MEMO

To: Jane Tsong, WCA

From: Anne Senter, PhD and Scott Brown, P.G.

Date: April 30, 2021

Subject: Existing Conditions and Restoration Opportunities in the San Gabriel River and Azusa Floodplain

Introduction

The Watershed Conservation Authority (WCA) has asked Balance Hydrologics (Balance) for assistance in assessing potential restoration opportunities in the San Gabriel River Canyon below Morris Dam and along the Azusa floodplain (Figure 1). A general understanding of potential restoration opportunities in a major regional river that has important water supply, habitat, and recreational benefits, may inform prioritization of parcels for conservation acquisition. Parcels that have more potential to contribute to water supply, water quality, habitat, and/or recreational benefits may be considered to be especially high priority for public acquisition.

This memorandum summarizes a reconnaissance-level field site investigation intended to identify restoration opportunities for WCA in the San Gabriel River/Azusa Floodplain area. The opportunities discussed below focus on geomorphic and hydrologic aspects of restoration in the identified channels and watersheds, and would be complementary to biological studies that consider riparian vegetation and aquatic species restoration opportunities. This memorandum briefly discusses generalized constraints in the area, followed by notable existing conditions and restoration opportunities at each site. Figures 1-14 illustrate existing conditions and several restoration opportunities. A brief conclusion lists a suite of studies that would be recommended to support future restoration efforts at these sites.

Generalized Constraints

Constraints present in the area are mostly organized by how mountain watersheds are managed to reduce risks to downstream development, and more recently, to promote groundwater recharge.

The natural flow regime and sediment supply from the upper San Gabriel River watershed are restricted by Morris Dam and San Gabriel Dam (Figure 1). Under more natural conditions, fish and other aquatic organisms would seek out fresh water refugia high within the watershed during the dry season. Under current conditions, the upper watershed is blocked, and freshwater releases are controlled by dam operations. Characterization of dam operations and required flow releases from Morris Dam, if any, is a current data gap that will need to be resolved during future studies. Most flows released from Morris Dam during low flow conditions are diverted to spreading grounds for percolation into the underlying groundwater aquifer just upstream of the confluence of Robert's Canyon with the mainstem river.

Downstream of the San Gabriel River meander bend, a series of grade control structures stretch across the channel to prevent downcutting (see Figure 14). The structures present barriers at a smaller scale than the dams, but which still moderate flow and sediment transport and present insurmountable fish passage barriers except under higher flow conditions. A thorough hydrology and hydraulics study would be needed to better understand how these structures control flow patterns. In addition, Santa Fe Dam is another barrier a few miles downstream. The river, the tributaries, and the fish and other aquatic species that depend on flow and habitat are in essence "trapped" between Morris Dam and Santa Fe Dam under current conditions.

The tributary watersheds of Van Tassell Canyon, Fish Canyon and Robert's Creek are somewhat less impacted than the San Gabriel River itself. Restrictions include disconnection of the tributary alluvial fans and flowpaths from the mainstem river, encroachment of infrastructure (housing, roads, levees, culverts) in the lower portions of the tributaries. However, once upstream in designated protected areas, channels and hillslopes generally exhibit natural geomorphic processes and conditions, even when local to development and under the pressures of increasing climate variability.

Existing Conditions and Restoration Opportunities

Balance staff member Anne Senter joined two WCA staff members for a field site visit on Wednesday, April 14, 2021. The team visited the San Gabriel River meander bend (Figure 2), Robert's Creek and Van Tassell Canyon. Fish Canyon was reviewed via aerial imagery as time did not allow for an on-the-ground visit to this watershed.

<u>San Gabriel River Meander Bend</u>

Existing Conditions

- The channel/floodplain interface between the river and the floodplain bars is disconnected where the Equestrian Center and the Buddhist Center are located (Figure 3) due to channel downcutting in the decades following upstream damming.
- Dams dampen the highest flood flows and tend to extend the lowest flows into seasons where the channel might have been historically dry. Flooding is possible at very high flows along all bars in the meander bend, as indicated by FEMA flood mapping (Figure 4).
    - High flow dampening results in less frequent flooding of the bars, loss of flood attenuation by flow no longer being able to spread out on the bars, and less sediment deposition and renewal processes during flood events, while at the same time damming cuts off the upstream sediment supply.
    - Extended lower flows tend to winnow-out moderately-sized sediments from reaches downstream of dams, and the dam blocks the flow of sediment that would normally replenish these materials.
    - Damming tends to result in channel downcutting in reaches below-dam, leaving silt and large clasts but few in-between sediment sizes, as was observed in the San Gabriel River meander bend reaches.

Restoration Possibilities

- Implementation of a gravel augmentation program on the undeveloped floodplain bar upstream of the Equestrian Center and across from the Buddhist Center could be used to reinvigorate sediment transport processes and supply a portion of the sediment that continues to be captured by upstream dams. This supply could be positioned to activate at a range of dam release flows.
- Gravels that are periodically removed from behind Morris Dam and San Gabriel Dam would be an ideal sediment supply source, though gravels from other sources could also be candidate materials.
- The undeveloped floodplain bar appears to have a relatively stable bar surface due to regulation of dam outflow releases as described above. The bar surface could be broken up and a higher-flow channel could be constructed to activate the bar surface more readily.
    - This action could be constructed to modestly redirect higher flood flows away from the Buddhist Center on the opposite bar.
- Gravel augmentation in the channel itself would provide an immediate upgrade to habitat for aquatic species. It is evident that the riverbed is largely comprised of cobble to boulder clast sizes coated with a layer of silty sediments, and that the riverbed lacks gravel-sized sediments that are key geomorphic components to healthy habitat for fish and other aquatic species (Figure 5 and 6).
- The floodplain bar that is currently occupied by the Equestrian Center could have its ground surfaces lowered to reactive channel-floodplain processes. Creation of a channel and backwater areas on the bar that would activate during higher flows would provide aquatic refugia and off-channel habitat areas.
- There are numerous gravel augmentation, channel creation, and anadromous fish habitat programs in California that could provide guidance to restoration efforts in the San Gabriel River meander bend. Examples include:
    - Hilton Creek (Santa Ynez River, the reservoir supplies flow for steelhead habitat)
    - Trinity River (Northern CA, gravel augmentation downstream of the dam)
    - Mokelumne River (Central CA, gravel augmentation and off-channel habitat for Chinook salmon downstream of the dam)
    - Merced River (Central CA, gravel augmentation between dams)
    - Dry Creek (Russian River, off-channel habitat)
    - Stevens Creek (San Francisco Bay tributary, off-channel habitat for steelhead)
- Coldwater Springs (Figure 7) delivers a source of additional water to the river channel just west of San Gabriel Canyon Road (Figure 8), and includes a pond that currently provides cool, deep, off-channel habitat for aquatic species.
    - As we understand it, however, this is not a natural spring with a near-permanent water supply from groundwater upwelling. Instead, if Morris Dam flows cease during extended dry or drought conditions, this water supply is also cut off, so designation of this area as refugia may be limited.
    - Moreover, outflow to the river passes through a buried culvert (approximately 20 feet long under an access road), which is a likely fish passage barrier in its current condition.

