

# APPENDIX H: HYDROLOGY, HYDRAULICS AND GEOMORPHOLOGY- OPPORTUNITIES & CONSTRAINTS

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## MEMO

**DATE:** May 24, 2001

**TO:** Lynne Dwyer  
North East Trees

**FROM:** Chip Paulson

**SUBJECT:** POTENTIAL ARROYO SECO WATERSHED RESTORATION  
PROJECTS FROM HYDROLOGY, HYDRAULICS AND  
GEOMORPHOLOGY TEAM

Following is a summary of opportunities, constraints, potential projects, and recommended studies for typical sections of the Arroyo Seco. This summary is based upon the detailed hydrologic, hydraulic, and geomorphologic analysis of existing information presented in our recent technical report entitled: "Arroyo Seco Watershed Restoration Feasibility Study, Phase 1, Technical Report, Hydrology, Hydraulics And Geomorphology Engineering Information And Studies" dated May 21, 2001.

### **Location: Hahamongna Basin**

#### **Opportunities**

- The Hahamongna Basin Master Plan makes recommendations regarding site development and sediment management that are consistent with ASWRFS objectives.
- Devil's Gate Reservoir provides flood flow reduction for the lower Arroyo Seco channel. Future optimizing this benefit would make it easier to implement downstream channel naturalization projects.
- Pasadena would like to develop additional ground water recharge potential in the Basin. This is a primary recharge area for the Raymond Ground Water Basin. There may be opportunities for meeting this objective using an alluvial channel design.
- Habitat protection is required for the Arroyo toad. Habitat requirements are consistent with stream naturalization objectives.
- LACDPW has talked about wanting to investigate the feasibility of a permanent water conservation pool in the Basin. This could provide the ability to manage in-stream flows downstream of the dam during low flow seasons.

#### **Constraints**

- This is the sediment deposition area for all sediment generated by the upper Arroyo Seco watershed. This has always been a highly depositional area with channel instability. Sediment management is currently a difficult problem for Basin managers.
- The usable Basin area is limited by the City of Pasadena ground water recharge basins on the east side, the JPL parking lots on the north side, and the Oak Grove/Hahamongna Watershed Park facilities on the west side.

- The City of Pasadena diversion to the ground water recharge basins is at the inlet to the Basin. For much of the year most of the Arroyo Seco streamflow is diverted to the recharge basins.
- Pasadena is proposing to construct several new recharge basins in the reservoir area, south of the existing basins.

#### **Potential Projects**

- Replace proposed new recharge basins with recharge in the natural channel and floodplain alluvium in the Basin. Design a low flow channel and construct flow spreaders if necessary to distribute base flows and storm runoff over a wide area.
- Perform sediment excavation from the Basin consistent with the recommendations of the Hahamongna Basin Watershed Plan.

#### **Recommended Studies**

- Test the feasibility of recharging the ground water basin with surface flows in the channel through Hahamongna Basin. Requires a detailed monitoring program and cooperation by the City of Pasadena.
- Test the feasibility of developing a permanent water conservation pool in the Basin without impacting flood management benefits. This would enhance ground water recharge and provide unique open water habitat in the Basin.
- A sediment management plan is needed to deal with sediment produced from the upstream watershed.
- Investigate alternative Basin configurations or dam operations to improve the ability of the reservoir to reduce Capital Storm outflows. If outflows could be reduced, all downstream stream naturalization projects would be made more feasible.

#### **Location: Immediately Below Devil's Gate Dam to Start of Existing Concrete Channel**

#### **Opportunities**

- The natural channel in the narrow canyon creates high recreational value.
- Bedrock outcrops reduce erosion potential.

#### **Constraints**

- Access would be difficult for construction equipment.
- Concrete slabs, rubble and other construction debris, mostly from construction of the 210 Freeway, have been dumped in this area.
- Clear-water releases from Devil's Gate Reservoir have high erosion potential.

#### **Potential Projects**

- Implement a stream cleanup program to remove concrete slabs and other debris.
- Implement localized erosion protection projects (e.g., bank regrading and revegetation, channel grade control structures, riprap) as identified by the recommended channel hydraulic study.

