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Led by USC Dornsife Public Exchange, in collaboration with the USC River Team and the 100 Acre Partnership, and supported by the Mountains Recreation and Conservation Authority (MRCA)

The Taylor Yard River Connection Study

Technically-enhanced design guidance to inform the implementation of Los Angeles River ecosystem restoration objectives



April 2026



Mountains Recreation & Conservation Authority

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Disclaimer

The views expressed herein are those of the authors and not necessarily those of the University of Southern California as a whole. For more information, contact: publicexchange@usc.edu

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Land acknowledgement

The project team acknowledges that the Taylor Yard site and surrounding Los Angeles River watershed are located on the ancestral homelands of the Gabrielino Tongva, Gabrieleno Kizh, Fernandeño Tataviam, and Chumash people. These original stewards have cared for the lands and waterways of this region, including the Los Angeles River and its watershed, since time immemorial. We honor their enduring presence, cultural knowledge, and commitment to protecting and maintaining these lands and waters, and we respectfully recognize the descendants who continue this stewardship today.

Executive Summary

The Taylor Yard River Connection Study provides up-to-date river connection design solutions that address new opportunities and constraints revealed during the design of the Bowtie and Paseo del Río Projects on the G1 and G2 parcels, respectively. By combining advanced hydraulic modeling with updated site information, the project has produced three conceptual schemes that create a “hydrologic connection” between the LA River and these parcels and help achieve the goals set out in the approved 2016 United States Army Corps of Engineers (USACE) Los Angeles River Ecosystem Restoration Integrated Feasibility Report (LARER) and the City of Los Angeles’ 2021 Integrated Feasibility Report (City IFR), especially the “Island” design.

The Study is led by USC Dornsife Public Exchange with the USC River Team (Viterbi School of Engineering, School of Architecture, and School of Cinematic Arts), in partnership with the Mountains Recreation and Conservation Authority (MRCA) (with funding from the Santa Monica Mountains Conservancy) and in coordination with the 100 Acre Partnership at Taylor Yard.

Design Objective: Deliver hydraulically viable conceptual designs that create a hydrologic connection between the Taylor Yard parcel (G2) and Bowtie (G1) (as necessary) that help achieve the habitat and public access goals of the LARER and City IFR, while maintaining or improving flood conveyance.

Approach & Tools:

- Integrated **conceptual design + hydraulics** to enable coordination and constraint management.
- **Physical modeling:** 1:120 modular flume testing 5–100-year events.
- **Numerical modeling:** 2D simulations in “Celeris,” calibrated to the Taylor Yard reach.
- **Constraints/Opportunities Mapping** underground utilities, power transmission line right-of-way easements, soil pollution, historic artifacts, High Speed Rail interfaces, existing/planned projects and infrastructure.

Primary Design Alternatives:

1. **North Island (Revised “Island”):** A full-depth side channel that bifurcates flow around a vegetated island; reduces local flooding in tests, meets power-line restrictions and limits, and adds multi-thread river habitat (native wetland, valley foothill riparian, coastal oak woodland, native meadow). Select paths and overlooks are situated to minimize habitat disturbance, while creating high-quality human access and habitat observation.
2. **South Tributary (Groundwater Basin):** A ~30-ft deep basin and shaded stream connected via culvert for fish passage/spawning, emphasizing groundwater-cooled aquatic refuge conditions and native wetland/valley foothill riparian habitat; this alternative allows for potential phased remediation. An encircling path includes a habitat-immersive stewardship-focused area and a programmable overlook that minimizes habitat disturbance.
3. **Parabolic Terracing:** Profiled terraces to increase cross-sectional capacity, improve hydraulics, and host tiered habitats; scalable and potentially the most constructible near-term flood benefit. Adds access to new in-channel “wild” river walk & kayak launches/pull-ins.



Pollution & Remediation: Designs avoid pollution hotspots of diesel (TPH), lead, and VOCs to minimize excavation. Possible remediation methods include treatment and stabilization, capping, land-farming, and targeted contamination barrier walls where groundwater interaction is possible. However, this report does not recommend any specific remediation plan or method and defers the final remediation strategy to the relevant agencies. Preliminary comparisons indicate a >50% reduction in remediation cost due to reduced excavation, hotspot removal, and cap areas for the North Island relative to the City IFR Island design. The South Tributary anticipates 30–50% lower remediation costs than City IFR concepts, contingent on VOC treatment phasing.

Preliminary Flood Protection Findings: Northern side-channel permutations reduce the potential for local overtopping; some downstream effects require parapet/terrace mitigation. Terracing trials show net flood-capacity gains, especially with strategically added roughness (vegetation). The South Tributary interacts with groundwater and does not influence storm event channel flow.

Constructibility & Phasing: Bridge/culvert solutions maintain LADWP access with inlet/outlet siting to be finalized through structural review. Pilot projects for each of the three schemes are proposed to de-risk engineering, advance remediation, and demonstrate benefits.

Recommended Next Steps: Develop 30% designs for selected alternatives. Tasks include calibrating/verifying hydraulic models, finalizing inlet and outlet engineering, informing remediation planning and cost estimates, and coordinating with Paseo del Río and Bowtie design teams.

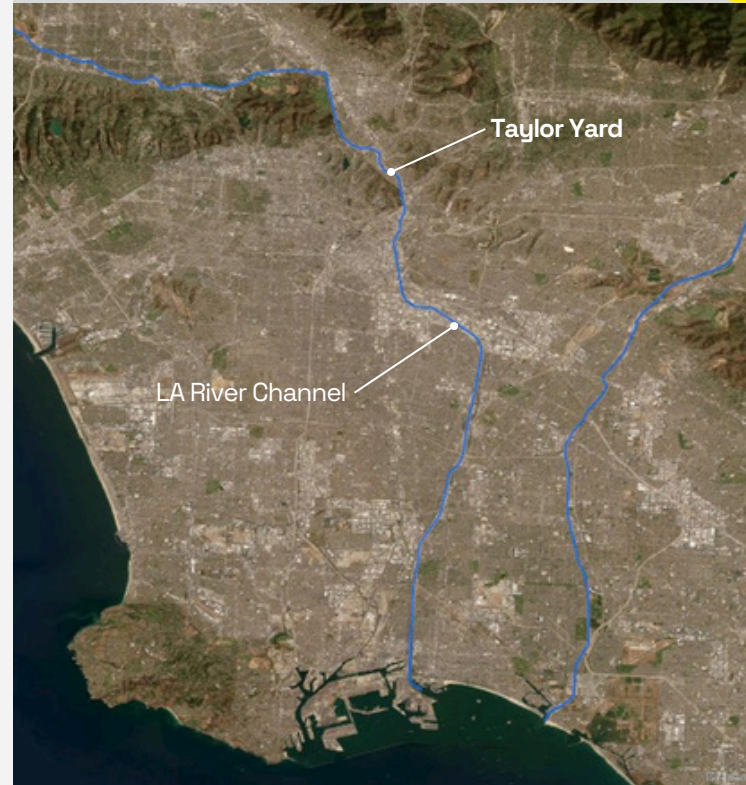


Combined Scheme Site Plan



Introduction

The Taylor Yard River Connection project represents a critical step toward realizing the 2016 United States Army Corps of Engineers (USACE) LARER Study's vision for a revitalized, ecologically functional, and flood-resilient Los Angeles River.



Situated within the G1 and G2 parcels of Taylor Yard, spanning the Cypress Park and Glassell Park neighborhoods, this effort seeks to reestablish the river's hydrological and ecological connectivity through the design of a multi-functional in-channel "Northern Island" at the northern end of the G2 site and a "South Tributary" groundwater-fed ecosystem restoration feature at the southern end of the G2 site. The project responds directly to the LARER Study, which identified the Taylor Yard reach as one of the few locations in the Los Angeles River corridor with the spatial and hydraulic conditions necessary to implement large-scale multi-benefit restoration. The project also incorporates the current conceptual designs of the G1 Bowtie Park and G2 Paseo del Río projects.

Led by USC Dornsife Public Exchange, in collaboration with the USC River Team (Viterbi School of Engineering, School of Architecture, and School of Cinematic Arts), in partnership with the Mountains Recreation and Conservation Authority (MRCA) (with funding from the Santa Monica Mountains Conservancy) and in coordination with the 100 Acre Partnership at Taylor Yard, this study provides engineering and design guidance to inform the implementation phase of the LARER Study's ecosystem restoration objectives at Taylor Yard. The project integrates physical hydraulic and numerical modeling with enhanced visualization to collectively evaluate design alternatives and their influence on flood behavior, habitat potential, recreation, and constructibility constraints.

This effort builds upon the extensive body of planning work led by the City of Los Angeles Bureau of Engineering (BOE), the USACE, and the 100 Acre Partnership, with new modeling and updated information on constraints and opportunities. These refinements seek to facilitate further coordination between multiple stakeholders and landowners and to maintain momentum. The goal remains the same: determine hydraulically viable and ecologically optimized alternative designs for the site that satisfy flood control standards while advancing regional goals for ecosystem restoration, public access, and recreation.

A Hydrologic Connection

At the core of the Taylor Yard study is the reestablishment of a hydrologic connection—a physical and functional linkage between the main Los Angeles River channel and its groundwater within adjacent floodplain, wetland, or side-channel features. This will allow river water, long confined to the concrete-walled channel, to have a rich and multi-faceted relationship with adjacent landscapes.

Hydrologic connection in this context refers broadly to any connection between the river channel and its water within or adjacent to the G1 and G2 parcels. This includes open diversions of water from the main channel that operate during storm events, as well as more controlled fish-habitat-enhancing connections. In all cases, excavating down to existing groundwater elevations is a key hydrologic connection strategy and a means to sustain high quality groundwater-dependent ecosystems, as exists within this soft-bottom section of the river channel and as historically existed within the floodplain at the site.

The "Island" scheme was initially developed in the City of Los Angeles' 2021 Integrated Feasibility Report (City IFR) and approved by City Council, but its implementation has been challenged by numerous critical and shifting constraints, as well as limited hydraulic modeling. Furthermore, the city-led Paseo del Río Project and the California Department of Parks and Recreation (CDPR)-led G1 Bowtie Park project are nearing implementation, requiring new coordination. Given these new considerations, the MRCA and 100 Acre Partnership wanted to understand how the G1 and G2 parcels could still be involved in achieving a hydrologic connection, whether by revising the Island design or by other means.

The USC River Team was tasked by the MRCA to explore this concept through modeling and design optimization, using both physical and numerical models to assess design alternatives that would support a hydrologic connection at Taylor Yard.

Throughout the planning process, "hydrologic connection" has been interpreted in several ways by partner agencies and stakeholders:

- Flood protection managers have prioritized the connection as not exacerbating flood risk; favoring new channel configurations that avoid reducing conveyance or increasing upstream or downstream stage elevations.
- Ecological restoration practitioners view the connection as a means to restore habitat.
- Community and design partners see it as an opportunity to reconnect people and place, improving access and visibility into an active river system.

The USC team's approach seeks to integrate these interpretations, producing a hydraulically feasible design that also meets ecological and social goals.



IIDL Approach

Since its inception, the USC River Team’s Integrated Infrastructure Design Lab (IIDL)—housed in the City of Los Angeles’ Hydraulic Research Laboratory in the Elysian Valley—has been developing methodologies tailored to the complex challenges of multi-functional infrastructure design. The lab is a collaboration between the USC School of Architecture, USC Viterbi School of Engineering, and USC Cinematic Arts. This team recognizes that designing and implementing infrastructure with multiple benefits requires innovative design approaches and robust stakeholder collaboration. To achieve this, IIDL has invested in advanced tools that facilitate design coordination across disciplines and diverse stakeholders. The site in question epitomizes this need and opportunity, serving as the lab's initial focus area. Prior to this project, the team constructed an enhanced hydraulic physical and numerical model of the LA River and Taylor Yard site. The physical hydraulic model, located adjacent to the project area in the City’s Hydraulic Research Laboratory, was made possible by an agreement between USC and the City of Los Angeles Bureau of Engineering (BOE).

Hydraulic Modeling and Integrated Conceptual Design

IIDL was well poised to deploy its innovative hydraulic tools and other design capacities to assist in creating a suitable hydrologic connection. A multifunctional design process, co-led by engineering, ecology, and landscape architecture designers, was augmented by the lab’s capacity to integrate hydraulic modeling with conceptual design. Deferring this analysis for the City IFR Island design, and then belatedly discovering the need for major changes and coordination, was a key impetus for employing the lab’s hydraulic approach. Integrating conceptual design with hydraulic modeling has helped guide, innovate, and solidify the project’s spatial design, providing a critical advantage for such complex and constrained projects. This approach has subsequently helped the multidisciplinary team to advance ecological and open space goals while navigating and addressing specific spatial and coordination challenges, ranging from site pollution to coordination with other stakeholders and landowners. The early hydraulic testing has mitigated stakeholder concerns and confirmed the feasibility of the designs at a formative stage in the process. For further discussion of the tools and methodology, refer to Appendix B, General Approach, and Appendix C, Physical Model Results.

Stakeholder Communication and Engagement

A key tenet of the IIDL approach is making advanced design practices inclusive for a diverse set of stakeholders. In addition to regular team meetings, the team organized a series of in-person workshops where members of the engineering firm WSP and the 100 Acre Partnership (comprising the MRCA, the City of Los Angeles Bureau of Engineering (BOE), and CDPR) interacted with both the Celeris system and the enhanced physical model. The engagement strategy helped promote understanding and acceptance of design decisions, improve attendance, and enhance coordination among stakeholders. Over the course of the 12-month project, we conducted quarterly meetings, with two hosted in person at the lab, and two hosted remotely.



Clockshop Community Engagement Event

Managing Major Critical Constraints & Opportunities, Existing & Future

During the development of the Bowtie and Paseo del Río projects, multiple site constraints evolved and were better understood, rendering past proposals impracticable. A key motivation of this study was to utilize the latest understanding of site constraints and opportunities to develop new conceptual proposals. To do so, IIDL, in close coordination with the 100 Acre Partnership and other consultants, integrated various constraints into its advanced tools and design capacities to simultaneously navigate these and other complex spatial constraints on the site. This includes various existing underground utilities and easements, high voltage transmission towers and lines, two historic railway turntables on the G1 and G2 parcels, central to the Bowtie and Paseo del Río designs, other historic artifacts on site, and the future High Speed Rail (HSR) line. The team also worked extensively with WSP consultants to address pervasive site pollutants, one of the most challenging constraints. Additionally, the team carefully considered how its designs would fit seamlessly with the upcoming Paseo del Río and Bowtie Park projects. A detailed discussion and mapping of these constraints are covered in a later section.

Constructibility & Pilot Projects

IIDL is cognizant of the challenge of modifying the existing Los Angeles River channel, as well as the complex constructibility challenges presented by the G1 and G2 sites. Among its many considerations in this regard, the team proposed strategically smaller “pilot” projects, discussed in each project proposal section. These could help demonstrate the feasibility of new approaches and identify key challenges and solutions, while also initiating the project implementation.

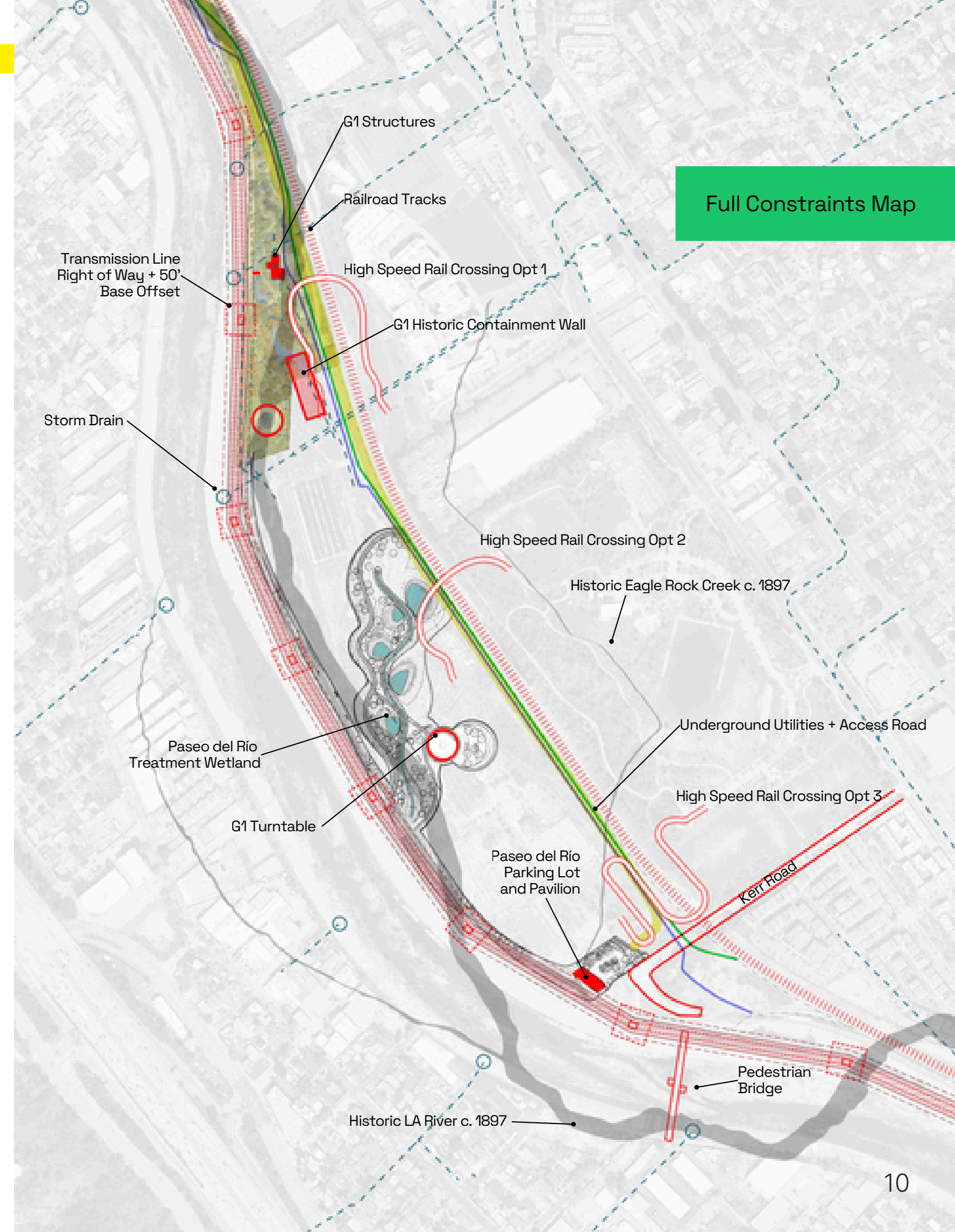


Site Information

The project focuses primarily on the G2 Taylor Yard parcel within the Cypress Park and Glassell Park neighborhoods of Los Angeles. This parcel, purchased in 2017 by the City of Los Angeles, and on which the MRCA has an easement, represents a prime opportunity for a river revitalization project. The site has been highlighted in several major planning efforts, including the City's Los Angeles River Revitalization Master Plan (2007), the USACE LARER Study (2016), and more recently, in greater detail, within the City Implementation Feasibility Report (2022), which identified an approved and preferred "Island" project concept. The study extends north of the G2 into the adjoining area of the G1 parcel (the "Bowtie"), which is owned by CDPR with a park project design in progress. The G2 Paseo del Río project design is also in progress with the City and the 100 Acre Partnership. The study also includes the Los Angeles River channel adjacent to these parcels, and to some extent, downstream from the G2 parcel. This section of the Los Angeles River is managed by the USACE and is included in their LARER study.

Constraints & Opportunities

The project study area contains a range of constraints and opportunities that will significantly shape any future project. Changes to these have impacted the viability of the previously approved "Island" scheme. For this reason, our study began with an investigation and mapping of these factors. The following section identifies the key constraints encountered when designing the G2 hydraulic connection. For more information on individual constraints, refer to the City IFR.

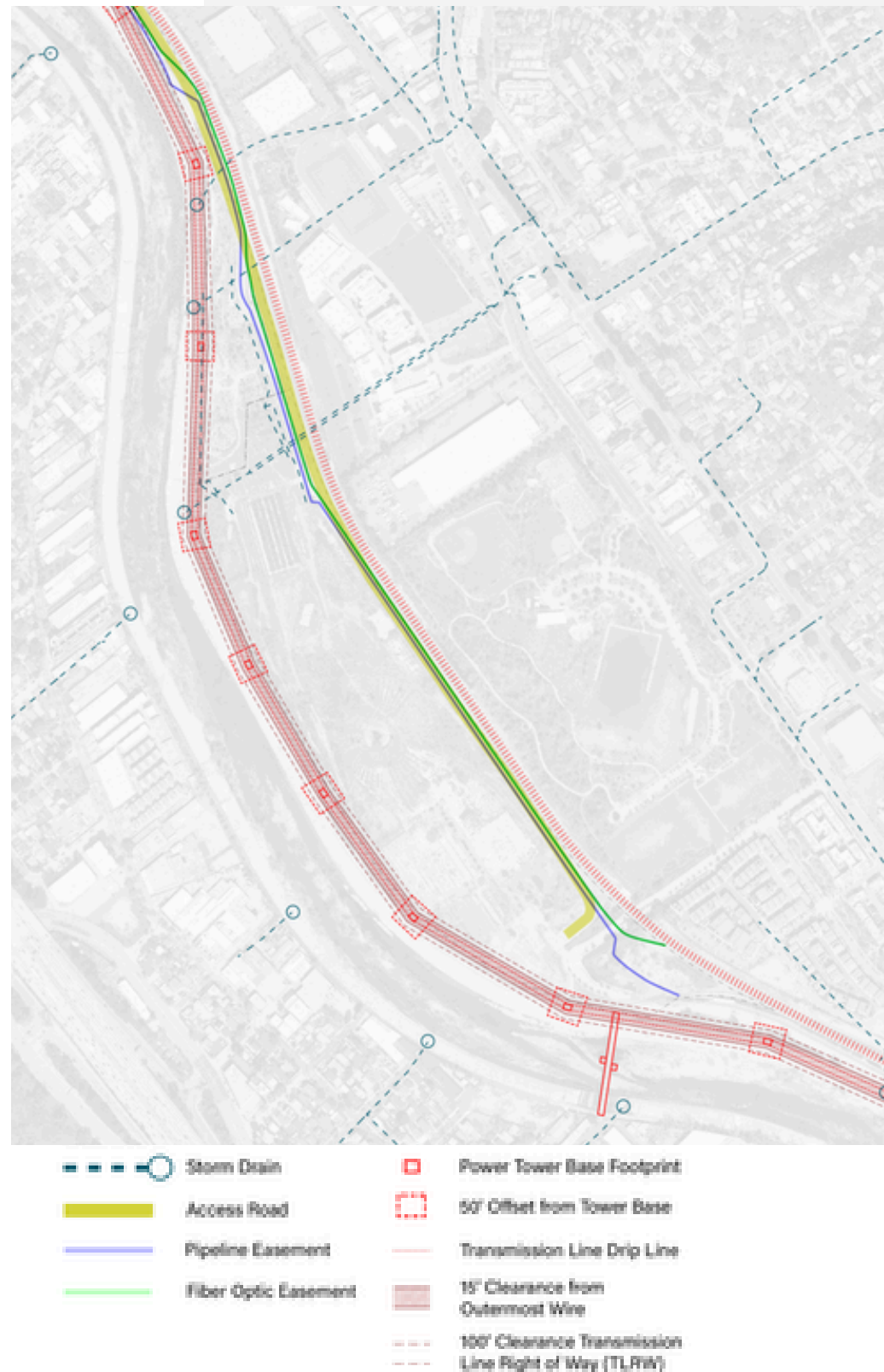




Utilities

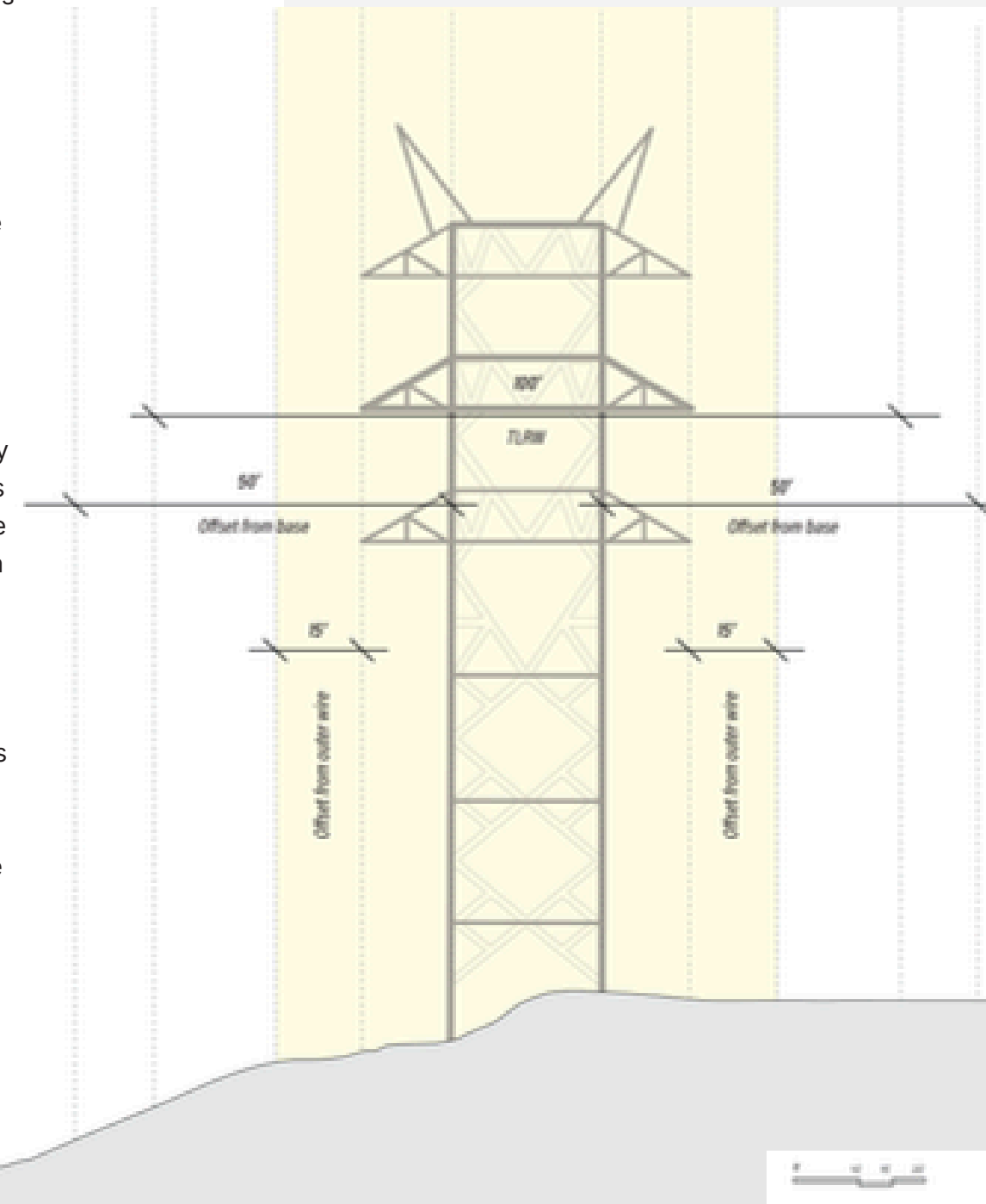
The majority of active underground utilities on the site are adjacent to the railroad, including a 10'-wide fiber optic line easement and a 6'-wide oil pipeline easement. These lie underneath an access road and tail track easement that also runs along the railroad and should be respected in future designs.

