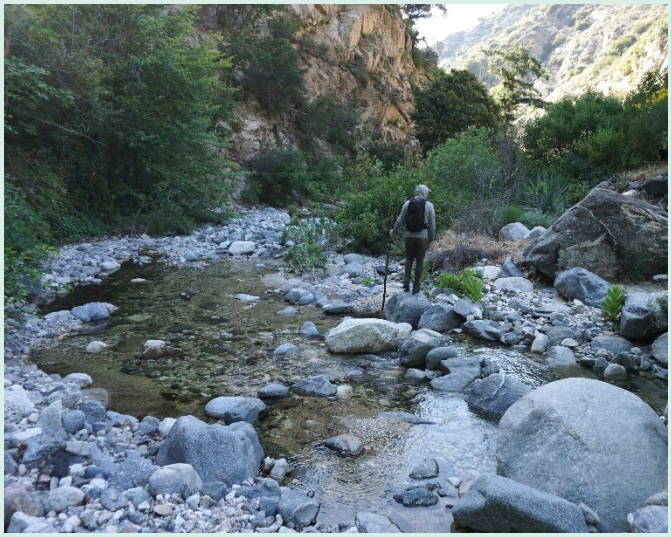
60% BASIS OF DESIGN REPORT ◦ MAY 2022

Los Angeles River Fish Passage and Habitat Structures Design



PREPARED FOR

Council for Watershed Health

Wildlife Conservation Board
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PREPARED BY

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Stillwater Sciences

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Cover photos:
Clockwise from upper left: perennial stream habitat in the upper Arroyo Seco (Stillwater Sciences); Los Angeles River LARERR Reach 8A under storm conditions (Stillwater Sciences); looking north from LARERR Reach 8A at the N Main Street crossing of the LA River (NHC); adult steelhead (NOAA Fisheries).

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1 INTRODUCTION

Anadromous fish like Southern California steelhead (*Oncorhynchus mykiss*) (steelhead) serve as an indicator of aquatic habitat connectivity and quality at the watershed scale. Although steelhead have not been recently documented in the Los Angeles (LA) River watershed, native rainbow trout, the freshwater resident life history form of *O. mykiss* that do not migrate to the ocean, are currently or have recently been found in several headwater tributaries including Big Tujunga Creek and the Arroyo Seco above Devil's Gate Dam (SRMA 2020). Recently, 469 *O. mykiss* were translocated into the Arroyo Seco during fish rescue operations in streams impacted by wildfire (CDFW 2020). Steelhead reestablishment is a lofty but attainable goal that is consistent with the City of Los Angeles Mayor's Office biodiversity goals, the National Marine Fisheries Service's (NMFS) recovery goals for the regional steelhead population group (NMFS 2012), and other adopted sustainability, resiliency, and biodiversity policies and plans on federal, state, regional, and local levels.

Providing successful passage for steelhead between the ocean and their mountain spawning and rearing habitats is a significant challenge for reestablishment efforts. Adult and juvenile steelhead formerly navigated the LA River and tributaries during the migratory freshwater phases of their life cycle. While suitable spawning and rearing habitat still exists in some mountain tributary streams within the watershed, extensive urbanization, flood control infrastructure, and water uses have severely altered the intervening reaches of the LA River and portions of the tributaries, effectively preventing upstream and downstream migration. Multiple funding opportunities and multi-benefit watershed projects are aligning to allow for planning and implementation of steelhead recovery actions. These actions address challenges associated with recovery of this keystone species and provide opportunities to address other integrated water management objectives and needs of urban communities within the watershed and LA region.

The LA River Fish Passage and Habitat Structures Design (LAR FPHS) project (Project) examines potential ways to redesign the channel bed and banks to evaluate alternatives that would provide migration passage and habitat features to benefit steelhead within the Project Reach, which extends 4.8 miles from the downstream end of the Glendale Narrows soft-bottom segment to Washington Boulevard (Figure 1-1). The Project Reach coincides with a downstream segment of Reach 6b, Reach 7, and Reach 8 of the City of LA and U.S. Army Corps of Engineers, Los Angeles District (USACE) LA River Ecosystem Restoration and Recreation Project (LARERR) reach. As its main objectives, the Project will complete a 60% level design of a fish passage channel and associated habitat features within the Project Reach; a regulatory and environmental permitting strategy for the selected design alternative as described in Section 14 and presented in separate regulatory and environmental permitting documents; and a comprehensive description of the LA River watershed ecology, geology, geomorphology, sediment processes, and aquatic species and habitats relevant to steelhead recovery. This report provides the basis for the 60% design; the LA River watershed is described in *Conceptual Ecological Model (CEM) and Limiting Factors Analysis (LFA) for Steelhead in the Los Angeles River Watershed* (Stillwater Sciences 2020).

The channel modifications proposed within the Project Reach alone will not fully restore the steelhead migration passage between the ocean and tributaries, but the Project serves as a first step in surmounting challenges inherent in urbanized watersheds and channelized streams to enhance fish passage and migration corridors to upper tributaries. Full re-establishment of steelhead in the LA River watershed will require a basin-wide effort to improve habitat, provide fish passage solutions, improve water quality, control non-native species, and wisely manage

water, sediment, and other watershed-based inputs that create, regulate, and maintain habitat for steelhead and other native aquatic and riparian species (Stillwater Sciences 2020).

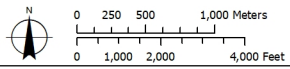
The Project is funded by the State of California Wildlife Conservation Board (WCB) under a Proposition 68 Restoration Grant for Wildlife Corridors and Fish Passage Program, and by the Santa Monica Mountains Conservancy (SMMC) under a Proposition 1 Grant for Urban Creeks protection and enhancement. The Project is led by the Council for Watershed Health (CWH) and the design team of Stillwater Sciences, Northwest Hydraulic Consultants, TRC Engineers, Gannett Fleming, and the U.S. Department of the Interior Bureau of Reclamation. The Project is proceeding in coordination with other partners and government agencies, including the Friends of the Los Angeles River (FoLAR), Arroyo Seco Foundation, and Southern California Coastal Water Research Project (SCCWRP), and the City of LA Mayor's Office and Bureau of Engineering (BOE). The City of LA BOE is serving as the California Environmental Quality Act (CEQA) Lead Agency for the Project.

Figure 1-1. Project Reach Map

Project Reach

River mile

Map Sources:
Imagery: NAIP 2018
Rivers, streams, cities: ESRI 2016
River miles: LA River Index



Stillwater Sciences

2 BACKGROUND AND PURPOSE

Previous deliverables for the Project included the *Conceptual Ecological Model (CEM) and Limiting Factors Analysis (LFA) for Steelhead in the Los Angeles River Watershed* (Stillwater Sciences 2020), which described the LA River watershed, steelhead life history and ecology, and steelhead limiting factors; a 30% level Basis of Design Report (Stillwater Sciences 2021) describing alternatives for fish passage channels and habitat features in the Project Reach and outcomes of design workshops, media, and outreach activities; and the Los Angeles River ARBOR Reach 8A Design Development Technical Memorandum (Stillwater Sciences 2022), which provided the preliminary plans and interim design descriptions of the LARERR Reach 8A Pilot Project. These prior reports provided background on the challenges for complete recovery of the steelhead in the LA River watershed that informed the screening of multiple preliminary alternatives and development of the LARERR Reach 8A Pilot Project and "Concept A," which are the alternatives that were advanced to the 60% level design. The following subsections provide background information on how the two alternatives originated and were selected to be advanced to the 60% level design.

2.1 LARERR Reach 8A Pilot Project Background

At the 30% level design phase, the design team evaluated alternatives for fish passage and habitat structures within the Project Reach (Figure 1-1). Alternatives developed as part of the 30% level design phase included Concept A (44-foot-wide fish passage channel), Concept B (60-foot-wide fish passage channel), and the LARERR Reach 8A Pilot Project (approximately 22-foot-wide fish passage channel), among others. Following review of the 30% level design alternatives, the City of LA Mayor's Office, in coordination with the USACE, determined that the LARERR Reach 8A Pilot Project alternative should be advanced to a 60% level design owing to the fact it significantly improves steelhead passage while minimizing construction disturbance and cost, as well as an ease of integration with the modifications proposed in the LARERR (USACE 2015). The detailed design of the LARERR has not been developed and thus the design team's understanding of LARERR is limited to general footprints of the project features.

The LARERR Reach 8A Pilot Project is developed solely for an approximately one-quarter-mile segment of LARERR Reach 8. The one-quarter-mile segment associated with the LARERR Reach 8A Pilot Project is hereinafter referred to as Reach 8A (Figure 1-1). The LARERR Reach 8A Pilot Project provides fish passage through a broad range of flows and significantly improves the existing fish passage condition in Reach 8A from virtually none to acceptable velocity and depth conditions for most flows occurring annually. The proposed modifications to create a fish passage pathway are focused at the low-flow channel (LFC) of the main flood control channel. At flood flows, the roughened LFC's effect on the main channel hydraulics is small because most of the flow is occurring in the main channel overbanks. Although narrow compared to the total channel width, focusing modifications at the LFC provides a fish passage pathway while minimizing effects on flood water surface. Flood effects are sensitive to the roughened pathway width and other factors such as compensating increases in flow area. The principal of using one or more roughened passage pathways that are only part of the total channel width, and that have reduced velocity compared to the remainder of the channel's flow, could be applied to other high-speed channels in flood-sensitive settings. Although the LARERR Reach 8A Pilot Project may not provide as many ecological benefits as other alternatives having larger footprints evaluated at the 30% design level (e.g., Concepts A and B), it will demonstrate the effectiveness of various habitat and fish passage features, flood performance, and maintenance and monitoring needs, so

that refinements in the design may be incorporated into future LA River restoration projects. The one-quarter-mile LARERR Reach 8A Pilot Project likely could be permitted and constructed faster than fish passage design concepts presented for the 4.8-mile Project Reach, because it is simple and effective and will not interfere with future designs included in the LARERR, and spearhead the regional steelhead recovery effort.

2.2 Concept A (4.8-mile Reach Project) Background

The design team, in consultation with the City of Los Angeles Mayor's Office and WCB, suggested that Concept A or B be carried forward to the 60% level design as a potential alternative that could be applied to the Project Reach outside of Reach 8A (Figure 1-1). This is because the selected LARERR Reach 8A Pilot Project addresses only a portion of the Project Reach and provides fewer ecological benefits compared to Concept A and B. The project team chose Concept A to address the entire Project Reach and is hereinafter referred to as the 4.8-mile Reach Project.

As part of the 30% design level, the fish passage performance for Concepts A and B were evaluated in a two-dimensional (2D) hydraulic model at two selected sub-reaches (e.g., Arroyo Seco confluence and between 1st and 4th Street), and flood performance for the two concepts was assessed for the Project Reach in a one-dimensional hydraulic model (Stillwater Sciences 2021). The model results indicated that both concepts generally achieved the objective of providing suitable fish passage hydraulic conditions at both high (Qhfp, 4,660 cubic feet per second [cfs] and 6,544 cfs) and low fish passage design flows (Qlfp, 121 cfs), including the assumed future baseflow (25 cfs). Concept A produced slightly less favorable fish passage conditions (smaller areas of low-velocity zones, and a short section of high velocity area at the Arroyo Seco confluence) but resulted in reduced flood impact due to its narrower and deeper cross section of the roughened fish channel compared to Concept B. Due to its significantly narrower footprint, Concept A is more economical to construct, partially due to the need for less channel modification in order to pass through existing bridge crossings and pier spacing. Concept A is also easier to integrate with other planned LA River projects compared to Concept B. For these reasons, the design team opted for advancing Concept A (the 4.8-mile Reach Project) to the 60% level design.

2.3 Purpose

The purpose of this report is to present the 60% level design plans and associated design basis for the roughly 0.25-mile-long LARERR Reach 8A Pilot Project and the 4.8-mile Reach Project (i.e., Concept A). Appendices A, B, and C include the 60% level engineering plans, specifications table of contents taken from BOE's Master Specifications Library, and construction cost estimates, respectively. Results of HEC-RAS and SRH-2D hydraulic models are provided in Appendices D and E, respectively. A brief technical memorandum summarizing the procedures and findings from the Risk and Uncertainty (R&U) analysis is provided in Appendix G.

Comments received on the 30% level Basis of Design Report (Stillwater Sciences 2021) and the Los Angeles River ARBOR Reach 8A Design Development Technical Memorandum (Stillwater Sciences 2022) are incorporated in the work presented in this report. Detailed descriptions of LA River basin ecology, geology, geomorphology, sediment processes, and aquatic habitats and species are documented in the *CEM and LFA for Steelhead in the Los Angeles River Watershed* (Stillwater Sciences 2020). Regulatory and environmental permitting for the Project will be addressed in separate documents as described in Section 14.

The focus of this report and Project is in-channel design for a steelhead riverine migratory corridor. However, restoration of the LA River includes other priorities beyond recovery of the historically depleted steelhead population. This Project is aware of and conscious not to impair existing, future, and historical uses of the LA River. These include regional support of housing, recreation, public access to nature, and other socio-cultural impacts associated with LA River projects, as well as specific projects proposed within the Project Reach, such as the LA River Ecosystem Restoration Project, Los Angeles County Metropolitan Transportation Authority (Metro) LA River Path Project, and the California High-Speed Rail.

3 WATERSHED CHARACTERISTICS

The LA River flows 51 miles from Canoga Park to the Pacific Ocean, draining an 834-square-mile watershed that is bounded by three mountain ranges (the San Gabriel Mountains, Santa Monica Mountains, and Santa Susana Mountains/Simi Hills), alluvial fans, fluvial valleys, and a broad coastal plain. The mountainous headwaters of the LA River, which occur within the Angeles National Forest, San Gabriel Mountains National Monument, Santa Monica Mountains, and Santa Susana Mountains, are predominantly undeveloped, with large natural areas of forest, chaparral, and shrub-scrub. Hilly terrain in the lower watershed is sparsely developed and still maintains some patches of the chaparral, coastal sage scrub, and woodlands that were prevalent prior to large-scale development. Flatter terrain in the lower watershed has been nearly completely developed and is now home to more than 4.5 million people (CWH 2018, Sheng and Wilson 2009). The LA River watershed is in a region with a Mediterranean climate characterized by warm, dry summers and cool, wet winters with short and sometimes intense winter storm events. Although there is little variability in air temperature in the winter across locations within the watershed, average air temperatures in coastal areas are cooler than more inland locations. Precipitation in the region is also variable. This is due, in part, to orographic enhancement of precipitation on southerly facing slopes, which traps moist ocean air against the mountains and creates spatial variation in precipitation as elevation increases (CWH 2018, WRCC 2020). Detailed descriptions of the LA River watershed characteristics are documented in Stillwater Sciences (2020).

4 PROJECT REACH

The 4.8-mile-long Project Reach begins at the downstream end of the Glendale Narrows soft-bottom reach of the LA River, extends past the Arroyo Seco confluence, through downtown LA, and downstream to Washington Boulevard. The upstream half of the Project Reach coincides with a downstream segment of Reaches 6b, 7a, 7b, and 8 of the LA River Ecosystem Restoration Project (Figure 1-1). The Project Reach lies entirely within the limits of the City of Los Angeles, and the channel is on land owned by the City of Los Angeles. The USACE maintains the channel lining, subdrain system, levees, flap gates, vegetation, access, and oversight of operations and maintenance within the LA River right-of-way (ROW) of the Project Reach (LACPW 2021). The LA County Flood Control District does have intermittent infrastructure, ROW, and flood control easements through the Project Reach. Coordination with the LA County Flood Control District for the 4.8-mile Reach Project, including the Permitting Section of the County's Land Development Division, will continue in the next phase of design.

Figure 4-1 illustrates typical cross section geometry of the existing LA River channel within the Project Reach. The channel is a mostly trapezoidal concrete channel approximately 30 feet deep

with a bottom width of 160 feet and a top width that ranges from approximately 216 to 269 feet. Portions of the channel with a rectangular cross-section include a short section upstream of the Arroyo Seco confluence that is approximately 31 feet deep with a width of 177 feet; and a short section near the downstream Project boundary at Washington Boulevard that is approximately 30 feet deep with a width of 280 feet. There are variations in left and right channel wall elevations at some locations within the Project Reach. A low-flow channel (LFC) runs along the center of the main channel, except near Washington Boulevard, where the LFC is replaced by a center divider and splits to run along both sides of the main channel downstream of the Project Reach. The LFC channel is approximately 0.5 to 1 foot deep, except for a roughly 616-foot section in Reach 8A that is up to 1.5 feet deep. The LFC has a constant 20-foot top width through the Project Reach and bottom width varies from 18 to 14 feet wide, depending on depth. The LFC bisects the LA River channel bottom into river right (western) and left (eastern) channel bottom portions as shown in Figure 4-1.

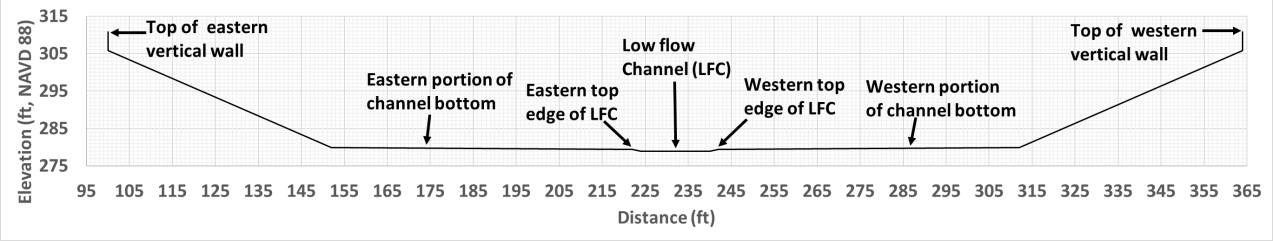


Figure 4-1. Typical channel geometry looking downstream through the Project Reach.

The Project Reach has 19 total bridge crossings, some of which present significant challenges to flood control when potential fish passage channels and habitat features are considered. Bridges with piers and abutments within the channel footprint constrict flood flows, and so introducing roughness elements (i.e., fish passage features) in the channel can induce a hydraulic jump upstream of the bridge. During the design development, the flood water level responses to proposed fish passage design were evaluated at each bridge and appropriate modifications to the channel were considered to reduce adverse flood impacts at the bridges (see Section 8.2).

Based on the review of available as-built drawings and utility mappings, a shallow, 48-inch-diameter concrete gravity sewer line was identified to present the most significant constraint to the design development within the Project Reach. The sewer line crosses under the LA River channel at the upstream boundary of the Project Reach, near the transition to the Glendale Narrows soft-bottom reach. Its crown elevation is indicated to be 2.25 feet below the invert elevation of the LFC. Other utilities that cross the channel within the Project Reach include an abandoned sewer at the 6th Street crossing, active sewer between 6th and 7th Street, an active sewer at the Interstate 10 exchange, and a natural gas line at the Olympic Boulevard crossing. Refer to Sheet CD 101 for their location and alignment. These will require further evaluation in the next design phase to detail protection of the utilities as well as measures to avoid trench collapse and ensure safety of the construction crew. Sewer location should be coordinated with the LA BOE Wastewater Conveyance Engineering Division Third Party Review group. Overhead electric power transmission lines cross the channel within the Project Reach at multiple locations. Coordination with utility services is recommended in the next design phase to avoid hazards and disruptions during construction.

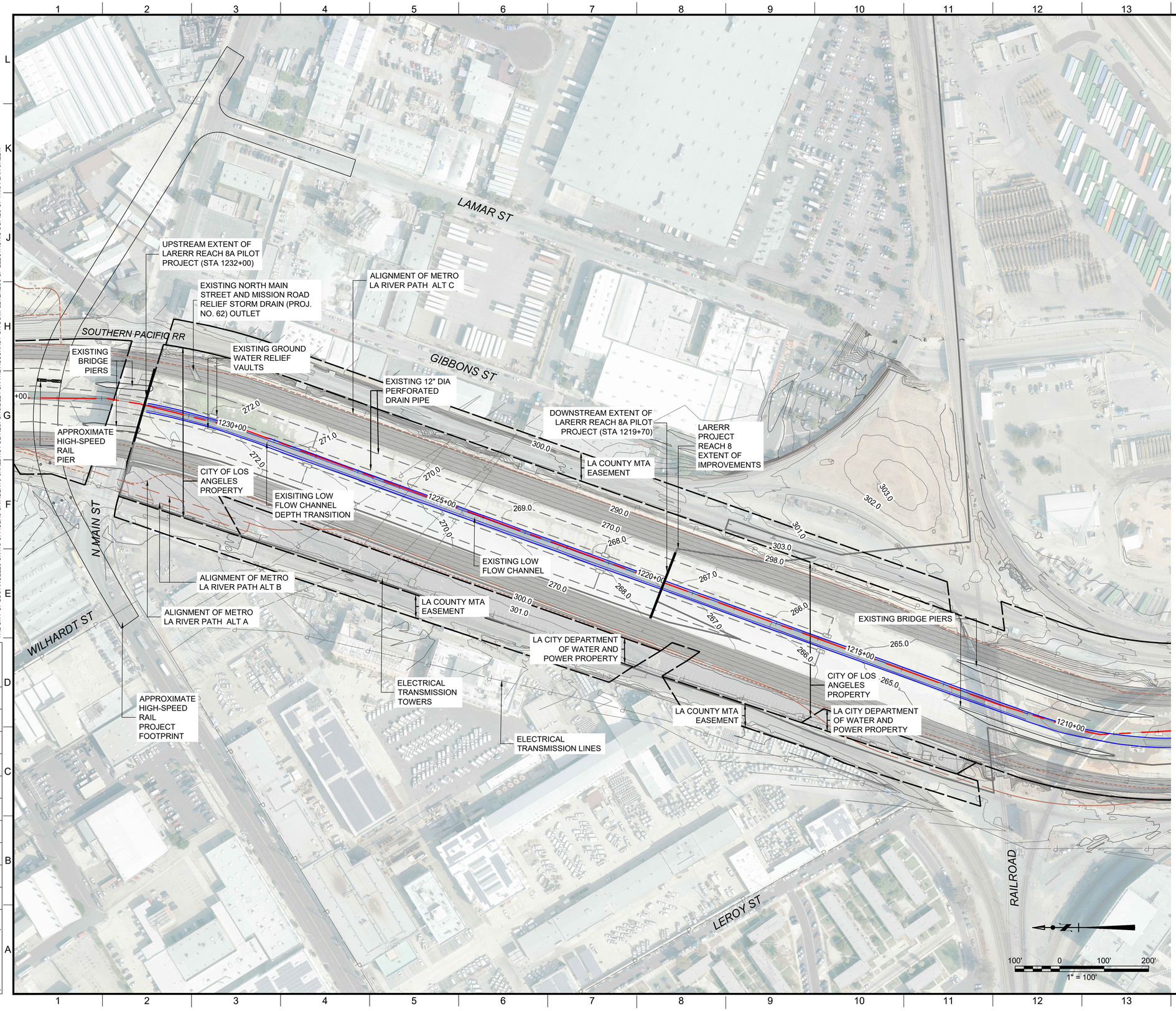
A subdrain system mitigates potential build-up of water pore pressures under the channel within the Project Reach. The system consists of a network of perforated drainpipes, groundwater relief

vaults, and cleanouts on the channel invert. The drainpipes are buried beneath the concrete lining to collect and deliver groundwater to a relief vault, and groundwater is then discharged into the LA River channel via outlets that are installed on the side of the relief vault. The drainpipes are shallow and located close to the LFC throughout the Project Reach. An approximate location of the subdrain system was mapped based on as-built drawings and orthophotos (USACE 2019) for LARERR Reach 8A (see Section 4.1), and the information will be supplemented to include the rest of the Project Reach in the next design phase.

4.1 LARERR Reach 8A

Reach 8A is the one-quarter-mile segment of the Project Reach, where the LARERR Reach 8A Pilot Project is proposed. The LARERR Reach 8A Pilot Project is the preferred alternative selected from the 30% level design phase, and thus a detailed base map (Figure 4-2) was developed to illustrate existing features and potential constraints around Reach 8A. Figure 4-2 shows the approximate footprint of the LARERR (USACE 2015), footprint of the proposed bridge north of the existing N Main Street crossing (California High-Speed Rail Authority 2021), existing N Main Street Bridge piers, proposed Metro LA River Path alignments (LA Metro 2019), parcel boundaries and ROW (California High-Speed Rail Authority 2021), and existing channel subdrain alignment (USACE 1943, 1984). There are no bridge crossings or potential underground utility conflicts within Reach 8A. The topographic map included in Figure 4-2 is developed from the LiDAR surface provided by USACE (2019). The stationing in Figure 4-2 matches that of the regulatory flood hydraulic model (USACE 2008).

The upstream limit (STA 1232+00) for the LARERR Reach 8A Pilot Project was set as the south side of the N Main Street crossing to minimize potential conflicts with the California High-Speed Rail Project, which proposes to construct a new vehicular bridge on the north side of the existing N Main Street crossing and over the existing Metro railroad tracks and LA River. The new bridge will be supported by a single in-channel pier. The N Main Street crossing will remain in place due to its historical significance but will be closed to public access (California High-Speed Rail Authority 2021). The downstream limit (STA 1219+70) was selected to coincide and avoid interference with the upstream project boundary of proposed modifications at Piggyback Yard (also known as the Los Angeles Transportation Center [LATC] intermodal terminal) included with the LARERR. Similarly, the width of the proposed modifications was defined to not interfere with proposed terracing of the west bank of the LA River channel included with the LARERR.



LEGEND

- ELECTRICAL TRANSMISSION LINES
- PARCEL BOUNDARIES/RIGHT OF WAY
- PROPOSED HIGH-SPEED TRAIN PROJECT FOOTPRINT
- METRO LA RIVER PATH ALTERNATIVE A
- METRO LA RIVER PATH ALTERNATIVE B
- METRO LA RIVER PATH ALTERNATIVE C
- LA RIVER ECOSYSTEM RESTORATION PROJECT REACH 8 EXTENT OF IMPROVEMENTS
- 12" DIA PERFORATED DRAIN PIPE
- EXISTING MAJOR CONTOUR (5 FT)
- EXISTING MINOR CONTOUR (1 FT)
- USACE REGULATORY HEC-RAS MODEL ALIGNMENT

TOPOGRAPHY IS BASED ON LIDAR AND PHOTOGRAMMETRY MAPPING FOR THE LA RIVER ECOSYSTEM RESTORATION PROJECT DATED OCTOBER 2019 WITH HORIZONTAL DATUM NAD 83 CALIFORNIA STATE PLANE ZONE V US FOOT AND NAVD 88 VERTICAL DATUM IN U.S. SURVEY FEET (USACE 2019).

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HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: BASEMAP

PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN

ADDRESS: LOS ANGELES, CALIFORNIA

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		04/08/22	
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CIP NO.

INDEX NO.

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ARCHITECT:	XX	04/08/22
DESIGNED BY:	EW	04/08/22
DRAWN BY:	KRE	04/08/22
CHECKED BY:	TRS	04/08/22
APPROVED BY:	NT	04/08/22

WORK ORDER
XXX

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FIGURE 4-2

SHEET X OF XX SHEETS

The shape of the channel through Reach 8A is trapezoidal with a section of vertical wall at the top of the trapezoid along both banks. On average, the channel depth is about 30 feet including the section of vertical wall, and the top and bottom widths are about 260 feet and 160 feet, respectively. There is an approximately 20-foot-wide (top width) LFC with varying depths, generally ranging between 1 and 1.5 feet.

According to the as-built drawings for a rehabilitation of the LFC (USACE 1984), the subdrain system within Reach 8A consists of a network of 12-inch-diameter perforated drain pipes, groundwater relief vaults, and cleanouts on the channel invert. Within Reach 8A, there are two parallel drain pipes (approximately 18 inches of cover) with their centerlines located approximately 10 feet and 18 feet away from the top edges of the LFC on either side. The outer edge of the relief vault is estimated to be about 6 feet away from the top edges of the LFC on either side of the LFC. There are a total of 6 relief vaults (3 on either side of the LFC) within Reach 8A. The as-builts (USACE 1984) indicate that portions of the drain pipes are damaged and require replacement, and thus the location of the subdrain system should be investigated further in the next design phase.

An inspection of the topographical map with corresponding orthophotos (USACE 2019) revealed irregular features on the channel bottom, which may have resulted from previous channel rehabilitation projects. These features were neither captured in as-built drawings (USACE 1943 and 1984) nor in the regulatory hydraulic model (USACE 2008) geometry input file, but they were confirmed by visual site inspection by the design team.

From the site inspection and a review of the topographical map, the LFC top and bottom widths and slope are generally in agreement with as-builts. Although variations may have resulted from breaklines that were included in the LiDAR data provided by USACE. Specific findings are as follows:

1. An abrupt transition in LFC depth from 1 to 1.5 feet (moving downstream) at STA 1229+20 (approximately 330 feet downstream of N Main Street)
2. Gradual transition of the LFC back to a 1-foot-deep channel at around station 1223+00 (approximately 950 feet downstream of N Main Street)
3. About 4-inch-thick concrete overlay on the western portion of the LA River channel bottom, making it higher than the eastern portion of the LFC
4. About 5-inch-high reverse lip (i.e., berm) along the eastern top edge of the LFC upstream of the LFC depth transition
5. Intermittent reverse lip of varying heights along the eastern top edge of the LFC downstream of the LFC depth transition
6. Continuous lip (i.e., swale) on the western top edge of the LFC downstream of the LFC depth transition, likely formed by a mismatch between the concrete overlay and the top of LFC

5 DESIGN TARGET AND CONSIDERATIONS

5.1 Fish Passage Design Flows

The hydraulic design approach for fish passage projects as described in the California Salmonid Stream Habitat Restoration Manual (CDFW 2010) was originally developed for culvert crossings. It references design criteria specified in CDFW (2002) and NMFS (2001) guidelines. Additional design criteria specific to fishways are described in Anadromous Salmonid Passage Facility Design (NMFS 2011). However, CDFW and NMFS do not provide guidance on design flows for fish passage projects within a flood control channel. The guidance selected to determine design flow criteria for the Project was judged to provide the closest available representation of conditions within the Project Reach.

Passage design flows must be specified to designate the flow range over which upstream passage for adult fish is provided. Use of a passage design flow range is intended to mimic conditions in undisturbed settings as feasible, with fish able to migrate upstream under hydrologic conditions that provide the best opportunity for reaching spawning areas. The design flow range is intended to provide passage most of the time during the migration season, recognizing that design for passage at flows associated with infrequent flood events (i.e., the 100-year event) would involve extensive and expensive channel modifications while providing a marginal increase in annual migration opportunities over the life of the project.

The fish passage design flows considered for the Project are summarized in Table 5-1 and are based on a review of NMFS and CDFW guidance and input received from NMFS and CDFW during technical meetings (November and December 2020). A wide range of design flows, including intermediate flows in addition to high (Qhfp) and low fish passage design flows (Qlfp), were considered to evaluate variations in hydraulic characteristics (depth and velocity) in the fish passage channel and to understand the performance of the proposed channel modifications over various flow rates.

Fish passage design flows are derived from a flow duration analysis performed on daily mean streamflow data. As summarized in Table 5-1, the high fish passage design flows for adult salmonids are based on the 1% exceedance flow listed in CDFW (2002) and NMFS (2001) criteria for fish passage at road crossings; the 1% exceedance in the migration season reflects an addendum for California projects (NMFS 2019) to the 2001 NMFS criteria. Both high design flows were used for evaluation of hydraulics relevant to fish passage, recognizing that passage under the higher value (1% exceedance in the migration season, 6,544 cfs) may not be feasible for the LARERR Reach 8A Pilot Project, given its reduced footprint. The low fish passage design flow is based on the 50% annual exceedance flow listed in CDFW (2002) and NMFS (2001) guidelines. Additionally, 95% and 5% migration season exceedance flows (NMFS 2011) and a 5% annual exceedance flow (CDFW 2002) were determined and included in the analysis as intermediate flows. Two additional discharges were modeled that do not correspond to a specific return period or target flow from the literature: 360 cfs and 595 cfs. These are intermediate flows between the 50% annual exceedance and the 5% annual exceedance. Flows in this range occur relatively frequently and are important for fish passage between peak flow events when discharges in the river are elevated above baseflow.

Fish passage design flows presented in Table 5-1 were developed from daily mean streamflow data available from Los Angeles County Public Works (LACPW) gages. The details of the data source and flow duration analyses results are presented in the 30% Basis of Design Report

(Stillwater Sciences 2021). For this Project, December to June was used to represent the migration season (COMB 2011; Booth 2016, 2020).

The current, altered LA River watershed creates a flashy hydrologic regime, where storm flows rise and recede quickly. This reduces the amount of time steelhead are able to migrate upstream during each storm when compared to historical conditions and increases the need to provide additional passage opportunities during baseflow, or in between storm events. Although NMFS and CDFW do not provide guidance on steelhead passage at baseflow, hydraulic conditions were evaluated to determine whether the LARERR Reach 8A Pilot Project and 4.8-mile Reach Project provide suitable conditions for fish passage at baseflow to increase the amount of time during the year that steelhead could potentially migrate upstream by providing passage not just at peak flows but after a storm has passed. Baseflows in the LA River (50–95% exceedance values) are presently dominated by reclaimed water discharge. The lowest flow of 25 cfs in Table 5-1 recognizes that these reclaimed water flows could be diverted in the future for other uses, reducing baseflow compared to current conditions (at present, approximately 70 cfs based on the 95% exceedance flow for the year). This lower value can provide a useful test of the effects of a potentially reduced baseflow on passage conditions but is not based on any actual projections of future flow conditions.

Table 5-1. Fish passage design and intermediate flows applicable to the Project Reach; low (Qlfp) and high (Qhfp) adult salmonid design flows are shaded.

Flow duration characteristics	Source	Design flow (cfs)
Potential future baseflow	Future low flow	25
95% Exceedance (Migration season baseflow)	Salmonids low fish passage design flow for fishway (NMFS 2011)	75
50% Exceedance (Annual) (Qlfp)	Adult salmonids low fish passage design flow at road crossings (CDFW 2002, NMFS 2001)	121
None	Intermediate flow	360
None	Intermediate flow	595
5% Exceedance (Annual)	Native non-salmonid high fish passage design flow at road crossings (CDFW 2002)	830
5% Exceedance (Migration season)	Salmonids high fish passage design flow for fishway (NMFS 2011)	1,553
1% Exceedance (Annual) (Qhfp)	Adult salmonids high fish passage design flow at road crossings (CDFW 2002, NMFS 2001)	4,660
1% Exceedance (Migration season) (Qhfp)	Adult salmonids high fish passage design flow at road crossings (NMFS 2019)	6,544

A flow duration analysis was conducted for the Los Angeles River Above the Arroyo Seco gage (LACPW F57C) plus the Arroyo Seco Below Devil's Gate Dam gage (LACPW F277) and for the Los Angeles River Below Wardlow Road gage (LACPW F319) minus the Rio Hondo Above Stewart and Gray gage (LACPW F45) for the period 1985 to 2019 to help determine the number of days the daily average flow rate within the Project Reach were above each of the design flow thresholds presented in Table 5-1. Results are presented below in Tables 5-2 and 5-3. A second flow duration analysis was conducted on the previous dataset but focused on the number of days the daily average flow rate exceeded the design storm events (830 cfs, 1,553 cfs, 4,660 cfs, and 6,544 cfs) during the steelhead migration window (December-June). Results are presented in Figures 5-1 and 5-2.

Table 5-2. Flow duration for the Los Angeles River Above the Arroyo Seco gage (LACPW F57C) plus the Arroyo Seco Below Devil's Gate Dam gage (LACPW F277) for the period 1985–2019.

Water year	Number of days in record	Number of days over:								
		25 cfs	75 cfs	121 cfs	360 cfs	595 cfs	830 cfs	1553 cfs	4660 cfs	6544 cfs
1985	304	304	18	11	3	2	1	1	0	0
1986	365	365	303	45	27	22	18	13	2	0
1987	273	273	263	24	13	7	6	1	0	0
No data available for 1988 to 1991										
1991	19	19	1	0	0	0	0	0	0	0
1992	305	305	217	216	83	24	18	14	7	7
1993	303	303	303	287	50	48	41	32	14	12
1994	176	176	164	126	6	5	3	0	0	0
1995	343	343	343	333	71	64	52	19	10	8
1996	167	167	167	133	15	10	7	2	0	0
1997	365	365	365	178	23	18	13	8	0	0
1998	151	151	151	58	32	28	26	16	8	4
1999	365	365	365	110	15	14	13	0	0	0
2000	366	366	366	124	20	15	13	8	0	0
2001	365	365	365	266	26	18	17	10	3	2
2002	365	365	364	290	12	5	4	2	0	0
2003	365	365	365	265	13	13	12	8	2	1
2004	366	366	366	260	20	16	10	8	2	1
2005	365	365	365	261	92	74	61	33	17	11
2006	365	365	365	191	25	15	13	7	1	0
2007	365	365	365	104	10	8	6	1	0	0
2008	366	366	323	121	47	18	17	9	2	2
2009	365	365	283	29	14	12	9	6	0	0
2010	365	365	357	87	23	18	16	11	3	2
2011	365	365	365	131	43	26	20	11	2	1
2012	366	366	365	50	14	11	9	6	0	0
2013	365	365	362	69	11	4	3	2	0	0
2014	365	365	357	9	4	4	3	3	2	0
2015	365	365	342	33	19	14	11	5	1	0
2016	366	366	303	33	11	9	8	4	0	0
2017	361	361	176	80	32	23	19	16	2	1
2018	365	365	176	51	12	11	9	4	0	0
2019	365	365	179	81	40	34	28	13	2	0

Table 5-3. Flow duration for the Los Angeles River Below Wardlow Road gage (LACPW F319) minus the Rio Hondo Above Stewart and Gray gage (LACPW F45) for the period 1985–2019.

Water year	Number of days in record	Number of days over:								
		25 cfs	75 cfs	121 cfs	360 cfs	595 cfs	830 cfs	1553 cfs	4660 cfs	6544 cfs
1985	304	304	82	22	8	4	2	1	1	0
1986	365	365	331	92	37	26	23	14	5	1
1987	365	365	363	82	19	11	9	4	1	0
1988	366	366	366	77	20	15	11	7	1	0
1989	365	365	365	304	17	15	12	6	0	0
1990	365	365	364	330	12	9	5	2	1	1
1991	365	365	365	285	30	19	14	11	4	1
1992	366	366	366	365	77	49	36	24	12	5
1993	365	365	365	365	103	82	70	47	25	19
1994	365	365	365	344	25	17	13	8	0	0
1995	312	312	312	309	65	49	43	32	13	10
1996	366	366	366	326	20	13	9	5	2	1
1997	365	365	365	306	23	21	17	10	2	2
1998	151	151	151	146	69	44	38	25	10	10
No data available for 1999										
2000	92	92	92	92	5	3	3	1	0	0
2001	365	365	365	361	24	20	18	14	5	4
2002	365	365	365	327	15	8	4	1	0	0
2003	365	365	346	123	16	13	13	10	3	2
2004	366	366	359	48	18	16	15	9	2	2
2005	364	364	364	363	66	49	43	31	16	12
2006	365	365	365	281	23	16	14	10	4	0
2007	365	365	365	157	11	8	5	2	0	0
2008	366	366	366	131	18	17	17	12	3	3
2009	363	363	363	96	14	10	10	7	3	0
2010	365	365	365	347	23	19	18	11	4	3
2011	364	364	364	359	34	30	24	14	4	3
2012	366	366	366	350	26	19	19	12	0	0
2013	365	365	365	349	29	21	18	11	0	0
2014	365	365	365	96	13	9	7	5	3	1
2015	365	365	365	196	26	20	17	9	3	1
2016	366	366	366	246	25	19	14	9	2	1
2017	365	365	365	351	42	37	26	17	6	2
2018	365	365	365	303	16	14	13	8	1	1
2019	365	365	242	129	41	35	28	22	9	5

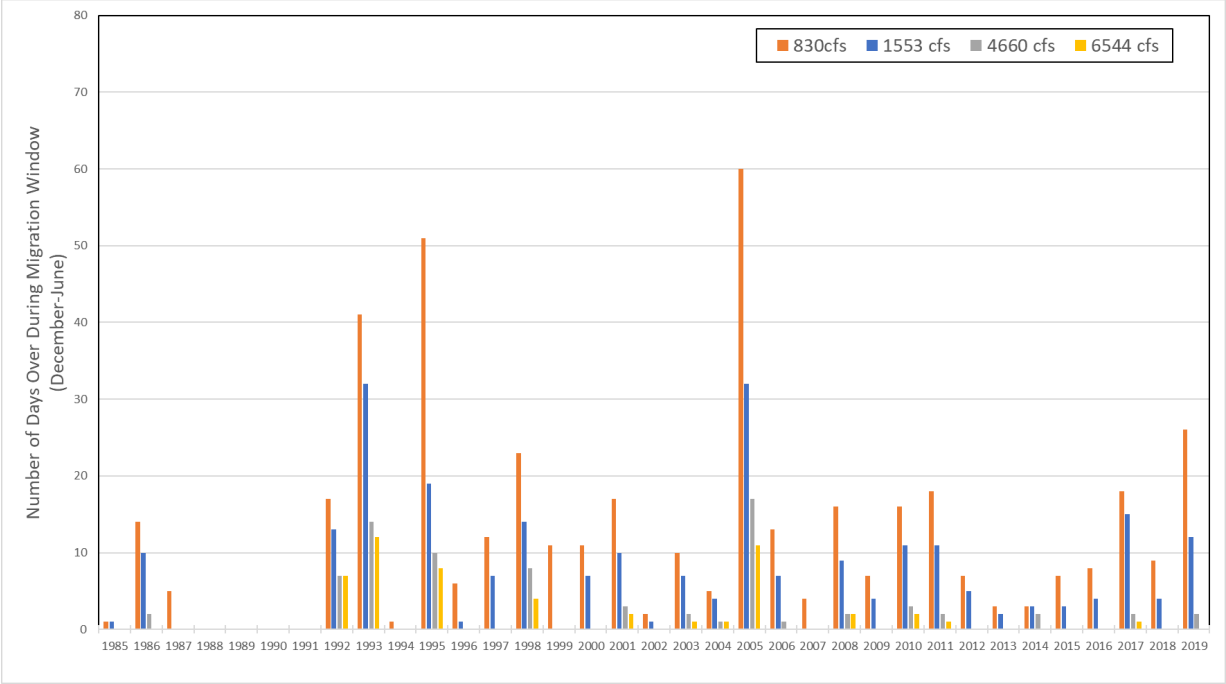

Figure 5-1. Flow duration for the Los Angeles River Above the Arroyo Seco gage (LACPW F57C) plus the Arroyo Seco Below Devil's Gate Dam gage (LACPW F277) for the period 1985–2019 during the steelhead migration window (December-June). No data are available for the years 1988–1991.

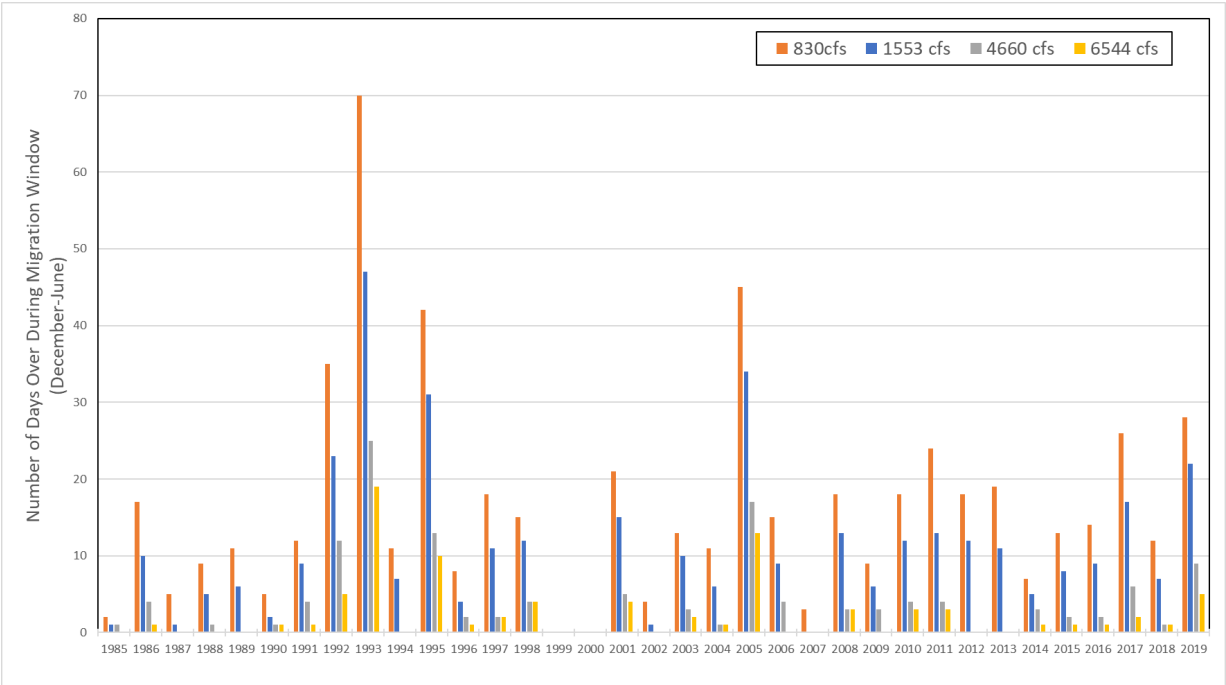

Figure 5-2. Flow duration for the Los Angeles River Below Wardlow Road gage (LACPW F319) minus the Rio Hondo Above Stewart and Gray gage (LACPW F45) for the period 1985–2019 during the steelhead migration window (December-June). No data are available for the years 1999–2000.

5.2 Fish Passage Depth and Velocity Targets

The CDFW (2002) and NMFS (2001) guidelines specify suitable upstream passage conditions for salmonids through culverts, but they do not address fish passage through flood control channels such as the LA River. These guidelines, which are widely recognized as being conservative (Michael Love and Associates 2007), recommend a minimum water depth of 1 foot and a maximum water velocity less than 2 feet per second (ft/s) for culverts exceeding 300 feet in length for adult salmonids at the fish passage design flows. Because the existing culvert guidelines do not provide hydraulic criteria appropriate for conditions within the Project Reach, the design guidelines for culvert crossings were combined with swimming modes of adult steelhead based on literature to develop depth and velocity targets for evaluating fish passage hydraulic conditions for the Project.

Table 5-4 presents the water velocity targets developed for the Project. As shown in the table, the water velocity categories are binned in uniform increments of 2 ft/s, and swimming modes of adult steelhead are related to each water velocity class, recognizing that swim speed must exceed water velocity for upstream migration against the flow. Refer to Figures 6-3 and 6-4 for an analysis of depth and water velocity under existing conditions in the Project Reach. Sustained swimming mode can be maintained by adult steelhead indefinitely (or until finite energy reserves are exhausted), prolonged mode can be maintained for extended periods of time (minutes to an hour) before reaching fatigue, and darting/burst mode can only be maintained for seconds before fatigue. These swimming modes correspond closely to adult steelhead swim performance data reported by Bell (1991), Flosi et al. (2010), and others. For design purposes, water velocities (greater than 10 ft/s) that require burst/daring swimming mode were considered unsuitable, and water velocities (between 6 and 10 ft/s) that require prolonged swimming mode were determined to be acceptable locally if velocity refuge such as boulders and pockets are available along the migration passage. The water velocity range between 6 and 10 ft/s was assumed to be acceptable for a maximum distance of 60 feet to be consistent with the culvert design criteria. The water velocity categories, as summarized in Table 5-4, are intended to be slightly conservative in relation to observed steelhead swimming abilities (i.e., steelhead may pass in higher velocities in natural streams) and should account for variability in swimming performance due to differences in fish size and condition, but are considered appropriate for application as design or evaluation targets to provide some measure of safety factor in the design.

Table 5-4. Water velocity targets for evaluating quality of passage conditions.

Steelhead passage conditions	Swimming mode	Water velocity (V) categories (ft/s)
Resting	Sustained	0<V<2
Favorable	Sustained	2<V<4
Suitable	Sustained	4<V<6
Acceptable Locally*	Prolonged	6<V<8
Marginal Locally*	Prolonged	8<V<10
Unsuitable	Burst/Darting	>10

* Assume maximum allowable distance of 60 feet.

5.3 Flood Control Target

5.3.1 Project Reach

Flood control for the 4.8-mile Reach Project is assessed based on freeboard, which is an interim indicator for flood performance of the proposed project by comparing the water surface elevations to the top of wall of the LA River channel. A Risk and Uncertainty (R&U) analysis consistent with Engineer Manual (EM) 1110-2-1619 (USACE 1996) will be performed once the detailed design of LARERR becomes available and the 4.8-mile Reach Project layouts can be better defined in coordination with the USACE. The R&U analysis estimates the likelihood of water levels exceeding a target threshold for a given flood event, considering uncertainty in both hydrology and hydraulics. This method replaces the historical use of the standard freeboard approach to account for a project's uncertainty associated with flood hydrology and hydraulics.

Precedent for the USACE granting Section 408 Permission to projects on the LA River that increase water surface elevation while meeting required freeboard, or provide mitigation to achieve the required freeboard, include the Taylor Yard Bikeway and Pedestrian Bridge and the North Atwater Multi-Modal Bridge. General freeboard allowances designated in EM 1110-2-1601 (USACE 1994) are 2.5 feet for trapezoidal concrete-lined channels and 3 feet where an earthen levee or concrete flood walls are present. The design team selected a target of 4 feet as the minimum freeboard above a peak 100-year flood flow for the Project Reach to provide greater freeboard than those specified in EM 1110-2-1601 and to anticipate uncertainties included with the future R&U analysis. To provide additional conservatism, the 100-year flood flow in the Project Reach (93,800 cfs and 109,000 cfs for segments upstream and downstream of the Arroyo Seco confluence, respectively) is higher than the channel's design discharge (83,700 cfs and 104,000 cfs for segments upstream and downstream of the Arroyo Seco confluence, respectively) as identified by the USACE (1992).

5.3.2 LARERR Reach 8A

The flood risk evaluation for the LARERR Reach 8A Pilot Project is an R&U analysis consistent with EM 1110-2-1619 (USACE 1996). A scope of work describing the methodology proposed for the R&U analysis was prepared and submitted for review by USACE, but comments have not yet been received.

The R&U analysis compares the long-term risk and conditional non-exceedance probability for existing and proposed LARERR Reach 8A Pilot Project conditions. The evaluation is based on HEC-RAS 1D modeling and estimates of uncertainty in the discharge-probability and stage-discharge relationships for the LA River channel within Reach 8A. These parameters were used in a Monte Carlo simulation in the USACE Hydrologic Engineering Center's Flood Damage Analysis (HEC-FDA) program version 1.4.3 (USACE 2021) to compute long-term risk and conditional non-exceedance probability (assurance) over a range of discharges. The procedures and results are briefly summarized in Section 7.3, and a technical memorandum describing the analysis is included in Appendix G.

6 EXISTING CONDITIONS HYDRAULICS

6.1 Hydraulic Model

During the 30% design development, the 1D HEC-RAS model provided by the USACE Los Angeles District office (USACE 2008), herein referred to as the 2008 LAR Model, was updated based on available as-built drawings and a more recent USACE model (USACE 2016) that was built as part of the USACE Floodplain Management Services to support Federal Emergency Management Agency inundation map updates. The bridge modeling technique was also altered to be consistent with the method used in the 2016 USACE model. Specifically, the bridge modeling approach in the 2008 LAR Model was switched from a standard bridge routine to modeling blocked obstructions for bridge piers and lids for bridge decks. The updated bridge modeling approach eliminated hydraulic jumps simulated previously by the 2008 LAR Model at N Broadway Street, N Main Street, Union Pacific Railroad (UPRR) downstream of N Main Street, and 6th Street. It showed a modest increase in water surface elevations through the bridges that resulted from the constrictions in flow area from bridge piers. Additionally, the 2008 LAR Model flow file was updated to include the 100-year discharge (USACE 1992), which is higher and more conservative than the channel design discharge, and fish passage design flows (Table 5-1). Details of the modifications made to the 2008 LAR Model are described in the 30% Basis of Design Report (Stillwater Sciences 2021).

For the 60% level design, additional improvements were made to the above modified 2008 LAR Model by updating the cross sections between upstream of N Main Street and downstream of UPRR bridges (from STA 1239+79 to STA 1204+58) with cross sections extracted from the LiDAR surface (USACE 2019) to better reflect the current channel conditions in Reach 8A. A detailed discussion of the LiDAR surface for Reach 8A is presented in Section 4.1. Two additional cross sections (STA 1229+20 and STA 1229+14) were included in the model geometry file to characterize an abrupt depth transition in the LFC. Finally, the model vertical datum was converted from the National Geodetic Vertical Datum of 1929 (NGVD 29) to NAVD 88 to match the new LiDAR surface using the following conversion equation: El. NAVD 88 = El. NGVD 29 + 2.5 feet. The model geometry cross sections outside of Reach 8A will be updated and refined as necessary in the future design phase. This model, prepared as part of the 60% level design, herein referred to as the Updated 2008 LAR Model, was used to evaluate the LA River channel hydraulics for flood and fish passage design flows under existing conditions.

6.2 Flood Flows

Figure 6-1 presents water surface (primary y-axis) and velocity (secondary y-axis) profiles predicted by the Updated 2008 LAR Model through the Project Reach, including Reach 8A, for the 100-year flood event under existing conditions. The figure also shows profiles for critical water surface elevation to indicate flow regime, top of vertical wall elevation, the 4-foot freeboard based on the lowest of either the east or west top of vertical wall elevation, and locations of bridge crossings. The predicted water surface and critical water surface profiles in the figure indicate that under existing conditions, the flow regime within the Project Reach is supercritical except for the upstream end of the Project Reach, where the LA River channel transitions from vegetated (and the flow is subcritical) to concrete-lined channel. The freeboard ranges between 1 foot (upstream end of Project Reach) and 20 feet (downstream end of Project Reach). Freeboard is approximately 3.9 feet downstream of the 7th Street Bridge. The cross-section averaged channel velocities are about 38 ft/s throughout the Project Reach during the 100-year flood event.

Figure 6-2 provides the same information as Figure 6-1 but focuses on Reach 8A. The 4-foot freeboard profile is shown in Figure 6-2 as a reference only. As discussed in Section 5.3, the flood risk for the LARERR Reach 8A Pilot Project is evaluated according to the R&U analysis, instead of allowing for the target 4-foot freeboard. The figure shows that under existing conditions during the 100-year flood event the flow regime is supercritical based on the plotted critical water surface elevation, the freeboard ranges between about 7 feet and 16 feet, and the channel velocities are about 36 ft/s through Reach 8A.

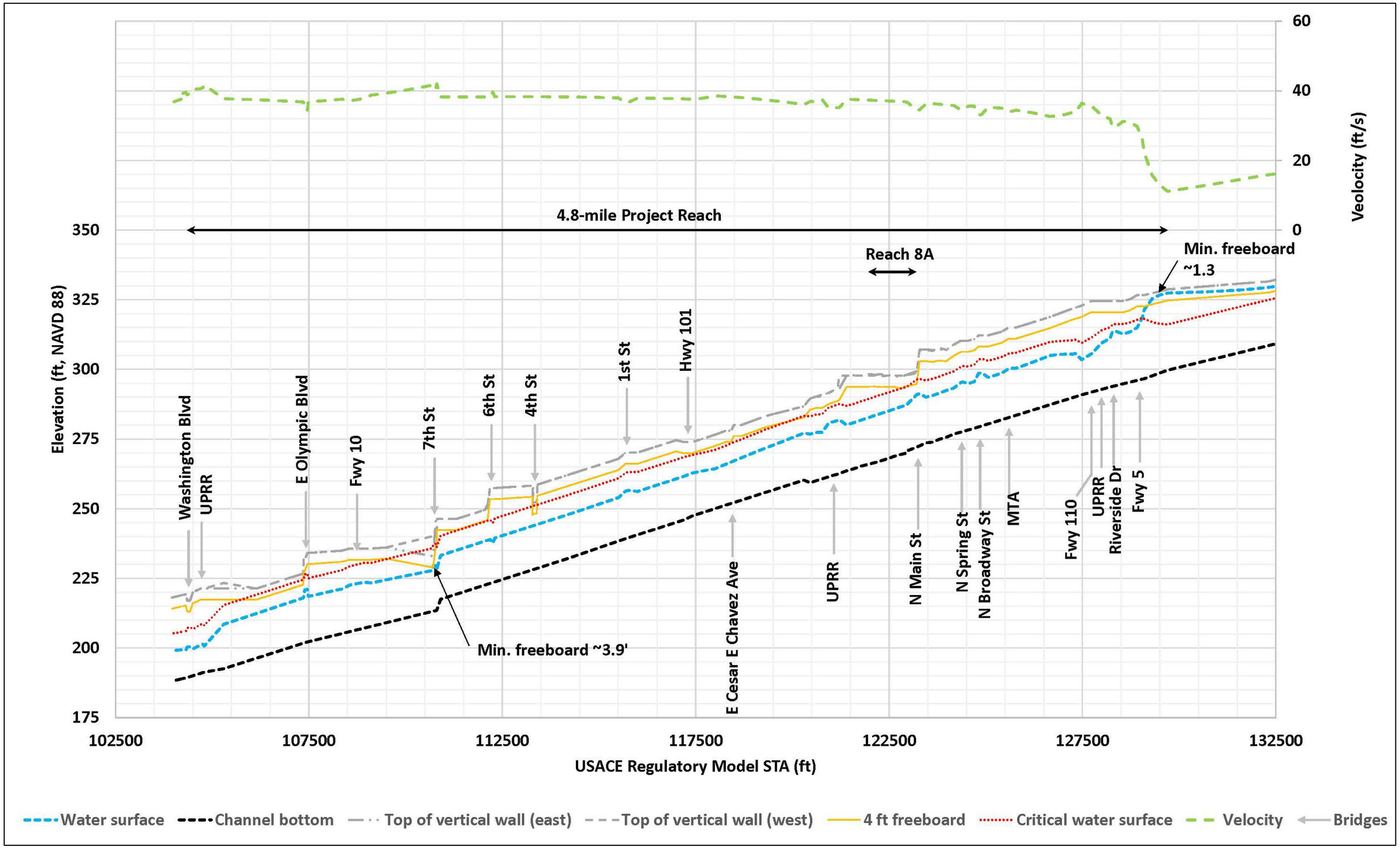

Figure 6-1. Existing conditions 100-year discharge water surface and velocity profiles through the Project Reach.