- Nevertheless, flow from the springs to the pond could be managed such that ponded water could persist through an extended dry period and provide a dry season refugia.

Robert's Creek

Current Conditions

- The creek reach that runs through the Mountain Cove residential development is a straight channel with trapezoidal cross-sectional geometry that was most likely built to contain an estimated 100-year flood event from the upper watershed (a typical configuration for creeks that flow through developments).
- The riparian corridor (trees and other vegetation species that need a consistent water source and tend to form a corridor along a watercourse) in the Mountain Cove reach was relatively robust in the upstream direction and appeared to provide some shade (Figure 9), whereas most vegetation was smaller and set-back from the channel in the downstream direction.
    - Discussions indicated that a vegetation management program likely limits the spread and growth potential of in-channel vegetation.
- The channel bed, through Mountain Cove and upstream as far as was walked by foot during our field visit (roughly 0.4 miles upstream of the development), was filled with silty- to sandy-sized sediment typical of cyclical recent post-fire fire-flood-sedimentation conditions.
    - In the Mountain Cove reach, channel bed structure was not evident under the sedimentation from post-fire erosion from the 2020 Ranch 2 Fire.
    - In the upstream reaches, the channel showed signs of downcutting through the fine post-fire sediments, and a return to toward an equilibrium condition where gravels and cobbles predominate on the channel bed (Figure 10).
    - The riparian corridor upstream of the development was partially burned but appeared to be mostly intact and recovering from the recent fire.
- The substrate composition of the upstream reach, as far as was walked, appeared to be healthy mix of mostly alluvial sands, gravels and cobbles with some sediments originating from the hillslopes (especially post-fire) and relatively frequent bedrock outcropping.
    - Upstream reconnaissance extended to a point where an off-channel refugia area was identified (Figure 10, upper left-hand corner). Given the size of the watershed and its tributaries, such features may be relatively common but would need to be verified.

Restoration Possibilities

- Episodic conditions, such as post-fire erosion and sedimentation as observed in this watershed, are generally short-term events that tend to mostly flush out of the system during wet seasons in the years following fire.
- Restoring the Mountain Cove reach to a condition that could support fish movement into and out of the watershed would be beneficial for existing or reintroduced fish species and provide the opportunity for fish and other aquatic species to potentially populate the watershed and/or use the creek as refugia during high flow events in the river.

    - The size of Robert's Creek watershed is similar to that of adjacent Fish Canyon watershed to the northeast (see Figure 1). The name "Fish Canyon", similar watershed sizes, and adjacent locations suggests that fish were probably historically present in the Robert's Creek watershed as well as Fish Canyon.
    - The Mountain Cove reach should be monitored (which could be as minimal as a couple/few site visits during the rainy season to visually assess conditions) over the next rainy season or two to assess whether channel bed structure seen in the upstream reach is also present but currently buried in the Mountain Cove reach.
    - If the Mountain Cove reach does not have appropriate channel bed structure elements needed for fish movement and passage, further study would be needed to develop restoration concepts.
- The primary restoration concept for the Mountain Cove reach would likely be the addition of pool-riffle structures to the channel bed.
    - The width of the reach may be enough to improve sinuosity and reduce slope, which can be advantageous to fish moving through the reach.
    - Pools would provide deeper locations that hold water longer, and that allow fish and other aquatic species to rest and seek refuge.
    - Riffles would provide shallower locations where water is oxygenated, and bugs are plentiful.
- Restoration concepts in the Mountain Cove reach would include the confluence of Robert's Creek with the San Gabriel River.
    - The confluence should be assessed to understand under what flow conditions fish in the San Gabriel River could access Robert's Creek and whether adjustments should be made to allow for greater accessibility for fish.
- The management plan for the riparian corridor in the Mountain Cove reach should be revisited and potentially adjusted to provide for more growth to achieve mature vegetative cover, assuming groundwater conditions would permit, which would improve the overall quality of habitat through this reach.
- The watershed upstream of the Mountain Cove reach appeared to be recovering from post-fire sedimentation and not in need of active management or restoration efforts from a geomorphic processes perspective.
    - A more extensive reconnaissance effort would be needed to better characterize the watershed, and to identify fresh water refugia and fish passage barriers if and where present.

<u>Van Tassell Canyon</u>

Current Conditions

- Van Tassell Canyon is blocked from flowing freely into the San Gabriel River by Fish Canyon Road, fencing, and a temporary levee of sediment deliberately piled on both sides of the road. These factors create barriers perpendicular to flow and prevent the creek from naturally flowing to the river.
    - The one culvert under the road is obstructed by sedimentation.
    - Van Tassell Canyon upstream of the road is leveed along the southwestern side to the toe of the first hillslope but appears to retain its historical configuration along the northeastern side.

