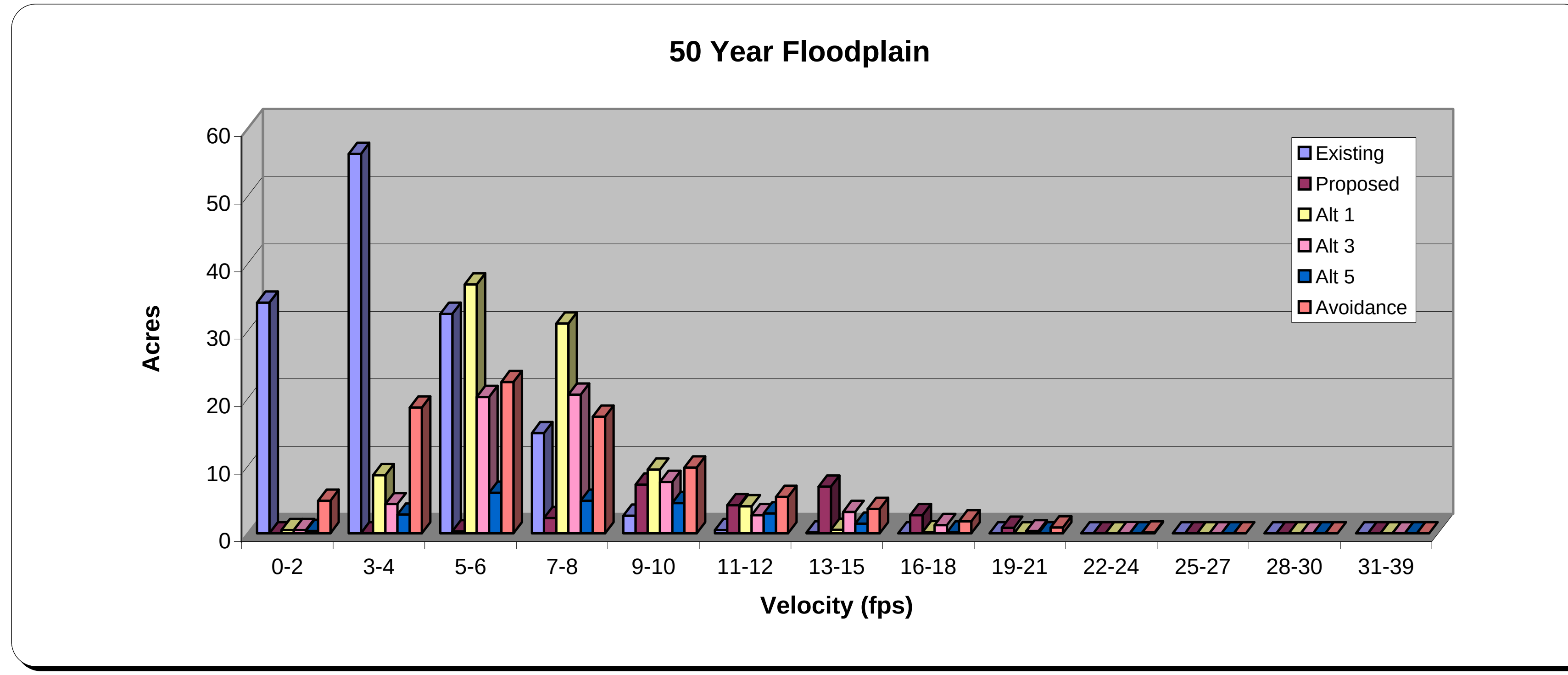
**Figure 5.11**
**Potrero Canyon Floodplain Area by Velocity Distribution**

# Potrero Canyon Floodplain Area by Velocity Analysis

| Velocity Profile (fps) | 50 Year | | | | | |
|---|---|---|---|---|---|---|
| | Existing | Proposed | Alt 1 | Alt 3 | Alt 5 | Avoidance |
| 0-2 | 34.2 | 0.0 | 0.5 | 0.5 | 0.4 | 4.9 |
| 3-4 | 56.2 | 0.0 | 8.6 | 4.3 | 2.8 | 18.6 |
| 5-6 | 32.5 | 0.3 | 36.9 | 20.2 | 6.0 | 22.4 |
| 7-8 | 14.8 | 2.3 | 31.1 | 20.5 | 4.8 | 17.3 |
| 9-10 | 2.6 | 7.2 | 9.4 | 7.6 | 4.5 | 9.7 |
| 11-12 | 0.5 | 4.2 | 4.0 | 2.7 | 2.9 | 5.4 |
| 13-15 | 0.2 | 6.9 | 0.5 | 3.2 | 1.4 | 3.6 |
| 16-18 | 0.0 | 2.7 | 0.2 | 1.2 | 0.1 | 1.8 |
| 19-21 | 0.0 | 0.8 | 0.0 | 0.3 | 0.0 | 0.9 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **141.0** | **24.5** | **91.3** | **60.7** | **23.0** | **84.7** |




| Velocity Profile (fps) | 100 Year | | | | | |
|---|---|---|---|---|---|---|
| | Existing | Proposed | Alt 1 | Alt 3 | Alt 5 | Avoidance |
| 0-2 | 36.8 | 0.0 | 0.4 | 0.3 | 0.3 | 6.0 |
| 3-4 | 59.2 | 0.0 | 6.2 | 3.6 | 2.1 | 18.7 |
| 5-6 | 36.6 | 0.3 | 30.1 | 14.1 | 3.7 | 24.0 |
| 7-8 | 21.1 | 1.5 | 33.7 | 23.5 | 5.0 | 18.6 |
| 9-10 | 3.6 | 5.4 | 14.2 | 10.3 | 3.7 | 11.1 |
| 11-12 | 0.8 | 6.3 | 5.5 | 3.8 | 3.5 | 6.6 |
| 13-15 | 0.2 | 6.8 | 1.5 | 3.3 | 5.0 | 3.9 |
| 16-18 | 0.0 | 3.1 | 0.2 | 1.8 | 2.7 | 2.0 |
| 19-21 | 0.0 | 1.6 | 0.0 | 0.6 | 0.5 | 0.9 |
| 22-24 | 0.0 | 0.1 | 0.0 | 0.1 | 0.0 | 0.3 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **158.4** | **25.3** | **91.8** | **61.5** | **26.6** | **92.1** |