In addition to those existing utility easements, there are several storm drains and parcel drains that outlet into the river. These storm drains could be potential water sources for constructed wetlands or terraces. Two of these storm drains near the southern G1/northern G2 area are identified as possible water diversion sources for the Paseo del Río water quality component.



Utilities Map

The transmission lines are among the most restrictive constraints to proposed designs. There are five transmission towers along the G2 parcel and five along the G1 parcel. Each tower has a 50' offset zone around its base that limits planting and furniture placement. There are several additional constraints to consider underneath the length of the transmission lines. First, there is a 15' offset from the outermost wire (wire zone) where no trees or furniture are to be placed. The total transmission line right of way (TLRW) is 100' wide and runs along the entire length of the transmission lines, which run in straight lines between the towers, crossing over the river channel in some places and over inland areas in others. Structures and plants outside of the 15' wire zone, but inside the TLRW, should not exceed 14' in height. The power lines are maintained and operated by LADWP. LADWP requests a 20' wide maintenance road to access and maintain their towers.



Power tower section



G1/G2 Existing & Planned Projects

A. Paseo del Río

The Paseo del Río is the first major project on the G2 parcel. It encompasses 14 acres of the 42-acre site and is composed of a mile-long greenway, entry plaza, and water quality feature, centered around the former G2 turntable. The Bureau of Engineering is leading the design and construction of the Paseo.

B. Bowtie

CDPR purchased the G1, or Bowtie, parcel in 2003. There is a comprehensive plan for the entire parcel that will connect with the Paseo del Río Greenway. Phase 1 of the project broke ground in 2024 for the Nature Conservancy (TNC)-led wetland demonstration project and is expected to be completed in 2026. Phase 2 design will be completed at the end of 2026 with construction starting in the summer of 2027, and phase 3 to follow. The Bowtie parcel is a subunit of the nearby Río de Los Angeles State Park, which opened in 2007.

C. Historic Artifacts

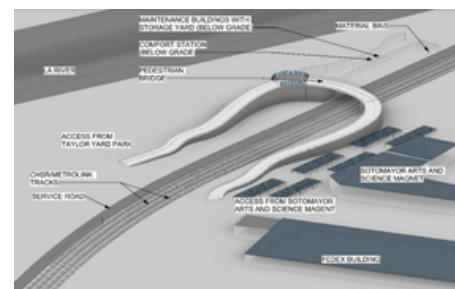
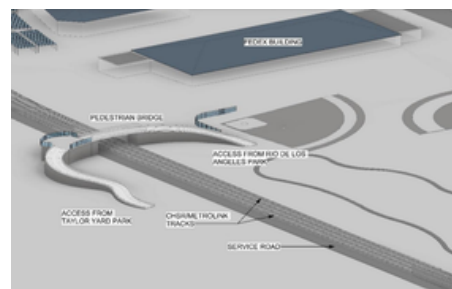
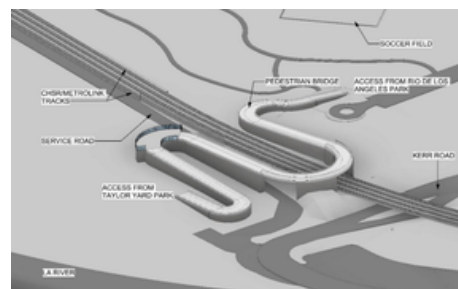
While in operation as a railyard, Taylor Yard had two large turntables that redirected trains for servicing. Today, their footprints are still visible and are deemed historic artifacts. Both the Paseo del Río and Bowtie projects incorporate these turntable footprints into their designs.

State Parks has also identified a former above ground storage tank containment wall as a significant historic artifact. The containment area crosses the G1 and G2 parcel boundary, but the wall itself is on the G1 side. As of now, State Parks has decided to preserve the wall but is open to its demolition or relocation with State Historic Preservation Officer approval.

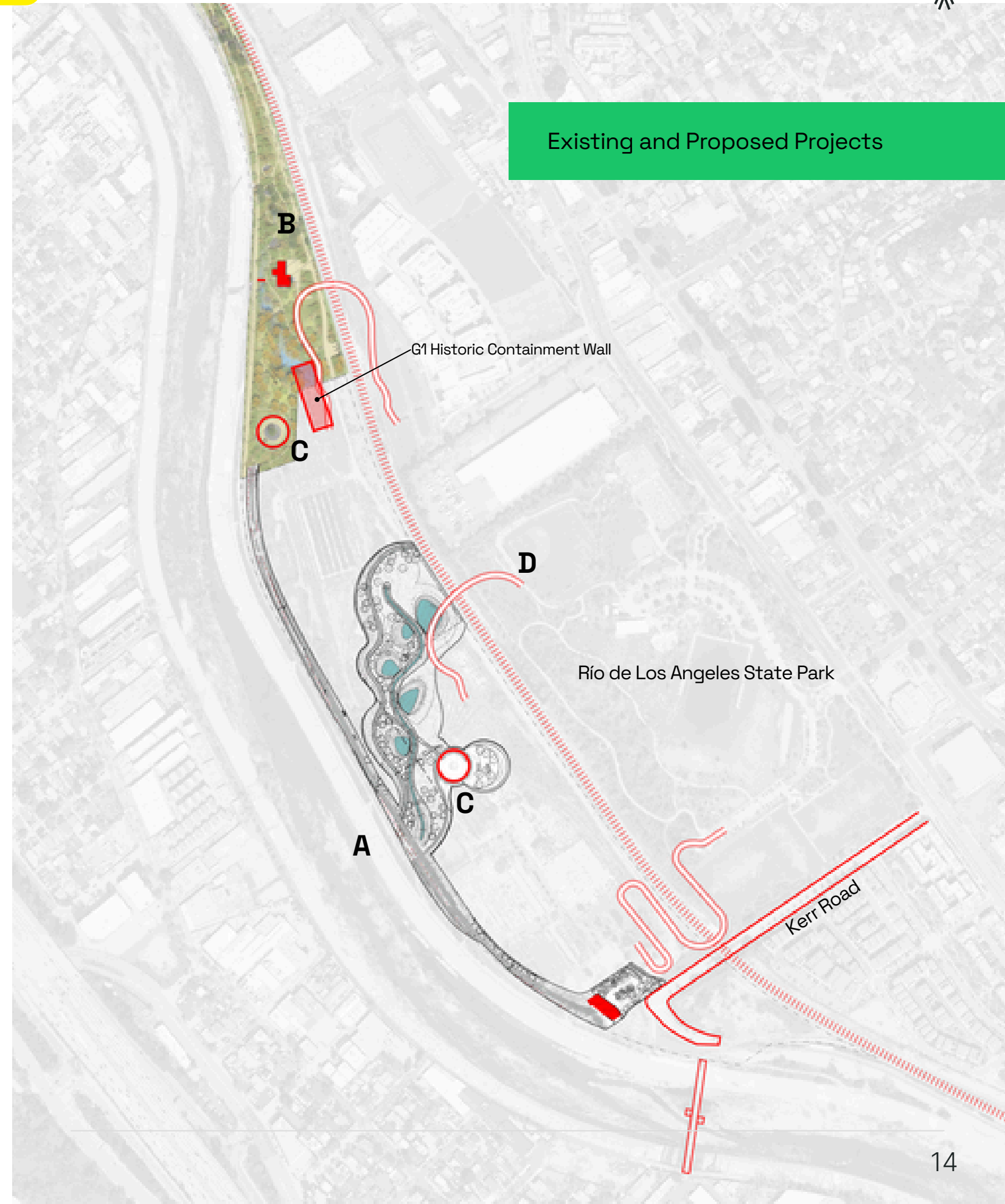
D. High Speed Rail

While CAHSR infrastructure would be limited to within the Metrolink right-of-way (ROW), it would require several modifications to structures adjacent to the G2 parcel. The rail bridge crossing over Kerr Road will require modification to accommodate the HSR undercrossing requirement of 15' of clearance. There would also be an additional bridge to support the tail track relocation.

Several options for a pedestrian bridge connecting Río de Los Angeles State Park and Taylor Yard have been proposed. These would require at least 27' of clearance above the HSR line. Final concepts show three options with a filled base.



High Speed Rail Crossings, Source: California High-Speed Rail Authority, 2023.

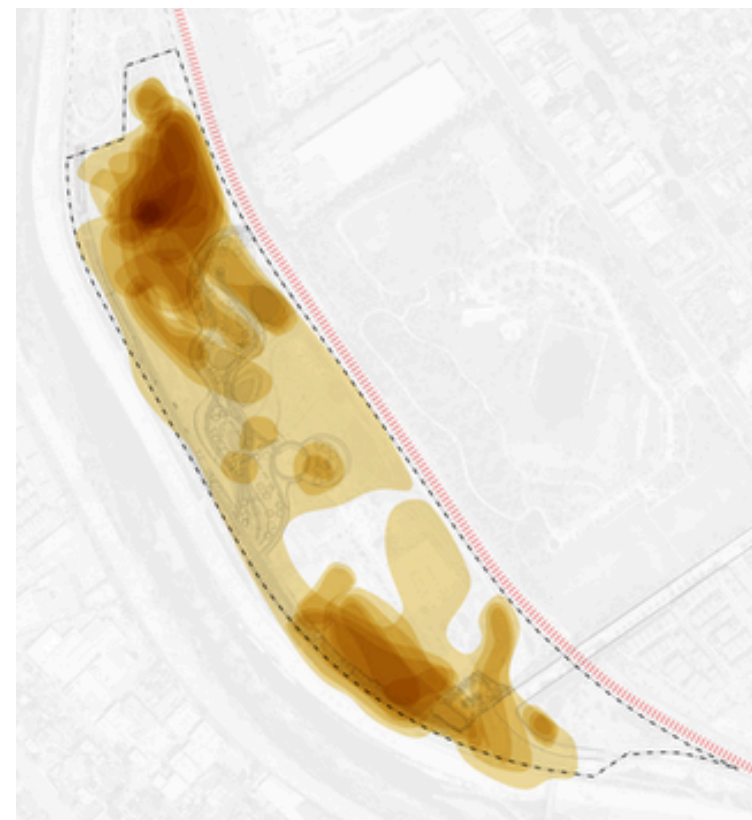




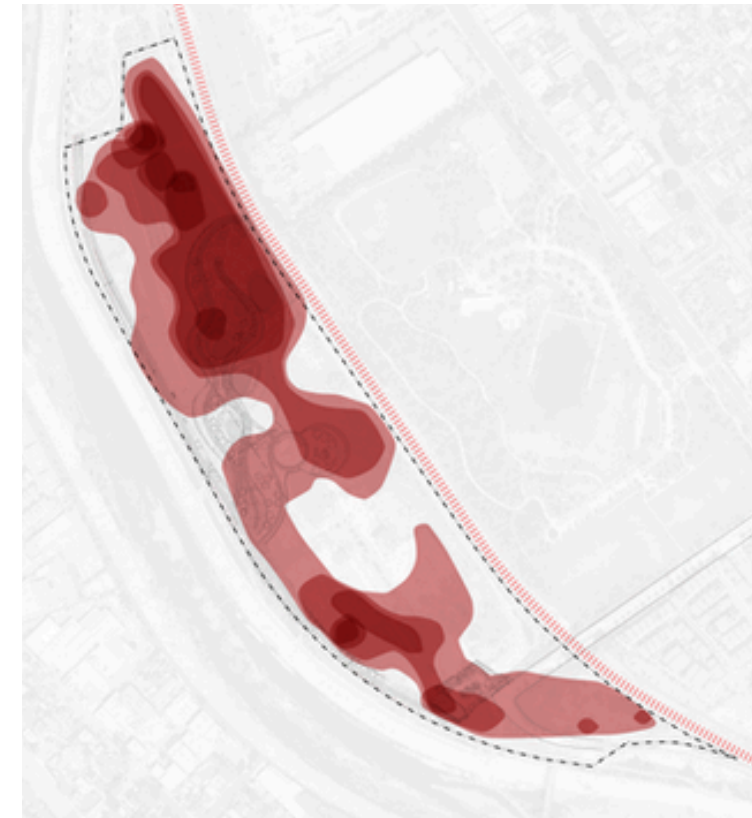
Pollution

The G2 site is heavily polluted from decades of industrial use as a train yard with certain areas having higher concentrations of pollutants than others. Of concern are petroleum hydrocarbons (TPH), metals (lead), volatile organic compounds (VOCs), and semi-volatile organic compounds (SVOCs), each appearing in different concentrations throughout the site and each requiring its own remediation strategy. Contaminant maps shown here are redrawn from the 2020 WSP Report of Findings. They identify the locations of contaminants at or exceeding DTSC commercial or residential screening levels and EPA regional screening levels. Darker areas indicate increased contaminant depth and concentration.

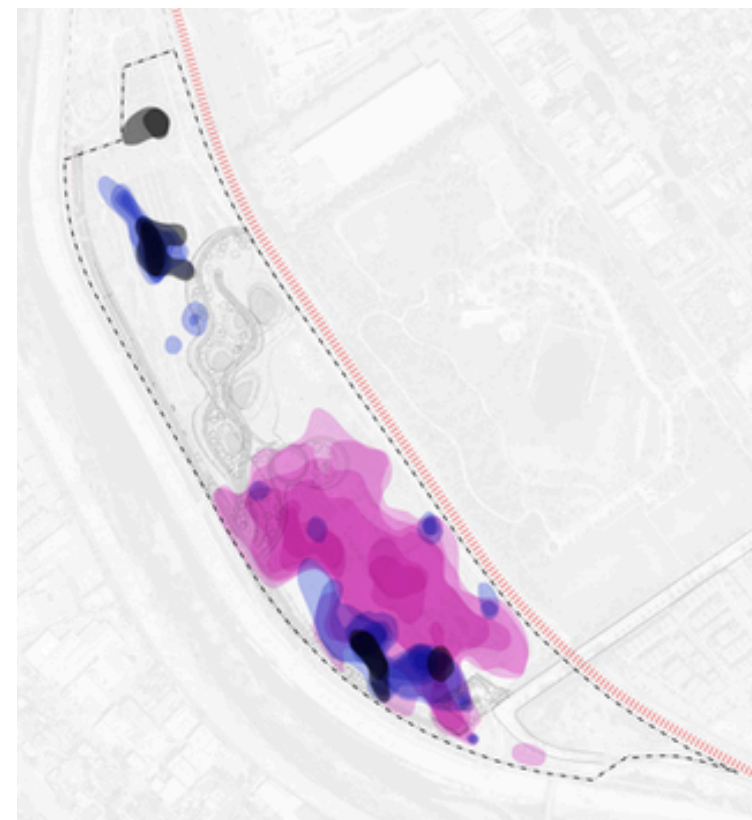
The exact combination, sequence, and timeline of remediation to be performed will be determined as projects proceed. The City and State are working with the California Department of Toxic Substances Control to ensure safe and effective remediation approaches are used for the site. There may be a need for additional research to better understand groundwater dynamics and exact concentrations throughout the site. Proven methods like land farming, soil vapor extraction (SVE), and capping and stabilization are viable remediation options for this site. The designs proposed in this report assume that the pollution has been contained or remediated to the appropriate levels but defer any specific remediation strategy recommendations to the relevant agencies.



Hydrocarbon Pollution Map, Source, WSP. Redrawn by IIDL



Lead Pollution Map, Source, WSP. Redrawn by IIDL



VOC Pollution Map, Source, WSP. Redrawn by IIDL

VOC Key

	Benzene
	Vinyl Chloride
	PCE



Hydraulic Conditions

This section of the Los Angeles River has limited flood conveyance capacity. The City IFR summarizes the known hydraulic conditions of the river. According to studies produced by the USACE, this section of the river does not meet the National Flood Insurance Program requirements of accommodating a 100-year flood, which is assumed to have a 1% chance of occurring in any given year. Assuming a clean trapezoidal channel, the design discharge at the G1 and G2 stretch is 83,700 cfs (cubic feet per second) based on discharge frequency analysis in the 1991 Los Angeles County Drainage Area (LACDA) study conducted by the USACE. However, over time, with vegetation growth and increased sedimentation, conveyance capacity has been reduced to 50,500 cfs. For this section of the river, the 1991 LACDA study estimated the 100-year flood discharge to be 93,800 cfs and the 10-year flood discharge to be 49,400 cfs. These estimates indicate that the section is at risk for overtopping in an approximately 11-year event.

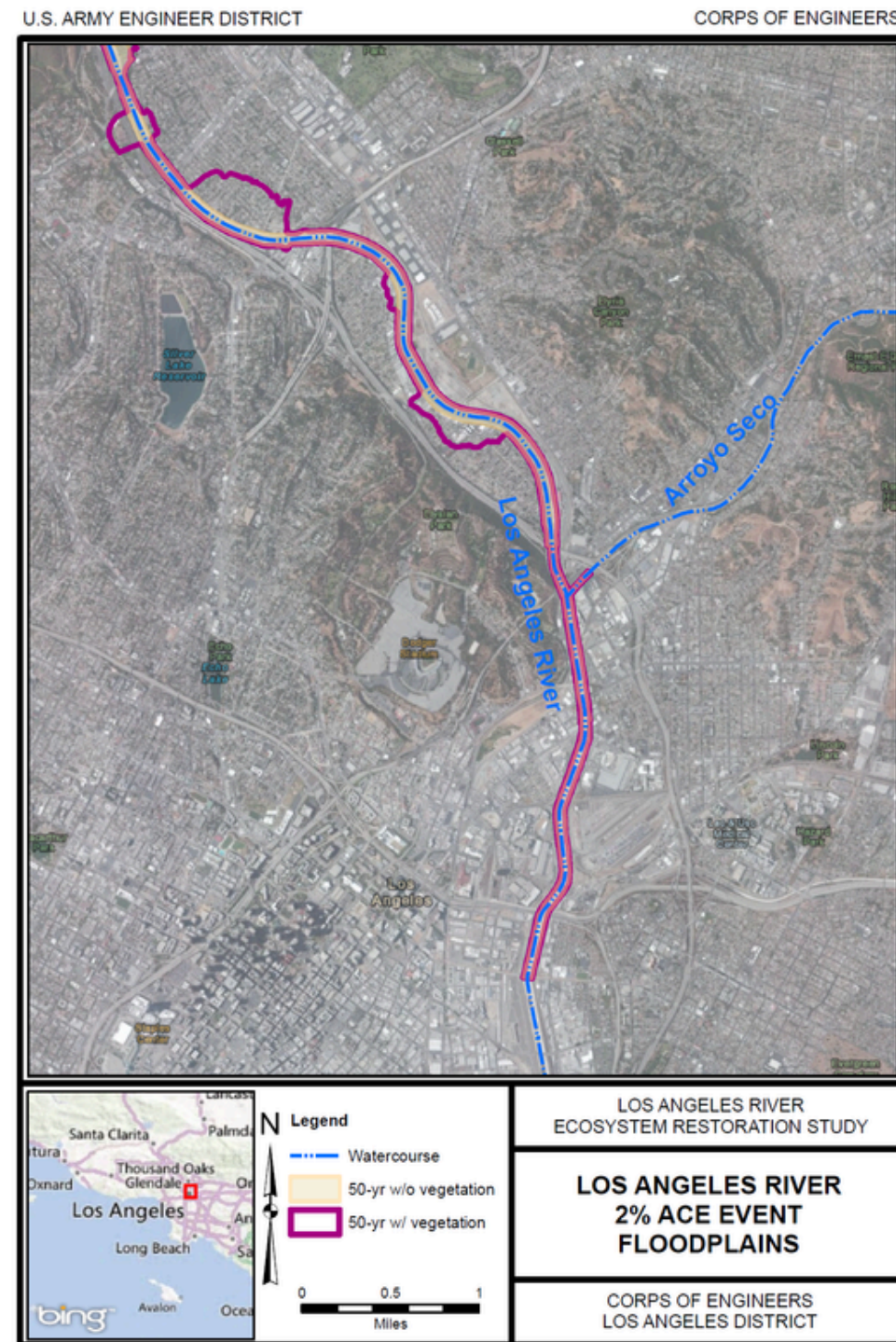
More recent flood frequency analyses, provided by the USACE in the 2024 Los Angeles River Ecosystem Restoration (LARER) Design Documentation Report, show lower discharge in the LA River above Arroyo Seco. Specifically, the 2024 LARER report indicates a 100-year flood discharge of 65,300 cfs and a 10-year flood discharge of 41,300 cfs. With these revised estimates, the assumed existing channel capacity of 50,500 cfs corresponds roughly to a 25-year flood (see Table 9-9 in the 2024 LARER report). The reduced discharge estimates in the 2024 LARER report compared to the 1991 LACDA study reflect active management of flow in the LA River in the intervening period and updated hydrologic and hydraulic modeling assumptions.

The stated goal of the City IFR projects is to maintain the existing level of flood protection. In this study, we seek to match this goal or, if possible, improve flood protection. Note that this report retains the more conservative 1991 LACDA study flood discharge estimates.

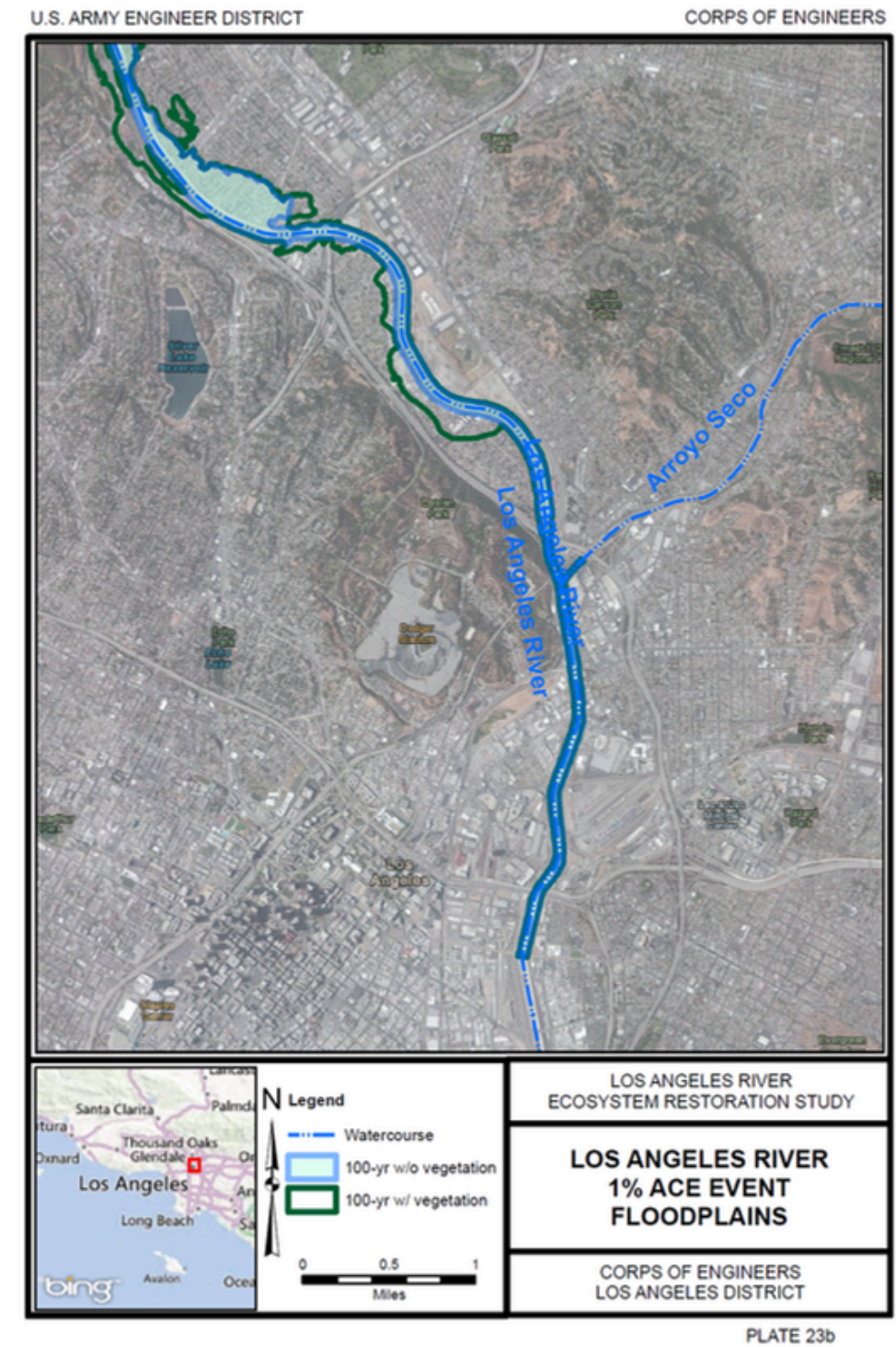
See City IFR Chapter 7, “River Hydraulics and Flood Management” and the Hydrology Appendix in the 2024 LARER report for more information.