- The channel bed from Fish Canyon Road to the Van Tassell Mtway Trail (Figure 11) contained angular, gravel-sized sediment with little channel structure. The road, fencing and temporary levees act as a sediment transport barrier, so what should be a sloping alluvial fan to the river appears to be choked with sediment at this time. More investigation into what the historical condition and, presumably, a more-natural state of the alluvial fan, is needed to better understand this area.
    - The watershed was completed burned in the 2016 Fish Fire; the angularity of the channel bed sediments suggests large quantities of rock were eroded from the burned hillslopes and transported into the channel corridor post-fire.
- The channel bed upstream of where the Van Tassell Mtway Trail crosses the creek contained ample angular sediment, but also exhibited channel structure that was likely to be structurally-diverse enough for upstream and downstream fish movement (Figure 12).
    - Further upstream, channel bed composition included more bedrock, boulders, ground vegetation and gravelly soil.
- Observations during reconnaissance were made along roughly 0.6 miles of the mainstem upstream of the trail (Figure 13). The channel was contained within a relatively narrow corridor bounded by steep bedrock hillslopes, and exhibited moist channel bed conditions and abundant vegetation on the nearby hillslopes (although few woody-stemmed riparian species).
    - Reconnaissance was turned around at a waterfall approximately 6-10 feet in height with just enough water to wet the boulder surface (Figure 13, lower right corner). The waterfall is very likely a fish passage barrier under almost all circumstances.
- Returning downstream, we found one small pool of water (Figure 13, lower left corner) with trickling flow. In addition, water appeared to be seeping from a few locations along the right bank (when looking downstream), indicating groundwater expression from local bedrock aquifers. Finally, the confluence of the largest tributary to the west (the trail traverses its ridge) was also wet. Additional reconnaissance would be needed to investigate whether fresh water refugia might be available to fish in this tributary throughout the dry season.
- Review of the confluence of Van Tassell with the San Gabriel River was attempted by walking along the local earthen grade control structure to where the concrete grade control structure begins (Figure 14), but no clear confluence was found. Upon review, aerial imagery shows that Van Tassell turns south and empties into the San Gabriel River at the next-downstream grade control (Figure 14, right).
- A brief review of Google Earth imagery from pre-fire 2016 to present yielded the following observations:
    - October 18, 2016 image shows an expanse of relatively mature vegetation in the floodplain upstream and downstream of Fish Canyon Road. The image also reveals work along the southwestern levee in the channel to clear vegetation, which is a typical management activity in anticipation of flooding and/or the fire-flood-sedimentation cycle.
    - March 16, 2017 image (also see Figure 14) shows burned hillslopes and a distinct change in the amount of sediment (much more) and vegetation (much less) in the floodplain upstream of Fish Canyon Road. This image also reveals a series of

concrete k-bars placed along the upstream side of the road to direct sediment and flow over the road.
    - The May 2, 2019 image is the best recent image that shows vegetation is beginning to in-fill areas on both sides of the road that were previously scoured clear by post-fire flooding and heavy sediment loads.

Restoration Possibilities

- Van Tassell Canyon downstream of Van Tassell Mtway Trail to Fish Canyon Road appears to have accumulated excess sediment from post-fire erosion following the 2016 Fish Fire and management actions taken to direct and/or slow sediment transporting out of the watershed into the San Gabriel River.
- The primary restoration concept for Van Tassell would be to restore physical linkages between the canyon and the river to promote fish passage and sediment transport processes.
    - Supporting fish movement into and out of the watershed would be beneficial for existing or reintroduced fish species and provide the opportunity for fish and other aquatic species to potentially populate the watershed and/or use the floodplain as refugia during high flow events in the river.
    - A best-case restoration scenario would be to replace the surface road with a freespan bridge across the lower Van Tassell Canyon floodplain.
    - A more practical restoration scenario would be to install new (additional or larger) culverts under the road to allow for more connectivity than under current conditions.
        - Renewed connectivity would provide a sediment supply to the river that is currently disconnected to a large degree.
        - Properly-sized "bottomless" culverts could be installed, which allows for a natural channel bed amenable to fish passage. More study would be needed to understand the sediment cycle and to ensure appropriate sizing.
- The watershed upstream of Van Tassell Mtway Trail appeared to be recovering from post-fire sedimentation and not in need of active management or restoration efforts from a geomorphic processes perspective.
    - However, most riparian trees were burned, so the feasibility of developing a restoration planting plan could be investigated.
    - In addition, a more extensive reconnaissance effort could be used to verify whether fresh water refugia areas are available to fish in the tributary reaches of the watershed.

<u>Fish Canyon</u>

Current Conditions

- We were not able to visit Fish Canyon during our field reconnaissance day due to time limitations.
- A review of recent Google Earth imagery yielded the following observations:
    - A mining operation (Vulcan Materials) has been operating since at least 1984 (oldest Google Earth image) along the lower canyon extent for approximately 0.7-mile before the creek confluences with the San Gabriel River.

- In the September 25, 2020 image, the channel is surrounded by road and denuded hillslopes. The channel itself is buried for approximately 500 feet through the middle of the 0.7-mile section so that trucks can move between the eastern and western hillslopes that appear to be under active mining.
    - The channel upstream of the buried section ranges in width from about 85 to 125 feet and appears to support a modest riparian corridor.
    - The channel downstream of the buried section ranges in width from about 60 to 85 feet. It appears to support some vegetation but less than the upstream section.
    - The channel must pass under Fish Canyon Road before reaching the river. There appear to be two large concrete culvert pipes laying on the channel bed that are not properly installed, but much is unknown about these structures since this review was limited to aerial imagery.

Restoration Possibilities

- The watershed was most likely named "Fish Canyon" because fish were historically present in the system. Therefore, restoring the channel to a condition that would support fish movement into and out of the watershed would be beneficial for existing or reintroduced fish species.
    - A reconnaissance site visit would be needed to reasonably identify restoration concepts for this watershed.
- At a simplified level, from what we have learned during discussions and can interpret from Google Earth imagery, the mining operations are likely a constant source of disruption to the channel from heightened noise, dust and air pollution levels, channel burial, culverting, and possibly from loose hillslope sediment transporting into the channel.
    - A best-case restoration scenario would be removal of all mining operations from the area and restoration of the channel and hillslopes to more natural conditions.
    - A more practical restoration scenario may include expanding channel corridor width to provide a larger buffer, removing road coverings from the channel and either installing bridges for truck traffic or changing operations so trucks could cross the creek on Fish Canyon Road, removing debris in the channel, installing an appropriate culvert under Fish Canyon Road to restore access from the river into the watershed for fish, restoring a riparian corridor throughout the mining area, and ensuring appropriate geomorphic structure in the channel bed to promote fish passage.