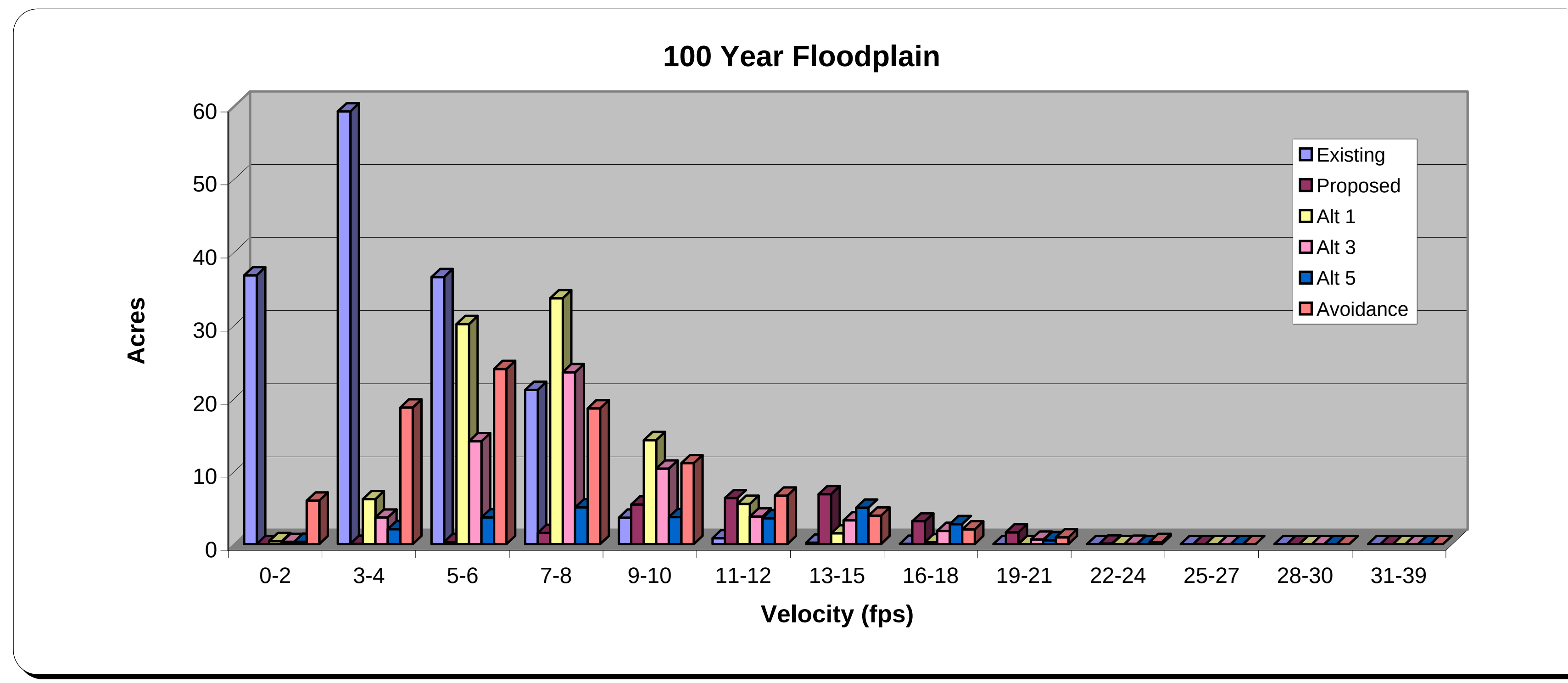





**Figure 5.12**
**Potrero Canyon Floodplain Area by Velocity Distribution**

# Long Canyon Floodplain Area

| Flood Frequency | Existing (AC) | Proposed (AC) | Delta (AC) | Delta (%) | Alt 1 (AC) | Delta (AC) | Delta (%) | Alt 2 (AC) | Delta (AC) | Delta (%) | Avoidance (AC) | Delta (AC) | Delta (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 Year | 10.4 | 7.8 | -2.6 | -0.2 | 8.5 | -1.9 | -0.2 | 10.2 | -0.2 | 0.0 | 9.7 | -0.7 | -0.1 |
| 5 Year | 12.6 | 8.4 | -4.2 | -0.3 | 9.5 | -3.0 | -0.2 | 11.0 | -1.5 | -0.1 | 11.1 | -1.4 | -0.1 |
| 10 Year | 17.6 | 8.9 | -8.7 | -0.5 | 10.8 | -6.8 | -0.4 | 11.9 | -5.7 | -0.3 | 13.4 | -4.1 | -0.2 |
| 20 Year | 24.6 | 9.6 | -14.9 | -0.6 | 12.6 | -12.0 | -0.5 | 13.1 | -11.4 | -0.5 | 16.1 | -8.4 | -0.3 |
| 50 Year | 25.7 | 10.0 | -15.7 | -0.6 | 13.7 | -12.0 | -0.5 | 14.0 | -11.7 | -0.5 | 17.0 | -8.7 | -0.3 |
| 100 Year | 26.7 | 10.3 | -16.4 | -0.6 | 14.6 | -12.1 | -0.5 | 14.6 | -12.1 | -0.5 | 17.9 | -8.8 | -0.3 |

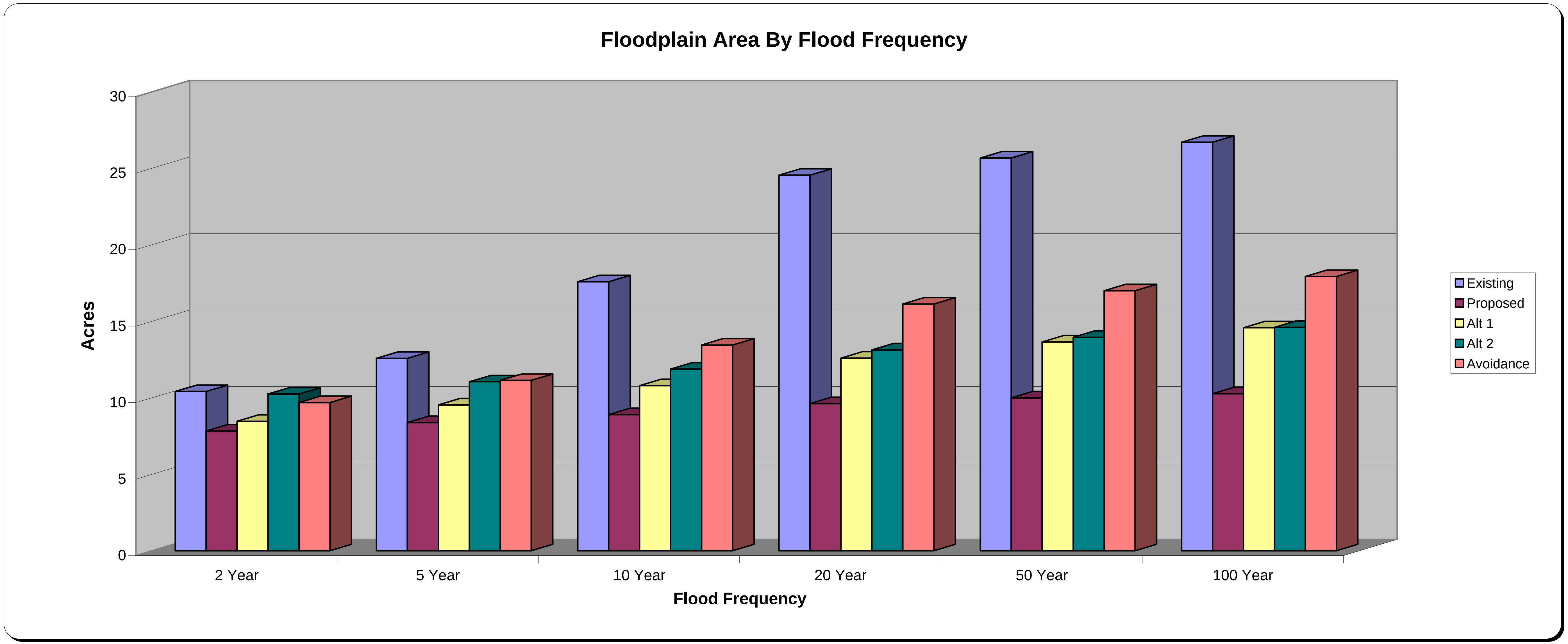



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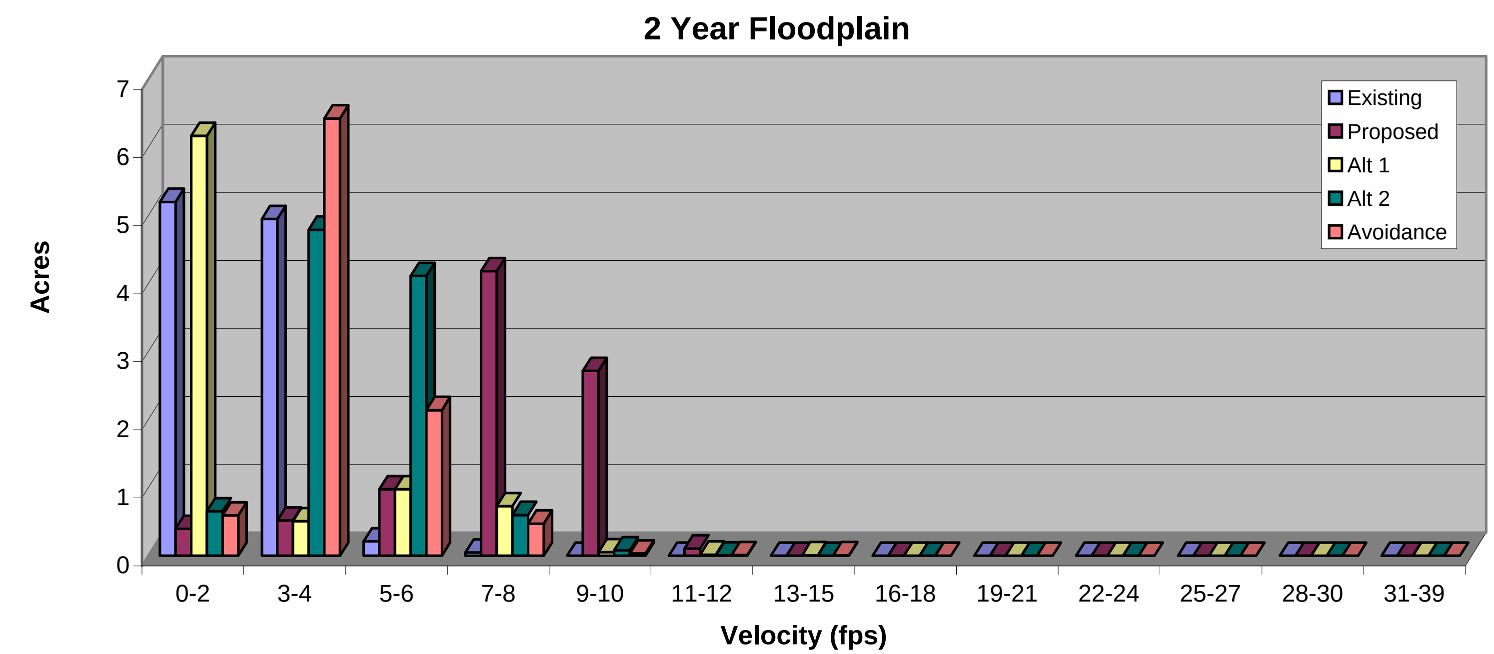
**Figure 5.13**
**Long Canyon Floodplain Area Summary**