Hydraulic Conditions



USACE HEC-RAS 50 Year Flood Event



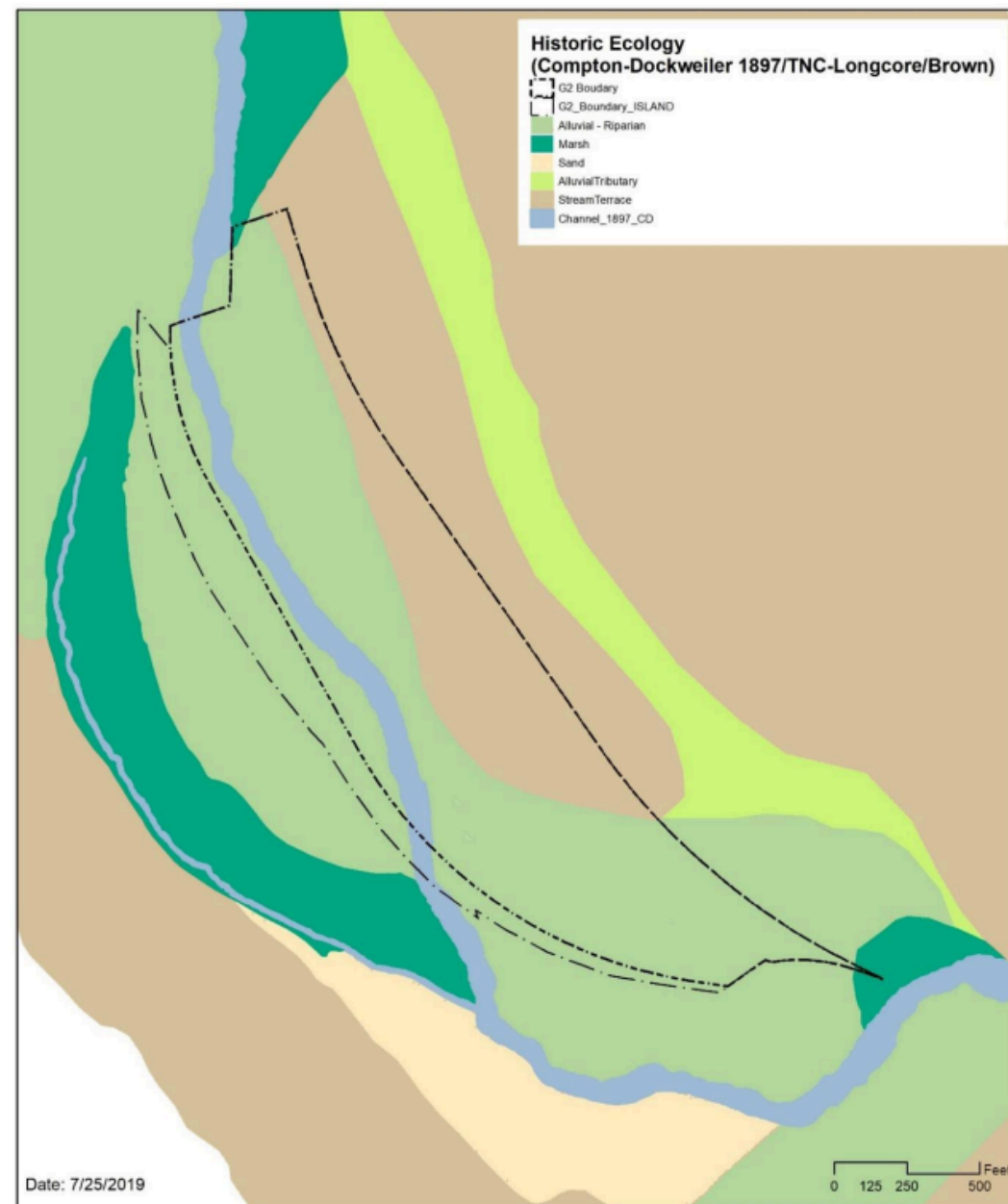
USACE HEC-RAS 100 Year Flood Event



Natural History

Prior to channelization, the area now occupied by Taylor Yard was once a wide floodplain that hosted a diverse patchwork of braided channels, marshes, thickets, and riparian woodlands that were highly dynamic. This site also included a relatively substantial tributary to the Los Angeles River, encompassing a watershed of around 2,000 acres originating in the current Eagle Rock area. The naturally high water table is what limited the full channelization of this reach of the LA River, resulting in the existing “soft bottom” covered in stones. Because this area has very shallow groundwater, it is an ideal location for creek daylighting and riparian restoration projects.

Figure 8-5. Estimated Historic Pre-European Settlement Conditions



Habitat Types

Taylor Yard has immense potential for quality habitat that hosts species targeted in LARER, the City IFR, and the California Environmental Flows Framework (CEFF). These also support habitat goals outlined in the USACE Ecosystem Restoration project Appendix G and Chapter 8.4 of the City IFR. Restored floodplain areas could support valley foothill riparian vegetation suitable for the least Bell's vireo. Upland habitat could support native grasslands, coastal sage scrub, and coastal oak woodlands. Other strategies, like vegetated terraces can support different habitats based on solar aspect, frequency of inundation from high flows, and hydrology from runoff and groundwater connections.

Additionally, the schemes include restoration of native fish habitat in line with projects and plans to recover native fish within the Los Angeles River watershed, including the National Marine Fisheries Service (NMFS) Southern California Steelhead Recovery Plan (2012), the U.S. Fish and Wildlife Service Recovery Plan for the Santa Ana sucker (2017), and the LA BOE Los Angeles Fish Passage and Habitat Design Structures Project. Low lying areas with access to clean groundwater, supplemented with river water or storm drain diversions, could support marsh and aquatic habitats. With suitable groundwater contributions, shade, and geomorphology, restored aquatic habitats may provide thermal refugia with suitable conditions for arroyo chub, Southern California steelhead trout, and Santa Ana sucker, including spawning and rearing stages.



Valley foothill riparian



Coastal oak woodland/Native meadow



Native wetland



Designs

This report presents a set of conceptual design alternatives developed to approximately 15 percent design completion. These concepts are intended to illustrate feasible approaches for advancing the Taylor Yard River Connection project, providing sufficient technical detail to evaluate overall viability, constraints, and opportunities, while remaining flexible to support further refinement through stakeholder input and subsequent design phases.



Design Assumptions

Several assumptions on construction and remediation were made to develop designs that were testable by physical and numerical models and measurable in terms of added habitat, excavated soil, and added channel capacity.

We assume the following has been completed:

- Full remediation of soils from lead, VOCs, and hydrocarbons using a combination of soil vapor extraction, land farming, capping, and cutoff walls to control groundwater interaction with the channel.
- Selected habitats would not interfere with remediation methods. For example, large trees and deep rooting plants are planted away from assumed engineered caps over lead polluted soils to preserve the cap's integrity.
- Pilot projects ensure project feasibility and safety, including consistent access to clean groundwater.
- While these designs avoid major structures of existing or in progress projects, affected agencies such as CDPR and LADWP will have reviewed and approved necessary alterations to their existing designs and infrastructure.
- The engineering of side channels, kayak launches, and terraces will be thoroughly reviewed to ensure they create no adverse hydraulic effects.



Full Scheme Plan



North Island Scheme

The North Island scheme enhances the previously recommended island scheme presented in the City IFR by addressing critical constraints, including the Bowtie maintenance buildings, G1 and G2 turntables, historic features, transmission line restrictions, hydraulic concerns, and soil pollution. Refinements also include a robust set of habitat and open space features, adapting the original island scheme to the form and program of the Paseo del Río. Reflecting the original intention of the City IFR Island scheme, this “island” is created by a smaller side channel with a section of naturalized terraces inspired by historically braided channels and terraces of the LA River. This island also foregrounds the riparian and marsh habitat restoration dependent on the cool, clean groundwater afforded by a full-depth side channel.

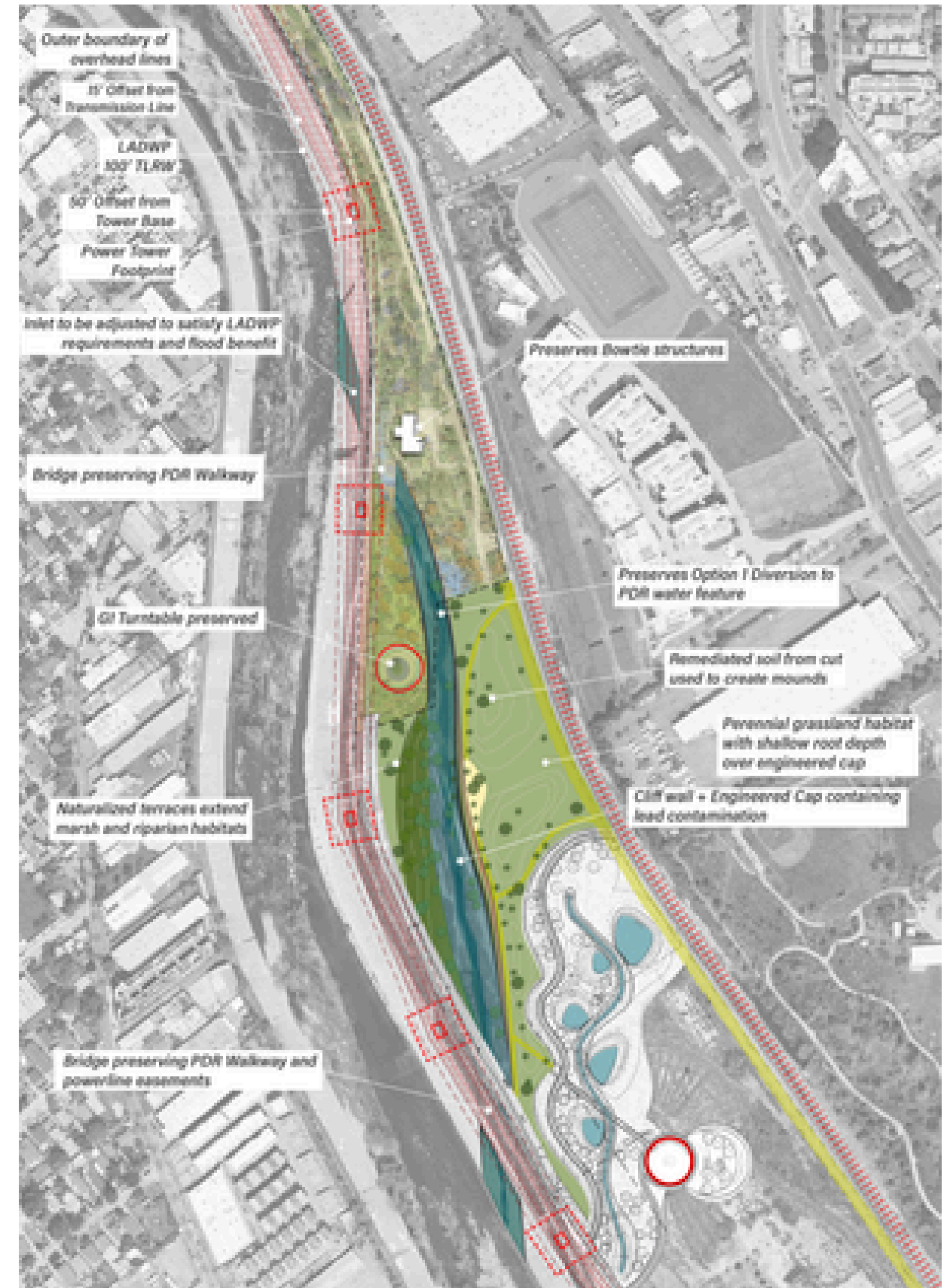
Full Scheme

Despite prior feasibility modeling, no effort had discovered a suitable island and side-channel geometry and placement (including inlet and outlet) that effectively addressed river hydraulics. The IIDL utilized several tools to refine the one-dimensional HEC-RAS modeling results found in the City IFR. The following modeling processes supported the proposed scheme:

- Physical hydraulic modeling of island alternatives in a 1:120-scale modular flume capable of simulating 5- to 100-year flood events.
- Coupled 2D numerical modeling in the USC-developed Celeris environment, refined for the G1–G2 reach.
- AR-based stakeholder visualization, allowing decision-makers to evaluate trade-offs among flood safety, habitat creation, and access in real time.

The work provides actionable data for design and regulatory coordination, reducing uncertainty and accelerating implementation readiness for the LARER Study’s preferred alternatives, as reflected in and advanced by the City IFR.

This full scheme’s primary feature is a 2000’-long full depth side channel that reaches groundwater and receives a portion of year-round base flows and storm flows from the river. This scheme accomplishes three goals. First, it improves flooding conditions adjacent to the G2 parcel. Second, it reintroduces the approved “island” scheme from the City IFR while still respecting LADWP’s transmission line constraints. Finally, it puts restoration first by incorporating naturalized terraces with a riparian forest on the southern tip of the island and proposes habitat compatible with the chosen remediation method on the lead-contaminated portions of the site. By cutting a side channel through the G2 parcel, this scheme builds on the accessible recreational path created by the Paseo del Río by creating a new way into the river.



North Island Plan



Recreation and Adjacent Open Space Integration

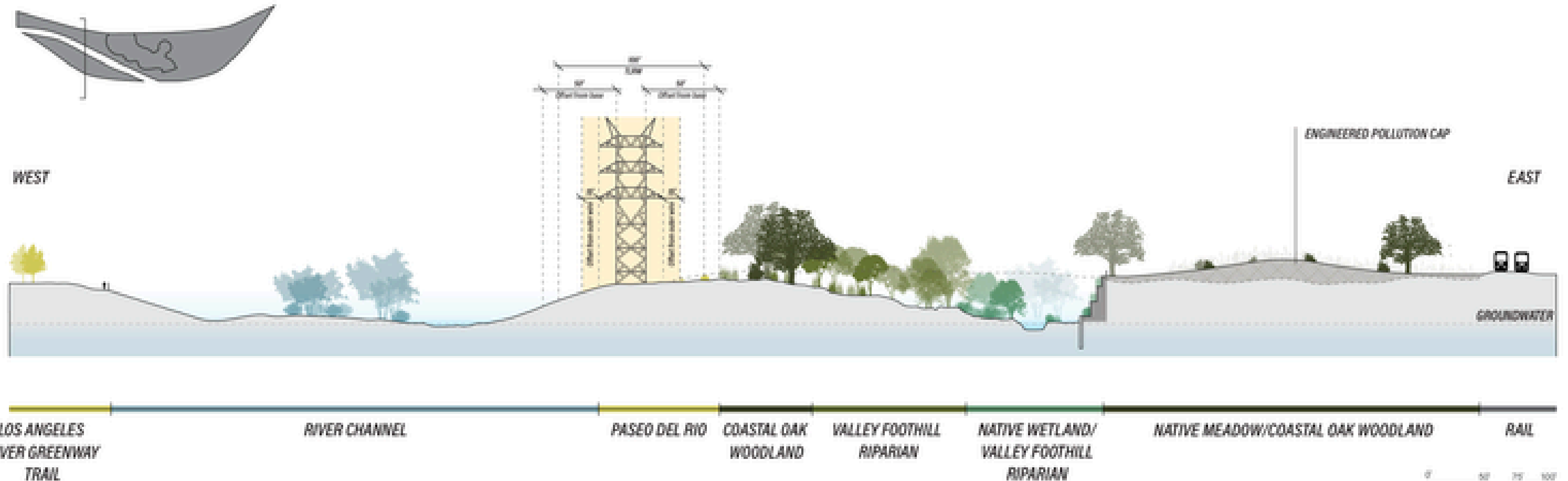
The side channel enhances the existing Paseo del Río River walk as it transitions between the G2 and G1 parcels. The bridges over the inlets and outlets allow visitors to look over and down into the river, not unlike the pedestrian bridge at the southern end of the G2 parcel. Once on the island, visitors will be “surrounded” by the river. In particular, river terraces leading down to the side channel with valley foothill riparian species offer a glimpse of a more naturalized river bank, unseen in other reaches of the LA River. The scheme also enhances the G1 turntable, turning it into a focal point of the island.

Across the island, atop the engineered cap is a perennial native grassland, a rare habitat in the LA basin. This habitat was chosen under the assumption that an engineered cap would be required in this area. The grassland will have limited trails to preserve the integrity of the habitat. One larger gathering space is located on its edge, adjacent to the side channel. Remediated soil can be used to create mounds throughout the site, creating visual interest and blocking sound from the railroad. The access road against the tracks serves as an alternate route across the G2 parcel. This grassland will be a stark contrast to the dramatic groundwater basin of the South Tributary scheme, turning the G2 parcel into a demonstration of southern California native habitats connected by the Paseo del Río.





SECTION KEY MAP



Accounting for Constraints

A side channel 50' wide with vertical wall inlets can pass between the proposed Bowtie Park structure and the nearest transmission line base, while still respecting the tower's 50' clearance. A 50' side channel outlet is also able to pass between the Paseo del Río and the nearest transmission line, while obeying the 50' clearance. Further structural engineering and discussion with LADWP are required to finalize the position and size of the inlet and outlet.

Bridges or crossings will be constructed to preserve the Paseo del Río's pedestrian walkway, while enabling access to the "island". These bridges also preserve the LADWP access road to the power towers. The bridge widths will be coordinated with the LADWP so as not to interfere with the maintenance and safety of the towers.

The side channel inlet is located on the G1 parcel and will require negotiation with CDPR on maintenance. It will also need to be coordinated with the Paseo del Río's storm drain diversions and pump stations. In addition to the G1/G2 historic turntables, a remnant of a storage tank foundation

and wall crosses the G1/G2 parcel boundary and lies in the path of the North Island side channel. Further discussion with CDPR is required regarding the feasibility of this demolition. However, given site constraints, this report concludes that an inlet between the G1 maintenance buildings and G1 turntable is the ideal location.

The flow regime in the side channel will depend upon future mainstem flow recommendations from the LA River CEFF process, including ensuring that diversion does not reduce summer kayak passage depth. Alternative flow regimes should be evaluated in future phases of work, including limiting flow to wet-season base flows. Such conditions may benefit native amphibians that favor such ephemeral channels and/or may maximize the portion of cool groundwater in the side channel during summer, favoring native fish species. Alternatively, designs could support sufficient depth for summer kayak passage in the side channel.



North Island Habitat

By diverting a small amount of dry and wet-season base flow from the river to the side channel, the favorable hydraulic and hydrologic conditions there could allow for high quality riparian and aquatic habitat that is not limited by the extreme flows that occur within the mainstem. This scheme restores approximately 6 acres of coastal oak woodland/native meadow, 2 acres of valley foothill riparian, and 3 acres of native wetland and river wash mixed with bars of willow scrub throughout the side channel habitat, supporting least Bell's vireo and other target species identified by the CEFF and LARER plans. Final habitat type is contingent upon the chosen remediation methods and their resulting constraints or limitations.

The side channel imitates the naturally multi-threaded channel character of the Los Angeles River. By optimizing the side channel flow regime to be cooled with groundwater and shaded with vegetation, a thermal refuge for native fish and other aquatic species may be created. Further optimization of the side channel flow regime may provide fish passage benefits during periods of high flows and favorable substrate and channel conditions for spawning and rearing of native fish, potentially including arroyo chub, Santa Ana sucker, and southern California steelhead. Successful aquatic habitat will also depend on completion of fish passage projects planned throughout the river, restoration of native fish populations within the Elysian Valley, and control of invasive species such as largemouth bass. While the side channel construction will disrupt ~1 acre of G1 least Bell's vireo habitat, it will add over 8 acres of varied restored habitat types bridging the G1 and G2 parcels.

Habitat Key

NM



**Coastal Oak Woodland/
Native Meadow:
6 Acres**

FR



**Valley Foothill Riparian:
2 Acre**

OW

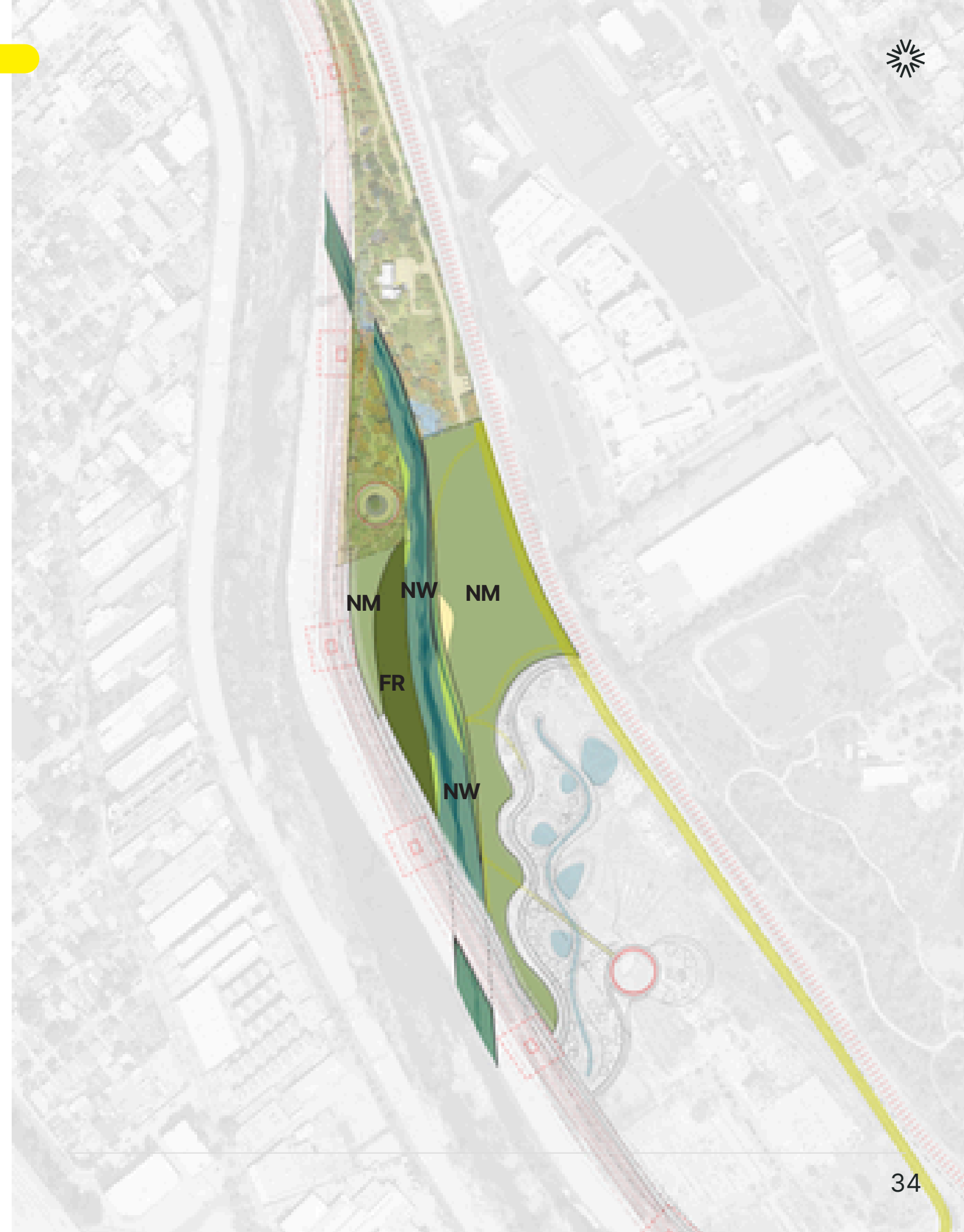


**Valley Foothill
Riparian/Open Water:
2,000' ft length**

NW



**Native Wetland/Open
Water:
3 Acres**





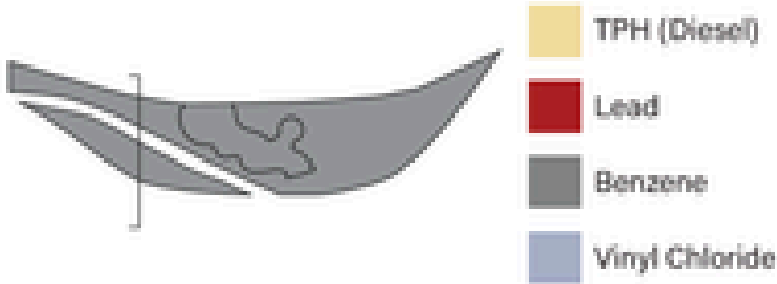
Remediation

The area affected by the North Island side channel has low levels of VOC contamination but high levels of diesel and lead. The side channel is positioned to avoid the highest concentrations of lead while still being hydraulically feasible. Depending on the approved remediation plan, lead in other areas would likely be hauled away or stabilized and capped.

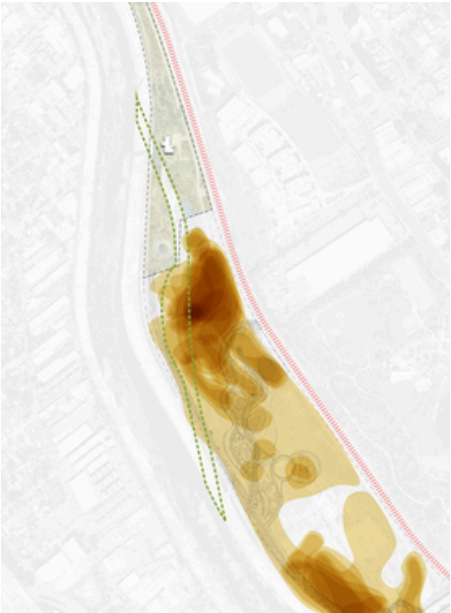
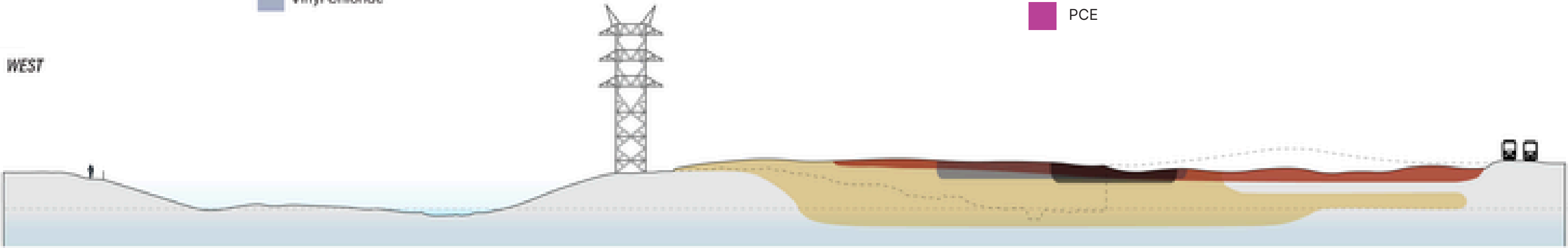
The side channel similarly skirts most of the deeper, high-concentration diesel contamination, though the depth of contamination and its impact on daylight groundwater remain to be determined. Further studies on groundwater dynamics are required to ensure that no pollution seeps into the side channel.

SECTION KEY MAP

POLLUTANT KEY



WEST

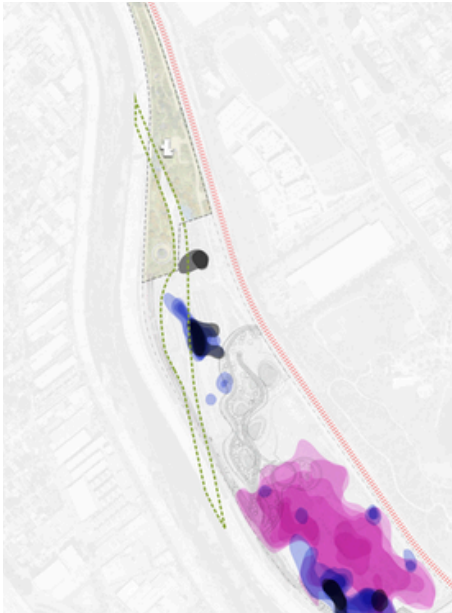


TPH

Total Soil Displacement:
175,000 Cubic Yards
Hydrocarbon contaminated
soil: 48,000 Cubic Yards

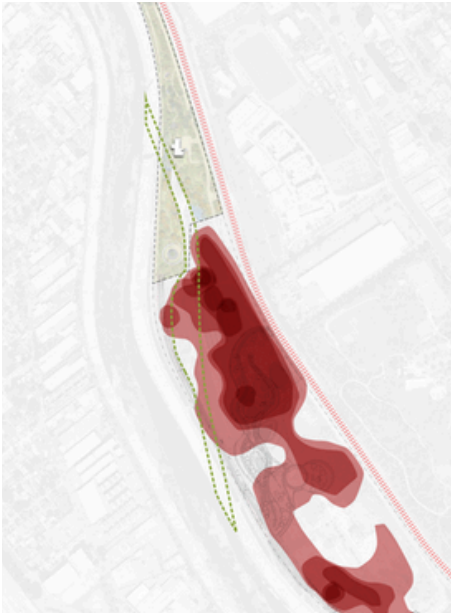
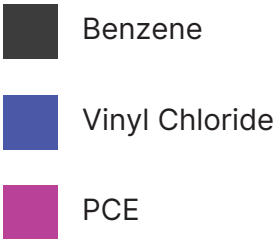


Diesel



VOCs

Total Soil Displacement:
175,000 Cubic Yards
VOC contaminated soil:
9,000 Cubic Yards



Lead

Total Soil Displacement:
175,000 Cubic Yards
Lead contaminated soil:
22,000 Cubic Yards



Lead



Hydraulic Analysis

Integrated hydraulic analysis clarifies and improves upon the previous City IFR island scheme by identifying a side channel configuration that avoids major constraints and improves localized flood protection. This channel placement and hydraulic performance were analyzed through the lab's physical and numerical models. Previous HEC-RAS models show the river channel underperforming in this area, flooding the neighborhood adjacent to the G2 parcel in a 50-year flood event. While the City IFR had rough cross-sectional analyses on the water speed and water surface effects of a side channel, a thorough study on the most ideal island placement and configuration had not been done. Additionally, several new constraints have arisen since the publication of the City IFR that would interfere with the previous island design, notably the Paseo del Río and the high cost to move the power towers.

