# HISTORICAL CHANGE ANALYSIS IN LIVERMORE-AMADOR VALLEY: IMPLICATIONS FOR LANDSCAPE-SCALE MANAGEMENT STRATEGIES

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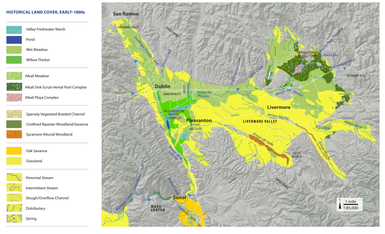
## ABSTRACT

Urbanization and hydromodification in Livermore-Amador Valley (the Valley) over the last 150 years have created a highly altered stream network and given rise to a variety of stream management challenges, including sedimentation, channel incision, and instream and riparian habitat loss. This study applied recent historical ecology research to investigate potential landscape-scale management strategies for two streams within the Valley: Arroyo Mocho and Arroyo las Positas. Explorations of historical landscape patterns and processes were used to identify underlying causes of management challenges, create conceptual models showing physical and ecological controls for each system, and develop landscape-scale management and restoration strategies. To increase the resilience of the stream network, recommended management actions include restoration of braided stream morphology, increased floodplain creation and connectivity, preservation of remaining alkali wetlands, and implementation of Low Impact Development (LID) strategies within a watershed framework.

## INTRODUCTION




Land and water use changes in Livermore-Amador Valley (the Valley) over the past 150 years have impaired the ability of the stream network to provide valued watershed functions such as groundwater recharge and high-quality wildlife habitat. Along Arroyo Mocho, the construction of flood control channels has converted many reaches from braided to single-threaded, which has likely reduced off-channel habitat and contributed to downstream sediment deposition. Artificial augmentation of base flows, coupled with urban development on the surrounding floodplain, has resulted in an unnaturally narrow riparian corridor and encroachment by dense vegetation. Along Arroyo las Positas, channelization and increases in impervious surface cover have likely increased flow velocities and created an imbalance of water and sediment, leading to channel incision and downstream sedimentation. In addition, urban development has reduced and fragmented rare wetland habitats in the Springtown alkali sink.

Today, managers are exploring ways to balance the demand for flood control and reliable water supply with the need to protect ecosystem functions such as high-quality riparian and instream habitat. This study drew on findings from the recently-completed Alameda Creek Watershed Historical Ecology Study (Stanford et al. 2013) to analyze contemporary stream management challenges in Livermore-Amador Valley and identify potential landscape-scale management strategies. Sustainable, long-term solutions to watershed management problems require watershed-scale strategies that capitalize on underlying physical processes to restore target functions and enhance ecological resilience (Beechie et al. 2010). Analysis of historical landscape structure and function can reveal persistent geologic, geomorphic, and hydrologic controls that in many cases continue to operate today, and therefore determine both opportunities and constraints for stream management.

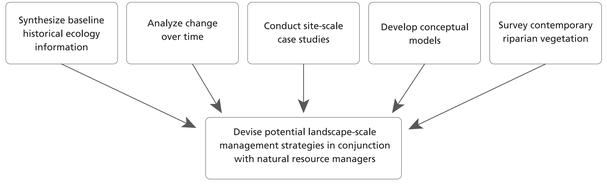
## OBJECTIVES

1) Identify how the physical, ecological, and anthropogenic changes to the Livermore-Amador Valley over the past 150 years have contributed to contemporary stream management challenges, with a focus on Arroyo Mocho and Arroyo las Positas.

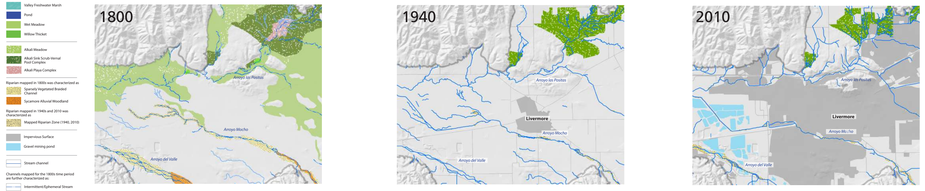
2) Use insights about landscape-scale patterns and processes drawn from historical ecology and contemporary studies to develop potentially cost-saving management strategies to mitigate erosion and sedimentation, restore in-channel complexity and floodplain connectivity, and improve riparian and aquatic habitat.