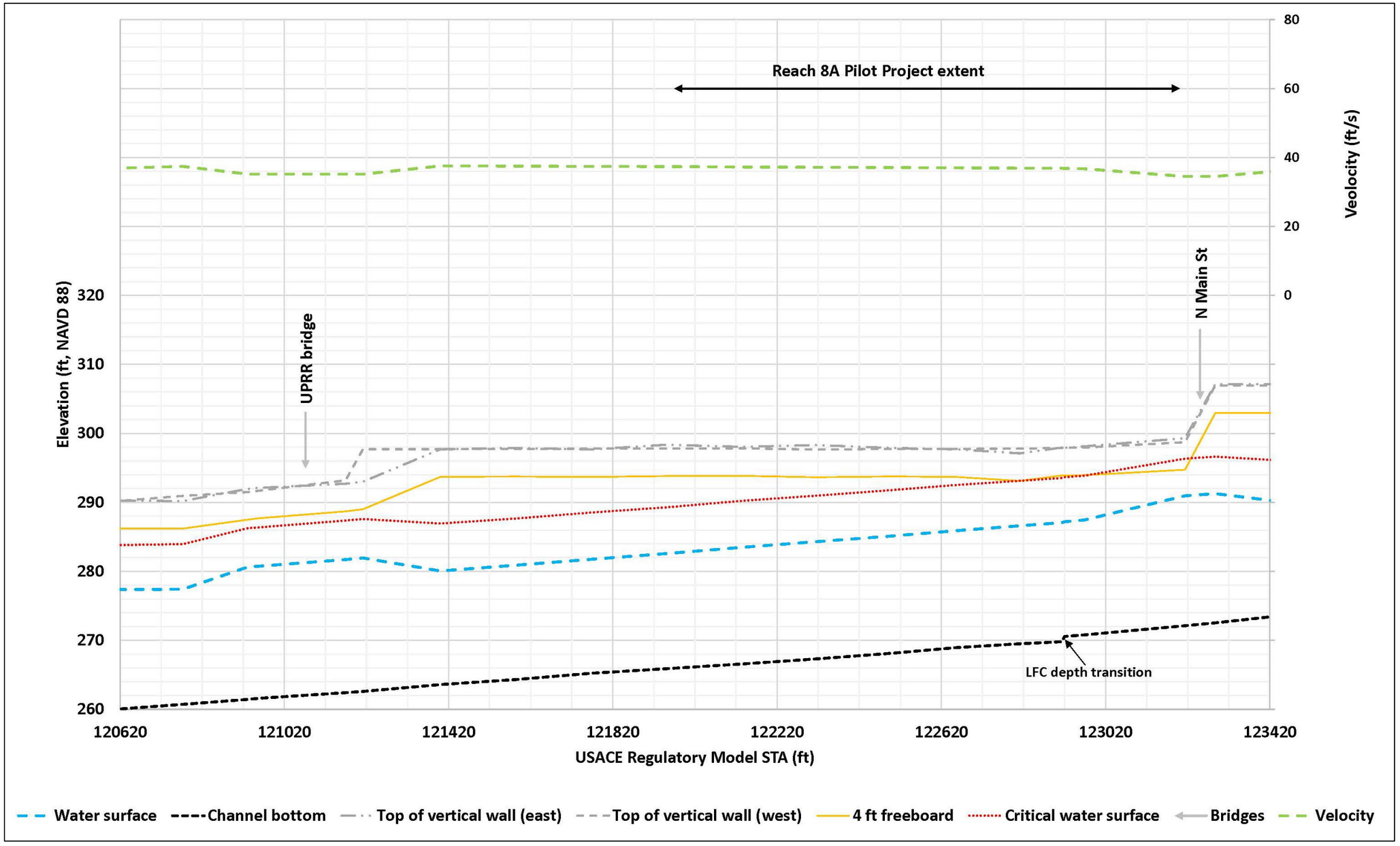

Figure 6-2. Existing conditions 100-year discharge water surface and velocity profiles through LARERR Reach 8A Pilot Project.

6.3 Fish Passage Flows

Channelization of the mainstem LA River has created a challenge for upstream migrating fish. When flows are low, water depth is insufficient at most locations for adult steelhead to migrate upstream and pass obstacles. When flows increase, the shape and smooth surface of the channelized concrete riverbed and banks create velocities that are too high for adult steelhead to swim upstream against, as demonstrated by the Updated 2008 LAR Model.

Figures 6-3 and 6-4 present velocity and depth within the LFC, respectively, under existing conditions for a range of fish passage flows and the potential future baseflow (25 cfs) computed by the Updated 2008 LAR Model. The LFC velocity and depth are both averaged over the Project Reach and Reach 8A. As described in Section 4, the LFC has a constant top width (20 feet) through the Project Reach and is 0.5 to 1 foot deep, except for Reach 8A, where the LFC depths are 1 or 1.5 feet. In Figures 6-3 and 6-4, discrepancies in the average velocity and depth computed for the Project Reach and Reach 8A are due to Reach 8A having a deeper LFC than the rest of the Project Reach. The figures indicate that upstream migration in the Project Reach is limited by depth (too shallow) at Qlfp (121 cfs) and by velocity (too fast) at both Qhfp (4,660 and 6,544 cfs) under existing conditions. At Qlfp, the average depth in the Project Reach is predicted to be less than the 1-foot minimum depth criterion for fish passage. At both Qhfp, velocities exceed 6 ft/s, and there are no resting habitat features available in the LA River. It is assumed that velocities greater than 6 ft/s are acceptable only locally and would require resting habitat features such as boulders and pockets for fish to recover along their migration route.

Generally, the Project Reach-averaged capacity of the existing LFC can also be estimated from Figure 6-4. For instance, at a typical baseflow (assumed to be about 70 cfs, or 95% exceedance flow for the year) and Qlfp (121 cfs), Figure 6-4 shows corresponding average depths through the Project Reach to be about 0.8 feet and 0.9 feet, respectively. Therefore, it can be estimated that baseflow and Qlfp are both contained within at least a 1-foot-deep LFC but spills for a 0.5-foot-deep LFC.

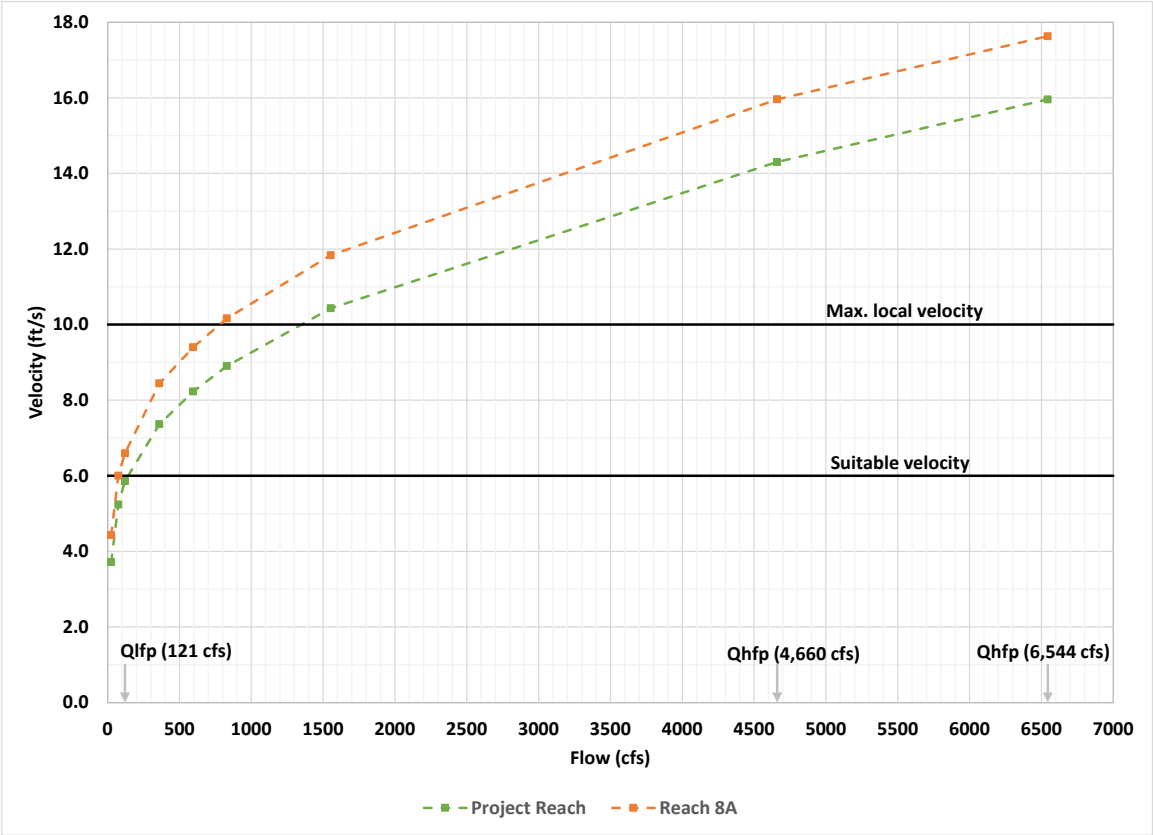

Figure 6-3. Velocities averaged over the Project Reach and Reach 8A under existing conditions for a range of fish passage flows, including high (Qhfp) and low (Qlfp) fish passage design flows in the low-flow channel.

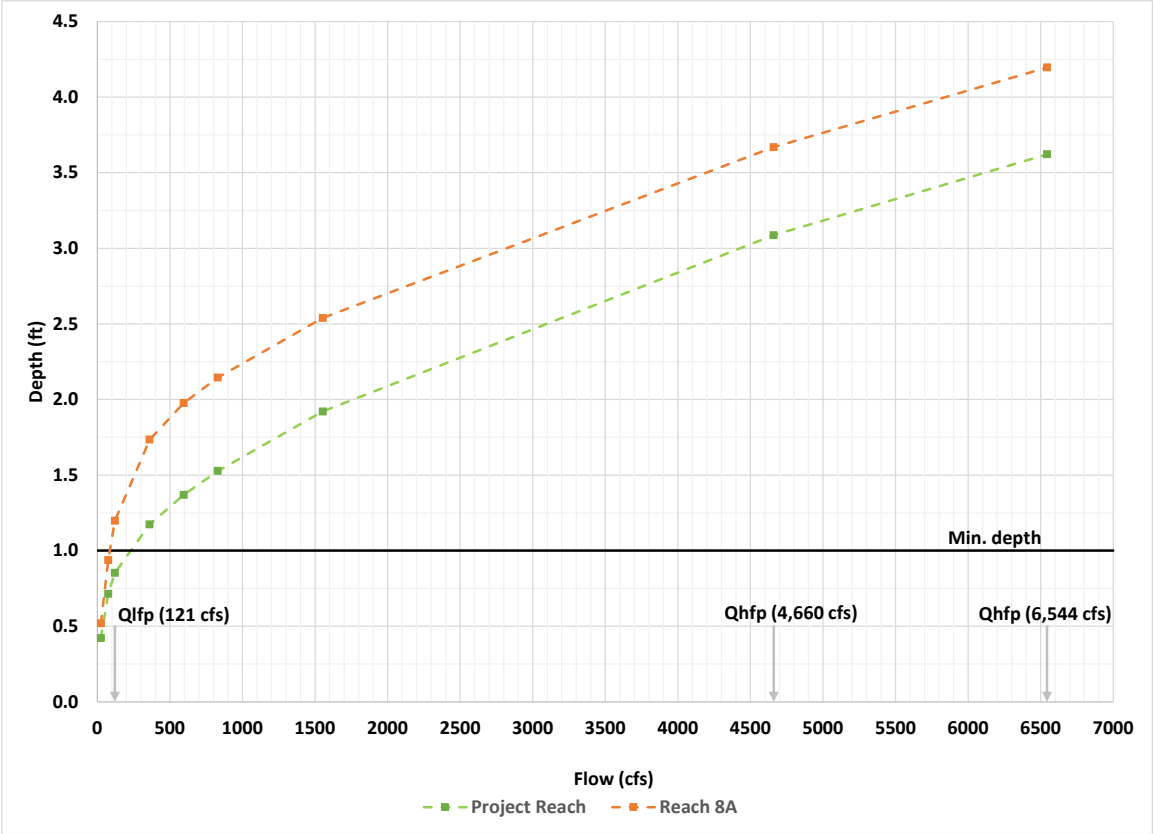

Figure 6-4. Depths averaged over the Project Reach and Reach 8A under existing conditions for a range of fish passage flows, including high (Qhfp) and low (Qlfp) fish passage design flows in low-flow channel.

7 LARERR REACH 8A PILOT PROJECT

The LARERR Reach 8A Pilot Project was the selected alternative for the upstream portion of LARERR Reach 8, referred to as Reach 8A, from the 30% level design phase. It extends from the downstream face of N Main Street to approximately one-quarter mile south (i.e., Reach 8A). The LARERR Reach 8A Pilot project is formulated to significantly improve steelhead passage while minimizing construction cost and complexity and to avoid potential design conflicts with LARERR. Hydraulic performances relevant to flood and fish passage for LARERR Reach 8A Pilot Project are presented in Sections 7.2.1, 7.2.2, and 7.3.

As examined in Section 6, the existing geometry and smooth concrete lining of the channelized LA River is efficient at conveying flood flows, but velocities are too high at moderate flows and depths too shallow at lower flows for fish passage. The general design approach for improving upstream passage is to provide increased depth where necessary and lower velocities for fish passage flows by adding deeper inset channels and roughness to the existing LFC. Because the deeper inset channel will add flow conveyance area to the channel cross section, the increased area can be used to offset the reduced flood capacity effects of increased roughness. In addition to lowering average velocities at fish passage flows, the design aims to increase hydraulic diversity in the channel to simulate natural conditions that are beneficial to fish and other aquatic

organisms. This design objective is achieved through the combination of the inset channels with additional habitat components including resting pockets, scour pools, anchored boulders, and planter features. The 60% level design drawings for the LARERR Reach 8A Pilot Project are included in Appendix A.

7.1 Habitat Features

7.1.1 Inset channel

The inset channel would be a 7.5-foot-wide rectangular channel lined with concreted rock (median particle sizes range between 6 and 9 inches) to add roughness and variability in bed topography with a meandering thalweg to provide favorable and diverse hydraulic conditions for fish passage through a range of design flows. To minimize an associated rise in water surface elevation from added roughness, the proposed channel modifications increase the channel cross-sectional area by lowering the channel invert elevation and setting back the east top edge of the LFC. The inset channel invert would be approximately 1.5 feet below the existing LFC invert elevation. With the inset channel installed, the overall top width of the LFC would increase only slightly from 20 feet to 22 feet. To limit the LARERR Reach 8A Pilot Project construction costs, inset channels are proposed only along the portions of the LFC where the existing depths are less than 1.5 feet to minimize modifications to the existing LFC.

There are two sections of inset channel proposed in Reach 8A. The upstream section of inset channel would be installed between N Main Street and the location of an existing transition in depth of the LFC, and the downstream section of inset channel would be installed near the downstream limit of Reach 8A. The new inset channels would be constructed along the east edge of the existing LFC to limit the potential relocation of relief vaults associated with the channel subdrain system and avoid potential conflicts with the terracing of the western riverbank currently proposed under LARERR. Anchored boulders would be added to the existing LFC along both sections of inset channel proposed in Reach 8A. Details of the boulder sizing and placement patterns are presented in Section 7.1.3. Vegetation features using the weephole or perforated slab tie-in concept (Section 7.1.6) would be incorporated along the top edge of the inset channels for habitat and aesthetic improvements.

Plan and profile views of the inset channel are presented in Sheets CI 212 through CI 214 in Appendix A. Typical cross sections and typical plan with concreted rock configurations for the inset channel are provided in Sheets CI 506 and CI 511, respectively, in Appendix A.

7.1.2 Low-flow channel with boulders

Where the existing LFC depth is approximately 1.5 feet, the LARERR Reach 8A Pilot Project proposes to install a series of boulder clusters anchored to the bed of the existing LFC without an adjacent inset channel. The existing depth of the LFC in these sections is sufficient for adult steelhead passage and the boulders provide favorable velocities and migration paths without the need for an inset channel. Reducing the length of inset channel within the LAREER Reach 8A Pilot Project where the existing LFC exceeds fish passage depth targets significantly reduces overall project construction costs. Details of the boulder sizing and placement patterns are presented in Section 7.1.3.

The existing LFC geometry would not be altered through this section of the LARERR Reach 8A Pilot Project except in the areas where resting pockets (discussed in Section 7.1.4) are proposed. Therefore, maintenance vehicles may cross the LFC by avoiding boulder clusters and resting

pockets, which are spaced far enough apart to provide vehicle crossing. Vegetation features using the weephole concept (Section 7.1.6.2) would be incorporated intermittently along top edges of the LFC for habitat and aesthetic improvements.

Plan and profile views of the LFC with boulders are presented in Sheets CI 212 and CI 213 in Appendix A. A cross section of the LFC with boulders is provided in Sheet CI 510 in Appendix A.

7.1.3 Boulder clusters and scour pools

Boulder clusters are often used in fish passage design to create topographic variability that produces hydraulic complexities in a stream. Boulders protrude into the flow, causing a backwater effect immediately upstream and a downstream low-velocity wake zone in the lee of the boulder where migrating adult steelhead may rest. These low-velocity zones provide fish resting habitat and possible migration paths as migrating adults can recover from periods of prolonged or burst swimming at high flows when velocities may exceed design targets. Boulder placement also enhances the aesthetic value of a concrete-lined urban channel like the LA River by simulating natural environments and adding visual variability. Boulders would be anchored to the channel bed to prevent them from washing downstream during a flood event.

The maximum boulder size was selected to reduce impacts on the channel flood hydraulics. Because the hydraulic behavior of a supercritical channel (i.e., the LA River channel) around a relatively large obstruction is difficult to accurately predict when using 1D and 2D models, the maximum boulder size was set so that the top of the boulder would be no more than 1.5 feet above the top edge elevations of the LFC. The velocity-reducing effect of boulders is observed to diminish significantly with increases in boulder submergence ratio. Based on these criteria, the maximum boulder dimension would be about 3 feet (long axis) by 2.5 feet (short axis) by 2.5 feet (height above LFC).

Each boulder cluster will contain one to five boulders. The boulder clusters were placed strategically along the LFC so that fish can use low-velocity zones in the wake of clusters to maneuver through patches of wake zones downstream of clusters. A physical model of boulder cluster configurations by the U.S. Department of the Interior, Bureau of Reclamation (2020) demonstrated that the width of a boulder cluster wake zone is equal to the width of a boulder cluster, and the length is about 4 to 8 times the width. Based on this information, the boulder clusters were placed with an average spacing of 30 feet throughout the LFC. Variable cluster configurations were used in the design to account for variation in fish size and improve aesthetics. The proposed boulder placement will allow for maintenance vehicle passage across the LFC. Boulders alternate periodically between the left and right sides of the LFC to simulate an alternating bar sequence that may be found in a natural channel with relatively straight alignment. Most clusters are also offset from the LFC centerline to provide a minimum of 6-foot clearance for recreational use such as kayaking. In 2010, the U.S. Environmental Protection Agency designated the LA River as a "Traditional Navigable Waterway" under the Clean Water Act, which facilitates recreation such as kayaking. Two designated recreation zones upstream of the Project Reach, Elysian Valley and the Sepulveda Basin, are currently open for kayaking and are managed and patrolled by the Mountains Recreation and Conservation Authority (MRCA). The proposed Project does not currently have a public access or recreation objective but does consider this potential future use in the overall project design as described in Section 13 and specifically with regard to the spacing of the individual boulders. Boulders as proposed in the design would provide enough clearance for kayaks as well as increased hydraulic diversity in the channel for more interesting kayaking runs than existing conditions provide.

Scour pools (6-foot-wide, 12-foot-long, 1-foot-deep) would be constructed downstream of selected boulder clusters to simulate natural stream bed conditions. Section 12 describes the vector control design considerations (e.g., mosquito control) for these features. Scour pools function in tandem with boulder clusters to further enhance favorable hydraulic conditions for fish passage. Scour pools are located in the wake zone of boulder clusters (downstream side) creating a vertical flow expansion that further decreases flow velocity and increases flow depth. Scour pool features mimic scour holes that form downstream of boulders in natural rivers due to the acceleration of flow around the sides and over the top of boulders during flood events. Scour pools in natural streams are common areas for fishes to rest and hold during low flow conditions.

Layout of the boulder clusters and scour pools are presented in Sheets CI 212 through CI 214 in Appendix A. Detailed plan, profile, and section are provided in Sheet CI 510 in Appendix A.

7.1.4 Resting pockets

Resting pockets are designed to provide low-velocity areas where steelhead can rest and recover from fatigue during migration. Therefore, the spacing of the pockets influences fish passage success. Steelhead in resting pockets would be potentially vulnerable to predation and human harassment. Assuming steelhead may occupy the resting pockets for longer periods of time compared to the other design features, sufficient water depth is needed in the pockets to minimize the potential for predation and harassment during resting. Overhead cover and shade provided by streamside vegetation in planter boxes adjacent to some resting pockets would provide additional protection against predation and disturbance (see Section 7.1.6.1).

A set of equations developed for a fish routing, energetics, and locomotion modeling study (Michael Love and Associates 2007) was used as a reference to determine the pocket spacing. According to the equations, the pocket spacing would vary with water velocity, velocity of fish relative to the ground (i.e., ground speed), and fish body length (BL). Figure 7-1 presents the recommended maximum pocket spacing in a range of water velocities for a 24.5-inch BL (i.e., average-sized steelhead per Michael Love and Associates 2007) and an 18-inch BL fish (i.e., smaller-sized steelhead with commensurately lower-than-average swimming abilities). The maximum spacing computed in Figure 7-1 assumes that fish swim in prolonged mode at a constant, optimum ground velocity regardless of water velocity. For prolonged swimming, the optimum ground speeds for 18- and 24.5-inch BL fish were calculated to be 3.1 ft/s and 4.2 ft/s, respectively. Based on this information, 100-foot spacing was selected for the LARERR Reach 8A Pilot Project resting pockets. This assumed spacing will allow an 18-inch BL fish to successfully swim through Reach 8A when the channel velocities are around 6 ft/s (830 cfs), and larger fish to pass through Reach 8A at much higher channel velocities. Migration-fatigue modeling specific to the Project Reach was beyond the scope of this study. Stillwater Sciences has initiated preliminary migration-fatigue analysis for the LARERR Reach 8A Pilot Project to support analysis of reclaimed water diversion impacts on future LA River restoration projects, which may be available to inform more precise, and potentially less costly, spacing criteria for subsequent design phases for the Project.

Three types (Types A, B, and C) of resting pockets are proposed for the LARERR Reach 8A Pilot Project. Type A and B resting pockets would be constructed adjacent to the inset channel. Type A resting pockets includes vegetation features using two planter boxes surrounded by a perforated slab tie-in (Section 7.1.6) to provide overhead cover for fish recovering from fatigue. Type B resting pockets includes a vegetation feature using the perforated slab tie-in approach and a cantilever concrete overhang over a portion of the resting pocket to provide overhead cover for fish recovering from fatigue. Type C resting pockets would be constructed within the existing

LFC side slope and overhead vegetation cover would be provided by a planter box surrounded by a perforated slab tie-in. The bottom of Type A and B resting pockets would be roughened with concreted rock (median particle sizes range between 6 and 9 inches), and there would be a 4-foot-wide by 6-foot-long resting area in the upstream end, followed by a 12-foot-long downstream section with a gradual transition (2:1) to steadily accelerate flow out of the resting pocket and promote sediment flushing. Type C resting pockets have a similar configuration except that the width is slightly wider to fit within the side slope of the existing LFC. The invert elevations of the upstream portion of the Type A/B and Type C resting pockets would be about 1.5 feet and 1 foot below the existing LFC invert, respectively. This configuration would provide at least 1.5 feet of depth over an area that is at least one average steelhead BL wide (approximately 2 feet) within the resting pocket. Section 12 describes the vector control design considerations for these features.

Two Type A, four Type B, and six Type C resting pockets are proposed through Reach 8A. Resting pockets would be constructed along the east edge of the existing LFC to limit the potential relocation of subdrain pipelines and vaults on the west side of the existing LFC and avoid potential conflicts with the terracing of the western riverbank currently proposed under the LARERR.

Layout of the resting pockets are presented in Sheets CI 212 through CI 214 in Appendix A. Detailed plan and sections for Types A, B, and C resting pockets are provided in Sheets CI 507, CI 508, and CI 509, respectively, in Appendix A.

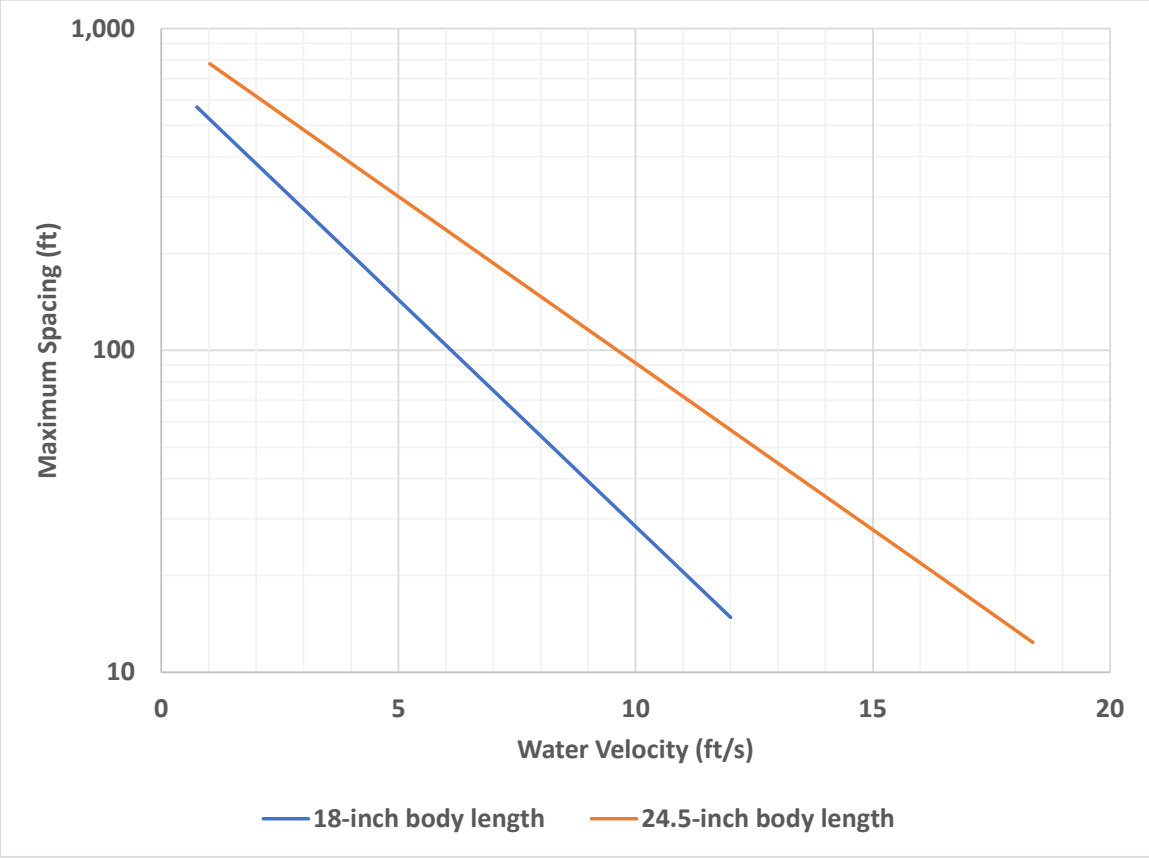

Figure 7-1. Maximum resting pocket spacing for fish swimming in prolonged mode at a constant, optimum ground speed.

7.1.5 Stormwater treatment area

The stormwater treatment area would consist of an approximately 2,000-square-foot vegetated area and a 6-inch-tall, drivable berm constructed at the existing LA County Department of Public Works (LACPW) storm drain outlet (Storm Drain Project No. 62). The dry-weather flows from the storm drain would be conveyed to the LFC through the vegetated area, which would help to trap some pollutants present in the dry-weather flows. Although limited, potential water quality benefits that may be realized include trapping of particulate matter, which may reduce several particle-associated pollutants such as trace metals and phosphorus; and adsorption of organic pollutants on wetted portions of planted materials. Although these benefits are expected only during low flows and much of the sequestered materials would be remobilized during high flows, increased dilution during high flows would be expected to reduce potential toxicity associated with these pollutants. In addition to the water quality benefits associated with particle trapping, the vegetated areas may promote an overall increase in wetted area and areal extent of attached algae colonization. Attached algae at this location could be expected to promote photosynthetically driven diel variations of pH in the storm drain flow, which may promote inactivation of coliform bacteria and E. coli.

Depending on the condition of the existing concrete lining, the vegetation within the water quality enhancement feature would be installed in the existing concrete lining using either the 4- or 6-inch diameter the weephole concept (Section 7.1.6). Considering the sizes of the weephole openings, plant species such as sedges (*Carex* spp.) and rushes (*Juncus* spp.) would be suitable for this application. Planting layout and schedule for the stormwater treatment area will be developed in the next design phase.

Layout and typical section through the stormwater treatment area are presented in Sheet CI 512 in Appendix A.

7.1.6 Vegetation features

Much of the 4.8-mile Project Reach studied in the 30% design phase passes through disadvantaged neighborhoods with limited green space and urban forest. Vegetation components of the Project will provide habitat value for fish and other species as well as attractive visual and recreational open space connections for surrounding neighborhoods. Vegetation will be integrated into the LARERR Reach 8A Pilot Project using the planter boxes, weephole, and perforated slab tie-in concepts described in subsections below. These concepts are designed to allow vegetation while preventing damage to the concrete lining and in part to manage plant density in the channel.

Vegetation selected for the planter box and weephole/perforated slab tie-in concepts are based on consideration of planting dimensions (i.e., mature plant height) in combination with information on local native species that are appropriate for the inundation regime these planting locations will experience. Because the plants were selected from a list of native plants appropriate for the area, they will also provide biological benefits to the Project area. Table 7-1 summarizes potential candidate species considered for the planter box and weephole/perforated slab tie-in concepts for the LARERR Reach 8A Pilot Project. References reviewed include:

- CalFlora and eFlora range maps (CalFlora 2021, Jepson Flora Project 2021)
- Previously documented species (TNC 2016, Garrett 1993)
- Los Angeles River planning documents (LA County 2020, USACE 2015, City of LA 2015)

- Arid West (AW) wetland indicator status (i.e., Obligate (OBL)[1], Facultative Wetland (FACW)[2]) (USACE 2020)
- CalScape database for lifeform, evergreen/deciduous, height/width, availability in nurseries (CNPS 2021)
- USDA Plants Characteristics Search for root depth, anaerobic tolerance, drainage preferences (USDA 2021)

Selected species were reviewed against plants previously documented in the watershed (e.g., TNC 2016, Garrett 1993) or palettes included with LA River planning documents such as the LARERR IFR (USACE 2015), LA River Master Plan (LACPW 2021), and City of LA's River Improvement Overlay (RIO) District. All species comply with standards set by the City of LA's RIO plan and all but three of the selected species (*Carex alma, Carex praegracilis,* and *Juncus rugulosus*) were included in the reviewed documents. The three species which were not included in the reviewed documents are known to occur in the LA River watershed as documented in CalFlora (2021).

Table 7-1. List of potential candidate species for proposed vegetation features.

Scientific name	Common name	Mature plant heights (feet)	Water requirements[1]
Artemisia douglasiana	mugwort	up to 8.0	low, moderate - high
Bidens laevis	bur-marigold	0.7–8.0	moderate - high
Carex alma	sedge	up to 3.0	high
Carex praegracilis	clustered field sedge	2.0–3.5	low, moderate - high
Carex schottii	Schott's sedge	up to 5.0	high
Carex senta	rough sedge	3.0	moderate - high
Eleocharis macrostachya	pale spikerush	1.5–3.0	moderate - high
Eleocharis parishii	Parish's spikerush	1.6	moderate - high
Elymus tritichoides	beardless wild rye	2.1–4.3	moderate - high
Epilobium ciliatum subsp. *ciliatum*	fringed willowherb	1.6–6.0	low, moderate - high
Eriophyllum confertiflorum	golden yarrow	1.6–2.3	very low
Erythranthe cardinalis	scarlet monkeyflower	1.5–3.0	moderate - high
Euthamia occidentalis	western goldenrod	3.5–7.0	moderate - high
Juncus mexicanus	Mexican rush	0.3–2.6	moderate - high
Juncus patens	rush	1.0–3.0	moderate - high
Juncus rugulosus	wrinkled rush	2.3	moderate - high
Juncus textilis	basket rush	3.3–7.0	moderate - high
Schoenoplectus acutus var. *occidentalis*	common tule	13.0	high
Schoenoplectus americanus	Olney's three-square bulrush	3.5–7.0	moderate - high
Schoenoplectus californicus	southern bulrush	6.0–12.0	moderate - high
Typha latifolia	broad-leaved cattail	1.0–5.0	moderate - high

[1] CNPS 2021; USACE 2020

[1] Almost always is a hydrophyte, rarely in uplands.
[2] Usually is a hydrophyte but occasionally found in uplands.

7.1.6.1 Planter boxes

Planter boxes would be installed adjacent to Type A and C resting pockets to provide shade for fish recovering from fatigue. Planter boxes are precast concrete units with an open connection to the subgrade for groundwater interaction. They are configured as 5-foot-wide, 7-foot-long, and 4-foot-deep (outside dimensions) rectangular boxes with a grid of dividers on top to retain soil during high flow events. Each grid element would be a 19-inch by 19-inch space for plantings. The planter boxes would be filled with a 2.5-foot-thick rock layer on the bottom to prevent potential scouring beyond this layer and a 1.5-foot-thick growing media on top of the rock layer.

Plant species suitable for the planter boxes are common tule (*Schoenoplectus acutus* var. *occidentalis),* southern bulrush (*Schoenoplectus californicus)* and broad-leaved cattail (*Typha latifolia),* because they would provide the most cover and shade. Additional species listed in Table 7-1 may be considered pending inputs from the USACE.

Layout and sections for the planter boxes placed adjected to Type A and C resting pockets are provided in CI 507 and CI 509, respectively, in Appendix A.

7.1.6.2 Weepholes and perforated slab tie-in

Weephole and perforated slab tie-in concepts are similar to planter boxes except that they are more compact and economical to construct. Both concepts involve installation of High-Density Polyethylene (HDPE) sleeves filled with growing media for planting. The weepholes would be constructed in the undamaged areas of the existing concrete lining, while the perforated slab tie-in concept would be applied to areas where new concrete is proposed. These concepts expand on observed vegetation within existing flood control structures, where opportunistic plants will grow in weepholes or other penetrations through the concrete. Although plants are typically removed as part of maintenance activities, if the channel lining was protected then small penetrations in the lining could be used as a planting site.

The weephole and perforated slab tie-in diameters would be 6 or 4 inches to accommodate structural rebar in between the penetration locations. The HDPE sleeves would protect the concrete lining by directing the root growth into subgrade and away from the channel lining. The HDPE sleeves would penetrate through the concrete lining and drain rock layer, extending approximately 6 inches below the drain rock layer. Open connections through the lining would also provide groundwater interaction. The weephole and/or perforated slab tie-in concepts would be placed adjacent to planter boxes, the stormwater treatment area, as well as in other areas near the edges of the LFC.

Small plant species, such as Parish's spikerush (*Eleocharis parishii*) and wrinkled rush (*Juncus rugulosus*) would be suitable for this application due to the confined space for plants to grow in. Additional species listed in Table 7-1 may be considered pending inputs from the USACE.

Layout and section for the perforated slab planting concept is provided in Sheet CI 513 in Appendix A.

7.2 Proposed Conditions Hydraulics

7.2.1 Flood hydraulics

The 1D HEC-RAS Updated 2008 LAR Model was modified to represent proposed conditions and assess the flood impacts for LARERR Reach 8A Pilot Project. The primary modifications include changes in the geometry to represent the proposed inset channel sections and changes in hydraulic roughness to represent the inset channel concreted rock lining, boulders on the LFC, and vegetation. Resting pockets and scour pools are not represented in the evaluation, because they will not change the overall conveyance area and thus will not significantly impact the flood water surface elevation. The model results also inform the R&U analysis, which is described in Section 7.3.

Roughness values in the proposed condition model were selected for the inset channel based on bed material size using the Strickler equation (USACE 1994) and compared to depth-dependent roughness estimators such as the Mussetter and Limerinos equations, which are among several referenced for use in roughened channel fish passage projects by CFDW (2010). A single Manning's n-value (0.03) was selected for use in the flood model to represent the proposed inset channel. Roughness values representing intermittent boulder clusters on the LFC are difficult to estimate, because most roughness predictors in the hydraulic engineering literature are based on continuous roughness surfaces rather than intermittent features. A single Manning's n-value of 0.022 was applied to the LFC with boulders based on engineering judgment, recognizing considerable uncertainty in the values. Roughness values used to represent vegetation were based on the proposed species listed in Table 7-1, which are primarily low-growing herbaceous plants and do not include woody shrubs or trees. A single Manning's n-value (0.03) was selected to represent low herbaceous vegetation planted in weepholes or perforations in the concrete lining. A single Manning's n-value was applied to the existing concrete lining. Note that these roughness values are base values and the model's sensitivity to n-values were evaluated as part of the R&U analysis by adjusting them to low bound and high bound n-values (Appendix G).

The model results provide an assessment of expected changes in flood water surface elevations due to combined changes in channel geometry and roughness. Figure 7-2 shows computed 100-year flood water surface and velocity profiles for existing and proposed conditions. Comparison of both the water surface and velocity profiles indicates minimal change from existing to proposed conditions. Moreover, the computed proposed profile is substantially below the 4-foot freeboard profile shown in Figure 7-2 throughout LARERR Reach 8A.

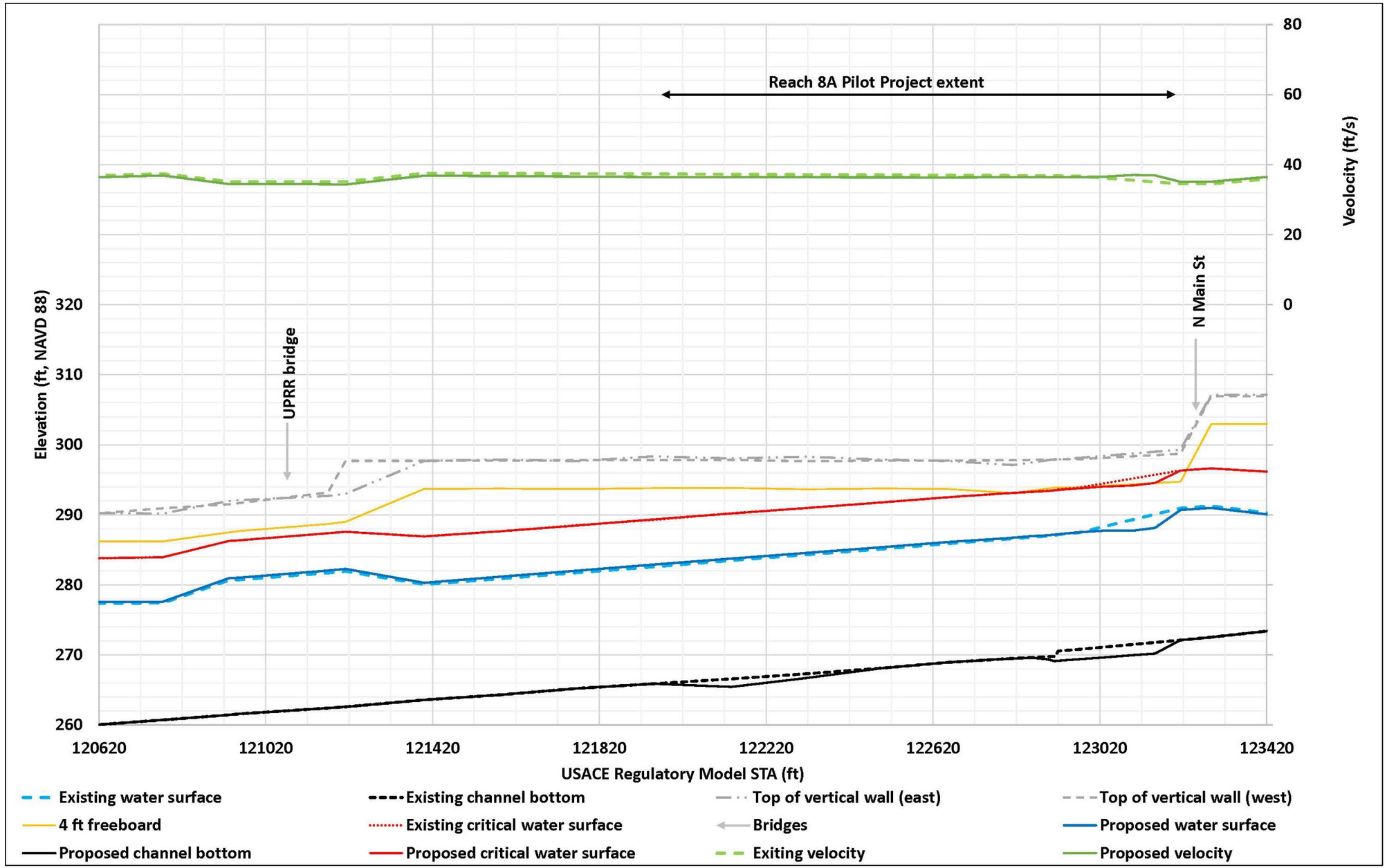

Figure 7-2. Comparisons of existing and proposed conditions 100-year discharge water surface and velocity profiles.

7.2.2 Fish passage hydraulics

Hydraulic performance of the features proposed under the LARERR Reach 8A Pilot Project was evaluated initially in a 1D HEC-RAS model without considering the local effects of habitat features such as boulder clusters and resting pockets. To better evaluate the effects of wake zones behind boulder clusters, local accelerations around the boulder clusters, and low-velocity circulation zones inside resting pockets for a range of fish passage design flows, a 2D model was developed.

7.2.2.1 1D HEC-RAS Model

An initial evaluation of fish passage hydraulics was performed by modifying the 1D HEC-RAS Updated 2008 LAR Model to include the inset channel. For this purpose, bank stations in the model were set at the limits of the 20- to 22-foot-wide fish passage channel (inset channel plus LFC with boulders or LFC with boulders), and Manning's n-values were estimated with depth-dependent roughness predictors for the inset channel. The roughness values selected were a simplified set of values varying with depth based on the Mussetter equation. This equation predicts roughness based on relative submergence of the bed material (depth/roughness height) and is useful for evaluation of flows over a range of relative submergence from 0.2 to 3.7 (CDFW 2010). For LARERR Reach 8A, this corresponds to most of the flows of interest for fish passage. Depth-dependent n-values were also selected for an assumed 4-foot-wide band of herbaceous vegetation along the east side of the inset channel sections, and for boulder roughness on the existing LFC beds.

Findings from the 1D model are presented in the Los Angeles River ARBOR Reach 8A Design Development Technical Memorandum (Stillwater Sciences 2022). In summary, results from the 1D model indicated that the inset channel sections likely provide suitable passage over a wider range of flows than the sections with boulders on the LFC for fish in sustained swimming mode. Overall, without considering added benefits from boulder clusters and resting pockets, the inset channel section is predicted to produce suitable velocities up to approximately 1,800 cfs with depths greater than 1 foot. The model results indicated that potential passage may occur up to approximately 6,500 cfs with resting areas included. Where the LFC with boulders is proposed, suitable passage conditions occur up to 830 cfs and potential passage may be possible up to 4,800 cfs with resting areas included. The 2D model results discussed in Section 7.2.2.2 show more favorable results for fish passage and incorporate resting pockets and boulder clusters into the analysis.

7.2.2.2 SRH-2D Model

Model setup and methods

To analyze the expected fish passage performance of the Reach 8A 60% design, hydraulic conditions were predicted using 2D numerical modeling. Here, the Sedimentation and River Hydraulics – Two-Dimensional (SRH-2D; v 3.3.0) model was used. The 2D model was developed in Surface-water Modeling System (SMS; version 13.1.18) software.

The Reach 8A terrain used in the SRH-2D model was created from a combination of LiDAR (USACE 2019) and design topographic drawings for the proposed conditions. The computational mesh is dense (0.5-ft spacing) within the LFC to adequately model features such as boulders and resting pockets. Cell resolution is coarser (5-ft spacing) for the rest of the flood control channel. The final mesh consists of approximately 250,000 elements that include quadrilateral and triangular cells. The approximate outlines of piers at the N Main Street Bridge were removed

from the mesh and modeled as the edge of the model domain, which prevents flow from going through the solid bridge piers and provides detailed hydraulic results immediately upstream from the design reach.

A depth-varied Manning's roughness coefficient (n) was used for the inset channel, resting pockets, and boulder clusters (Figure 7-3). Roughness is added at these locations in the design using grouted rock and anchored boulders. The varying n-values represent differences in effective flow area and roughness associated with the level of submergence. Effective roughness decreases when flow depths are large relative to the height of protruding objects. Conversely, shallow flows have a larger roughness because the water surface is more affected by irregularities in the bed surface. The n-values were estimated using the Mussetter (1989) equation, which is a function of channel invert slope, median bed material size (0.36 feet for this Project), and relative submergence of the larger particles (D_{84}; 1.15 feet for this Project). Mussetter's equation is one of the methods provided in CDFW guidance (2010) for roughened channels and is applicable to a wide range of channel slopes and relative submergence. SRH-2D iterates to calculate depth and roughness at every cell where the design roughness curve is specified. The fish passage flows are relatively shallow (typically 1 to 6 feet deep), resulting in higher roughness values for the inset channel, resting pockets and boulders. However, the depth-varied roughness converges with the n-values used in the 1D flood analysis model at larger flows and greater depths. A constant n-value of 0.014 (smooth concrete) was applied to non-roughened portions of the LFC and all concrete within the larger flood control channel. The design includes installing planter boxes and weep holes at some locations adjacent to the LFC and a constant n-value of 0.03 was modeled for these features.

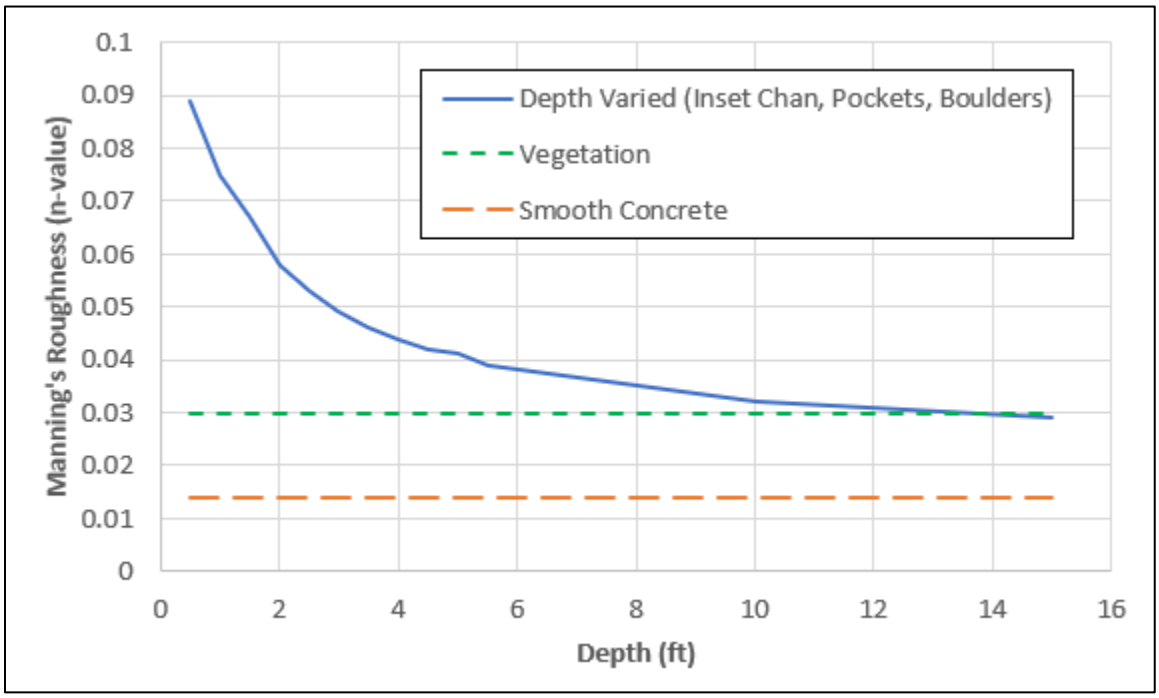

Figure 7-3. Design roughness values applied to the 2D hydraulic model computations. Polygons delineated within the model domain represent the location and extent of each roughness zone.

A 2D model requires user input to establish the upstream and downstream boundary conditions. The upstream boundary conditions were set to the fish passage design discharges (see Table 5-1 above).

Upstream and downstream boundary conditions were calculated as the water surface elevation based on normal depth for each discharge. The model domain consists of a mixed flow regime where smooth concrete sections are generally supercritical and roughened sections are generally subcritical. Lower flows, less than about 1000 cfs, are very close to critical depth at the upstream and downstream model boundary. Higher flows are more strongly supercritical. Therefore, a water surface rating curve was applied at both boundary locations to allow the model to solve for supercritical and subcritical flows. A sensitivity analysis was conducted to ensure boundary conditions were not influencing model results. The upstream boundary was placed about 900 feet from the design extent and the downstream boundary was placed about 700 feet from the design extent.

Model simulations were conducted until achieving a stable, steady-state solution for each discharge. Depth and velocity results were then exported to a Geographic Information System (GIS) for further analysis using the criteria described in Section 5. The analysis method first converted the model meshes to shapefiles and then mapped model results to each cell in the mesh. Next, the model results were clipped to include only the cells with modeled depth greater than 1 foot within the area of interest. Cells within the clipped area were then categorized into the range of velocity zones (see Table 5-4 above). The total area of each velocity zone was computed per 1,000-foot stream length. However, favorable fish passage conditions rely not just on total low-velocity area but on longitudinal connectivity. To assess the spatial distribution of the various velocity zones, all adjacent cells of the same velocity category were merged in GIS. These larger polygons could then be analyzed to determine if the favorable velocity zones were connected and if they were located along a potential migration path.

Results

Fish passage is expected to occur almost exclusively within the modified low-flow and inset channel where the design features of boulders, resting pockets, scour pools, and added roughness will be installed. Fish are unlikely to migrate over the smooth concrete overbank area outside the low-flow or inset channel. Beyond the modified low-flow or inset portions of the channel, depth is too shallow at low flows and velocity is too fast at high flows for upstream passage. As flows increase, velocities in the low-flow and inset channel width will also increase, but not as much as the smooth concrete overbank area, which creates more favorable fish passage conditions within the low-flow and inset channel width compared to the overbank. As the total flow in the channel increases, the fraction of flow within the roughened low-flow and inset channel width decreases, which also reduces the roughened channel's effect on flood hydraulics. Therefore, it is instructive to consider the fraction of total discharge that will be conveyed within the low-flow and inset channel width (Figure 7-4).

The 2D model calculates the lateral distribution of depth, velocity, and discharge. Discharge results were extracted at two typical locations, one that includes an inset channel and one location where the only design modification is installing boulders. The flow contained within the LFC is similar for both locations because the added depth and cross-sectional area of the inset channel is counteracted by the added roughness. All flow is contained within the LFC at 25 cfs. At 75 cfs, about 90 to 95% is contained, which decreases to 70 to 80% at 121 cfs. Only 40% of the flow is contained at 360 cfs, which decreases to about 25% at 830 cfs. The highest fish passage flows, 4,660 cfs and 6,544 cfs, convey about 10% of the total flow within the LFC width. This trend demonstrates that changes to the LFC have less potential to impact hydraulics at higher flows

because most of the water is conveyed by the concrete overbank. However, local modifications may be able to positively affect depth and velocity for fish passage over a narrow width.

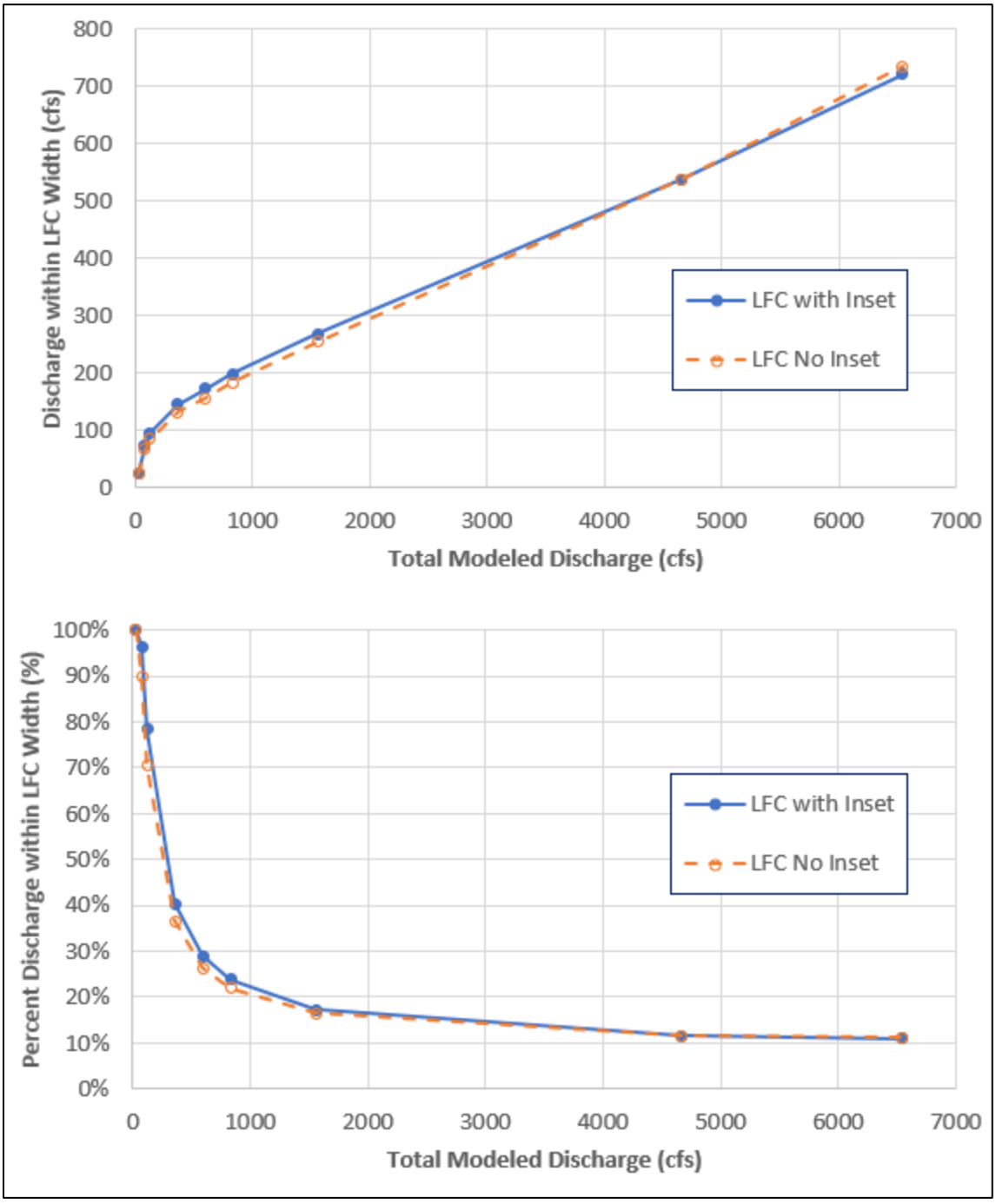

Figure 7-4. Fraction of total modeled discharge within the LFC top width for design configurations with and without an inset channel.

Figure 7-5 presents results for the total area within Reach 8A that is classified by the depth and velocity criteria. Longitudinal connectivity is further evaluated at the end of this section. Across all flow rates, there is a contiguous area of suitable or locally acceptable velocity and depth, except for the 25 cfs flow where depth is limiting (too shallow) for the portions of Reach 8A where a new, deeper inset channel is not proposed. Velocity rarely exceeds 4 ft/s at discharges of 360 cfs or less. About 10% to 20% of the inundated area has a depth greater than 1 foot at these low flows. At the medium fish passage flows, between 595 cfs and 1553 cfs, there is a distribution between all five velocity classes. Velocities less than 4 ft/s occupy about 10% of the inundated area while velocities less than 6 ft/s occupy about 20% of the inundated area. At the highest fish passage flows (4,660 cfs and 6,544 cfs) there is almost no resting area (0 to 2 ft/s), but the suitable (4 to 6 ft/s) velocity zone is still relatively abundant. It is important to consider that the 2D results are depth averaged, so there are likely low-velocity zones that exist lower in the water column near the bed of the channel, especially near features such as boulders and resting pockets. Depth is the limiting factor at the low to moderate fish passage flows (830 cfs and lower) because there are significant shallow areas where flow spreads out over the concrete. At 1,553 cfs, nearly all the project reach has depth greater than 1 foot. At the highest fish passage flows (4,660 cfs and 6,544 cfs), velocity is the limiting factor and is rarely less than 8 ft/s outside the LFC. There is a mix of suitable and locally acceptable passage conditions within the LFC at these flows.

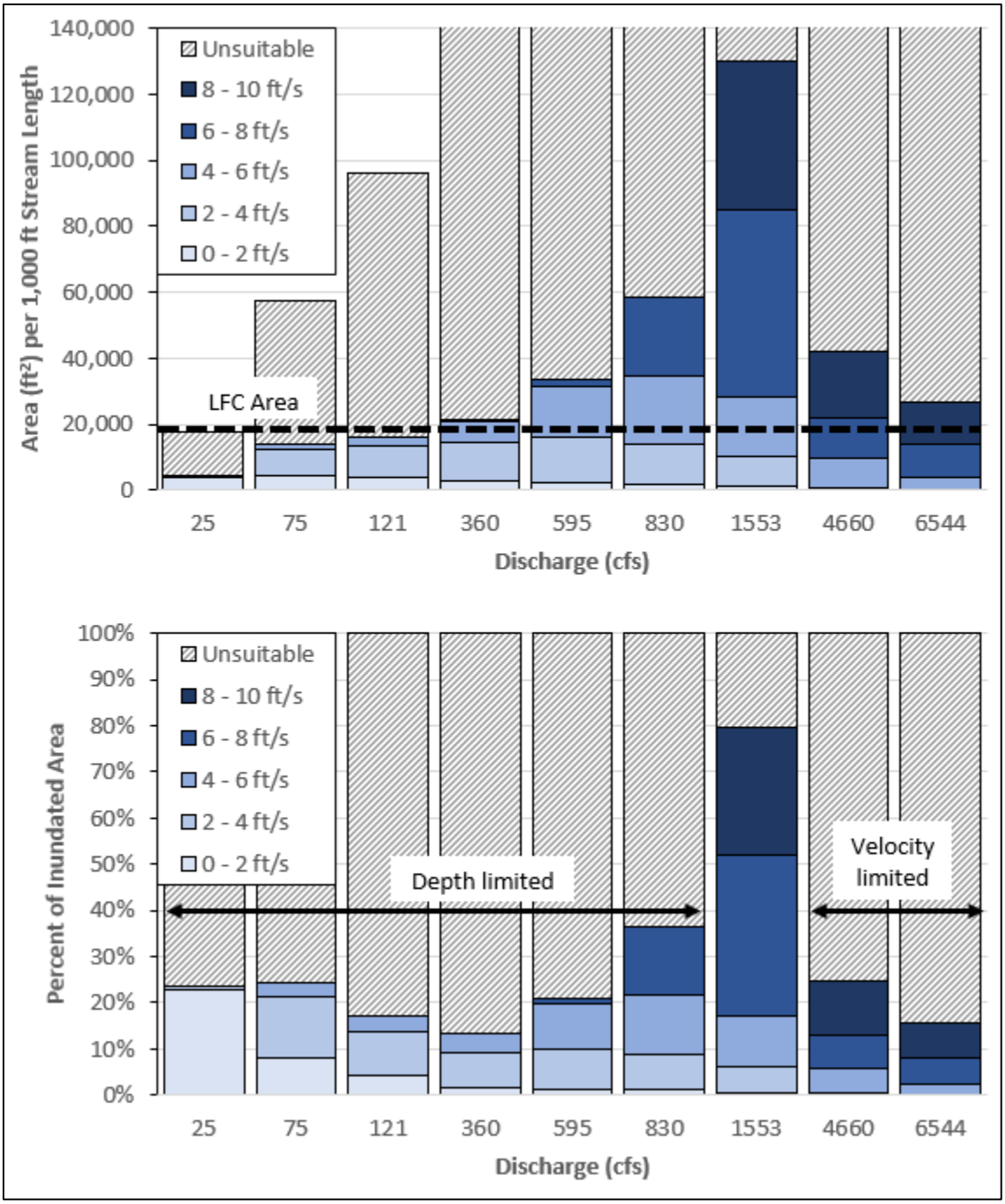

Figure 7-5. Area of velocity classes (top) and percent of inundated area (bottom) as a function of discharge for the Reach 8A design extent. Results are normalized per 1,000 feet of stream length. Velocity results are only reported where depth exceeds 1 foot.