These numerical model studies showed some effectiveness of a southern side channel, however the number of constraints (including the orientation of the Paseo del Río, the placement of the power towers, and the existing pedestrian bridge, primarily), makes a southern side channel an unattractive option. In contrast, the area north of the Paseo Del Río offered more flexibility in terms of channel orientation, inlet, and outlet. In nearly all of the northern side-channel permutations, there was a reduction or elimination in flooding on the side opposite the north island compared to the existing channel tests. These tests did not resolve overtopping adjacent to the pedestrian bridge, with that area being particularly susceptible to overtopping due to local topography and velocities.

On the physical model, the northern side channel had a similar positive effect on flooding directly across from the side channel. Several iterations with varying levels of vegetation, terrace roughness, and inlet and outlet sizes also highlighted the side channels' effect on downstream flooding. While all these tests are preliminary, requiring further iterations, calibration, and verification with HEC-RAS, they demonstrate the positive effects of a side channel on local flooding.



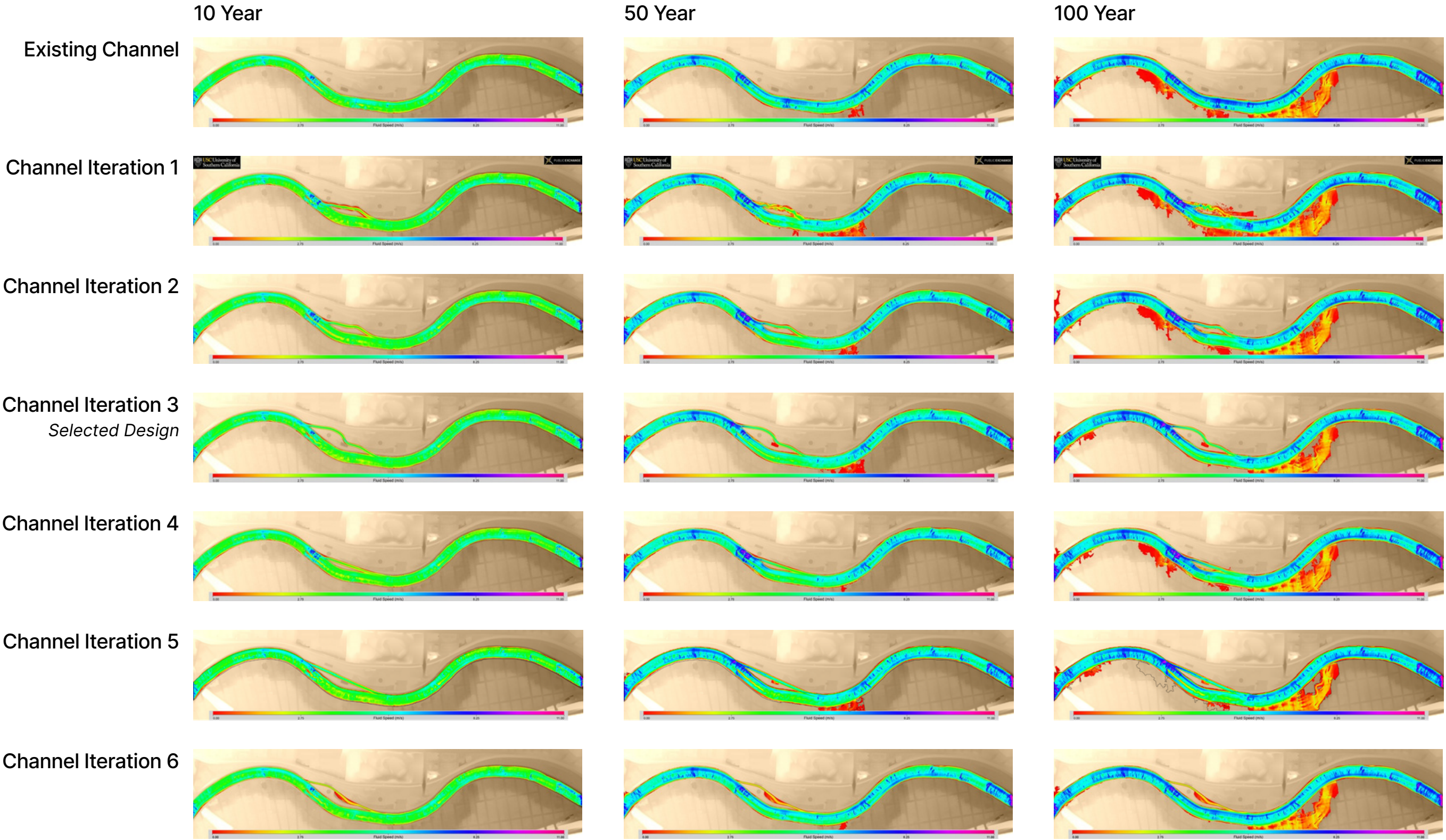
OVERHEAD IMAGE TRACE



Example Physical Model Hydraulic Test Trace. Image shows a 50 year flood event running through the North Island scheme. For full physical model results, refer to Appendix C, Physical Model Results.



Celeris Matrix





Pilot

To construct a full depth side channel with habitat benefits in this portion of the site, hydrocarbons and other groundwater pollutants must be prevented from entering the side channel. As a first step, the north island pilot is a way to test and confirm a successful remediation plan for this site, ensuring that daylight groundwater is clean and suitable for habitat and recreation. The pilot tests the effectiveness of a cutoff wall and its impacts on the groundwater flows into the river, as such a wall would inevitably alter the groundwater dynamics in this stretch of the river. It would also test and refine the remediation plan for the remaining length of the side channel. Remediated areas would also be an ideal place to test and construct naturalized terraces planted with riparian forest. The final pilot would consist of naturalized terraces leading down to a small groundwater basin and the pilot retaining and cutoff wall. Given the extended timescale needed to engineer and construct the diversion inlet and outlet, a pilot project within the G2 parcel boundary could help establish the final side channel path.



Pilot Features

- Pilot 30' cliff or terrace wall with groundwater cutoff wall
- Groundwater basin
- Naturalized terraces with riparian forest

Constructibility Conclusions

Relative to the Island scheme developed in the City IFR, this scheme has a number of improvements. In addition to improving local flood protection (see pg 37), it is anticipated that the updated North Island proposal presented here reduces total excavation volume by over 50%, hotspot (lead and hydrocarbon) removal requirements by approximately 30-40%, and cap installation areas by over 50%. Given these reductions, it is anticipated that remediation costs will decrease by over 50% relative to those for the Island scheme. Moreover, apart from the need to create channel inlets and outlets, the scheme minimizes impact on the existing concrete sidewalls in the main channel.

Some physical constructibility challenges remain. The North Island scheme was designed to minimize impact on the existing LADWP high-voltage towers. However, it will require the construction of bridges covering the channel inlet and outlet to maintain LADWP access and the maintenance road. The possibility of a groundwater connection between the side channel and the heavily polluted northeastern section of the site will require extensive engineering to minimize pollutant transfer. To push this scheme to 30% design and beyond, further consideration of the required engineering and costs to construct the side channel is needed. Additionally, further site testing is recommended to understand the dynamics of pollution and groundwater in this portion of the site.



South Tributary Scheme

The southern tributary is centered around a 30'-deep groundwater basin, featuring a riparian forest leading to a marsh and 1000' of constructed/restored stream connected to the LA River via a culvert. Within the culvert, a specialized fish ladder will be designed, preventing invasive bass and other species from entering the tributary while still promoting steelhead and other native fish passage.

Full Scheme

The restored tributary reflects the historic tributary draining the Eagle Rock area into the Los Angeles River on or near Taylor Yard (the location of this confluence naturally varied over time). The restored tributary is supplied by groundwater seeps present in the area and may be further supplemented with discharge from the adjacent treatment wetland (that also is fed by the Eagle Rock drainage area of the historic tributary) or a piped diversion of some base flow from the North Side Channel. Inside the basin, the marsh and stream will be kept shaded and cool by the riparian forest canopy, their position against a 30' constructed cliff wall, and the optimal contribution of cool groundwater. Walnut Creek below Puddingstone Reservoir in the San Gabriel River watershed suggests that streams with similar shade and groundwater conditions within warm urban microclimates may support favorable temperature conditions for native Southern California steelhead spawning and rearing if designed appropriately (Stillwater Sciences, 2024). The cool, moist northeast aspect of the cliff wall may also be suitable for unique vegetation such as native ferns, mosses, and dudleya species.

This stream, marsh, and cliff configuration also discourages disturbance from visitors, prioritizing the restoration of habitat. Pathways will be carefully laid out allowing visitors to view and observe the basin from above without disturbing the restored habitat while also expanding on the Bowtie and Paseo del Río paths. The southern tributary scheme fills in the gap between the wetland and pavilion areas of the Paseo del Río with high-quality restored habitat and a unique experience that integrates the recreational and ecological aspects of the LA River.

Full Scheme Features:

- Extensive marsh, valley foothill riparian, and aquatic habitats
- Observation platforms and trails surrounding the basin
- Culvert with a fish ladder that allows native fish access
- Groundwater-fed, with potential supplement from Paseo del Río wetlands or diversion of flow from the North Side Channel



South Tributary Plan



Recreation and Adjacent Open Space Integration

Maintaining the groundwater basin's habitat requires dedicated stewardship and isolation from direct recreational access, such as walking trails. Limited pathways will be carefully laid out, guiding visitors through a selected transect of restored habitats, from oak scrub woodland to riparian woodland and willow scrub, concluding at an observation platform above the marsh, just below the turntable feature of the Paseo del Río. The scheme will extend the Paseo del Río walking path, creating a shaded

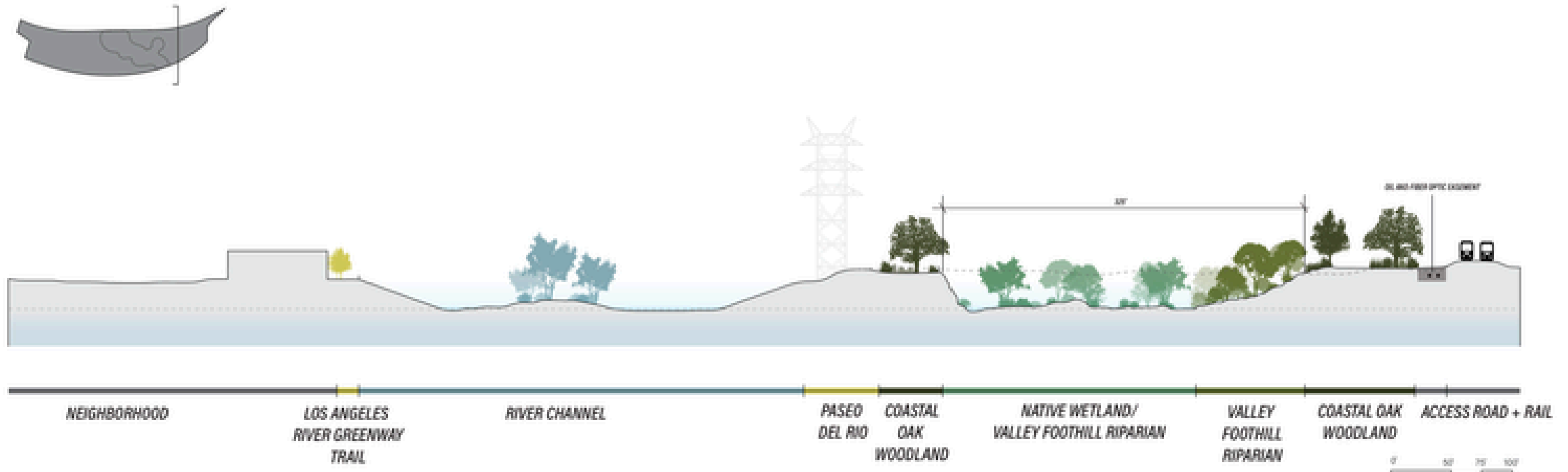
observation deck atop the basin's cliff wall that offers a panoramic view of the South Tributary, suitable for bird watching and monitoring seasonal and successional change. This scheme plays an essential role in filling the gap between the Paseo del Río's wetland and pavilion areas with high-quality habitat, with select trails and observation points providing educational and stewardship opportunities.



View of South Tributary Scheme with proposed Paseo del Río pavilion and walking path.



SECTION KEY MAP



Southern Tributary Section

Accounting for Constraints

The southern portion of the G2 parcel is bound by the train tracks and access road to the east, the upcoming Paseo del Río wetland to the north, and Kerr Road to the south. Along the train tracks are fiber optic and oil pipeline easements, as well as an access road. The Paseo del Río pavilion and parking lot will also be located in this portion of the site. These features, along with the patterns of pollution, shape the form and location of the groundwater basin. Due to these constraints, the southern tributary has no direct surface connection to the main channel, instead gaining its water from groundwater, supplemented by storm drains, North Island side channel, or the Paseo del Río wetland. This proves beneficial, as the final scheme avoids crossing the TLRW and the Paseo del Río while also allowing a specialized culvert and fish ladder to slip through the levee wall with minimal impact. This keeps the restored marsh safe from high velocity flows, and the fish ladder limits access to invasive bass (see South Tributary Habitat section).



Southern Tributary Habitat

The primary restored habitats for this scheme will be native wetlands surrounded by naturalized terraces with valley foothill riparian vegetation that supports least Bell's vireo habitat. Upland portions of the site will host coastal oak woodland and native grasslands atop engineered soil pollution caps (if necessary). Within the basin, the scheme features a 1000'-long restored stream in the vicinity of the wash that historically drained the approximately 2000-acre Eagle Rock watershed. The stream is shaded and buffered by riparian woodlands and marsh, with the goal of achieving suitable conditions for spawning of steelhead trout, Santa Ana sucker, and arroyo chub, and favorable conditions for native amphibian and reptile species, including the Southwestern pond turtle. Temperature analysis of Walnut Creek below Puddingstone Reservoir in the San Gabriel River watershed suggests that sites with similar shade and groundwater conditions within warm urban microclimates may support favorable temperature conditions for native Southern California steelhead spawning and rearing if designed appropriately (Stillwater Sciences, 2024).

Further evaluation of flow contributions from groundwater, and potential diverted flow from the North Island side channel or Paseo del Río wetland discharge, should be completed to optimize depth, temperature, and substrate conditions for key life-cycle stages of these native fish species. A fish ladder at the connection through the levee wall with the mainstem of the LA River will prevent invasive fish from entering the stream. Habitat type and scale are also contingent upon successful study and remediation of pollutants in the soil and potentially in the groundwater. The drawn scheme assumes full remediation, treatment, or removal of pollutants.

Habitat Key

CW



Coastal Oak Woodland:
9 Acres

FR



Valley Foothill Riparian:
3.5 Acres

NW



Native Wetland:
3 Acres

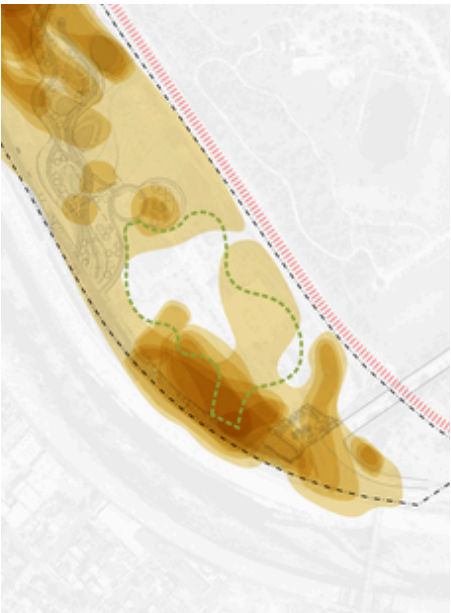




Remediation

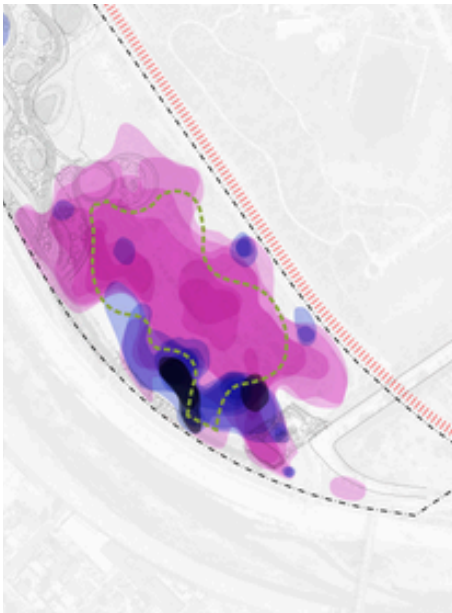
The southern portion of the site was the former home of the Taylor Yard “diesel shop” and is the source of several pollutants (City IFR). While lead and diesel are limited in this area compared to other areas in the G2 parcel, there is a significant concentration of VOCs near the proposed groundwater basin-to-river connection. Current studies suggest that most of the VOC in soil have not reached groundwater. This is promising for future restoration and daylighting plans, as certain prevalent VOCs identified on site, such as Tetrachloroethylene (PCE), are significantly more difficult to remediate once mobilized in the water table.

The southern tributary basin is positioned to minimize the excavation and hauling of diesel- and lead-contaminated soil. A host of remediation methods, such as SVE, and soil treatment are applicable in the remaining areas of contamination.



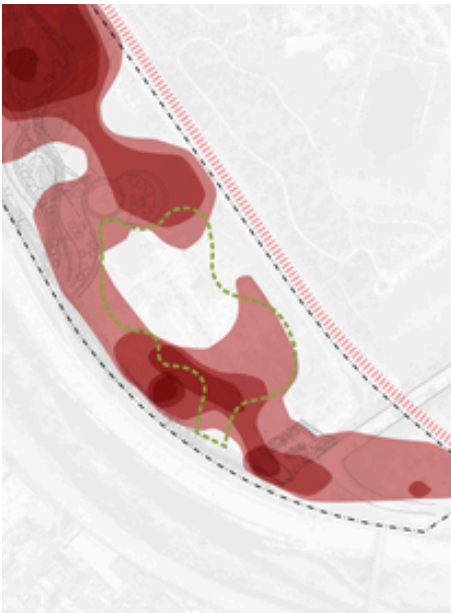
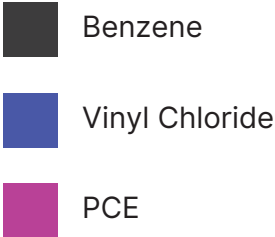
TPH

Total Soil Displacement:
175,000 Cubic Yards
Hydrocarbon contaminated
soil: 48,000 Cubic Yards



VOCs

Total Soil Displacement:
175,000 Cubic Yards
VOC contaminated soil:
9,000 Cubic Yards



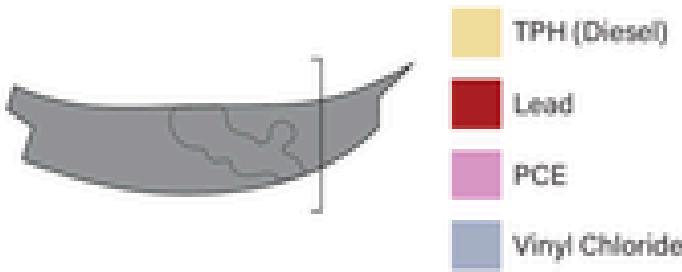
Lead

Total Soil Displacement:
175,000 Cubic Yards
Lead contaminated soil:
22,000 Cubic Yards



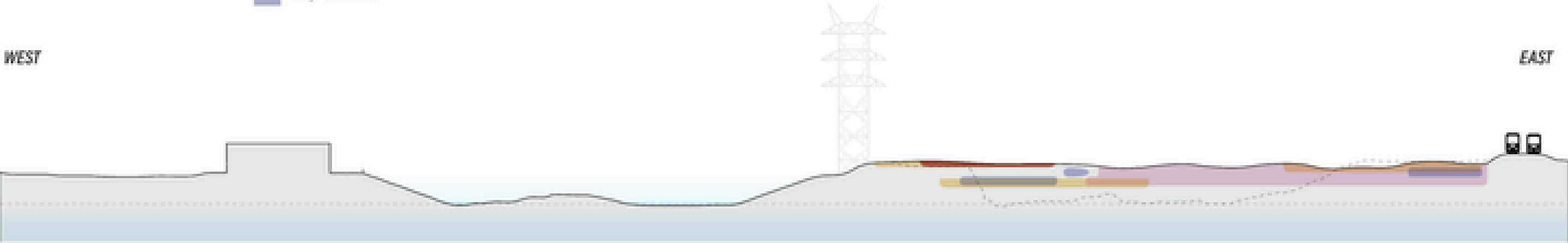
SECTION KEY MAP

POLLUTANT KEY



WEST

EAST





Pilot

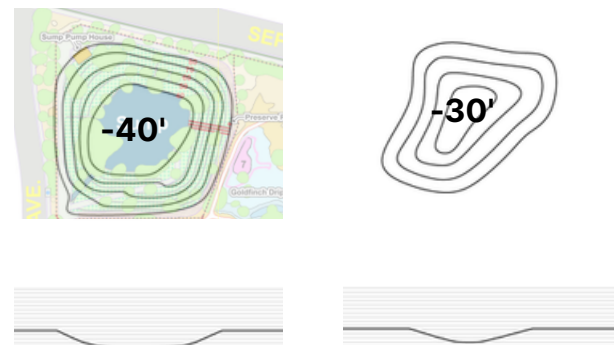
The goal of this pilot scheme is to further understand the soil and groundwater dynamics of the site. While certain tests have been done to understand subsurface activity in Taylor Yard, it is not fully known if a 30' basin would supply a sufficient amount of water to create marsh habitat or if supplemental water from storm drain diversion or the Paseo del Río wetlands is required. This pilot study will answer these questions.

This portion of Taylor Yard was a former “diesel shop” with high concentrations of VOCs in its former footprint. A work plan will be created to the satisfaction of DTSC to fully remediate the portion of the site relevant to this pilot project. To aid in this, the pilot is situated in an area with limited lead and hydrocarbon pollution. The basin will be excavated 30' below surface grade, exposing groundwater. For reference, the sump basin in the Madrona Wetlands in Torrance has a similar scale and depth. This pilot tests both the soil and groundwater characteristics and the remediation work plan for the rest of the site.



Pilot Scheme Features

- Pilot groundwater basin
- Riparian forest and marsh



Madrona Sump Basin (above left) scale reference to proposed Pilot Basin (above right)

Source: City of Torrance

Madrona Marsh Sump Basin (below)

Source: Alexander Robinson



Constructibility Conclusions

The South Tributary proposal reduces total excavation volume by roughly 40% relative to the Island and Soft Edge schemes proposed in the City IFR. Lead and hydrocarbon hotspot excavation and removal volumes are reduced by over 30%. VOC remediation remains a challenge given the large volume of VOC-impacted soil to be disturbed to create the tributary. Depending on the extent and depth of the VOC plume, it is anticipated that remediation costs for this scheme will be 30-50% lower than those for the Island and Soft Edge schemes. Additional challenges include grading to ensure appropriate drainage of the groundwater to the main channel, understanding potential backflow implications during high flow events in the main channel, and designing interactions with the Paseo del Río wetland.

Discounting the significant investment and time needed to remediate the site, the southern portion of the G2 parcel is relatively free of the constraints present in the other schemes.



Terracing

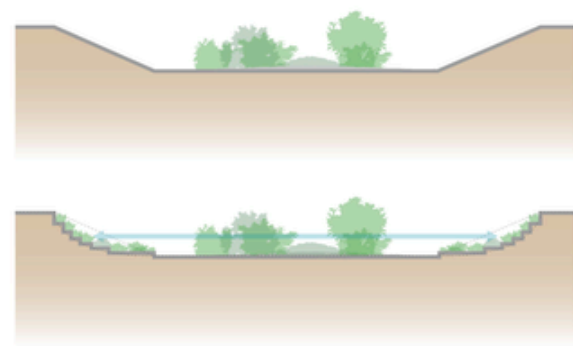
Terraces have been proposed in many previous schemes for the LA River. Building upon earlier design efforts, this scheme proposes terraces with a “parabolic” profile, in which the width and height of each step changes inversely as they approach the top of the channel. This increases the cross-sectional area of the channel, thus increasing capacity while providing more opportunity to introduce habitat and recreation areas.

Full Scheme

The terraces contain various floodplain habitats based on their elevation. The G2 parcel provides a public-facing proof of concept for terracing that could expand to other sections of the LA River. Integrated into our scheme are two kayak launches/take-ins at the northern and southern ends of the G2 parcel. These also serve as pedestrian access points that are connected by an in-channel “Wild” river walk. Cutting back the terraces adjacent to the kayak launches also creates a hydraulic refuge from the main channel, turning the launches into valuable habitat features during high-flow events. While terracing reduces direct access to the river channel, it is possible to design a sloping terrace system that maintains the parabolic profile. While this prototype needs to be further tested, it creates additional channel capacity and allows continuous ramped access to the channel bottom.

Full Scheme Features

- Parabolic terraces increase channel capacity
- System can be expanded beyond the G2 parcel
- Terraces are planted with native vegetation dependent on height and water regime.
- Integrated ramps or kayak launches preserve pedestrian access to the channel bottom and provide hydraulic refuge during high-flow events.
- The “Wild” river walk runs at the bottom of the terraces, between access points.