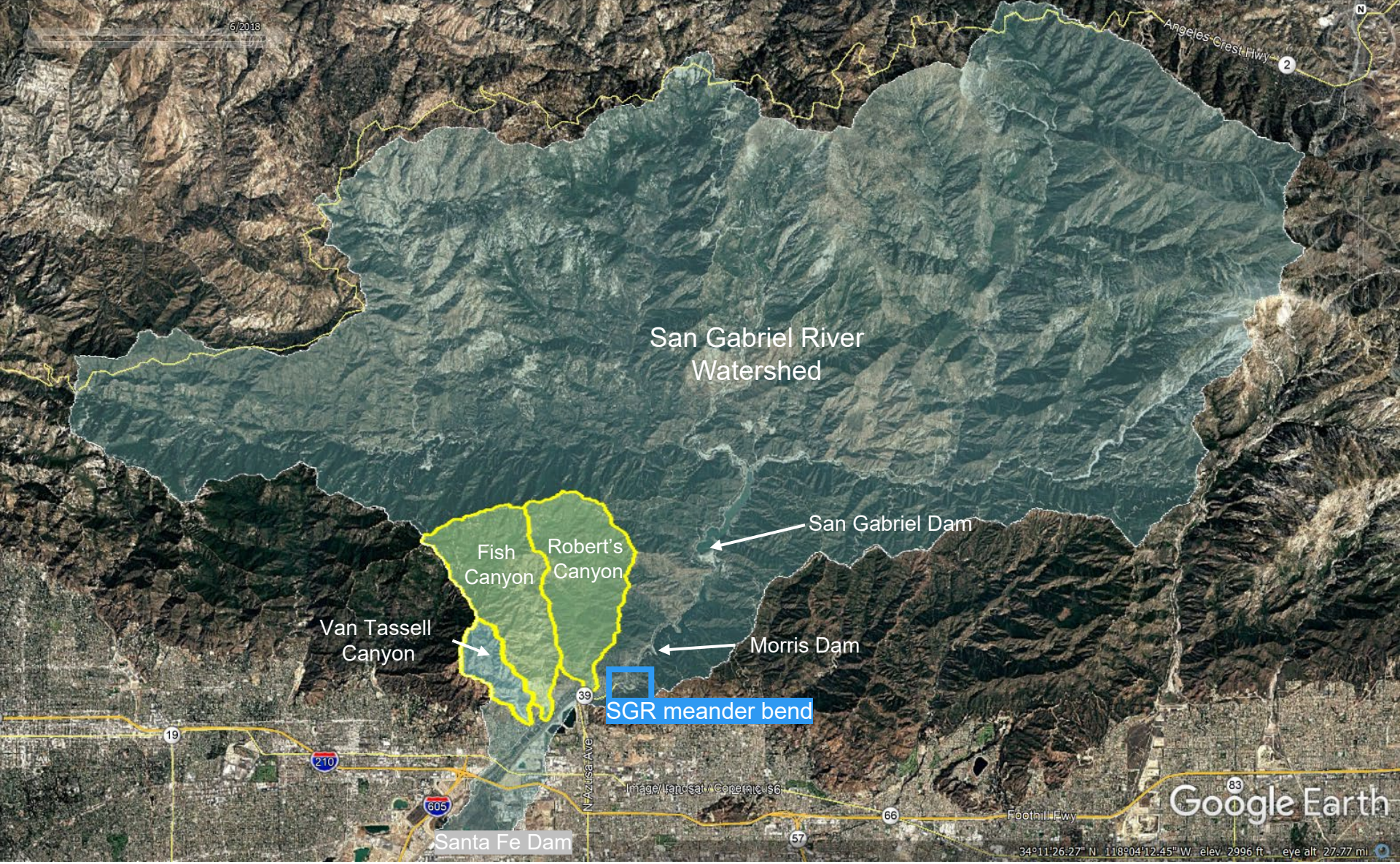
Future Steps

Specific geomorphic and hydrologic restoration concepts, either in the San Gabriel River meander bend area or in one of the watersheds as discussed above, should be assessed more thoroughly via additional studies at an appropriate time. Such efforts would involve collection of data, investigation of processes local to the specified restoration area, and assessment of the feasibility of concepts.

An initial phase "feasibility study" would include a geomorphic investigation, hydrologic analyses of flow conditions, sediment supply studies, and hydraulic modeling of existing

conditions and potential proposed conditions. These studies would be used to assess concept feasibility and support further development of restoration concepts (as outlined above and which could include other ideas as studies proceed). A typical outcome for a feasibility study would be to select a set of preferred restoration elements with the appropriate stakeholders that are supported by the above investigations. Restoration concepts amenable to stakeholders would be carried forward through additional design phases and would ultimately result in implementation of construction and/or management actions to enhance geomorphic processes and aquatic habitat in these watersheds.

Given the limited nature of the reconnaissance efforts, this memorandum should not be considered a comprehensive summary of existing site-specific or watershed-scale conditions, or of the possible range in restoration opportunities or constraints that may apply at local or regional scales.