Appendix E shows plan view maps of the velocity and depth analysis from 2D model results. There are four panels to represent the Reach 8A design extent from upstream to downstream, each spanning a stream length of about 330 feet. The velocity zones are symbolized with different shades of blue where depth exceeds 1 foot, and the inundated area boundary is also included for each fish passage design discharge. The maps confirm that velocity is favorable (< 4 ft/s) within

the LFC at the low to moderate flows (up to 830 cfs). At 1,553 cfs, there is a mix of resting (0–2 ft/s), favorable (2–4 ft/s), and suitable (4–6 ft/s) velocity zones within the LFC and higher velocities (>6 ft/s) on the concrete overbank. The water surface is also near the top of the boulders at 1,553 cfs, which maximizes their impact. Boulders control the flow patterns by shifting higher velocities to the channel edges and creating lower velocity in the wake zones downstream of the boulders. Velocity is mostly suitable within the LFC at 4,660 and 6,544 cfs, although there are patches of locally acceptable (6–8 ft/s) and marginal (8–10 ft/s) areas. At these highest flows, which are only exceeded during 1% of the year (4,660 cfs) or 1% of the migration season (6,544 cfs), velocity is either marginal or unsuitable outside the design LFC area.

Figure 7-6 provides an example velocity map at one location for the four highest modeled discharges. This area includes the transition from the LFC to the inset channel near the downstream section of Reach 8A. There are two typical cross sections that further demonstrate the spatial velocity patterns: results from Cross Section A-A' are represented in Figure 7-7 and results from Cross Section B-B' are represented in Figure 7-8. Cross Section A-A' includes a scour pool and is immediately downstream from a V-shaped boulder cluster. The scour pool is intended to provide additional depth and overhead cover as fish are resting in the low-velocity wake zone downstream of the boulders. The wake zone generally produces velocities that are two classes lower than adjacent areas outside the wake zone. At 121 to 1,553 cfs the wake zone has velocities that are 0–2 ft/s (resting) while velocities increase to 4–6 ft/s (suitable) outside the wake zone. At the highest flows (4,660 and 6,544 cfs), velocities are 4–6 ft/s (suitable) in the wake zone and 8–10 ft/s (marginal locally) outside the wake zone.

Cross Section B-B' illustrates the effects from a resting pocket within the inset channel. At lower flows (121 cfs and below), there is a recirculating eddy within the resting pocket that creates near-zero velocities along the left bank. The benefits of the resting pocket diminish at higher flows because water that overtops the LFC can flow over the resting pocket and disrupt the eddy. However, velocity is likely sheltered near the bed within the upstream portion of the resting pocket, which is not reflected in depth-averaged results from a 2D model. The map at 6,544 cfs (lower right of Figure 7-6) indicates that the resting pocket does increase the suitable migration area within the inset channel. Without a resting pocket, lateral velocity distribution for the inset channel is very similar to results for Cross Section B-B' at discharges above 121 cfs. However, lower flows (121 cfs and below) do not have near-zero velocities at the left bank. Inset channel velocities are slightly higher along the left bank because of the steeper side slope. Generally, the presence of an inset channel is most important for providing sufficient depth at lower flows, while boulder clusters have a greater effect on the local velocity field at moderate and high flows.

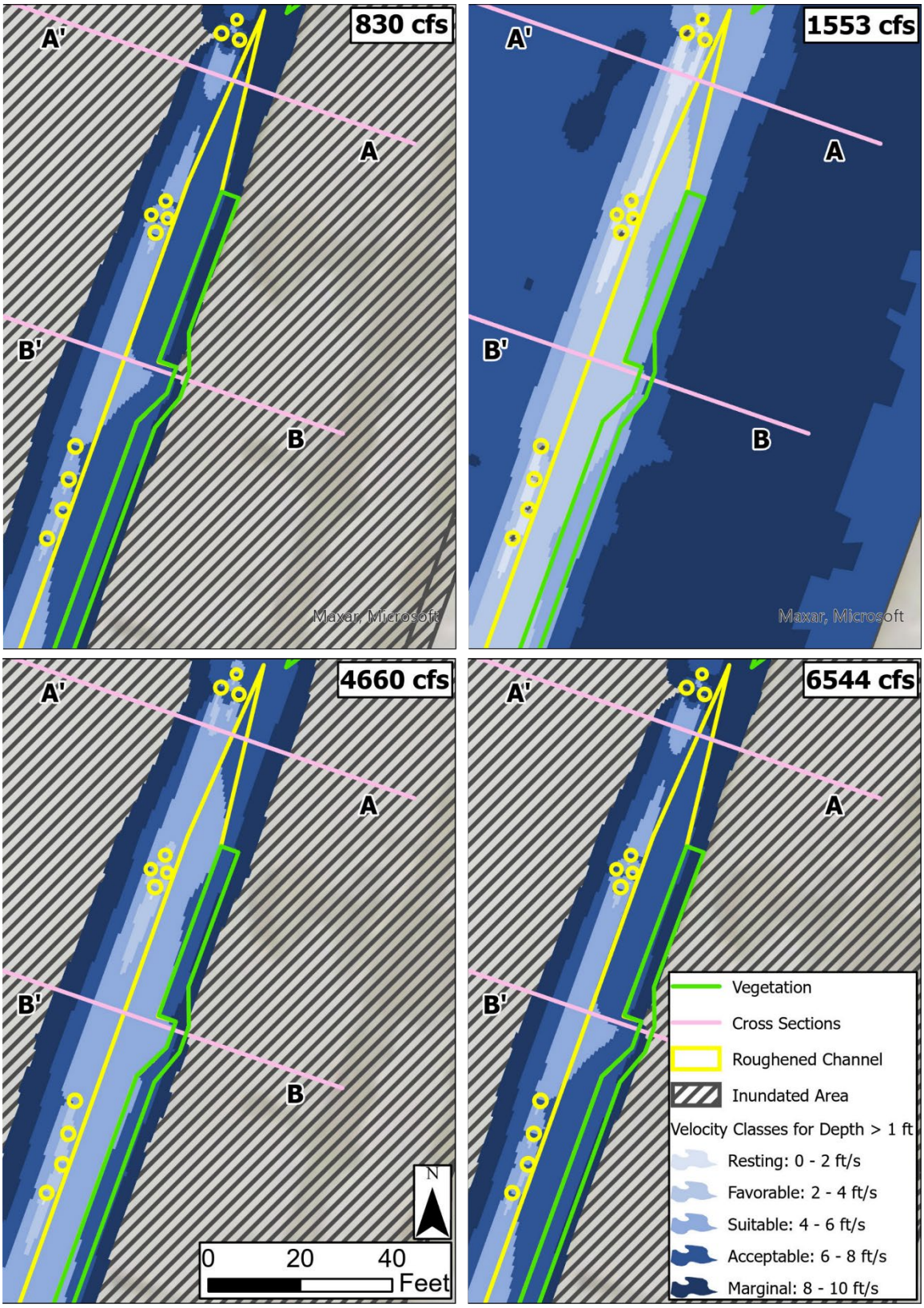

Figure 7-6. Example fish passage suitability map. Discharges are 830 cfs (top left), 1553 cfs (top right), 4660 cfs (bottom left), and 6544 cfs (bottom right).

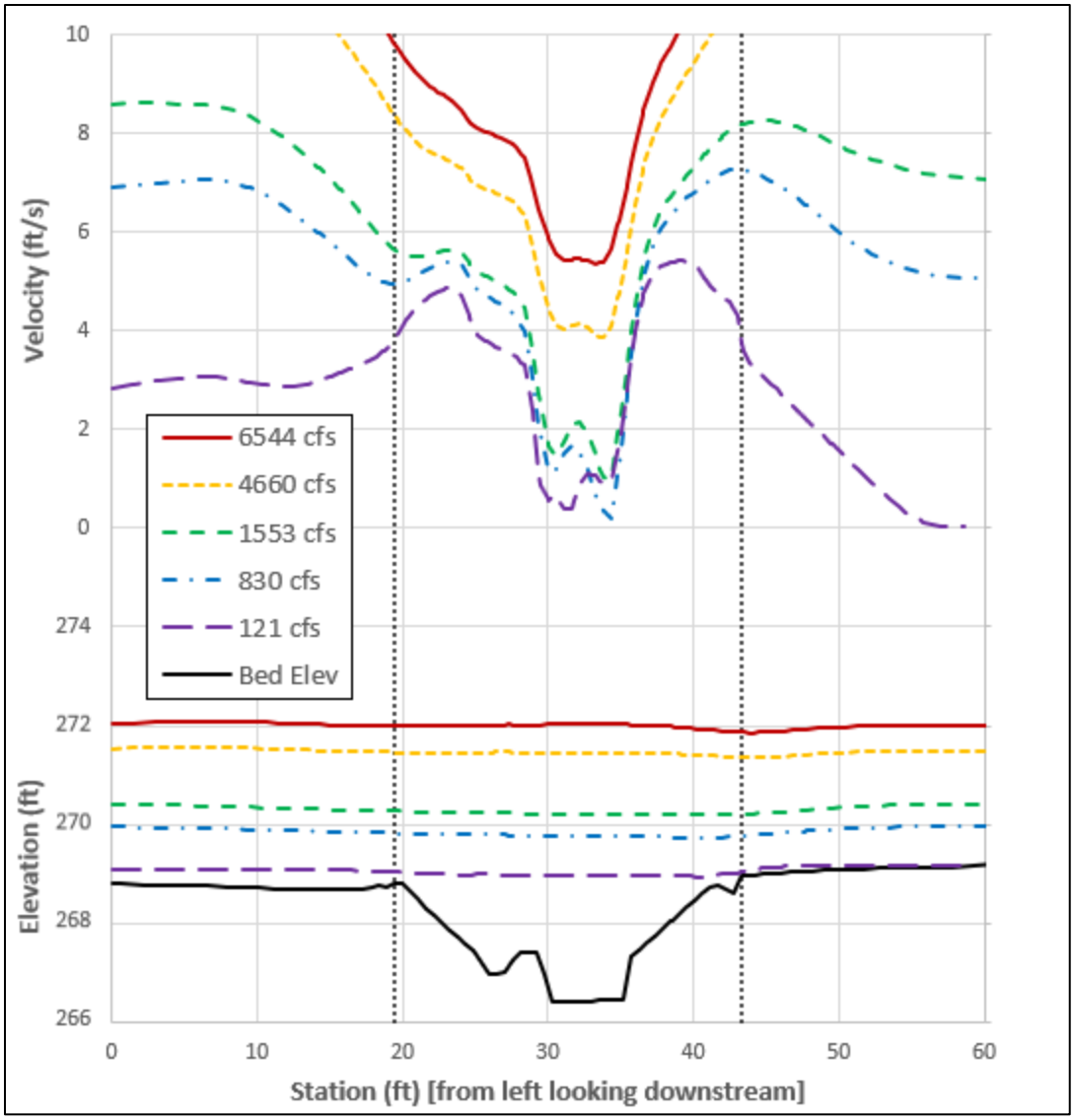

Figure 7-7. Bed and water surface elevation with corresponding velocity distribution at Cross Section A-A' (from Figure 7-6). Vertical dashed lines represent locations of LFC top of bank. Cross section is at a scour pool immediately downstream from a boulder cluster. Note effect from boulder wake zone and scour pool between Station 30 and 35.

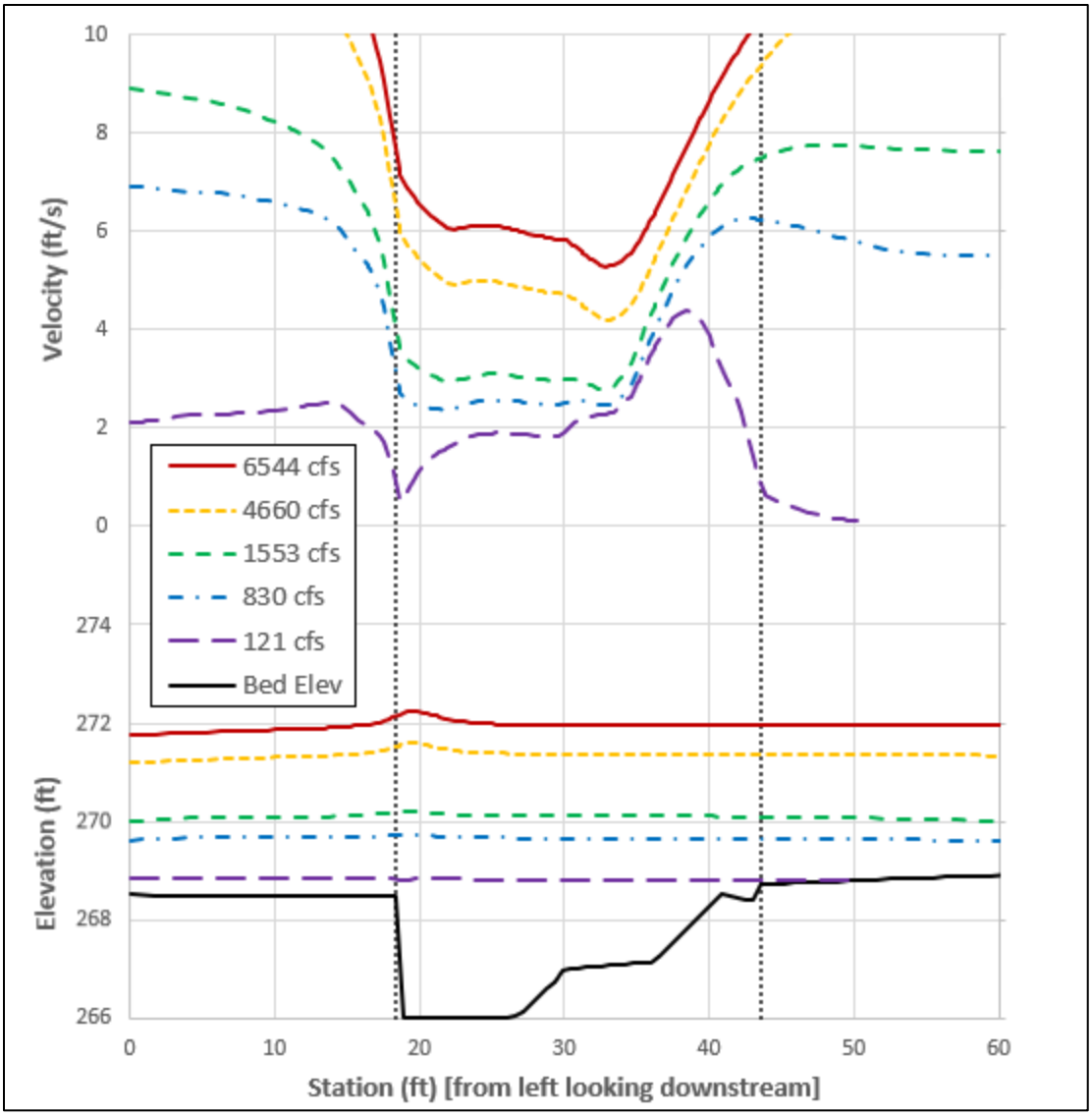

Figure 7-8. Bed and water surface elevation with corresponding velocity distribution at Cross Section B-B' (from Figure 7-6). Vertical dashed lines represent locations of LFC top of bank. Cross section is at a resting pocket. Note effect from eddy providing velocity shelter near the bank at low flow (121 cfs). Higher flows overtop the pocket and disrupt the eddy, although there may still be lower velocity near the bed.

Velocity maps (Appendix E) were inspected to analyze potential adult fish migration paths from downstream to upstream. A migration path was digitized for each flow using 2D model results and assuming that a fish would follow the path of lowest velocity when moving through the design reach (Figure 7-9). The migration paths were then intersected with the velocity classes to determine the location and distance where a fish would encounter different velocities when swimming upstream. These results are plotted in Figure 7-10, which distinguishes velocity patch sizes less than or greater than 10 feet. All velocities are averaged within each 2 ft/s increment to produce an average velocity for that category. The number of patches within each velocity class illustrates that the Reach 8A design produces a diverse array of hydraulics and morphologic

complexity. A fish would not have to migrate through a velocity patch longer than 10 feet and above 6 ft/s until the upstream end of the reach at 1,553 cfs. There are not a significant number of patches longer than 10 feet and above 6 ft/s within the reach until the highest flow of 6,544 cfs. The highest velocities occur at the upstream end of the design reach because of the effects from the N Main Street Bridge piers. The piers constrict the flow at the largest discharges, which causes elevated velocities within the upstream-most 50 feet of Reach 8A.

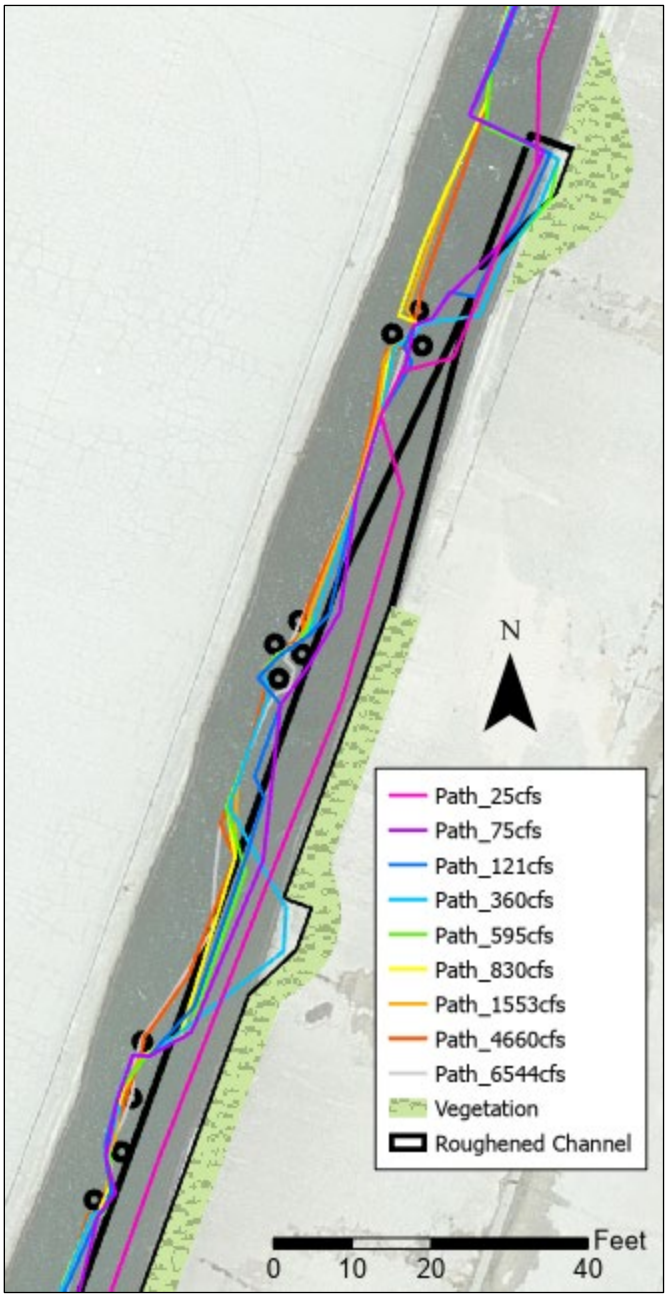

Figure 7-9. Example fish passage migration paths at different flows. Lines follow path of lowest velocity from downstream to upstream.

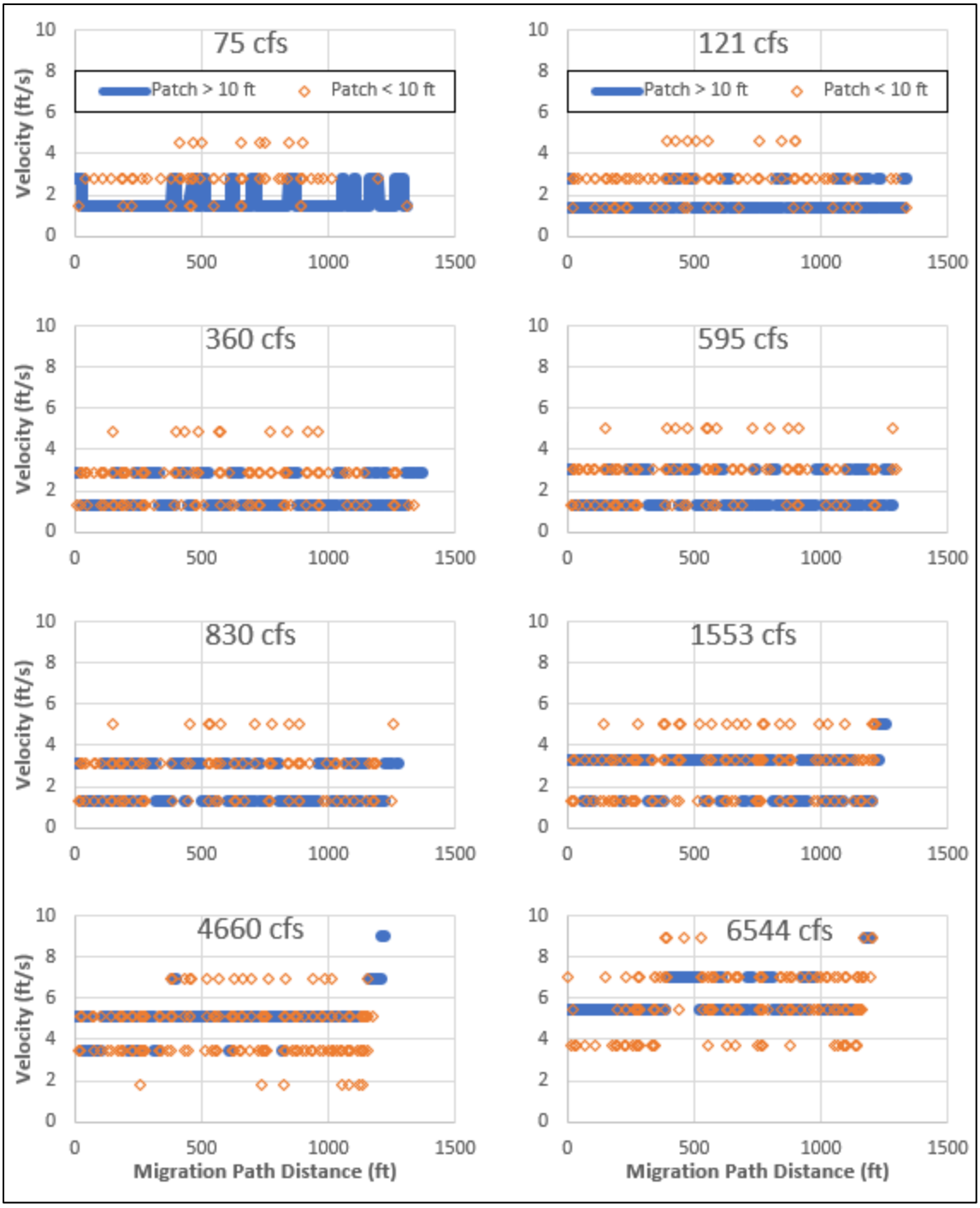

Figure 7-10. Velocities encountered by migrating fish over range of flows. Distance is measured from downstream to upstream within Reach 8A. Velocity patch size is classified as greater than or less than 10 feet.

Figure 7-11 and Table 7-2 summarize results from the migration path analysis. The lowest flow (25 cfs) represents a possible future condition if there is increased reuse of wastewater treatment effluent. At this flow, about 35% of the distance is classified as unsuitable because of shallow depths. Passage may still be possible because depths are between 0.5 and 1.0 foot, but sections

without an inset channel or scour pool do not meet the 1-foot target depth criterion. Current low to moderate discharges, between 75 and 830 cfs, all have continuous depths greater than 1 foot. These flows also have velocities less than 2 ft/s for about 60 to 75% of the migration distance. A migrating fish would not encounter velocities above 4 ft/s except for isolated 4–6 ft/s patches that are less than 10 feet long. Resting habitat is still abundant at 1,553 cfs, although the favorable (2–4 ft/s) zone becomes more common and there is an increase of suitable (4–6 ft/s) patches.

Velocity does not exceed 6 ft/s along the migration path until 4,660 cfs, where about 6% of the distance is acceptable locally (6–8 ft/s), 1% is marginal locally (8–10 ft/s), and 1% is unsuitable (> 10 ft/s). The marginal and unsuitable areas only occur at the upstream end near N Main Street Bridge as discussed above. The longest 6–8 ft/s velocity zone is 21 feet at 4,660 cfs, and the only 8–10 ft/s velocity zone is 14 feet long. At 6,544 cfs, only 5% of the migration distance has a velocity less than 4 ft/s. About 60% of the distance has velocities that are suitable and about 30% of the distance has velocities that are acceptable locally. The longest 6–8 ft/s velocity zone is 57 feet, and the longest 8–10 ft/s velocity zone is 19 feet. The unsuitable area, with velocities of 10–14 ft/s, is about 40 feet long near the bridge. Special design treatments would likely be required to further reduce velocities under bridges where there are piers or abutments that constrict flow. The 90% level design will include additional treatments and channel configurations at the N Main Street bridge to provide passage up to the 6,544 cfs flow rate. Alternatively, fish could hold downstream of these bridges until flows decrease. The Reach 8A design does not extend to the N Main Street Bridge but is affected by high velocities downstream from the bridge.

In summary, the Reach 8A design is expected to provide upstream steelhead passage between 75 and 4,660 cfs. Passage may also be possible at 6,544 cfs for larger steelhead, although conditions are challenging and may require increasing the extent of roughened channel area or adding more resting areas that are effective at this highest flow. For example, initial modeling completed for a preliminary Reach 8A design condition demonstrated that roughening the entire LFC rather than just the inset channel would likely reduce velocities enough to provide passage at 6,544 cfs.

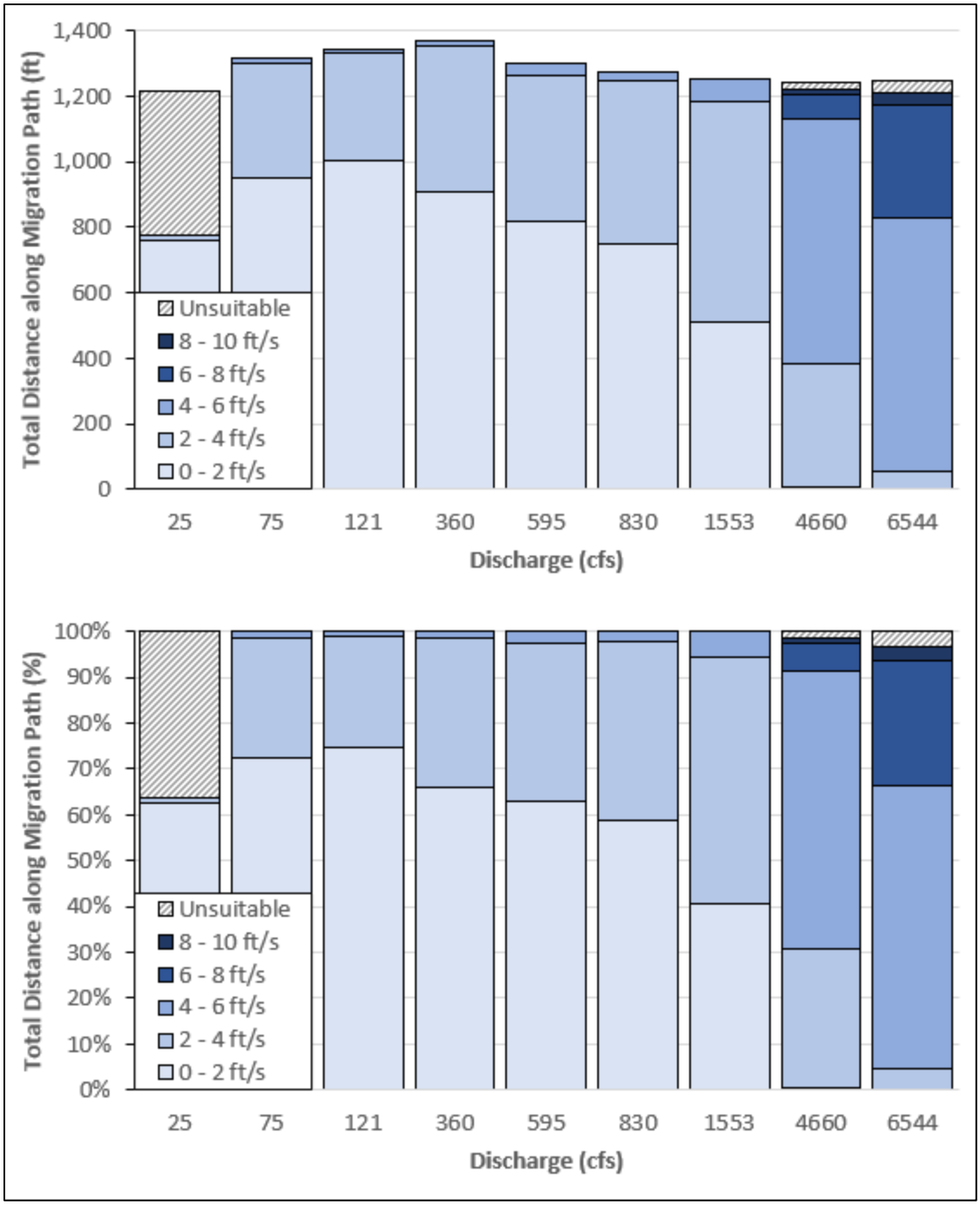

Figure 7-11. Velocity distribution along assumed migration path for each modeled discharge.

Table 7-2. Longitudinal connectivity of velocity zones within LFC for Reach 8A design.

Modeled discharge (cfs)	Highest velocity zone along migration path	Notes
25	<2 ft/s	Multiple segments up to 84 ft long with depth ≈ 0.8 ft (< 1 ft)
75	<4 ft/s	Intermittent gaps (distance < 10 ft) with velocity 4–6 ft/s
121	<4 ft/s	Intermittent gaps (distance < 10 ft) with velocity 4–6 ft/s
360	<4 ft/s	Intermittent gaps (distance < 10 ft) with velocity 4–6 ft/s
595	<4 ft/s	Intermittent gaps (distance < 10 ft) with velocity 4–6 ft/s
830	<4 ft/s	Intermittent gaps (distance < 10 ft) with velocity 4–6 ft/s
1553	<6 ft/s	Mostly (94%) < 4 ft/s; largest 4–6 ft/s velocity zone is 22 ft long
4660	<8 ft/s*	Mostly (91%) < 6 ft/s; largest 6–8 ft/s velocity zone is 21 ft long
6544	<10 ft/s*	Mostly (66%) < 6 ft/s; largest 6–8 ft/s velocity zone is 57 ft long; largest 8–10 ft/s velocity zone is 19 ft long

* Note: highest velocities (marginal and unsuitable classes) occur within the upstream-most 50 feet of the design reach because of flow acceleration between the bridge piers

7.3 Flood Risk and Uncertainty Analysis

A Risk &Uncertainty (R&U) analysis was performed following the procedures of the USACE EM 1110-2-1619 (USACE 1996) to assess flood performance of proposed improvements in LARERR Reach 8A. The R&U process involves estimating the likelihood of water levels exceeding a target threshold for a given flood event, considering uncertainty in both hydrology and hydraulics. The analysis was conducted with the HEC-FDA computer program (USACE 2021). A technical memorandum that summarizes procedures and assumptions used in the analysis is provided in Appendix G.

The R&U analysis involved computing a non-exceedance probability (CNP, i.e., the probability that for a given flood, the target stage will not be exceeded) and long-term risk (i.e., the cumulative risk of exceeding the target stage at least once, over long time periods) at four index points considering two target elevations (stages). Three of the four index points were within the LARERR Reach 8A and were located immediately downstream, about 281 feet downstream, and about 904 feet downstream of the N Main Street Bridge. The fourth point was located downstream of the LARERR Reach 8A Pilot Project improvements at the Union Pacific Railroad Bridge. The two target stages at each index point included one elevation representing the top of the concrete channel wall and one 2.5 feet below the top of wall, providing an allowance for wave action in the supercritical channel. The CNP and long-term risk were computed for both existing and proposed conditions for the two target stages under a range of flood flows.

The computed CNP results indicated that the LARERR Reach 8A Pilot Project would influence neither the CNP nor the long-term risk at the upstream-most index point for both target stages under all flood flows. The LARERR Reach 8A Pilot Project would cause a slight decrease in CNP for a given flood but no more than 1% and 2% for the 100-year and 500-year flood events, respectively, for both target stages considered at the other three index points. The evaluation of the long-term risk of stage exceedances showed that the project would have a modest increase in

long-term risk, with the 50-year cumulative risk of exceedance increasing by less than 1% for both target stages.

The lowest values for CNP (assurance) and highest values for long-term risk were computed at the upstream index point, where the proposed improvements for fish passage had no effect. Assurance for the target stage at the top of the channel wall was 80.7% in the 1% annual exceedance probability (AEP), or 100-yr event. Assurance at all three other index points was greater than 98.9%, exceeding a typical USACE standard of 95% assurance for the 1% AEP for new flood control facilities. Review of the analysis methods and results with USACE is needed to verify the results and to determine whether the improvements can be approved for construction as designed or will require some design modification for mitigation of the slight reductions in computed CNPs and long- term risk. Pending review from USACE and any design modifications, additional analysis will be completed in the subsequent phase of design.

8 4.8-MILE REACH PROJECT

Concept A (44-foot-wide fish passage channel) was selected and applied to the entire 4.8-mile Project Reach and referred to as the 4.8-mile Reach Project. It was developed in addition to the LARERR Reach 8A Pilot Project (Section 7), because the selected LARERR Reach 8A Pilot Project covers only a quarter-mile-long segment of the Project Reach and provides less ecological benefits compared to alternatives with a larger footprint such as Concept A. Design elements of the 4.8-mile Reach Project include the roughened inset channel, boulder clusters, resting pockets, holding pools, a roughened chute, and vegetation features. Compared to the intermittent inset channel proposed for the LARERR Reach 8A Pilot Project, the 4.8-mile Reach Project inset channel is continuous, wider, and deeper. Sections below describe the 4.8-mile Reach Project habitat features. Additional channel modifications at selected bridge crossings are necessary to reduce flood risk impacts (recommended modifications are discussed in Section 8.2). Transition into and out of the LARERR Reach 8A Pilot Project will be developed in future design phases as the details of the LARERR become available. It was assumed that the 4.8-mile Reach Project design would fully replace the LARERR Reach 8A Pilot Project design through Reach 8A.

8.1 Habitat Features

8.1.1 Inset channel

The 4.8-mile Reach Project inset channel is a roughened compound channel with a deep LFC and shallow benches with varying slopes. The channel will activate shallow edge habitat and produce varied hydraulics across the channel section as water level rises. The overall top width of the inset channel is 44 feet, and the deepest point of the channel is 5 feet below the existing main channel bottom elevation.

A straight channel planform was maintained through most of the Project Reach to minimize potential conflicts with the LARERR. Near the proposed Metro LA River Path access locations (i.e., north of N Broadway Street crossing; at E Cesar Chavez Avenue crossing; and at 6th Street crossing), a sinuous channel planform was applied to improve aesthetics, allow connectivity with adjacent habitat areas, and to maximize multi-benefit opportunities within the channel bed. Both channel planforms would feature a thalweg that migrates between left and right toes of the inset channel to mimic natural streams. The inset channel will be lined with concreted rock (median particle sizes range between 6 and 9 inches) to add roughness and variability in bed topography.

Plan and profile views of the inset channel are presented in Sheets CI 201 through CI 211 in Appendix A. Typical cross sections and typical plan with concreted rock configurations for the inset channel are provided in Sheets CI 501 and 505, respectively, in Appendix A.

8.1.2 Boulder clusters

Anchored boulder clusters would be placed within the deepest section and bench of the inset channel to produce hydraulic complexities and low-velocity wake zones. These low-velocity zones provide fish habitat and possible migration paths. Like the LARERR Reach 8A Pilot Project, the maximum boulder dimension is proposed to be about 3 feet (long axis) by 2.5 feet (short axis) by 2.5 feet (height) and placed with an average of 30-foot interval between clusters. Scour pools would not be necessary for the 4.8-mile Reach Project as the inset channel is deeper compared to that of the LARERR Reach 8A Pilot Project. The 2D modeling results (Stillwater Sciences 2021) indicated an approximately 60-foot-long segment within the 4.8-mile Reach Project inset channel near the Arroyo Seco confluence, where velocities range between 6 and 8 ft/s. Velocities greater than 6 ft/s are acceptable only locally and would require resting habitat features for fish to successfully migrate. Strategic placement of boulder clusters in this area would help to create low-velocity zones, vastly improving fish passage conditions through this area.

Typical layout and typical section of the boulder clusters are presented in Sheet CI 505 in Appendix A. It is assumed that the layout patterns shown in Sheet CI 505 will be repeated throughout the Project Reach.

8.1.3 Resting pockets

Resting pockets would provide low-velocity areas, where steelhead can rest and recover from fatigue during migration. A preliminary 2D model of selected segments of the Project Reach (Stillwater 2021) indicate that the 44-foot-wide inset channel alone adequately achieves the fish passage objective at Qhfp at most places in the Project Reach. As a result, the resting pockets would be placed at a greater interval (approximately 1,000 feet) compared to the LARERR Reach 8A Pilot Project (approximately 100 feet). The resting pockets would be 10-foot-wide by 10-foot-long resting area followed by a 20-foot-long contracting section, which is slightly more than double the size of the LARERR Reach 8A Pilot Project resting pockets. Resting pockets would be embedded inside the side slope of the inset channel and the bottom would be roughened with concreted rock. A total of 25 resting pockets would be constructed on east and west margins of the inset channel within the Project Reach. Vegetation features may be incorporated into the resting pocket to provide cover for fish, using weephole, perforated slab tie-in, and/or planter box concepts. Section 12 describes the vector control design considerations for these features.

Layout of the resting pockets are presented in Sheets CI 201 through CI 211 in Appendix A. Detailed plan and section are provided in Sheet CI 504 in Appendix A.

8.1.4 Holding pools

Steelhead that do not reach perennial habitat within a single storm event hold in pools near confluences and other favorable locations to wait for the next storm event to continue migration, or they abandon their migration and return to the ocean. The 4.8-mile Reach Project proposes construction of holding pools immediately downstream of the Arroyo Seco confluence, which is a suitable location for such a feature as fish would naturally stage there prior to migrating upstream

into the Arroyo Seco or soft-bottom reach upstream of the Project Reach. Considering the lower, flashier flows in Arroyo Seco compared to the LA River, holding pools may be necessary for fish to stage as they await additional storm flows to continue migration. Additional sites along the Project Reach that are selected for holding pools are between Highway 101 and 1st Street, where the future Metro LA River Path multi-modal bridge crossing is proposed; and downstream of the 7th street crossing at the Hollenbeck Creek (or drain) confluence.

Holding pools were designed to ensure sufficient depth to protect steelhead from avian predators and sufficient active flow to prevent both stagnation and increased water temperatures that could attract non-native fish or disease vectors such as mosquitos. The pools are approximately 8 feet deep and 60 feet wide with sloped upstream and downstream tie-ins to the 44-foot-wide fish passage channel that allows for flushing of sediment. Each site will have two holding pools that are in-line with the LFC so that pools receive flow year-round to avoid stranding and stagnation. Section 12 describes the vector control design considerations for these features.

Detailed plan, section, and profile for the holding pools are provided in Sheet CI 503 in Appendix A.

8.1.5 Roughened chute at 7th Street

A roughened chute would be constructed to improve fish passage hydraulics at a 4-foot-high, 100-foot-long ramp (4% slope) that is located on the downstream side of the 7th Street crossing. It is designed to create hydraulic diversity that emulates conditions found in steep natural channels. Although short segments may be steeper, overall slopes of roughened chutes commonly range between 3% and 5%, which are within the range of channel slopes that steelhead traverse in natural systems (CDFW 2009). The chute would maintain the 44-foot inset channel width but would be shallower (3 feet deep) and would require larger particle sizes (median particle sizes range between 12 and 18 inches) compared to the rest of the Project Reach to add more resistance to produce acceptable velocities. The largest sized rocks (approximately 4 feet) will be placed strategically along the chute to create hydraulic cover and low-velocity zones for fish to swim through. Detailed hydraulic analysis will be performed in the next design phase to assess the hydraulics relevant to fish passage and flood flows as the design detail evolves.

General location and footprint of the roughened chute is shown in Sheet CI 208 in Appendix A.

8.1.6 Vegetation features

Herbaceous vegetation would be incorporated along the inner margins and benches of the inset channel with the perforated slab concept (Section 7.1.6). The vegetation layout would be confined to the footprint of the inset channel to reduce potential conflict with the ongoing LARERR design development. However, additional planting may be included on the outer margins of the inset channel and holding pools with the use of perforated slab, weephole, or planter box concepts for habitat and aesthetic improvements as details of the LARERR layout develops in the future. Appropriate plant species will be selected from Table 7-1.

Sheet CI 501 in Appendix A shows planting features incorporated inside the inset channel.

8.2 Proposed Conditions Hydraulics

8.2.1 Flood hydraulics

The initial evaluation of the proposed 4.8-mile Reach Project modifications effects on flood hydraulics was performed using a 1D HEC-RAS hydraulic model. The 1D HEC-RAS Updated 2008 LAR Model was modified to reflect proposed conditions for Concept A. The modifications include changes in the geometry to represent the proposed inset channel sections and necessary channel modifications at selected bridges to prevent a hydraulic jump from occurring. As summarized in Table 8-1, the treatments are designed to increase an overall flow area through the bridge opening to offset the impacts of increased roughness from the 44-foot-wide (top width) roughened inset channel. For bridges that are not listed in Table 8-1, the inset channel would generally follow the existing LFC alignment, and the channel cross section through the bridge would not require channel modifications to reduce flood impacts. A single value Manning's n-value of 0.03 was selected in the flood model to represent the combined roughness from the concreted rock and light herbaceous vegetation placed within the inset channel. Vegetation may be incorporated outside the proposed inset and the details of additional vegetation will be evaluated in the next design phase as details of the LARERR layout develops.

Table 8-1. Proposed channel modifications at bridges for the 4.8-mile Reach Project.

Bridges	Recommended modifications
Riverside Drive	• Add 25-foot-wide (top width), 1.5-foot-deep split flow channel through the east bay • The 44-foot-wide (top width) inset channel would flow through the west bay, following the existing LFC alignment • The split flow channel would connect to the inset channel approximately 200 feet upstream and downstream of the bridge
North Broadway Street	• Set back the toe of the existing western channel bank by approximately 20 feet and retain the slope above with an approximately 10-foot-high vertical wall • The 44-foot-wide (top width) inset channel would flow through the east bay, following the existing LFC alignment
1st Street	• Set back the toe of the existing western channel bank by approximately 12 feet and retain the slope above with an approximately 6-foot-high vertical wall • The 44-foot-wide (top width) inset channel would flow through the west bay • The existing LFC through the east bay would be filled
Olympic Boulevard	• Set back the toe of the existing western channel bank by approximately 24 feet and retain the slope above with an approximately 12-foot-high vertical wall • The 44-foot-wide (top width) inset channel would flow through the middle bay, following the existing LFC alignment

Figure 8-1 shows computed 100-year flood water surface and velocity profiles for existing conditions and the 4.8-mile Reach Project. As seen in the existing conditions analysis, the water surface profile shifts from subcritical to supercritical flow at the soft-bottom to concrete-lined channel transition (upstream of Interstate 5) and then remains supercritical for the rest of the Project Reach. The figure R&U Figure 8-1 does not show the impact of the proposed roughened chute at 7th Street on the flood water surface. However, a preliminary assessment predicted that an increase in the water surface elevation relative to exiting conditions is minimal and occurs only locally. Detailed hydraulic analysis for the roughened chute will be performed in the next design phase. Further assessment of impact on flood water surface by the 4.8-mile Reach Project will be performed with a R&U analysis consistent with the USACE guidance (USACE 1996), once the detailed design of the LARERR become available and the 4.8-mile Reach Project layout is better defined in coordination with the USACE.

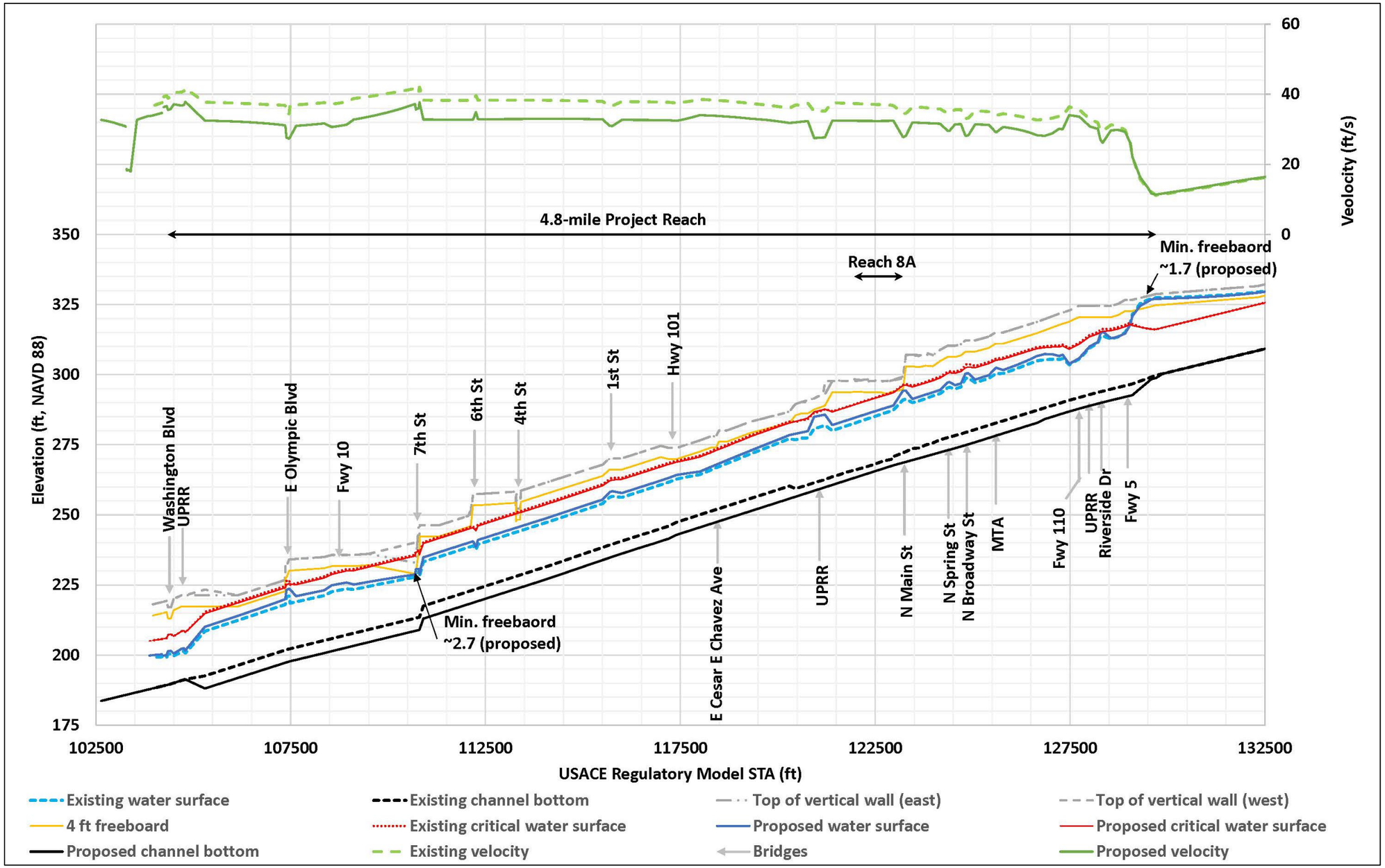

Figure 8-1. The 4.8-mile Reach Project 100-year discharge water surface and velocity profiles through the Project Reach.

8.2.2 Fish passage hydraulics

The hydraulics relevant to fish passage for the 4.8-mile Reach Project was evaluated for two sub-sections of the Project Reach using a 2D hydraulic model (SRH-2D) as part of the 30% conceptual design phase. The 2D model geometry included the 44-foot-wide inset channel and holding pools only. The model may be updated to include the resting pockets and anchored boulder clusters in the subsequent design phase, once the detailed design of LARERR becomes available and the 4.8-mile Reach Project footprint can be better defined in coordination with the USACE. The sub-sections include an approximately three-quarter-mile segment at the Arroyo Seco confluence to evaluate the hydraulic response of merging, high-velocity flows from the tributary and mainstem; and an approximately 1-mile-long segment between 1st Street and 4th Street to evaluate typical representative hydraulic conditions through the Project Reach. Details of the model development procedures, input data, assumptions, and results are presented in 30% Basis of Design Report (Stillwater Sciences 2021). Appendix F shows plan view maps of the velocity and depth analysis from 2D model results.

In summary, the 2D model results showed that the inset channel provides adequate depth (greater than 1 foot) even at assumed future baseflow of 25 cfs. Further, the model demonstrated that the inset channel maintains velocities sufficiently low to provide fish passage through a range of flows, including Qhfp (6,544 cfs) with the exception of an approximately 60-foot-long segment at the Arroyo Seco confluence, where the inset channel produces velocities ranging between 6 ft/s and 10 ft/s. As noted in Section 8.1.2, fish passage conditions would be improved through this area by strategically placing the boulder clusters to create connected low-velocity zones. Moreover, the 2D model results indicated that the proposed resting pools in the Arroyo Seco confluence provide large low-velocity, circulation zones suitable for resting (less than 2 ft/s) for discharges up to about 1,553 cfs (5% exceedance during migration season). At Qhfp (6,544 cfs), the velocities within the circulation zones are predicted to increase up to about 4 ft/s, as an increase in flood stage washes out the circulation effect.

It should be noted that the model results are based on depth-average velocities and thus may overestimate the near-bed velocities of the holding pools, which may provide suitable resting conditions at discharges even at Qhfp.

9 GEOTECHNICAL AND STRUCTURAL DESIGN

Geotechnical and structural design for the Project to date was informed through a desktop review of available data and reporting. The following section describes existing conditions and considerations relative to the geotechnical and structural design of the Project.

9.1 Geotechnical Conditions

Soils below the channel bottom are expected to comprise alluvial deposits, which are medium dense to very dense sand; sand with varying amounts of silt; gravel with silt; and scattered cobbles. Soils within the channel banks can be expected to comprise variable thicknesses of fill overlying alluvial deposits. Fill could include loose soil and man-made or natural debris (garbage, construction debris, railroad ties, bricks asphalt, cobbles, and/or boulders). Alluvial deposits within the channel banks can be expected to comprise loose to very dense sand; sand with varying amounts of silt; gravel with silt; and scattered cobbles.

Groundwater in the area studied as part of the USACE LA River Ecosystem Restoration IFR (USACE 2015) was encountered in the shallow subsurface at depths from 15 to 30 feet along the upper banks of the LA River and at depths of river bottom (ground surface within the channel). The historical data reviewed for this Project confirm these findings. These groundwater depths were obtained either from piezometers located at various distances from the Project, from observations, and at different times and eras. Therefore, they should not be interpreted to reflect conditions across the entire Project site at any time. Groundwater levels can fluctuate as a function of precipitation, irrigation, drainage, and grading.

9.2 Geotechnical Considerations

Subsurface geotechnical conditions are not anticipated to significantly impact the final design of the Project. However, there are several geotechnical aspects of the Project to consider in the overall design and construction of the Project.

9.2.1 Erosion and fines migration

The Project area is known to have high erosion/scour potential. Where existing concrete is removed, mitigation measures would need to be integrated into the design to incorporate similarly scour-resistant materials. Construction joints between new and existing concrete would need to be designed to control or prevent unintended introduction of water into subsurface soils and potential loss of fines from beneath the structure due to subsurface water piping upward through the joint.

For excavation work, the possibility of work extending below the groundwater level would require dewatering during construction to avoid migration of soils and potential undermining of adjacent in-channel structures to remain.

9.2.2 Excavations and fill

The soil deposits identified in the available boring logs should be able to be excavated using conventional excavation equipment. Most of the bedrock noted in the available boring logs was described as weathered or heavily weathered and should be able to be excavated using conventional equipment. If bedrock is encountered above the planned foundation invert elevation, rock fragmentation may be necessary prior to removal. Conversely, if loose material is encountered at the foundation invert elevation, over-excavation may be necessary to achieve a stable base for the foundation construction. Large boulders or man-made buried obstructions encountered in excavations may be larger than anticipated and difficult to remove, which could make it difficult to establish proper stable subgrades.

Temporary slopes should be excavated in accordance with the latest edition of the CAL-OSHA excavation and trench safety standards as a minimum. The sandy soils present at the site should be preliminary classified as Type C according to the CAL-OSHA classification system. The maximum allowable slope for Type C soil is 1½H:1V. However, flatter slopes may be required to provide a stable temporary configuration.

Engineered fill, where planned, should be placed in maximum 8-inch-thick loose lifts, moisture-conditioned to within 2% of optimum moisture content, and compacted to at least 95% relative compaction.

9.3 Structural Considerations

The structural design basis and governing codes for the fish passage channel and habitat feature designs are determined by the intended purpose and desired performance of the new structures. These items are a function of a range of system characteristics, such as design flows, topography, proximity to other structures, surface and subsurface drainage, and the sensitivity of the finished system to seepage and leakage.

Various American Concrete Institute (ACI) building codes will be followed in the structural design. ACI 350 will be followed as the governing code for watertight concrete joints, and ACI 318 and ACI 360 will be the governing codes for concrete joints designed to limit seepage and provide erosion protection but that are not intended to be watertight. Where movement joints are required by design, flexible waterstops and joint sealants will be selected that allow for long-term movement between structural members.

Vertically constructed sides of the inset channel will be excavated at a shallower angle to prevent material sloughing and undermining of the existing channel invert to remain. Amounts of over excavation will depend on the competency of the existing subgrade and if additional compaction or preparation of the base layer is required. The new channel will be lined with poured-in-place concrete placed neatly against excavated subgrade. Channel roughening features, such as concreted rock, will be placed on top of, or above, the structural concrete as required by the design.

Structural design of the fish passage channel and habitat structures is based on the following assumptions:

1. The existing channel lining is a structurally competent system of sidewalls and invert.
2. The existing drainage features beneath the existing invert slab are functional, and relieve hydrostatic pressure into the river, preventing uplift.
3. Overcrossing pier foundations in the river channel have deep foundations comprised of vertical and angled piles.
4. Design assumptions will be field verified before construction.

9.3.1 Proposed structures

Stability of proposed structures is anticipated to be primarily impacted by occasional high flows during storm events. Because the proposed improvements will have relatively shallow foundations with little to no soil overburden, structures constructed within the channel will need to be heavy enough to prevent floatation, designed with appropriate anchorage to existing structures, and with appropriate drainage to prevent uplift/sliding.

9.3.2 Reach 8A existing structures

The LARERR Reach 8A Pilot Project design avoids modifications adjacent to the channel banks by placing features away from the bank or toe of the channel wall by a distance at least 75% of the main channel height. This alignment is expected to be outside of the zone of influence of the channel bank. Throughout LARERR Reach 8A, rail tracks are adjacent to the river at the top of the banks. The current alignment of the proposed improvements is not expected to influence the rail tracks.

The generally shallow nature of the proposed improvements through this reach do not represent significant structural changes in the channel lining. The existing subdrain systems under the invert slab should be located and evaluated to ensure that they are continuing to function appropriately. If the existing drains conflict with the proposed improvements, they should be replaced at a similar location that avoids conflict with the improvements.

9.3.3 The 4.8-mile Reach Project existing structures

The alignment and location of channel improvements of the 4.8-mile Reach Project consider potential impacts to existing structures and foundations. Excavations for new improvements have been located as far from existing structures (e.g., adjacent bridge piers and abutments) as geometrically possible to minimize impacts to the load capacity of the structure foundations and the need for required mitigation. Improvements made in or against the riverbanks will need to be evaluated to mitigate impacts to the surrounding slopes and walls. Loading from nearby existing structure foundations may need to be considered in the structural design for the fish passage improvements. Rail tracks are located adjacent to the river at the top of the banks through most of the Project Reach. Improvements designed near these locations may need to be designed for restrained loading conditions (rather than active loading) to limit movement.

Locations where improvements cannot be located outside of the zone of influence of the embankments or existing structures should be evaluated on a case-by-case basis. In locations of select bridges along the alignment of the 4.8-mile Reach Project, modifications to the typical channel section are required to locate the improvements outside the zone of influence of bridge supports. Additionally, in some locations, modifications to the existing embankments will need to be incorporated to accommodate flood hydraulics. The most significant embankment modification will be a 12-foot vertical cut in the trapezoidal channel shape to increase flow capacity at Olympic Boulevard (Section 8.2). This vertical cut will need to be constructed with a top-down retaining method to minimize over excavation that would need to occur, in order to install a traditional cantilever wall with spread footing.

9.4 Future Investigations

The readily available historical data collected within the boundary of the channel is limited. Geotechnical and concrete investigations would be required for the final design phase of the Project. These investigations include borings and field investigations in the channel to further assess the existing condition of the channel lining and subgrade as well as local groundwater conditions to inform the detailed structural and geotechnical design. Additionally, oil has been observed seeping through the concrete lining in the Project Reach and should be investigated in more detail to determine implications to the structural and geotechnical design, as well as potential for the Project to increase the rate of oil seepage into the channel. These investigations may result in changes to the proposed design in the next phase of the Project.

10 CONSTRUCTION CONSIDERATIONS

In-channel construction would be limited by the need to provide flood protection during the storm season. Per the requirements of the USACE LA River Ecosystem Restoration Project IFR (USACE 2015), in-channel construction would only occur from April 16th through October 14th. Staging and mobilization for construction can occur outside the channel year-round and would be scheduled so that in-channel work could proceed on the first day permitted in consideration of flood control operations to complete the Project within one dry season.

Construction would involve locally saw cutting and modifying the existing LFC and the LA River channel bottom to install the habitat features such as inset channels, resting pockets, boulder clusters, holding pools (4.8-mile Reach Project only) stormwater treatment area (LARERR Reach 8A Pilot Project only) and planting features. Depending on the conditions of the concrete lining, small areas of the existing concrete lining would be cored to install weepholes. Some excavation would be required to install the proposed habitat features. While channel embankment modifications are not necessary for the LARERR Reach 8A Pilot Project due to its compact footprint, they are required for the 4.8-mile Reach Project to increase flow capacity at selected bridge crossings as discussed in Section 8.2 and Section 9.3.3. Stabilization of the subgrade and channel lining would occur during excavation and construction to avoid impacts to the existing channel lining.

The planter boxes would be a precast unit, manufactured in a controlled facility and delivered to the site for final assembly. Precast features would include rebar protruding from the feature for structural connections to the existing lining. Remaining features such as the inset channels, resting pockets, boulder clusters, holding pools (4.8-mile Reach Project only), curb for the stormwater treatment area (LARERR Reach 8A Pilot Project only), and perforated slab tie-ins would require cast-in-place construction.

Construction access would occur at the existing access ramp at the Arroyo Seco confluence or the new access ramp at the 6th Street Viaduct (Sheet GC 101 of Appendix A). No new access ramps or roadways are proposed as part of the Project. Construction staging areas for equipment and material storage are identified in the USACE LA River Ecosystem Restoration Project IFR (USACE 2015) and are located outside the channel (Sheet GC 101 of Appendix A). However, some staging of equipment during construction may occur within undisturbed areas inside the channel.

Dry season construction is expected to reduce, but not eliminate, water diversion needs. Dewatering would be required as the boring logs for nearby projects (4th Street Viaduct, 6th Street Viaduct, N Main Street, Albion Park) show a range of 1 to 36 feet for depth to groundwater. Dewatering would be required for excavations associated with the habitat features. The LFC has continuous dry-weather flows; therefore, flow diversion would also be necessary to avoid in-stream impacts and disturbances during construction. This would be achieved through temporary berms to bypass dry-weather flows around the work area.

The existing LA River channel through the Project Reach is entirely concrete. There is no existing riparian vegetation or native aquatic habitat such as substrate or another natural channel bed. Project construction would not contribute to disturbance of habitat, vegetation, or riparian areas. Best management practices and measures would be implemented to avoid and minimize potential negative effects during construction.