3) Identify opportunities and constraints associated with potential management strategies.

## METHODS

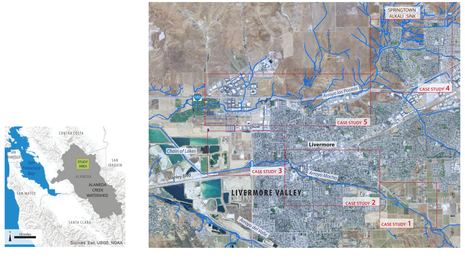



## CHANGE OVER TIME




Change over time of wetland and riparian habitat, stream configurations, gravel mining locations, and extent of impervious surfaces between 1800, 1940, and 2010.

## SELECTED CASE STUDIES




### CASE STUDY 1: ARROYO MOCHO SOUTHEAST

#### Current Management Problems

- Narrowing of creek corridor has led to reduced in-channel sediment storage
- Loss of riparian habitat
- Increased base flows from South Bay Aqueduct and urban runoff
- Replacement of sycamore alluvial woodland with willows and other pioneer species

#### Historical Conditions

- High coarse sediment supply from watershed
- Primarily braided channel
- Frequent flooding
- In-channel water and sediment storage (in contrast to water and sediment transport along Arroyo las Positas)
- Riparian zone dominated by sycamore alluvial woodland

#### Future Potential

- Restore braided channel where unfarmed land is available or agricultural land becomes available, to increase sediment storage, reduce sedimentation problems downstream, and enhance riparian habitat (see case studies 2 and 3)

#### Change Over Time

- Agricultural expansion into riparian corridor
- Conversion from braided to single-threaded channel
- Decreased sediment deposition

Historical channel configuration over modern aerial photo. Today Arroyo Mocho is a single-threaded channel through this reach. (NAIP 2009)

Historical channel configuration over modern aerial. Light blue lines represent inactive side channels observed in the field. (NAIP 2009)


Density of mature sycamores along Arroyo Mocho is highest in areas where trees have probably established following a flood event when these areas were still part of the active floodplain.

### CASE STUDY 2: ARROYO MOCHO (HOLMES STREET TO MADEIROS PARKWAY)

#### Current Management Problems

- Significant sedimentation upstream of Holmes Street Bridge and Stanley Boulevard Bridge
- Subject to flooding

#### Historical Conditions

- Groundwater recharge
- Braided channel up to modern-day Holmes Street Bridge, after which it transitioned to a single stem reach
- Gradation from sycamore alluvial woodland to sparsely vegetated riparian corridor

#### Change Over Time

- Confinement of stream corridor by heavy urbanization. There is still significant open space at Robertson Park and Madeiros Parkway, but the channel is not migrating across it anymore
- Constriction of channel by bridges
- Conversion from braided to single-threaded channel
- Increase in riparian vegetation density and change in species composition
- Change from intermittent to perennial flow

#### Future Potential

- Restore/reconnect inactive side channels and undeveloped portions of floodplain
- Redesign Holmes Street Bridge to reduce constriction of channel
- Parks provide lots of room for reconnecting the channel to the floodplain and re-introduction of braiding

Aerial photos from 1940 and 2007 show the persistence of Arroyo Mocho's distributaries decades after ditching and urbanization pressures. (USDA 1940, Google Earth 2007)

### CASE STUDY 3: ARROYO MOCHO DISTRIBUTARIES

#### Current Management Problems

- Significant sedimentation within the flood control channel west of Isabel Avenue and in the alternate northern channel east of Isabel Avenue
- Subject to flooding
- Poor quality riparian habitat

#### Historical Conditions

- Arroyo Mocho lost definition and spread out into distributaries
- Groundwater recharge
- Subsurface flow continued to the Pleasanton marsh
- Vegetation dominated by oak and grassland matrix