#### **Recommended Studies**

- Conduct a detailed hydraulic and geomorphic investigation of channel conditions with respect to erosion potential.

## **Location: Brookside Golf Course (Start of Concrete Channel to Rose Bowl)**

### **Opportunities**

- A relatively broad floodplain area is available (especially compared to other parts of the Arroyo Seco corridor) with few buildings or other infrastructure interferences. Sinuosity could be incorporated into a reconstructed channel alignment.
- Access for constructing channel modifications is easy.
- A naturalized channel would improve aesthetics of the public country club.
- Allowing overflows into floodplain storage would reduce downstream peak discharges. This reach has the highest potential for floodplain storage benefits of any reach in the study area.
- The City of Pasadena Central Arroyo Master Plan recognizes the community's desire to pursue opportunities for stream restoration in this area.

### **Constraints**

- Creating a new channel alignment would require revisions to the golf course layout.
- Creating an active floodplain incorporating portions of the golf course facilities would require additional maintenance of golf areas. Capital Storm overflow velocities would approach 10 ft/sec, which would damage turf. Country club buildings (e.g., club house, maintenance buildings) would be in a flood hazard area.
- The Washington Blvd bridge does not necessarily need to remain in its present location, but the bridge would have to be relocated if the channel alignment is shifted in order to provide access to the country club.
- The Central Arroyo Master Plan, while advocating natural stream courses where feasible, states a preference for a covered channel with a low flow stream through the golf course. This could make the concept of a naturally functioning channel and floodplain system more difficult to promote.

### **Potential Projects**

- Remove the concrete lined channel, and replace it with a naturally functioning channel having 2-year capacity in a low flow channel and 10-year capacity in a main channel. The main channel should have a slope of about 0.006 ft/ft to keep velocities close to non-erosive levels (about 5 ft/sec). This would require use of numerous grade control structures in the main channel (as many as 10 1-ft drops for every 1,000 feet of channel length). These would be designed to aesthetically blend in with the golf course.
- Develop a new channel alignment incorporating additional sinuosity. This would reduce (but not eliminate) the need for in-channel grade control structures.
- If necessary based on further hydraulic analyses, design floodplain grade control structures to keep overflow velocities from eroding turf areas. These would primarily be buried and would be incorporated into the golf course re-landscaping.
- Flood-proof country club buildings in the new floodplain. This could be accomplished by use of landscaped berms, low flood walls, or other methods.

### **Recommended Studies**

- Conduct a detailed hydraulic analysis of the modified channel and floodplain.
- Conduct a detailed geomorphic analysis to determine an appropriate combination of channel sinuosity and channel geometry.

- Retain a golf course landscape architect to develop alternate golf course layouts that would be consistent with a more sinuous channel alignment and periodic flooding during severe events.

### **Location: Rose Bowl Area**

#### **Opportunities**

- The channel through this reach is bordered by parking lots and other open space without buildings (except, of course, the Rose Bowl itself).
- The Central Arroyo Master Plan recognizes the community's desire to pursue opportunities for stream restoration in this area.

#### **Constraints**

- The Rose Bowl stadium is close to the channel and is considered a permanent feature of the stream corridor.
- Rose Bowl area parking is at a premium during large events, so any parking areas removed by the project would have to be replaced elsewhere. This includes turf areas frequently used for parking during large events. Parking was a contentious issue in development of the Central Arroyo Master Plan.
- Brookside Park, south of Seco Street, contains ballfields, tennis courts, pools, and other developed recreation facilities that are in the geologic floodplain.
- The Seco Street bridge must remain, although it could be shifted left or right from its current position.
- The Rosemont Pavilion will remain until at least 2017, so must be protected from flooding.
- The Central Arroyo Master Plan states a preference for a covered channel through the parking lots. This could make more natural solutions more difficult to promote.