## Long Canyon Floodplain Area by Velocity Distribution

| Velocity Profile (fps) | 2 Year Existing | Proposed | Alt 1 | Alt 2 | Avoidance |
|---|---|---|---|---|---|
| 0-2 | 5.2 | 0.8 | 6.2 | 0.7 | 0.6 |
| 3-4 | 4.9 | 2.8 | 0.5 | 4.8 | 6.4 |
| 5-6 | 0.2 | 3.7 | 1.0 | 4.1 | 2.1 |
| 7-8 | 0.0 | 0.1 | 0.7 | 0.6 | 0.5 |
| 9-10 | 0.0 | 0.2 | 0.1 | 0.1 | 0.0 |
| 11-12 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 |
| 13-15 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 16-18 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **10.4** | **7.8** | **8.5** | **10.2** | **9.7** |




| Velocity Profile (fps) | 5 Year Existing | Proposed | Alt 1 | Alt 2 | Avoidance |
|---|---|---|---|---|---|
| 0-2 | 2.1 | 0.5 | 6.5 | 0.4 | 0.4 |
| 3-4 | 8.3 | 0.9 | 0.8 | 1.6 | 3.9 |
| 5-6 | 1.9 | 3.8 | 0.2 | 4.7 | 5.4 |
| 7-8 | 0.2 | 3.0 | 1.4 | 3.3 | 1.1 |
| 9-10 | 0.1 | 0.1 | 0.6 | 0.5 | 0.3 |
| 11-12 | 0.0 | 0.0 | 0.1 | 0.2 | 0.1 |
| 13-15 | 0.0 | 0.0 | 0.0 | 0.2 | 0.0 |
| 16-18 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **12.6** | **8.4** | **9.5** | **11.0** | **11.1** |

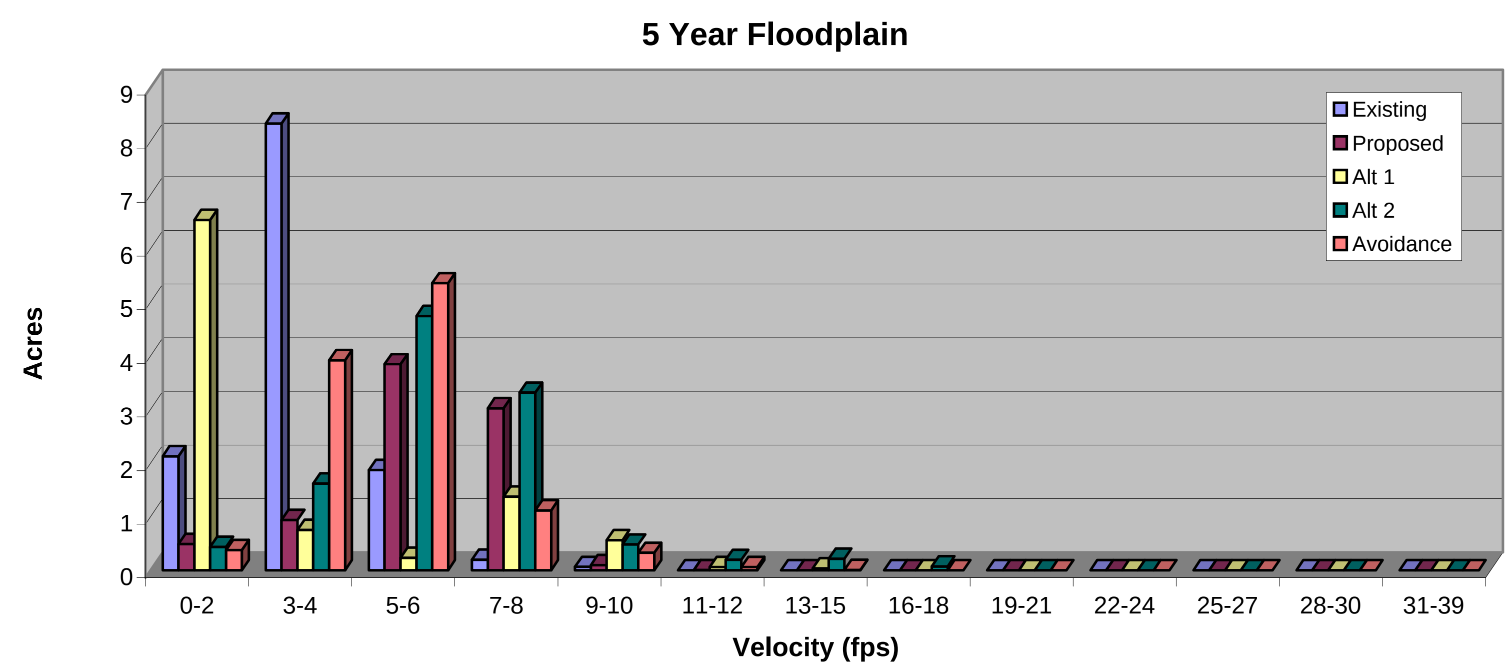
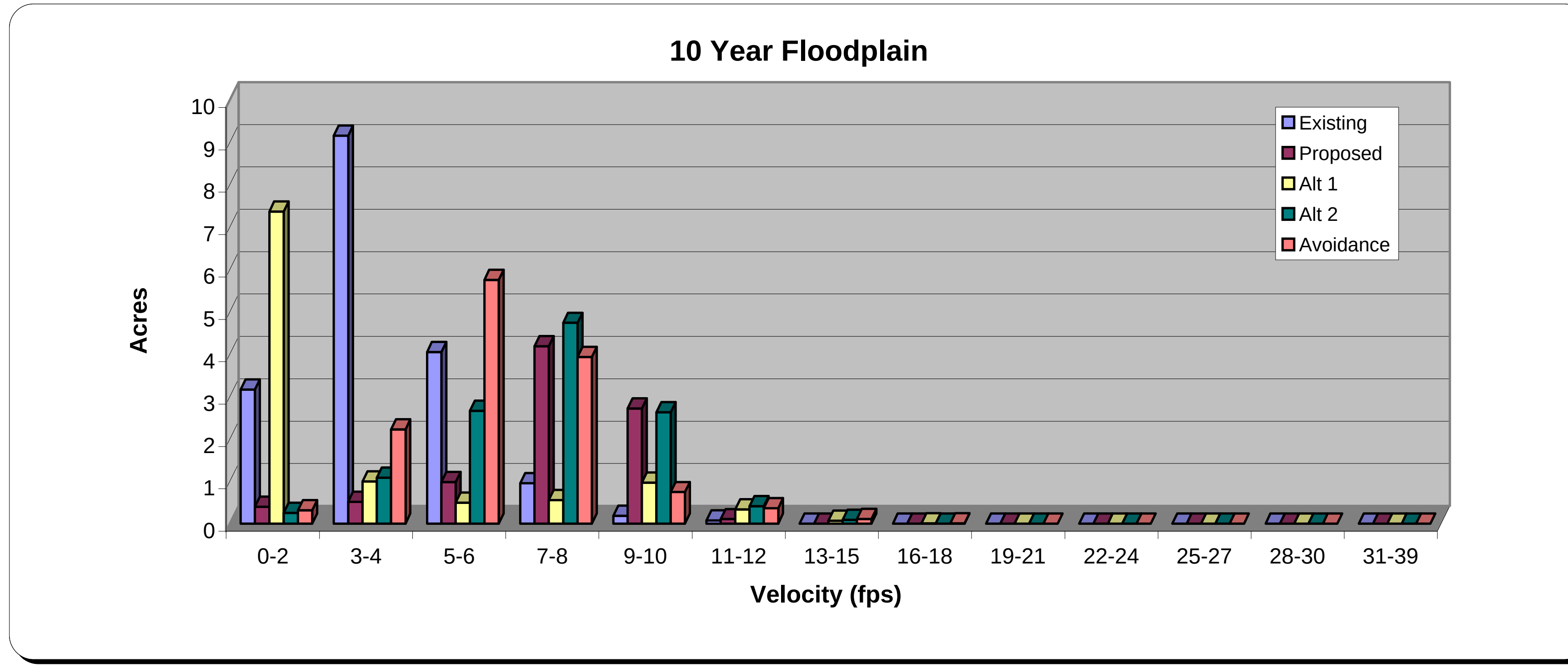