11 MONITORING RECOMMENDATIONS

11.1 Biological Parameters

11.1.1 Fish

The objectives of fish monitoring within the project reach are to: a) evaluate fish species composition and associations with habitat (including fish passage structures); b) monitor seasonal changes in species composition; and c) evaluate passage success. The approaches and methods for monitoring fish within the Project Reach could include visual observation, seining, backpack electrofishing, angling, and traps (e.g., minnow traps or fykes). State and federal permits would not be required for visually based surveys, but all other methods would likely require state (Scientific Collection Permit) and federal (Section 7 10a1a) permits due to the potential presence of threatened and endangered species. Monitoring would occur seasonally and include surveys during summer baseflow conditions and during winter. Winter surveys should occur between storm events when flows are considered safe for accessing the Project Reach. These surveys would document existing fish species (native and non-native) but could also be used to monitor for steelhead if surveys occur during winter flows when steelhead could be present within the project area. For example, surveys conducted during the winter could observe steelhead utilizing holding habitat (e.g., resting pockets) in the Project Reach in between flow events that provide passage.

To the extent feasible, all fish monitoring would follow recent guidelines presented in CDFW Fish Bulletin 182 (CDFW 2022) and use methods compatible with previous and ongoing survey efforts by FoLAR, the Resource Conservation District Santa Monica Mountains (RCDSMM), University of California (UC) Extension, Trout Unlimited, CDFW, and others. For example, FoLAR led fish surveys using angling and seining in the Glendale Narrows (FoLAR 2008) and the LA River estuary (FoLAR 2016). Fish monitoring in the Project Reach could be conducted by any of those organizations in coordination with their efforts.

In addition, the Project Reach could be equipped (or designed to be compatible) with stationary antennas that could detect fish tagged with transmitters (tags) that emit signals. Passive integrative transponder (PIT) tags are relatively inexpensive (~$3.00 each), are injectable (i.e., no need for sutures), and their small size (about the diameter of a pencil lead) make them applicable to both juveniles and adult fish (as well other aquatic species). The design team recommends at least two PIT detection sites, a downstream and upstream site, be installed in the Project Reach to monitor passage success and timing of tagged fish. Since there are currently no tagging programs within the watershed, at a minimum the design team recommends the designs accommodate future installation of PIT antennas. If PIT detection sites are subsequently established in other reaches of the LA River and/or tributaries, PIT detectors at the Project Reach can be used as part of an array to document the rate and timing of tagged fish moving throughout the river system.

PIT detection arrays (i.e., antennae) can be installed in permanent, accessible grooves recessed into the bed and banks of the river channel. These channels can be built into the channel during construction as part of the infrastructure and would be constructed at or slightly below grade to minimize hydraulic influence. The grooves would be constructed to accommodate the PIT antennae, which are typically cables or plates that require connection to a control device away from the channel. Access for installation of the PIT antennae, as well as repair and maintenance, could be provided via several possible design configurations including installation of the antenna cables in protective PVC pipe set within the engineered grooves and fastened to the channel bed by durable fasteners embedded permanently into the concrete during construction, or by covering

the antenna cables with removable, perforated metal grating secured to the channel bed with a similar system of permanently embedded fasteners. Details of the monitoring instrumentation anchoring and configuration in the channel bed will be developed in the next design phase.

11.1.2 Invertebrates

The specific objectives of invertebrate monitoring will be to determine taxonomic composition and species richness. Benthic macroinvertebrates (BMI) and terrestrial invertebrates should be monitored using methods compatible with previous and ongoing survey efforts conducted throughout the LA River basin, such as the Los Angeles River Watershed Monitoring Program (LARWMP) led by CWH. California Stream Condition Index (CSCI) methodology would be used to assess BMI community condition, providing an assessment of biotic integrity and relative impairment of the aquatic ecosystem that can be compared to other similar rivers in California. To evaluate food web support and other ecological functions of the riparian and emergent aquatic vegetation, terrestrial invertebrates can be surveyed using sweep nets or other methods, as applicable within or adjacent to the site where vegetation is available. Monitoring would be conducted seasonally, concurrent with fish monitoring.

11.1.3 Periphyton

Algae samples should be collected in conjunction with BMI surveys using methods compatible with previous and ongoing survey efforts being conducted by LARWMP. For example, the Algal Stream Condition Index (ASCI) is one method that can be used to assess algae and provide an indicator of stream condition.

11.1.4 Vegetation

Vegetation features (Section 7.1.6) along the margins of an inset channel will serve multiple functions including providing shading, cover, temperature control, avian predation deterrence, and habitat for aquatic and terrestrial species and inputs of organic matter to the aquatic ecosystem. The objectives of vegetation monitoring will be to evaluate plant species composition, survival, and cover, as well as to evaluate function such as shading of aquatic habitat. Additionally, a California Rapid Assessment Method (CRAM), as has been used by the LARWMP, will be completed prior to construction and at the end of the establishment period for comparison of conditions. A detailed list of target weeds and performance criteria will be established (e.g., >80% native cover, <5% target weed cover) in the next design phase. Methods for sampling vegetation will be compatible with previous and ongoing survey efforts in the watershed and may include plot or transect-based sampling. Monitoring will be performed on an annual basis in late spring or early summer. Additional monitoring may be necessary for maintenance purposes; see Section 12 below.

11.1.5 Wildlife

Monitoring for wildlife within the Project Reach may include avian, amphibian, and reptile species with the objective to determine species composition and richness. Visual encounter surveys may be the most feasible and appropriate method to identify and enumerate avian species. Amphibian and reptiles can also be identified and enumerated using visual surveys, but in some cases can also be identified using methods described above for fish monitoring. Monitoring should be conducted seasonally coincident with key life history events for species such as nesting season for avian species and breeding season for amphibians.

11.2 Physical and Chemical Parameters

11.2.1 Flow

To evaluate whether the proposed channel improvements result in water velocities and depths sufficient for fish passage and that velocity refuge is also provided, flows and depth should be monitored over a range of stage and discharge conditions using an Acoustic Doppler Current Profile (ADCP) sensor incorporated into the surface of the design or temporarily deployed from an overhead cable or boom along the Project Reach. The ADCP provides 2D water velocity and depth measures within the site that can be used to empirically evaluate whether water velocities and depths match design criteria and are conducive to fish passage. The ADCP deployment should capture each of the proposed fish passage and habitat structures including resting pockets, inset channel, boulders, scour pools, holding pools, and vegetation elements.

11.2.2 Water quality

Temperature and dissolved oxygen (DO) are critical abiotic factors for fish. Water temperature should be monitored to evaluate thermal suitability for fish within the Project Reach. Temperature data loggers that record and store temperature readings at fixed time intervals can be deployed within the Project Reach, specifically within the LFC, inset channel, holding pools, and resting pockets. Data loggers can be deployed at different depths to evaluate the availability of thermal refugia in holding pools and temperature differences at key locations such as storm drain outfalls and tributary inputs. Anchor bolts, chains or other permanent attachment points are recommended to secure loggers and prevent instrument loss during high flows. Loggers should remain in the water throughout the year to evaluate seasonal variation in temperature. Dissolved oxygen sensors can be included at the same locations or as part of the same loggers used for temperature.

Nutrients, bacteria, and toxicants within the project reach should also be monitored using methods compatible with previous and ongoing survey efforts by others within the watershed. Because the Project is not expected to influence bacteria and toxicants, any nearby monitoring of these parameters would be sufficient to understand conditions within the Project Reach. Of specific relevance to migrating adult steelhead is a toxic compound from tire rubber, known as 6PPD-quinone, that has been implicated in coho salmon mortality in the Pacific Northwestern U.S. (Tian et al. 2021), which is not currently being monitored within the LA River watershed. This toxic compound has the potential to limit migration success of steelhead in the LA River and should be considered as an additional toxicant to monitor within the Project Reach and the larger basin.

11.2.3 Sedimentation

Sedimentation within the Project Reach has the potential to compromise habitat available to fish and has implications for maintenance. Drones or other visual-based methods are recommended to map sedimentation within the broader Project Reach. A handheld probe, such as a stadia rod, can be used to measure sediment depth relative to permanent elevation benchmarks at specific locations within the Project Reach, such as downstream of boulder clusters and other habitat features, against infrastructure or within resting pools. Grain size of sediment will also be noted to provide a measure of habitat quality for aquatic organisms.

11.2.4 Trash

Similar to sedimentation above, trash accumulation should be mapped within the Project Reach using aerial mapping and/or on-the-ground visual inspection. Trash type and size can be

documented to inform maintenance approaches and to plan for opportunities to evaluate the effectiveness of best management practices and monitoring within the Project Reach sections more prone to trash accumulation (e.g. fish resting pockets). For example, if large trash accumulates within the Project Reach, mechanical removal may be necessary.

11.2.5 Project features

Project features such as the inset channel, resting pockets, anchored boulder clusters, and holding pools should be inspected for signs of deterioration and damage annually and following extreme flow events. This in turn will help document performance and effectiveness of the passage and habitat features and inform adaptive management actions and maintenance needs over time.

11.3 Opportunities for Collaboration/Integration

The Los Angeles River Watershed Monitoring Program (LARWMP), led by CWH, conducts annual water quality and habitat assessments to better understand the health of the LA River watershed. The LARWMP samples many of the biotic (BMIs, algae) and abiotic (physical habitat, water quality, sediment, trash) components described above within the LA River watershed. Thus, coordination with the LARWMP will reduce effort and cost associated with monitoring within the Project Reach. Furthermore, data collected by the LARWMP within the Project Reach can serve as a baseline for evaluating changes in conditions after Project construction, and data collected in other locations in the watershed can serve as controls. Some data of interest for project-related monitoring and maintenance (e.g., fish, flows, wildlife, physical damage to infrastructure, continuous temperature, and DO measures to name a few) are not included within the LARWMP surveys, and thus would need to be collected separately. Additional surveys would be needed within the Project Reach to allow more fine scale assessments of Project function and to evaluate seasonal changes in biotic and abiotic conditions.

12 OPERATIONS AND MAINTENANCE RECOMMENDATIONS

This section describes recommended operations and maintenance (O&M) needs for the Project. Monitoring elements in Section 11 will help to identify and refine O&M needs over time. Operation and maintenance responsibilities of the Project would be determined by responsibilities outlined in the USACE LA River Ecosystem Restoration Project IFR (USACE 2015). Consistent with the IFR, O&M responsibilities of the Project would be shared by the City of Los Angeles for fish passage and habitat features and the USACE for flood risk management. As the restoration project sponsor, the City of Los Angeles would maintain constructed fish passage and habitat features, including invasive plant management. With the City maintaining the proposed Project features, it is assumed that there would be no additional O&M requirements of the USACE to continue their existing flood risk management of the channel.

Buildup of sediment and trash could reduce the effectiveness of the Project features and compromise fish passage and habitat function. Habitat features were designed to promote flushing of sediment and small debris during high flows. For example, the downstream edge of the resting pockets is sloped to reduce trapping of debris and sediment. The approaches for removing sediment and trash are dependent on the amount, type, residence time, and distribution of sediment and trash within the Project Reach, which should be evaluated using monitoring procedures recommended in Section 11. Mechanical removal may be necessary when larger sized pieces of debris, trash, boulders, etc. are introduced into the Project Reach through downstream

movement during high flows or through human introduction directly within the Project Reach. Removal of sediment and trash should occur annually or following extreme flow events to ensure continuous function of the fish passage features.

Damage and deterioration of the Project features will be monitored as recommended in Section 11. Maintenance may be required to repair or replace infrastructure that no longer meets intended functions or that poses safety hazards.

Invasive species are a major ecological concern in the LA River, and it is anticipated that invasive species (flora and fauna) could occupy the site. Removal of invasive species may be required to limit negative effects on native species. For example, non-native, predatory fish species such as largemouth bass could occupy pool habitat that serves as resting habitat within the project reach. Removal of non-native predator species from these habitats would reduce the potential for predation on native species that could occupy the same habitats such as steelhead smolts, arroyo chub, and others. An O&M Plan will be developed in the future phases of the project and include consultation with CDFW and NMFS to ensure a no jeopardy opinion for any protected species that could potentially occur within the Project Reach over the life of the project during maintenance activities. The O&M Plan may be referenced in Section 7 consultation with CDFW and NMFS. Additionally, final permit applications will inform conditions and mitigation measures to include in the O&M Plan for protection of biological resources.

Weed management will be performed to remove target species as necessary (e.g., monthly when channel access is permitted) so that the established project performance criteria can be achieved. A list of target plant species will be developed in the next design phase focusing on species detrimental to the successful establishment of plantings including those that have a California Invasive Plant Council (Cal-IPC) rating of "high," or any other species deemed appropriate by a qualified biologist in consideration of the site. During periodic (e.g., monthly) monitoring events the presence of these species will be assessed. Methods for weed management may include mechanical and chemical treatment alternatives. Maintenance during the storm season will be performed in coordination with the USACE for channel access and safety concerns and only performed when conditions return to baseflow and no storms are forecast.

Vegetation features as described in Section 7.1.6 would require maintenance to ensure continued function of providing shading, cover, and habitat for native aquatic and terrestrial species. Herbaceous plant species were selected so that mature height of the plant, plant base, and root depth would not greatly impact flood hydraulics or undermine the structural integrity of the channel lining. The in-channel inundation regime and water supply would be sufficient to ensure survival of the selected species without supplemental irrigation. During the first six months, the plantings should be monitored on a monthly basis to assess health and vigor of the species and determine if any replacement plantings are necessary. Replacement plantings will be reinstalled so that the established performance criteria can be achieved. If the plants look drought stressed at any point, hand watering should be initiated on a weekly basis. As described in Section 11, detailed performance criteria will be developed in future project phases.

Human activities such as graffiti, introduction of trash, and establishment of homeless camps could create safety issues as well as impact the function and aesthetics within the Project Reach. In addition to trash removal described above, additional maintenance may be required to remove graffiti and waste or relocate homeless encampments. The addition of signage and fencing (and associated maintenance) may also be required within the Project Reach to protect the channel right of way during construction.

Vehicle access into the LA River channel bottom is currently achieved through ramps at the Arroyo Seco confluence and Downey Street. A new vehicle access at the Sixth Street Viaduct is under construction. The Project maintains at least a 12-foot-wide, drivable, continuous vehicle access path through the Project Reach between the access points on either side of the proposed inset channel. Crossing of the fish passage channel would be possible at intermittent locations along LARERR Reach 8A. The existing LFC geometry would not be altered between STA 1229+20 and 1223+00 except in the areas where resting pockets are proposed. Therefore, maintenance vehicles may cross the LFC through the spacing between boulder clusters and resting pockets in the section where the LFC geometry is not altered. The inset channel proposed for the 4.8-mile Reach Project is much deeper than that of the LARERR Reach 8A Pilot Project and may require a permanent crossing for a maintenance vehicle.

Most maintenance activity will be conducted during the dry season from April 16th through October 14th. Essential maintenance performed outside of the dry season will need to be in coordination with the USACE for channel access and safety during storm season and only occur when conditions return to baseflow and no storms are forecast.

The design of the habitat features considers vector control by reducing standing water, where vectors can easily breed. For instance, the resting pockets, scour pools, and holding pools are proposed within or connected to the inset channel or LFC with continuous baseflows to avoid accumulation of stagnant water in these features. The Greater LA County Vector Control District will be consulted in future design phases during development of the Operations and Maintenance plan for the project.

13 RECREATION AND MULTIPLE BENEFITS

The Project is the first phase of a larger integrated LA River fish passage program that will integrate multi-benefit opportunities such as education, recreation, water quality improvements, regional connectivity, and other objectives identified through public outreach programming. The Project design is intended to complement and enhance these future recreation and multi-benefit design opportunities by providing vegetation in the currently barren LA River channel within the Project Reach and restoration of aquatic habitat including historical steelhead populations. Additionally, the Project design does not interfere with planned recreational or ecological restoration projects such as the Metro LA River Path Project and LARERR. Future coordination on any recreational objectives for LA River projects should involve the MRCA, which manages two designated recreation zones on the LA River, Elysian Valley, and the Sepulveda Basin, where activities include kayaking, fishing, and public access.

14 ENVIRONMENTAL PERMITTING

The City of Los Angeles, Bureau of Engineering is serving as the CEQA Lead Agency for the Project. Project phasing, related projects, and other linkages to the proposed project have been reviewed to define the CEQA project description. An administrative draft Initial Study is currently being prepared to determine the scope of the environmental document. Once the Initial Study is finalized, the City will then initiate scoping with circulation of the Notice of Preparation and Initial Study. It is anticipated that the proposed design for the 4.8-mile Reach Project will likely trigger an EIR pursuant to CEQA.

Consultation with permitting agencies has been initiated and will continue during the preparation of the environmental document. Permits would be secured after completion of the environmental phase and final design. It is anticipated that the Project would be permitted under a CDFW Section 1602 Streambed Alteration Agreement, a USACE Section 404 Nationwide Permit Authorization (NWP) and Section 408 permit (for those areas that are not integrated with the LA River Ecosystem Restoration Project), and a Regional Water Quality Control Board (RWQCB) 401 Water Quality Certification. Coordination with the USACE for the 4.8-mile Reach Project will be based on the Congressional Authorization of the LA River Ecosystem Restoration Project allowing implementation of any concept integrated to that project without the need for Section 408 permission from the USACE.

The LARERR Reach 8A Pilot Project could be integrated with the LA River Ecosystem Restoration Project and in particular within Reach 8 of the LA River Ecosystem Restoration Project, which the City of Los Angeles will be leading as the local sponsor. As the City of Los Angeles, Bureau of Engineering is serving as the CEQA Lead Agency for the Project, defining the LARERR Reach 8A Pilot Project reach within the LA River Ecosystem Restoration Project Reach 8 will allow consistency through design and permitting stages as the City of Los Angeles works with the USACE during design of the LA River Ecosystem Restoration Project.

Most of the permits for the 4.8-mile Reach Project would also be required for the LARERR Reach 8A Pilot Project, including a CDFW Section 1602 Streambed Alteration Agreement, a USACE Section 404 Nationwide Permit Authorization (NWP), and a Regional Water Quality Control Board (RWQCB) 401 Water Quality Certification. Coordination with the USACE for the LARERR Reach 8A Pilot Project will be based on the Congressional Authorization of the LA River Ecosystem Restoration Project allowing implementation of any concept integrated to that project without the need for Section 408 permission from the USACE.

Throughout Fiscal Year 2020–21, CDFW implemented several initiatives to increase the pace and scale of restoration through permitting and granting efficiencies under its Cutting the Green Tape (CGT) Initiative. Senate Bill (SB) 155 added Section 21080.56 to California Public Resources Code. This section provides a new CEQA statutory exemption until January 1, 2025, for fish and wildlife restoration projects that meet certain requirements (Statutory Exemption for Restoration Projects [SERP]). Several coordination meetings were held with CDFW to discuss CGT initiatives. Based on our conversations with CDFW, pursuit of the SERP for the LARERR Reach 8A Pilot Project is recommended. This exemption would only apply to the CEQA, while all other permits would still be required. However, based on discussions with CDFW, pursuing the SERP requires the design to be fixed and as the 4.8-mile Reach Project design is subject to change while the LA River Ecosystem Restoration Project's design advances, it would not be appropriate for SERP at this time. Consultation with CDFW will inform whether the SERP would be appropriate for the 4.8-mile Reach Project once the LA River Ecosystem Restoration Project's design is more advanced.

15 PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COSTS

The preliminary opinion of probable construction costs (OPCC) has been developed consistent to the 60% level of design. The OPCC for the 4.8-mile Reach Project and LARERR Reach 8A Pilot Project are presented in Appendix C.

15.1 Unit Quantity Development

Quantities have been estimated from preliminary details created by the design team. Quantity estimates are based on overall dimensions of major project features, anticipated structure types and dimensions, approximate estimates for earthwork and rock materials, and construction schedule estimates. Demolition or cut areas have been estimated from the overlay of proposed improvements on existing typical sections. Fill or improvement areas have been estimated from design sections and details. These areas have then been applied along estimated lengths of river improvements to develop the volume quantity estimates.

15.2 Unit Cost Development

Unit prices were developed with estimated crew costs and production rates, and unit prices for materials and work items from cost estimating guides and experience of the project team. Unit costs also considered project location. Unit costs developed and agreed upon by the project team were used with the various unit quantities of different alternatives to provide comparable costs. Unit costs for the inset channel and control of water are blends or sums of work items that may ultimately be estimated and priced individually. For example, modifying or replacing the existing subdrain system is included in the unit cost for the 4.8-mile Reach Project inset channel and dewatering costs for pumping, diversions, storage, shoring, and settling are included in the control of water allowances for both projects.

15.2.1 Project elements

Primary project elements include the continuous channel improvements, locally deepening the channel to achieve project hydraulic goals, and increasing the channel roughness as well as resting pockets, holding pools, vegetation features, and boulders for additional hydraulic diversity and habitat in the channel. The geometry and size of these elements have been driven by hydraulic modeling and understanding of steelhead life cycle needs. The design and construction considerations have been based on the engineering judgment and experience of the design team. Typical section view drawings and details developed by the design team have been used to estimate quantities.

15.2.2 Allowances

Allowances have been estimated based on the experience of the design team and example bid sheets received for similarly located projects from the City of Los Angeles Bureau of Engineering. The allowances for traffic control, and construction site best management practices are considered to be the same cost regardless of the design alternative constructed.

The method of water control (dewatering or bypass) will vary depending on depth of excavation and groundwater along the reach being improved with more upstream reaches having higher dewatering costs due to higher groundwater levels. It is assumed that deep excavations for the inset channel, holding pools, resting pockets, and scour pools will require dewatering of groundwater during construction while other elements that do not require deep excavations, such as anchored boulders on the existing LFC or coring weepholes into the existing channel lining, would require surface water diversion of the baseflow. Groundwater control will require pumping, potentially a cutoff and collection system or shallow well points, and settling of diverted groundwater to control turbidity in settling tanks and/or filtration. Estimates for dewatering assume groundwater can be treated on site and returned to the channel downstream of the work area. Surface water diversions can be achieved with a bypass channel in the main

channel overbank around the work area conveyed by gravity without the need for additional pumping. Control of water estimates will be further refined in the next design phase with input from geotechnical investigations including local groundwater levels.

Mobilization and demobilization costs account for transporting equipment and crews to the project site, setting up site facilities and staging area, as well as demobilizing all equipment and crews, removal of staging areas and disassembly for all other field facilities after construction is complete. These costs do not include acquisition or leasing of land for construction staging and access areas.

Costs for planning, engineering and design include the preparation of plans, specifications, and engineering during construction. These costs do not include preparation and fees for permitting, physical model construction and analysis, USACE coordination and review periods, and public outreach. As discussed in Section 14, the environmental documents and permits, such as Section 408, may be exempt for this project or require a rigorous preparation and review period with variable associated costs that likely exceed the standard cost estimating allowances. Additionally, due to the flood control objective and high-profile nature of LA River projects, USACE coordination and public outreach costs are likely to be higher than standard cost estimating allowances would account for.

Allowances for mobilization and demobilization; planning, engineering, and design; and construction management were estimated to be a higher percentage of the construction cost for the LARERR Reach 8A Pilot Project, but still lower total cost, when compared to the 4.8-mile Reach Project. The lower construction cost for the LARERR Reach 8A Pilot Project resulted in unrealistically low estimates for total mobilization and demobilization; planning, engineering, and design; and construction management using the same percentage of total construction cost as the 4.8-mile Reach Project and were adjusted based on the judgement and experience of the design team.

15.2.3 Construction duration

To date the project has been developed to a 60% level and it is anticipated that development of the environmental and design documents will continue for the next two years. Construction is not anticipated to begin until 2024. Unit prices and other costs have been estimated based on current available data. Inflation, based on recent data, has been assumed to continue at a rate of 3 percent per year into the future. Multi-year construction for the 4.8-mile Reach Project includes the anticipated amount of work occurring each year and costs have been escalated per year, to the anticipated year of construction. The LARERR Reach 8A Pilot Project is anticipated to be completed within one year.

15.3 Uncertainties

Uncertainties in this opinion of probable construction costs result from the stage of design, limited information on some physical conditions at the site, limited geotechnical data at the project location, uncertainty in construction timing and number of construction seasons for multi-year construction, and permitting and environmental protection requirements that are not yet fully defined.

One primary uncertainty is actual site conditions due to the lack of soil and geologic information at the specific location of the proposed project facilities. This information forms the basis of

structural design for the walls, requirements for control of water and other features. Site-specific soil and geologic information that differs from preliminary assumptions may impact the design of some project elements.

The environmental document for the project is in progress. Agency review and input to the document should reduce uncertainty related to required environmental protections.

Contingencies represent allowances to cover unknowns, uncertainties or unanticipated conditions that are not possible to adequately evaluate from the data on hand, and the level to which the project has been developed. Contingencies represent an estimated cost to cover the identified risks. An overall contingency of 30 percent has been used to capture potential design changes and uncertainties in quantities and unit prices for the preliminary design. As the project progresses, design of key elements will be advanced to address project risks and uncertainties.

In providing rough order of magnitude construction costs, the Client understands that the project design team has no control over the cost or availability of labor, equipment or materials, or over market conditions of the Contractor's method of pricing, and that the design team's opinions of probable construction costs are made on the basis of professional judgment and experience.

16 NEXT STEPS

This report presents the 60% level design basis for the LARERR Reach 8A Pilot Project and the 4.8-mile Reach Project. The 60% level design plans with supporting materials such as the specifications table of contents, itemized cost estimates, model output files, and the LARERR Reach 8A Pilot Project R&U technical memorandum are included as appendices. The design development for the Project was implemented with limited guidance and coordination with the USACE due to lack of available resources or a Section 214 Agreement for direct funding of Section 408 Permission requirements and consultation on review of the 4.8-Mile Reach Project; thus, some alterations to the design are anticipated pending inputs from the USACE. The Project design is also based on limited descriptions of the LARERR project features; therefore, the Project may require some adjustments as the details for LARERR become available. The project design was developed based on desktop studies and readily available data and reporting, including as-built plans, existing boring logs, and geotechnical reporting. The topographic data for Reach 8A was developed from the LiDAR data (USACE 2019). However, the cross-section data from various hydraulic models were the primary source of information used to develop a surface for the 4.8-mile Reach project, because the LiDAR data did not sufficiently cover the Project Reach, in particular downstream of LARERR Reach 8. It is recommended that site-specific subsurface data, refined topographic mappings, and utility and subdrain data be obtained to better identify the site constraints and help inform the design refinement in the next phase of the Project. Recommended analysis and Design refinements needed to advance the 60% level design are identified as follows:

- Obtain USACE Section 214 agreements between the USACE and the City to engage USACE in the review process for the 4.8-mile Reach Project
- Perform site survey to verify existing LiDAR topographical map, confirm bridge geometry, supplement specific areas as needed, and locate the subdrain system
- Additional LiDAR survey of the 4.8-mile Project Reach downstream of LARERR Reach 8 to supplement the LiDAR topographic map (USACE 2019)
- Perform utility coordination

- Perform geotechnical investigation
- Perform physical and computational fluid dynamics (CFD) modeling
- Refine and advance civil design based on findings from physical and CFD modeling results
- Structural designs based on site-specific subsurface data
- Refine planting configurations and species
- Develop an Operations and Maintenance Plan for the project features
- Develop a Monitoring and Adaptive Management Plan for the project features including project performance criteria
- Complete CEQA and permitting
- Conduct public outreach/education and tribal consultation to bolster project understanding and to inform the public about the steelhead recovery actions

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Appendices

Appendix A

60% Plans

CITY OF LOS ANGELES
DEPARTMENT OF PUBLIC WORKS
BUREAU OF ENGINEERING

LA RIVER FISH PASSAGE & HABITAT STRUCTURES PROJECT

LOCATION MAP

NOT TO SCALE

SHEET INDEX

SHEET NO.	SHEET NAME	TITLE
1	GI001	TITLE
2	CG001	CIVIL NOTES & ABBREVIATIONS
3	GC101	STAGING & ACCESS
4	CD101	4.8–MILE REACH DEMOLITION & UTILITY PLAN
5	CD102	REACH 8A DEMOLITION & UTILITY PLAN
6	CI401	4.8–MILE REACH PLAN & PROFILE OVERVIEW 1
7	CI402	4.8–MILE REACH PLAN & PROFILE OVERVIEW 2
8	CI201	4.8–MILE REACH PLAN & PROFILE 226+00 TO 250+12
9	CI202	4.8–MILE REACH PLAN & PROFILE 202+00 TO 226+00
10	CI203	4.8–MILE REACH PLAN & PROFILE 178+00 TO 202+00
11	CI204	4.8–MILE REACH PLAN & PROFILE 154+00 TO 178+00
12	CI205	4.8–MILE REACH PLAN & PROFILE 130+00 TO 154+00
13	CI206	4.8–MILE REACH PLAN & PROFILE 106+00 TO 130+00
14	CI207	4.8–MILE REACH PLAN & PROFILE 82+00 TO 106+00
15	CI208	4.8–MILE REACH PLAN & PROFILE 58+00 TO 82+00
16	CI209	4.8–MILE REACH PLAN & PROFILE 34+00 TO 58+00
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19	CI403	REACH 8A PROPOSED PLAN & PROFILE
20	CI212	REACH 8A UPSTREAM PLAN & PROFILE
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23	CI501	4.8–MILE REACH CHANNEL TYPICAL CROSS SECTIONS
24	CI502	4.8–MILE REACH BRIDGE TYPICAL CROSS SECTIONS
25	CI503	4.8–MILE REACH HOLDING POOL TYPICAL CROSS SECTION
26	CI504	4.8–MILE REACH RESTING POCKET TYPICAL CROSS SECTION
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28	CI506	REACH 8A INSET CHANNEL TYPICAL CROSS SECTION
29	CI507	REACH 8A INSET CHANNEL RESTING POCKET DETAILS TYPE A
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32	CI510	REACH 8A LOW FLOW CHANNEL BOULDER & SCOUR POOL DETAILS
33	CI511	REACH 8A ROCK LINING PLACEMENT & GROUTED ROCK DETAIL
34	CI512	REACH 8A STORMDRAIN CONNECTION & CURB DETAIL
35	CI513	4.8–MILE REACH & REACH 8A PERFORATED SLAB DETAIL
36	CI514	STAGING & ACCESS CONSTRUCTION FENCE & SILT BARRIER
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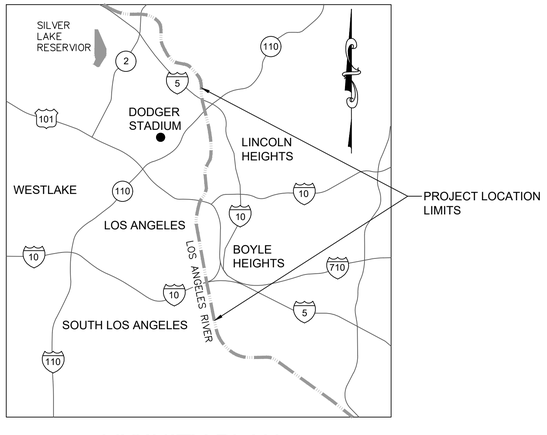
39	SB303	4.8–MILE REACH HOLDING POOL, RESTING POCKET, & BRIDGE TYPICAL CROSS SECTIONS
40	SB304	REACH 8A TYPICAL CHANNEL SECTION & RESTING POCKET SECTIONS
41	SD505	ANCHORED BOULDERS, PLANTED WEEP HOLE, & PERFORATED SLAB TIE–IN DETAILS



VICINITY PLAN

NOT TO SCALE

PROJECT TEAM

PROJECT MANAGEMENT: BUREAU OF ENGINEERING CLEAN WATER DIVISION
XXXXXX, P.E.
PROJECT MANAGER
XXXXXX, P.E.
CONSTRUCTION MANAGER

STREETS LIGHTING: BUREAU OF STREET LIGHTING
XXXXXX, P.E.
DIRECTOR
XXXXXX, P.E.
PROJECT MANAGER

BID AND AWARD: PROJECT AWARD AND CONTROL DIVISION
XXXXXX, P.E.
DIVISION MANAGER

GEOTECHNICAL: GEOTECHNICAL ENGINEERING GROUP
XXXXXX, P.E.
DIVISION ENGINEER

STREETS: ACTIVE TRANSPORTATION PROGRAM GROUP
XXXXXXXX_XXXXXXXXXXX, P.E.
GROUP MANAGER
XXXXXXXX_XXXXXXXXXXX, P.E.
PROJECT ENGINEER

TRAFFIC SIGNALS AND STRIPING: LOS ANGELES DEPARTMENT OF TRANSPORTATION
XXXXXXXX_XXXXXXXXXXX
GENERAL MANAGER
XXXXXXXX_XXXXXXXXXXX
GROUP MANAGER

SURVEY: SURVEY DIVISION
XXXXXXXX_XXXXXXXXXXX, P.L.S.
CHIEF LAND SURVEYOR

ENVIRONMENTAL: ENVIRONMENTAL MANAGEMENT GROUP
XXXXXXXX_XXXXXXXXXXX
GROUP MANAGER

INSPECTION: BUREAU OF CONTRACT ADMINISTRATION
XXXXXXXX_XXXXXXXXXXX
DIRECTOR (INSPECTOR OF PUBLIC WORKS)

REAL ESTATE: REAL ESTATE GROUP
XXXXXXXX_XXXXXXXXXXX
GROUP MANAGER

STORM WATER: STORMWATER GROUP
XXXXXXXX_XXXXXXXXXXX, P.E.
GROUP MANAGER

DESIGN: CONSULTANT
XXXXXXXX_XXXXXXXXXXX, P.E.
DESIGN MANAGER

ENGINEERING
CITY OF LOS ANGELES

• THIS PLAN WAS ELECTRONICALLY SIGNED AND STAMPED •

REGISTERED PROFESSIONAL ENGINEER No. XXXXX CIVIL STATE OF CALIFORNIA

DEPARTMENT OF PUBLIC WORKS
BUREAU OF ENGINEERING
VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V
SHEET TITLE: TITLE
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

NO. | REVISIONS: | DATE: | BY:

CIP NO. XXX
SHEET TYPE
INDEX NO. XXX

CITY OF LOS ANGELES
GARY LEE MOORE, P.E., ENV SP — CITY ENGINEER — DATE
DEPUTY CITY ENGINEER/PROGRAM MANAGER — CITY ENGINEER — DATE

WORK ORDER NO.
E1908721

SHEET NAME
GI001
SHEET 1 OF 41 SHEETS

THE CITY OF LOS ANGELES OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.

REVISION DATE(S) (DESIGN STAGE ONLY)

Sheet Version 4.0

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GENERAL NOTES

SAFETY AND SECURITY

1. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL ASPECTS OF SAFETY INCLUDING, BUT NOT LIMITED TO EXCAVATION, TRENCHING, SHORING, TRAFFIC CONTROL, AND SECURITY.
2. THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR PROVIDING STABLE EXCAVATIONS AND TEMPORARY SLOPES AND FOR SATISFYING ALL APPLICABLE FEDERAL, STATE, AND LOCAL REGULATIONS. ALL EXCAVATIONS SHALL MEET OSHA REQUIREMENTS.
3. EXISTING FACILITIES NOT INDICATED TO BE REMOVED SHALL BE PROTECTED IN PLACE OR REPLACED IN KIND, AS APPROVED BY THE OWNER AND ENGINEER.

CONTRACT DOCUMENTS AND REQUIREMENTS

1. THE CONTRACTOR SHALL EXERCISE CARE TO AVOID DAMAGE TO EXISTING PUBLIC AND PRIVATE PROPERTY, INCLUDING ALL UTILITIES. ALL DAMAGED ITEMS SHALL BE REPLACED OR REPAIRED AT CONTRACTOR'S EXPENSE.
2. IN THE EVENT OF A CONFLICT, THE ORDER OF PRECEDENCE SHALL BE AS FOLLOWS: (1) PERMIT CONDITIONS, (2) PROJECT SPECIFICATIONS, (3) CONSTRUCTION PLANSET.
3. THE CONTRACTOR SHALL REFER TO THE CONTRACT SPECIFICATIONS FOR DESCRIPTION OF MATERIALS REFERRED TO BY SIZE, CLASS, TYPE, DESCRIPTION, OR OTHERWISE SPECIFIED ON THE DRAWINGS.
4. NO FIELD FIT CHANGES SHALL BE MADE WITHOUT THE ENGINEER BEING PRESENT ON SITE AND WITHOUT CONCURRENCE OF THE OWNER. THE DESIGNER DOES NOT TAKE RESPONSIBILITY FOR MODIFICATIONS OF THESE PLANS OR DESIGN CHANGES THAT OCCUR DURING CONSTRUCTION WITHOUT PRIOR APPROVAL OF THE ENGINEER.
5. THE CONTRACTOR SHALL CONFINE ALL WORK TO THE CONSTRUCTION LIMITS SHOWN ON THE PLANS AND DESCRIBED IN THE CONTRACT DOCUMENTS.
6. SCALES SHOWN ARE FOR FULL SIZE SHEETS (22" x 34") AND REQUIRE ADJUSTMENT FOR HALF (11" x 17") SIZE.
7. ALL GRADES SHOWN ARE FINISHED GRADES, UNLESS OTHERWISE NOTED ON THE DRAWINGS.
8. DIMENSIONS AND NOTATIONS SUPERCEDE SCALE OF THE DRAWINGS.
9. THE WORK WILL TAKE PLACE IN AND AROUND A STREAM, WHICH IS SUBJECT TO PERIODIC FLOODING. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE CONTROL OF SURFACE AND SUBSURFACE WATER DURING THE COURSE OF THE WORK. ANY DAMAGE TO THE WORK RESULTING FROM SURFACE FLOWS, BASE FLOWS, OR FLOOD FLOWS SHALL BE CORRECTED BY THE CONTRACTOR AT THE CONTRACTOR'S SOLE COST.
10. CONSTRUCTION OF THE PROPOSED WORK WILL TAKE PLACE WITHIN THE CHANNEL AND WATER CONTROL MEASURES WILL BE REQUIRED. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE ACCEPTANCE AND CONTROL OF DRAINAGE WATER FROM AREAS ADJACENT TO THE RIVER AND ITS TRIBUTARIES INCLUDING STORMWATER OUTFALLS. THE CONTRACTOR SHALL BE SOLELY RESPONSIBLE FOR ESTABLISHING MEANS AND METHODS OF GROUND AND SURFACE WATER CONTROL APPROPRIATE FOR THIS CONSTRUCTION IN ACCORDANCE WITH THE REQUIREMENTS OF THE PROJECT DRAWINGS AND SPECIFICATIONS, AND ALL APPLICABLE FEDERAL, STATE, AND LOCAL REGULATIONS, AND ALL PERMITS. THE CONTRACTOR WILL PREPARE A DIVERSION AND DEWATERING PLAN, CONSISTENT WITH PROJECT PERMITS, FOR REVIEW AND APPROVAL BY THE ENGINEER. THE DIVERSION AND DEWATERING PLAN SHALL DESCRIBE THE METHOD TO BE USED FOR LOW FLOW DIVERSION AND DEWATERING OF EXCAVATION, INCLUDING CAPACITIES, TREATMENT, AND METHOD OF DISPOSAL.
11. SHOULD ARCHAEOLOGICAL REMAINS OR ARTIFACTS BE ENCOUNTERED DURING CONSTRUCTION, LAND ALTERATION WORK IN THE GENERAL VICINITY OF THE FINDS SHALL BE HALTED AND A QUALIFIED ARCHAEOLOGIST AND THE OWNER SHALL BE NOTIFIED IMMEDIATELY. WORK ON THE PROJECT SHALL NOT BE RESUMED UNTIL A MITIGATION PLAN WITH ADEQUATE MEASURES FOR SITE PROTECTION IS REVIEWED AND APPROVED BY THE OWNER.
12. IN-CHANNEL WORK WILL COMMENCE NO EARLIER THAN APRIL 16TH AND WILL BE COMPLETED ON OR BEFORE OCTOBER 14TH UNLESS OTHERWISE APPROVED.
13. WORK WILL BE PERFORMED BETWEEN THE HOURS OF 9AM AND 5PM, MONDAY THROUGH FRIDAY, UNLESS OTHERWISE APPROVED.
14. CONSTRUCTION OF THE PROJECT IS SUBJECT TO CONDITIONS OF PERMITS ISSUED BY REGULATORY AGENCIES, INCLUDING THE US ARMY CORPS OF ENGINEERS, CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE, AND REGIONAL WATER QUALITY CONTROL BOARD.
15. CONSTRUCTION OPERATION SHALL CONFORM TO THE APPROVED SWPPP PREPARED BY THE CONTRACTOR AND PROJECT PERMITS.

STAGING, ACCESS, AND TRAFFIC CONTROL

1. THE EXACT LIMITS OF THE CONTRACTOR'S PARKING AND STAGING AREA FOR MATERIAL STOCKPILING, OFFICE TRAILERS, AND PARKING FOR PUBLIC SHALL BE SUBMITTED BY THE CONTRACTOR FOR REVIEW AND APPROVAL BY THE OWNER.
2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PREPARING, SUBMITTING, AND ADHERING TO A TRAFFIC CONTROL PLAN FOR APPROVAL BY THE OWNER.
3. THE CONTRACTOR SHALL MAINTAIN ACCESS ROUTES AND STAGING AREAS IN A CLEAN CONDITION AND SHALL BE RESPONSIBLE FOR THE CLEAN UP OF ANY TRASH OR MUD ON THE SITE OR ADJACENT STREETS AS A RESULT OF CONSTRUCTION. THE CONTRACTOR SHALL RESTORE ACCESS AREAS AND ACCESS ROADS TO THEIR ORIGINAL GRADES AND CONDITIONS. THE COST TO RESTORE THESE AREAS SHALL NOT BE MEASURED AND PAID FOR SEPARATELY BUT SHALL BE INCLUDED IN THE COST OF THE WORK.
4. THE CONTRACTOR SHALL REMOVE ALL TEMPORARY CONSTRUCTION FACILITIES SUCH AS HAUL ROADS, WORK AREAS, STRUCTURES, FOUNDATIONS OF TEMPORARY STRUCTURES, STOCKPILES OF EXCESS WASTE MATERIALS, OR ANY OTHER VESTIGES OF CONSTRUCTION AS DIRECTED BY THE ENGINEER.

UTILITIES

1. THE CONTRACTOR SHALL NOTIFY DIGALERT (811 OR 800-422-4133) PRIOR TO START OF ANY CONSTRUCTION.
2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR IDENTIFYING AND AVOIDING DAMAGE TO UTILITIES. THE CONTRACTOR SHALL IMMEDIATELY NOTIFY THE ENGINEER OF ANY POTENTIAL CONFLICTS WITH UTILITIES ENCOUNTERED DURING CONSTRUCTION.
3. THE CONTRACTOR SHALL NOTE THAT ALL UTILITIES MAY NOT APPEAR ON THESE PLANS AND THAT THE POTENTIAL CONFLICT WITH UTILITIES SHALL BE CONSIDERED IN THE PREPARATION OF COST ESTIMATES AND BIDS.
4. THE CONTRACTOR SHALL COORDINATE WITH BOE'S WASTEWATER CONVEYANCE ENGINEERING (WCE) DIVISION, SPECIFICALLY THE THIRD PARTY REVIEW GROUP FOR ANY WORK IN THE VISCINITY OF UTILITIES SHOWN ON CD101 & CD102 AND INCLUDING TRENCHING, WEIGHT OF MACHINERY, REQUIREMENTS FOR HAND TOOLS, SPILL PROTECTION MEASURES, ETC.

PERMITTING

1. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY AND ALL PERMITS, LICENSES, FEES, AND BONDS THAT ARE NECESSARY AS REQUIRED BY THE LOCAL JURISDICTION OR OTHER AGENCIES REQUIRED TO CONSTRUCT THE PROJECT.
2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING AND COMPLYING WITH THE REQUIREMENTS OF ANY PERMITS PERTAINING TO WATER AND EROSION CONTROL.
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR COMPLYING WITH ALL PERMIT CONDITIONS, LAWS, ORDINANCES, CODES AND/OR REGULATIONS APPLICABLE FOR PROJECT IMPLEMENTATION.

SURVEYING, TOPOGRAPHIC DATA, AND RIGHT OF WAY

1. REACH 8A EXISTING TOPOGRAPHY IS BASED ON LiDAR AND PHOTOGRAMMETRY MAPPING FOR THE LA RIVER ECOSYSTEM RESTORATION PROJECT DATED OCTOBER 2019 WITH HORIZONTAL DATUM NAD 83 CALIFORNIA STATE PLANE ZONE V US FOOT AND NAVD 88 VERTICAL DATUM IN U.S. SURVEY FEET.
2. THE 4.8 MILE REACH EXISTING TOPOGRAPHY IS BASED ON THE USACE 2008 REGULATORY MODEL, 2016 USACE FLOOD PLAIN MANAGEMENT SERVICES MODEL, AND AVAILABLE AS-BUILT INFORMATION WITH HORIZONTAL DATUM NAD 83 CALIFORNIA STATE PLANE ZONE V US FOOT AND VERTICAL DATUM CONVERTED FROM NGVD 29 TO NAVD 88 IN U.S. SURVEY FEET.
3. PARCEL, RIGHT OF WAY, EASEMENT, AND TOPOGRAPHY INFORMATION IS APPROXIMATE AND SHOULD BE VERIFIED PRIOR TO WORK. CONSTRUCTION IS ONLY ALLOWED ON PARCELS WITH OWNERSHIP APPROVAL.
4. CONTRACTOR WILL VERYFIY AND CHECK EXISTING CONDITIONS PRIOR TO CONSTRUCTION. THE CONTRACTOR SHALL VERIFY LOCATIONS, LEVELS, DISTANCES, AND FEATURES THAT MAY AFFECT THE WORK. SHOULD EXISTING CONDITIONS DIFFER FROM THOSE SHOWN OR INDICATED, CONTRACTOR MUST NOTIFY THE ENGINEER PRIOR TO START OF CONSTRUCTION.
5. THE ENGINEER WILL PROVIDE FIELD DIRECTION FOR ADJUSTMENTS IN PROJECT FEATURES, LINES, AND GRADES TO FIT ACTUAL CONDITIONS AT THE TIME OF CONSTRUCTION IF MINOR DEVIATIONS FROM THE SHOWN GRADE ARE OBSERVED.
6. THE CONTRACTOR SHALL PROVIDE ALL CONSTRUCTION SURVEYING. IT IS RECOMMENDED THAT THE CONTRACTOR MAINTAIN A SURVEY GRADE GPS UNIT ONSITE WITH THE DESIGN CONTROL POINTS, AND FEATURE LOCATIONS LOADED FOR REFERENCE.

REVIEW AND INSPECTIONS

1. ALL MATERIALS AND WORKMANSHIP SHALL BE SUBJECT TO INSPECTION BY THE OWNER, THE ENGINEER AND/OR THEIR REPRESENTATIVES. THE PROJECT OWNER RESERVES THE RIGHT TO ACCEPT OR REJECT ANY SUCH MATERIALS AND WORKMANSHIP THAT DOES NOT CONFORM TO ITS STANDARDS AND SPECIFICATIONS SHOWN IN THE CONTRACT DOCUMENTS.

ABBREVIATIONS & DEFINITIONS

O.C. = ON CENTER
DIA = DIAMETER
LF = LINEAR FEET
SQ FT = SQUARE FEET
THALWEG = THE LINE OF LOWEST ELEVATION WITHIN A VALLEY OR WATERCOURSE. THE THALWEG IS OFTEN CORRELATED TO THE LOCATION OF HIGHEST DEPTH AND VELOCITY IN A GIVEN RIVER CHANNEL.
LARERR = LA RIVER ECOSYSTEM RESTORATION AND RECREATION PROJECT
REACH 8A = LARERR REACH 8A

THE CITY OF LOS ANGELES OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.

REVISION DATES (DESIGN STAGE ONLY)

BUREAU OF ENGINEERING • THIS PLAN WAS ELECTRONICALLY • SIGNED AND STAMPED

ENGINEERING
CITY OF LOS ANGELES

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: CIVIL NOTES & ABBREVIATIONS
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
		5/4/2022	
		5/4/2022	
		5/4/2022	
		5/4/2022	

CIP NO. ----

INDEX NO. ----

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

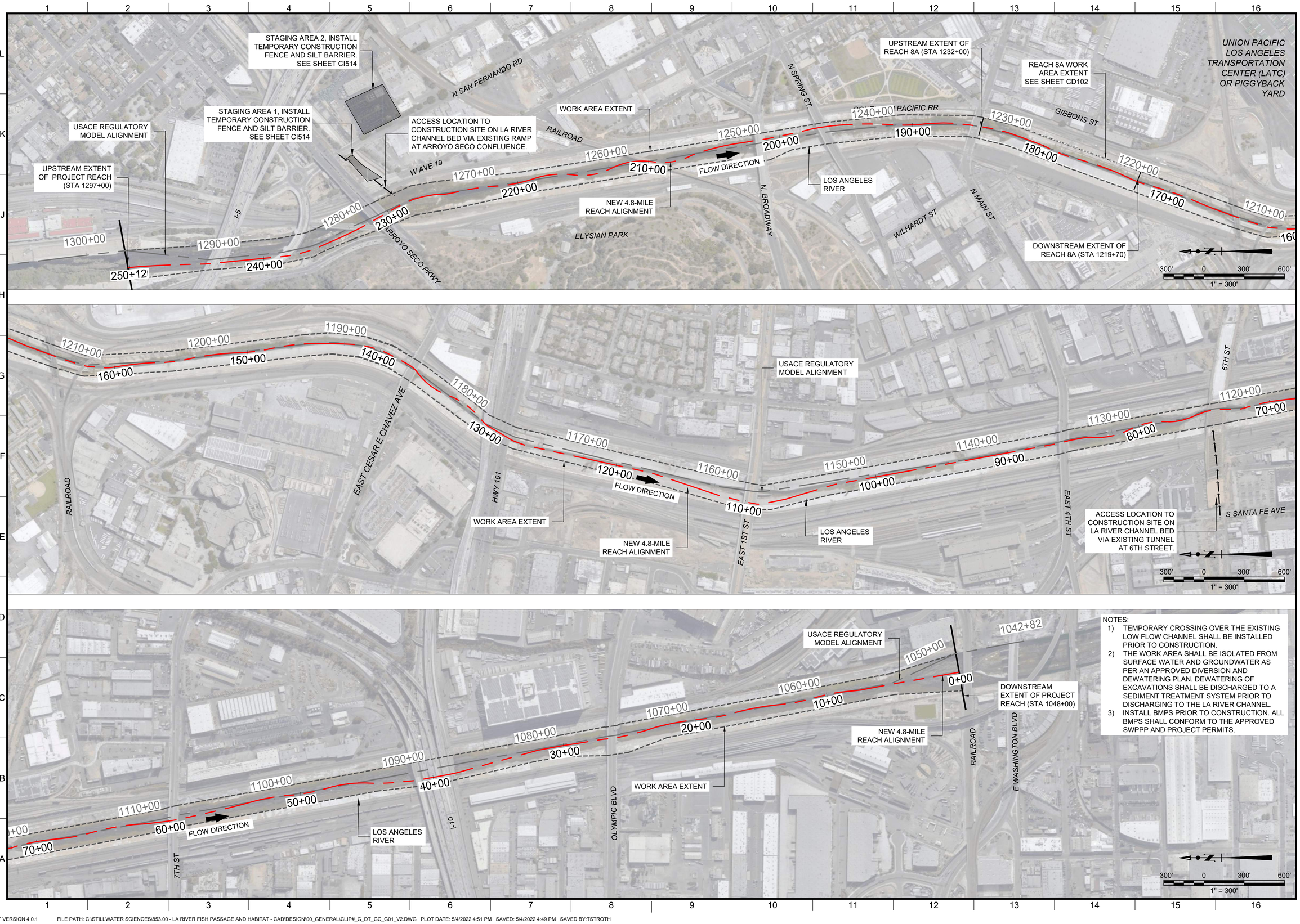
GARY LEE MOORE, P.E., ENV SP — CITY ENGINEER — DATE 5/4/2022

DESIGN GROUP		DATE
ENGINEER:	NT	5/4/2022
ARCHITECT:		5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

WORK ORDER
E1908721

SHEET NAME
CG001

SHEET 2 OF 41 SHEETS



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REVISION DATES (DESIGN STAGE ONLY)

ENGINEERING
CITY OF LOS ANGELES

THIS PLAN WAS ELECTRONICALLY • SIGNED AND STAMPED

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS
BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: STAGING & ACCESS

PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN

ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
		5/4/2022	
		5/4/2022	
		5/4/2022	
		5/4/2022	

CIP NO. ----

INDEX NO. ----

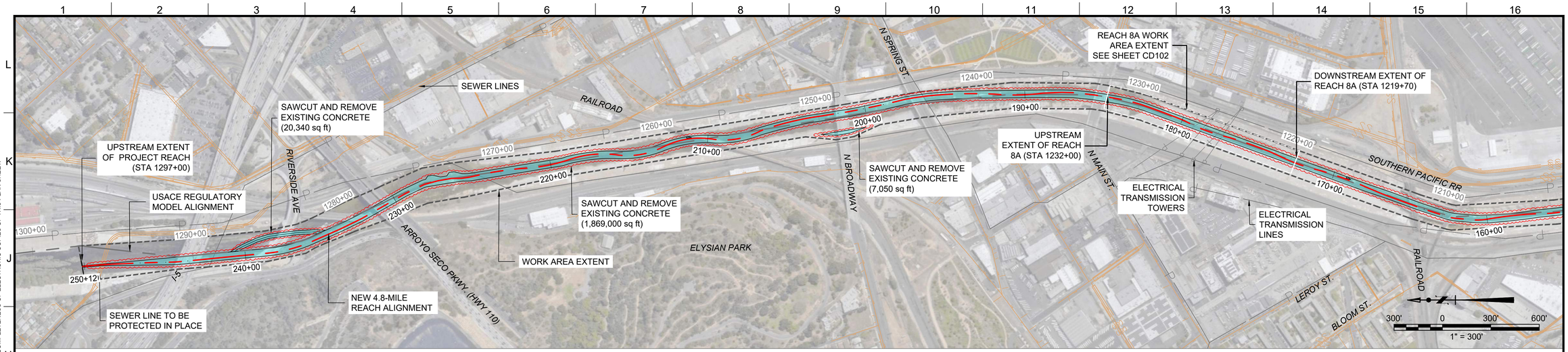
GARY LEE MOORE, P.E., ENV SP — CITY ENGINEER — DATE 5/4/2022

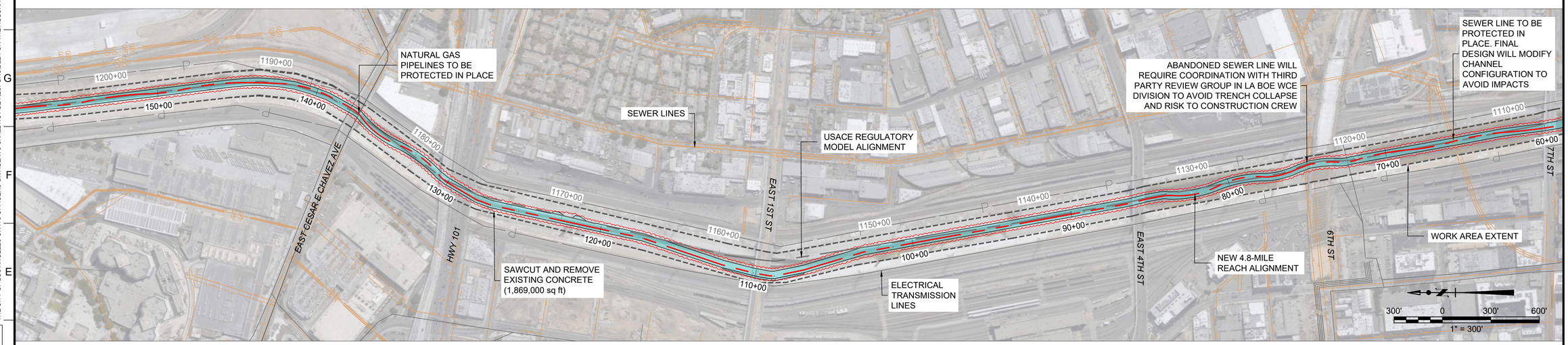
DESIGN GROUP		DATE
ENGINEER:	NT	5/4/2022
ARCHITECT:	---	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

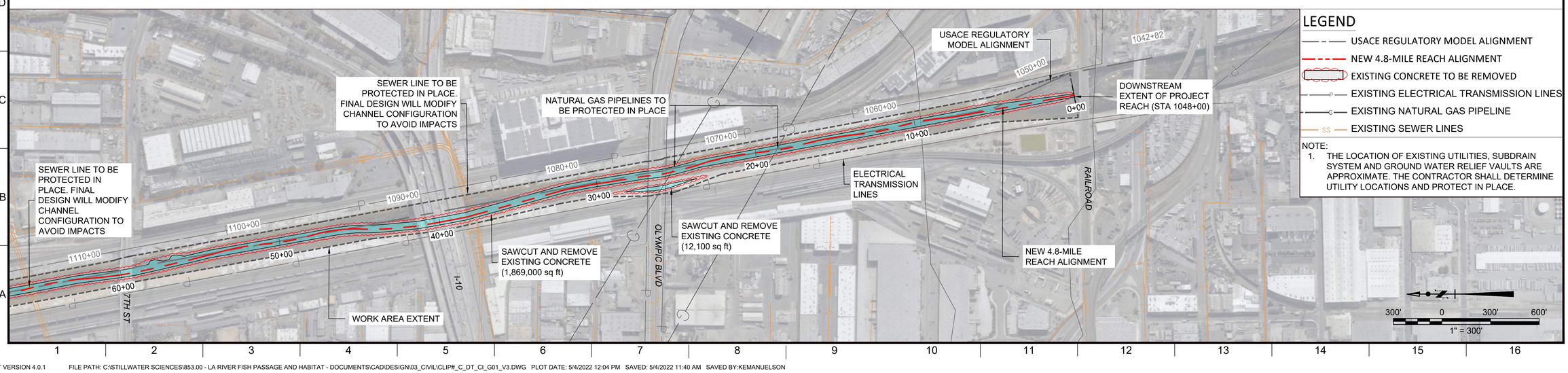
WORK ORDER
E1908721

SHEET NAME
GC101

SHEET 3 OF 41 SHEETS







LEGEND

- USACE REGULATORY MODEL ALIGNMENT
- NEW 4.8-MILE REACH ALIGNMENT
- EXISTING CONCRETE TO BE REMOVED
- EXISTING ELECTRICAL TRANSMISSION LINES
- EXISTING NATURAL GAS PIPELINE
- EXISTING SEWER LINES

NOTE:
1. THE LOCATION OF EXISTING UTILITIES, SUBDRAIN SYSTEM AND GROUND WATER RELIEF VAULTS ARE APPROXIMATE. THE CONTRACTOR SHALL DETERMINE UTILITY LOCATIONS AND PROTECT IN PLACE.

THE CITY OF LOS ANGELES OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.