#### **Potential Projects**

- Remove the existing concrete channel and replace it with an unlined channel having 10-year capacity. Utilize drop structures as necessary to reduce slopes and velocities to non-erosive levels.
- Provide flood-proofing (e.g., a landscaped berm) for Rose Bowl Stadium.
- Re-grade parking lots adjacent to the channel as a series of terraces that are lower than the current elevation of the parking lots. The terraced parking area should be capable of conveying the difference between the 10-year discharge (which would be carried in the channel) and the Capital Storm discharge.
- Consider constructing a parking structure to replace the stream-side parking spaces and reduce the overflow parking that must currently be accommodated on turf areas.

#### **Recommended Studies**

- Conduct a detailed hydraulic analysis of the modified channel and floodplain.

### **Location: Holly Street to Colorado Boulevard**

#### **Opportunities**

- This section is currently in a natural condition, with heavy vegetation and little evidence of channel erosion.
- A historical grade control structure at the downstream end of the reach stabilizes the main channel grade.
- The narrow canyon and the grade control structure apparently force ground water to the surface, creating sustained surface flows downstream and making it possible to divert flows into the BFI created wetlands project.

#### **Constraints**

- The narrow canyon contains only a small floodplain area.
- This reach contains three bridges (Holly Street, Ventura Freeway and Colorado Blvd), although the bridge decks are high above the flow area so the only obstruction is created by the piers.
- Access for construction equipment would be difficult.

#### **Potential Projects**

- None

#### **Recommended Studies**

- Monitor changes in channel geometry and sediment transport in this reach as upstream and downstream channel naturalization projects are implemented. This would assure that this reach remains stable, and would provide useful information for design of channel naturalization projects in other reaches.
- Conduct a detailed hydraulic analysis of the channel and floodplain.

### **Location: Lower Arroyo Park (Colorado Blvd to San Rafael Ave/Laguna Rd)**

#### **Opportunities**

- The area is a series of open space parks and low-intensity recreation areas that could co-exist with a floodplain.
- The BFI constructed wetland is in the upstream portion of this reach. The wetland has demonstrated, among other things, that healthy riparian vegetation can be sustained along the Arroyo Seco corridor when a dependable water supply is available.
- The BFI wetland must be sustained by diversions from the main channel. If the ground water table were raised sufficiently, many of the native plants could be able to survive without the streamflow diversion.
- Allowing for floodplain overflows and floodplain storage could reduce downstream peak discharges.
- Naturalizing this reach would tie in well with the upstream unimproved channel section.

#### **Constraints**

- Creating a functioning floodplain at the BFI wetland could damage the water delivery infrastructure currently needed to support the existing vegetation.
- The open space park has some recreation facilities that could be damaged by periodic channel overflows.

- The La Loma Street bridge crosses the channel in the middle of this reach, although the bridge deck is high above the floodplain elevation.
- Much of the potential floodplain between La Loma Street and San Rafael Avenue is very narrow, with little potential for significantly increasing the channel length by increasing sinuosity.
- The Busch Gardens residential area is located at the downstream end of this reach. This high-end residential area would be in the floodplain if the concrete channel were removed.

#### **Potential Projects**

- Remove the concrete channel and create a naturally functioning channel and floodplain system. Design a low flow channel with 2-year capacity and a main channel with 10-year capacity. Higher flows would overflow to the floodplain.
- Raise the channel invert as high as possible consistent with the capacity objectives in order to maintain the ground water table as high as possible.
- Create a new channel alignment that meanders across the floodplain between the two canyon walls.
- This section of channel was probably originally concrete lined by LACDPW because of historic or potential erosion problems. Design aesthetic grade control structures for the main channel as necessary based on the results of the proposed hydraulic model. It is possible that buried grade control structures will be required across the entire floodplain to prevent excessive floodplain erosion during severe flood events.
- In the long-term, acquire the Busch Gardens residential parcels that are in the Capital Storm floodplain. In the short-term, provide a levee, flood wall or other flood-proofing measures to protect existing homes from Capital Storm flood damage after the channel naturalization project is implemented.