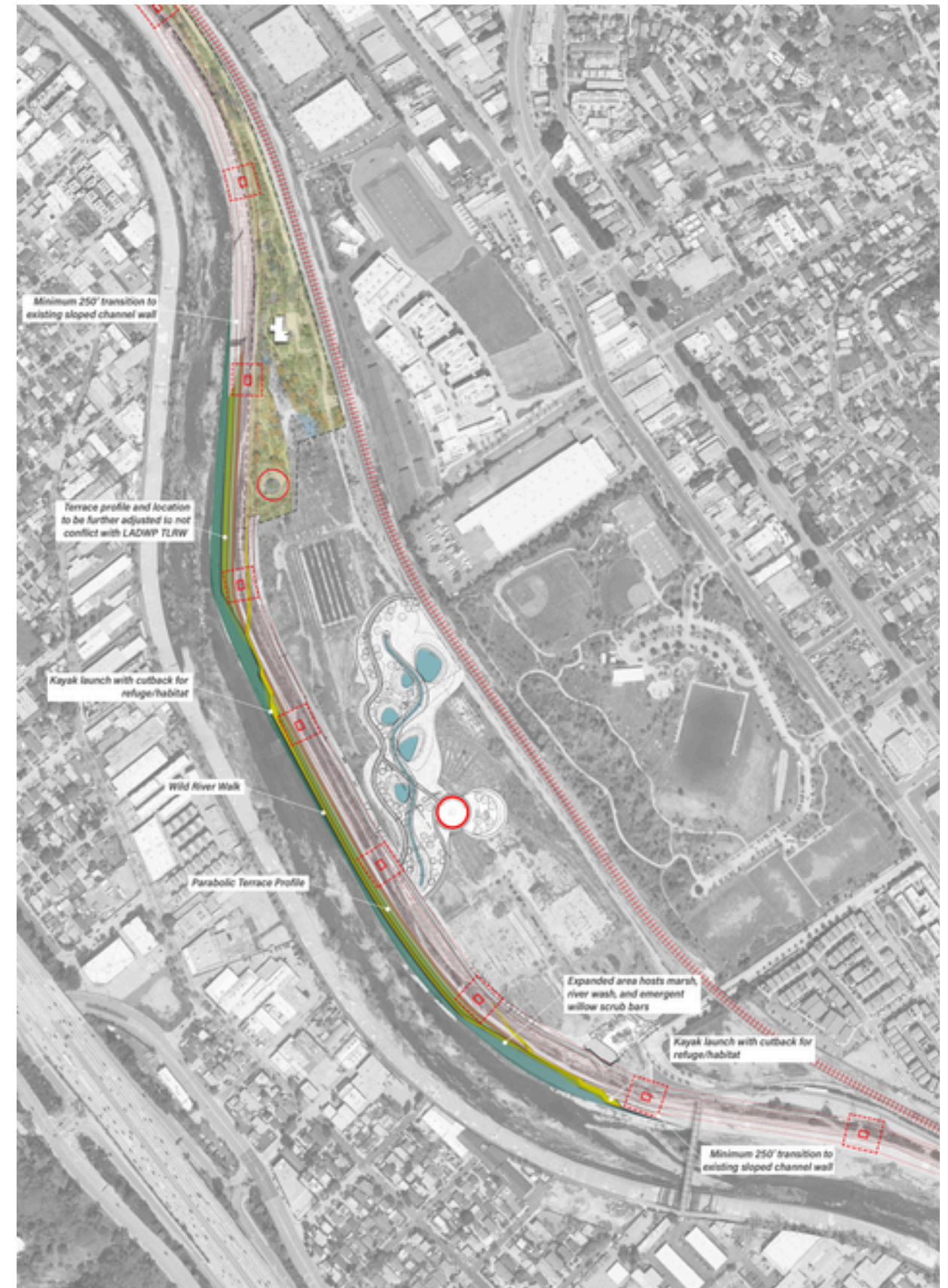


Trapezoidal Main Channel

Area	645 m ²
Hydraulic Radius	5.8 m
Max Flow ($n = 0.05$)	2210 m ³ /s 78000 cfs

Terraced Main Channel

Area	750 m ²
Hydraulic Radius	6.0 m
Max Flow ($n = 0.05$)	2630 m ³ /s 92800 cfs



Terrace Plan



Parabolic Terrace Render



Sloped Parabolic Terrace Render

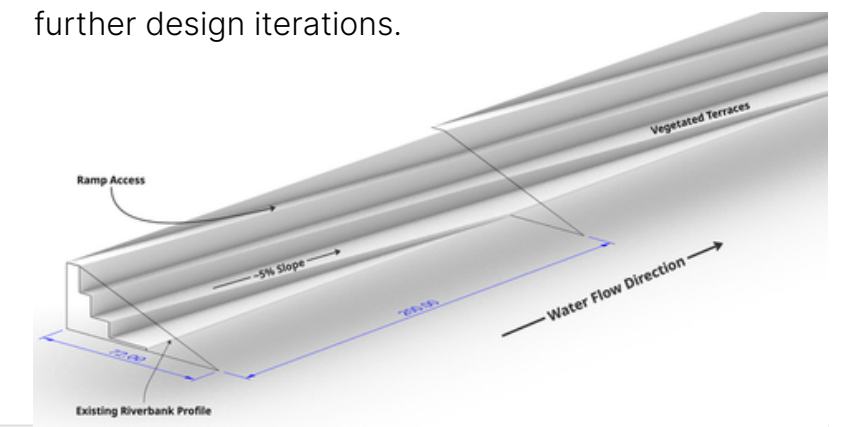


Recreation & Adjacent Open Space Integration

While terracing limits access to the river basin compared to sloped channel walls, it offers a more focused river experience by limiting access to the kayak launch and retrieval ramps. (Note: this is not a limitation of the sloped terraces). This controlled access allows for a safer river experience. The extended river bottom creates space for the “Wild” river walk, composed of a trail adjacent to the lowest terraces that weaves through bars of willow scrub that shift and change over time. This scheme, more than the others, prioritizes interaction with the river, allowing pedestrians, cyclists, fishers, and kayakers a direct and protected way to engage with the river.

This study proposes two options, for terracing along the G2 parcel. The first is a set of linear terraces with a parabolic profile i.e. terraces closer to the channel bottom are wider while upper terraces are narrower. This has been tested on the physical hydraulic model and Celeris, both of which show promising results, lowering flooding.

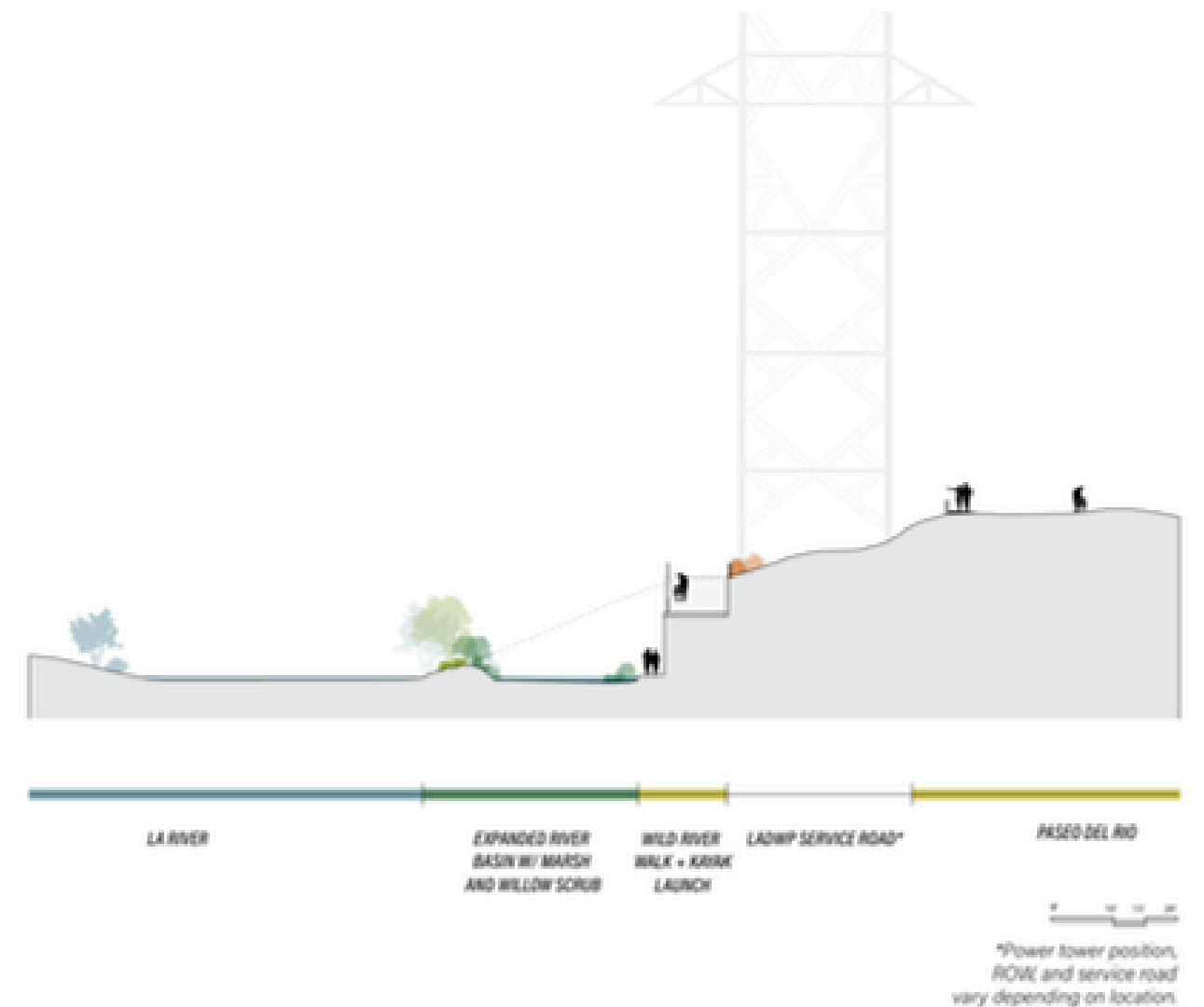
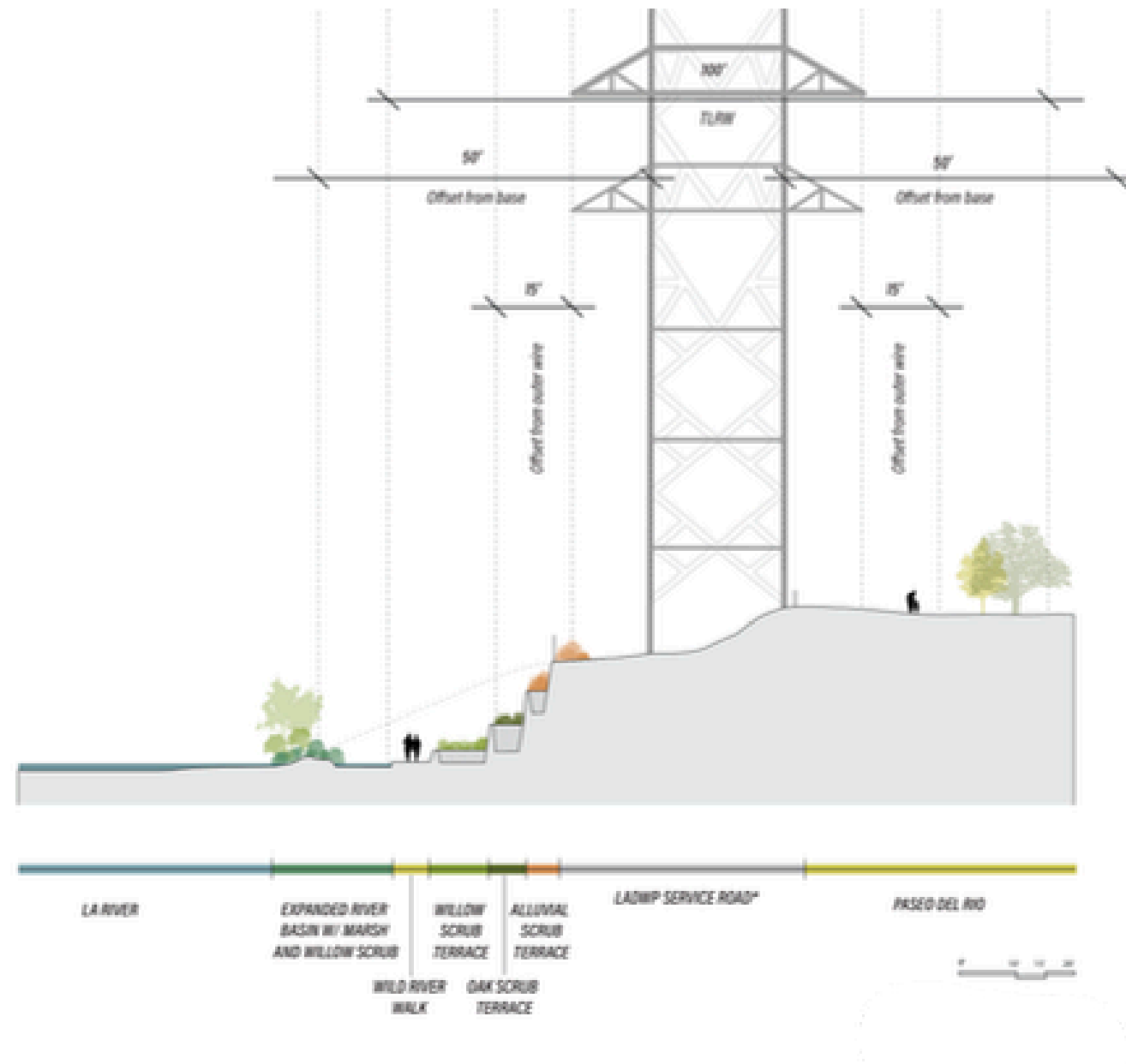
The second, more novel option, is a set of continually sloping terraces that maintain a parabolic profile. This would allow continual, accessible access to the channel bottom. This scheme will be tested in further design iterations.

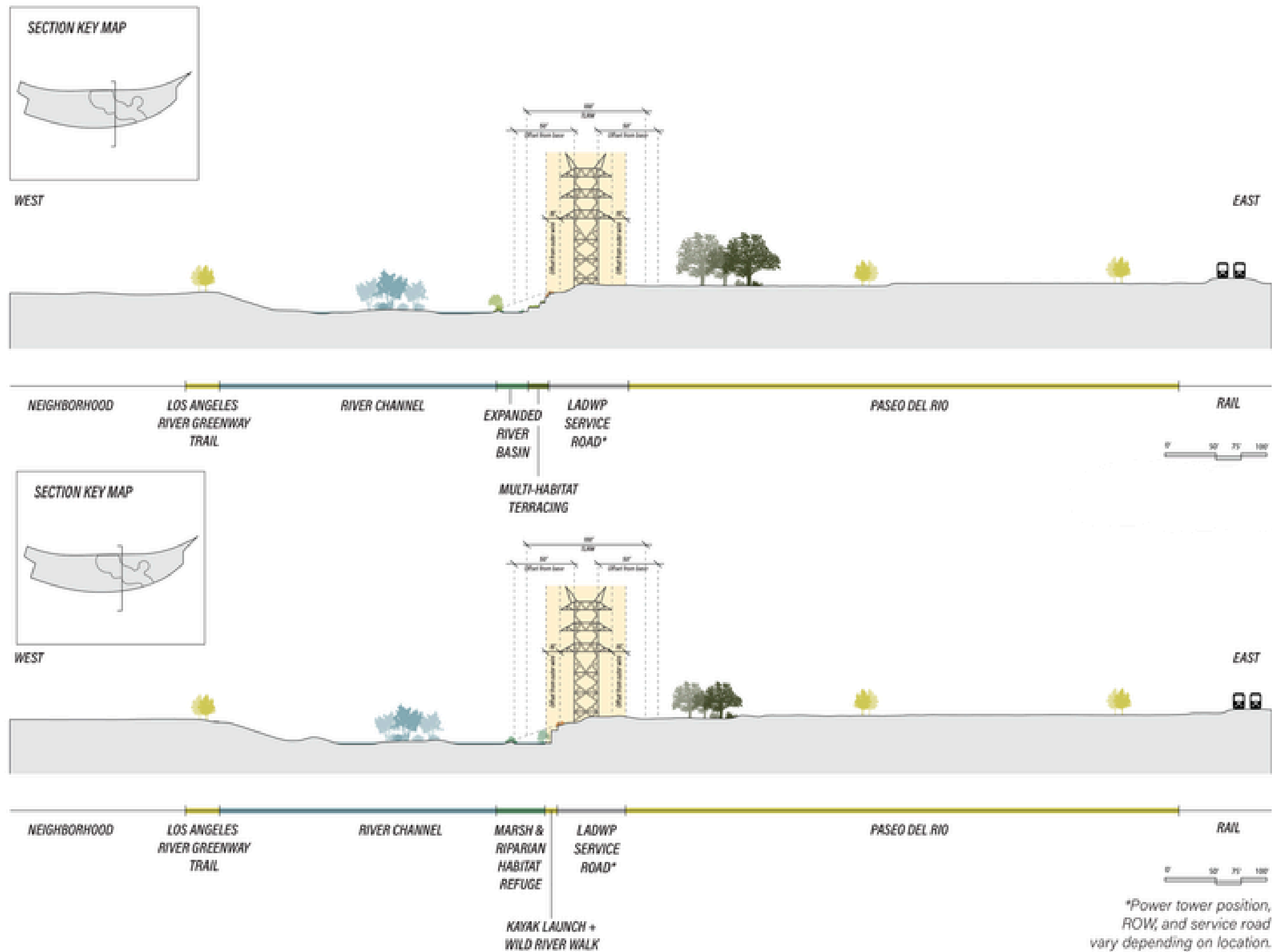




Accounting for Constraints

While the previous schemes have adapted to meet the requirements of LADWP, any modifications to the channel wall would impact the TLRW and the 50' offset from the tower base. Further discussion with LADWP and structural engineers is required to ensure the terraces will not have a negative impact on the integrity of the transmission towers and lines, while also providing adequate flood protection and room for habitat.







Terracing Habitat

Vegetation within the terraces is determined by each level's height from the channel bottom and its access to supplemental water. There is potential for certain sections of terracing to receive diverted stormwater which would change the supportable habitat. As drawn, the terraces have three steps. The upper two terraces would have native meadow and low lying oak scrub vegetation. The lowest step would have willow scrub, marsh, or wet meadow vegetation. In order to comply with LADWP TLRW requirements and preserve hydraulic performance, vegetation on the terraces would be maintained below 15'. Within the refuge of the kayak launch, marsh habitat would be restored and maintained per LADWP requirements.

Habitat Key



Native Meadow
0.75 Acres



Valley Foothill Riparian:
1 Acres



Native Wetland:
2.5 Acres





Hydraulic Analysis

Multiple terrace profiles and extents were tested on numerical and physical models. While both Celeris and the current physical model have certain limitations when modeling such a proposal, both models show that terracing has positive effects on the flood capacity in this reach of the LA River.

Within the numerical model, several tests were performed with terraces on the east, west, and both banks of the river at various lengths and with various profiles. In general, shorter stretches of terracing, directly across from flood hotspots, still provide some benefit; however, terracing is more effective when it is applied to longer lengths of the channel. Although there is greater flood capacity when both sides of the river are terraced, tests with terracing only on the eastern channel wall running the length of the G2 showed improvement and did not negatively affect the hydraulics in the model.

The physical model affords a higher resolution when creating the parabolic profile of the terrace. It also makes it possible to represent and adjust the effect of vegetation on each of the terraces. Based on this series of tests, adding resistance (vegetation) to the lower terraces improves the flood capacity of the channel compared to the existing sloped channel walls. Bare terraces performed worse than the existing channel wall, with overtopping increasing near the pedestrian bridge. Half-vegetated terraces, achieved by covering half the terrace surface with roughness tape, improved flooding, reducing overtopping extents throughout the model. Fully vegetated terraces with roughness tape covering the majority of the terrace surface further improved flooding, eliminating upstream overtopping near Newell St. and reducing flooding near the pedestrian bridge.

While the full hydraulic effect of vegetated terraces is not known, both the physical and numerical models show improvement compared to the existing channel's flood capacity. The physical model results, while not conclusive, emphasize the potential impact of certain vegetation types on flood patterns and must be further studied to determine the optimal terrace profile and vegetation regime.

OVERHEAD IMAGE TRACE



Example Physical Model Hydraulic Test Trace. Image shows a 50 year flood event with terraces against the G2 parcel. For full physical model results, refer to Appendix C, Physical Model Results.



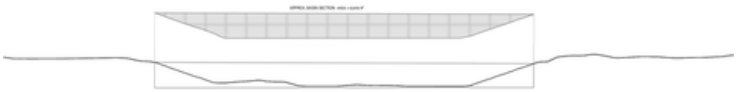
Celeris Matrix

Cross Section

Terracing Extent

100 Year

Existing Channel



V1
Terrace
Both Sides
Whole Channel
Profile 3



V2
Terrace
West
Whole Channel
Profile 3



V3
East
Whole Channel
Profile 3



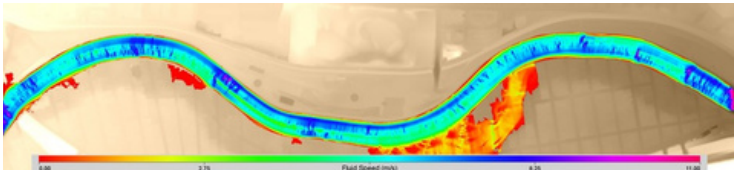
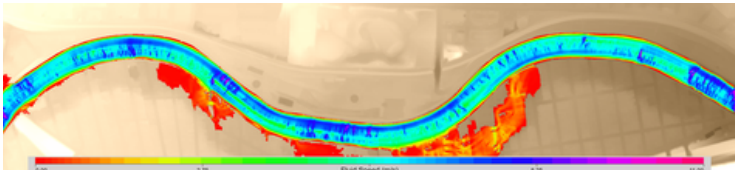
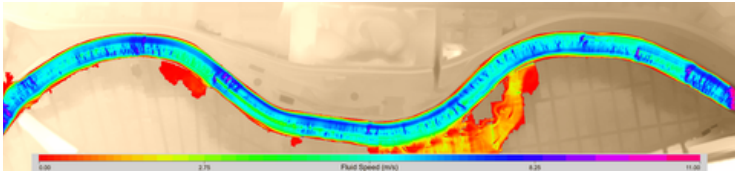
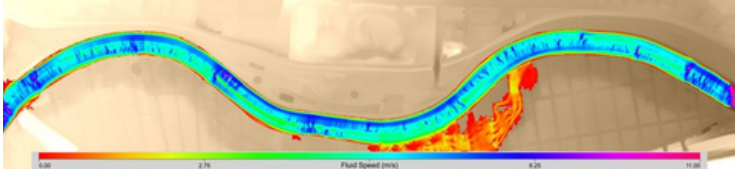
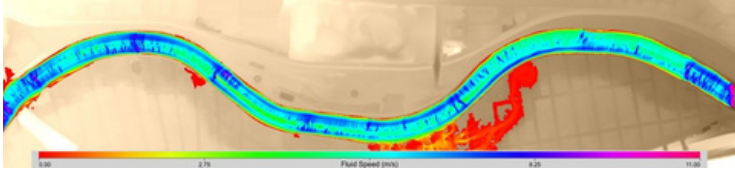
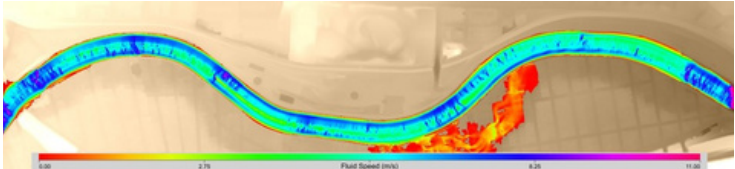
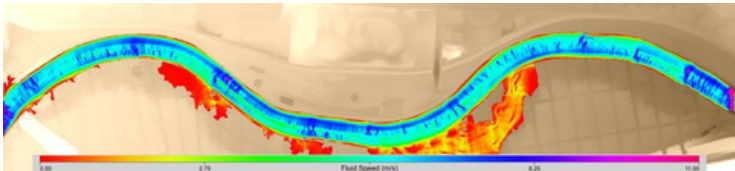
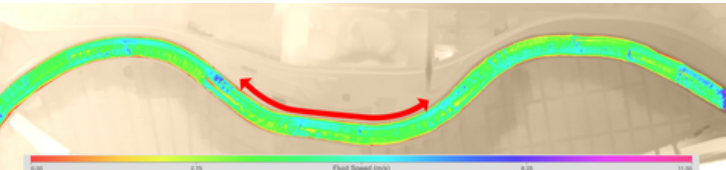
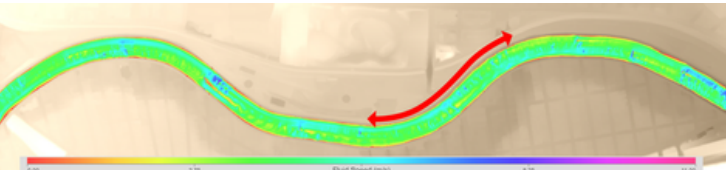
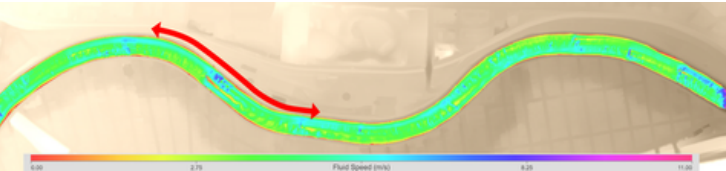
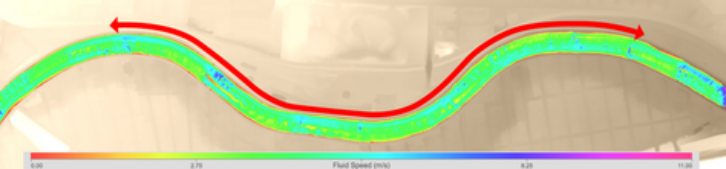
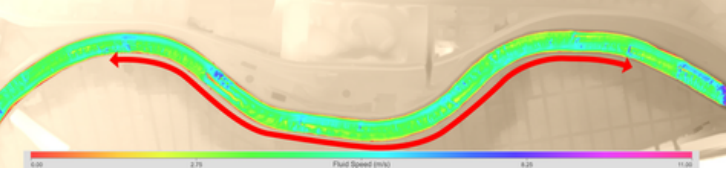
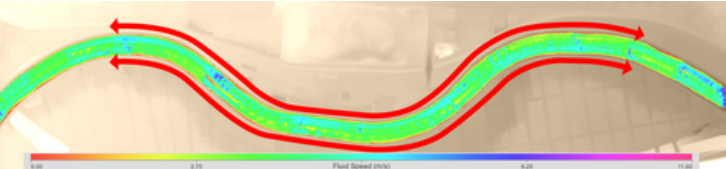
V4
East
North Channel
Profile 3



V5
East
South Channel
Profile 3



V6
East
Along G2 Parcel
Profile 3





Pilot

The pilot project marks an important first step towards a terraced LA River. The pilot improves upon the proposed kayak launch location adjacent to the Paseo del Río pavilion. The launch is an extended ramp sloping downwards parallel to the river flow. The ramp staggers towards the river, establishing the parabolic profile of the future terraces. The aggressive cutback creates a refuge from turbulent flows for fish and makes space for additional habitat restoration. This pilot is a feasible first step in reconstructing the sloped channel walls, providing habitat and a dedicated recreational access point to the river. Because the extent of pollution underneath the channel walls is unknown, the pilot seeks to understand how the existing channel wall affects groundwater and pollution flows into the main channel and will further inform the construction of the full terraces and other modifications to the channel. A second pilot project upstream could allow for the implementation of the “Wild” river walk as described in the full scheme.