**Figure 5.14**
**Long Canyon Floodplain Area by Velocity Distribution**

# Long Canyon Floodplain Area by Velocity Distribution

| Velocity Profile (fps) | 10 Year Existing | 10 Year Proposed | 10 Year Alt 1 | 10 Year Alt 2 | 10 Year Avoidance |
|---|---|---|---|---|---|
| 0-2 | 3.2 | 0.4 | 7.4 | 0.3 | 0.3 |
| 3-4 | 9.2 | 0.5 | 1.0 | 1.1 | 2.2 |
| 5-6 | 4.0 | 1.0 | 0.5 | 2.7 | 5.7 |
| 7-8 | 1.0 | 4.2 | 0.6 | 4.7 | 3.9 |
| 9-10 | 0.2 | 2.7 | 1.0 | 2.6 | 0.7 |
| 11-12 | 0.1 | 0.1 | 0.3 | 0.4 | 0.4 |
| 13-15 | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 |
| 16-18 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **17.6** | **8.9** | **10.8** | **11.9** | **13.4** |




| Velocity Profile (fps) | 20 Year Existing | 20 Year Proposed | 20 Year Alt 1 | 20 Year Alt 2 | 20 Year Avoidance |
|---|---|---|---|---|---|
| 0-2 | 4.1 | 0.4 | 8.4 | 0.4 | 0.8 |
| 3-4 | 9.0 | 0.6 | 0.4 | 1.2 | 2.1 |
| 5-6 | 7.0 | 0.6 | 1.0 | 1.9 | 3.8 |
| 7-8 | 3.3 | 1.1 | 0.6 | 2.8 | 5.1 |
| 9-10 | 0.8 | 3.0 | 0.6 | 3.8 | 3.3 |
| 11-12 | 0.2 | 3.5 | 1.0 | 2.4 | 0.7 |
| 13-15 | 0.1 | 0.4 | 0.6 | 0.7 | 0.3 |
| 16-18 | 0.0 | 0.0 | 0.0 | 0.1 | 0.1 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **24.6** | **9.6** | **12.6** | **13.1** | **16.1** |

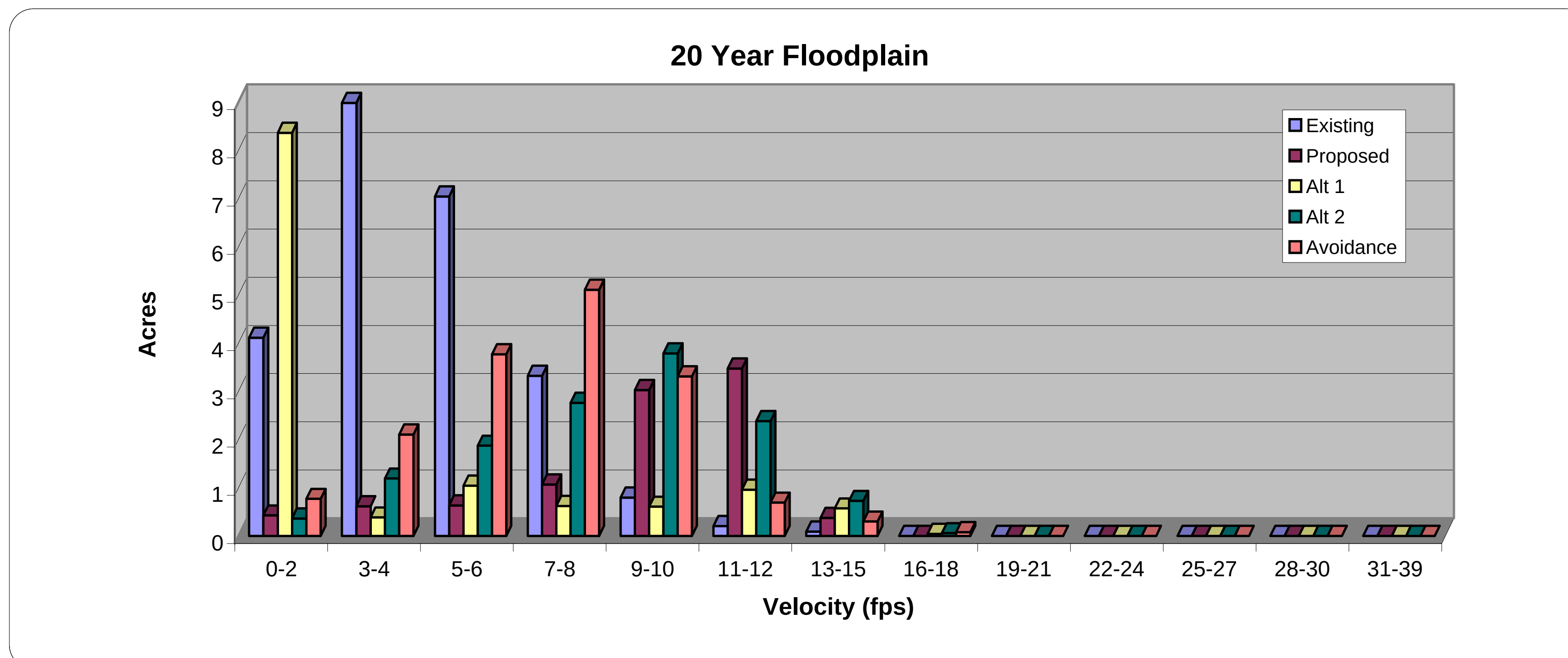
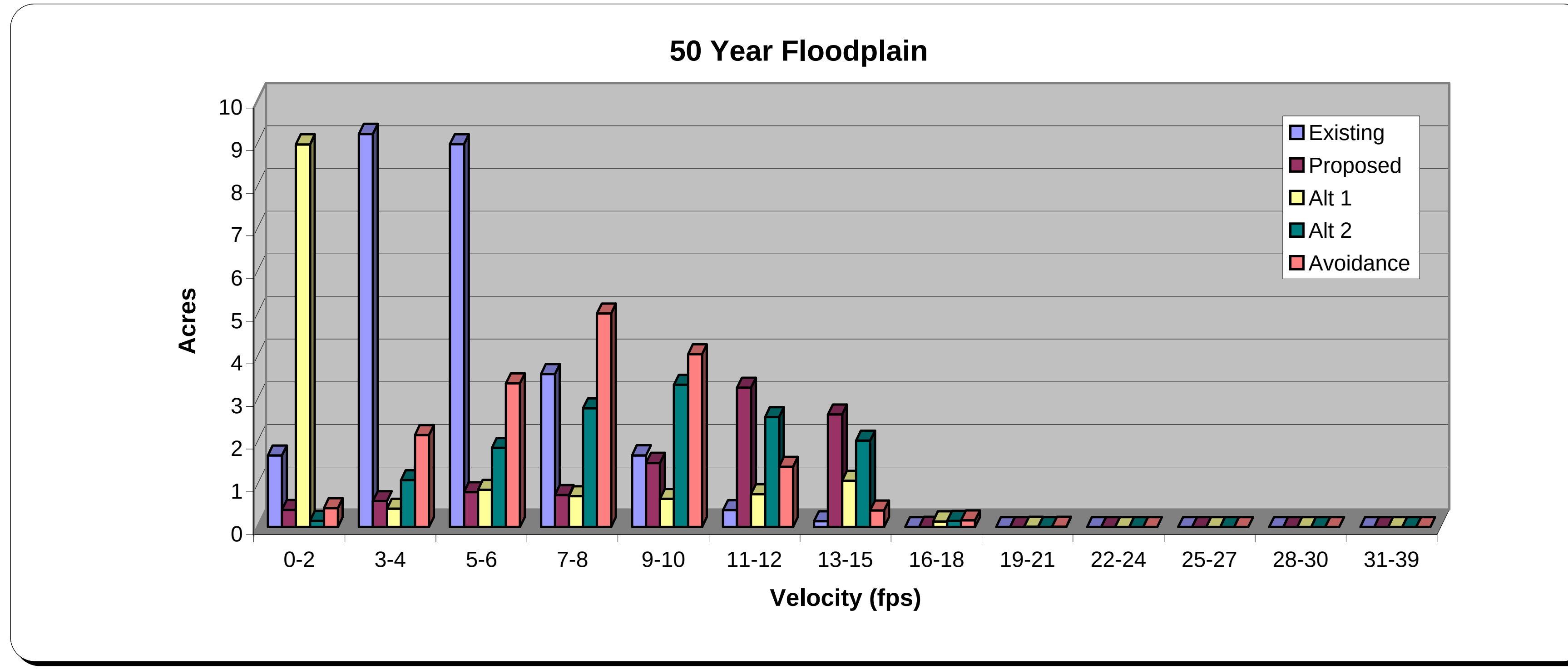