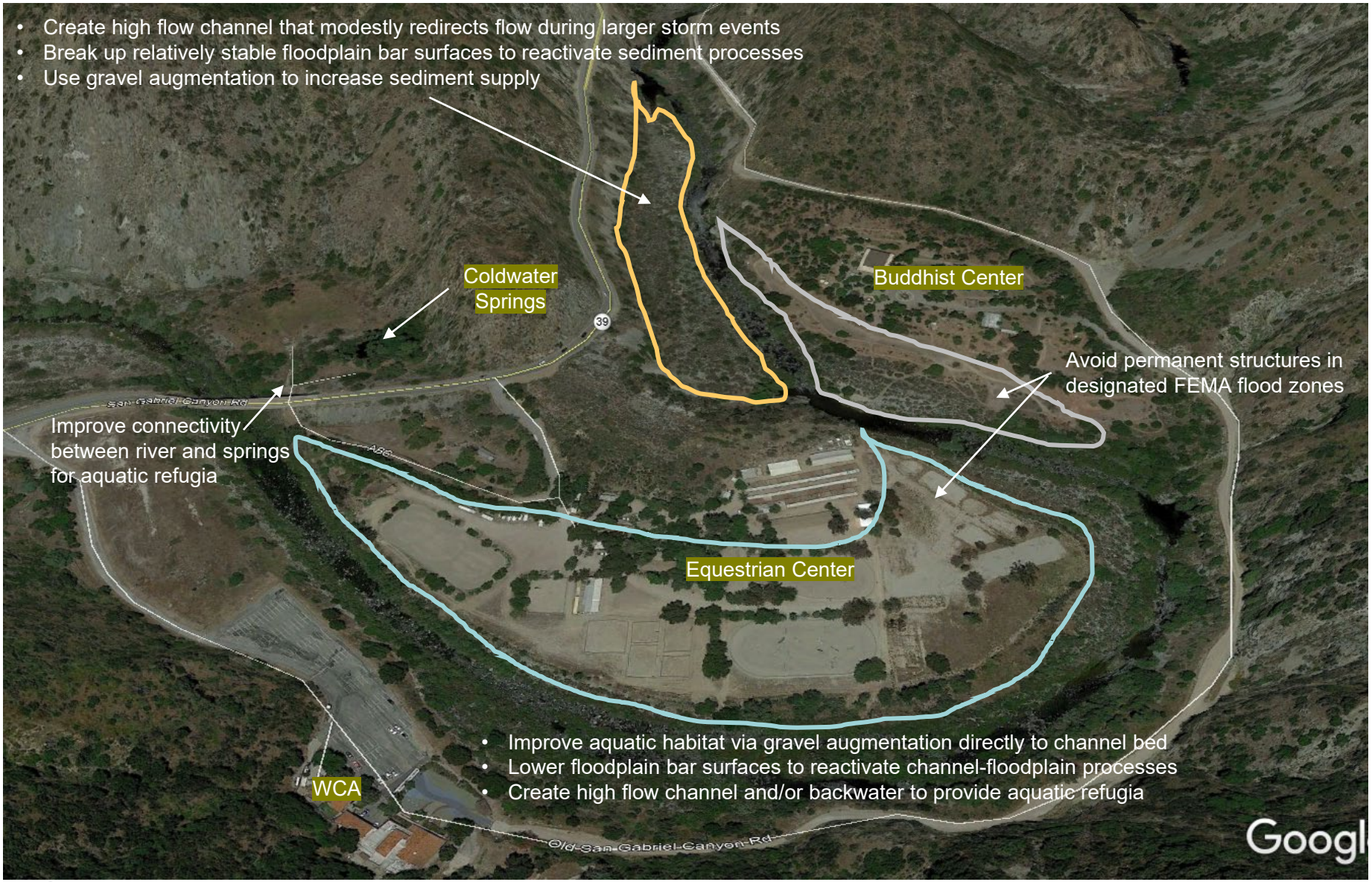


Balance Hydrologics

Figure 1. San Gabriel River Watershed. The San Gabriel River meander bend below Morris Dam, Robert's Canyon, Fish Canyon and Van Tassell Canyon were reviewed for restoration opportunities in mid- to late-April 2021.