Kayak Launch Render

Pilot Features

- Kayak launch with habitat/refuge during high flows

Constructibility Conclusions

Terracing along the G2 parcel and beyond would not only help increase flood capacity in this vulnerable reach of the LA River, but would also add extra habitat and aesthetic appeal. However, there are multiple uncertainties that prevent a full understanding of its constructibility. It is currently unknown, for example, the extent of pollution (lead, VOCs, TPH, etc.) beneath the channel walls, thus preventing a full understanding of the engineering of these terraces and their final cost. Given the existing orientation of LADWP transmission lines and towers, excavation would almost certainly need to occur within the LADWP TLRW and 50' offset from the towers. Further negotiation with LADWP and consultation with structural engineers are required to ensure that these terraces would not interfere with the operations and safety of the towers. Despite these constraints, terracing would still provide both aesthetic and hydraulic improvements to the existing channel. Additionally, their expandable nature allows certain sections to be constructed over time, further adding to the river's flood capacity.



Comparison of Schemes - Features and Constraints

	North Island Channel	Southern Tributary	Terraces
Features	• Full depth side channel providing flood relief • Naturalized terrace with riparian vegetation • Native perennial grassland atop capped pollution • Side channel restores historic LA River multi-threaded channel form and provides native wetland and aquatic habitat benefits.	• Full depth to groundwater basin • Culvert under levee wall connects stream and main channel, allowing fish passage • Perimeter walking path and overlook allows for observation of restored habitat • Restored tributary in historic location of Eagle Rock tributary confluence with LA River provides native wetland and aquatic habitat for native fish, including spawning and rearing. Potential supplemental water sources from Paseo del Río Wetland or north island channel diversion.	• Parabolic terrace • Kayak Launch
Constraints Impacted	• Existing storm drains to be redesigned/rerouted • Inlet begins in G1 parcel, affecting the final Bowtie Park design. Management and approval to be further discussed with State Parks. • Inlet and outlet to be adjusted to satisfy LADWP 50' offset from power tower foundation and wire zone requirements	• Basin to be coordinated to allow for future HSR pedestrian crossing. • Basin design to be coordinated to not infringe on access road and utility easements.	• Existing and former storm drains must be redesigned/rerouted • Terraces infringe on power tower 50' offset from foundation- to be evaluated by structural and LADWP
Pollution Interaction/Remediation	• Lead: Passes through high lead areas. Possible remediation methods include hauling and/or capping • VOC: Limited interaction with VOC interaction in this area. Possible remediation methods include SVE • Hydrocarbons: High interaction with diesel. Possible remediation includes land farming treatment or hauling.	• Lead: Moderate Interaction with lead. Basin located in areas with lower lead. Possible remediation methods include hauling and capping • VOC: Heavy VOC contamination. Will require intense soil treatment/hauling. Possible remediation methods include SVE. • Hydrocarbons: Moderate interaction with hydrocarbons. Basin location in areas with minimal diesel. Possible remediation includes land farming or hauling.	unknown
Habitat Restored	Total: 11 Acres	Total: 15.5 Acres	Total: 4.25 Acres
Coastal Oak Woodland/Native Meadow	6 Acres	9 Acres	1 Acre
Valley Foothill Riparian	2 Acres	3.5 Acres	0.75 Acres
Native Wetland	3 Acres	3 Acres	2.5 Acres
Valley Foothill Riparian/Open Water	2000' stream length	1000' stream length	
Soil displaced	175,000 Cubic Yards	221,000 Cubic Yards	



Comparison of Schemes - Performance and Impacts

The following table roughly estimates the relative performance, difficulty, and cost of various project tasks and features. Stars indiciate magnitude from low to high.

	Criteria	North Island	South Tributary	Terraces
Remediation: Lead	What is the difficulty of remediation for lead?	*****	****	n/a
Remediation: VOCs	What is the difficulty of remediation for VOCs?	**	*****	n/a
Remediation: Hydrocarbons	What is the difficulty of remediation for Hydrocarbons?	****	***	n/a
Excavation and Demo	How much excavation and demolition does this scheme require?	*****	****	***
Flood Mitigation	How much flood benefit does this offer?	****	n/a	***
Constraint Interaction	How many constraints does this scheme interact with	*****	**	*****
Habitat	How much and quality of habitat is restored in this scheme	****	*****	**
Recreational Amenities	How much public access and recreation is afforded by this scheme?	***	****	**



Comparison of Schemes - Habitat

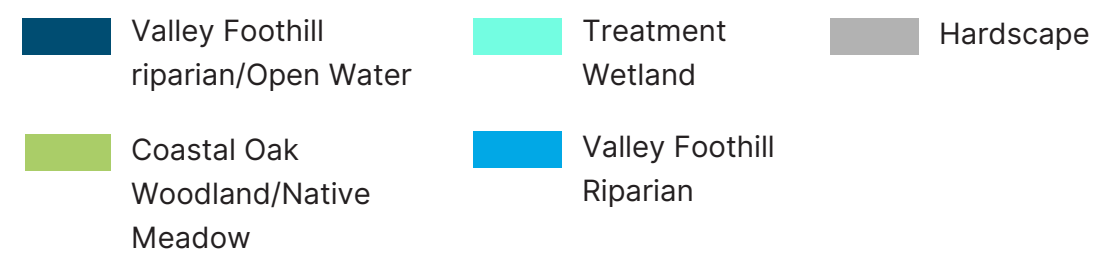
This section compares the acreages of restored habitat in the current Taylor Yard planned projects (Bowtie and Paseo del Río) and the USC schemes compared to the original City IFR Island Scheme.

Scheme	USC Schemes	USC Schemes with Bowtie	City IFR Island
Land Cover type	Acre	Acre	Acre
Developed	7	7.8	9.57
Park	8.7	8.85	14.22
Treatment Wetland	2	2.16	3.32
Off-Channel Native Marsh	2.79	2.79	NA
Valley Foothill Riparian/Open Water	6.78	6.78	4.44
Valley Foothill Riparian	4.23	4.23	9.04
Coastal Oak Woodland	12	15.5	8.39
Total	43.5	48.11	48.98
Total Habitat	27.8 (+2.6)	31.46 (+6.26)	25.2

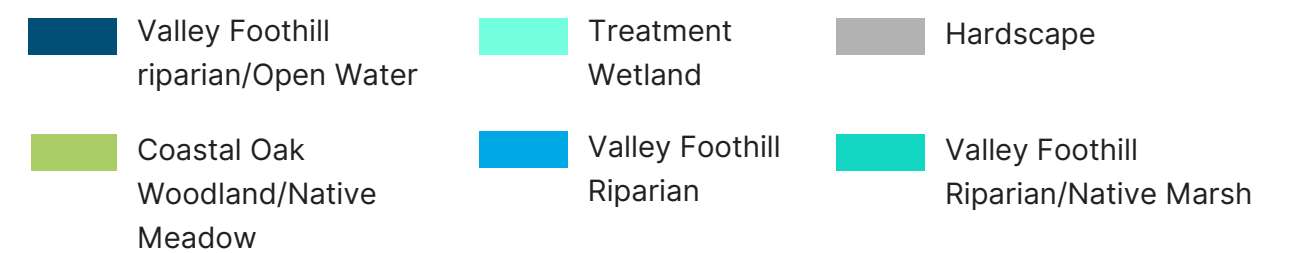
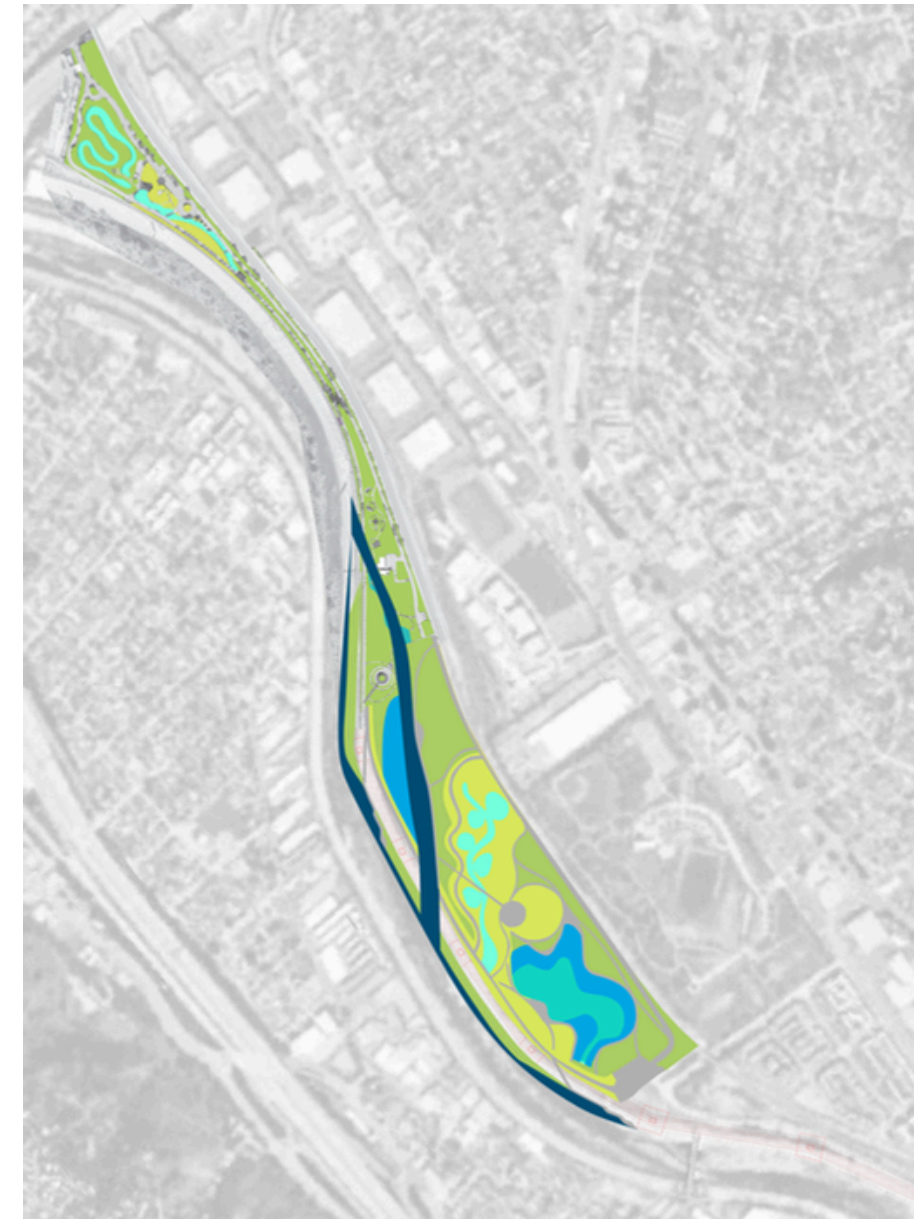


Habitat Comparison of Schemes

City IFR Island Scheme



USC Scheme with Bowtie Project





Appendix A, Habitat Suitability Potential



Habitat Suitability Potential

The following qualitative assessment of habitat potential across the three schemes was performed to support project decision-making. The assessment suggests species and associated habitat types that may benefit from each scheme, and the general level of priority that each species or habitat has as inferred from established plans for Taylor Yard and the broader LA River. This assessment can help readers compare the potential habitat benefits of each scheme and alignment with established habitat goals for the site and broader river; informing next steps including which schemes to prioritize moving forward; or proposing subsequent design refinements to advance current recommended habitat types or to prioritize different types or ecological functions.

Species considered include several focal species from the Los Angeles River California Environmental Flows Framework (CEFF) that serve as indicators to assess achievement of broader river habitat restoration goals, and priorities documented in plans including the LARER Project. Potential suitability for more general habitat types was also considered. These habitat types may be considered as indicators of broader biodiversity that may be supported by the project beyond the CEFF focal species. Since these species and types are part of broader river-wide goals, each has been weighted based on assumed priority for the species at Taylor Yard. Both the raw and weighted scores for suitability/priority are included on the following pages.



Habitat Suitability Potential (PRELIMINARY - TO BE CONFIRMED / STUDIED)	3=high, 2 = medium, 1=low, 0=limited to none	Taylor Yard Priority Weight	North Island				South Tributary		Terraces				Uplands	
CEFF Focal Species	Habitat Type Association (general)		Alt 1) full flow side channel (with riparian woodland/willow scrub, ephemeral wetlands)	Weighted	Alt 2) wetland/pond (riparian woodland, willow scrub, marsh, ephemeral wetland)	Weighted	Tributary/base flow side channel (riparian woodland, willow scrub, marsh, ephemeral wetlands)	Weighted	Alt 1) Marsh (wetland discharge, note that using water for terraces may reduce water available for trib or wetland/pond)	Weighted	Alt 2) Alluvial fan scrub (no wetland discharge , increases water available for trib and wetland/pond; engineer hydrology for arroyo toad?)	Weighted	Upland (Oak Woodland, CSS, grassland, vernal pool)	Weighted
Common green darner (<i>Anax junius</i>)	Aquatic, marsh	1	3	9	3	9	3	9	3	9	0	0	0	0
Western tiger swallowtail (<i>Papilio rutulus</i>)	General Riparian	1	3	9	3	9	3	9	3	9	0	0	2	6
California floater (<i>Anodonta californiensis</i>)	Aquatic	2	1	1	3	3	3	3	0	0	0	0	0	0
Steelhead, southern California Distinct Population Segment (<i>Oncorhynchus mykiss irideus</i>)	Aquatic	3	2	4	0	0	3	6	0	0	0	0	0	0
Santa Ana sucker (<i>Catostomus santaanae</i>)	Aquatic	3	2	4	0	0	3	6	0	0	0	0	0	0
Arroyo chub (<i>Gila orcuttii</i>)	Aquatic	2	2	4	2	4	3	6	0	0	0	0	0	0
Arroyo toad (<i>Anaxyrus californicus</i>)	Ephemeral wetland	3	1	1	0	0	2	2	1	1	2	2	1	1
Baja California tree frog (<i>Pseudacris hypochondriaca</i>)	Aquatic, marsh/riparian	1	2	4	3	6	3	6	2	4	1	2	1	2
Southwestern pond turtle (<i>Actinemys pallida</i>)	Aquatic, adjacent grassland	3	1	1	3	3	2	2	0	0	0	0	0	0
Least Bell's vireo (<i>Vireo bellii pusillus</i>)	Willow scrub, riparian	3	2	4	2	4	3	6	0	0	0	0	1	2
Belted kingfisher (<i>Megaceryle alcyon</i>)	General Riparian	1	3	9	3	9	3	9	1	3	0	0	1	3
Black-necked stilt (<i>Himantopus mexicanus</i>)	Open water, riverwash	2	3	9	0	0	1	3	2	6	1	3	1	3
Osprey (<i>Pandion haliaetus</i>)	General Riparian	1	3	9	3	9	2	6	0	0	0	0	1	3
Yuma myotis bat (<i>Myotis yumanensis</i>)	General Riparian	1	3	9	3	9	3	9	1	3	0	0	1	3
Bobcat (<i>Lynx rufus</i>)	Generalist	1	3	9	3	9	3	9	2	6	1	3	3	9
Mountain Lion (<i>Puma concolor</i>)	Generalist	1	1	1	1	1	1	1	1	1	1	1	1	1
CEFF Subtotal Score			35	87	32	75	41	92	16	42	6	11	13	33



Habitat Suitability Potential (PRELIMINARY - TO BE CONFIRMED / STUDIED)	3=high, 2 = medium, 1=low, 0=limited to none	Taylor Yard Priority Weight	North Island				South Tributary		Terraces				Uplands	
Other off-channel biodiversity opportunities:														
Wet mesic canyon habitat conditions possible adjacent to back of levee with additional potential species such as lower montane woodland habitat (California newt, dudleya, ferns...).		3	3	9	3	9	3	9	2	6	0	0	0	0
Oak woodland and coastal sage scrub habitat in upland areas (many wildlife species)		3	3	9	3	9	3	9	0	0	2	6	3	9
Vernal pools in upland areas on heavy soils associated species		3	3	9	3	9	3	9	0	0	2	6	3	9
Native perennial grassland		3	3	9	3	9	3	9	1	3	3	9	3	9
Wet meadow		3	3	9	3	9	3	9	3	9	0	0	3	9
Subtotal			15	45	15	45	15	45	6	18	7	21	12	36
Total Score			50	132	47	120	97	137	22	60	13	32	25	69



Appendix B, General Approach



General Approach

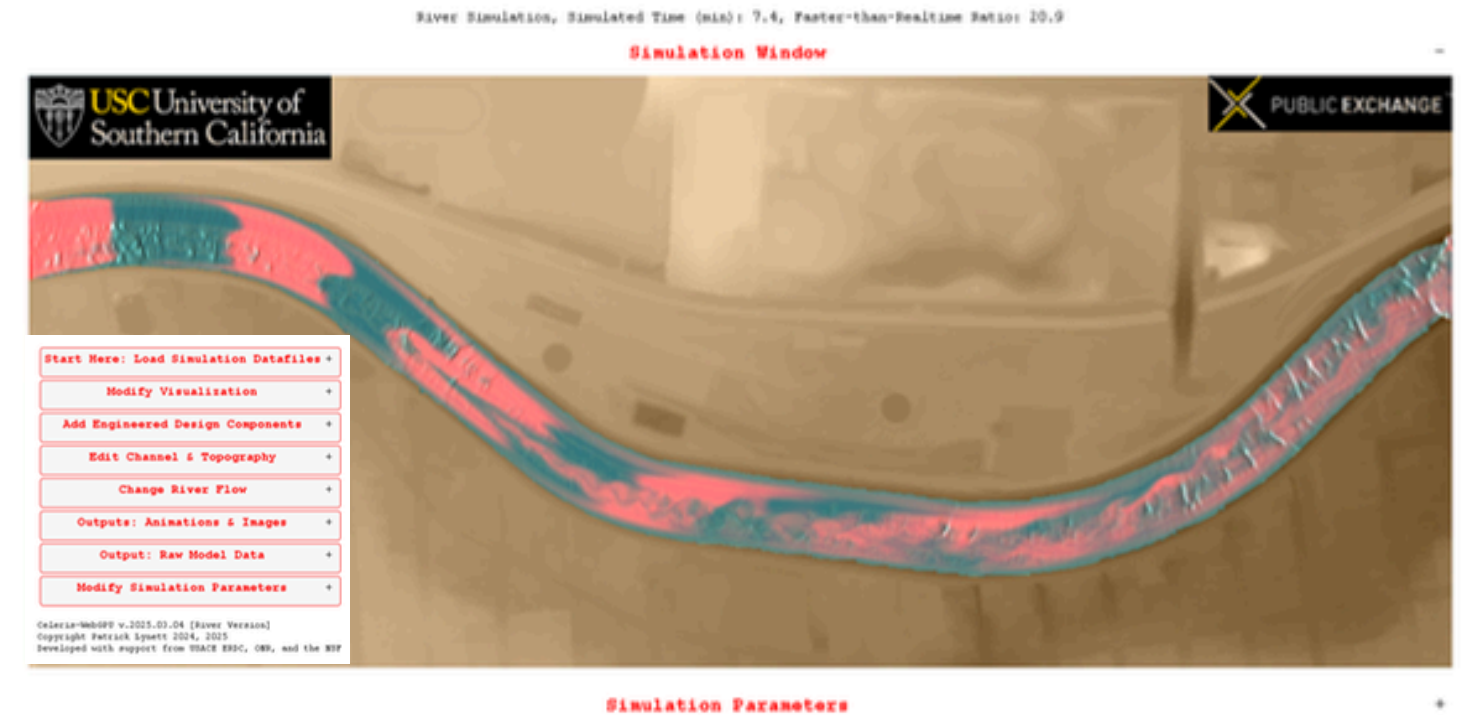
IIDL identifies that achieving the optimal design and implementation of multi-functional infrastructure and infrastructure retrofits, as proposed in various approved local plans for the Los Angeles River, requires a design approach that is both highly integrated and inclusive. The high-performance requirements of multi-functional infrastructure require multiple expert disciplines to collectively innovate at the highest level, while simultaneously including non-expert stakeholders, who are most impacted.

IIDL specializes in both developing and utilizing innovative integrated toolsets that integrate multiple expert methodologies with compelling and meaningful community and stakeholder engagement. In large measure, it achieves this through the development of advanced design tools that combine civil engineering, landscape architecture, ecological restoration, and community engagement. For urban river design, the lab has focused on enhancing hydraulic analysis models, both physical and numerical, with features and toolsets that enable the development of multi-functional designs in formats conducive to stakeholder communication, comprehension, and interaction.

This approach was inspired by the hydraulic physical modeling that the United States Army Corps of Engineers conducted in the 1940s to design the Los Angeles River to provide value as flood protection alone. Given the critical need to maintain or improve the Los Angeles River flood protection, hydraulic modeling remains a critical test; all designs must be vetted with both physical and numerical modeling. Given its importance in defining the boundaries of what is possible, IIDL has positioned hydraulic modeling in the early stages of design development and community outreach. It also leverages the compelling community engagement potential that hydraulic modeling offers.

Enhanced Hydraulic Modeling

IIDL employs both an enhanced numerical and physical hydraulic modeling system with various enhancements developed in-house. Each is equipped to facilitate more effective multi-functional design and community engagement.



Celeris

Celeris-WebGPU is an interactive, browser-based simulator that solves the nonlinear shallow water wave equations to model riverine hydraulics with high fidelity. It employs a validated physics-based engine (adapted from advanced shallow-water/Boussinesq wave models) to capture complex, nonlinear wave propagation and flow behavior with rigorous accuracy (Tavakkol & Lynett, 2017, 2020; Lynett et al., 2025). The entire simulation runs on GPU hardware within the web browser, enabling faster-than-real-time computations and concurrent visualization of results. This allows planners and stakeholders to observe flow dynamics, including currents interacting with engineered structures and vegetation, in real time, with immediate visual feedback as the simulation progresses.



Design Tools

Celeris supports interactive scenario testing for river engineering design. Users can modify key parameters such as channel bathymetry, roughness, or in-stream structures on the fly, and the software immediately recomputes and visualizes the updated flow field. This real-time feedback enables designers to see how changes (e.g. adding a nature-based solution or altering a bank alignment) affect water levels, velocities, and other hydraulic variables within seconds, rather than waiting hours for new model results. The ability to rapidly visualize impacts on flow patterns helps assess design efficacy and identifying potential issues early in the design process.

By reducing simulation turnaround times, Celeris serves as an iterative design tool. Engineers can prototype multiple river modification concepts and compare their outcomes side by side. This approach streamlines the analysis workflow and allows for the integration of stakeholder feedback in near real-time, supporting a progression from early-stage concepts to final designs.



Outreach/Engagement Tools

Celeris is also a useful platform for stakeholder engagement and community outreach. As a web-based application requiring no installation, it can be accessed on common devices or shared via a simple URL. This broad accessibility lowers the barrier for participation, enabling community members and decision-makers to directly use or view the simulator without specialized software. The interface is user-friendly and visually intuitive, displaying simulation outputs (water depth, flow velocity, etc.) with clear color maps and animations that update in real time.

The real-time, interactive visuals make complex river dynamics more understandable to non-experts. Flow patterns and water levels respond immediately to scenario changes, allowing participants to observe how a proposed design modification influences flooding or habitat conditions. Such responsiveness provides an engaging, “hands-on” experience that makes technical concepts tangible and reinforces understanding through direct visual feedback. These qualities make Celeris well suited for public workshops, educational outreach sessions, and collaborative design discussions, where it can vividly communicate design impacts and encourage informed stakeholder input.

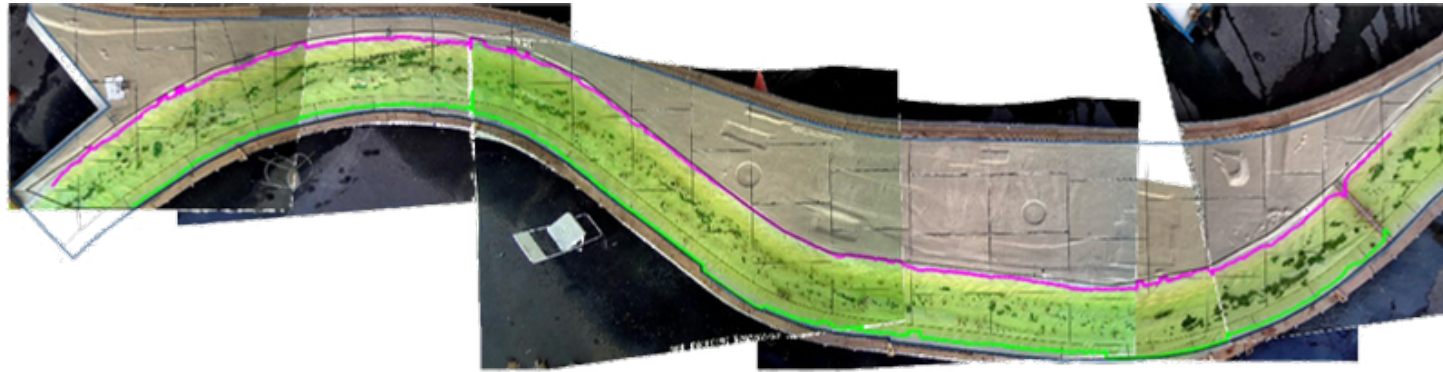
Physical Model

Physical testing was conducted using a 1:120 scale hydraulic model housed in the Los Angeles Bureau of Engineering Hydraulics Analysis Laboratory. The hydraulic model is approximately 60 feet long and spans both the G1 and G2 parcels. Consistent with established practice for scaled hydraulic models (Chanson, 2004), the model was scaled to ensure Froude (Fr) number similarity while maintaining a high-enough Reynolds (Re) number to generate fully-rough turbulent flow. Appropriate dynamic scaling required a mild (1.25x) slope exaggeration. A settling tank with flow conditioning upstream of the modeled section ensured uniform inflow into the model. An adjustable gate at the downstream end of the model was used to ensure that the model reproduced expected stage-discharge relationships in this section of the river. Prior HEC-RAS simulation results reported in the LARER study (USACE, 2016) were used as a benchmark for this calibration process, which considered scaled flows ranging from 5- to 100-year flood events. Flow in this section of the river is expected to remain in the subcritical regime ($Fr < 1$) for all flood scenarios.

The existing channel bathymetry for this section of the river was milled from high-density foam based on a prior high-resolution LiDAR scan. Vegetation distribution in the channel was mapped using overhead drone imaging and verified via ground-based surveys. This distribution was replicated in the scaled model using a novel pick-and-place vegetation system. This vegetation system, additional innovations to enable the design and testing of terraced sections and side channels, and an overhead camera system used to measure stage and identify regions of overtopping in the model are described below.