**Figure 5.15**
**Long Canyon Floodplain Area by Velocity Distribution**

# Long Canyon Floodplain Area by Velocity Distribution

| Velocity | 50 Year | | | | |
|---|---|---|---|---|---|
| Profile (fps) | Existing | Proposed | Alt 1 | Alt 2 | Avoidance |
| 0-2 | 1.7 | 0.4 | 9.0 | 0.1 | 0.4 |
| 3-4 | 9.2 | 0.6 | 0.4 | 1.1 | 2.2 |
| 5-6 | 9.0 | 0.8 | 0.9 | 1.9 | 3.4 |
| 7-8 | 3.6 | 0.7 | 0.7 | 2.8 | 5.0 |
| 9-10 | 1.7 | 1.5 | 0.7 | 3.3 | 4.1 |
| 11-12 | 0.4 | 3.3 | 0.8 | 2.6 | 1.4 |
| 13-15 | 0.1 | 2.6 | 1.1 | 2.0 | 0.4 |
| 16-18 | 0.0 | 0.0 | 0.1 | 0.1 | 0.2 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **25.7** | **10.0** | **13.7** | **14.0** | **17.0** |




| Velocity | 100 Year | | | | |
|---|---|---|---|---|---|
| Profile (fps) | Existing | Proposed | Alt 1 | Alt 2 | Avoidance |
| 0-2 | 1.1 | 0.4 | 9.6 | 0.2 | 0.4 |
| 3-4 | 6.5 | 0.7 | 0.6 | 0.7 | 2.6 |
| 5-6 | 11.2 | 0.9 | 1.0 | 2.0 | 3.2 |
| 7-8 | 4.8 | 0.8 | 0.5 | 2.7 | 4.9 |
| 9-10 | 2.2 | 1.1 | 0.6 | 2.8 | 4.1 |
| 11-12 | 0.6 | 2.6 | 0.7 | 3.4 | 1.9 |
| 13-15 | 0.2 | 3.6 | 1.3 | 2.5 | 0.6 |
| 16-18 | 0.0 | 0.1 | 0.3 | 0.3 | 0.2 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **26.7** | **10.3** | **14.6** | **14.6** | **17.9** |

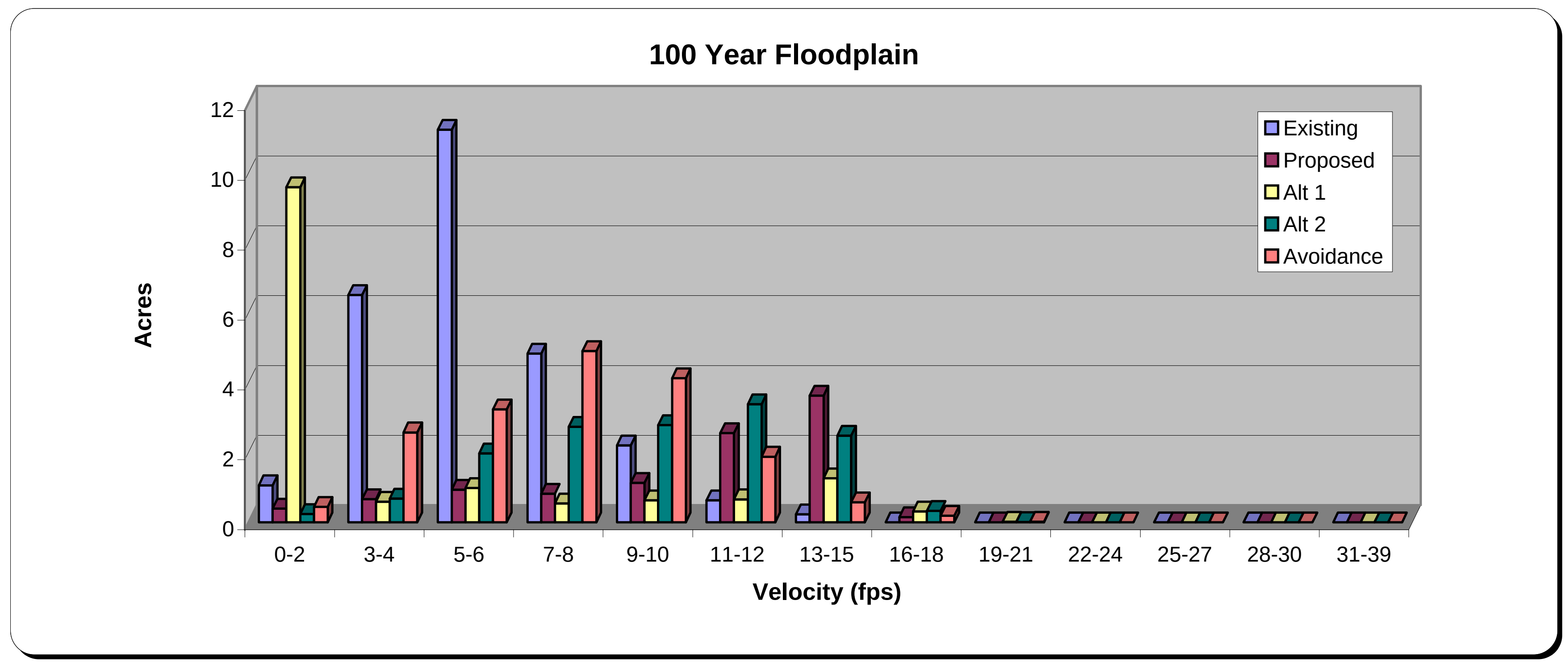



**Figure 5.16**
**Long Floodplain Area by Velocity Distribution**

## Lion Canyon Floodplain Area

| Flood Frequency | Existing (AC) |
|---|---|
| 2 Year | 11.1 |
| 5 Year | 11.1 |
| 10 Year | 11.1 |
| 20 Year | 11.1 |
| 50 Year | 12.5 |
| 100 Year | 13.0 |

| Proposed (AC) | Delta (AC) | Delta (%) |
|---|---|---|
| 4.2 | -6.9 | -0.6 |
| 4.5 | -6.6 | -0.6 |
| 4.7 | -6.4 | -0.6 |
| 5.2 | -5.9 | -0.5 |
| 5.0 | -7.5 | -0.6 |
| 5.0 | -8.0 | -0.6 |

| Alt 1 (AC) | Delta (AC) | Delta (%) |
|---|---|---|
| 4.2 | -6.9 | -0.6 |
| 4.5 | -6.6 | -0.6 |
| 4.7 | -6.4 | -0.6 |
| 5.2 | -5.9 | -0.5 |
| 5.5 | -7.0 | -0.6 |
| 5.8 | -7.2 | -0.6 |

| Avoidance (AC) | Delta (AC) | Delta (%) |
|---|---|---|
| 9.2 | -1.9 | -0.2 |
| 9.6 | -1.5 | -0.1 |
| 10.0 | -1.1 | -0.1 |
| 10.7 | -0.4 | 0.0 |
| 11.1 | -1.3 | -0.1 |
| 11.5 | -1.5 | -0.1 |