REVISION DATES (DESIGN STAGE ONLY)

ENGINEERING
CITY OF LOS ANGELES

THIS PLAN WAS ELECTRONICALLY • SIGNED AND STAMPED

BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH DEMOLITION & UTILITY PLAN
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
		5/4/2022	
		5/4/2022	
		5/4/2022	
		5/4/2022	

CIP NO. ----

INDEX NO. ----

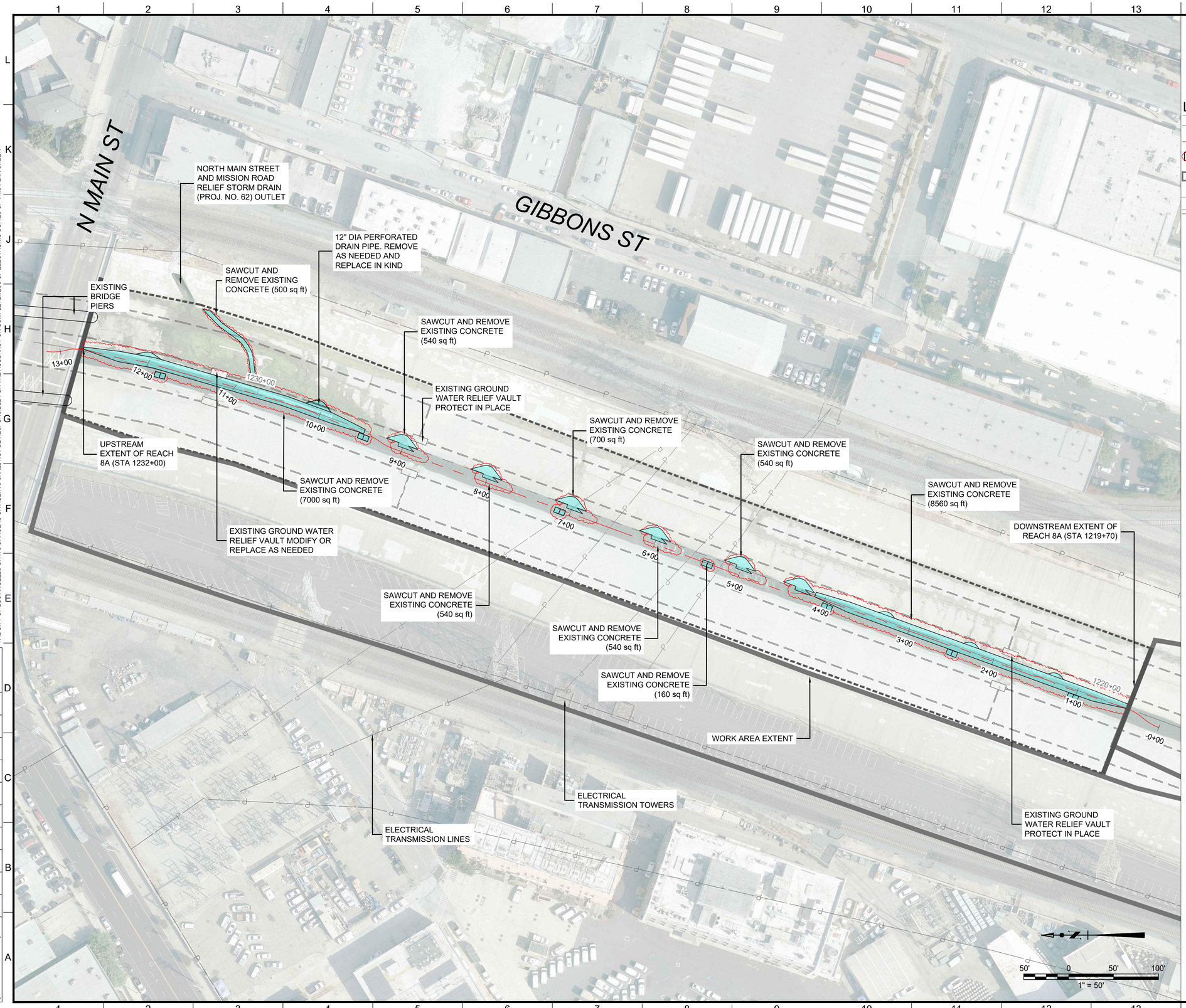
CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

CITY ENGINEER	DATE
GARY LEE MOORE, P.E., ENV SP	5/4/2022
DESIGN GROUP	
ENGINEER: NT	5/4/2022
ARCHITECT: ---	5/4/2022
DESIGNED BY: EW	5/4/2022
DRAWN BY: KRE	5/4/2022
CHECKED BY: TRS	5/4/2022
APPROVED BY: NT	5/4/2022

WORK ORDER
E1908721

SHEET NAME
CD101

SHEET 4 OF 41 SHEETS



LEGEND

- USACE REGULATORY MODEL ALIGNMENT
- NEW REACH 8A ALIGNMENT
- EXISTING CONCRETE TO BE REMOVED
- LA RIVER ECOSYSTEM RESTORATION AND RECREATION PROJECT REACH 8 EXTENTS
- EXISTING ELECTRICAL TRANSMISSION LINES
- EXISTING 12" DIA PERFORATED DRAIN PIPE

NOTE:
1. THE LOCATION OF EXISTING UTILITIES, SUBDRAIN SYSTEM AND GROUND WATER RELIEF VAULTS ARE APPROXIMATE. THE CONTRACTOR SHALL DETERMINE UTILITY LOCATIONS AND PROTECT IN PLACE.

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REVISION DATES (DESIGN STAGE ONLY)

ENGINEERING
CITY OF LOS ANGELES

THIS PLAN WAS ELECTRONICALLY • SIGNED AND STAMPED

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: REACH 8A DEMOLITION & UTILITY PLAN
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
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		5/4/2022	
		5/4/2022	

CIP NO. ----

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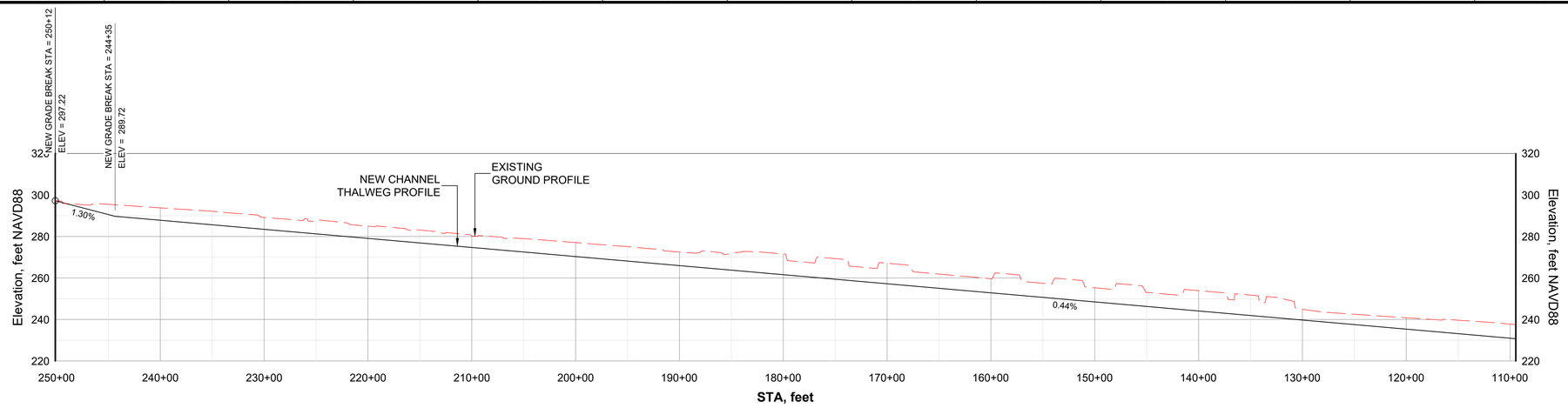
GARY LEE MOORE, P.E., ENV SP
CITY ENGINEER

DESIGN GROUP		DATE
ENGINEER:	NT	5/4/2022
ARCHITECT:	---	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

WORK ORDER
E1908721

SHEET NAME
CD102

SHEET 5 OF 41 SHEETS



NEW PROFILE - STATION 109+45 TO 250+12
SCALE: HORZ 1" = 600'
VERT 1" = 30'

LEGEND

- NEW 4.8-MILE REACH ALIGNMENT
- NEW 4.8-MILE REACH CHANNEL EXTENT

NOTES:
1. 12' DIA PERFORATED DRAIN PIPE WILL BE RELOCATED AS NECESSARY
2. BOULDER CLUSTERS WILL BE PLACED THROUGHOUT THE PROJECT REACH WITHIN THE 4.8-MILE CHANNEL FOOTPRINT. SEE TYPICAL LAYOUT ON SHEET CI505.
3. EXISTING AND NEW PROFILE FOLLOW NEW 4.8-MILE REACH ALIGNMENT. NOTE THAT VARIATION IN THE EXISTING PROFILE IS DUE TO SINUOSITY IN THE NEW 4.8-MILE REACH ALIGNMENT CROSSING EXISTING LOW FLOW CHANNEL.

UPSTREAM EXTENT OF 4.8-MILE REACH PROJECT (STA 250+12)

MATCH LINE AT STA 109+45' TO SHEET CI402

SEE SHEET CI201

SEE SHEET CI202

SEE SHEET CI203

SEE SHEET CI204

SEE SHEET CI205

SEE SHEET CI206

I-5

RAILROAD

N SPRING ST.

UNION PACIFIC LOS ANGELES TRANSPORTATION CENTER (LATC) OR PIGGYBACK YARD

ELYSIAN PARK

ARROYO SECO PKWY. (HWY 110)

N BROADWAY

N MAIN ST.

LEROY ST.

BLOOM ST

RAILROAD

EAST CESAR E CHAVEZ AVE

HWY 101

EAST 1ST ST

NEW 4.8-MILE REACH ALIGNMENT

REACH 8A WORK AREA EXTENT

WORK AREA EXTENT

250+12 240+00 230+00 220+00 210+00 200+00 190+00 180+00 170+00 160+00 150+00 140+00 130+00 120+00 110+00 100+00

600' 0 600' 1200'
1" = 600'

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REVISION DATES (DESIGN STAGE ONLY)

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ENGINEERING
CITY OF LOS ANGELES

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH PLAN & PROFILE OVERVIEW 1
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
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		5/4/2022	
		5/4/2022	
		5/4/2022	

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CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

CITY ENGINEER: GARY LEE MOORE, P.E., ENV SP — DATE: 5/4/2022

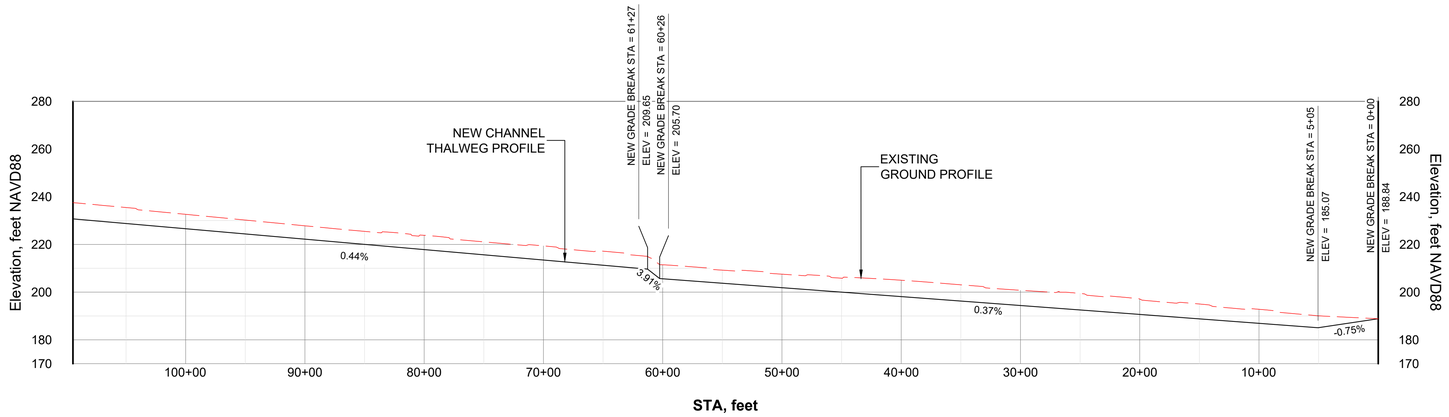
DESIGN GROUP

ENGINEER:	NT	5/4/2022
ARCHITECT:	----	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

WORK ORDER
E1908721

SHEET NAME
CI401

SHEET 6 OF 41 SHEETS



NEW PROFILE - STATION 0+00 TO 109+45
SCALE: HORZ 1" = 600'
VERT 1" = 30'

LEGEND

NEW 4.8-MILE REACH ALIGNMENT

NEW 4.8-MILE REACH CHANNEL EXTENT

NOTES:
1. 12' DIA PERFORATED DRAIN PIPE WILL BE RELOCATED AS NECESSARY
2. BOULDER CLUSTERS WILL BE PLACED THROUGHOUT THE PROJECT REACH WITHIN THE 4.8-MILE CHANNEL FOOTPRINT. SEE TYPICAL LAYOUT ON SHEET CI505.
3. EXISTING AND NEW PROFILE FOLLOW NEW 4.8-MILE REACH ALIGNMENT. NOTE THAT VARIATION IN THE EXISTING PROFILE IS DUE TO SINUOSITY IN THE NEW 4.8-MILE REACH ALIGNMENT CROSSING EXISTING LOW FLOW CHANNEL.

MATCH LINE AT STA 109+45' TO SHEET CI401

I-10

HWY 101

S SOTO ST

SEE SHEET CI210

SEE SHEET CI211

SEE SHEET CI209

SEE SHEET CI208

SEE SHEET CI207

DOWNSTREAM EXTENT OF PROJECT REACH (STA 1048+00)

E WASHINGTON BLVD

RAILROAD

OLYMPIC BLVD

I-10

7TH ST

6TH ST

EAST 4TH ST

EAST 1ST ST

0+00

10+00

20+00

30+00

40+00

50+00

60+00

70+00

80+00

90+00

100+00

110+00

WORK AREA EXTENT

NEW 4.8-MILE REACH ALIGNMENT

600' 0 600' 1200'
1" = 600'

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REVISION DATES (DESIGN STAGE ONLY)

ENGINEERING
CITY OF LOS ANGELES

THIS PLAN WAS ELECTRONICALLY • SIGNED AND STAMPED

BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH PLAN & PROFILE OVERVIEW 2

PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN

ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
		5/4/2022	
		5/4/2022	
		5/4/2022	
		5/4/2022	

CIP NO. ----

INDEX NO. ----

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

CITY ENGINEER: GARY LEE MOORE, P.E., ENV SP — DATE: 5/4/2022

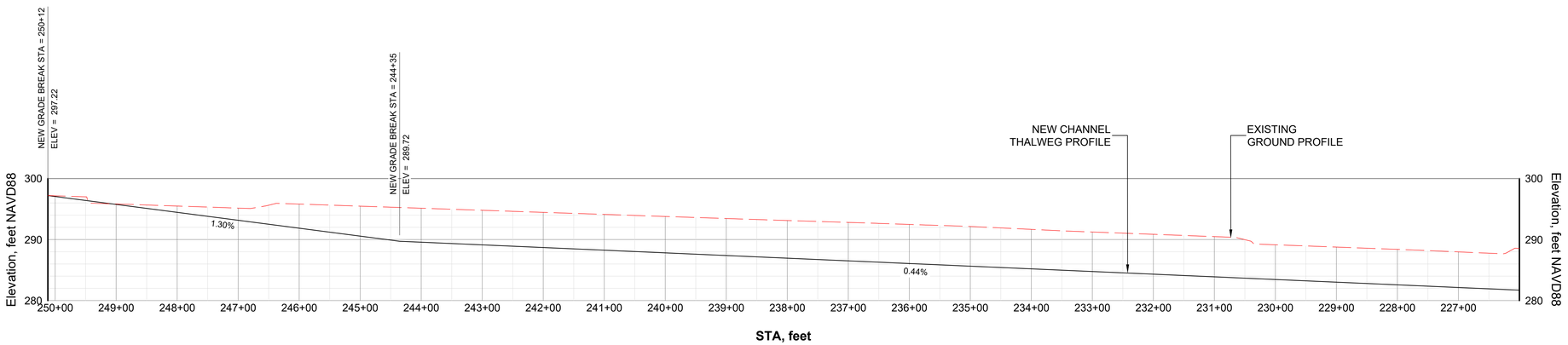
DESIGN GROUP

ENGINEER:	NT	5/4/2022
ARCHITECT:	----	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

WORK ORDER
E1908721

SHEET NAME
CI402

SHEET 7 OF 41 SHEETS

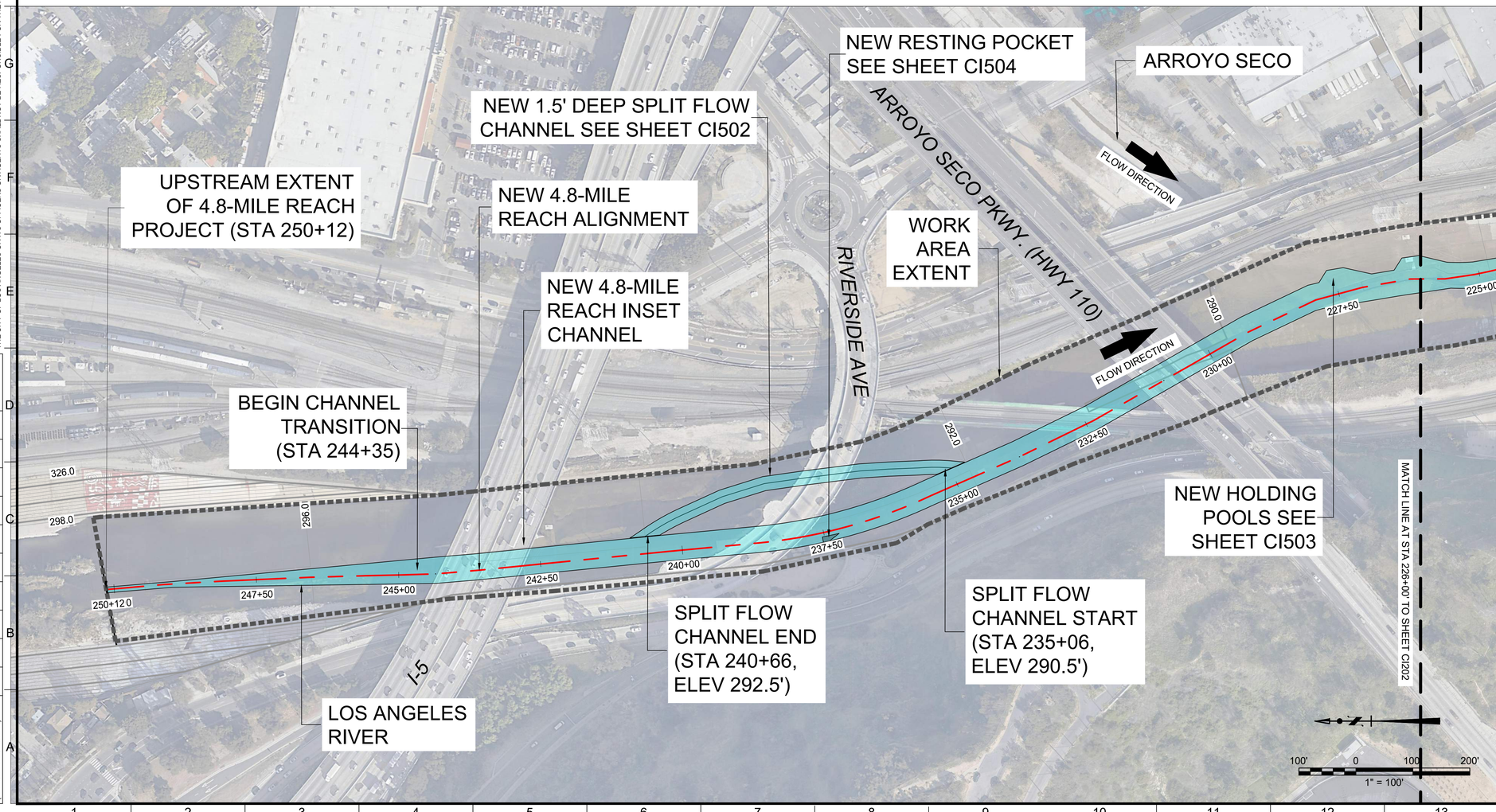


NEW PROFILE - STATION 226+00 TO 250+12
SCALE: HORZ 1" = 100'
VERT 1" = 20'

LEGEND

- EXISTING MAJOR CONTOUR (10FT)
- EXISTING MINOR CONTOUR (2FT)
- NEW 4.8-MILE REACH ALIGNMENT
- NEW 4.8-MILE CHANNEL EXTENT

NOTES:
1. 12' DIA PERFORATED DRAIN PIPE WILL BE RELOCATED AS NECESSARY
2. BOULDER CLUSTERS WILL BE PLACED THROUGHOUT THE PROJECT REACH WITHIN THE 4.8-MILE CHANNEL FOOTPRINT. SEE TYPICAL LAYOUT ON SHEET CI505.
3. EXISTING AND NEW PROFILE FOLLOW NEW 4.8-MILE REACH ALIGNMENT. NOTE THAT VARIATION IN THE EXISTING PROFILE IS DUE TO SINUOSITY IN THE NEW 4.8-MILE REACH ALIGNMENT CROSSING EXISTING LOW FLOW CHANNEL.



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REVISION DATES (DESIGN STAGE ONLY)

ENGINEERING
CITY OF LOS ANGELES

THIS PLAN WAS ELECTRONICALLY • SIGNED AND STAMPED •

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS
BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH PLAN & PROFILE 226+00 TO 250+12
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
		5/4/2022	
		5/4/2022	
		5/4/2022	
		5/4/2022	

CIP NO. ----

INDEX NO. ----

CITY ENGINEER

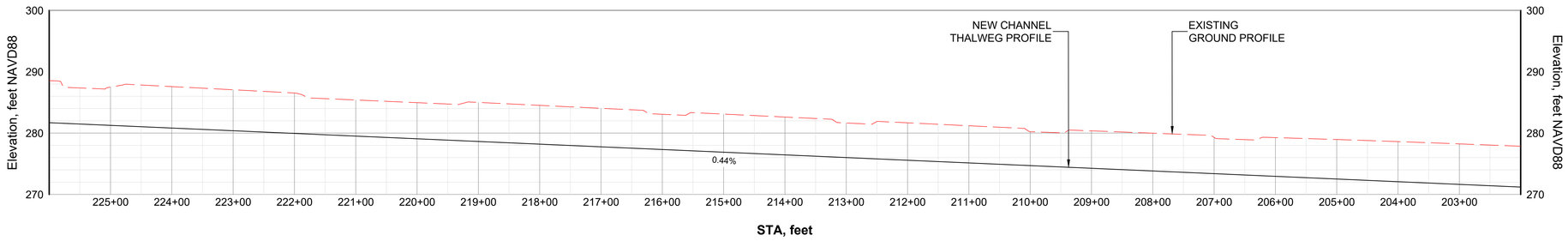
DESIGN GROUP		DATE
ENGINEER:	NT	5/4/2022
ARCHITECT:	---	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

GARY LEE MOORE, P.E., ENV SP

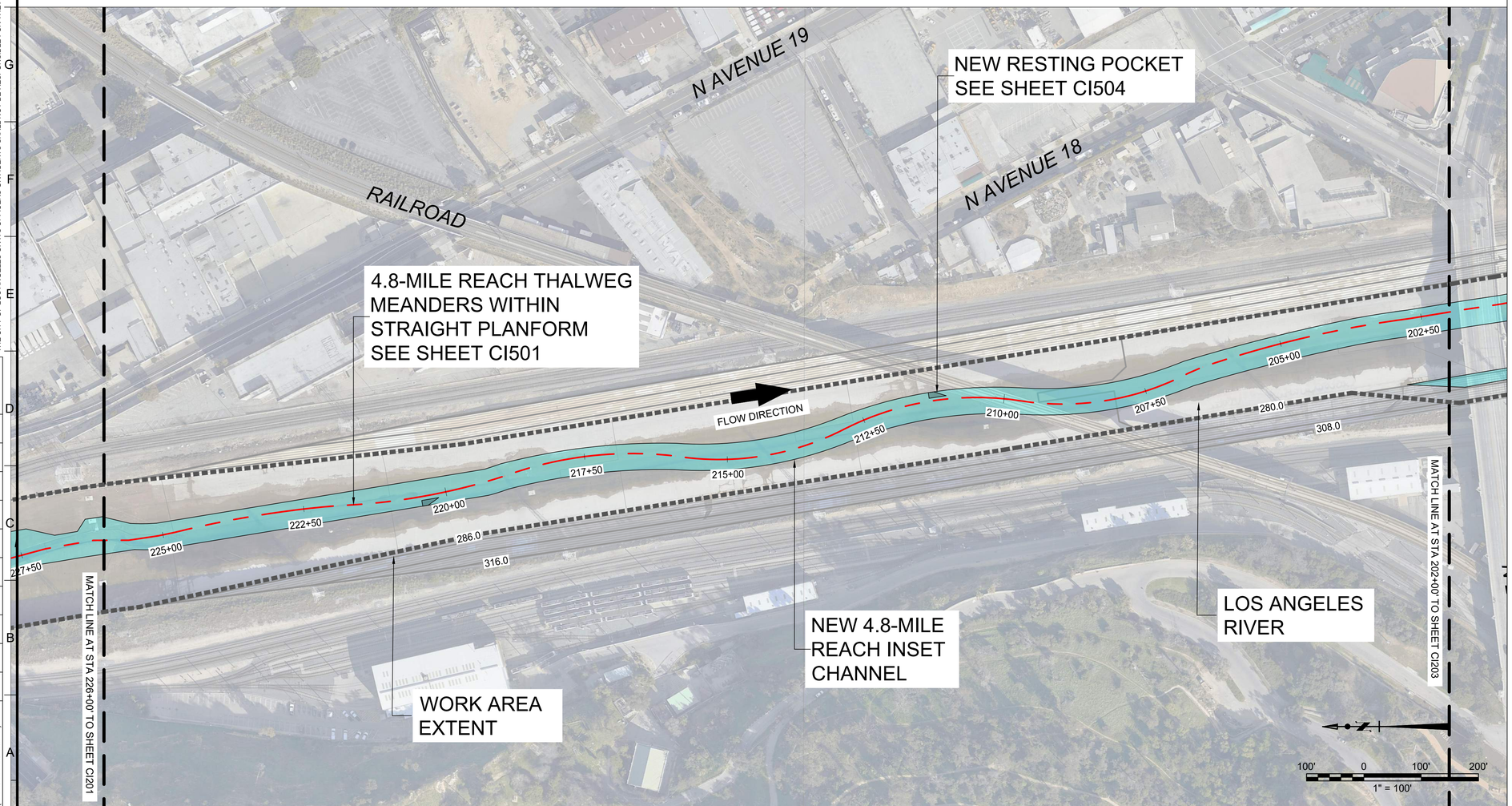
WORK ORDER
E1908721

SHEET NAME
CI201

SHEET 8 OF 41 SHEETS



NEW PROFILE - STATION 202+00 TO 226+00
SCALE: HORZ 1" = 100'
VERT 1" = 20'



LEGEND

- EXISTING MAJOR CONTOUR (10FT)
- EXISTING MINOR CONTOUR (2FT)
- NEW 4.8-MILE REACH ALIGNMENT
- NEW 4.8-MILE CHANNEL EXTENT

NOTES:
1. 12' DIA PERFORATED DRAIN PIPE WILL BE RELOCATED AS NECESSARY
2. BOULDER CLUSTERS WILL BE PLACED THROUGHOUT THE PROJECT REACH WITHIN THE 4.8-MILE CHANNEL FOOTPRINT. SEE TYPICAL LAYOUT ON SHEET CI505.
3. EXISTING AND NEW PROFILE FOLLOW NEW 4.8-MILE REACH ALIGNMENT. NOTE THAT VARIATION IN THE EXISTING PROFILE IS DUE TO SINUOSITY IN THE NEW 4.8-MILE REACH ALIGNMENT CROSSING EXISTING LOW FLOW CHANNEL.

THE CITY OF LOS ANGELES OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.

REVISION DATES
(DESIGN STAGE ONLY)

ENGINEERING
CITY OF LOS ANGELES

THIS PLAN WAS ELECTRONICALLY
• SIGNED AND STAMPED •

BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH PLAN & PROFILE 202+00 TO 226+00
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
		5/4/2022	
		5/4/2022	
		5/4/2022	
		5/4/2022	

CIP NO. ----

INDEX NO. ----

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

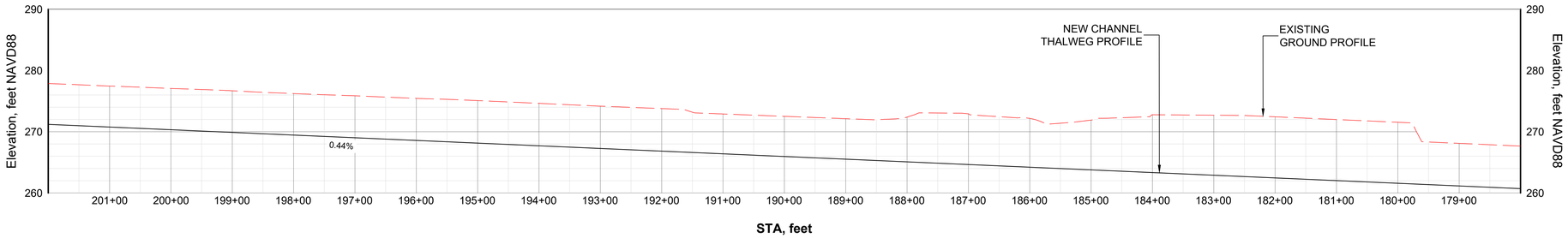
CITY ENGINEER — DATE
GARY LEE MOORE, P.E., ENV SP — 5/4/2022
DESIGN GROUP

ENGINEER:	NT	5/4/2022
ARCHITECT:	----	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

WORK ORDER
E1908721

SHEET NAME
CI202

SHEET 9 OF 41 SHEETS



NEW PROFILE - STATION 178+00 TO 202+00
SCALE: HORZ 1" = 100'
VERT 1" = 20'

LEGEND

- EXISTING MAJOR CONTOUR (10FT)
- EXISTING MINOR CONTOUR (2FT)
- NEW 4.8-MILE REACH ALIGNMENT
- NEW 4.8-MILE CHANNEL EXTENT

NOTES:
1. 12' DIA PERFORATED DRAIN PIPE WILL BE RELOCATED AS NECESSARY
2. BOULDER CLUSTERS WILL BE PLACED THROUGHOUT THE PROJECT REACH WITHIN THE 4.8-MILE CHANNEL FOOTPRINT. SEE TYPICAL LAYOUT ON SHEET CI505.
3. EXISTING AND NEW PROFILE FOLLOW NEW 4.8-MILE REACH ALIGNMENT. NOTE THAT VARIATION IN THE EXISTING PROFILE IS DUE TO SINUOSITY IN THE NEW 4.8-MILE REACH ALIGNMENT CROSSING EXISTING LOW FLOW CHANNEL.

NEW 4.8-MILE REACH INSET CHANNEL

4.8-MILE REACH THALWEG MEANDERS WITHIN STRAIGHT PLANFORM SEE SHEET CI501

REACH 8A WORK AREA EXTENT

MATCH LINE AT STA 178+00' TO SHEET CI204

N SPRING ST.

308.0
278.0
276.0
274.0
294.0
272.0
202+50
200+00
197+50
195+00
192+50
190+00
187+50
185+00
182+50
180+00
177+50

FLOW DIRECTION

NEW RESTING POCKET SEE SHEET CI504

WORK AREA EXTENT

N MAIN ST.

LOS ANGELES RIVER

MODIFICATIONS TO EXISTING CHANNEL WALL SEE SHEET CI502

MATCH LINE AT STA 202+00' TO SHEET CI203

N BROADWAY

100' 0 100' 200'
1" = 100'

THE CITY OF LOS ANGELES OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.

REVISION DATES (DESIGN STAGE ONLY)

ENGINEERING
CITY OF LOS ANGELES

THIS PLAN WAS ELECTRONICALLY • SIGNED AND STAMPED

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS
BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH PLAN & PROFILE 178+00 TO 202+00

PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN

ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
		5/4/2022	
		5/4/2022	
		5/4/2022	
		5/4/2022	

CIP NO. ----

INDEX NO. ----

CITY ENGINEER

GARY LEE MOORE, P.E., ENV SP

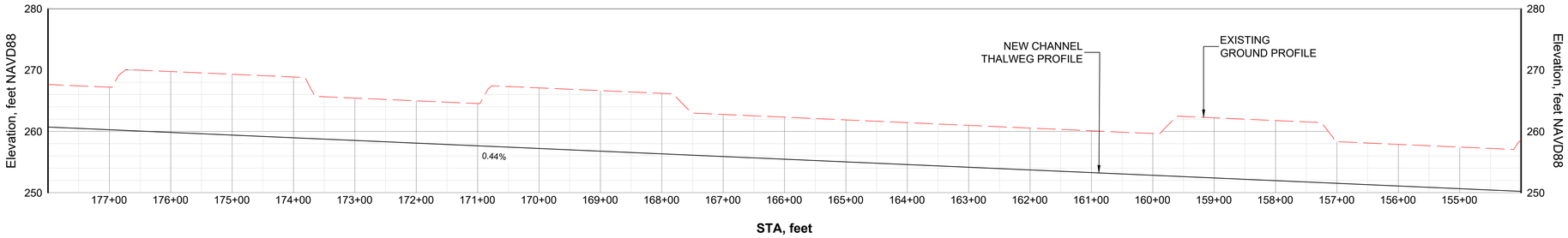
DESIGN GROUP

		DATE
ENGINEER:	NT	5/4/2022
ARCHITECT:	----	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

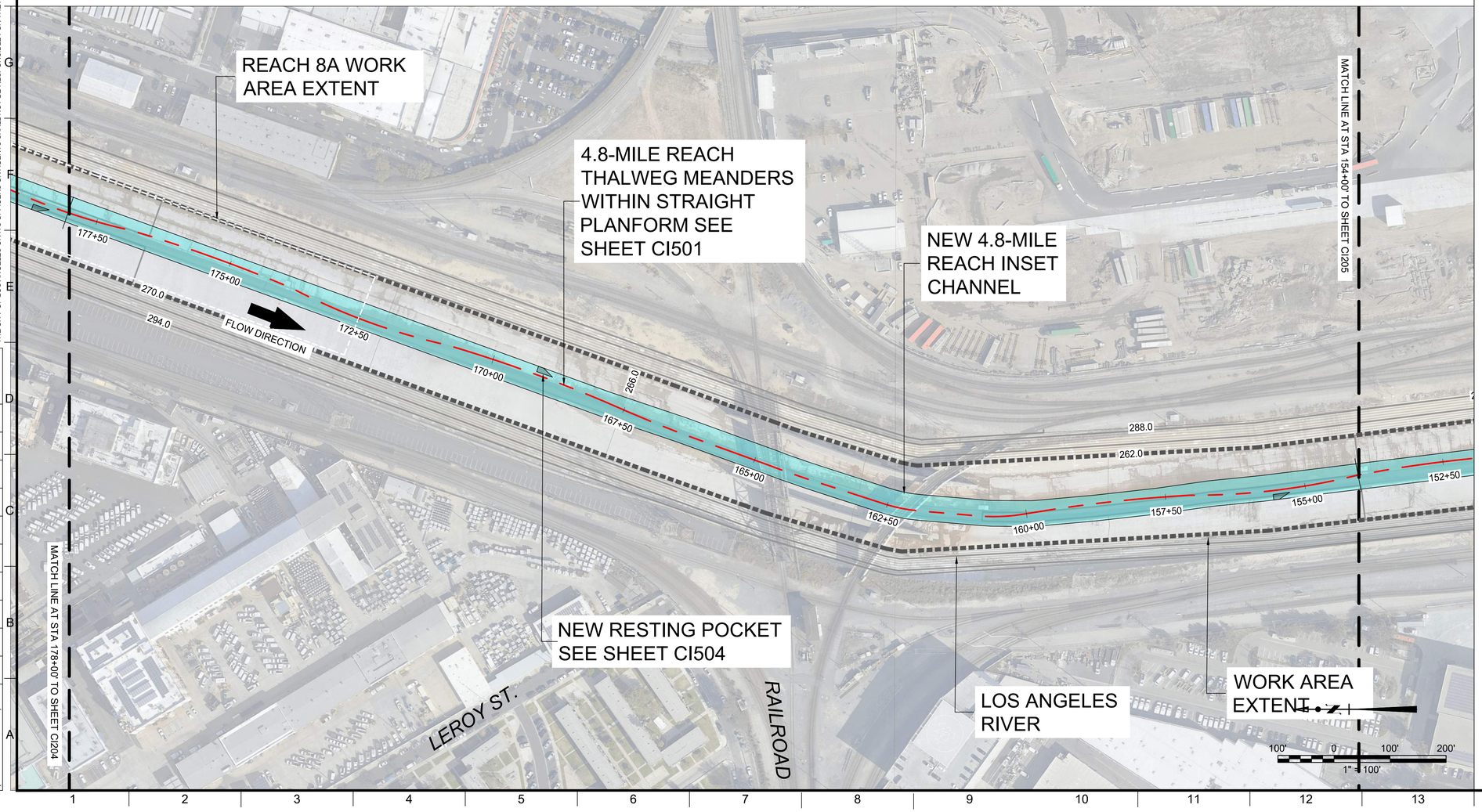
WORK ORDER
E1908721

SHEET NAME
CI203

SHEET 10 OF 41 SHEETS



NEW PROFILE - STATION 154+00 TO 178+00
SCALE: HORZ 1" = 100'
VERT 1" = 20'



LEGEND

- EXISTING MAJOR CONTOUR (10FT)
- EXISTING MINOR CONTOUR (2FT)
- NEW 4.8-MILE REACH ALIGNMENT
- NEW 4.8-MILE CHANNEL EXTENT

NOTES:

1. 12' DIA PERFORATED DRAIN PIPE WILL BE RELOCATED AS NECESSARY
2. BOULDER CLUSTERS WILL BE PLACED THROUGHOUT THE PROJECT REACH WITHIN THE 4.8-MILE CHANNEL FOOTPRINT. SEE TYPICAL LAYOUT ON SHEET CI505.
3. EXISTING AND NEW PROFILE FOLLOW NEW 4.8-MILE REACH ALIGNMENT. NOTE THAT VARIATION IN THE EXISTING PROFILE IS DUE TO SINUOSITY IN THE NEW 4.8-MILE REACH ALIGNMENT CROSSING EXISTING LOW FLOW CHANNEL.

THE CITY OF LOS ANGELES OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.

REVISION DATES (DESIGN STAGE ONLY)

ENGINEERING
CITY OF LOS ANGELES

THIS PLAN WAS ELECTRONICALLY • SIGNED AND STAMPED

BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH PLAN & PROFILE 154+00 TO 178+00
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
		5/4/2022	
		5/4/2022	
		5/4/2022	
		5/4/2022	

CIP NO. ----

INDEX NO. ----

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

CITY ENGINEER: GARY LEE MOORE, P.E., ENV SP — DATE: 5/4/2022

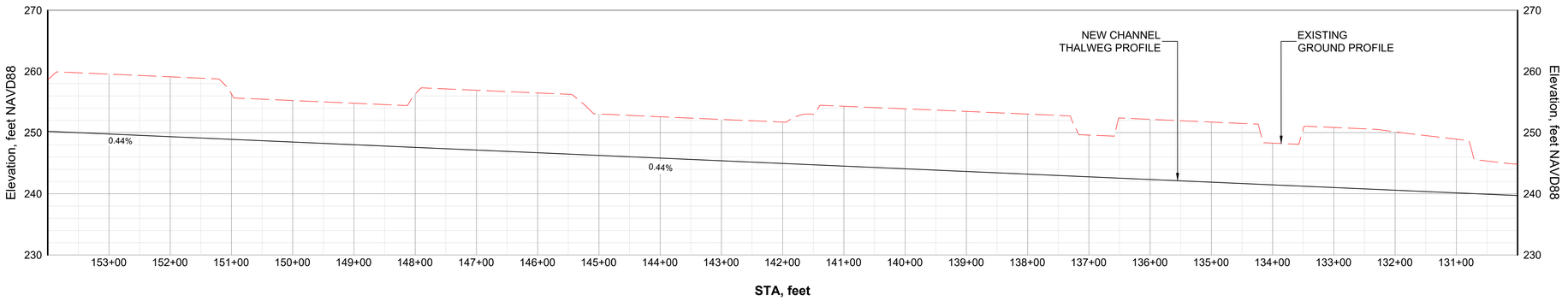
DESIGN GROUP

ENGINEER:	NT	5/4/2022
ARCHITECT:	----	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

WORK ORDER
E1908721

SHEET NAME
CI204

SHEET 11 OF 41 SHEETS



NEW PROFILE - STATION 130+00 TO 154+00
SCALE: HORZ 1" = 100'
VERT 1" = 20'

LEGEND

- EXISTING MAJOR CONTOUR (10FT)
- EXISTING MINOR CONTOUR (2FT)
- NEW 4.8-MILE REACH ALIGNMENT
- NEW 4.8-MILE CHANNEL EXTENT

NOTES:
1. 12' DIA PERFORATED DRAIN PIPE WILL BE RELOCATED AS NECESSARY
2. BOULDER CLUSTERS WILL BE PLACED THROUGHOUT THE PROJECT REACH WITHIN THE 4.8-MILE CHANNEL FOOTPRINT. SEE TYPICAL LAYOUT ON SHEET CI505.
3. EXISTING AND NEW PROFILE FOLLOW NEW 4.8-MILE REACH ALIGNMENT. NOTE THAT VARIATION IN THE EXISTING PROFILE IS DUE TO SINUOSITY IN THE NEW 4.8-MILE REACH ALIGNMENT CROSSING EXISTING LOW FLOW CHANNEL.

NEW RESTING POCKET
SEE SHEET CI504

LOS ANGELES RIVER

MATCH LINE AT STA 130+00 TO SHEET CI206

284.0
260.0
155+00
152+50
150+00
147+50
145+00
142+50
140+00
254.0
137+50
135+00
132+50
130+00
272.0
246.0
127+50

FLOW DIRECTION

NEW 4.8-MILE REACH INSET CHANNEL

WORK AREA EXTENT

EAST CESAR E CHAVEZ AVE

HWY 101

4.8-MILE REACH THALWEG MEANDERS WITHIN STRAIGHT PLANFORM
SEE SHEET CI501

4.8-MILE REACH THALWEG MEANDERS WITHIN MEANDERING PLANFORM
SEE SHEET CI501

MATCH LINE AT STA 154+00 TO SHEET CI204

100' 0 100' 200'
1" = 100'

THE CITY OF LOS ANGELES OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.

REVISION DATES (DESIGN STAGE ONLY)

ENGINEERING
CITY OF LOS ANGELES

THIS PLAN WAS ELECTRONICALLY • SIGNED AND STAMPED

BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH PLAN & PROFILE 130+00 TO 154+00
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
		5/4/2022	
		5/4/2022	
		5/4/2022	
		5/4/2022	

CIP NO. ----

INDEX NO. ----

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

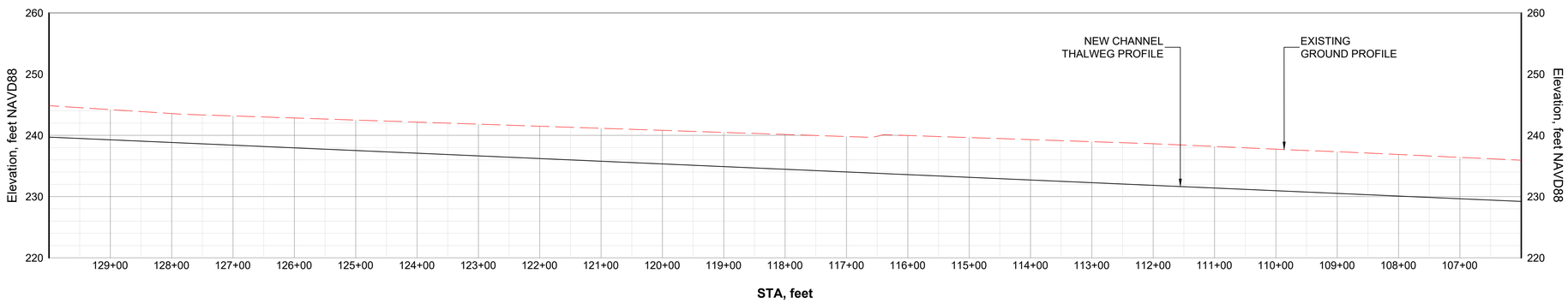
CITY ENGINEER: GARY LEE MOORE, P.E., ENV SP — DATE: 5/4/2022

DESIGN GROUP		DATE
ENGINEER:	NT	5/4/2022
ARCHITECT:	----	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

WORK ORDER
E1908721

SHEET NAME
CI205

SHEET 12 OF 41 SHEETS

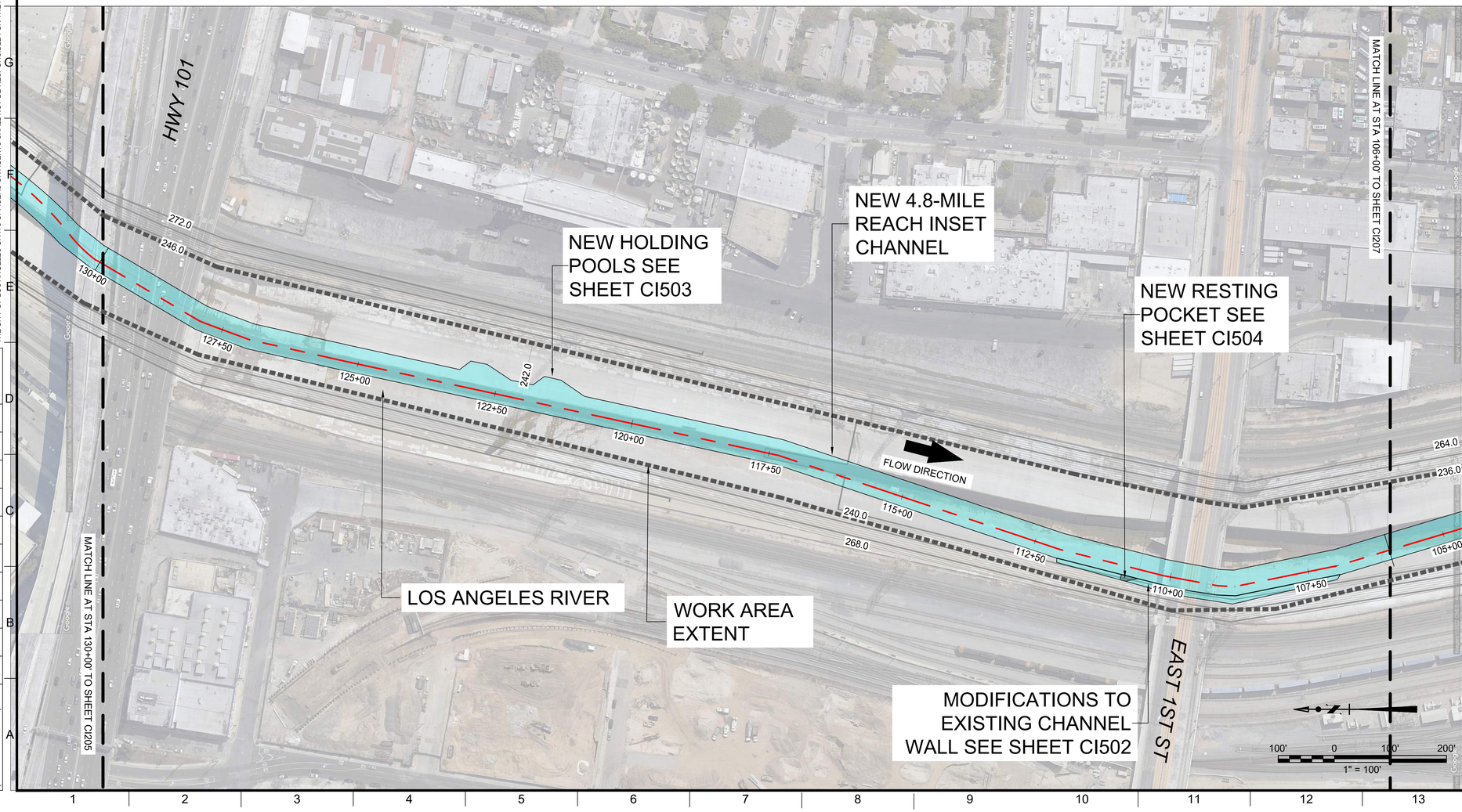


NEW PROFILE - STATION 106+00 TO 130+00
SCALE: HORZ 1" = 100'
VERT 1" = 20'

LEGEND

- EXISTING MAJOR CONTOUR (10FT)
- EXISTING MINOR CONTOUR (2FT)
- NEW 4.8-MILE REACH ALIGNMENT
- NEW 4.8-MILE CHANNEL EXTENT

NOTES:
1. 12' DIA PERFORATED DRAIN PIPE WILL BE RELOCATED AS NECESSARY
2. BOULDER CLUSTERS WILL BE PLACED THROUGHOUT THE PROJECT REACH WITHIN THE 4.8-MILE CHANNEL FOOTPRINT. SEE TYPICAL LAYOUT ON SHEET CI505.
3. EXISTING AND NEW PROFILE FOLLOW NEW 4.8-MILE REACH ALIGNMENT. NOTE THAT VARIATION IN THE EXISTING PROFILE IS DUE TO SINUOSITY IN THE NEW 4.8-MILE REACH ALIGNMENT CROSSING EXISTING LOW FLOW CHANNEL.



THE CITY OF LOS ANGELES OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.

REVISION DATES (DESIGN STAGE ONLY)

ENGINEERING
CITY OF LOS ANGELES

THIS PLAN WAS ELECTRONICALLY • SIGNED AND STAMPED

BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH PLAN & PROFILE 106+00 TO 130+00
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
		5/4/2022	
		5/4/2022	
		5/4/2022	
		5/4/2022	

CIP NO. ----

INDEX NO. ----

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

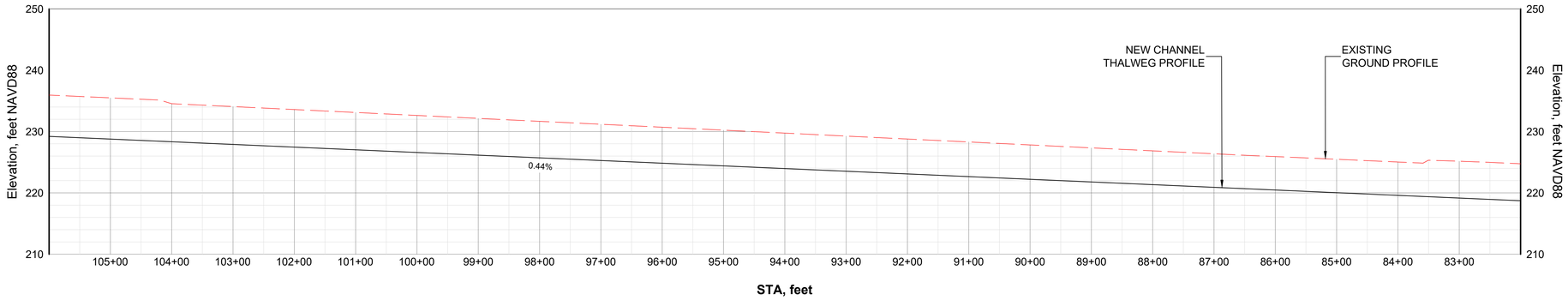
CITY ENGINEER: GARY LEE MOORE, P.E., ENV SP — DATE: 5/4/2022

DESIGN GROUP		DATE
ENGINEER:	NT	5/4/2022
ARCHITECT:	----	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

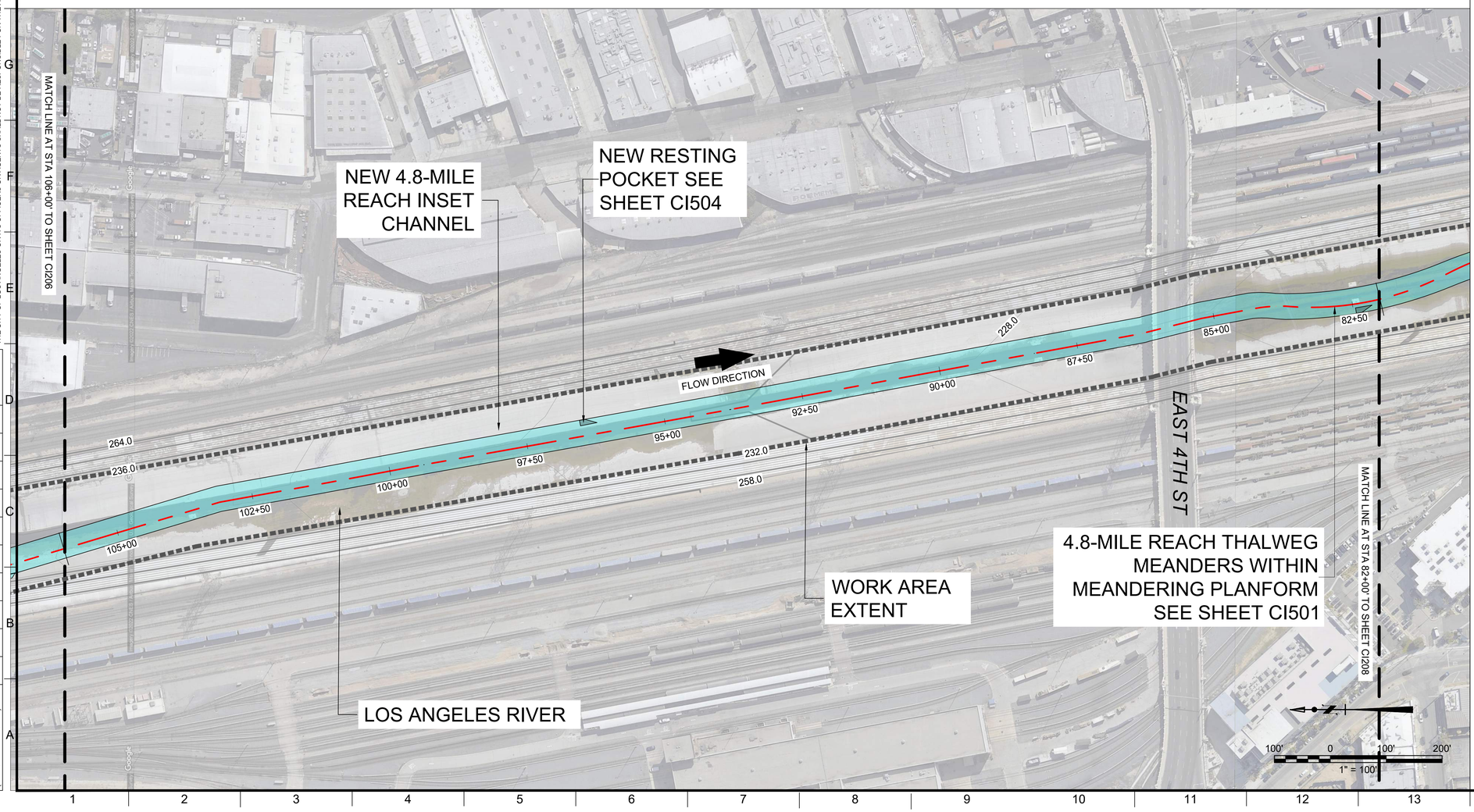
WORK ORDER E1908721

SHEET NAME CI206

SHEET 13 OF 41 SHEETS



NEW PROFILE - STATION 82+00 TO 106+00
SCALE: HORZ 1" = 100'
VERT 1" = 20'



LEGEND

- EXISTING MAJOR CONTOUR (10FT)
- EXISTING MINOR CONTOUR (2FT)
- NEW 4.8-MILE REACH ALIGNMENT
- NEW 4.8-MILE CHANNEL EXTENT

NOTES:
1. 12' DIA PERFORATED DRAIN PIPE WILL BE RELOCATED AS NECESSARY
2. BOULDER CLUSTERS WILL BE PLACED THROUGHOUT THE PROJECT REACH WITHIN THE 4.8-MILE CHANNEL FOOTPRINT. SEE TYPICAL LAYOUT ON SHEET CI505.
3. EXISTING AND NEW PROFILE FOLLOW NEW 4.8-MILE REACH ALIGNMENT. NOTE THAT VARIATION IN THE EXISTING PROFILE IS DUE TO SINUOSITY IN THE NEW 4.8-MILE REACH ALIGNMENT CROSSING EXISTING LOW FLOW CHANNEL.

THE CITY OF LOS ANGELES OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.

REVISION DATES (DESIGN STAGE ONLY)

ENGINEERING
CITY OF LOS ANGELES

THIS PLAN WAS ELECTRONICALLY • SIGNED AND STAMPED

BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH PLAN & PROFILE 82+00 TO 106+00
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
		5/4/2022	
		5/4/2022	
		5/4/2022	
		5/4/2022	

CIP NO. ----

INDEX NO. ----

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

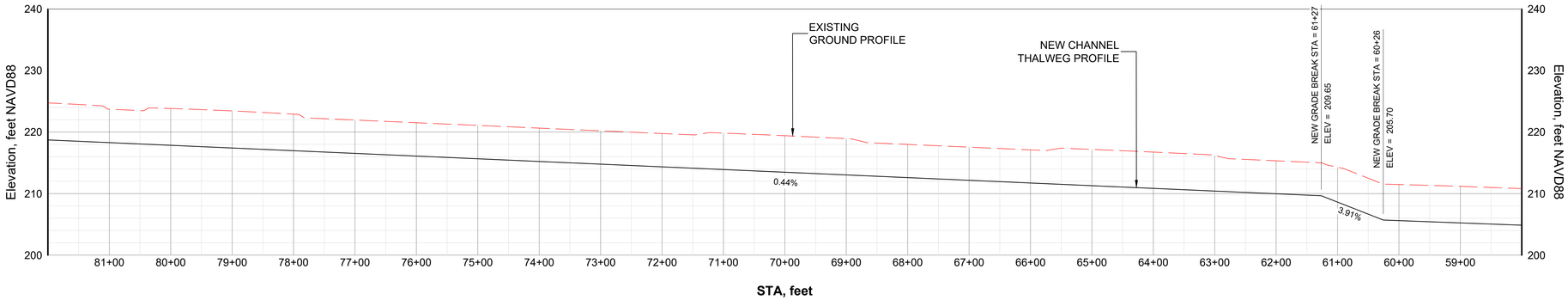
GARY LEE MOORE, P.E., ENV SP — CITY ENGINEER — DATE 5/4/2022

DESIGN GROUP		DATE
ENGINEER:	NT	5/4/2022
ARCHITECT:	----	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

WORK ORDER
E1908721

SHEET NAME
CI207

SHEET 14 OF 41 SHEETS

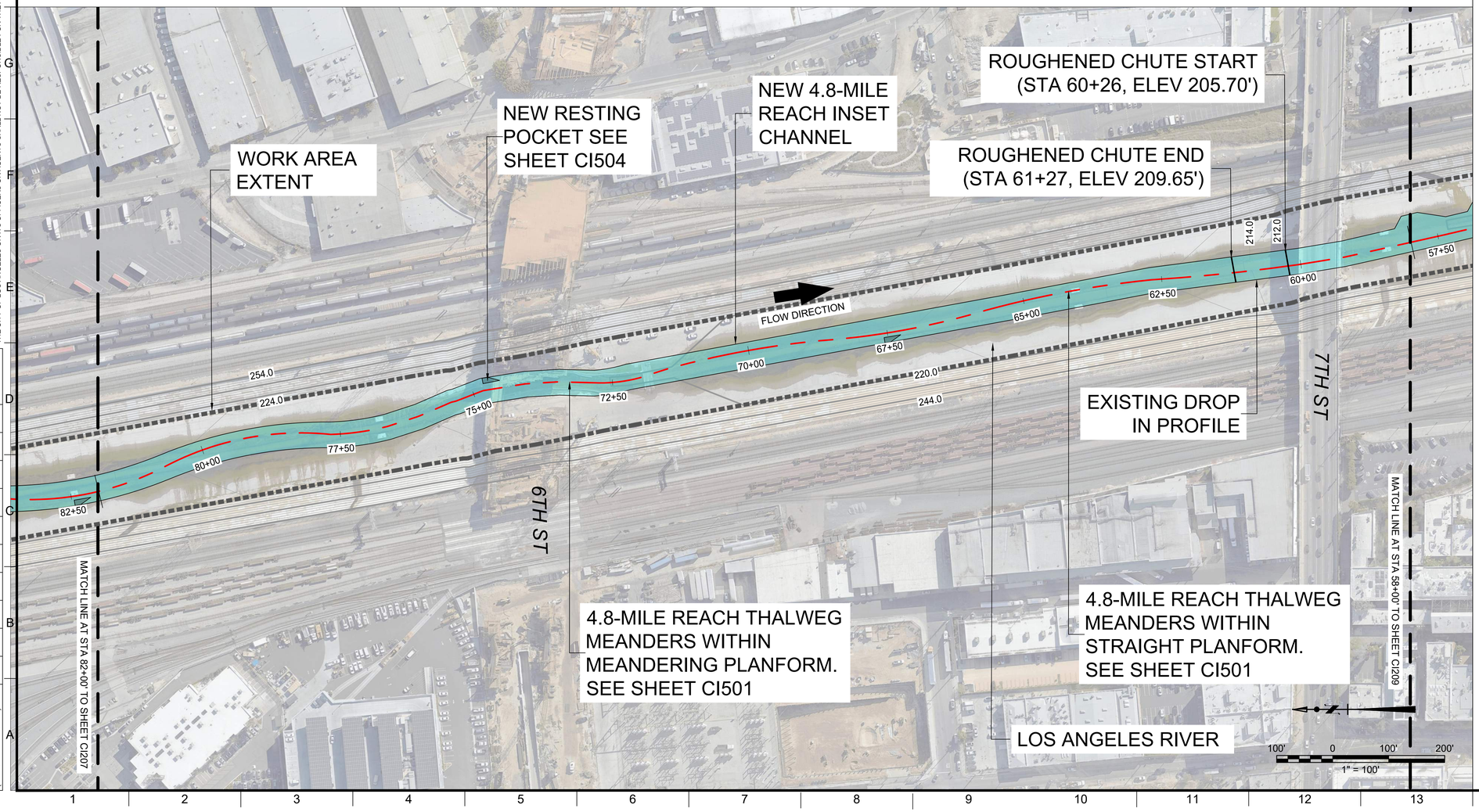


NEW PROFILE - STATION 58+00 TO 82+00
SCALE: HORZ 1" = 100'
VERT 1" = 20'

LEGEND

- EXISTING MAJOR CONTOUR (10FT)
- EXISTING MINOR CONTOUR (2FT)
- NEW 4.8-MILE REACH ALIGNMENT
- NEW 4.8-MILE CHANNEL EXTENT

NOTES:
1. 12' DIA PERFORATED DRAIN PIPE WILL BE RELOCATED AS NECESSARY
2. BOULDER CLUSTERS WILL BE PLACED THROUGHOUT THE PROJECT REACH WITHIN THE 4.8-MILE CHANNEL FOOTPRINT. SEE TYPICAL LAYOUT ON SHEET CI505.
3. EXISTING AND NEW PROFILE FOLLOW NEW 4.8-MILE REACH ALIGNMENT. NOTE THAT VARIATION IN THE EXISTING PROFILE IS DUE TO SINUOSITY IN THE NEW 4.8-MILE REACH ALIGNMENT CROSSING EXISTING LOW FLOW CHANNEL.