#### Change Over Time

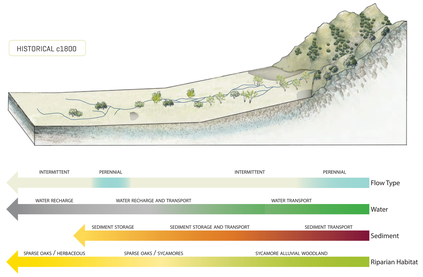
- Channel ditched in late 19th century
- Gravel mining during 20th century
- Encroachment of dense riparian vegetation, including eucalyptus and other non-natives
- Continued subsurface flow and muted expression of distributaries as late as 2005

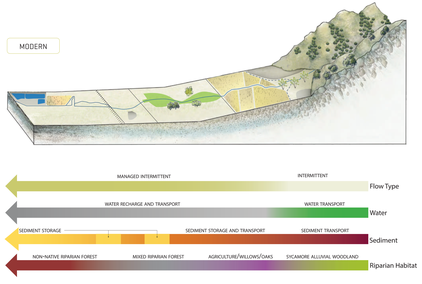
#### Future Potential

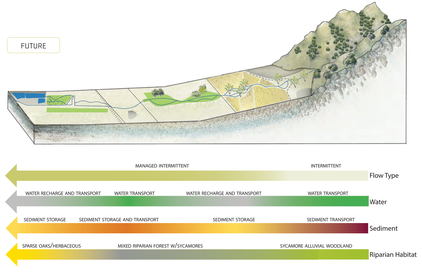
- Reconnect distributaries to channel, providing off-channel habitat and groundwater recharge during high flows
- Could eventually "reclaim" former gravel pits as an upstream expression of the Pleasanton marsh and connect them to the main channel, providing a sediment sink

## CONCEPTUAL MODELS

Past, present, and future conceptual models of Arroyo Mocho. The three oblique views represent conceptual depictions of the stream 1) during the historical period, 2) under present-day conditions, and 3) projected into the future based on potential management strategies identified in the case studies. Below the oblique view graphics are conceptual gradients of key physical and ecological parameters: seasonality of water flow, type of water transport (recharge or transport, or both), sediment dynamics, and state of riparian habitat.




## CONCLUSIONS

This study provides a first step towards developing a landscape-scale strategy for addressing stream management challenges in Livermore-Amador Valley. Although urbanization has irrevocably transformed the Valley and modified many hydrologic processes, key physical controls on landscape functioning, such as sediment supply and topographic gradients, are relatively intact. By harnessing these physical controls to promote watershed functions such as sediment storage, flood control, and wildlife habitat, managers can reduce costs while promoting the long term ecological resilience of the stream network.

The following table summarizes recommended management strategies, and the watershed functions they support, for different reaches of Arroyo Mocho and Arroyo las Positas:

| Stream | Reach | Intervention | Functions |
|---|---|---|---|
| Arroyo Mocho | 1. Southeast | Restore braiding where land is available | Increased sediment deposition and in channel storage, sycamore alluvial woodland |
| | 2. Holmes Street to Madeiros Parkway | Redesign Holmes Street Bridge, reconnect inactive side channels | Increased sediment deposition and in channel storage in parks, decreased sedimentation at Holmes Street Bridge, increased diversity in riparian habitat |
| | 3. Distributaries | Create channels to act as distributaries into gravel pits, reconnect floodplain habitat to channel | Sediment transport into gravel pits at high flows, reconnection of floodplains, re-introduction of native species |
| Arroyo las Positas | 4. Springtown Sink | Preserve remaining vernal pool habitat, implement LID strategies | Important habitat for rare and endangered species, flood attenuation, reduce channel incision |
| | 5. Arroyo las Positas | Preserve remaining vernal pool habitat along Cayetano Creek | Important habitat for rare and endangered species |
| | | Create inset floodplains at strategic locations | Decreased impacts of channel incision (lowering adjacent floodplain), mimic wet meadows, LID functions; flood attenuation |

### REFERENCES

Beechie, T. J., D. A. Sear, et al. (2010). "Process-based principles for restoring river ecosystems." BioScience 60(3): 209-222.

Stanford, B., R. Grossinger, et al. (2013). Alameda Creek Watershed historical ecology study. Richmond, CA, San Francisco Estuary Institute-Aquatic Science Center.

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