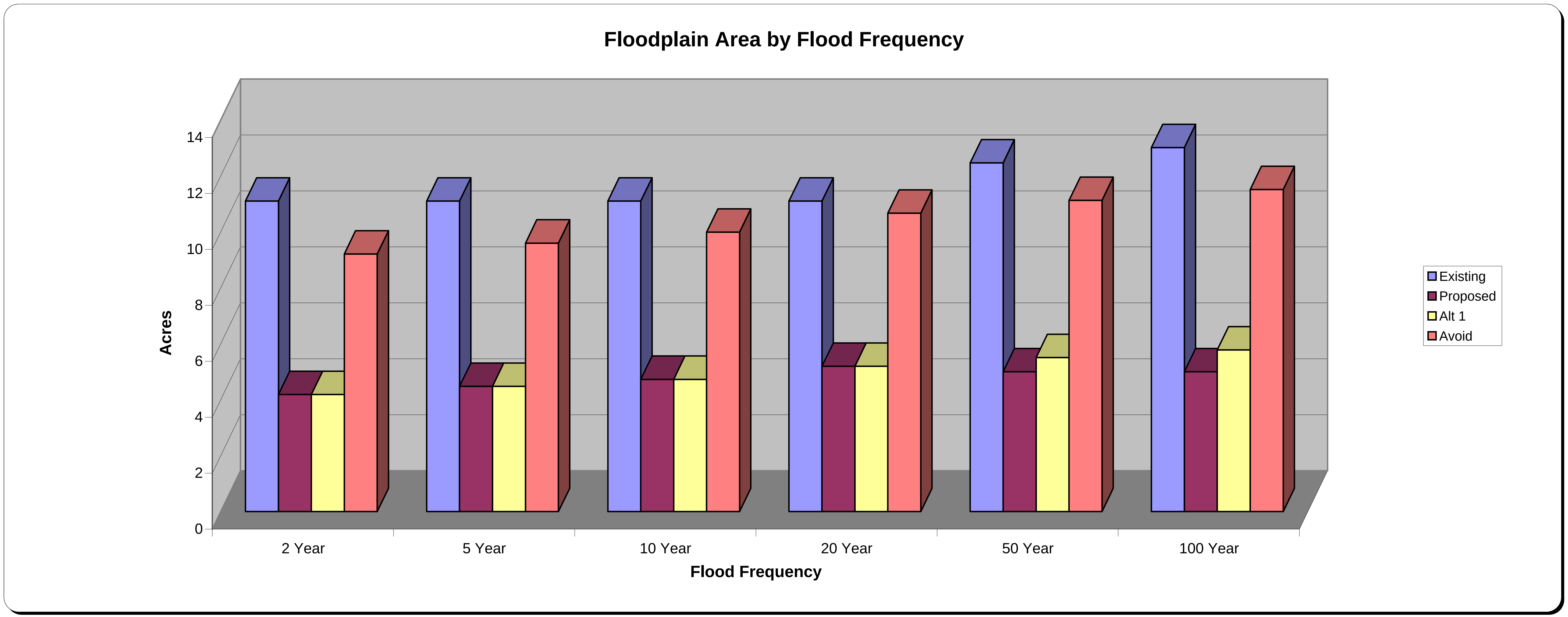



**Figure 5.17**
**Lion Canyon Floodplain Area**
**Summary**

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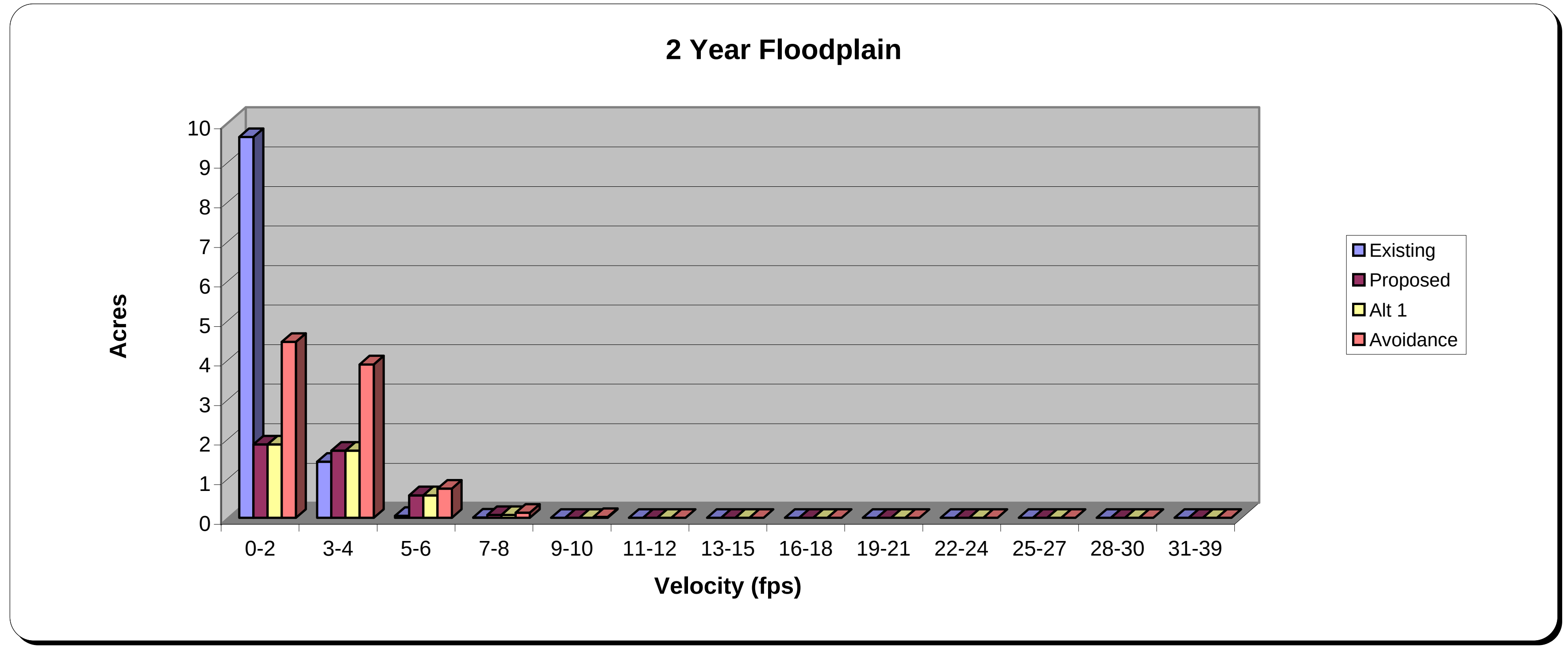
# Lion Canyon Floodplain Area by Velocity Distribution

| Velocity Profile (fps) | 2 Year Existing | 2 Year Proposed | 2 Year Alt 1 | 2 Year Avoidance |
|---|---|---|---|---|
| 0-2 | 9.6 | 1.9 | 1.9 | 4.4 |
| 3-4 | 1.4 | 1.7 | 1.7 | 3.9 |
| 5-6 | 0.1 | 0.6 | 0.6 | 0.7 |
| 7-8 | 0.0 | 0.1 | 0.1 | 0.1 |
| 9-10 | 0.0 | 0.0 | 0.0 | 0.0 |
| 11-12 | 0.0 | 0.0 | 0.0 | 0.0 |
| 13-15 | 0.0 | 0.0 | 0.0 | 0.0 |
| 16-18 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **11.1** | **4.2** | **4.2** | **9.2** |




| Velocity Profile (fps) | 5 Year Existing | 5 Year Proposed | 5 Year Alt 1 | 5 Year Avoidance |
|---|---|---|---|---|
| 0-2 | 7.8 | 0.5 | 0.5 | 2.1 |
| 3-4 | 3.0 | 2.7 | 2.7 | 5.8 |
| 5-6 | 0.3 | 1.0 | 1.0 | 1.4 |
| 7-8 | 0.0 | 0.2 | 0.2 | 0.2 |
| 9-10 | 0.0 | 0.1 | 0.1 | 0.1 |
| 11-12 | 0.0 | 0.0 | 0.0 | 0.0 |
| 13-15 | 0.0 | 0.0 | 0.0 | 0.0 |
| 16-18 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **11.1** | **4.5** | **4.5** | **9.6** |