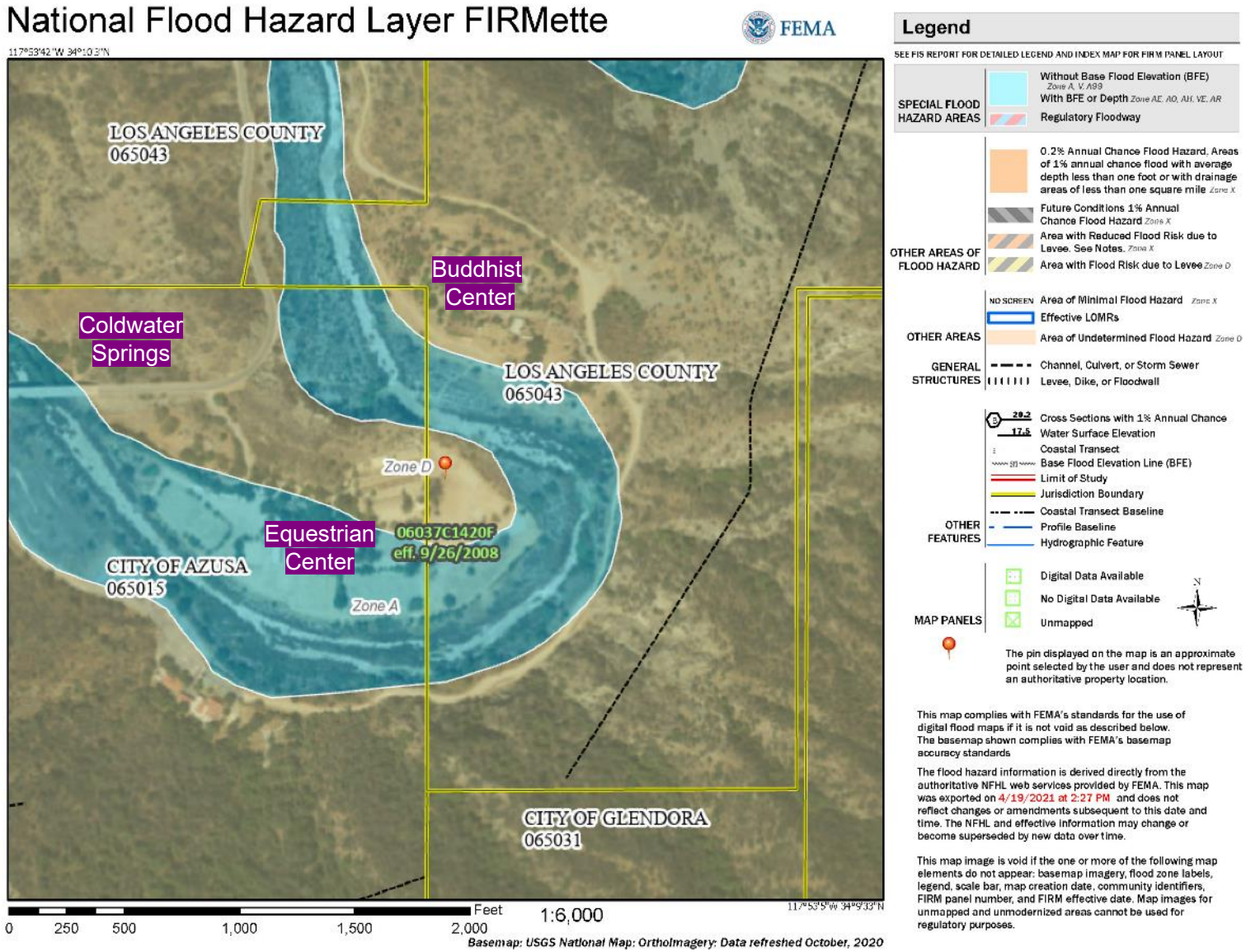
Balance Hydrologics

Figure 2. San Gabriel River meander bend below Morris Dam. The meander bend, located approximately 1.5-miles downstream of Morris Dam, has two relatively low-density occupants: a Buddhist Center and an Equestrian Center.



Balance Hydrologics

Figure 3. Restoration opportunities in the San Gabriel River along the meander bend. Next step recommendations include a restoration feasibility study including a geomorphic investigation, hydrologic analysis of dam releases, existing and proposed conditions hydraulic modeling, sediment supply study, and stakeholder engagement.

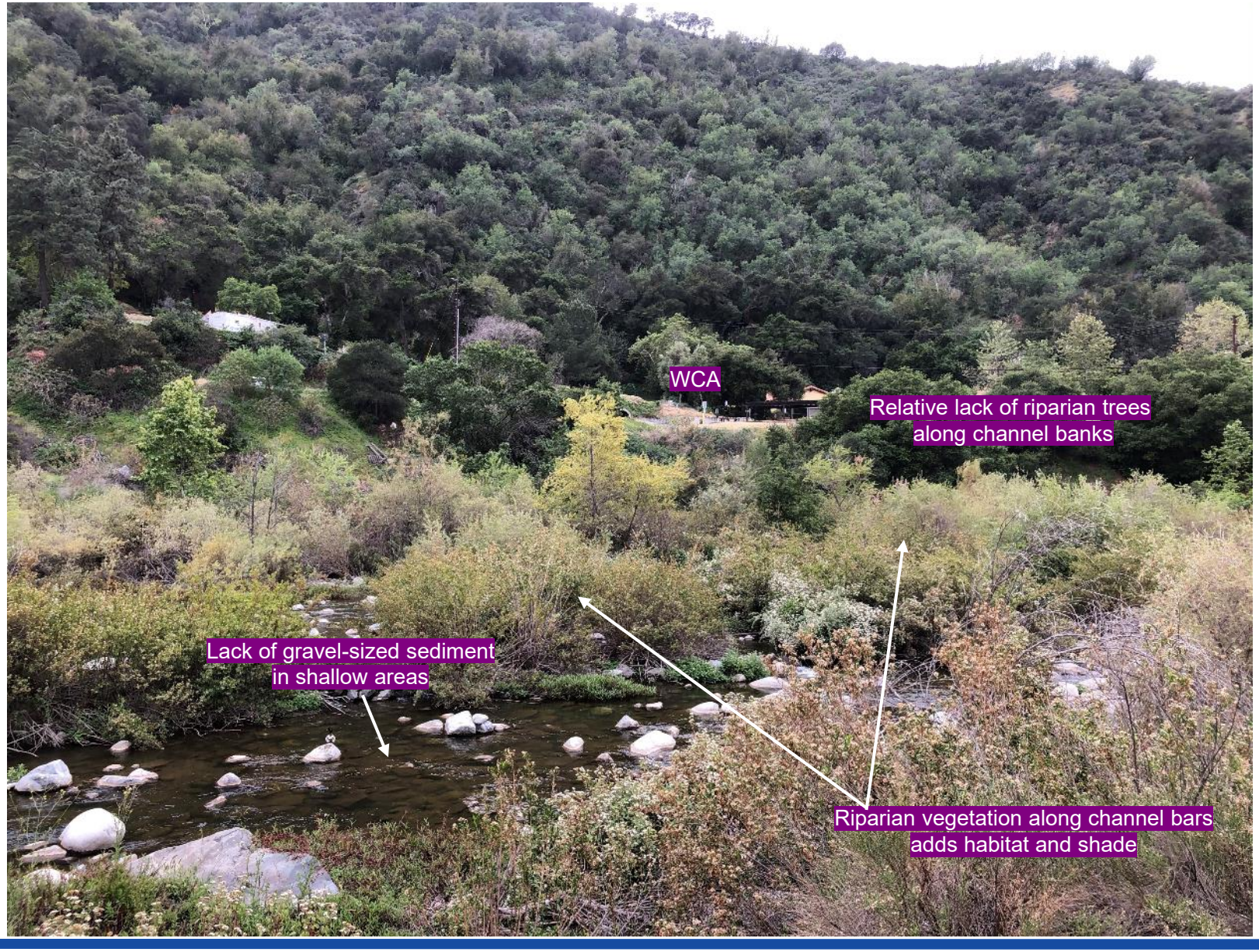


Balance Hydrologics

Figure 4. Federal Emergency Management Agency (FEMA) Flood Insurance Rate Map (FIRM #06037C1420F, effective 9/26/2008). FEMA used approximation methods to delineate the 100-year flood extent. Note that a portion of the outer bend occupied by the Buddhist Center is predicted to flood, and even more of the interior floodplain/bar occupied by the Equestrian Center.