Vegetation System

A novel pick-and-place vegetation system was developed to enable interactive design. This system comprised five classes of model vegetation, extra small (0-2'), small (2-4'), medium (4-6'), large (above 6') and trees. These pieces were designed to faithfully reproduce the resistance generated by vegetation of different heights and densities. Specifically, the spatial density and height of the model vegetation pieces were chosen to match: (i) the frontal vegetation area per unit bed area for each class of vegetation and (ii) the overall channel blockage, parameters that play a primary role in dictating effective roughness (Luhar and Nepf, 2013). The vegetation pieces were fabricated from silicone using injection molding with 3D-printed dyes. To ensure reliable attachment to the model under high-flow conditions, each vegetation piece had magnetic inserts at the bottom, and the physical model was finished with magnetic paint.



Overhead Camera System

An overhead camera system was used to track design changes, vegetation distribution patterns, and water levels for different flood events. The camera system comprised seven 5MP Ethernet cameras (Reolink 510) mounted on rails above the hydraulic model. The cameras were connected to a dedicated Ethernet switch and controlled via a PC workstation. Images acquired from the cameras were corrected for distortion and stitched together to create a composite image spanning the hydraulic model. Fluorescein dye was injected into the water during testing to allow for easier delineation of water depth. Overtopping locations were identified using physical markers placed at the edge of the model during testing. Water depths and overtopping extents were used to compare hydraulic performance for different design proposals under modeled flood events. The largest flows tested corresponded to a 100-year event.

Prototyping System

The physical model is constructed to facilitate rapid prototyping and design iterations. Magnetic paint over milled foam topography allows the testing of different patterns of vegetation using the magnetic pick-and-place system. Existing milled topography can be selectively removed to reveal a galvanized steel base that can accept a variety of magnetic, modular prototyping pieces, including custom-milled inserts, walls with adjustable slopes, and flexible terrace pieces. Combined with digital modeling and in-house 3D printing and CNC fabrication, the model is a highly flexible and adaptive tool to test and visualize new designs for this section of the river.



Augmented Reality System

The physical model of the river segment is enhanced through an augmented reality system, which provides information layers that cannot be shown in the physical model and offers an opportunity for comprehensive interaction with the model. The AR system is used to display vegetation, different flow scenarios, areas with pollution and easements, and other information. It, furthermore, allows users to make annotations, draw on the model, and mark certain spots.

The augmented reality (AR) interface is presented on iPads and referenced to the physical model through object tracking. The tracking ensures that the representation shown on the iPad matches the relative position of the iPad to the river model. As users walk around the model, the position and rendering on the iPad dynamically update to match the position change. This facilitates an intuitive way of navigating the model and the overlaid information displays. No interface or navigation aids are needed, participants simply move around the model and use the iPad as a window to look at the model and the additional information layers. iPads have been chosen for the ease of navigation and the familiar form factor resembling a notepad. In the interaction scenarios, the iPad is employed in a way similar to a notepad, allowing participants to use a pencil to make annotations and sketches on the iPad, which are overlaid in registration with the model position.

The design of the AR component allows users to quickly try out different design possibilities and sketch them in space, right on the surface of the actual geometry of the model. In order to respond to constraints of the environment and to avoid, for example, polluted areas or the power-line easements, these constraints can be visualized as an overlay on the model. Such properties are shown as semi-transparent volumes to give a clear sense of the extent of areas impacted by the constraint. Our intention behind introducing the AR component is to facilitate data-informed communication about the river that brings together diverse stakeholders and enables inclusive communication. The most important aspect is to bring all members of the design team and other stakeholders together around one table — in this case, the hydrological scale model, which is the center piece of our workshops and the 'table' around which everybody gathers and works.



Appendix C, Physical Model Results



Physical Model Hydraulic Analysis

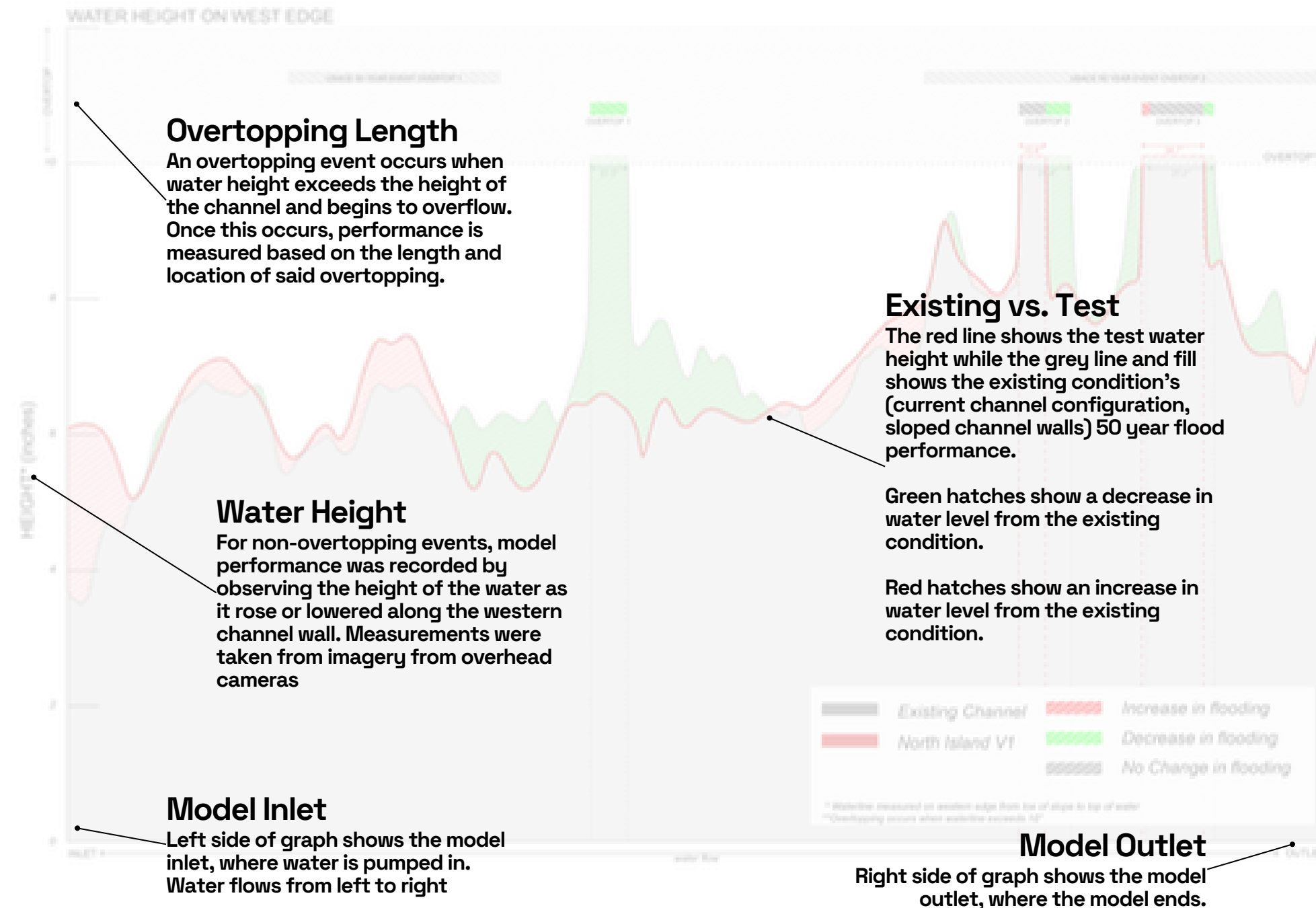
The following graphs show the preliminary results of the physical model hydraulic analyses. The tests looked at the impacts of a side channel (North Island) and terraced channel walls. A simulated 50-year flood event was used, as it allowed the measurement of smaller-scale stage height changes as a result of the channel alterations and better showed the increase or elimination of overtopping occurrences. Below is a key to read each graph.

North Island V1

Flood Event: 50 Year
Test Description: Vegetation on terraces, no vegetation in side channel

Primary Test and iteration

Title lists what is being tested (north island or terracing) and iteration (V1, V2 etc.) further outlined in the test description below.



OVERHEAD IMAGE TRACE

Legend: Existing Channel to Test Flood Event
Proposed Model: Existing Channel to Test Flood Event
Proposed Model: Test Channel to Test Flood Event

Overhead image

This shows the overhead image stitch used to generate the graphs. The red line shows the test water level while the grey lines show the existing 50-year flood performance.

Observations

Conclusions from each test are presented here.

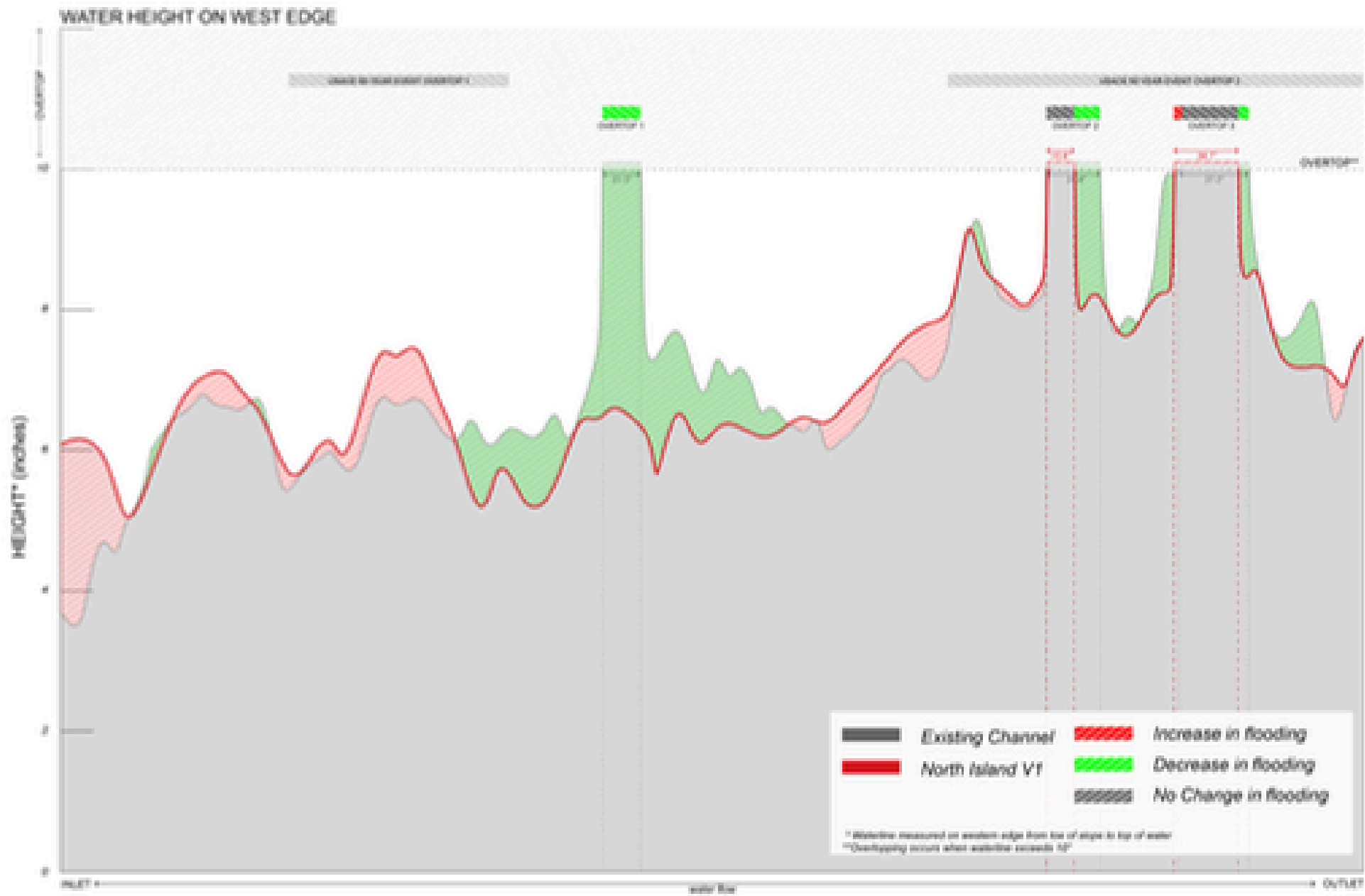
Observations:
During a 50 year storm event, vegetated terraces, in combination with an unvegetated side channel eliminates flooding adjacent to Newell St. and reduces flooding adjacent to Birkdale and Forney St.



Physical Model Hydraulic Analysis

North Island V1

Flood Event: 50 Year
Test Description: Vegetation on terraces, no vegetation in side channel



OVERHEAD IMAGE TRACE



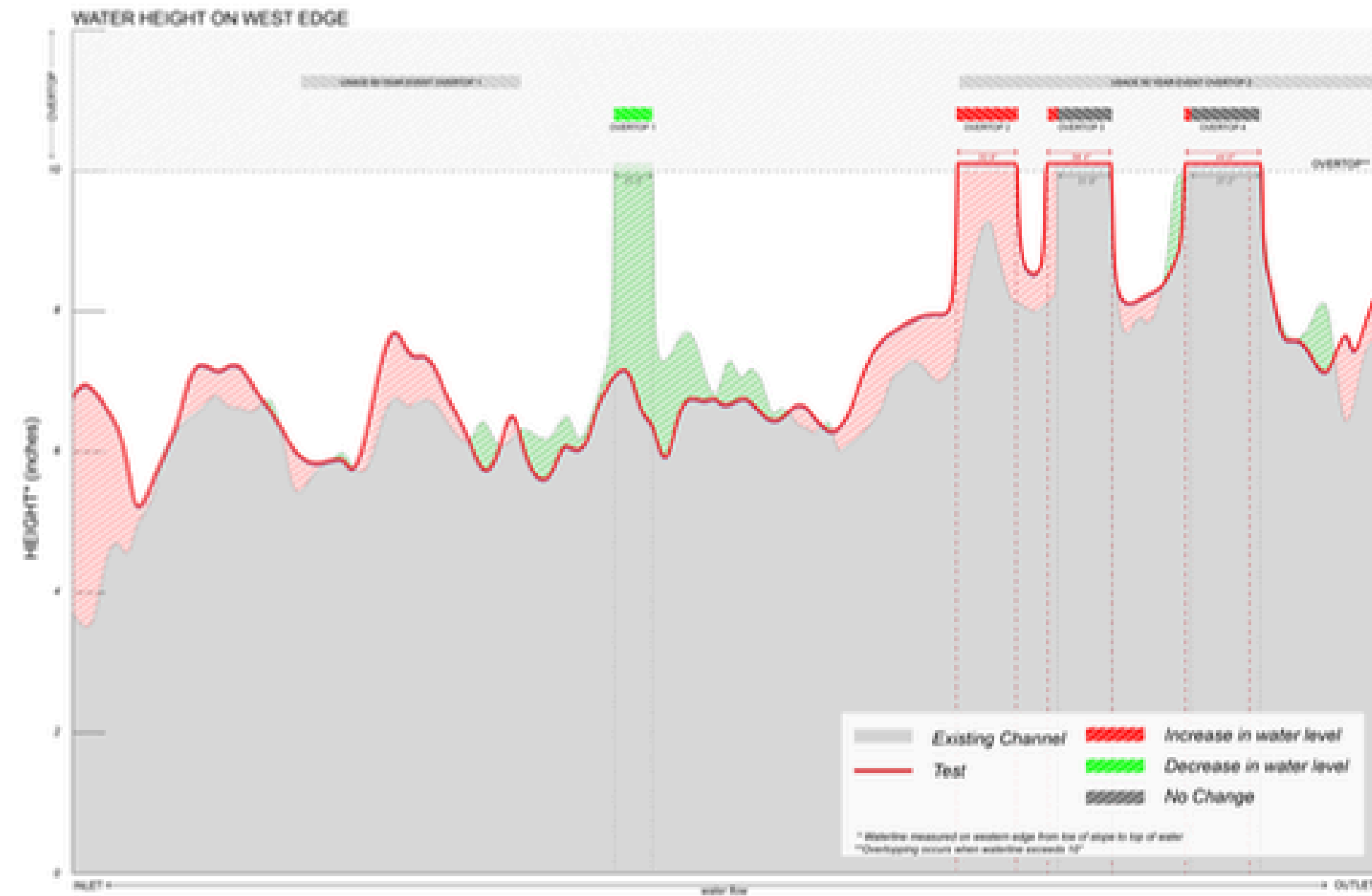
Observations:
During a 50 year storm event, vegetated terraces, in combination with an unvegetated side channel eliminates flooding adjacent to Newell St. and reduces flooding adjacent to Birkdale and Forney St.



Physical Model Hydraulic Analysis

North Island V2

Flood Event: 50 Year
Test Description: Vegetation on terraces, vegetation in side channel



OVERHEAD IMAGE TRACE



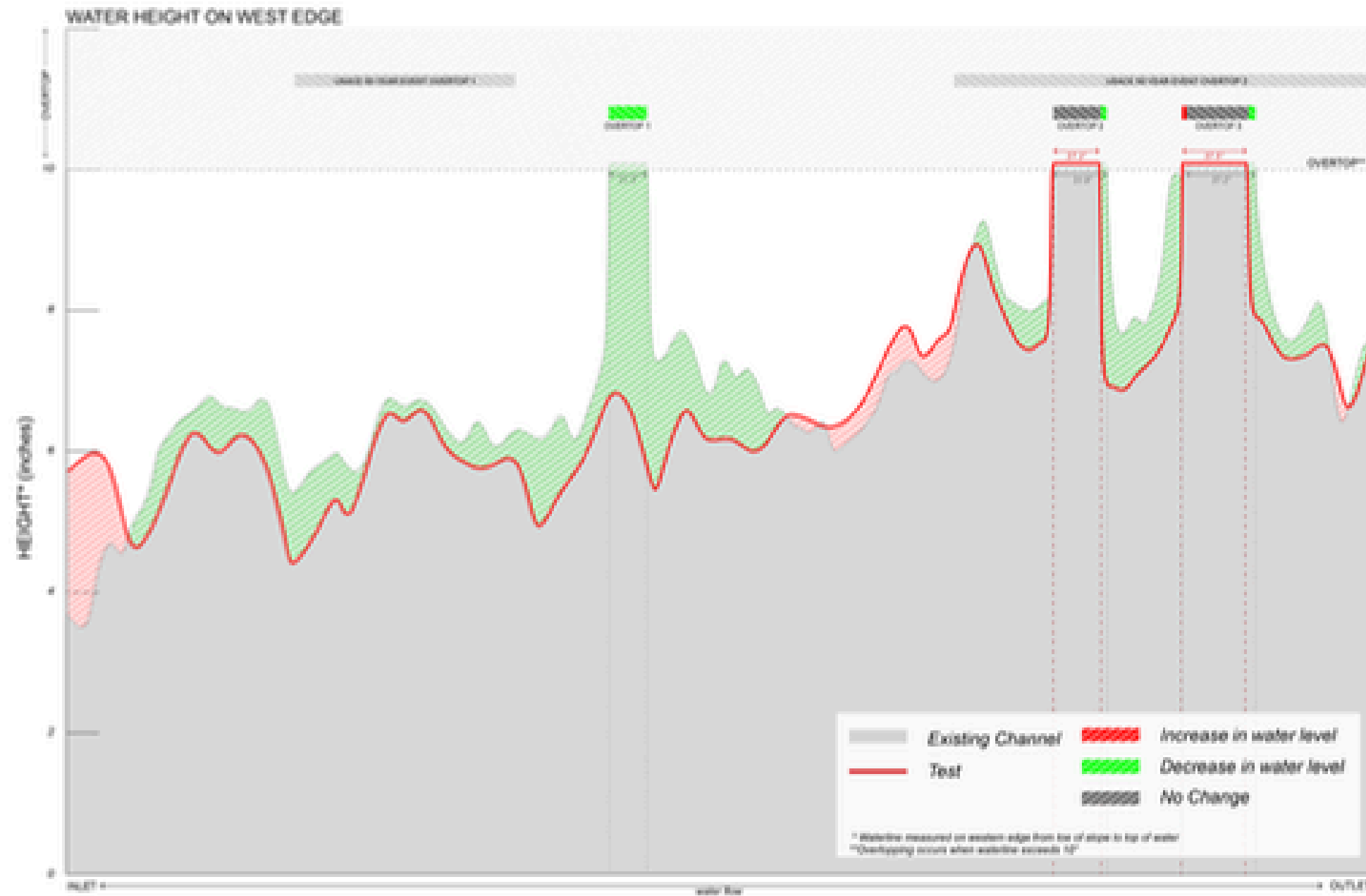
Observations:
During a 50 year storm event, vegetated terraces, in combination with an unvegetated side channel eliminates flooding adjacent to Newell St. but increases flooding downstream compared to the existing channel wall. An overtopping occurs adjacent to Forey St. not seen in the baseline test.



Physical Model Hydraulic Analysis

North Island V3

Flood Event: 50 Year
Test Description: No vegetation on terraces, vegetation in side channel



OVERHEAD IMAGE TRACE



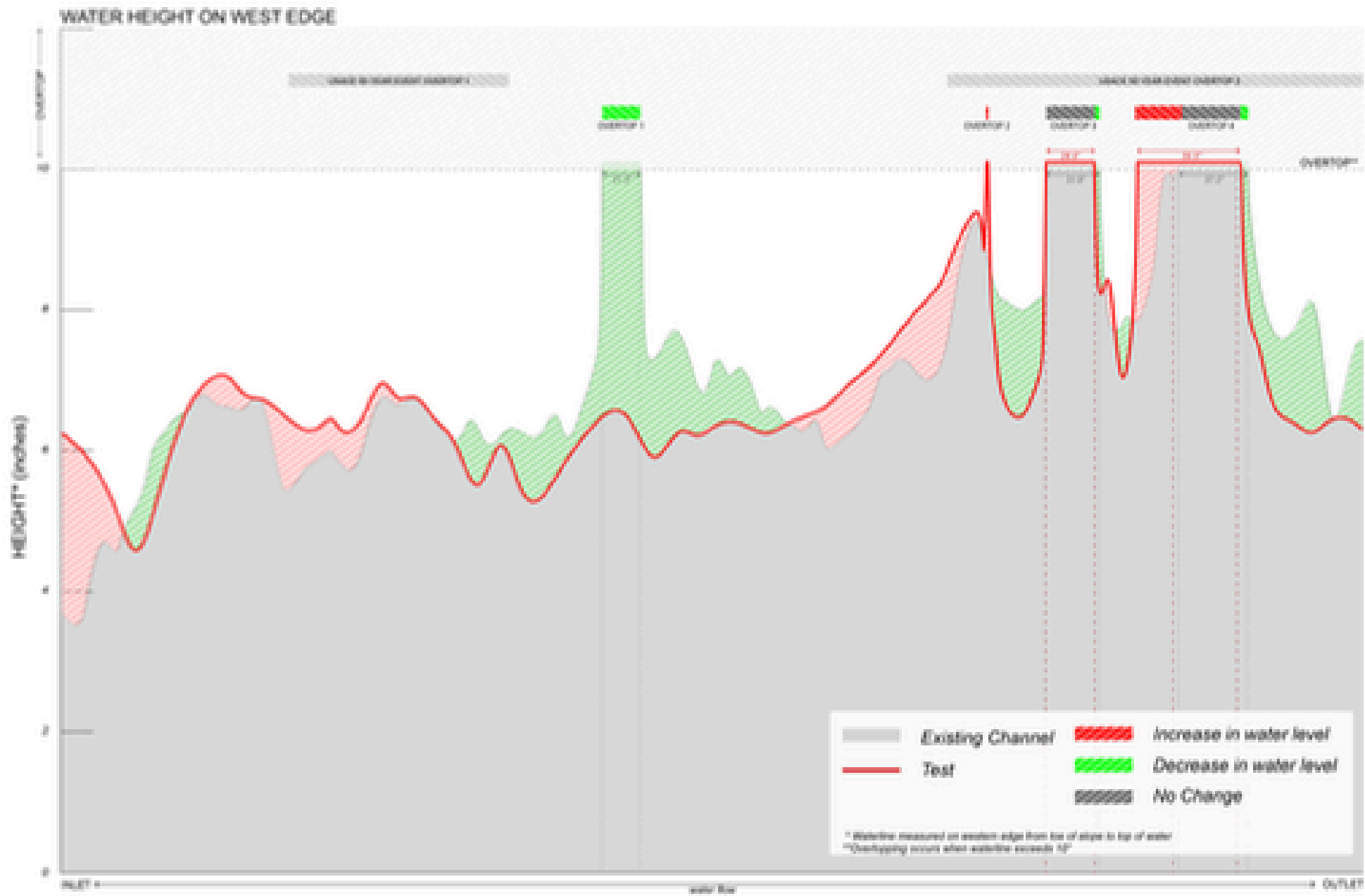
Observations:
During a 50 year storm event, unvegetated terraces, in combination with a vegetated side channel eliminates flooding adjacent to Newell St. and slightly improves the two overtopping locations downstream.