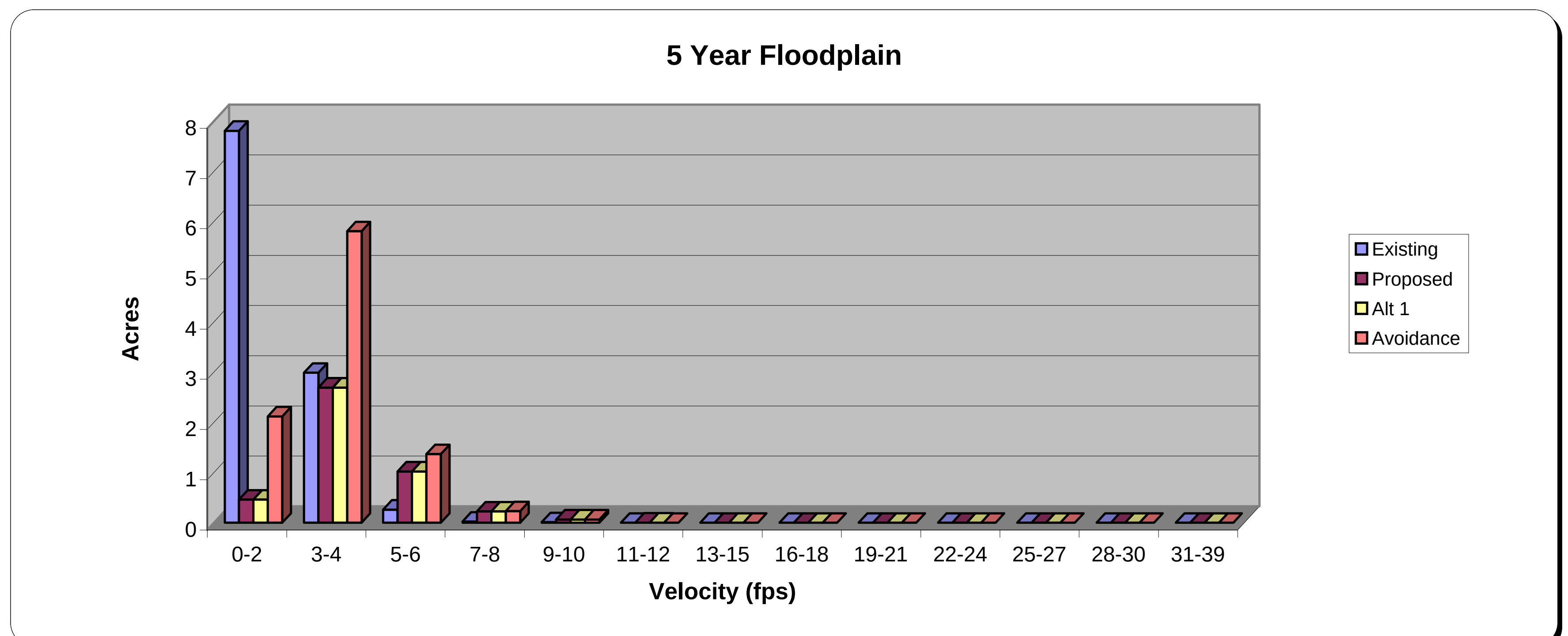
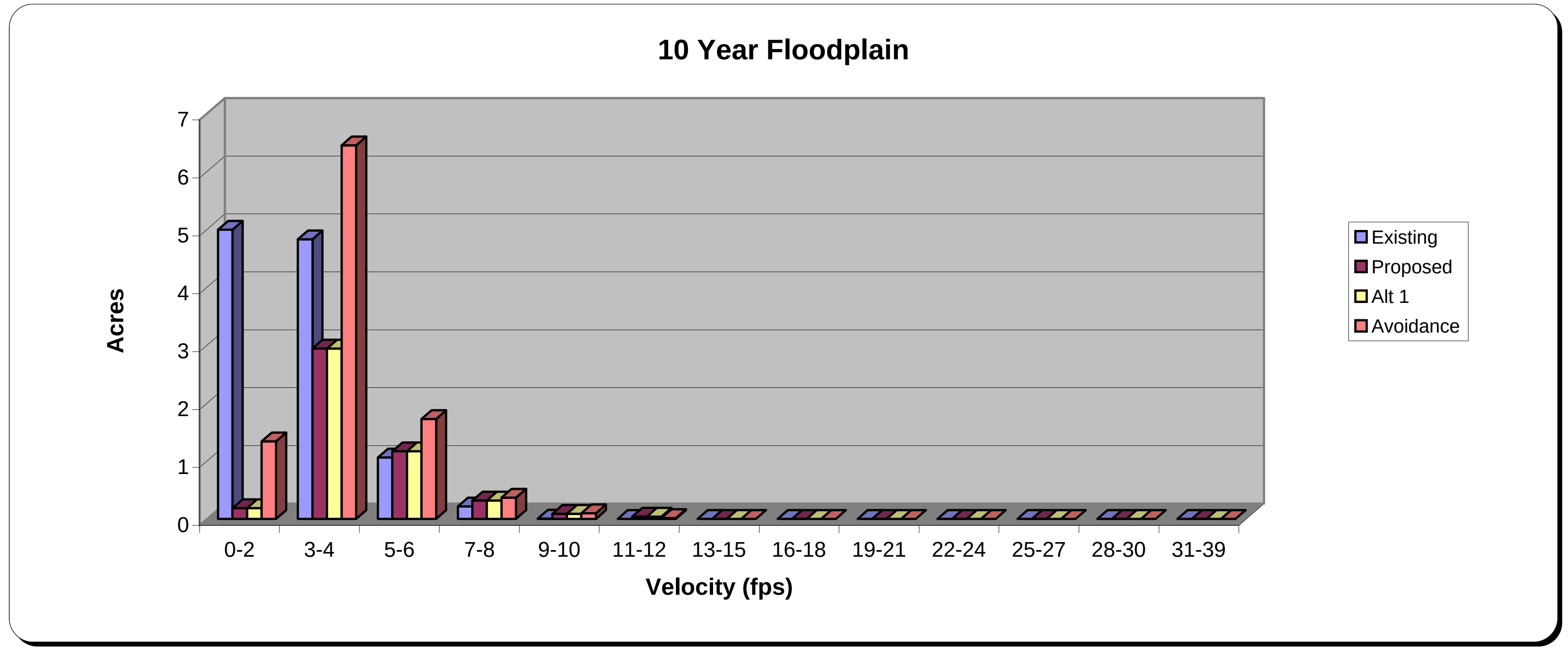


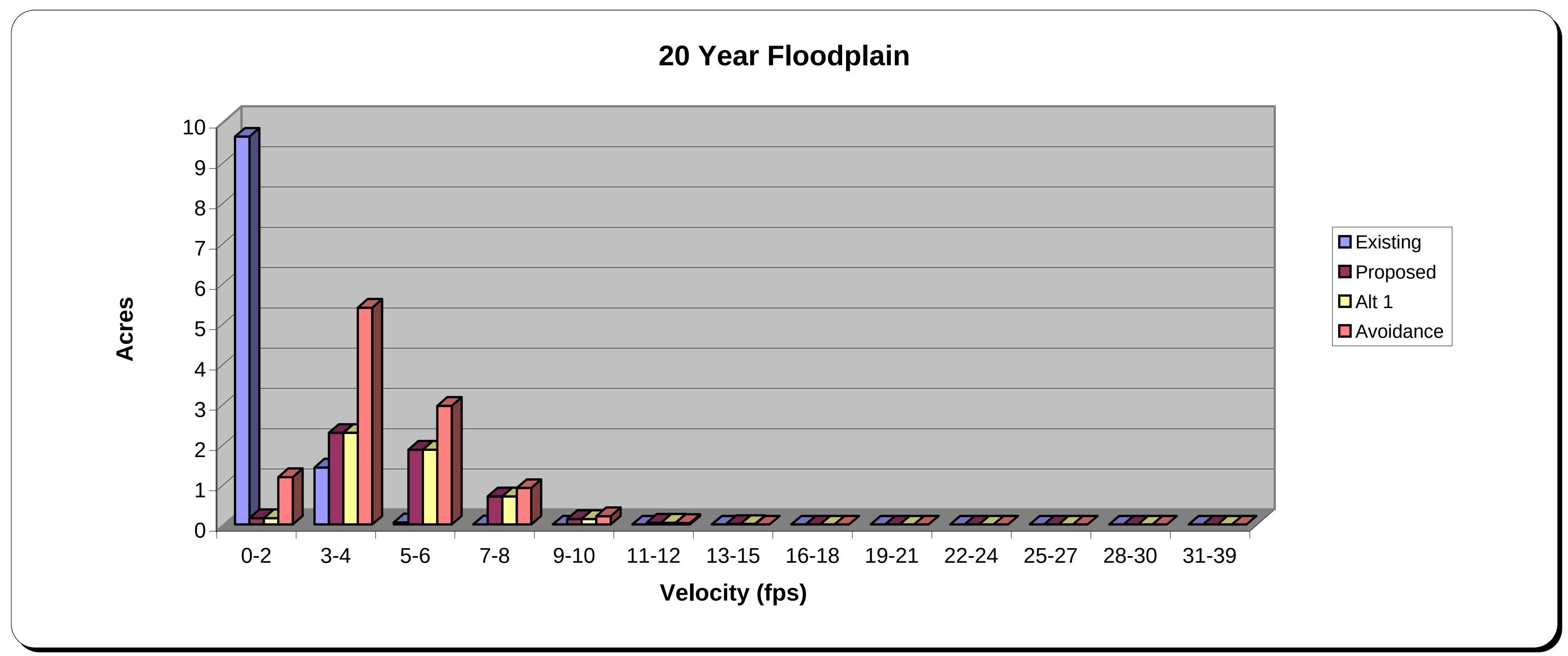

**Figure 5.18**
**Lion Canyon Floodplain Area**
**by Velocity Distribution**

# Lion Canyon Floodplain Area by Velocity Distribution

| Velocity Profile (fps) | 10 Year | | | |
|---|---|---|---|---|
| | Existing | Proposed | Alt 1 | Avoidance |
| 0-2 | 5.0 | 0.2 | 0.2 | 1.3 |
| 3-4 | 4.8 | 2.9 | 2.9 | 6.4 |
| 5-6 | 1.1 | 1.2 | 1.2 | 1.7 |
| 7-8 | 0.2 | 0.3 | 0.3 | 0.4 |
| 9-10 | 0.0 | 0.1 | 0.1 | 0.1 |
| 11-12 | 0.0 | 0.0 | 0.0 | 0.0 |
| 13-15 | 0.0 | 0.0 | 0.0 | 0.0 |
| 16-18 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **11.1** | **4.7** | **4.7** | **10.0** |




| Velocity Profile (fps) | 20 Year | | | |
|---|---|---|---|---|
| | Existing | Proposed | Alt 1 | Avoidance |
| 0-2 | 9.6 | 0.2 | 0.2 | 1.2 |
| 3-4 | 1.4 | 2.3 | 2.3 | 5.4 |
| 5-6 | 0.1 | 1.9 | 1.9 | 2.9 |
| 7-8 | 0.0 | 0.7 | 0.7 | 0.9 |
| 9-10 | 0.0 | 0.1 | 0.1 | 0.2 |
| 11-12 | 0.0 | 0.0 | 0.0 | 0.0 |
| 13-15 | 0.0 | 0.0 | 0.0 | 0.0 |
| 16-18 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **11.1** | **5.2** | **5.2** | **10.7** |