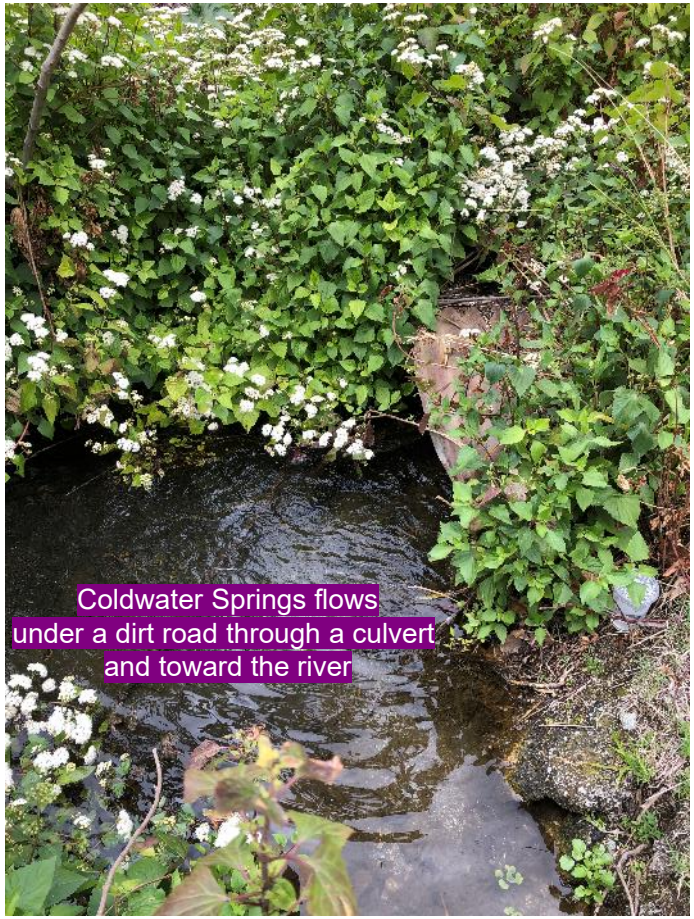
Balance Hydrologics

Figure 5. Looking upstream from Equestrian Center river-edge. There was a noticeable lack of gravel-sized sediment in shallow areas of the river channel. Appropriate sediment sizes are needed for aquatic species to thrive.



Balance Hydrologics

Figure 6. Looking from Equestrian Center to WCA. Channel was downcut with relatively steep banks. Winnowing of gravel-sized sediments and downcutting are symptomatic of below-dam channels where low flow is more prevalent and high flow is less prevalent than under natural conditions.

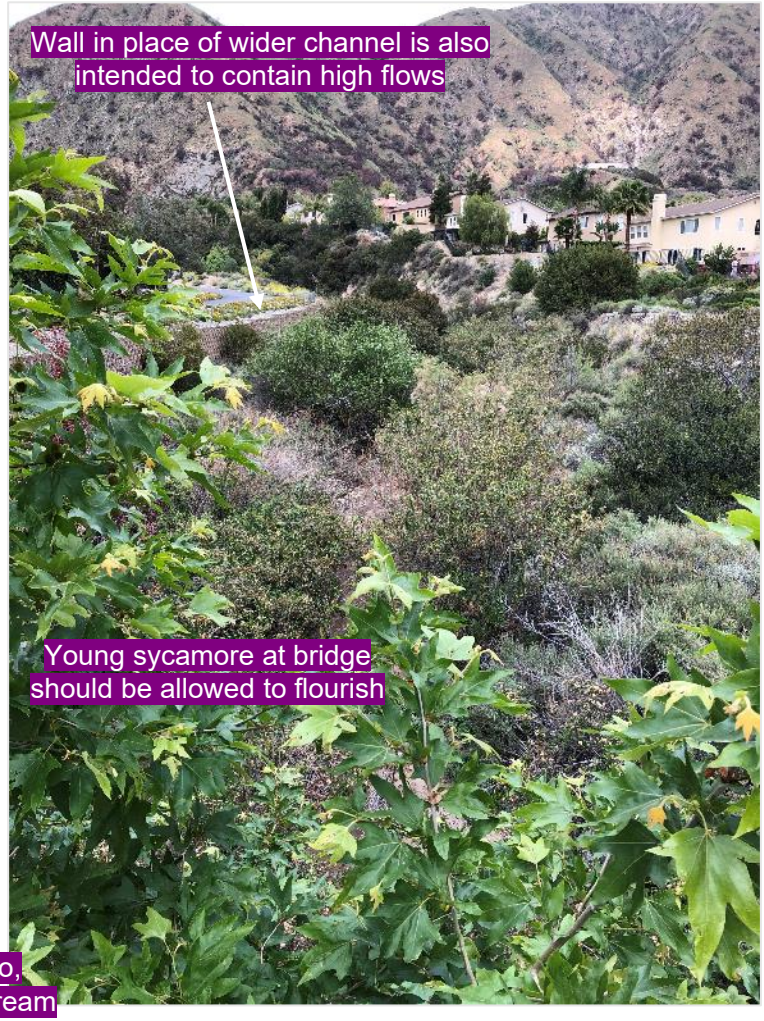


Balance Hydrologics

Figure 7. Coldwater Springs. A historical pipe brings San Gabriel River water from approximately 1 mile upstream to this location. Because the source of this water is the same as the source of river water, if outflow from the dam ceases due to dry conditions (and is not required), then this water source would also cease.

Balance Hydrologics

Figure 8. Looking upstream toward river. Recent fire evidence can be seen in the browned and blackened vegetation in the fore- and mid-ground of the image. Note that not all riparian vegetation burned. Riparian corridors are known to resist burning to some degree due to temperature and water content.



Lack of channel features may make it difficult for fish to navigate from the San Gabriel River into the upstream watershed over the next year or so, until channel roughness increases as fine post-fire sediments are washed downstream and depending on what channel structure lays below the silted layer.