THE CITY OF LOS ANGELES OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.

REVISION DATES (DESIGN STAGE ONLY)

ENGINEERING
CITY OF LOS ANGELES

THIS PLAN WAS ELECTRONICALLY • SIGNED AND STAMPED

BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH PLAN & PROFILE 58+00 TO 82+00
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA
ADDRESS

NO.	REVISIONS	DATE	BY
		5/4/2022	
		5/4/2022	
		5/4/2022	
		5/4/2022	

CIP NO. ----

INDEX NO. ----

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

CITY ENGINEER: GARY LEE MOORE, P.E., ENV SP — DATE: 5/4/2022

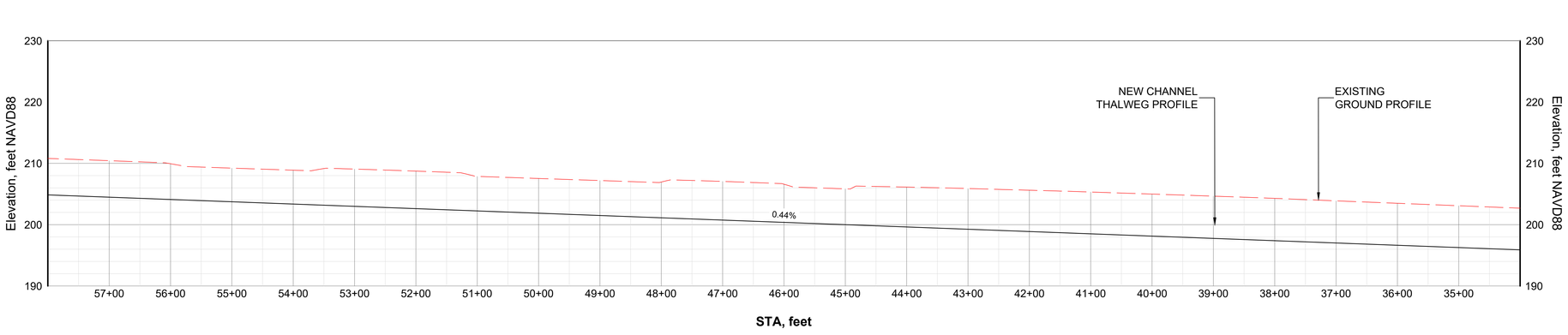
DESIGN GROUP

ENGINEER:	NT	5/4/2022
ARCHITECT:	----	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

WORK ORDER
E1908721

SHEET NAME
CI208

SHEET 15 OF 41 SHEETS



NEW PROFILE - STATION 34+00 TO 58+00
SCALE: HORZ 1" = 100'
VERT 1" = 20'

LEGEND

- EXISTING MAJOR CONTOUR (10FT)
- EXISTING MINOR CONTOUR (2FT)
- NEW 4.8-MILE REACH ALIGNMENT
- NEW 4.8-MILE CHANNEL EXTENT

NOTES:

1. 12' DIA PERFORATED DRAIN PIPE WILL BE RELOCATED AS NECESSARY
2. BOULDER CLUSTERS WILL BE PLACED THROUGHOUT THE PROJECT REACH WITHIN THE 4.8-MILE CHANNEL FOOTPRINT. SEE TYPICAL LAYOUT ON SHEET CI505.
3. EXISTING AND NEW PROFILE FOLLOW NEW 4.8-MILE REACH ALIGNMENT. NOTE THAT VARIATION IN THE EXISTING PROFILE IS DUE TO SINUOSITY IN THE NEW 4.8-MILE REACH ALIGNMENT CROSSING EXISTING LOW FLOW CHANNEL.

NEW 4.8-MILE REACH INSET CHANNEL

WORK AREA EXTENT

NEW HOLDING POOLS SEE SHEET CI503

NEW RESTING POCKET SEE SHEET CI504

LOS ANGELES RIVER

4.8-MILE REACH THALWEG MEANDERS WITHIN STRAIGHT PLANFORM. SEE SHEET CI501

FLOW DIRECTION

I-10

MATCH LINE AT STA 58+00' TO SHEET CI208

MATCH LINE AT STA 34+00' TO SHEET CI210

100' 0 100' 200'
1" = 100'

THE CITY OF LOS ANGELES OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.

REVISION DATES (DESIGN STAGE ONLY)

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS BUREAU OF ENGINEERING

THIS PLAN WAS ELECTRONICALLY • SIGNED AND STAMPED

ENGINEERING CITY OF LOS ANGELES

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH PLAN & PROFILE 34+00 TO 58+00
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
		5/4/2022	
		5/4/2022	
		5/4/2022	
		5/4/2022	

CIP NO. ----

INDEX NO. ----

CITY ENGINEER: GARY LEE MOORE, P.E., ENV.SP — DATE 5/4/2022

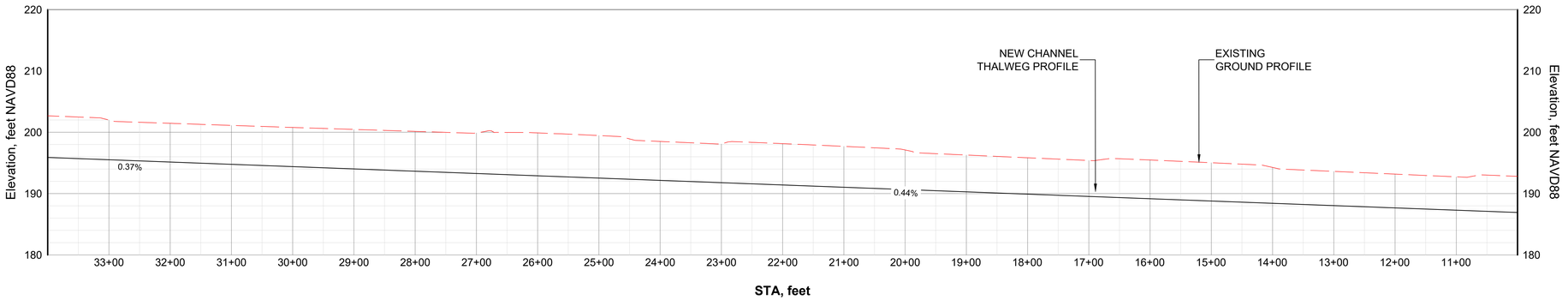
DESIGN GROUP

		DATE
ENGINEER:	NT	5/4/2022
ARCHITECT:	----	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

WORK ORDER E1908721

SHEET NAME CI209

SHEET 16 OF 41 SHEETS

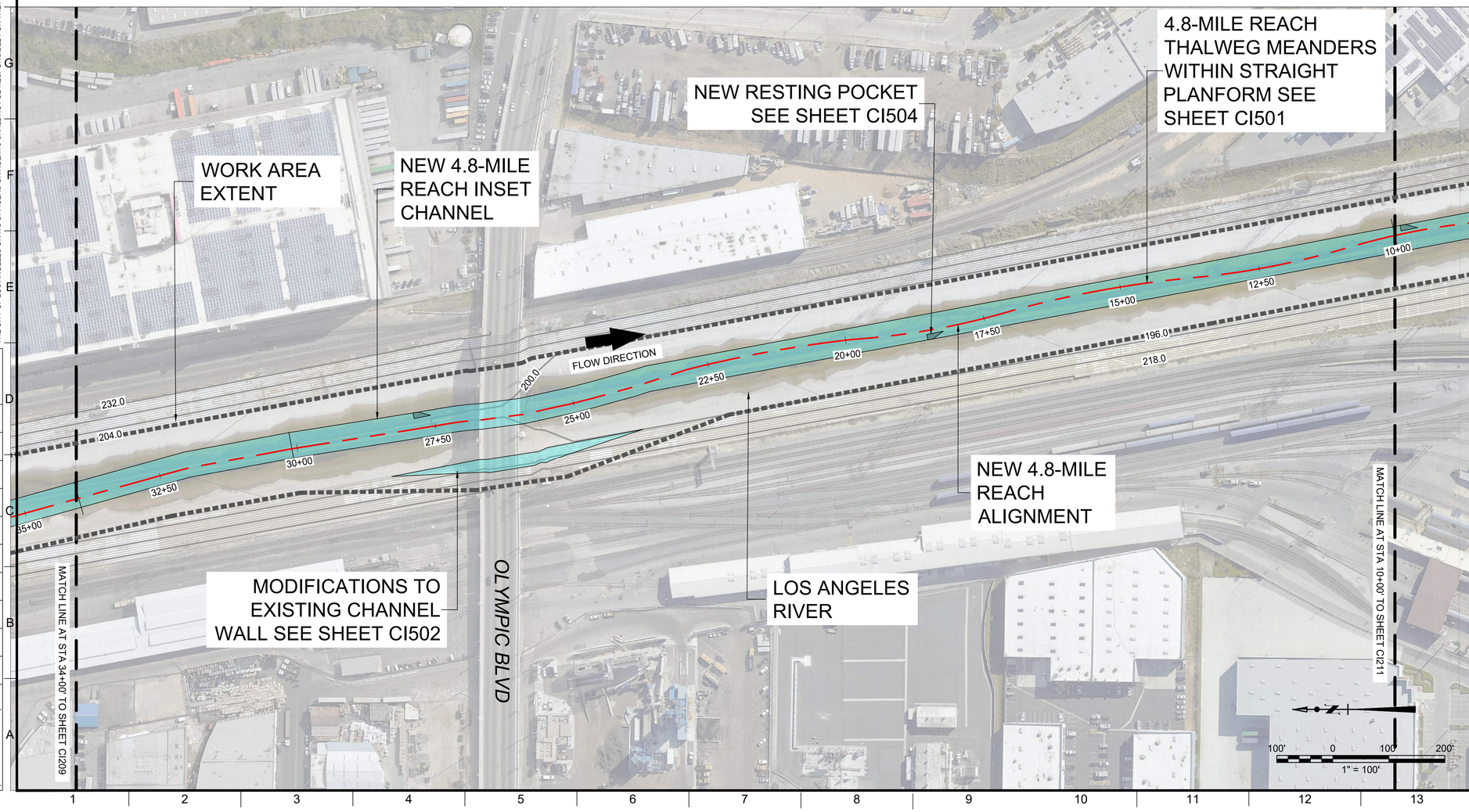


NEW PROFILE - STATION 10+00 TO 34+00
SCALE: HORZ 1" = 100'
VERT 1" = 20'

LEGEND

- EXISTING MAJOR CONTOUR (10FT)
- EXISTING MINOR CONTOUR (2FT)
- NEW 4.8-MILE REACH ALIGNMENT
- NEW 4.8-MILE CHANNEL EXTENT

NOTES:
1. 12' DIA PERFORATED DRAIN PIPE WILL BE RELOCATED AS NECESSARY
2. BOULDER CLUSTERS WILL BE PLACED THROUGHOUT THE PROJECT REACH WITHIN THE 4.8-MILE CHANNEL FOOTPRINT. SEE TYPICAL LAYOUT ON SHEET CI505.
3. EXISTING AND NEW PROFILE FOLLOW NEW 4.8-MILE REACH ALIGNMENT. NOTE THAT VARIATION IN THE EXISTING PROFILE IS DUE TO SINUOSITY IN THE NEW 4.8-MILE REACH ALIGNMENT CROSSING EXISTING LOW FLOW CHANNEL.



THE CITY OF LOS ANGELES OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.

REVISION DATES (DESIGN STAGE ONLY)

ENGINEERING
CITY OF LOS ANGELES

THIS PLAN WAS ELECTRONICALLY SIGNED AND STAMPED

BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH PLAN & PROFILE 10+00 TO 34+00

PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN

ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
		5/4/2022	
		5/4/2022	
		5/4/2022	
		5/4/2022	

CIP NO. ----

INDEX NO. ----

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

CITY ENGINEER: GARY LEE MOORE, P.E., ENV SP — DATE: 5/4/2022

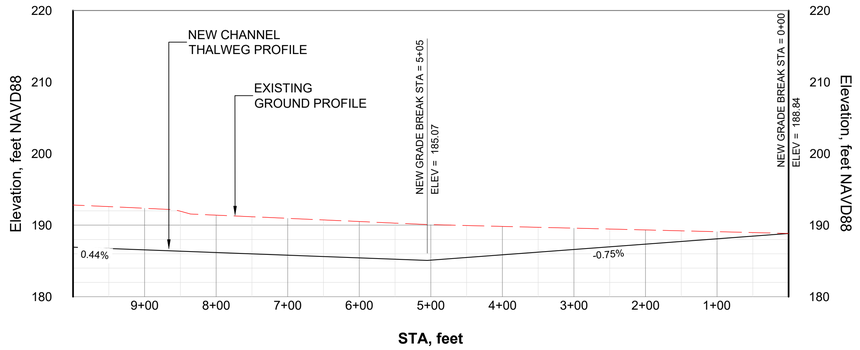
DESIGN GROUP

ENGINEER:	NT	5/4/2022
ARCHITECT:	----	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

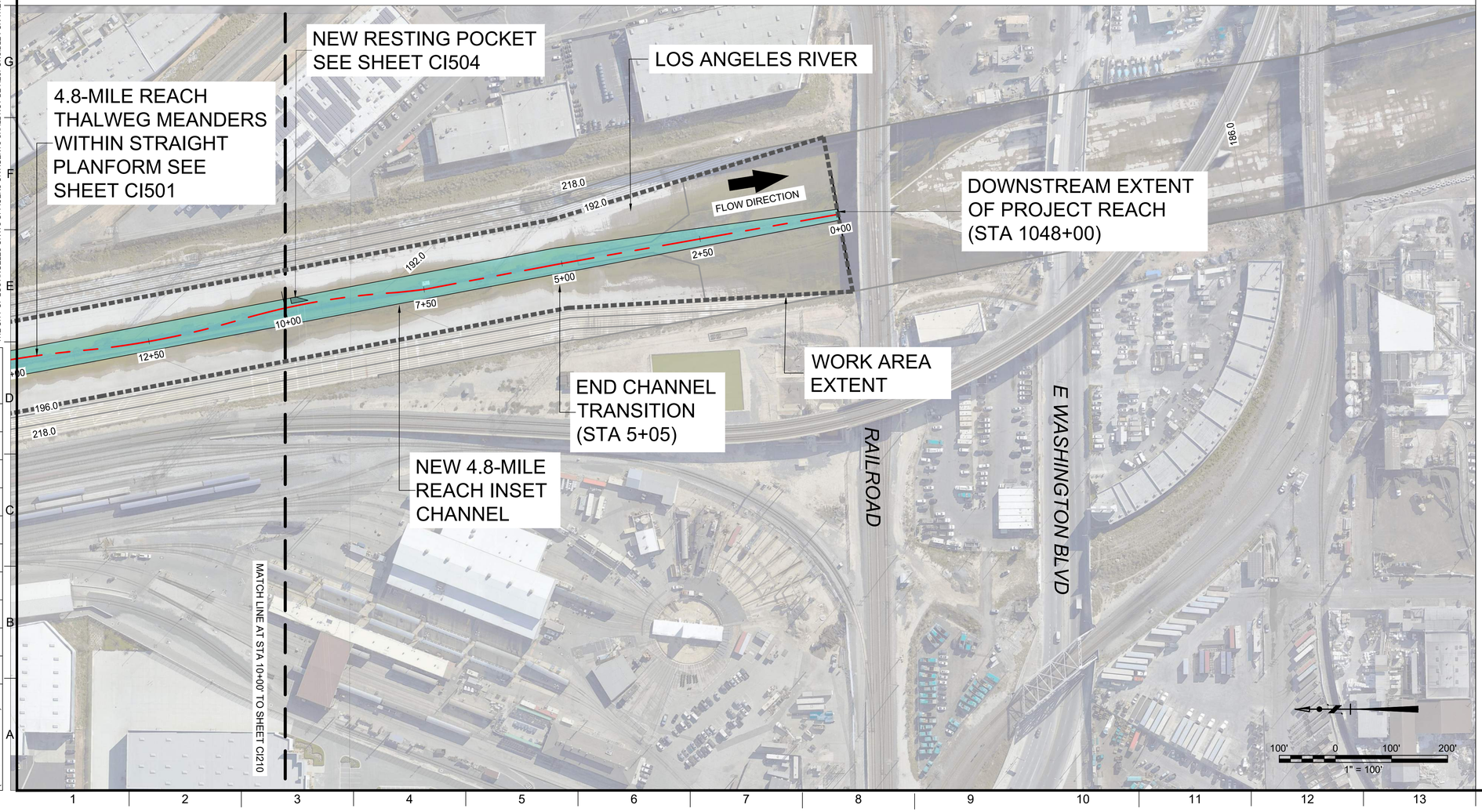
WORK ORDER
E1908721

SHEET NAME
CI210

SHEET 17 OF 41 SHEETS



NEW PROFILE - STATION 0+00 TO 10+00
SCALE: HORZ 1" = 100'
VERT 1" = 20'



LEGEND

- EXISTING MAJOR CONTOUR (10FT)
- EXISTING MINOR CONTOUR (2FT)
- NEW 4.8-MILE REACH ALIGNMENT
- NEW 4.8-MILE CHANNEL EXTENT

NOTES:
1. 12' DIA PERFORATED DRAIN PIPE WILL BE RELOCATED AS NECESSARY
2. BOULDER CLUSTERS WILL BE PLACED THROUGHOUT THE PROJECT REACH WITHIN THE 4.8-MILE CHANNEL FOOTPRINT. SEE TYPICAL LAYOUT ON SHEET CI505.
3. EXISTING AND NEW PROFILE FOLLOW NEW 4.8-MILE REACH ALIGNMENT. NOTE THAT VARIATION IN THE EXISTING PROFILE IS DUE TO SINUOSITY IN THE NEW 4.8-MILE REACH ALIGNMENT CROSSING EXISTING LOW FLOW CHANNEL.

THE CITY OF LOS ANGELES OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.

REVISION DATES (DESIGN STAGE ONLY)

ENGINEERING
CITY OF LOS ANGELES

THIS PLAN WAS ELECTRONICALLY • SIGNED AND STAMPED •

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS
BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH PLAN & PROFILE 0+00 TO 10+00
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
		5/4/2022	
		5/4/2022	
		5/4/2022	
		5/4/2022	

CIP NO. ----

INDEX NO. ----

CITY ENGINEER

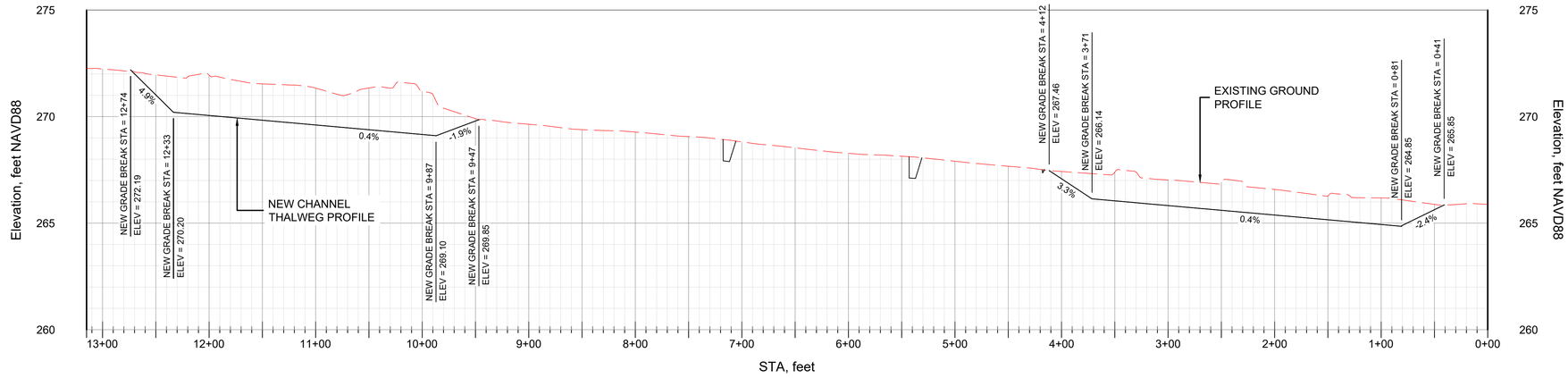
GARY LEE MOORE, P.E., ENV SP

DESIGN GROUP	DATE
ENGINEER: NT	5/4/2022
ARCHITECT: ---	5/4/2022
DESIGNED BY: EW	5/4/2022
DRAWN BY: KRE	5/4/2022
CHECKED BY: TRS	5/4/2022
APPROVED BY: NT	5/4/2022

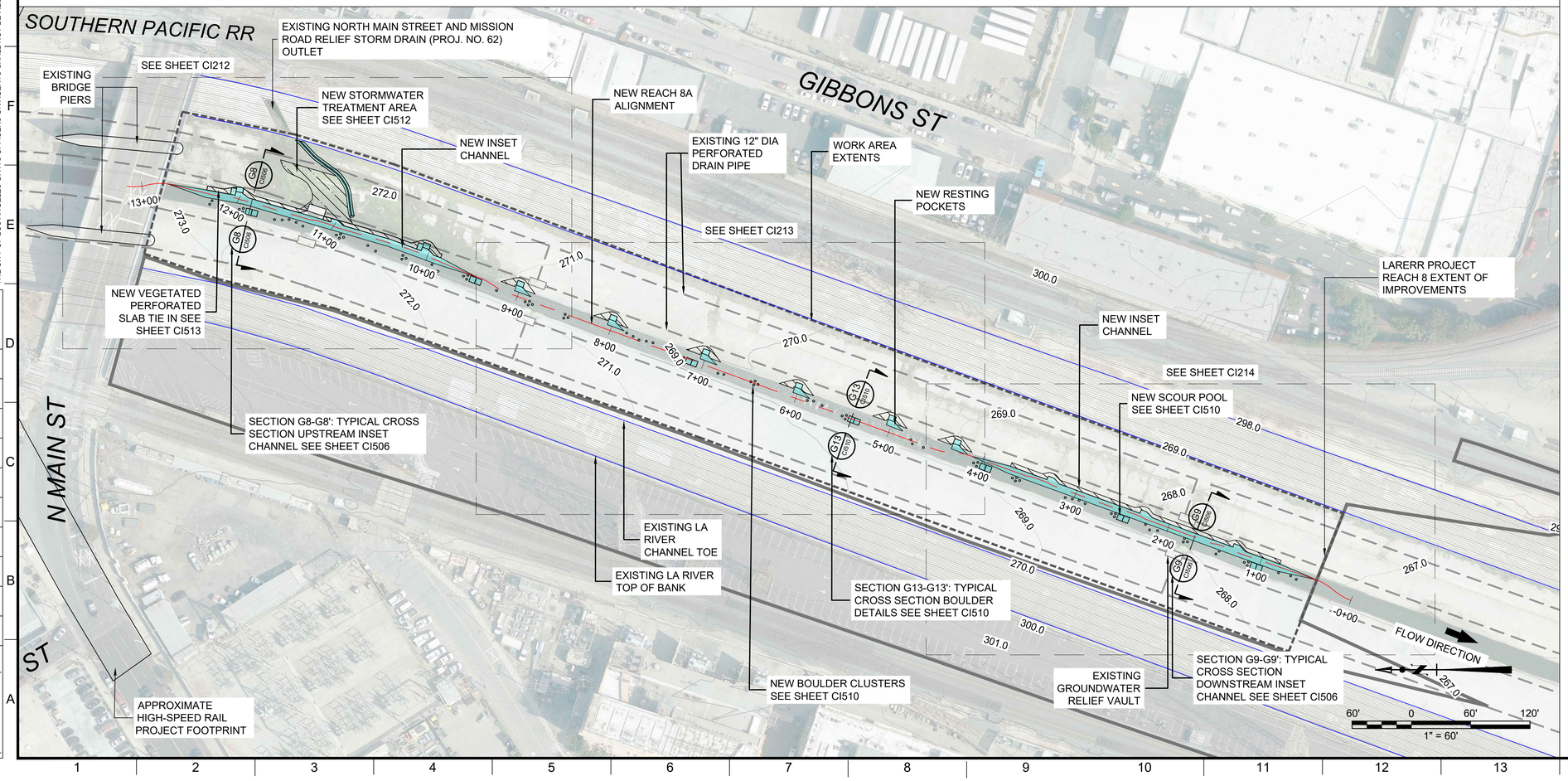
WORK ORDER
E1908721

SHEET NAME
CI211

SHEET 18 OF 41 SHEETS



NEW PROFILE - STATION 0+00 TO 13+15
SCALE: HORZ 1" = 60'
VERT 1" = 3'



LEGEND

- EXISTING MAJOR CONTOUR (5FT)
- EXISTING MINOR CONTOUR (1FT)
- NEW REACH 8A ALIGNMENT
- EXISTING 12" DIA PERFORATED DRAIN PIPE
- NEW REACH 8A CHANNEL FEATURES
- NEW VEGETATED WEEPHOLES
- NEW PERFORATED SLAB TIE IN

THE CITY OF LOS ANGELES OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.

REVISION DATES (DESIGN STAGE ONLY)

ENGINEERING
CITY OF LOS ANGELES

THIS PLAN WAS ELECTRONICALLY • SIGNED AND STAMPED

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS
BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: REACH 8A PROPOSED PLAN & PROFILE
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
		5/4/2022	
		5/4/2022	
		5/4/2022	
		5/4/2022	

CIP NO. ----

INDEX NO. ----

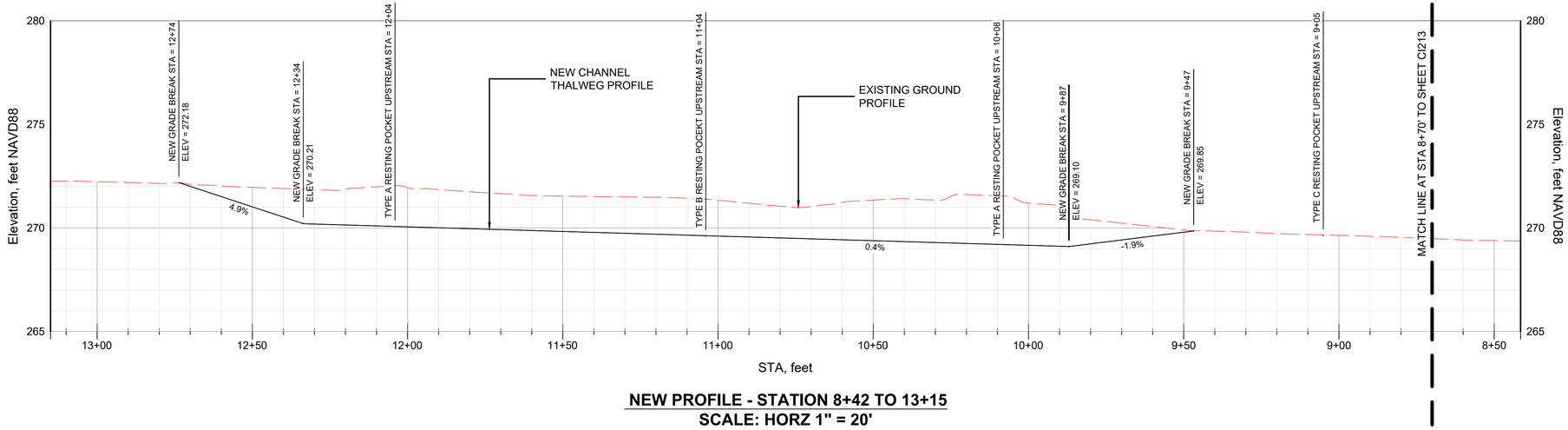
CITY ENGINEER: GARY LEE MOORE, P.E., ENV SP

DESIGN GROUP		DATE
ENGINEER:	NT	5/4/2022
ARCHITECT:	---	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

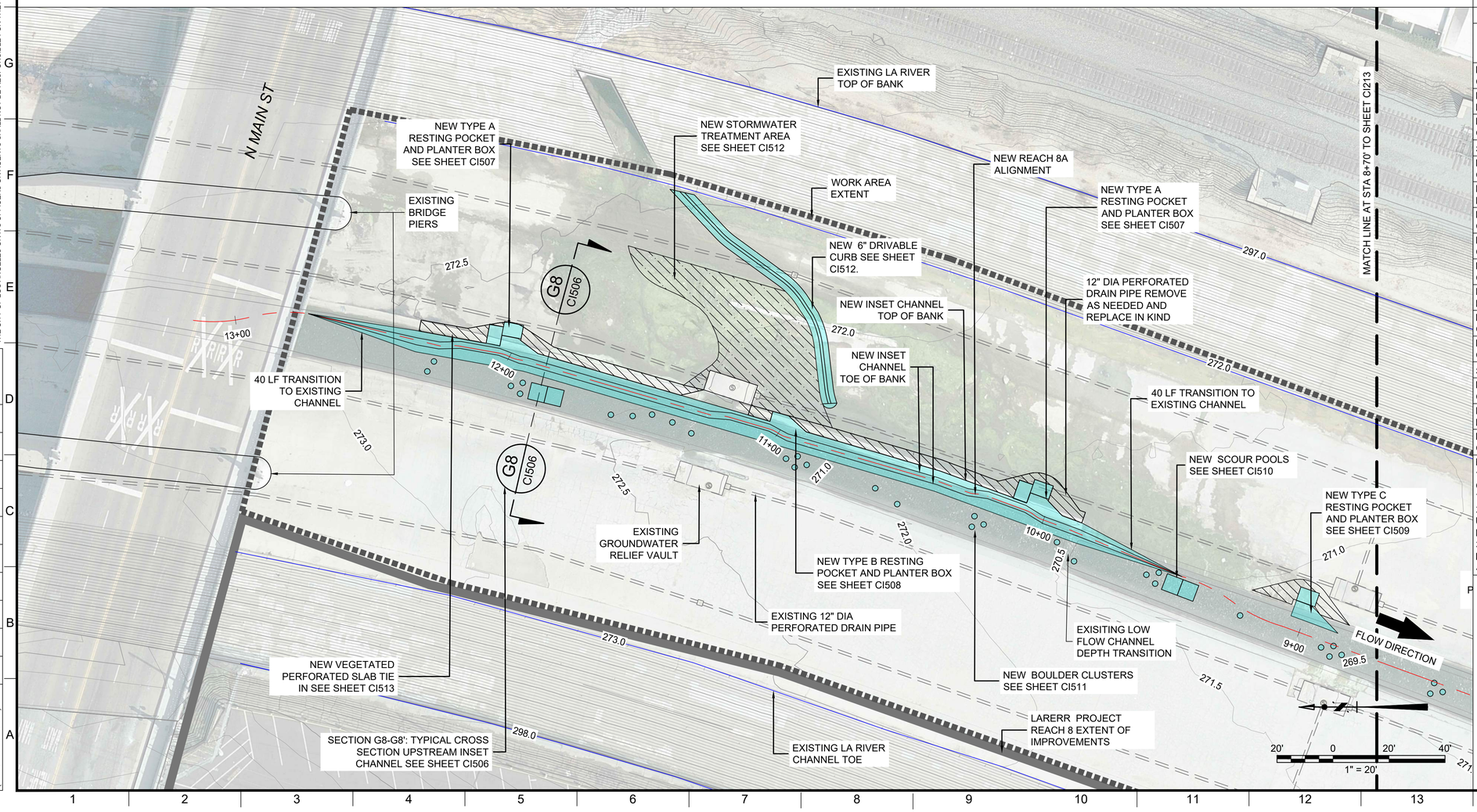
WORK ORDER
E1908721

SHEET NAME
CI403

SHEET 19 OF 41 SHEETS



NEW PROFILE - STATION 8+42 TO 13+15
SCALE: HORZ 1" = 20'
VERT 1" = 3'



LEGEND

- EXISTING MAJOR CONTOUR (2.5 FT)
- EXISTING MINOR CONTOUR (0.5 FT)
- NEW REACH 8A ALIGNMENT
- EXISTING 12" DIA PERFORATED DRAIN PIPE
- NEW REACH 8A CHANNEL FEATURES
- NEW VEGETATED WEEPHOLES
- NEW PERFORATED SLAB TIE IN

NEW FEATURE PLACEMENT

FEATURES	UPSTREAM STA (FT)	DOWNSTREAM STA (FT)	OFFSET (FT)	# OF BOULDERS
BOULDER CLUSTER	12+28	12+26	-	2
RESTING POCKET TYPE A	12+04	11+90	10	-
BOULDER CLUSTER	11+97	11+93	-	3
SCOUR POOL	11+90	11+78	-	-
BOULDER CLUSTER	11+59	11+30	-	5
RESTING POCKET TYPE B	11+04	10+90	10	-
BOULDER CLUSTER	10+95	10+87	-	4
BOULDER CLUSTER	10+61	10+52	-	2
BOULDER CLUSTER	10+24	10+20	-	3
RESTING POCKET TYPE A	10+08	9+94	10	-
BOULDER CLUSTER	9+93	9+84	-	2
BOULDER CLUSTER	9+59	9+55	-	3
SCOUR POOL	9+52	9+40	-	-
BOULDER CLUSTER	9+22		-	1
RESTING POCKET TYPE C	9+05	8+87	4.5	-
BOULDER CLUSTER	8+91	8+83	-	4

NOTES:
1. BOULDER CLUSTER STATIONS ARE GIVEN FROM THE CENTERLINE OF THE MOST UPSTREAM BOULDER IN THE CLUSTER TO THE MOST DOWNSTREAM BOULDER IN THE CLUSTER.
2. RESTING POCKET STATIONS ARE GIVEN FROM THE MOST UPSTREAM EDGE OF THE FEATURE TO THE MOST DOWNSTREAM EDGE OF THE FEATURE.
3. OFFSET IS THE HORIZONTAL DISTANCE FROM EXISTING LOW FLOW CHANNEL CENTERLINE TO THE START OF FEATURE.
4. STATIONS REFERENCE NEW REACH 8A ALIGNMENT.

THE CITY OF LOS ANGELES OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.

REVISION DATES (DESIGN STAGE ONLY)

ENGINEERING
CITY OF LOS ANGELES

THIS PLAN WAS ELECTRONICALLY • SIGNED AND STAMPED •

BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: REACH 8A UPSTREAM PLAN & PROFILE
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	BY	DATE
			5/4/2022
			5/4/2022
			5/4/2022
			5/4/2022

CIP NO. ----

INDEX NO. ----

CITY ENGINEER: GARY LEE MOORE, P.E., ENV SP — DATE 5/4/2022

DESIGN GROUP

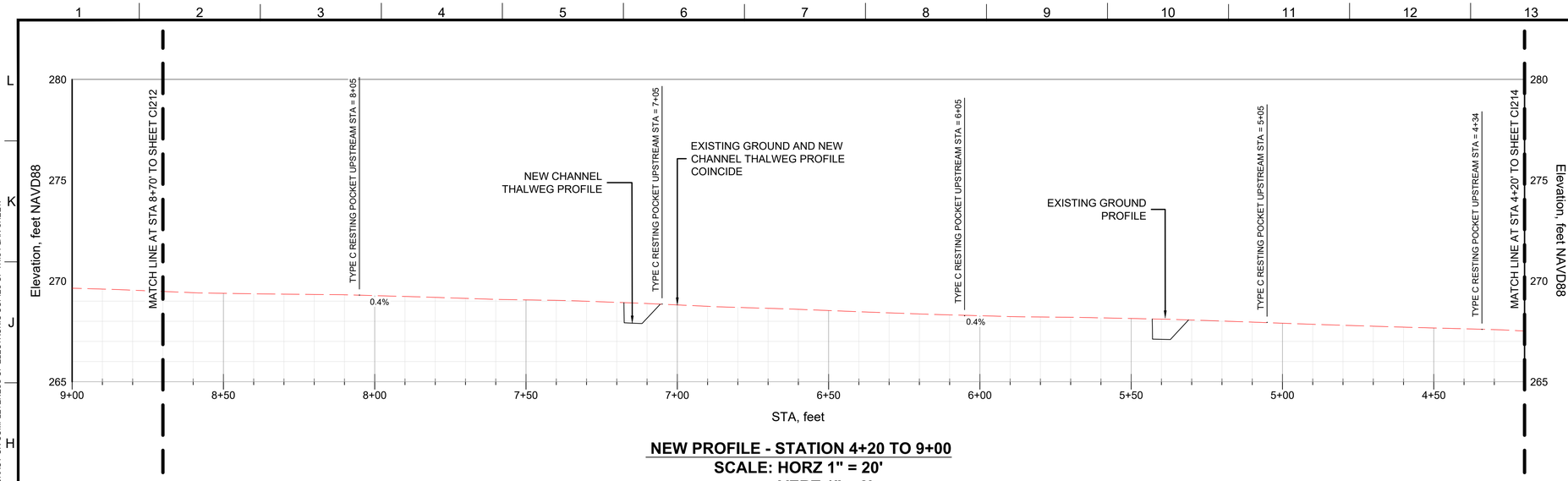
		DATE
ENGINEER:	NT	5/4/2022
ARCHITECT:	----	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

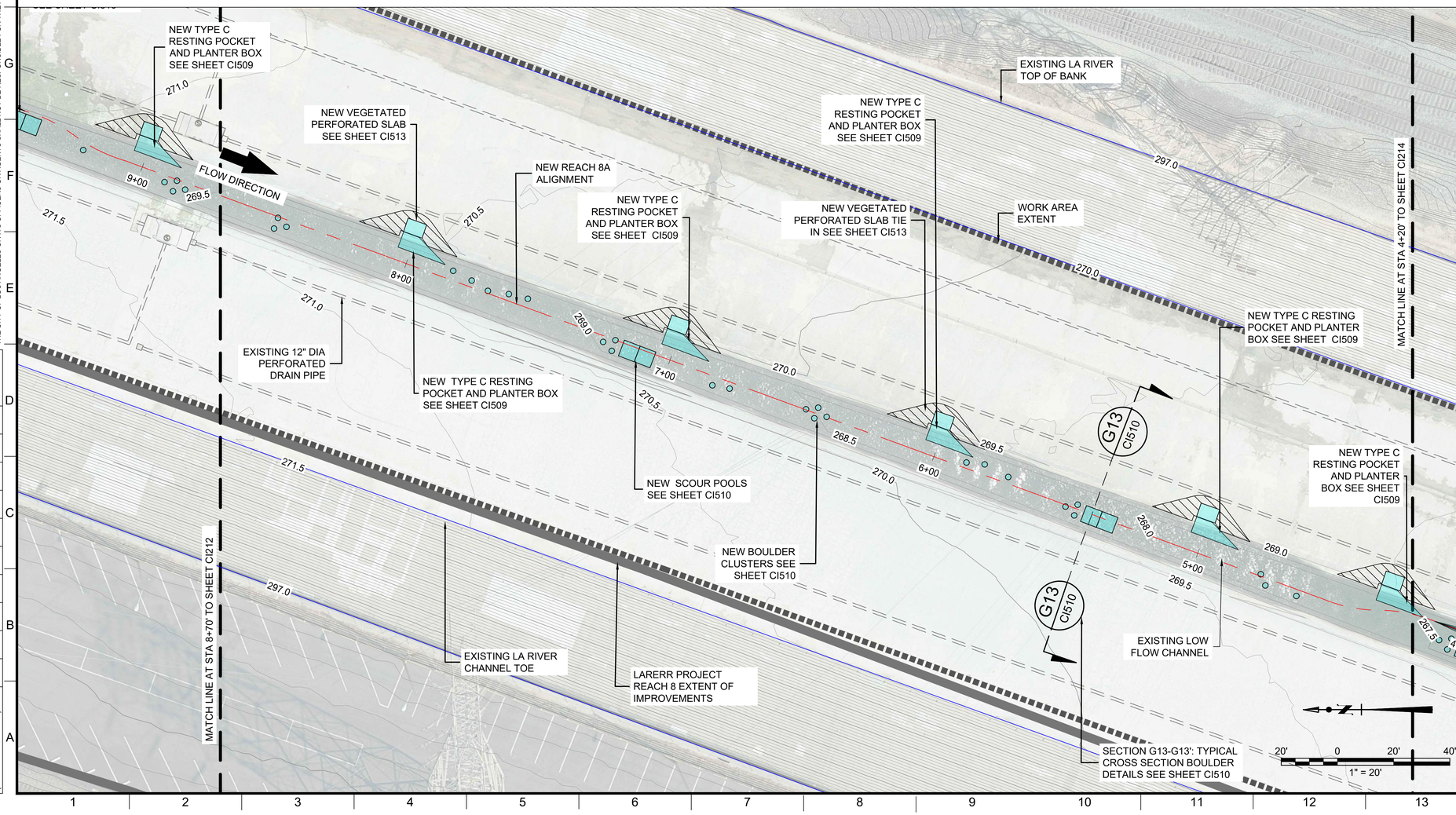
WORK ORDER E1908721

SHEET NAME CI212

SHEET 20 OF 41 SHEETS



NEW PROFILE - STATION 4+20 TO 9+00
SCALE: HORZ 1" = 20'
VERT 1" = 3'



LEGEND

- EXISTING MAJOR CONTOUR (2.5 FT)
- EXISTING MINOR CONTOUR (0.5 FT)
- NEW REACH 8A ALIGNMENT
- EXISTING 12" DIA PERFORATED DRAIN PIPE
- NEW REACH 8A CHANNEL FEATURES
- NEW VEGETATED WEEPHOLES
- NEW PERFORATED SLAB TIE IN

NEW FEATURE PLACEMENT

FEATURES	UPSTREAM STA (FT)	DOWNSTREAM STA (FT)	OFFSET (FT)	# OF BOULDERS
BOULDER CLUSTER	8+48	8+45	-	3
RESTING POCKET TYPE C	8+05	7+87	4.5	-
BOULDER CLUSTER	7+83	7+55	-	5
BOULDER CLUSTER	7+25	7+21	-	3
SCOUR POOL	7+18	7+06	-	-
RESTING POCKET TYPE C	7+05	6+87	4.5	-
BOULDER CLUSTER	6+83	6+77	-	2
BOULDER CLUSTER	6+49	6+41	-	4
RESTING POCKET TYPE C	6+05	5+87	4.5	-
BOULDER CLUSTER	5+88	5+73	-	3
BOULDER CLUSTER	5+50	5+46	-	3
SCOUR POOL	5+43	5+31	-	-
RESTING POCKET TYPE C	5+05	4+87	6.5	-
BOULDER CLUSTER	4+76	4+62	-	3
RESTING POCKET TYPE C	4+34	4+16	6.5	-

NOTES:
1. BOULDER CLUSTER STATIONS ARE GIVEN FROM THE CENTERLINE OF THE MOST UPSTREAM BOULDER IN THE CLUSTER TO THE MOST DOWNSTREAM BOULDER IN THE CLUSTER.
2. RESTING POCKET STATIONS ARE GIVEN FROM THE MOST UPSTREAM EDGE OF THE FEATURE TO THE MOST DOWNSTREAM EDGE OF THE FEATURE.
3. OFFSET IS THE HORIZONTAL DISTANCE FROM EXISTING LOW FLOW CHANNEL CENTERLINE TO THE START OF FEATURE.
4. STATIONS REFERENCE NEW REACH 8A ALIGNMENT.

THE CITY OF LOS ANGELES OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.

REVISION DATES (DESIGN STAGE ONLY)

ENGINEERING
CITY OF LOS ANGELES

THIS PLAN WAS ELECTRONICALLY • SIGNED AND STAMPED

BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: REACH 8A MIDSTREAM PLAN & PROFILE
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
		5/4/2022	
		5/4/2022	
		5/4/2022	
		5/4/2022	

CIP NO. ----

INDEX NO. ----

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

CITY ENGINEER: GARY LEE MOORE, P.E., ENV SP — DATE: 5/4/2022

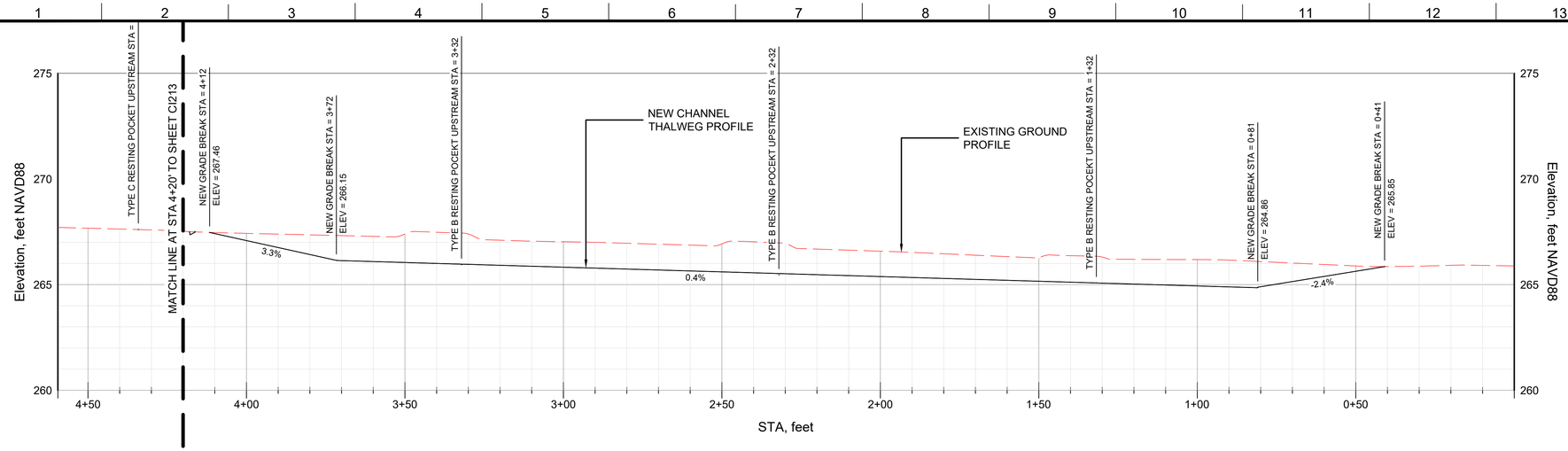
DESIGN GROUP

		DATE
ENGINEER:	NT	5/4/2022
ARCHITECT:	---	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

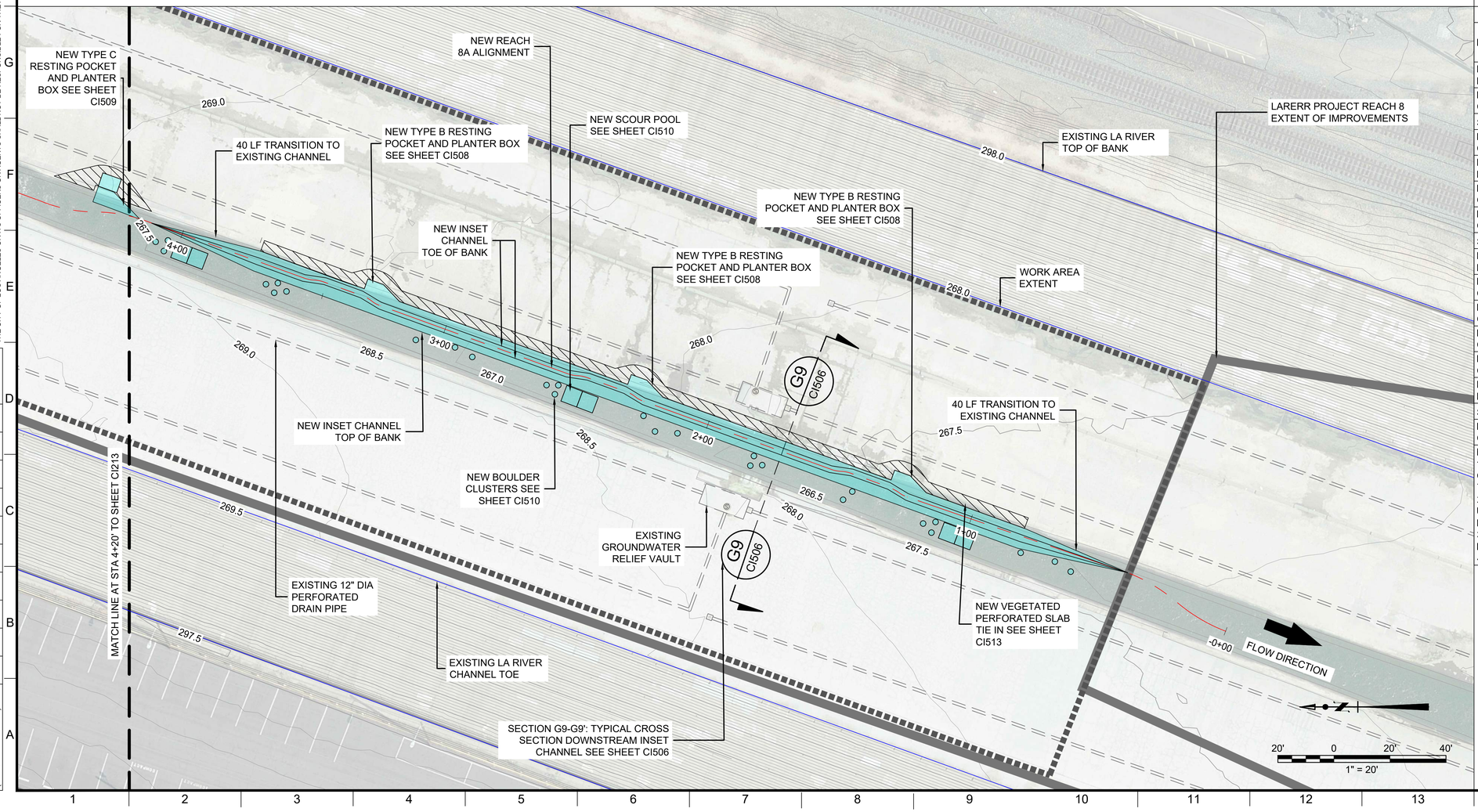
WORK ORDER
E1908721

SHEET NAME
CI213

SHEET 21 OF 41 SHEETS



NEW PROFILE - STATION 0+00 TO 4+60
SCALE: HORZ 1" = 20'
VERT 1" = 3'



LEGEND

- EXISTING MAJOR CONTOUR (2.5 FT)
- EXISTING MINOR CONTOUR (0.5 FT)
- NEW REACH 8A ALIGNMENT
- EXISTING 12" DIA PERFORATED DRAIN PIPE
- NEW REACH 8A CHANNEL FEATURES
- NEW VEGETATED WEEPHOLES
- NEW PERFORATED SLAB TIE IN

NEW FEATURE PLACEMENT

FEATURES	UPSTREAM STA (FT)	DOWNSTREAM STA (FT)	OFFSET (FT)	# OF BOULDERS
RESTING POCKET TYPE C	4+34	4+16	6.5	-
BOULDER CLUSTER	4+08	4+04	-	3
SCOUR POOL	4+00	3+88	-	-
BOULDER CLUSTER	3+66	3+58	-	4
RESTING POCKET TYPE B	3+32	3+18	10	-
BOULDER CLUSTER	3+09	2+88	-	4
BOULDER CLUSTER	2+59	2+55	-	3
SCOUR POOL	2+52	2+40	-	-
RESTING POCKET TYPE B	2+32	2+18	10	-
BOULDER CLUSTER	2+23	2+09	-	3
BOULDER CLUSTER	1+81	1+77	-	3
BOULDER CLUSTER	1+45	1+43	-	2
BOULDER CLUSTER	1+16	1+12	-	3
RESTING POCKET TYPE B	1+32	1+18	10	-
SCOUR POOL	1+09	0+97	-	-
BOULDER CLUSTER	0+79	0+60	-	3

NOTES:
1. BOULDER CLUSTER STATIONS ARE GIVEN FROM THE CENTERLINE OF THE MOST UPSTREAM BOULDER IN THE CLUSTER TO THE MOST DOWNSTREAM BOULDER IN THE CLUSTER.
2. RESTING POCKET STATIONS ARE GIVEN FROM THE MOST UPSTREAM EDGE OF THE FEATURE TO THE MOST DOWNSTREAM EDGE OF THE FEATURE.
3. OFFSET IS THE HORIZONTAL DISTANCE FROM EXISTING LOW FLOW CHANNEL CENTERLINE TO THE START OF FEATURE.
4. STATIONS REFERENCE NEW REACH 8A ALIGNMENT.

THE CITY OF LOS ANGELES OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.

REVISION DATES (DESIGN STAGE ONLY)

ENGINEERING
CITY OF LOS ANGELES

THIS PLAN WAS ELECTRONICALLY • SIGNED AND STAMPED •

BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: REACH 8A DOWNSTREAM PLAN & PROFILE
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
		5/4/2022	
		5/4/2022	
		5/4/2022	
		5/4/2022	

CIP NO. ----

INDEX NO. ----

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

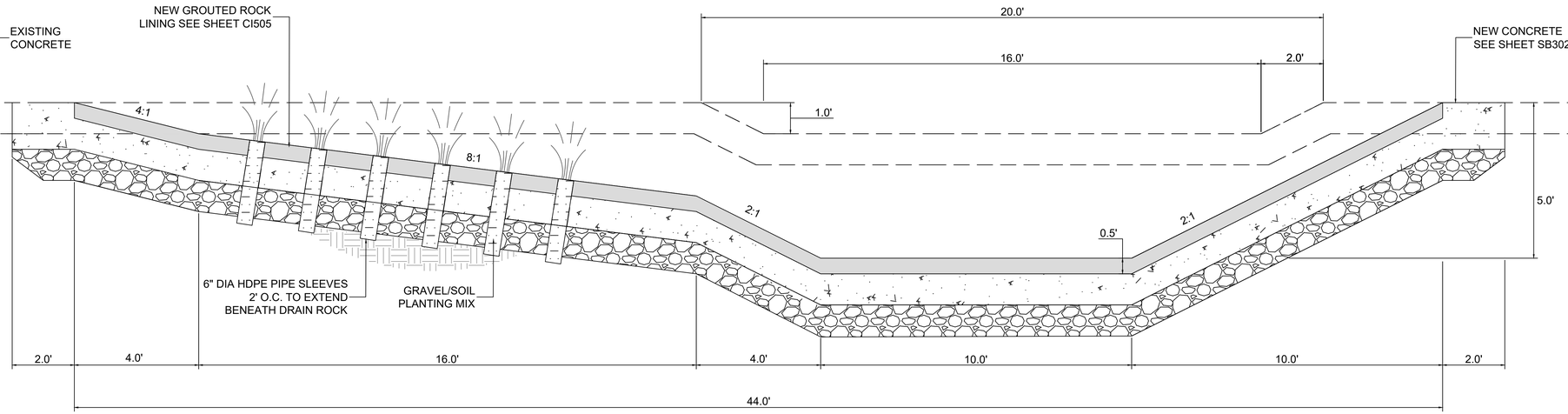
CITY ENGINEER: GARY LEE MOORE, P.E., ENV SP — DATE: 5/4/2022
DESIGN GROUP

		DATE
ENGINEER:	NT	5/4/2022
ARCHITECT:	----	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

WORK ORDER
E1908721

SHEET NAME
CI214

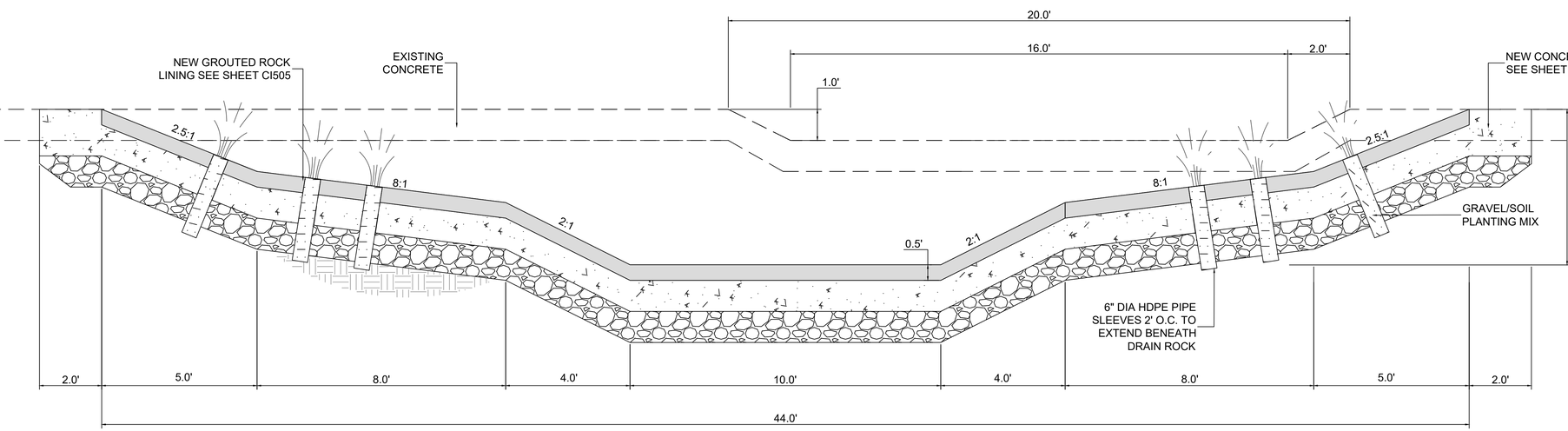
SHEET 22 OF 41 SHEETS



G1 — 4.8-MILE REACH TYPICAL CROSS SECTION (RIGHT ORIENTATION)
CI202 — SCALE: 1"=2'

LEGEND
- EXISTING CONCRETE
- NEW CONCRETE CHANNEL
- NEW DRAIN ROCK
- NEW GROUTED ROCK LINING
- NEW PERFORATED SLAB TIE IN
- EXISTING SUBGRADE

NOTE:
1. FOR SUBGRADE AND DRAINAGE LAYER DETAILS. SEE STRUCTURAL DWG SHEET SB303.
2. FOR TIE-IN TO EXISTING CONCRETE DETAILS. SEE STRUCTURAL DWG SHEET SD505.
3. LEFT ORIENTATION IS MIRROR IMAGE OF RIGHT ORIENTATION.
4. SEE STRUCTURAL DWG SB302 FOR ADDITIONAL INFORMATION ON 4.8 MILE REACH CHANNEL TYPICAL CROSS SECTION.