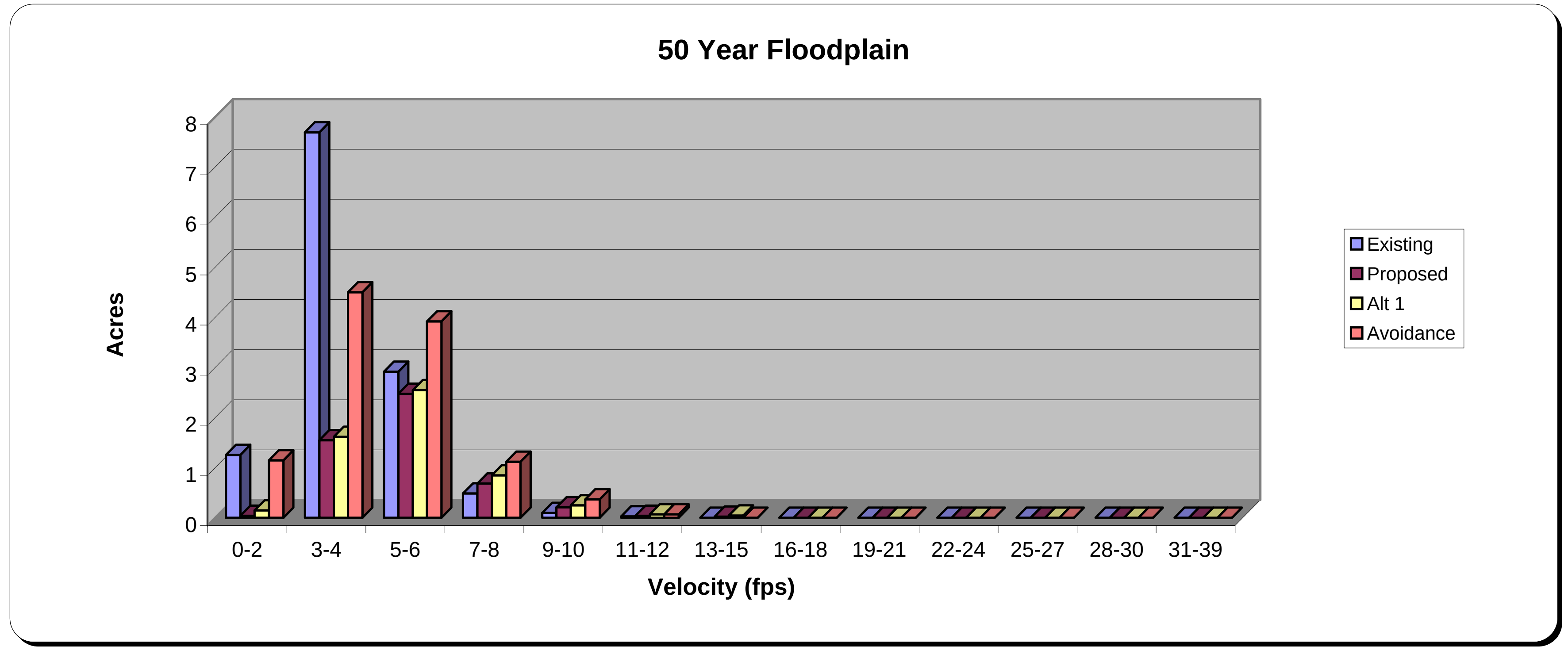



P:\8238E\GIS\tables\RMDP_CombinedTribs_20090209\RMDP_CombinedTribs_FPAndVel_PC3_20090302 - Lion Fig 5.19

**Figure 5.19**
**Lion Canyon Floodplain Area by Velocity Distribution**

# Lion Canyon Floodplain Area by Velocity Distribution

| Velocity Profile (fps) | 50 Year | | | |
|---|---|---|---|---|
| | Existing | Proposed | Alt 1 | Avoidance |
| 0-2 | 1.3 | 0.0 | 0.1 | 1.1 |
| 3-4 | 7.7 | 1.5 | 1.6 | 4.5 |
| 5-6 | 2.9 | 2.5 | 2.5 | 3.9 |
| 7-8 | 0.5 | 0.7 | 0.8 | 1.1 |
| 9-10 | 0.1 | 0.2 | 0.2 | 0.4 |
| 11-12 | 0.0 | 0.0 | 0.1 | 0.1 |
| 13-15 | 0.0 | 0.0 | 0.0 | 0.0 |
| 16-18 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **12.5** | **5.0** | **5.5** | **11.1** |




| Velocity Profile (fps) | 100 Year | | | |
|---|---|---|---|---|
| | Existing | Proposed | Alt 1 | Avoidance |
| 0-2 | 1.2 | 0.0 | 0.2 | 1.2 |
| 3-4 | 7.0 | 0.8 | 1.0 | 3.3 |
| 5-6 | 3.8 | 3.2 | 3.3 | 5.1 |
| 7-8 | 0.8 | 0.7 | 0.9 | 1.2 |
| 9-10 | 0.2 | 0.2 | 0.3 | 0.6 |
| 11-12 | 0.0 | 0.1 | 0.1 | 0.1 |
| 13-15 | 0.0 | 0.0 | 0.1 | 0.0 |
| 16-18 | 0.0 | 0.0 | 0.0 | 0.0 |
| 19-21 | 0.0 | 0.0 | 0.0 | 0.0 |
| 22-24 | 0.0 | 0.0 | 0.0 | 0.0 |
| 25-27 | 0.0 | 0.0 | 0.0 | 0.0 |
| 28-30 | 0.0 | 0.0 | 0.0 | 0.0 |
| 31-39 | 0.0 | 0.0 | 0.0 | 0.0 |
| **Total** | **13.0** | **5.0** | **5.8** | **11.5** |

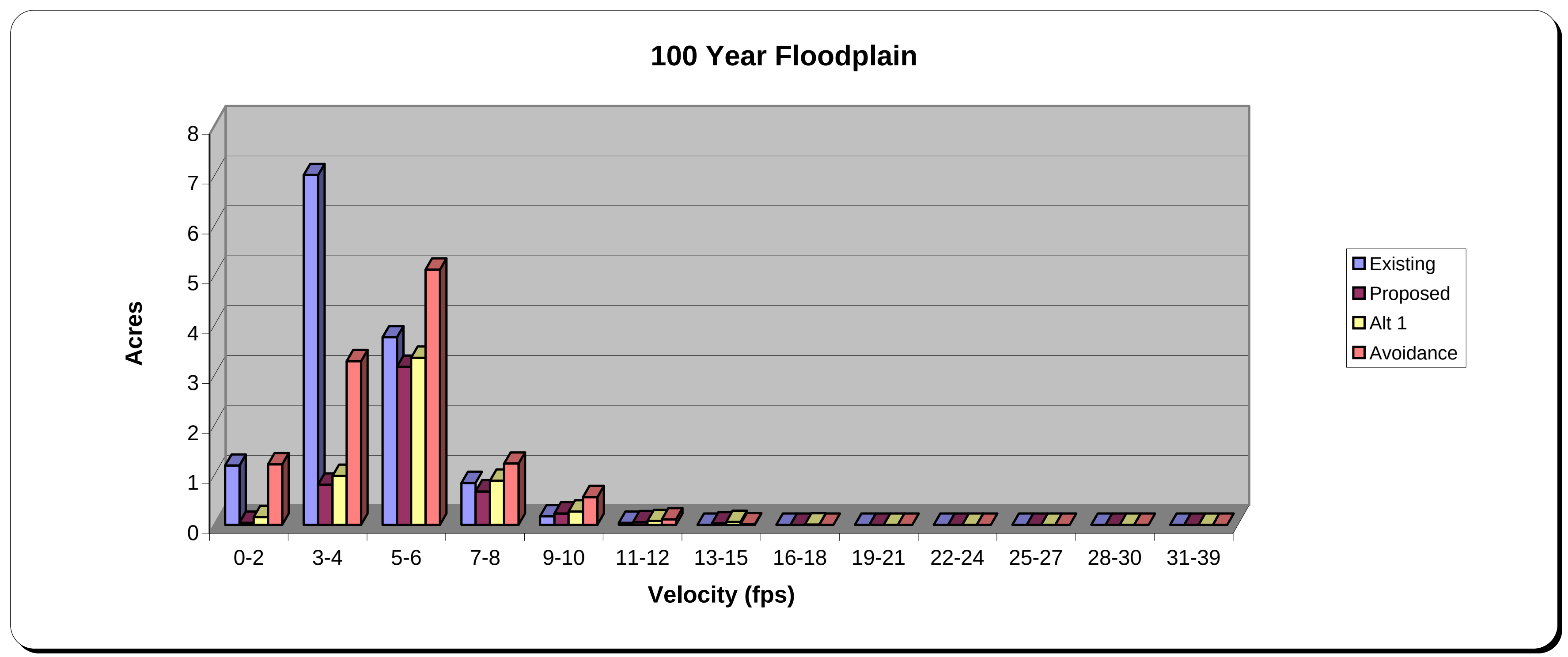





**Figure 5.20**
**Lion Canyon Floodplain Area**
**by Velocity Distribution**