Balance Hydrologics

Figure 9. Robert's Creek looking downstream (left) and upstream (right) from bridge in development. Trapezoidal channel geometry and a wall are intended to contain high flows moving through the Mountain Cove development. The channel lacks mature riparian trees in this area. Recent fire evidence from the 2020 Ranch 2 Fire can be seen in the fine silty sediment on the creek bed.

Balance Hydrologics

Figure 10. Robert's Creek upstream of development. Creek flow was present due to recent rain and/or snowmelt. The creek exhibited typical signs of the fire-flow response sequence. Fire promotes higher rates of erosion from hillslopes into channels, creating a higher sediment load that fills the channel. Flows that follow scour out fine sediments until the channel downcuts to a more typical equilibrium condition.

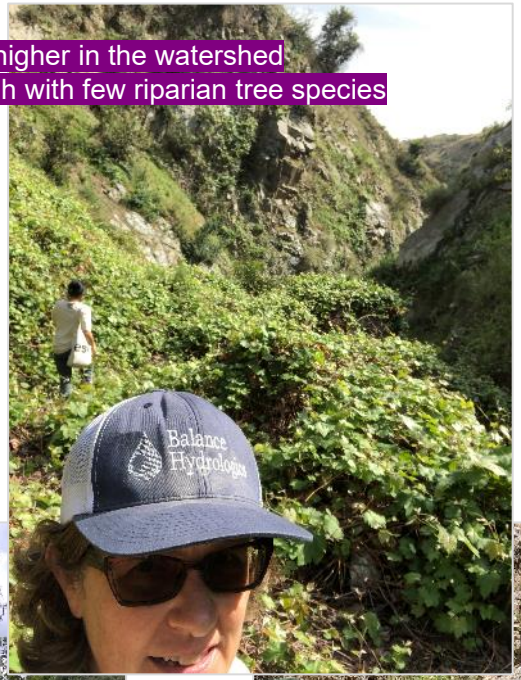
Balance Hydrologics

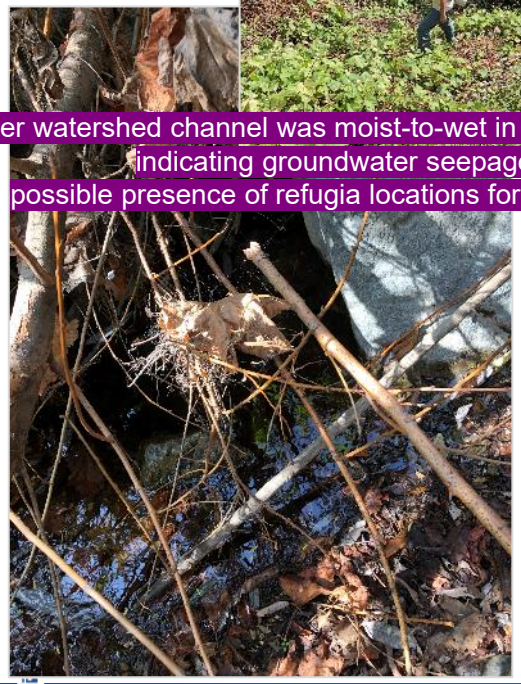
Figure 11. Van Tassel Canyon looking downstream (top) and upstream (bottom). Gravel-sized sediment predominates as the canyon stream slopes toward the San Gabriel River, likely a result of obstructions at Fish Canyon Road. The channel upstream of Van Tassell Mtway Trail was structurally diverse enough for fish movement.

Balance Hydrologics

Figure 12. Geomorphic processes in Van Tassell Canyon. Recent fire evidence from the 2016 Fish Fire includes still-standing burned riparian trees as well as angular sediments. Angular sediments indicate shedding from local hillslopes into the channel – a common post-fire occurrence. Conversely, rounded sediments indicate particle smoothing during fluvial (water) transport.

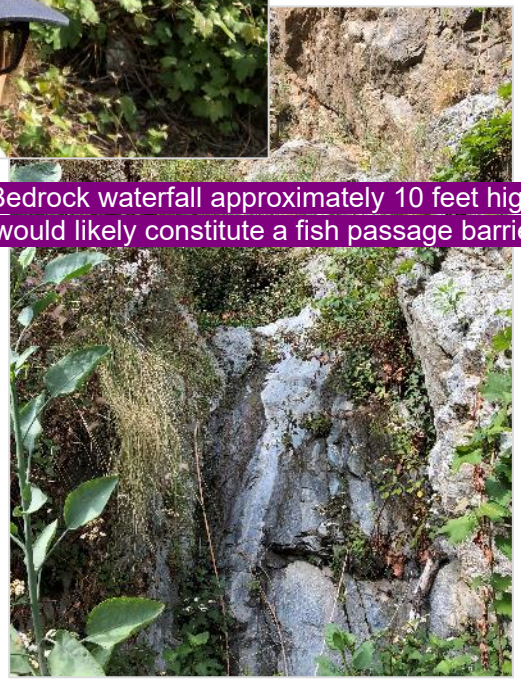
Beautiful views looking downstream from higher in the watershed show that post-fire revegetation is occurring, though with few riparian tree species





Upper watershed channel was moist-to-wet in numerous locations, indicating groundwater seepage and possible presence of refugia locations for aquatic species

Riparian tree with broken upper bole indicates probable cobble/boulder that bounced, injured, but did not kill this tree (note new growth)



Bedrock waterfall approximately 10 feet high would likely constitute a fish passage barrier

Balance Hydrologics

Figure 13. Van Tassell upper watershed. The channel was steep and fairly narrow; vegetative cover was thick, and moisture, standing water and/or very low flow was present throughout. Likely refugia locations would be available in the mainstem or potentially in larger tributaries along the southern extent of the watershed.

Balance Hydrologics

Figure 14. San Gabriel River grade controls. Van Tassell Canyon sediment supply does not reach the San Gabriel River except under episodic conditions such as post-fire flows. Fish Canyon Road is a sediment barrier, as are management practices such as installation of k-rails (see Google Earth image for better view). Grade control structures in the river promote channel stability instead of natural geomorphic processes.