G2 — 4.8-MILE REACH TYPICAL CROSS SECTION (CENTER ORIENTATION)
CI202 — SCALE: 1"=2'

THE CITY OF LOS ANGELES OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.

REVISION DATES (DESIGN STAGE ONLY)

ENGINEERING
CITY OF LOS ANGELES
Environmental Engineering Design

THIS PLAN WAS ELECTRONICALLY • SIGNED AND STAMPED

BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH CHANNEL TYPICAL CROSS SECTIONS
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

NO.	REVISIONS	DATE	BY
		5/4/2022	
		5/4/2022	
		5/4/2022	
		5/4/2022	
		5/4/2022	

CIP NO. ----

INDEX NO. ----

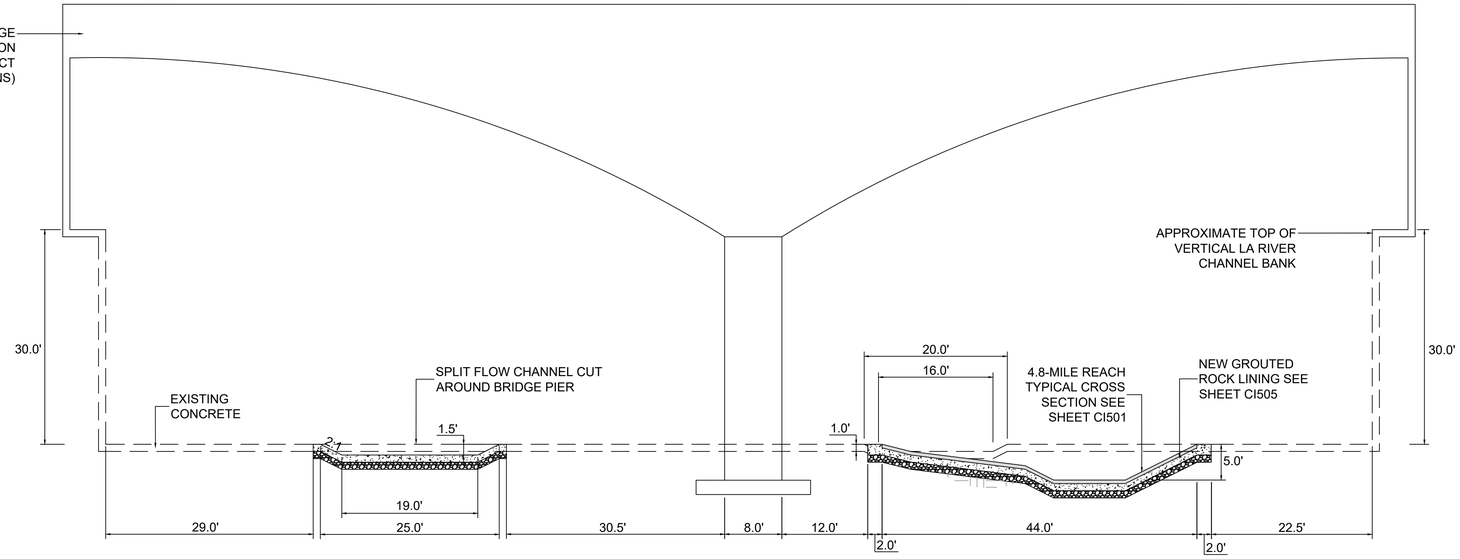
CITY ENGINEER
GARY LEE MOORE, P.E., ENV SP
DESIGN GROUP

		DATE
ENGINEER:	NT	5/4/2022
ARCHITECT:	----	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

WORK ORDER
E1908721

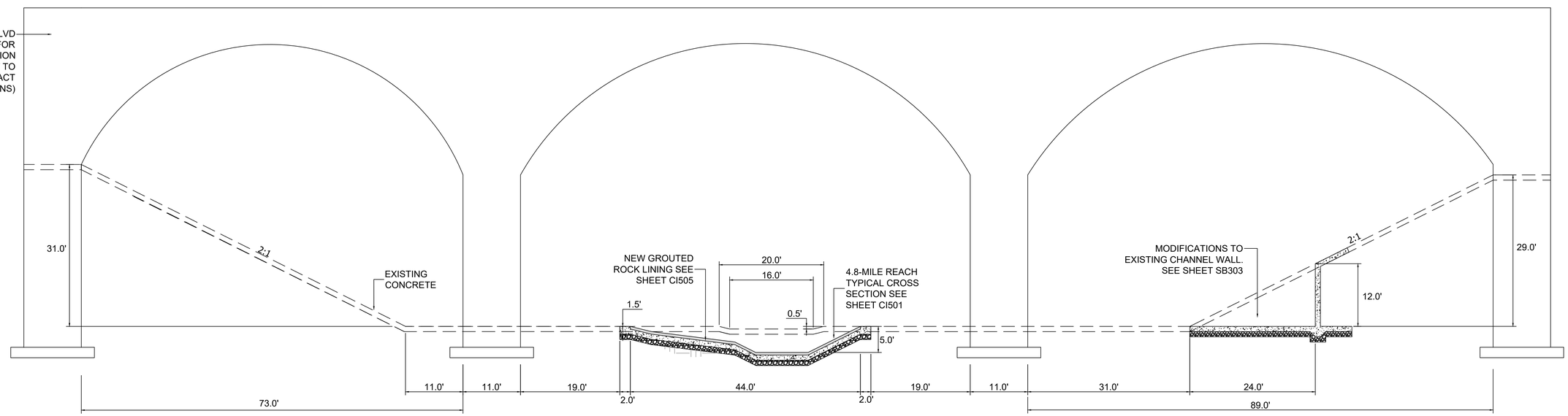
SHEET NAME
CI501

SHEET 23 OF 41 SHEETS



G3 / CI201 — 4.8-MILE REACH RIVERSIDE DRIVE BRIDGE CROSS SECTION

SCALE: 1"=10'



G4 / CI201 — 4.8-MILE REACH OLYMPIC BLVD BRIDGE CROSS SECTION

SCALE: 1"=10'

LEGEND

- EXISTING CONCRETE
- NEW CONCRETE CHANNEL
- NEW DRAIN ROCK
- NEW GROUTED ROCK LINING
- NEW PERFORATED SLAB TIE IN
- EXISTING SUBGRADE

NOTE:

1. FOR SUBGRADE AND DRAINAGE LAYER DETAILS. SEE STRUCTURAL DWG SHEET SB303.
2. FOR TIE-IN TO EXISTING CONCRETE DETAILS. SEE STRUCTURAL DWG SHEET SD505.
3. SEE STRUCTURAL DWG SB303 FOR ADDITIONAL INFORMATION ON 4.8 MILE REACH BRIDGE TYPICAL CROSS SECTION.

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ENGINEERING
CITY OF LOS ANGELES

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BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH BRIDGE TYPICAL CROSS SECTIONS
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
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		5/4/2022	
		5/4/2022	
		5/4/2022	

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CITY ENGINEER: GARY LEE MOORE, P.E., ENV SP — DATE: 5/4/2022

DESIGN GROUP		DATE
ENGINEER:	NT	5/4/2022
ARCHITECT:	----	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

WORK ORDER
E1908721

SHEET NAME
CI502

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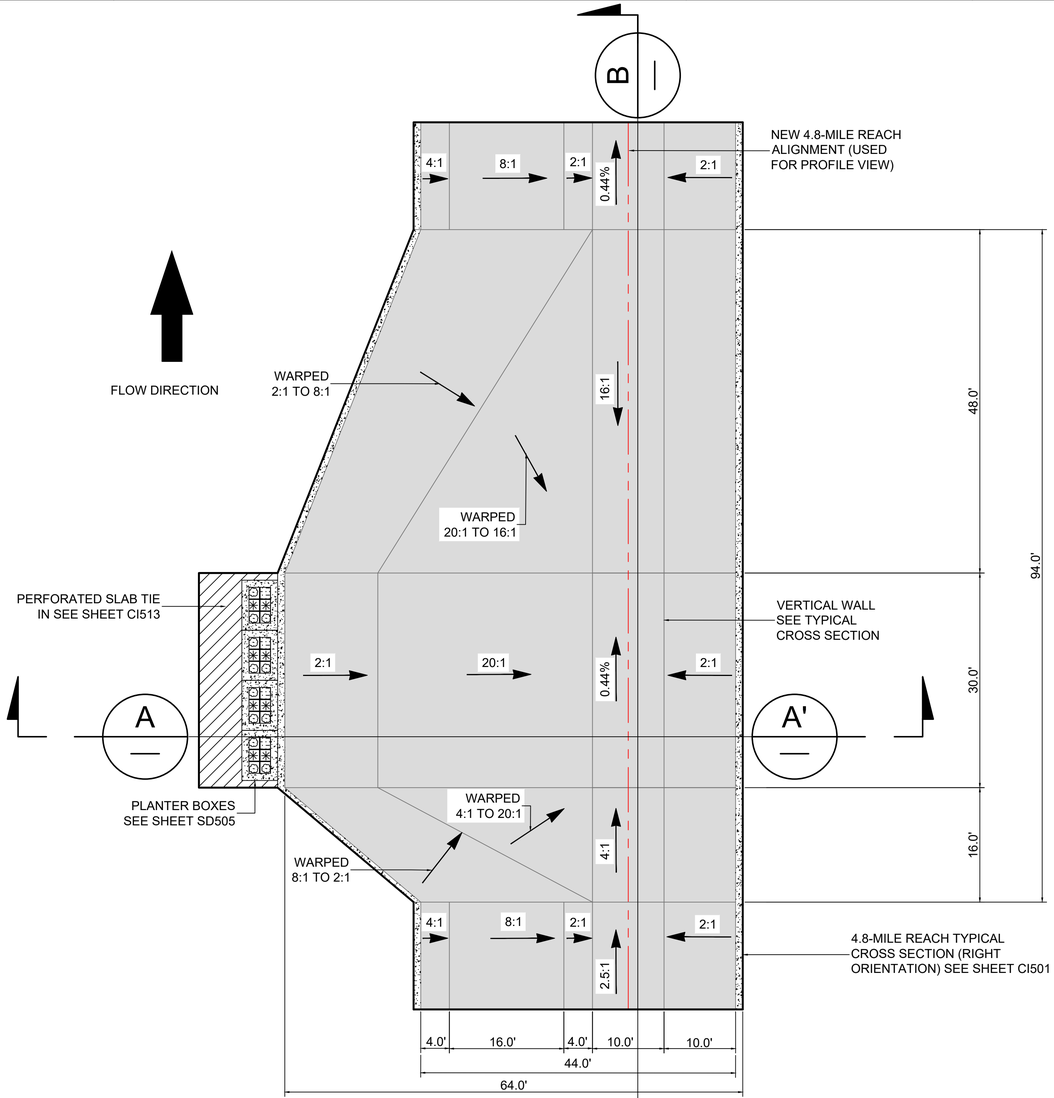
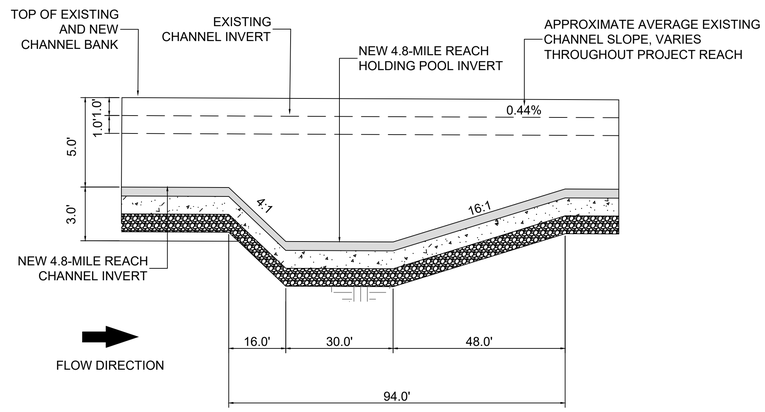
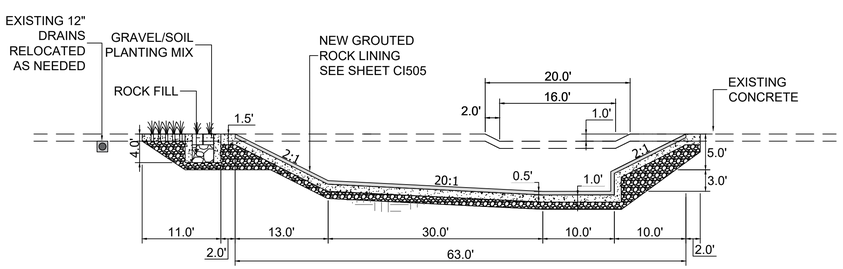


G5 / CI201 **4.8-MILE REACH HOLDING POOLS PLANVIEW**
SCALE: 1"=10'



B-B' **4.8-MILE REACH HOLDING POOLS PROFILE VIEW**
SCALE: 1"=20' (5 TIMES VERTICAL EXAGGERATION)



A-A' **4.8-MILE REACH HOLDING POOLS TYPICAL CROSS SECTION**
SCALE: 1"=10'

LEGEND

- EXISTING CONCRETE
- NEW CONCRETE CHANNEL
- NEW DRAIN ROCK
- NEW GROUTED ROCK LINING
- NEW PERFORATED SLAB TIE IN
- EXISTING SUBGRADE

NOTE:
1. FOR SUBGRADE AND DRAINAGE LAYER DETAILS. SEE STRUCTURAL DWG SHEET SB303.
2. FOR TIE-IN TO EXISTING CONCRETE DETAILS. SEE STRUCTURAL DWG SHEET SD505.
3. SEE STRUCTURAL DWG SB303 FOR ADDITIONAL INFORMATION ON 4.8 MILE REACH HOLDING POOL TYPICAL CROSS SECTION.

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BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH HOLDING POOL TYPICAL CROSS SECTION

PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN

ADDRESS: LOS ANGELES, CALIFORNIA

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CITY ENGINEER
GARY LEE MOORE, P.E., ENV SP
DATE 5/4/2022

DESIGN GROUP

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CHECKED BY:	TRS	5/4/2022
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CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

WORK ORDER
E1908721

SHEET NAME
CI503

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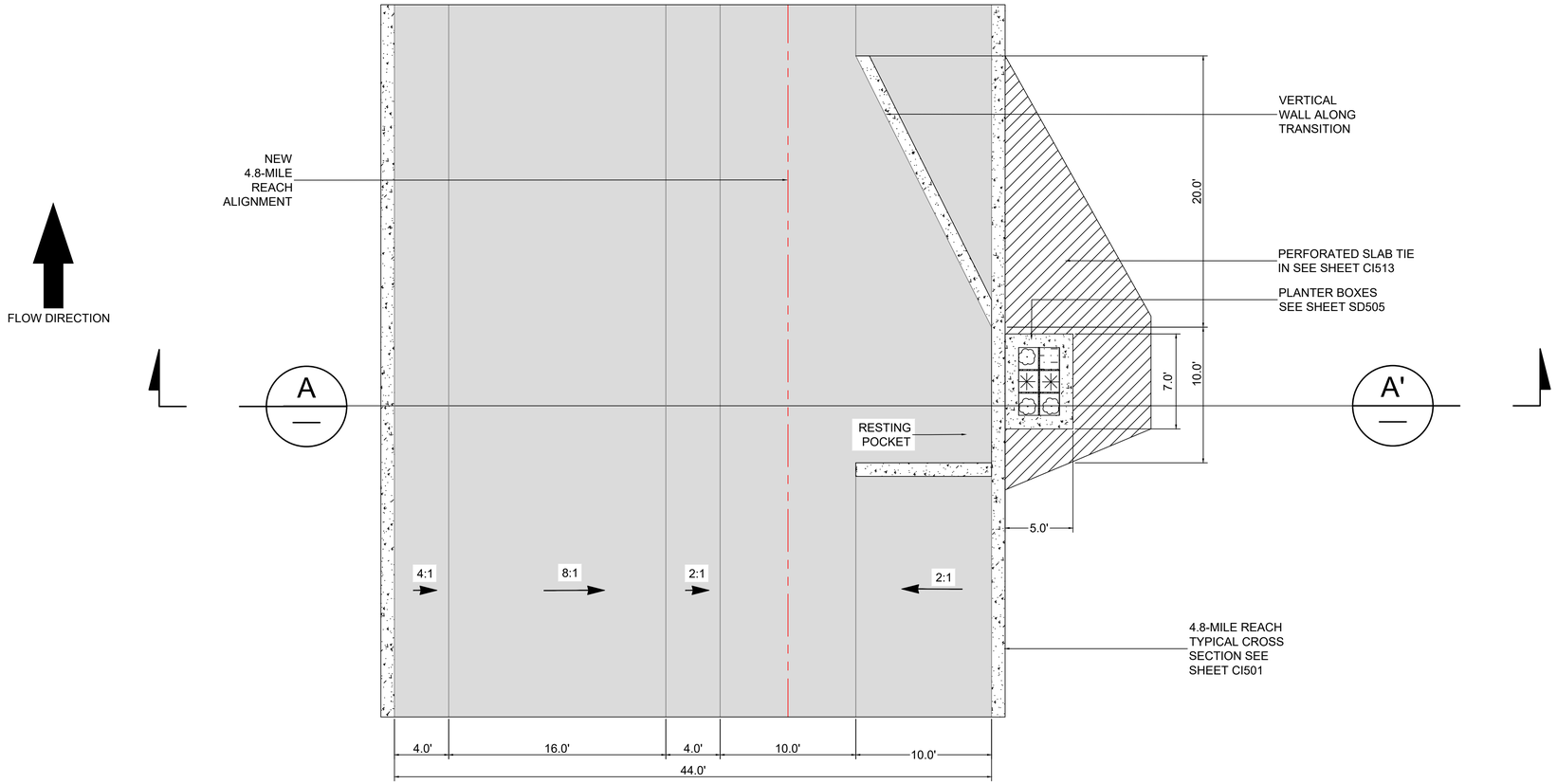
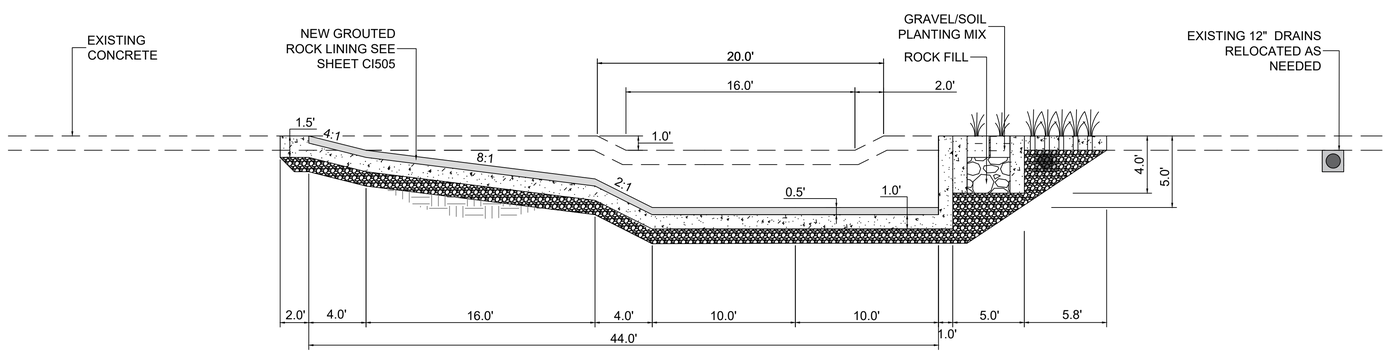


G6 / CI202 — 4.8-MILE REACH RESTING POCKET PLANVIEW
SCALE: 1"=5'

LEGEND

- EXISTING CONCRETE
- NEW CONCRETE CHANNEL
- NEW DRAIN ROCK
- NEW GROUTED ROCK LINING
- NEW PERFORATED SLAB TIE IN
- EXISTING SUBGRADE

NOTE:
1. FOR SUBGRADE AND DRAINAGE LAYER DETAILS. SEE STRUCTURAL DWG SHEET SB303.
2. FOR TIE-IN TO EXISTING CONCRETE DETAILS. SEE STRUCTURAL DWG SHEET SD505.
3. SEE STRUCTURAL DWG SB303 FOR ADDITIONAL INFORMATION ON 4.8 MILE REACH RESTING POCKET TYPICAL CROSS SECTION.



A-A' — 4.8-MILE REACH RESTING POCKET TYPICAL CROSS SECTION
SCALE: 1"=5'

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CITY OF LOS ANGELES

BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH RESTING POCKET TYPICAL CROSS SECTION
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

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		5/4/2022	
		5/4/2022	

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DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

WORK ORDER
E1908721

SHEET NAME
CI504

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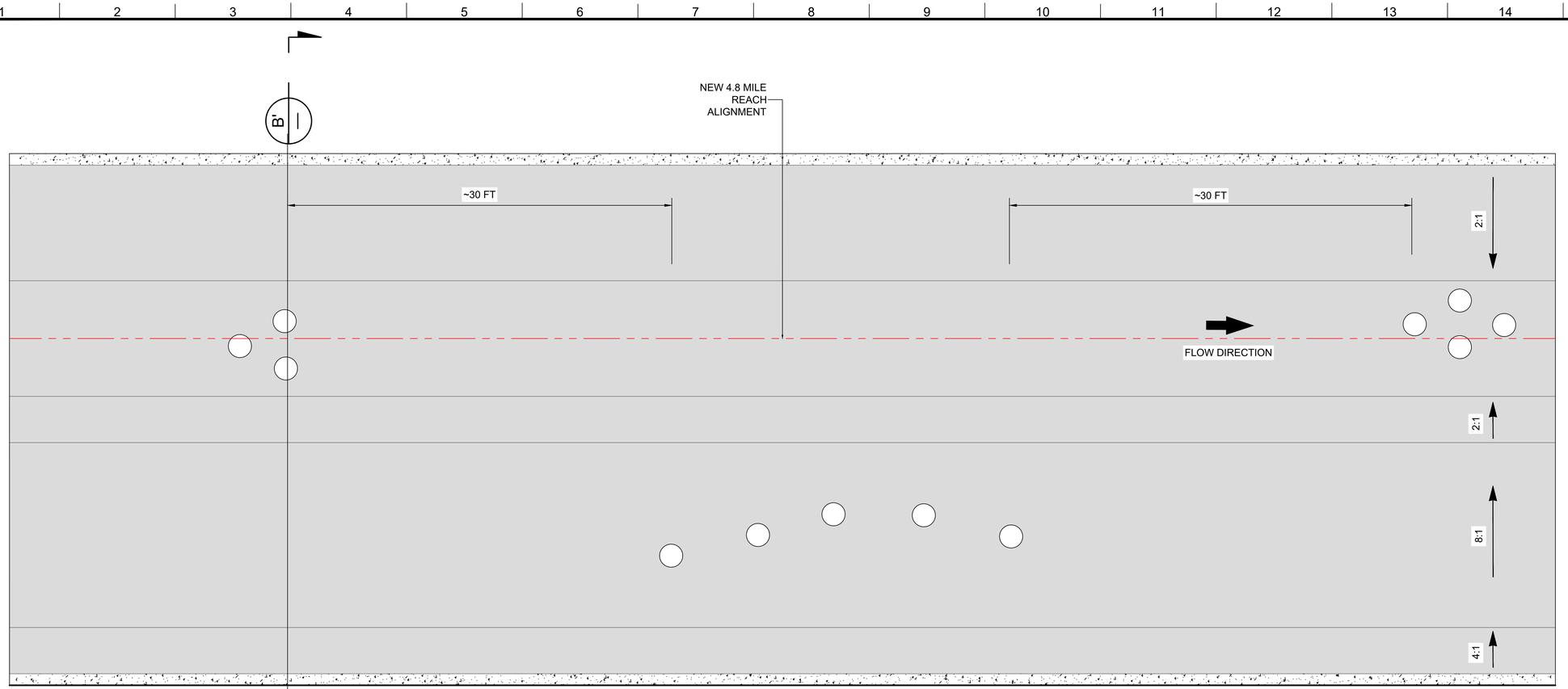
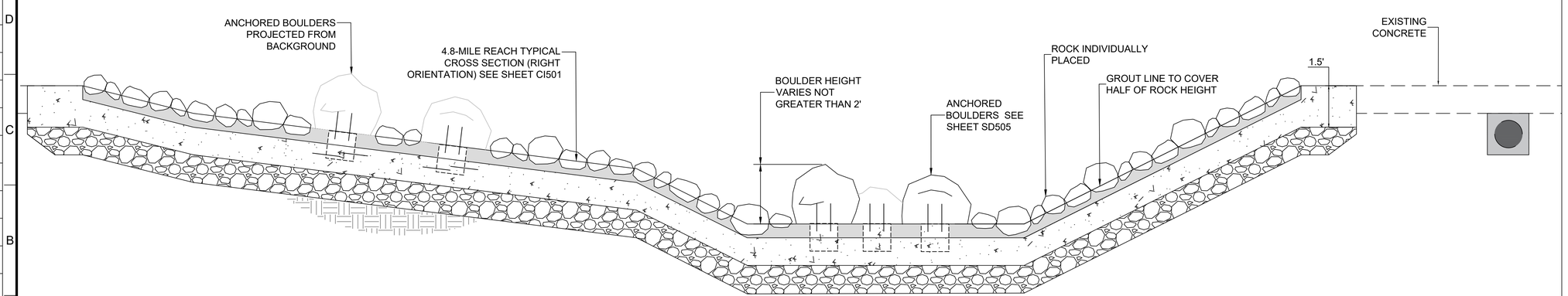
REVISION DATES (DESIGN STAGE ONLY)



G7 / CI401 — 4.8-MILE REACH ANCHORED BOULDER PLACEMENT TYPICAL
SCALE: 1" = 5'



B-B' — 4.8-MILE REACH TYPICAL CROSS SECTION GROUTED ROCK LINING AND ANCHORED BOULDER DETAILS
SCALE: 1" = 2'

LEGEND

- EXISTING CONCRETE
- NEW CONCRETE CHANNEL
- NEW DRAIN ROCK
- NEW GROUTED ROCK LINING
- NEW PERFORATED SLAB TIE IN
- EXISTING SUBGRADE

NOTE:
1. FOR SUBGRADE AND DRAINAGE LAYER DETAILS. SEE STRUCTURAL DWG SHEET SB303.
2. FOR TIE-IN TO EXISTING CONCRETE DETAILS. SEE STRUCTURAL DWG SHEET SD505.
3. GROUTED ROCK MATERIAL SHALL CONFORM TO THE FOLLOWING GRADATION:

GROUTED ROCK GRADATION		
% PASSING	MIN (IN)	MAX (IN)
D100	24	24
D84	15	20
D50	6	9
D15	4	5

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BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH ANCHORED BOULDER TYPICAL CROSS SECTION
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

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		5/4/2022	
		5/4/2022	
		5/4/2022	

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DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

WORK ORDER
E1908721

SHEET NAME
CI505

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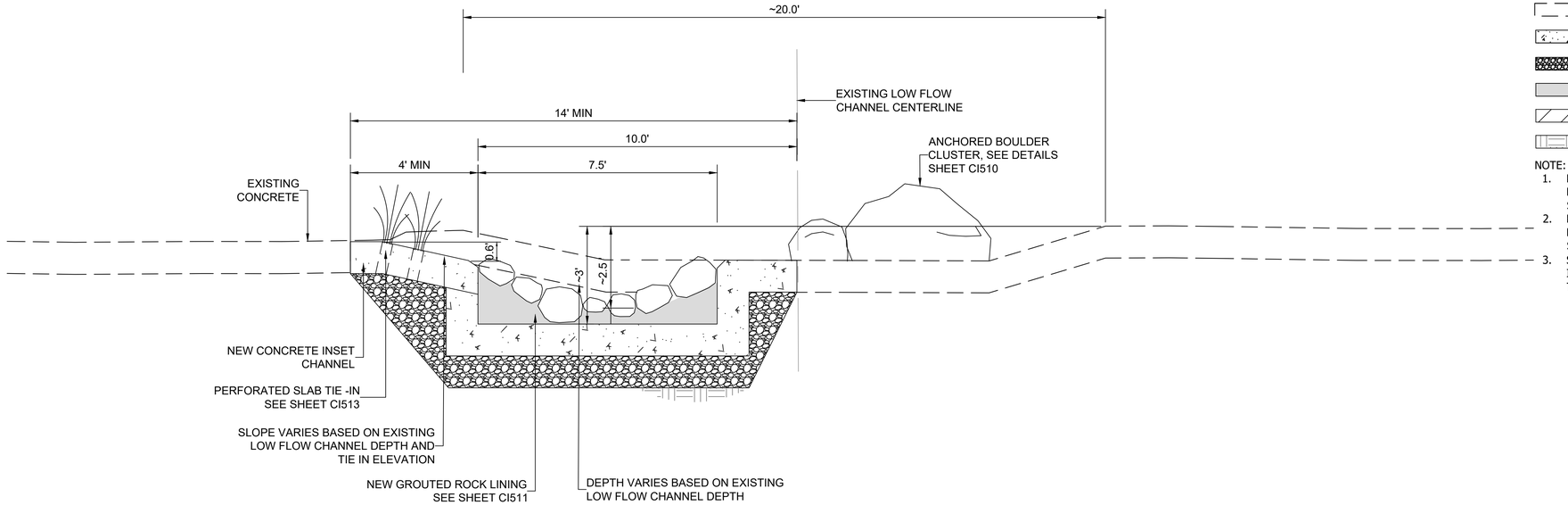


G8 / CI403 REACH 8A TYPICAL CROSS SECTION UPSTREAM INSET CHANNEL

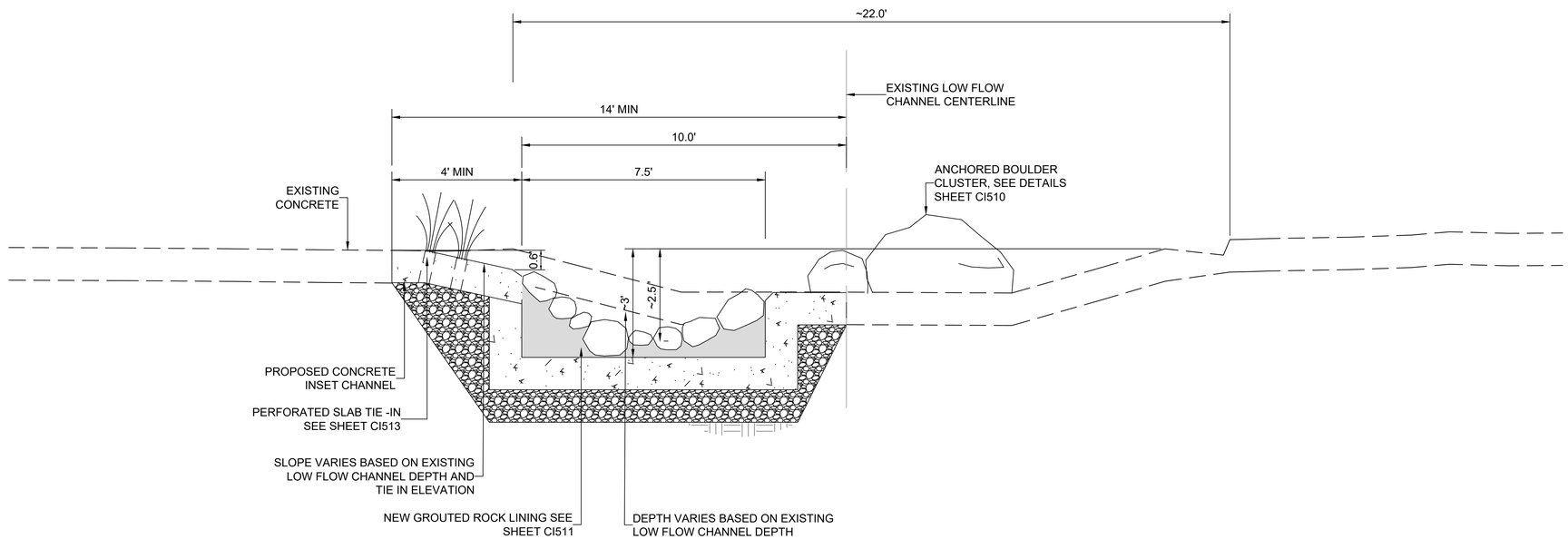
SCALE: 1"=2'

LEGEND

- EXISTING CONCRETE
- NEW CONCRETE CHANNEL
- NEW DRAIN ROCK
- NEW GROUTED ROCK LINING
- NEW PERFORATED SLAB TIE IN
- EXISTING SUBGRADE

NOTE:

1. FOR SUBGRADE AND DRAINAGE LAYER DETAILS. SEE STRUCTURAL DWG SHEET SB304
2. FOR TIE-IN TO EXISTING CONCRETE DETAILS. SEE STRUCTURAL DWG SHEET SD505
3. SEE STRUCTURAL DWG SB304 FOR ADDITIONAL INFORMATION ON REACH 8A INSET CHANNEL TYPICAL CROSS SECTION.



G9 / CI403 REACH 8A TYPICAL CROSS SECTION DOWNSTREAM INSET CHANNEL

SCALE: 1"=2'

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VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: REACH 8A INSET CHANNEL TYPICAL CROSS SECTION

PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN

ADDRESS: LOS ANGELES, CALIFORNIA

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DESIGN GROUP

ENGINEER:	NT	5/4/2022
ARCHITECT:	----	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

WORK ORDER
E1908721

SHEET NAME
CI506

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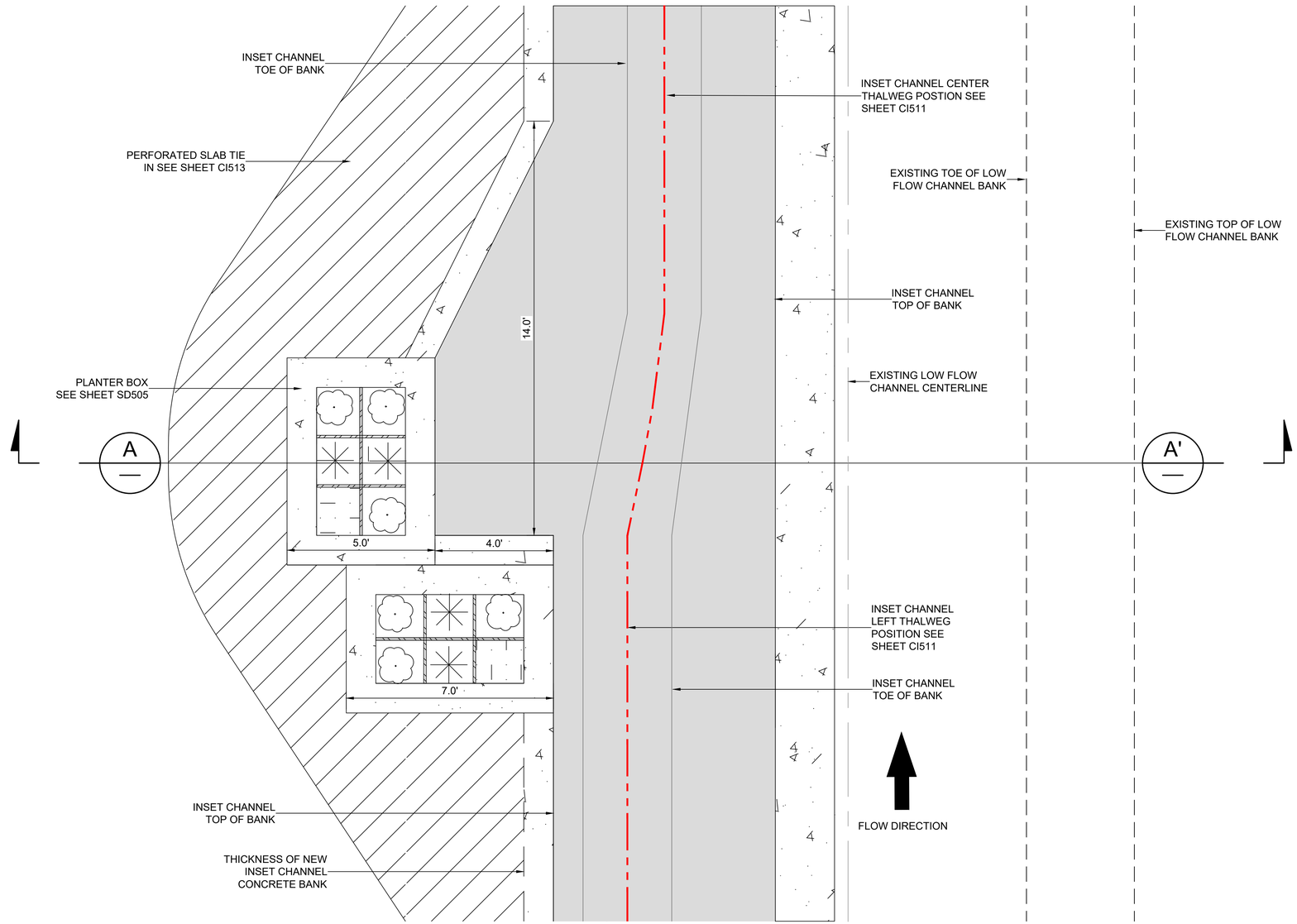
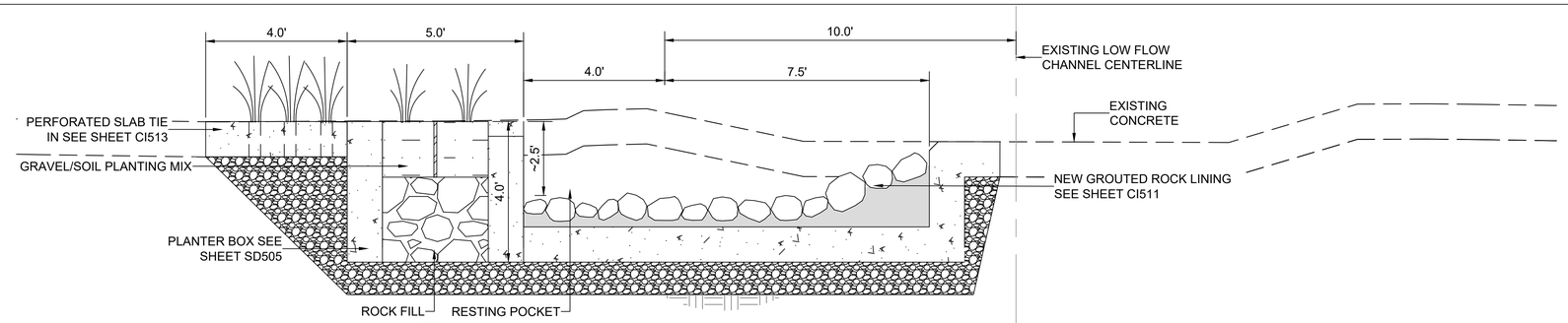


G10 / CI212 REACH 8A TYPE A RESTING POCKET WITH TWO PLANTER BOXES (WITHIN INSET CHANNEL)
SCALE: 1" = 2'



A-A' REACH 8A TYPE A RESTING POCKET SECTION VIEW
SCALE: 1" = 2'

LEGEND

- EXISTING CONCRETE
- NEW CONCRETE CHANNEL
- NEW DRAIN ROCK
- NEW GROUTED ROCK LINING
- NEW PERFORATED SLAB TIE IN
- EXISTING SUBGRADE

NOTE:
1. FOR SUBGRADE AND DRAINAGE LAYER DETAILS. SEE STRUCTURAL DWG SHEET SB304
2. FOR TIE-IN TO EXISTING CONCRETE DETAILS. SEE STRUCTURAL DWG SHEET SD505
3. SEE STRUCTURAL DWG SB304 FOR ADDITIONAL INFORMATION ON REACH 8A INSET CHANNEL TYPE A RESTING POCKET CROSS SECTION.

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VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: REACH 8A INSET CHANNEL RESTING POCKET DETAILS TYPE A
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

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CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

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E1908721

SHEET NAME
CI507

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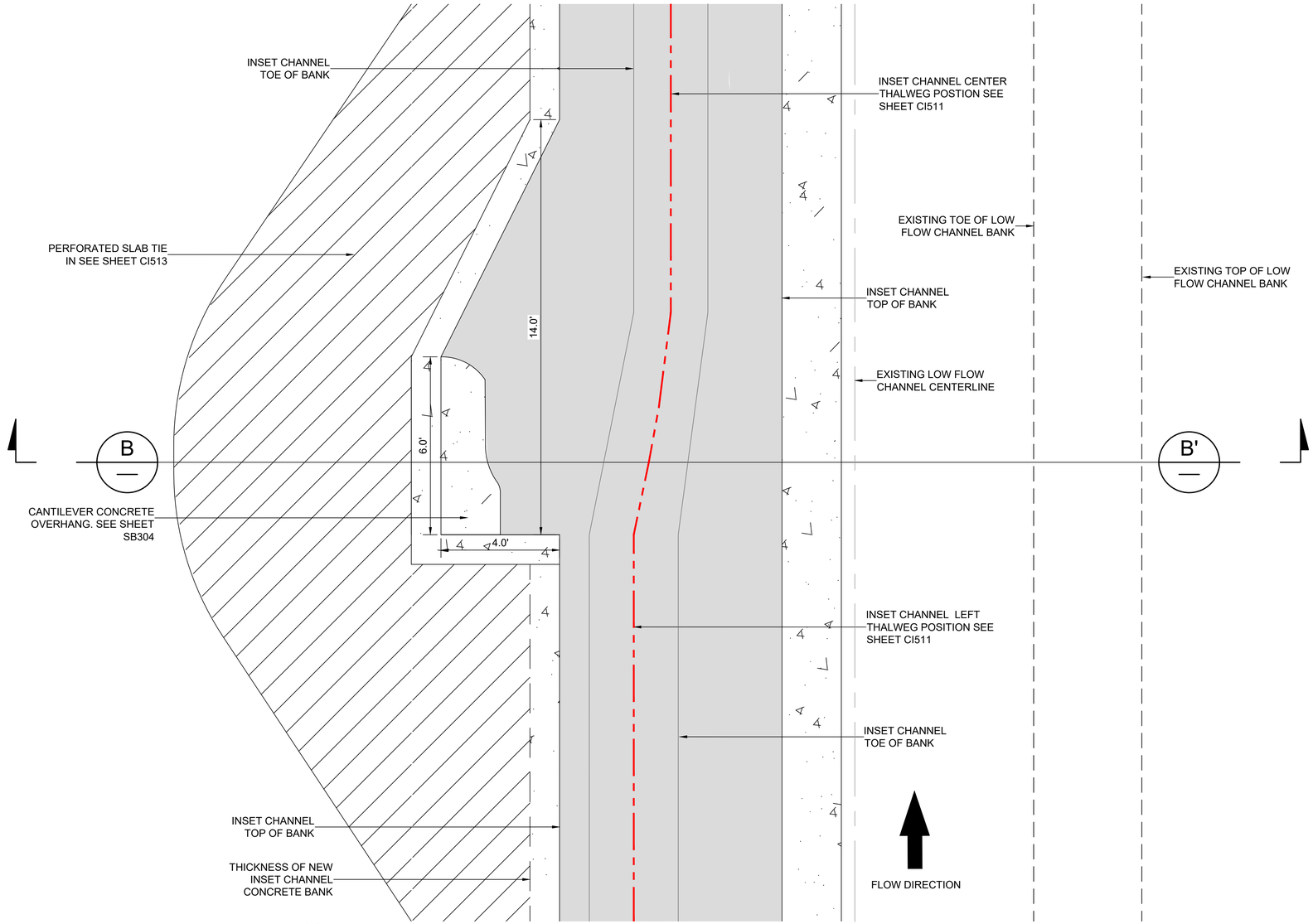
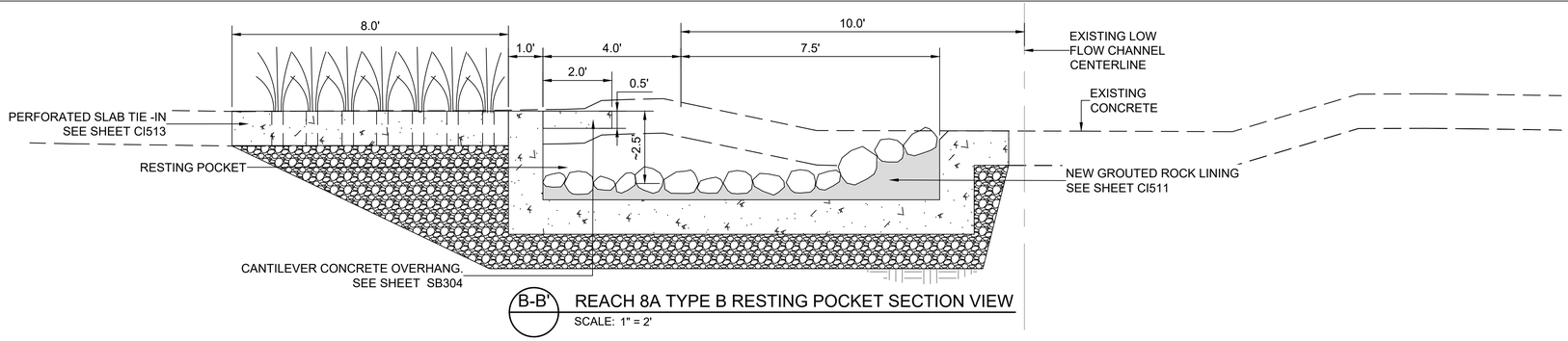


G11 / CI212 REACH 8A TYPE B RESTING POCKET WITH OVERHANG (WITHIN INSET CHANNEL)
SCALE: 1" = 2'



B-B' REACH 8A TYPE B RESTING POCKET SECTION VIEW
SCALE: 1" = 2'

LEGEND

- EXISTING CONCRETE
- NEW CONCRETE CHANNEL
- NEW DRAIN ROCK
- NEW GROUTED ROCK LINING
- NEW PERFORATED SLAB TIE IN
- EXISTING SUBGRADE

NOTE:
1. FOR SUBGRADE AND DRAINAGE LAYER DETAILS. SEE STRUCTURAL DWG SHEET SB304
2. FOR TIE-IN TO EXISTING CONCRETE DETAILS. SEE STRUCTURAL DWG SHEET SD505
3. SEE STRUCTURAL DWG SB304 FOR ADDITIONAL INFORMATION ON REACH 8A INSET CHANNEL TYPE B RESTING POCKET CROSS SECTION.

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HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: REACH 8A INSET CHANNEL RESTING POCKET DETAILS TYPE B
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

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		5/4/2022	

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APPROVED BY:	NT	5/4/2022

WORK ORDER
E1908721

SHEET NAME
CI508

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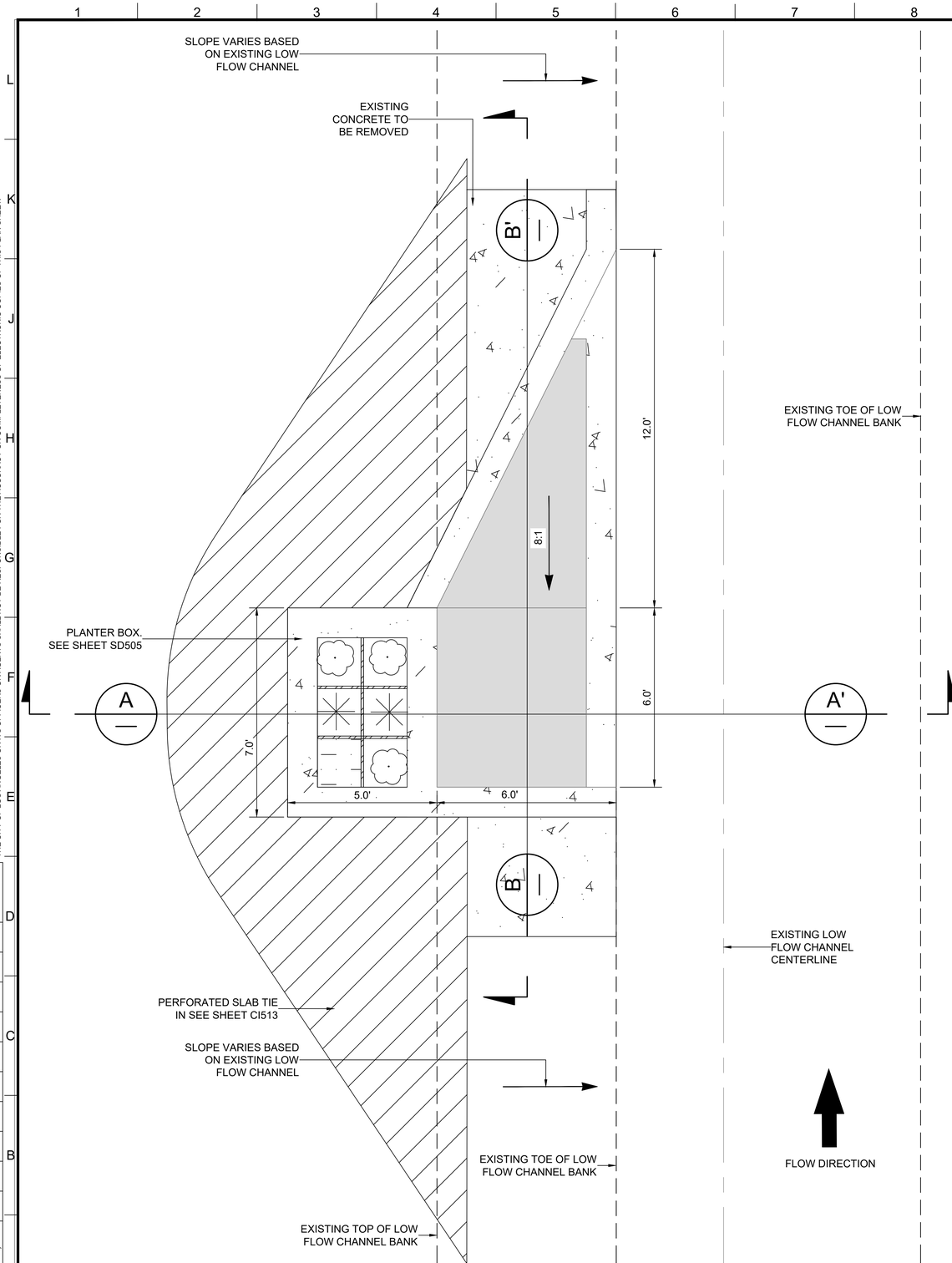
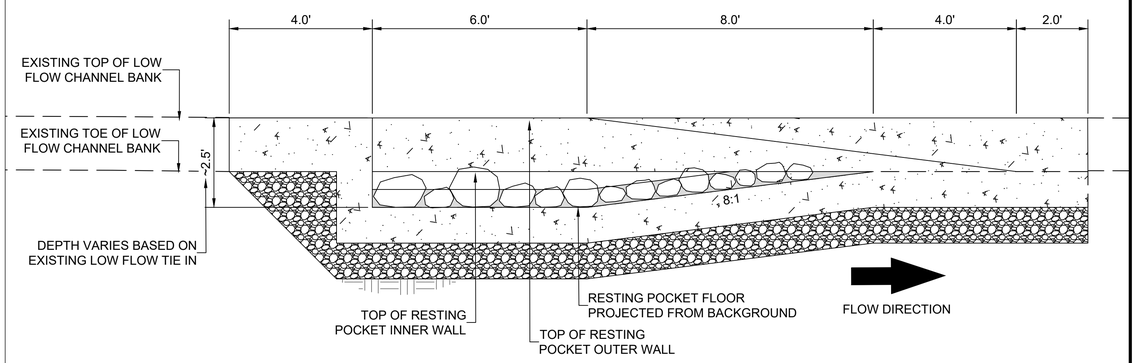


G12 / CI213 REACH 8A TYPE C RESTING POCKET WITH PLANTER BOX (WITHIN EXISTING LOW FLOW CHANNEL)
SCALE: 1" = 2'

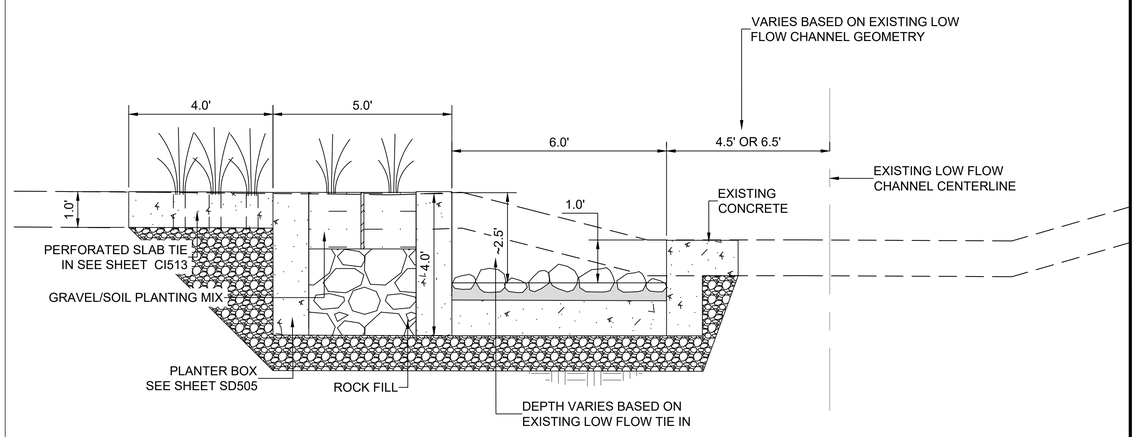
LEGEND

- EXISTING CONCRETE
- NEW CONCRETE CHANNEL
- NEW DRAIN ROCK
- NEW GROUTED ROCK LINING
- NEW PERFORATED SLAB TIE IN
- EXISTING SUBGRADE

NOTE:
1. FOR SUBGRADE AND DRAINAGE LAYER DETAILS. SEE STRUCTURAL DWG SHEET SB304
2. FOR TIE-IN TO EXISTING CONCRETE DETAILS. SEE STRUCTURAL DWG SHEET SD505
3. SEE STRUCTURAL DWG SB304 FOR ADDITIONAL INFORMATION ON REACH 8A RESTING POCKET CROSS SECTIONS.



B-B' REACH 8A TYPE C RESTING POCKET PROFILE VIEW
SCALE: 1" = 2'



A-A' REACH 8A TYPE C RESTING POCKET SECTION VIEW
SCALE: 1" = 2'

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BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: REACH 8A EXISTING LOW FLOW CHANNEL RESTING POCKET DETAIL TYPE C
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

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		5/4/2022	
		5/4/2022	

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ARCHITECT:	---	5/4/2022
DESIGNED BY:	EW	5/4/2022
DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

WORK ORDER E1908721

SHEET NAME CI509

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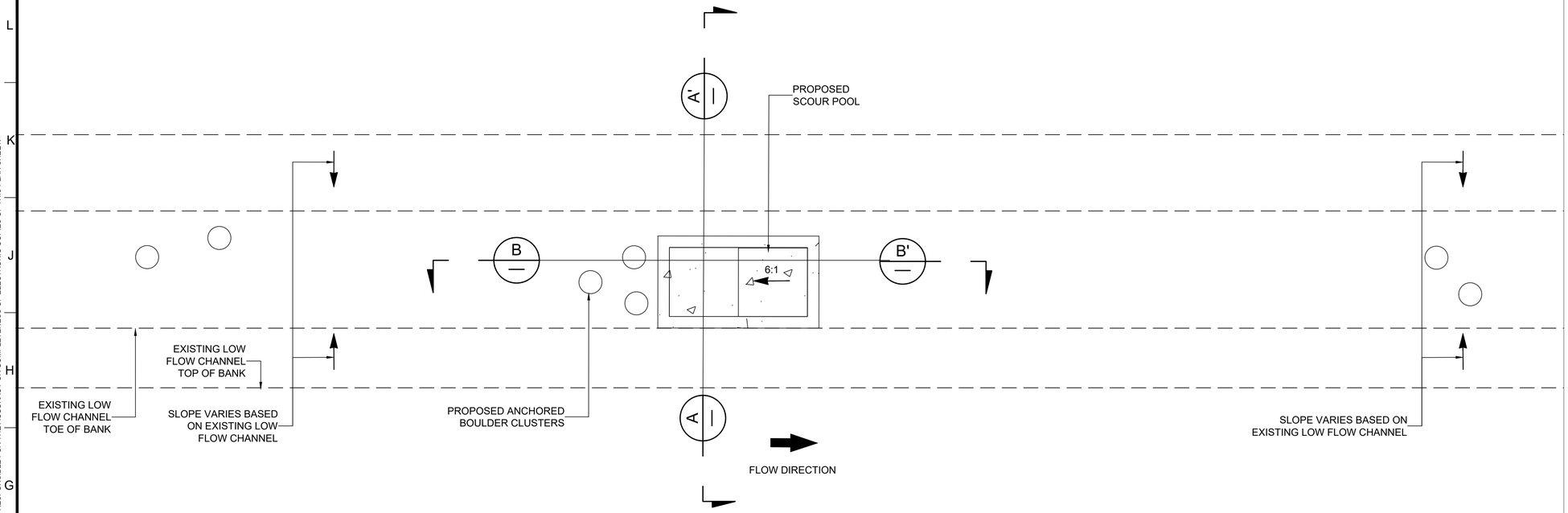


G13 / CI403 REACH 8A ANCHORED BOULDER AND SCOUR POOL DETAIL

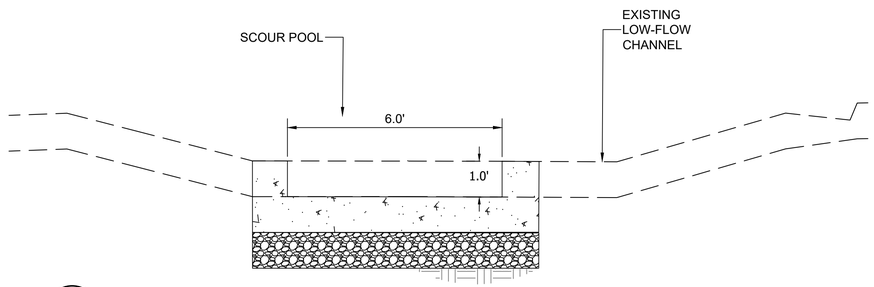
SCALE: 1" = 5'

LEGEND

- EXISTING CONCRETE
- NEW CONCRETE CHANNEL
- NEW DRAIN ROCK
- NEW GROUTED ROCK LINING
- NEW PERFORATED SLAB TIE IN
- EXISTING SUBGRADE

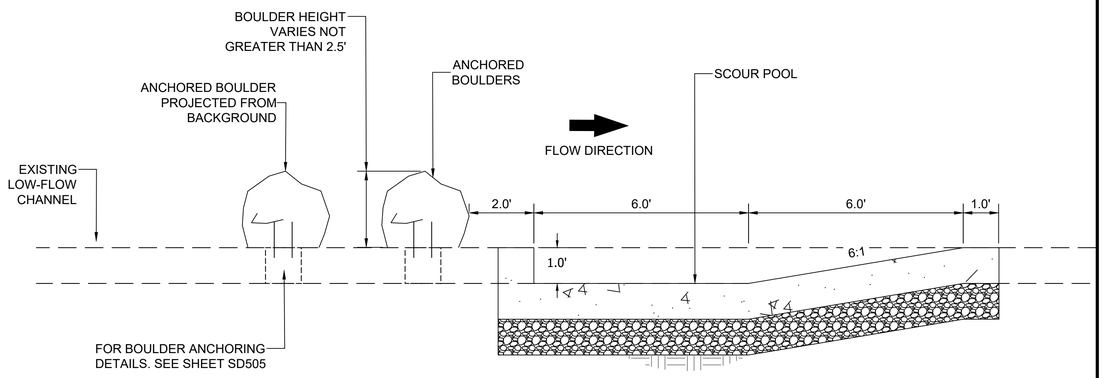
NOTE:

1. FOR SUBGRADE AND DRAINAGE LAYER DETAILS. SEE STRUCTURAL DWG SHEET SB304
2. FOR TIE-IN TO EXISTING CONCRETE DETAILS. SEE STRUCTURAL DWG SHEET SD505



A-A' REACH 8A SCOUR POOL IN EXISTING LOW FLOW CHANNEL SECTION VIEW

SCALE: 1" = 2'



B-B' REACH 8A EXISTING LOW FLOW CHANNEL WITH SCOUR POOL AND ANCHORED BOULDER PROFILE VIEW

SCALE: 1" = 2'

THE CITY OF LOS ANGELES OR ITS OFFICERS OR AGENTS SHALL NOT BE RESPONSIBLE FOR THE ACCURACY OR COMPLETENESS OF ELECTRONIC COPIES OF THIS PLAN SHEET.