Physical Model Hydraulic Analysis

North Island V4

Flood Event: 50 Year
Test Description: No vegetation on terraces, no vegetation in side channel



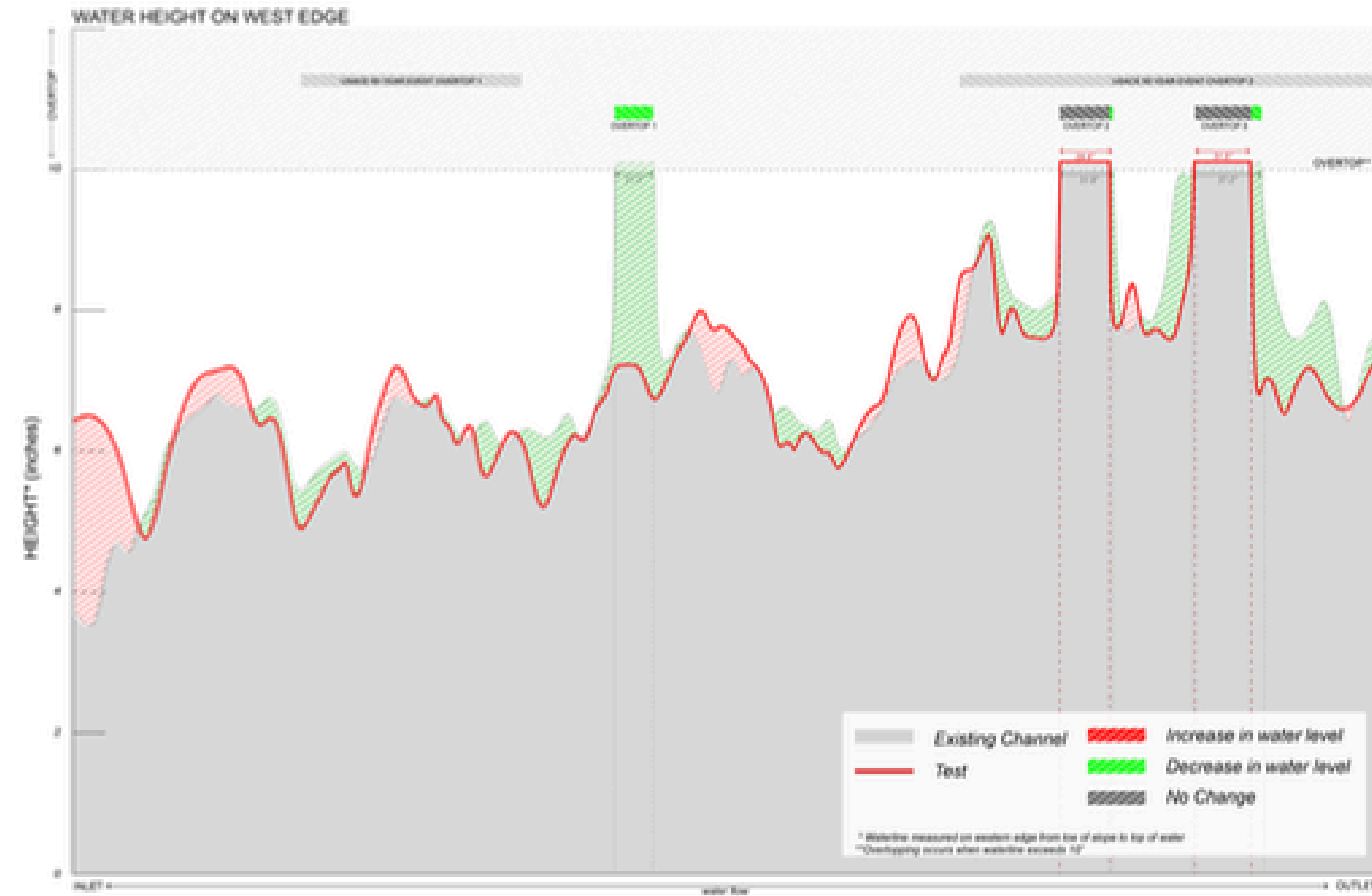
Observations:
During a 50 year storm event, unvegetated terraces, in combination with an unvegetated side channel appears to worsen flooding, increasing the length of overtopping near Birkdale St. and introduces a new overtopping location near Forney St.



Physical Model Hydraulic Analysis

North Island V5

Flood Event: 50 Year
Test Description: Vegetation before outlet, no vegetation after outlet



OVERHEAD IMAGE TRACE



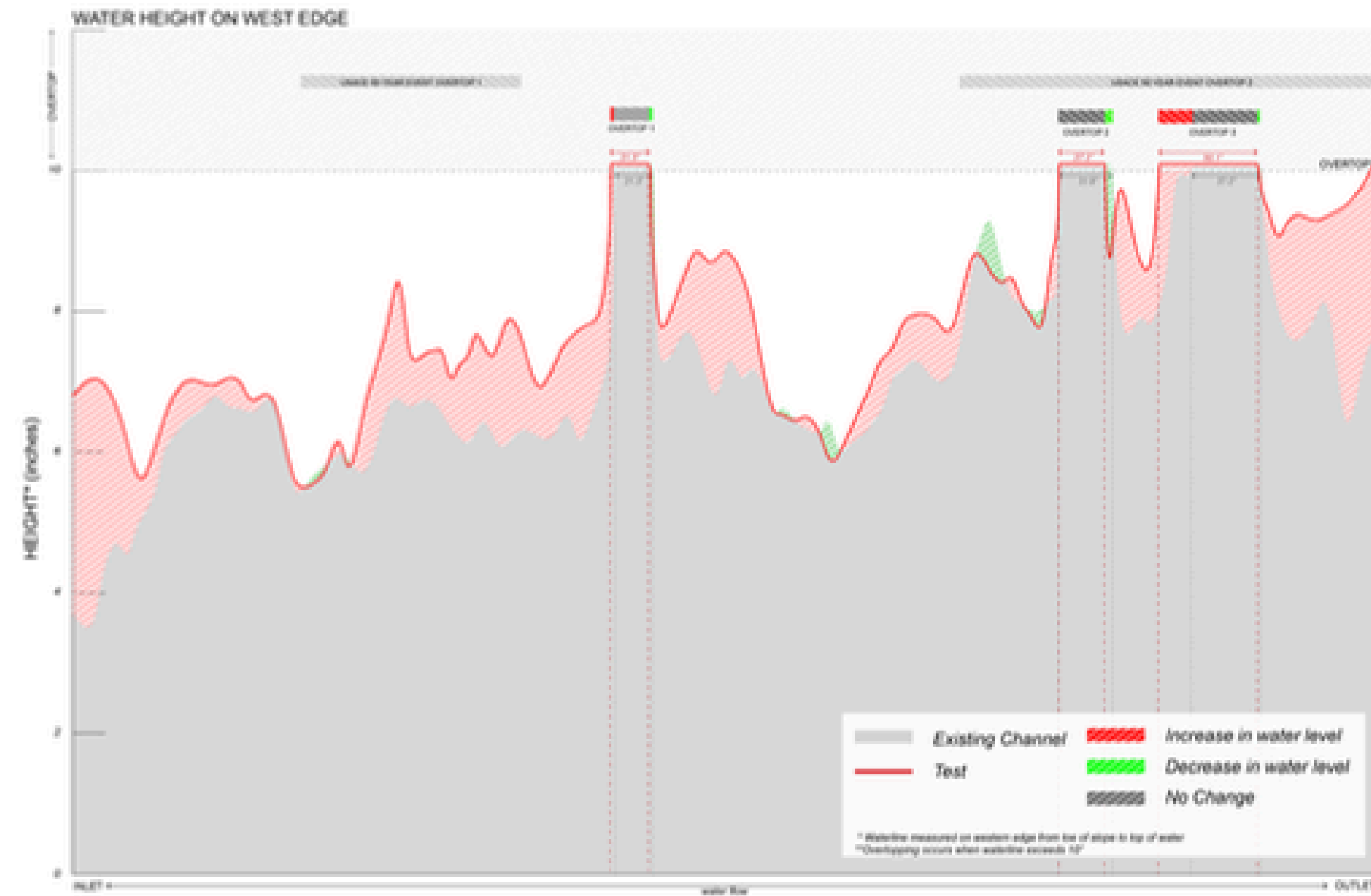
Observations:
During a 50 year storm event, having vegetation on terraces and in the side channel before the outlet, and no vegetation on terraces after the side channel outlet slightly improves flooding near Eads and Birkdale St.



Physical Model Hydraulic Analysis

Terrace V1

Flood Event: 50 Year
Test Description: No vegetation on terraces



OVERHEAD IMAGE TRACE



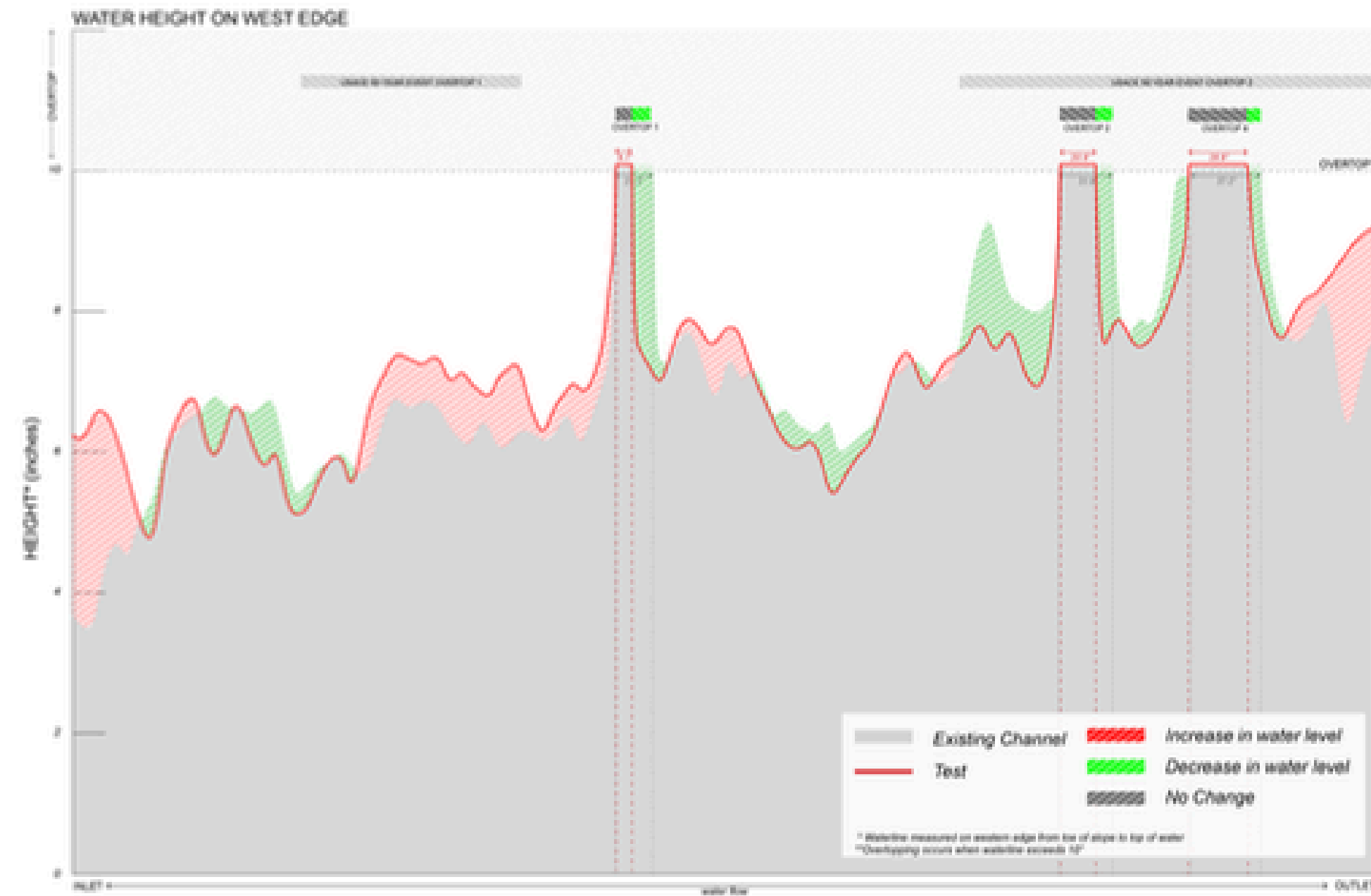
Observations:
During a 50 year storm event, unvegetated terraces performed worse overall compared to the existing channel. Overtopping occurred in similar locations to the control, with the overtopping extending to Cabot St.



Physical Model Hydraulic Analysis

Terrace V2

Flood Event: 50 Year
Test Description: Terraces half vegetated



OVERHEAD IMAGE TRACE



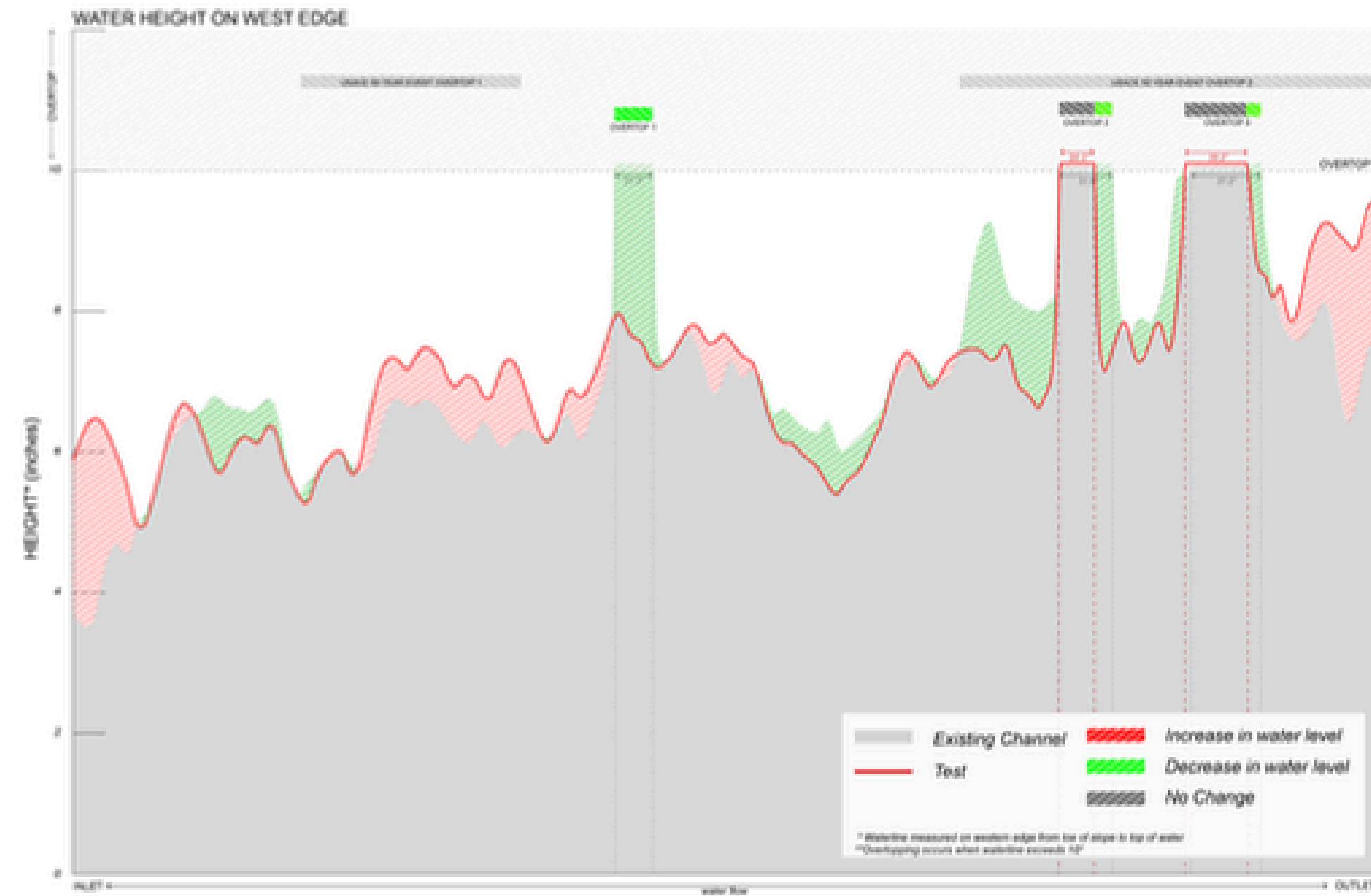
Observations:
During a 50 year storm event, partially vegetation on terraces improves on the existing condition. While overtopping still occurs in three locations, their extent is reduced in all instances.



Physical Model Hydraulic Analysis

Terrace V3

Flood Event: 50 Year
Test Description: Full vegetation on terraces



OVERHEAD IMAGE TRACE



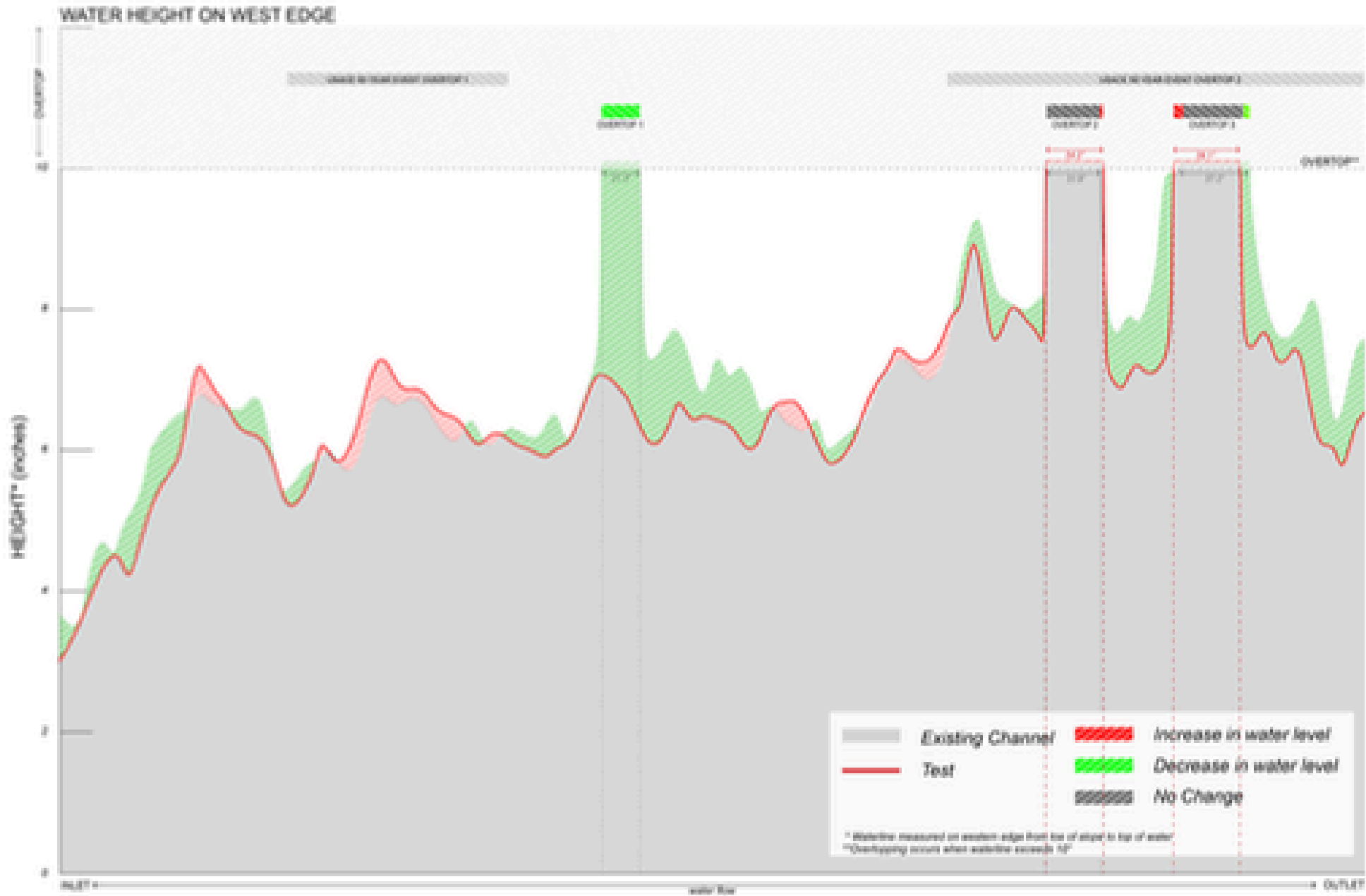
Observations:
During a 50 year storm event, fully vegetated terraces improve on the existing condition, eliminating overtopping near Newell St. and reducing the overtopping near Eads and Birkdale St.



Physical Model Hydraulic Analysis

Terrace V4

Flood Event: 50 Year
Test Description: Full vegetation on terraces, trees on first terrace



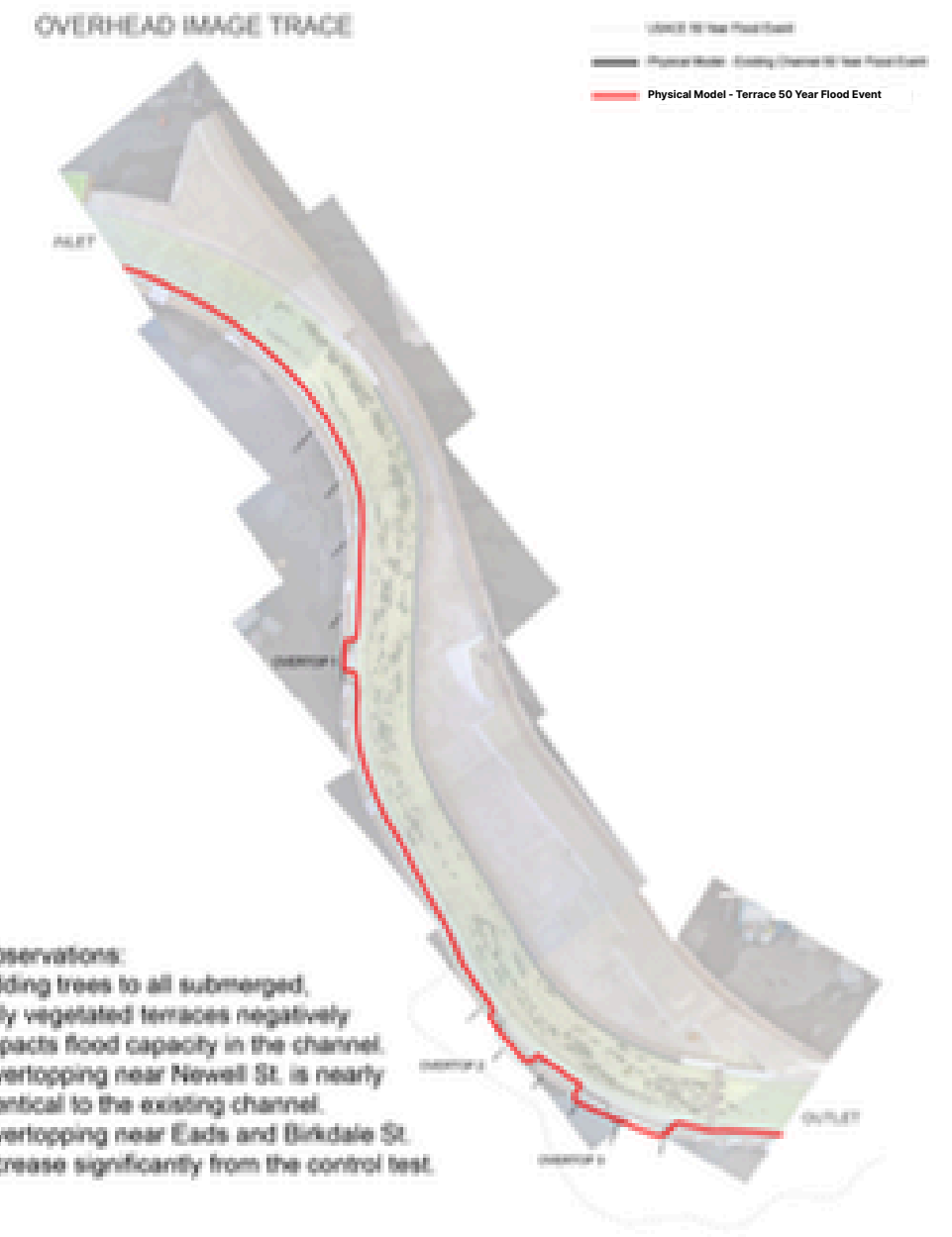
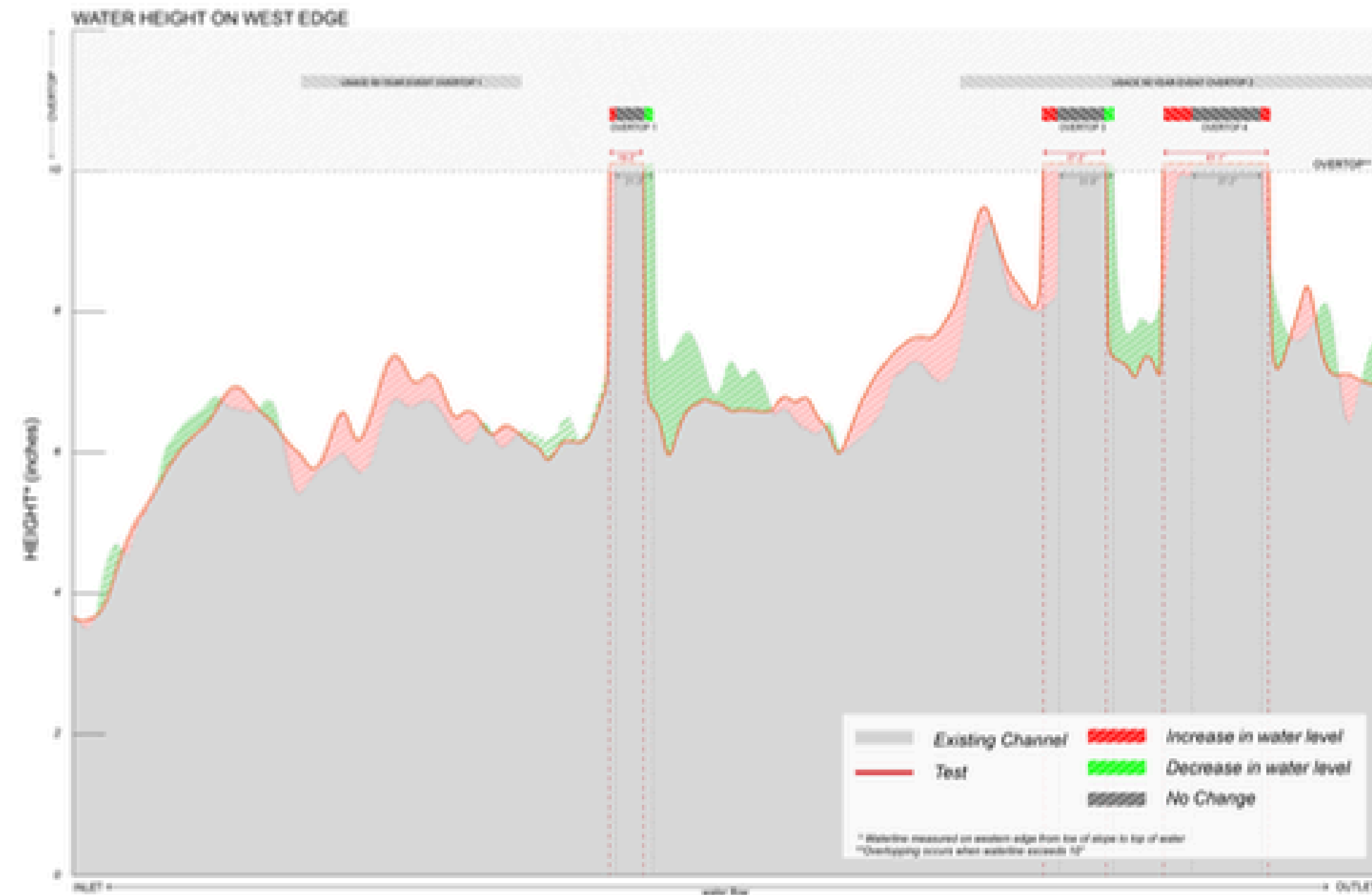
Observations:
Adding trees to the first step of fully vegetated terraces appears to broadly improve flood capacity throughout the channel and eliminates overtopping near Newell St. However, while overall water levels are reduced between Forney and Altman St., overtopping extents are marginally increased.



Physical Model Hydraulic Analysis

Terrace V5

Flood Event: 50 Year
Test Description: Full vegetation on terraces, trees on first and second terrace



Observations:
Adding trees to all submerged, fully vegetated terraces negatively impacts flood capacity in the channel. Overtopping near Newell St. is nearly identical to the existing channel. Overtopping near Eads and Birkdale St. increase significantly from the control test.



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