#### **Recommended Studies**

- Conduct a detailed hydraulic and geomorphic analysis of the channel and floodplain.
- Identify exactly which Busch Gardens parcels would be at risk from Capital Storm flooding if the channel were naturalized, and perform an appraisal for future acquisition.
- Determine existing ground water levels and estimate the increase in ground water levels that could be achieved with a naturalized channel.
- If necessary, redesign the BFI wetland irrigation system to resist damage during flood overflows.

#### **Location: San Rafael Ave to Pasadena Freeway**

##### **Opportunities**

- The geologic floodplain consists primarily of a equestrian complex (stables) and ballfields.
- Downstream of San Pasqual Ave the existing channel is an older section that consists of a concrete bottom and cobble side slopes. This section has maintenance problems and needs to be upgraded.

##### **Constraints**

- There are a number of residential structures in the geologic floodplain at San Pasqual Ave.
- In addition to the bridges at each end of the reach, the San Pasqual Ave bridge is located in the middle of the reach.
- The stables are an important recreation asset in the study area and should probably not be removed. Equestrian structures (barns, etc.) are immediately adjacent to the existing channel. (*Note – is it feasible to consider relocating them to another part of the Arroyo Seco corridor?*)
- The ballfields are City of South Pasadena facilities and are important city amenities.
- Flood overflows into the stable area could create water quality problems downstream.

#### **Potential Projects**

- Remove the existing concrete channel and create a natural channel with 50-year capacity (note – not Capital Storm capacity). Overflows for floods greater than 50-year would be allowed in the equestrian area and South Pasadena park.
- Provide flood-proofing for stable facilities, or perhaps reconstruct buildings at the edge of the floodplain rather than on the channel bank.
- Flood-proof any at-risk structures in the South Pasadena park.
- In the long-term, acquire any residential parcels in the Capital Storm floodplain and remove the structures. In the short-term, provide flood-proofing for these parcels when the channel naturalization project is implemented.

#### **Recommended Studies**

- Conduct a detailed hydraulic and geomorphic analysis of the channel and floodplain.
- Conduct a water quality evaluation to determine whether overflows into the stable area with an average frequency of once in 50 years would contribute to significant downstream water quality problems.
- Based on the results of the detailed hydraulic modeling, determine which existing structures would be in the Capital Storm floodplain if a 50-year natural channel were constructed.

### **Location: Pasadena Freeway to Pasadena Avenue**

#### **Opportunities**

- The east floodplain area consists of the South Pasadena golf course that could be flooded periodically.
- The west floodplain has a small undeveloped area that could accept flood overflows periodically.

#### **Constraints**

- The golf course area includes country club buildings that are adjacent to the channel bank.
- The west floodplain is constrained by the Pasadena Freeway (Historic Arroyo Seco Parkway), which must be protected from flooding.
- The east floodplain is constrained by a railroad line that must be protected from flooding.
- The bridges at each of the reach boundaries are permanent.

### **Potential Projects**

- Remove the existing concrete channel and create a natural channel with 50-year capacity (note – not Capital Storm capacity). Overflows for floods greater than 50-year would be allowed in the golf course and open area.
- Either flood-proof or relocate the country club buildings that are adjacent to the existing channel.

### **Recommended Studies**

- Conduct a detailed hydraulic and geomorphic analysis of the channel and floodplain. Assure that the freeway and railroad are not flooded during the Capital Storm.

### **Location: Pasadena Avenue to Hermon Avenue**

#### **Opportunities**

- Stables and associated open space are located on the east bank immediately downstream from Pasadena Avenue.
- A paved bikeway has been constructed on the east side of the concrete channel bottom.
- There is a small strip of open space available on both sides of the channel between Avenue 60 and Hermon Avenue.
- Much of the reach has less than Capital Storm capacity, and some sections have less than 100-year capacity. Therefore, some form of improvement will be required by LACDPW.

#### **Constraints**

- The reach contains six permanent bridges (including those at each end of the reach).
- The Pasadena Freeway is on the west channel bank for the entire reach.
- The alignment is fully constrained between Avenue 64 and Avenue 60.

#### **Potential Projects**

- Remove the concrete channel bottom and create a soft bottom channel. Keep the concrete channel side walls. Construct grade control features to reduce channel slope and flow velocity.
- Allow overflows into open areas; if necessary construct flood walls or other features to protect the freeway.

#### **Recommended Studies**

- Conduct a detailed hydraulic and geomorphic analysis of the channel and floodplain.
- Coordinate with recreation planners to determine if the existing paved bikeway should be left intact or replaced elsewhere in the corridor.

### **Location: Hermon Avenue to Arroyo Seco Recreation Center**

#### **Opportunities**

- The Arroyo Seco Recreation Area has ballfields and open space that could act as a floodplain.
- There is a paved bikeway on the concrete channel bottom.

**Constraints**

- This section is very confined by the Pasadena Freeway on the west and a hillside on the east.
- The reach contains one permanent road bridge and one footbridge.

**Potential Projects**

- It may be possible to remove the concrete bottom and create a soft bottom channel, keeping the concrete side walls. Construct grade control features to reduce channel slope and flow velocity.
- As an alternate, create a separate natural low flow channel over a buried flood facility (e.g., large buried concrete box structure).
- If not possible everywhere, create a soft bottom channel adjacent to Arroyo Seco Recreation Area.

**Recommended Studies**

- Conduct a detailed hydraulic and geomorphic analysis of the channel and floodplain.

**Location: Arroyo Seco Recreation Center to Pasadena Avenue****Opportunities**

- NET has a nursery on the east bank upstream of Pasadena Avenue.

**Constraints**

- The alignment is very constrained by the Pasadena Freeway and residential development, including Heritage Square.

**Potential Projects**

- Lower the channel invert and construct a soft bottom channel with concrete sides. In some areas of limited right-of-way this may have to be a rectangular cross section. Construct grade control features to reduce channel slope and flow velocity.
- As an alternate, create a separate natural low flow channel over a buried flood facility (e.g., large buried concrete box structure).

**Recommended Studies**

- Conduct a detailed hydraulic and geomorphic analysis of the channel and floodplain.

**Location: Pasadena Avenue to Los Angeles River****Opportunities**

- A multi-agency consortium is planning a park at the Arroyo Seco – Los Angeles River confluence.
- Open space is available within parts of the Caltrans right-of-way for the Pasadena Freeway – Golden State Freeway interchange.
- There is some undeveloped area in the industrial zone on the east bank downstream of Pasadena Avenue.

**Constraints**

- The reach contains six permanent bridge crossings.

- The alignment is very constrained by the Pasadena Freeway and industrial development.
- Projects requiring more right-of-way will require cooperation from Caltrans.

#### **Potential Projects**

- Lower the channel invert and construct a soft bottom channel with concrete sides. Widen the existing section where possible. Construct grade control features to reduce channel slope and flow velocity.
- As an alternate, create a separate natural low flow channel over a buried flood facility (e.g., large buried concrete box structure).
- Integrate naturalized channel features at the downstream end with the proposed Confluence Park.

#### **Recommended Studies**

- Conduct a detailed hydraulic and geomorphic analysis of the channel and floodplain.
- Cooperate with planning for Confluence Park.

## **POTENTIAL DEMONSTRATION PROJECTS**

1. Channel and floodplain naturalization in Lower Arroyo Park between BFI wetlands and La Loma Street bridge. Remove concrete channel, develop as much channel sinuosity as possible, create a 2-yr low flow channel and a 10-yr main channel. Design aesthetic channel and floodplain grade control structures.
2. Channel and floodplain naturalization in Lower Arroyo Park in the BFI wetlands section. Same design as #1. Integrate with natural area beneath Colorado Blvd bridge.
3. Redesign a terraced parking lot for the most downstream Rose Bowl parking area.
4. Develop a channel system through Hahamongna Basin that maximizes ground water recharge potential. Construct a portion of it and monitor performance to determine if this is a feasible alternative to constructing more recharge ponds.
5. Identify specific demonstration projects for BMPs to reduce runoff from the urban watershed.