REVISION DATES (DESIGN STAGE ONLY)

ENGINEERING
CITY OF LOS ANGELES

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BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: REACH 8A LOW FLOW CHANNEL BOULDER & SCOUR POOL DETAILS
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
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		5/4/2022	
		5/4/2022	
		5/4/2022	

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CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

CITY ENGINEER: GARY LEE MOORE, P.E., ENV SP — DATE: 5/4/2022

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		DATE
ENGINEER:	NT	5/4/2022
ARCHITECT:	----	5/4/2022
DESIGNED BY:	EW	5/4/2022
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CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

WORK ORDER
E1908721

SHEET NAME
CI510

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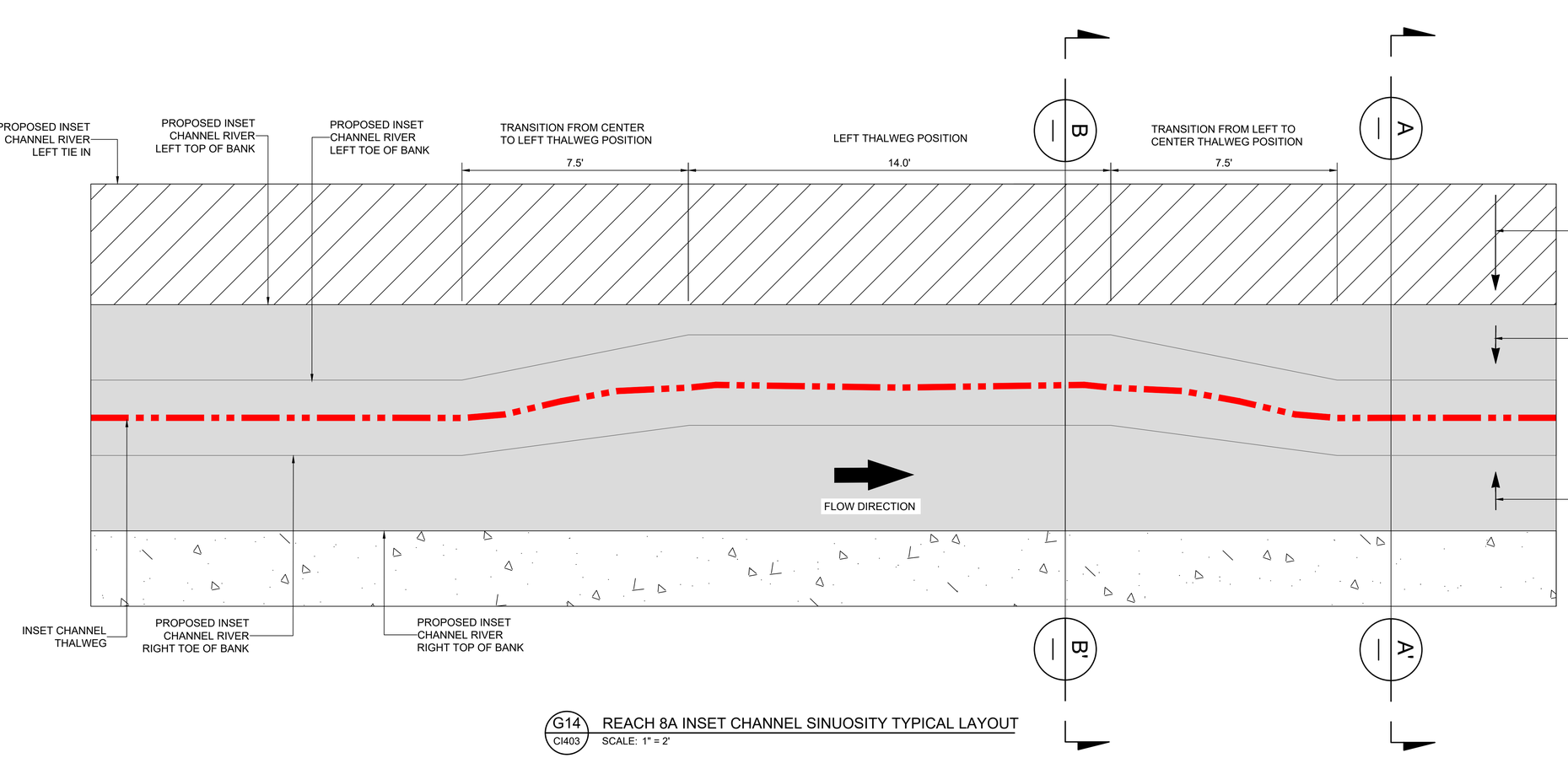


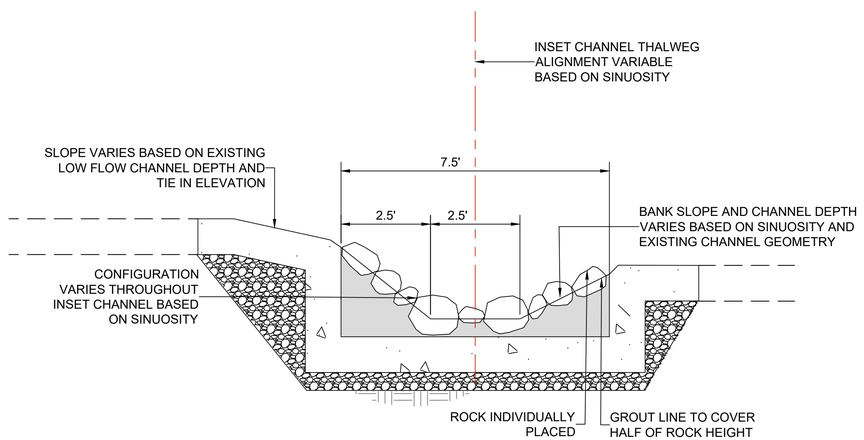
G14 / CI403 REACH 8A INSET CHANNEL SINUOSITY TYPICAL LAYOUT
SCALE: 1" = 2'

LEGEND

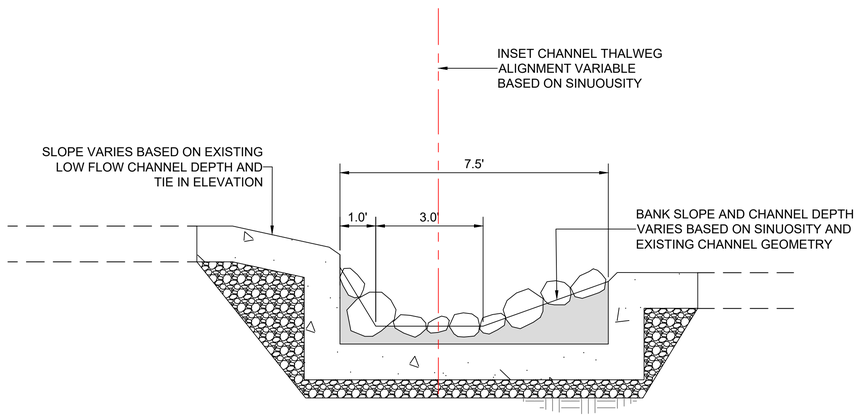
- EXISTING CONCRETE
- NEW CONCRETE CHANNEL
- NEW DRAIN ROCK
- NEW GROUTED ROCK LINING
- NEW PERFORATED SLAB TIE IN
- EXISTING SUBGRADE

NOTE:
1. FOR SUBGRADE AND DRAINAGE LAYER DETAILS. SEE STRUCTURAL DWG SHEET SB304
2. FOR TIE-IN TO EXISTING CONCRETE DETAILS. SEE STRUCTURAL DWG SHEET SD505
3. GROUTED ROCK MATERIAL SHALL CONFORM TO THE FOLLOWING GRADATION:

GROUTED ROCK GRADATION		
% PASSING	MIN (IN)	MAX (IN)
D100	24	24
D84	15	20
D50	6	9
D15	4	5



A-A' REACH 8A SECTION - CENTER THALWEG GROUTED ROCK CONFIGURATION
SCALE: 1"=2'



B-B' REACH 8A SECTION - LEFT THALWEG GROUTED ROCK CONFIGURATION
SCALE: 1"=2'

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ENGINEERING
CITY OF LOS ANGELES

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: REACH 8A ROCK LINING PLACEMENT & GROUTED ROCK DETAIL
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

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		5/4/2022	

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GARY LEE MOORE, P.E., ENV SP — CITY ENGINEER — DATE 5/4/2022

DESIGN GROUP	
ENGINEER:	NT
ARCHITECT:	----
DESIGNED BY:	EW
DRAWN BY:	KRE
CHECKED BY:	TRS
APPROVED BY:	NT

(all dates 5/4/2022)

WORK ORDER
E1908721

SHEET NAME
CI511

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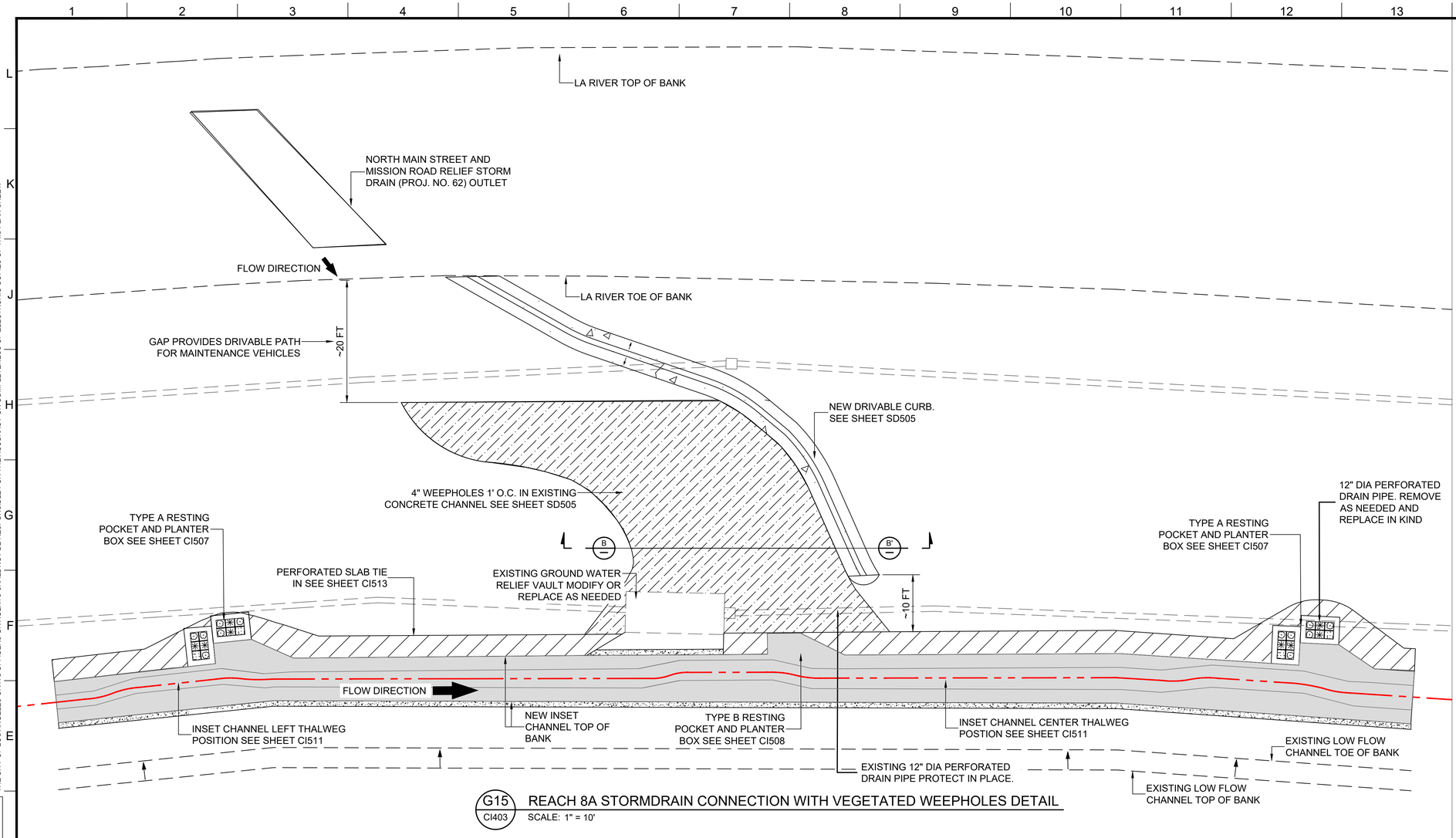
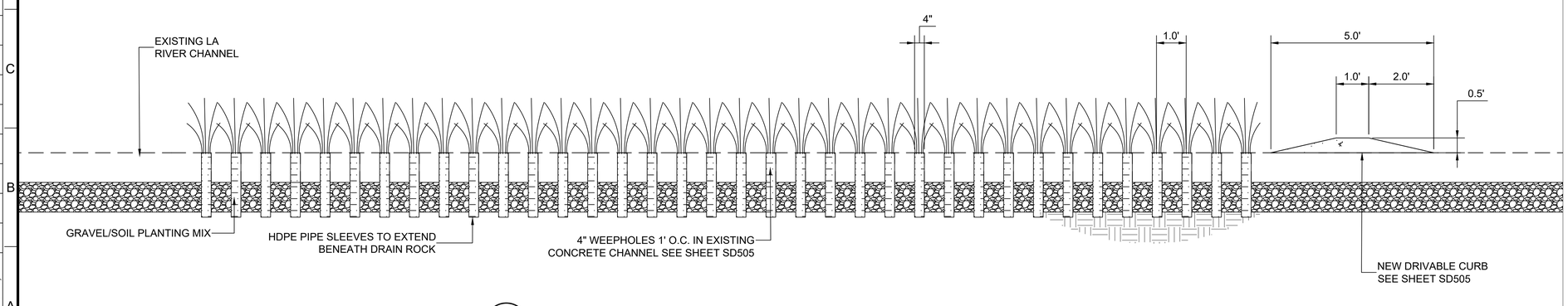


G15 / CI403 REACH 8A STORMDRAIN CONNECTION WITH VEGETATED WEEPHOLES DETAIL

SCALE: 1" = 10'



B-B' REACH 8A STORMDRAIN CONNECTION WITH VEGETATED WEEPHOLES SECTION VIEW

SCALE: 1" = 2'

LEGEND

- EXISTING CONCRETE
- NEW CONCRETE CHANNEL
- NEW DRAIN ROCK
- NEW GROUTED ROCK LINING
- NEW PERFORATED SLAB TIE IN
- EXISTING SUBGRADE

NOTE:

1. SPACING OF WEEPHOLES WILL DEPEND ON FIELD VERIFYING EXISTING COMPETENCY OF CONCRETE AND REBAR SPACING

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BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: REACH 8A STORMDRAIN CONNECTION & CURB DETAIL
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

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CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

CITY ENGINEER: GARY LEE MOORE, P.E., ENV.SP — DATE: 5/4/2022

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DRAWN BY:	KRE	5/4/2022
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

WORK ORDER
E1908721

SHEET NAME
CI512

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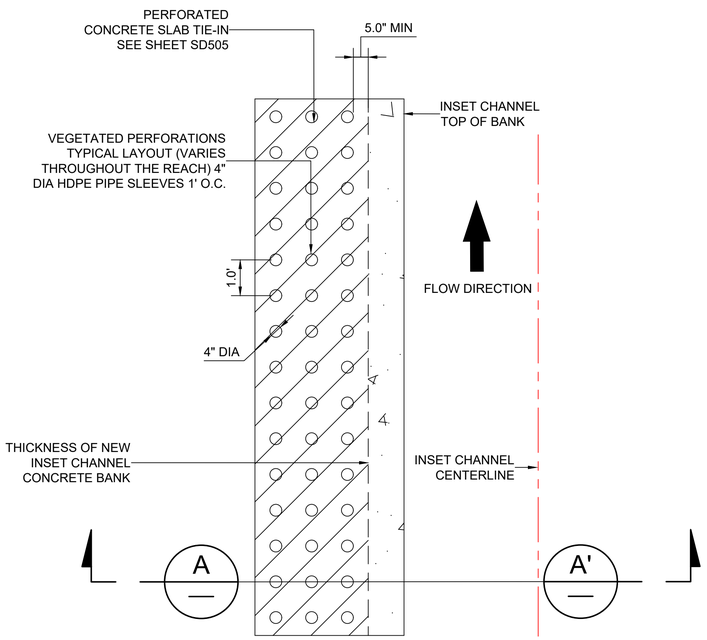
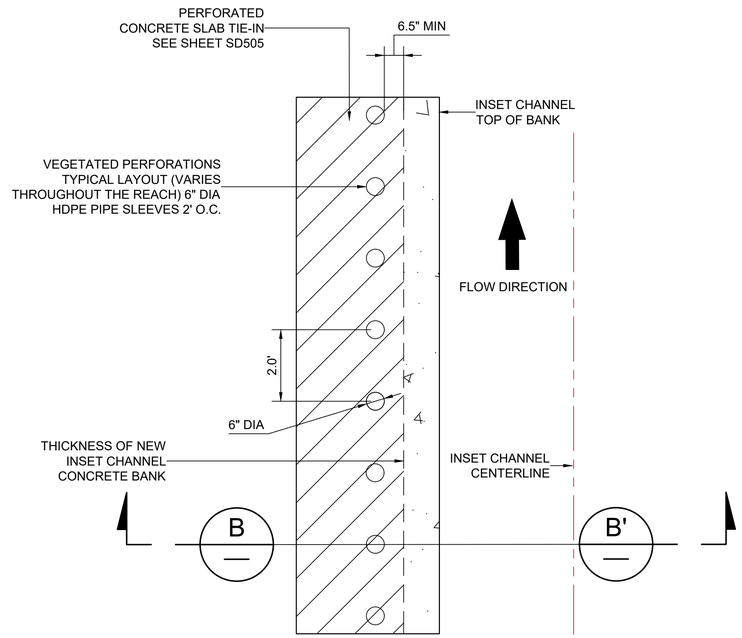


G16 / CI403 — 4.8-MILE REACH & REACH 8A 4" DIA PERFORATED SLAB TIE IN DETAIL

SCALE: 1" = 2'



G17 / CI403 — 4.8-MILE REACH & REACH 8A 6" DIA PERFORATED SLAB TIE IN DETAIL

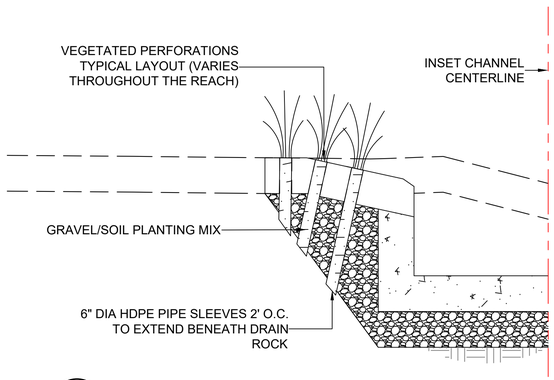
SCALE: 1" = 2'

LEGEND

- EXISTING CONCRETE
- NEW CONCRETE CHANNEL
- NEW DRAIN ROCK
- NEW GROUTED ROCK LINING
- NEW PERFORATED SLAB TIE IN
- EXISTING SUBGRADE

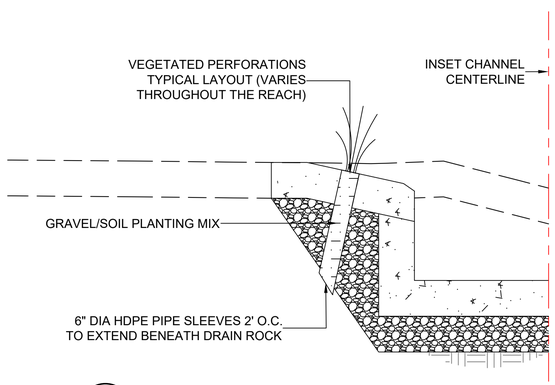
NOTE:

1. FOR SUBGRADE AND DRAINAGE LAYER DETAILS. SEE STRUCTURAL DWG SHEET SB304
2. FOR TIE-IN TO EXISTING CONCRETE DETAILS. SEE STRUCTURAL DWG SHEET SD505
3. SEE STRUCTURAL DWG SD505 FOR ADDITIONAL INFORMATION ON 4.8-MILE REACH AND REACH 8A PERFORATED SLAB DETAIL.



A-A' / CI503 — 4.8-MILE REACH & REACH 8A 4" DIA PERFORATED SLAB TIE IN SECTION VIEW

SCALE: 1" = 2'



B-B' / CI503 — 4.8-MILE REACH & REACH 8A 6" DIA PERFORATED SLAB TIE IN SECTION VIEW

SCALE: 1" = 2'

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CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH & REACH 8A PERFORATED SLAB DETAIL

PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN

ADDRESS: LOS ANGELES, CALIFORNIA

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		5/4/2022	
		5/4/2022	
		5/4/2022	

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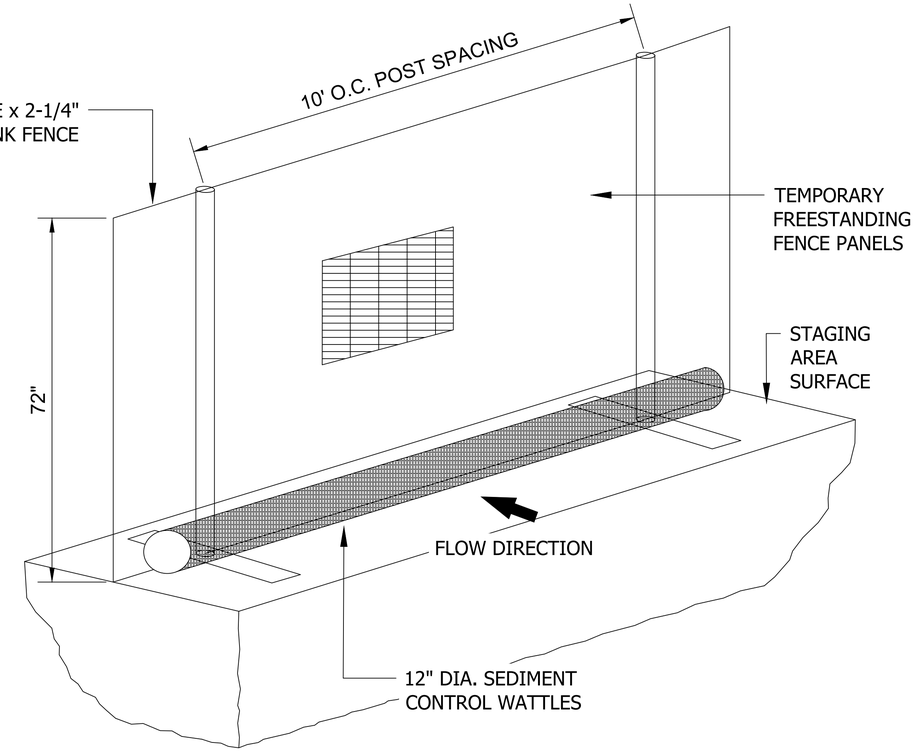
CHECKED BY:	TRS	5/4/2022
APPROVED BY:	NT	5/4/2022

WORK ORDER
E1908721

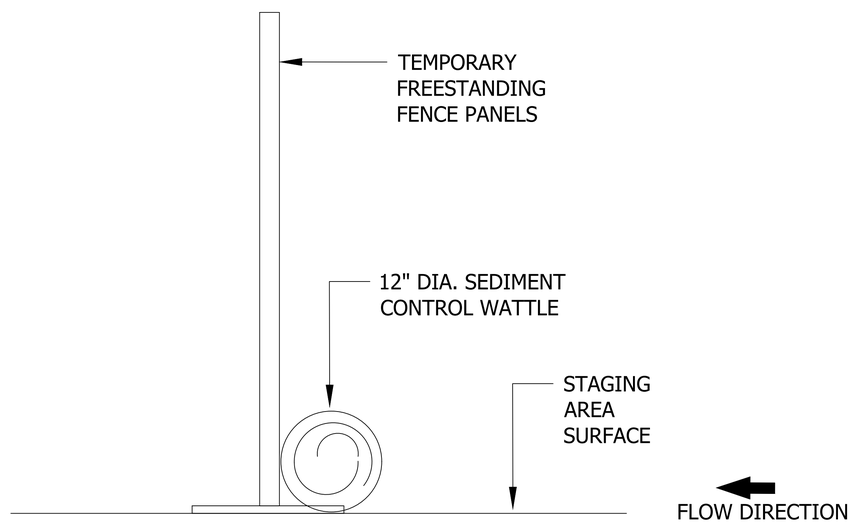
SHEET NAME
CI513

SHEET 35 OF 41 SHEETS

SHEET VERSION 4.0.1 FILE PATH: C:\STILLWATER SCIENCES\853.00 - LA RIVER FISH PASSAGE AND HABITAT - DOCUMENTS\CAD\DESIGN\03_CIVIL\C_DT_I_CI5_V2.DWG PLOT DATE: 5/4/2022 12:14 PM SAVED: 5/4/2022 11:41 AM SAVED BY:KEMANUELSON



G18 / GC101 STAGING AND ACCESS AREA CONSTRUCTION TEMPORARY CHAIN LINK FENCE AND SILT BARRIER
SCALE: NOT TO SCALE



G19 / GC101 STAGING AND ACCESS AREA CONSTRUCTION TEMPORARY CHAIN LINK FENCE AND SILT BARRIER
SCALE: NOT TO SCALE

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CITY OF LOS ANGELES

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BUREAU OF ENGINEERING

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: STAGING & ACCESS CONSTRUCTION FENCE & SILT BARRIER
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
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WORK ORDER
E1908721

SHEET NAME
CI514

SHEET 36 OF 41 SHEETS

STRUCTURAL PLANS FOR CONSTRUCTION OF LA RIVER FISH PASSAGE & HABITAT STRUCTURES

GENERAL NOTES

1. SPECIFICATIONS AND NOTES MAY BE PRESENTED SEPARATELY, BUT SUCH SEPARATION SHALL NOT BE CONSIDERED TO LIMIT THE WORK REQUIRED OF ANY PARTICULAR TRADE.
2. THE CONTRACTOR IS RESPONSIBLE FOR ALL CONSTRUCTION MEANS AND METHODS.
3. LOCATIONS AND DIMENSIONS OF EXISTING STRUCTURES AND FEATURES HAVE NOT BEEN VERIFIED. THE CONTRACTOR IS RESPONSIBLE FOR VERIFYING ALL CONTROLLING DIMENSIONS OF NEW AND EXISTING FEATURES PRIOR TO ORDERING OR FABRICATING MATERIAL OR CONSTRUCTING PROPOSED IMPROVEMENTS. REPORT ANY DISCREPANCIES TO THE ENGINEER PRIOR TO PROCEEDING WITH CONSTRUCTION OF THE FEATURE IN QUESTION.
4. PRIOR TO THE START OF CONSTRUCTION, LOCATE ALL EXISTING AND UNDERGROUND UTILITIES IN AND AROUND THE AREAS OF NEW CONSTRUCTION. VERIFY THAT THE PROPOSED CONSTRUCTION DOES NOT CONFLICT WITH EXISTING OR PROPOSED UTILITIES OR THAT APPROPRIATE MEANS ARE PROVIDED FOR REROUTING, SUPPORTING, PROTECTING, OR OTHERWISE INCORPORATING THE UTILITIES INTO THE CONSTRUCTION.
5. THE CONTRACTOR SHALL TAKE ALL PRECAUTIONARY MEASURES NECESSARY TO PROTECT FROM DAMAGE EXPOSED SUBGRADES, EXISTING IMPROVEMENTS, AND SURVEY MONUMENTS THAT ARE TO REMAIN IN PLACE. SUBGRADES AND IMPROVEMENTS DAMAGED BY THE CONTRACTOR'S OPERATIONS SHALL BE EXPEDITIOUSLY REPAIRED OR RECONSTRUCTED. CONTRACTOR SHALL NOTIFY THE OWNER OF DAMAGE AND OBTAIN APPROVAL TO REPAIR ALL DAMAGE BEFORE REPAIR WORK IS PERFORMED.
6. DURING CONSTRUCTION ACTIVITIES, THE CONTRACTOR SHALL VISUALLY MONITOR THE WORK AREA AND ADJACENT IMPROVEMENTS ON A DAILY BASIS FOR INDICATIONS OF MOVEMENT. THE CONTRACTOR SHALL STOP OPERATIONS IF DEFLECTION OR DISTRESS IS OBSERVED AND SHALL IMMEDIATELY NOTIFY THE OWNER AND THE ENGINEER.
7. NOTIFY THE OWNER AND/OR ENGINEER WHERE A CONFLICT OR DISCREPANCY OCCURS BETWEEN THESE DRAWINGS AND ANY OTHER PORTION OF THE CONTRACT DOCUMENTS OR EXISTING FIELD CONDITIONS.
8. MONITOR ADJACENT PROPERTY BY SURVEYING OR OTHER RECORDABLE METHODS. ACTION SHALL BE TAKEN TO PREVENT ADJACENT PROPERTY OR UTILITY DAMAGE.
9. PRODUCTS REFERENCED ON THE DRAWINGS SHALL BE CONSTRUCTED, INSTALLED, AND/OR APPLIED IN ACCORDANCE WITH THE MANUFACTURER'S WRITTEN RECOMMENDATIONS UNLESS OTHERWISE NOTED.
10. DO NOT SCALE DRAWINGS. CONTACT THE ENGINEER FOR ANY DIMENSIONS OR REQUIRED DETAIL NOT SHOWN.
11. THE CONTRACTOR SHALL MAINTAIN COMPLETE AND ACCURATE "AS-BUILT" DRAWINGS THROUGHOUT THE COURSE OF CONSTRUCTION, INCLUDING, BUT NOT LIMITED TO, THE LOCATIONS AND GRADES OF ALL UNDERGROUND AND SURFACE IMPROVEMENTS. THESE RECORDS SHALL BE MARKED IN RED (INCLUDE), GREEN (REMOVE), BLUE (COMMENTS/DIRECTIONS) STANDARD FORMAT AND SHALL BE DELIVERED TO THE OWNER WITHIN 30 DAYS AFTER RETURN TO SERVICE.

DESIGN BASIS AND LOADING

1. THE DESIGNS DEPICTED IN THESE DRAWINGS ARE BASED ON INFORMATION PROVIDED IN THE FOLLOWING REFERENCES:
   A. DRAFT GEOTECHNICAL REPORT BY GANNETT FLEMING INC., DATED NOVEMBER 24, 2020.
   B. CIVIL DESIGN DRAWINGS BY STILL WATER SCIENCES DATED MARCH 21, 2022.
   C. AS-BUILT DRAWINGS
2. DESIGN IS IN ACCORDANCE WITH THE FOLLOWING CODES AND STANDARDS:
   - 2019 CALIFORNIA BUILDING CODE
   - ACI 350-06, CODE REQUIREMENTS FOR ENVIRONMENTAL ENGINEERING CONCRETE STRUCTURES
   - AISC STEEL CONSTRUCTION MANUAL, 14TH EDITION
   - AWS D1.1 STRUCTURAL WELDING CODE
3. GEOTECHNICAL DESIGN PARAMETERS:
   - ACTIVE PRESSURE = 40 PCF
   - AT-REST EQUIVALENT FLUID PRESSURE = 60 PCF
   - ALLOWABLE LATERAL PRESSURE = 88 PSF
   - ALLOWABLE BEARING PRESSURE = 1938 PSF
   - COEFFICIENT OF FRICTION = 0.25
4. DESIGN LOADS:
   - DEAD LOADS :
     CONCRETE = 150 PCF
     STEEL = 490 PCF
   - VERTICAL TRAFFIC SURCHARGE = 250 PSF
5. SEISMIC DESIGN PARAMETERS:
   - SDS = 1.34g
   - PEAK GROUND ACCELERATION (MODIFIED) = 0.95g
   - SEISMIC COEFFICIENT (Kh) = 0.59g
6. STRUCTURES HAVE BEEN DESIGNED FOR OPERATIONAL LOADS ON THE COMPLETED STRUCTURES ONLY. PROTECT THE STRUCTURE WHERE EXCESSIVE CONSTRUCTION LOADS MAY OCCUR.

DEMOLITION

1. PROTECT EXISTING FEATURES THAT ARE TO REMAIN IN PLACE FROM DAMAGE UNLESS OTHERWISE NOTED.
2. REMOVE DETERIORATED AND DELAMINATED CONCRETE BY BREAKING UP AND DISLODGING FROM REINFORCEMENT USING CHIPPING, HYDRODEMOLITION, OR A COMBINATION OF BOTH.

EARTHWORK

1. NOTIFY UNDERGROUND SERVICE ALERT (USA NORTH) TO IDENTIFY THE LOCATION OF EXISTING UTILITIES AT LEAST TWO WORKING DAYS PRIOR TO ANY EXCAVATION WORK: (800)-227-2600 OR WWW.USANORTH.ORG.
2. THE CONTRACTOR IS RESPONSIBLE FOR STABILITY AND SHORING OF TEMPORARY CUT SLOPES AND TRENCHES, AND SHALL CONFORM TO THE REQUIREMENTS OF CAL-OSHA. THE MAXIMUM EFFECTIVE BACK SLOPE IS 1 $\frac{1}{2}$:1 (HORIZONTAL TO VERTICAL).
3. EXCAVATIONS SHALL BE KEPT CLEAN AND DRY FOR THE DURATION OF THE WORK PERFORMED.
4. ENGINEERED FILL, WHERE REQUIRED, SHALL BE PLACED IN MAXIMUM 8-INCH THICK LOOSE LIFTS, MOISTURE-CONDITIONED WITHIN 2% OF OPTIMUM MOISTURE CONTENT, AND COMPACTED TO A MINIMUM OF 95% RELATIVE COMPACTION.
5. DRAIN ROCK AND FILTER MATERIAL SHALL MATCH EXISTING IN KIND.

TEMPORARY ENVIRONMENTAL/EROSION CONTROL

1. CONTAIN SURFACE RUNOFF AND CEMENTITIOUS MATERIAL DURING CONSTRUCTION TO PREVENT CONTAMINATION OF GROUND AND SURFACE WATERS.
2. MAINTAIN THE SITE AND ADJACENT PROPERTY IN A CLEAN, SAFE, AND USABLE CONDITION. ALL SPILLS OF SOIL, ROCK, OR CONSTRUCTION DEBRIS SHALL BE PROMPTLY REMOVED.
3. CONTRACTOR IS RESPONSIBLE FOR IMPLEMENTING ACTIVITY-SPECIFIC EROSION AND SEDIMENT CONTROL PLAN (A-ESCP) AND BEST MANAGEMENT PRACTICES (BMPS) AS OUTLINED IN THE CITY OF LOS ANGELES STORM WATER FIELD MANUAL FOR CONSTRUCTION AND MAINTENANCE PROJECTS.

CONCRETE

1. CONCRETE STRENGTH AND MIX REQUIREMENTS:
   - MINIMUM 28-DAY COMPRESSIVE STRENGTH (f'c) = 4500 PSI
   - MAXIMUM WATER/CEMENT RATIO = 0.42
   - MAXIMUM AGGREGATE SIZE = 1-$\frac{1}{2}$"
   - AIR ENTRAINMENT = 4.5% MIN (SEE ACI 350-06 TABLE 4.2.1 FOR SMALLER AGGREGATE SIZE, ASSUME MODERATE EXPOSURE)
   - CEMENT = ASTM C150 TYPE II
   - EXPOSURE CLASSES:
     FREEZING AND THAWING = F2
     SULFATE = S0
     PERMEABILITY = W1
     CORROSION = C1
2. EXPOSED CONCRETE EDGES SHALL HAVE A $\frac{3}{4}$" CHAMFER
3. REINFORCING STEEL:
   - DEFORMED REBAR = ASTM A615, GRADE 60 (fy = 60 KSI)
4. REINFORCEMENT SPACING SHOWN IS CENTER TO CENTER OF BARS
5. UNLESS OTHERWISE NOTED, MAINTAIN COVERAGE TO THE FACE OF REBAR AS FOLLOWS:
   - CONCRETE CAST AGAINST EARTH = 3"
   - CONCRETE EXPOSED TO EARTH OR WEATHER:
     #5 AND SMALLER = 1 $\frac{1}{2}$"
     #6 AND GREATER = 2"
   - CONCRETE CAST AGAINST OTHER SURFACES = 1 $\frac{1}{2}$"
6. MINIMUM DEVELOPMENT AND LAP LENGTHS SHALL CONFORM TO TABLE 1, THIS SHEET.
7. USE SIMPSON STRONG-TIE-XP OR HILTI HIT HY 200 ANCHORING ADHESIVE, OR APPROVED EQUAL FOR DRILLED AND EPOXIED STEEL REINFORCEMENT.
8. WHERE FEASIBLE, CONCRETE SHALL BE PLACED MONOLITHICALLY THROUGH THE CHANNEL CROSS SECTION. WHERE CHANNEL SECTIONS ARE CONSTRUCTED SEPARATELY, INSTALL MASTIC WATERSTOP PER DETAIL X/DWG SD006.

CONCRETE ANCHORS

1. THOROUGHLY CLEAN DRILLED HOLES FOR ANCHORAGE PRIOR TO INSTALL.
2. THREADED RODS FOR CONCRETE ANCHORAGE SHALL BE ASTM F568M, CLASS 5.8.
3. ANCHOR EPOXY SHALL BE HILTI RE 500 V3, OAE.
4. ANCHORS SHALL BE INSTALLED IN HAMMED DRILLED HOLES PER THE MANUFACTURER'S RECOMMENDATIONS.

INSPECTION AND OBSERVATION

1. CONTRACTOR WILL PROVIDE QUALITY CONTROL RELATED TO CONSTRUCTION. THE OWNER WILL PROVIDE QUALITY ASSURANCE, MATERIALS TESTING AND SPECIAL INSPECTION RELATED TO CONSTRUCTION. THE OWNER WILL RETAIN THE SERVICES OF A CERTIFIED TESTING LABORATORY TO PERFORM ALL QUALITY ASSURANCE TESTS OF THE CONTRACTOR'S WORK. THE CONTRACTOR SHALL NOT CONSTRUE THE PERIODIC OBSERVATION AND/OR TESTING OF THE CONTRACTOR'S WORK AS PARTIAL OR INCREMENTAL ACCEPTANCE OF THE CONTRACTOR'S WORK. ONLY THE CERTIFIED TEST BY THE TESTING LABORATORY CAN BE USED TO VERIFY THE CONTRACTOR'S COMPLIANCE WITH THE PROJECT SPECIFICATIONS.
2. CONSTRUCTION OBSERVATION BY A QUALIFIED INSPECTOR AND/OR THE ENGINEER IS REQUIRED AT THE FOLLOWING STAGES OF CONSTRUCTION:
   - SUBGRADE PREPARATION
   - PLACEMENT OF NEW SUBDRAINS AND CLEANOUTS
   - PLACEMENT OF REINFORCING STEEL
   - PLACEMENT OF CONCRETE
   - PLACEMENT OF DOWELS FOR ANCHORED BOULDERS
3. REFER TO THE SPECIFICATIONS AND CONTRACT DOCUMENTS FOR ADDITIONAL QUALITY CONTROL/INSPECTION REQUIREMENTS.
4. NOTIFY THE INSPECTOR/ENGINEER AT LEAST 48 HOURS BEFORE INSPECTION OR OBSERVATION IS NEEDED.

LEGEND & ABBREVIATIONS

AB	AGGREGATE BASE
APPROX	APPROXIMATE
BOC	BOTTOM OF CONCRETE
CIP	CAST-IN-PLACE
CJ	CONSTRUCTION JOINT
℄	CENTER LINE
CLR	CLEAR
CMP	CORRUGATED METAL PIPE
CONC	CONCRETE
D/S	DOWNSTREAM
DIA OR Ø	PIPE DIAMETER
DEMO	DEMOLISH
DWG	DRAWING
EG	EXISTING GRADE
EJ	EXPANSION JOINT
ER	EDGE OF ROAD
FG	FINISHED GRADE
FL	FLOW LINE
FND	FOUNDATION
FV	FIELD VERIFY
INV	INVERT
LF	LINEAR FEET
MAX	MAXIMUM
MIN	MINIMUM
OAE	OR APPROVED EQUIVALENT
OC	ON CENTER
PIP	PROTECT-IN-PLACE
PVC	POLYVINYL CHLORIDE
RC	RELATIVE COMPACTION
REINF	REINFORCEMENT
S	SLOPE
SCH	SCHEDULE
SPEC	SPECIFICATION
SQ	SQUARE
STD	STANDARD
TOC	TOP OF CONCRETE
TOT	TOTAL
TYP	TYPICAL
U/S	UPSTREAM
⇨	FLOW PATH

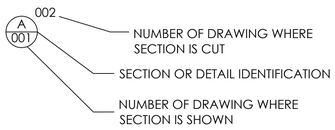

TABLE 1 - REQUIRED DEVELOPMENT/ LAP SPLICE LENGTH[A]

BAR SIZE	DEV LENGTH (IN)	CLASS B LAP SPLICE (IN)	STD HOOKS DEV L_{DH} (IN)
#4	15	24	5
#6	22	36	8
#8	45	59	11

A. BASED ON ACI 350-06 SECTIONS 12.2.2, 12.5, AND 12.15.1.

SHEET INDEX

SHEET NO.	TITLE
1	STRUCTURAL NOTES & ABBREVIATIONS
2	4.8-MILE REACH TYPICAL SECTIONS
3	4.8-MILE REACH HOLDING POOL, RESTING POCKET, & BRIDGE TYPICAL SECTIONS
4	"REACH 8A" TYPICAL CHANNEL SECTION & RESTING POCKET SECTIONS
5	ANCHORED BOULDERS, PLANTED WEEP HOLES, & PERFORATED SLAB TIE-IN DETAILS

PROJECT CONTACT

ENGINEER OF RECORD

GANNETT FLEMING, INC.
TOM SELL, PE
PHONE: (916) 677-4800

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BUREAU OF ENGINEERING
ENGINEERING
CITY OF LOS ANGELES
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VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: STRUCTURAL NOTES & ABBREVIATIONS
PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN
ADDRESS: LOS ANGELES, CALIFORNIA

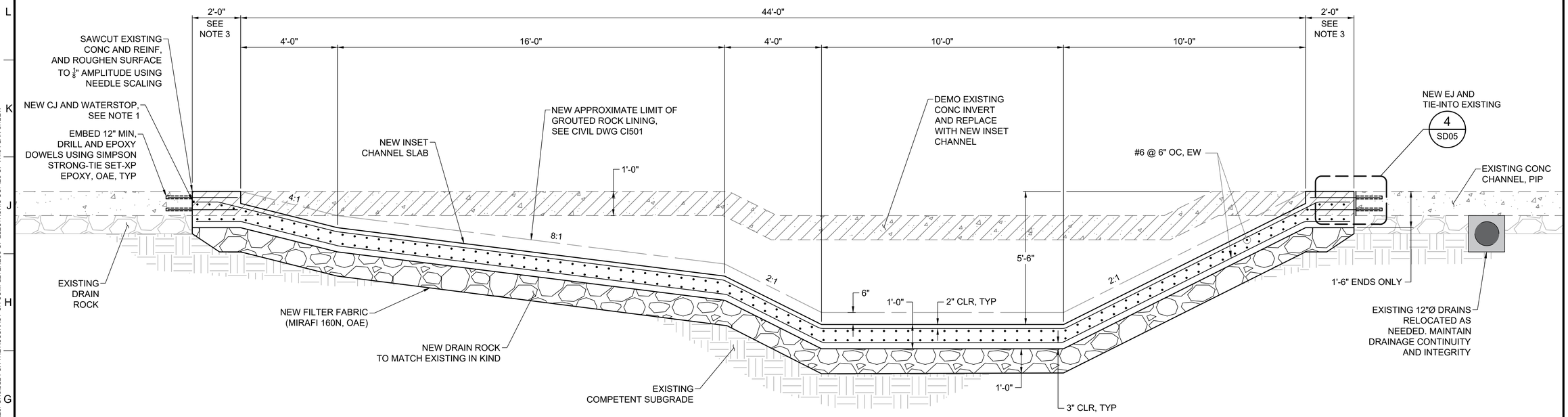
NO.	REVISIONS	DATE	BY
		YY/MM/DD	
		YY/MM/DD	
		YY/MM/DD	
		YY/MM/DD	

CIP NO. XXXX
INDEX NO. D-XXXXX

CITY ENGINEER	
DATE	22/05/04
GARY LEE MOORE, P.E., ENV SP	22/05/04
DESIGN GROUP	22/05/04
ENGINEER:	TOM SELL
ARCHITECT:	
DESIGNED BY:	C. REILLY
DRAWN BY:	C. REILLY
CHECKED BY:	J. ALLEN
APPROVED BY:	T. SELL

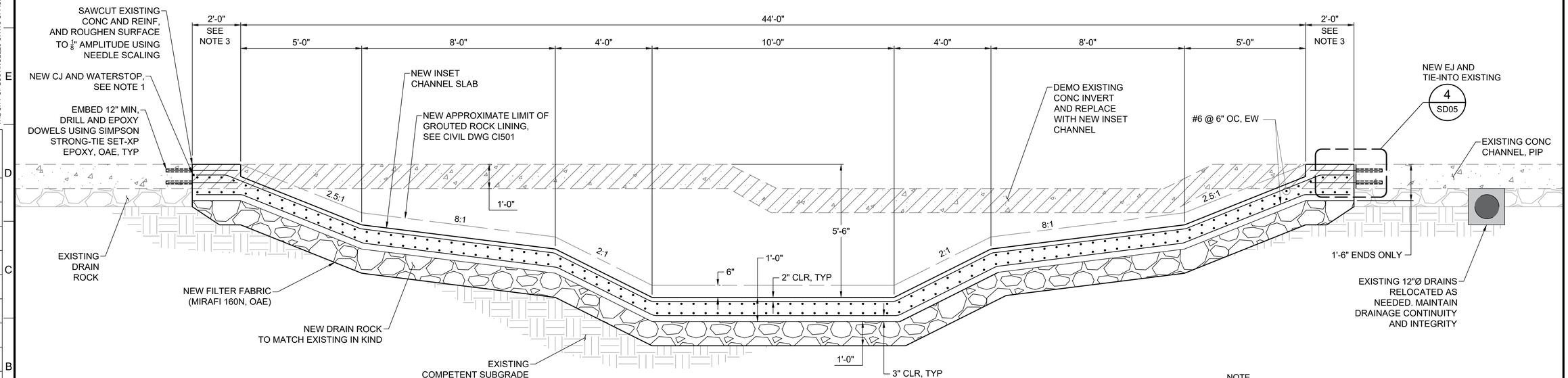
WORK ORDER
E1908721

SHEET NAME
SG001
SHEET 37 OF 41 SHEETS



4.8-MILE REACH TYPICAL CROSS SECTION (RIGHT ORIENTATION)

A SB02 SECTION
SCALE: 3"=1'-0"



4.8-MILE REACH TYPICAL CROSS SECTION (CENTER ORIENTATION)

B SB02 SECTION
SCALE: 1"=5'-0"

NOTE
1. INSTALL MASTIC WATER STOP "LOCKSTOP" BY GREENSTREAK, OAE. INSTALL PER MANUFACTURER'S RECOMMENDATIONS. USE WATER INTENSIVE EPOXY TO ADHERE WATER STOP TO CONSTRUCTION JOINT SURFACE. PROVIDE 1 INCH CLEAR COVER TO FACE OF BAR.
2. SEE CIVIL DWG CI501 FOR ADDITIONAL INFORMATION ON 4.8-MILE REACH TYPICAL CROSS SECTION.
3. FIELD FIT CONNECTION OF NEW CONCRETE TO EXISTING TO AVOID LOSS OF MATERIAL FROM BENEATH EXISTING CHANNEL.

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VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH TYPICAL SECTIONS

PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN

ADDRESS: LOS ANGELES, CALIFORNIA

NO.	REVISIONS	DATE	BY
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		YY/MM/DD	
		YY/MM/DD	
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CIP NO. XXXX

INDEX NO. D-XXXXX

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

CITY ENGINEER: GARY LEE MOORE, P.E., ENV SP — DATE: 22/05/04

DESIGN GROUP			
ENGINEER:	TOM SELL	22/05/04	
ARCHITECT:			
DESIGNED BY:	C. REILLY	22/05/04	
DRAWN BY:	C. REILLY	22/05/04	
CHECKED BY:	J. ALLEN	22/05/04	
APPROVED BY:	T. SELL	22/05/04	

WORK ORDER: E1908721

SHEET NAME: SB302

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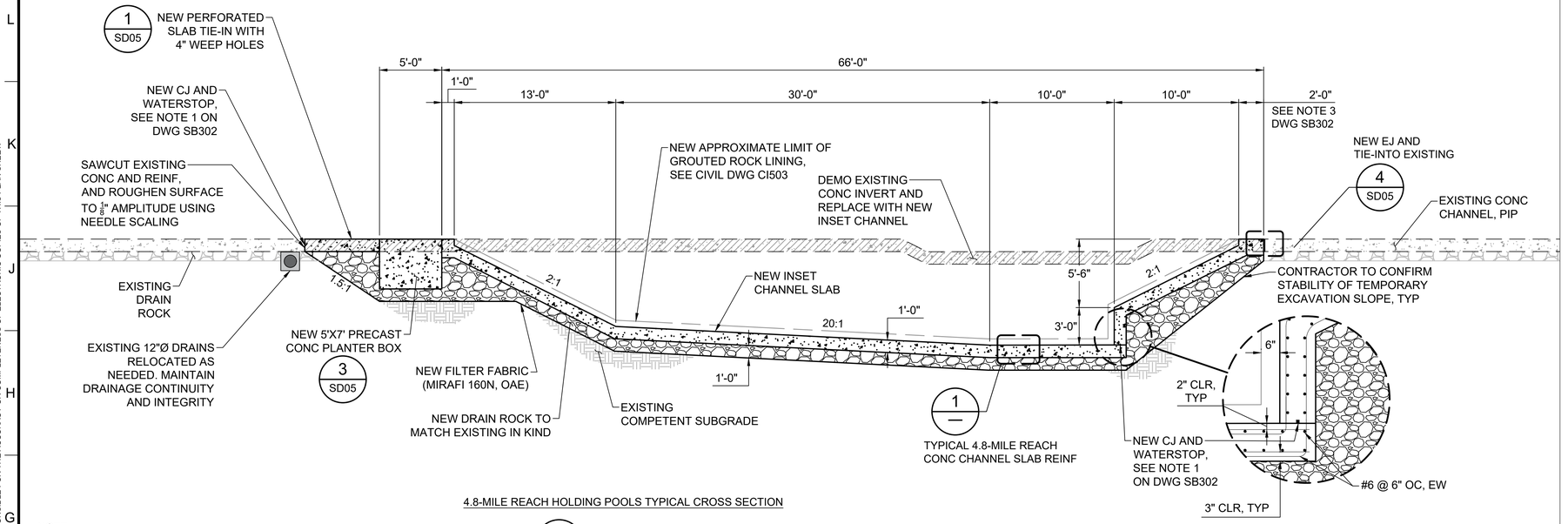
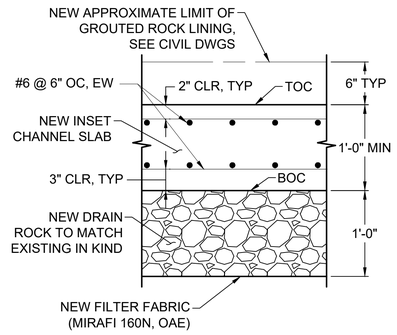


4.8-MILE REACH HOLDING POOLS TYPICAL CROSS SECTION

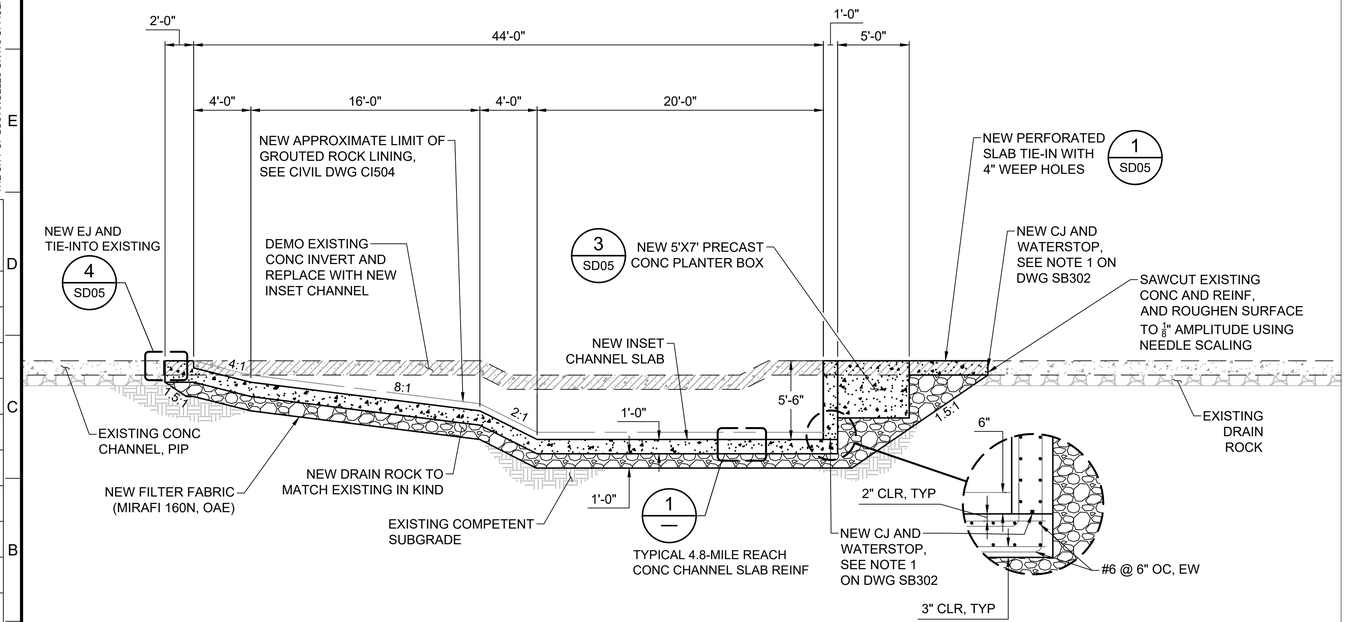
A SB03 SECTION
SCALE: 1"=5'-0"

NOTE
1. SEE CIVIL DWG CI503 FOR ADDITIONAL INFORMATION ON 4.8-MILE REACH HOLDING POOLS TYPICAL CROSS SECTION.



TYPICAL 4.8-MILE REACH CHANNEL SLAB REINFORCEMENT

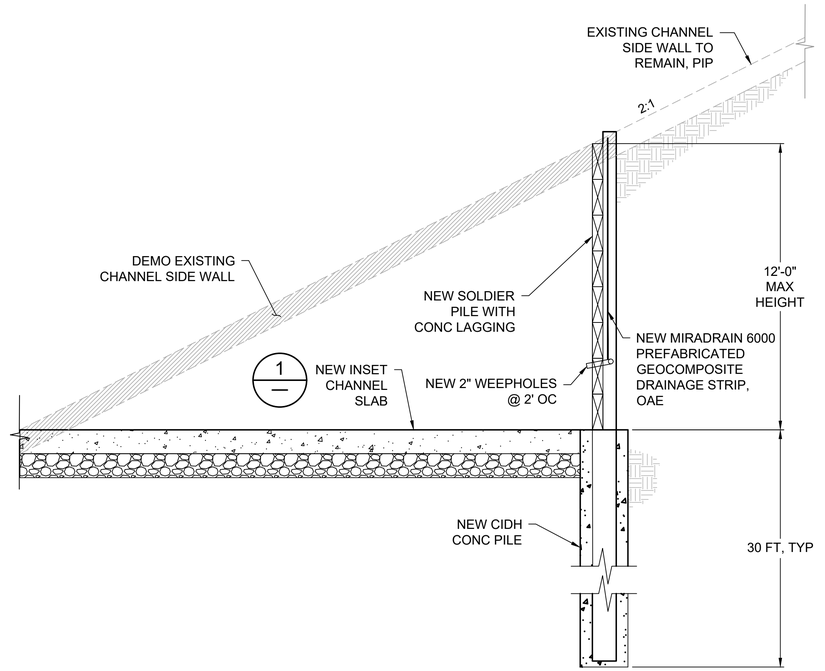
1 SB03 DETAIL
SCALE: 1"=10'-0"



4.8-MILE REACH RESTING POCKET TYPICAL CROSS SECTION

B SB03 SECTION
SCALE: 1"=5'-0"

NOTE
1. SEE CIVIL DWG CI504 FOR ADDITIONAL INFORMATION ON 4.8-MILE REACH RESTING POCKET TYPICAL CROSS SECTION.



4.8-MILE REACH OLYMPIC BLVD BRIDGE CROSS SECTION

C SB03 SECTION
SCALE: 1"=3'-0"

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HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: 4.8-MILE REACH HOLDING POOL, RESTING POCKET, & BRIDGE TYPICAL SECTIONS

PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN

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ENGINEER:	TOM SELL	22/05/04
ARCHITECT:		
DESIGNED BY:	C. REILLY	22/05/04
DRAWN BY:	C. REILLY	22/05/04
CHECKED BY:	J. ALLEN	22/05/04
APPROVED BY:	T. SELL	22/05/04

WORK ORDER
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SHEET NAME
SB303

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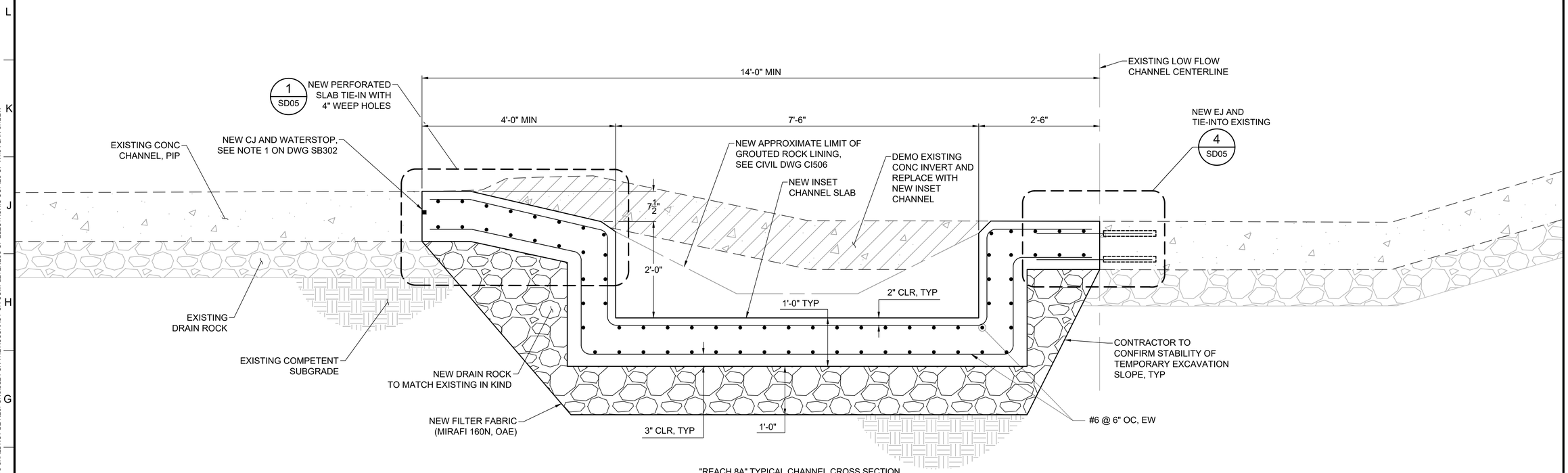
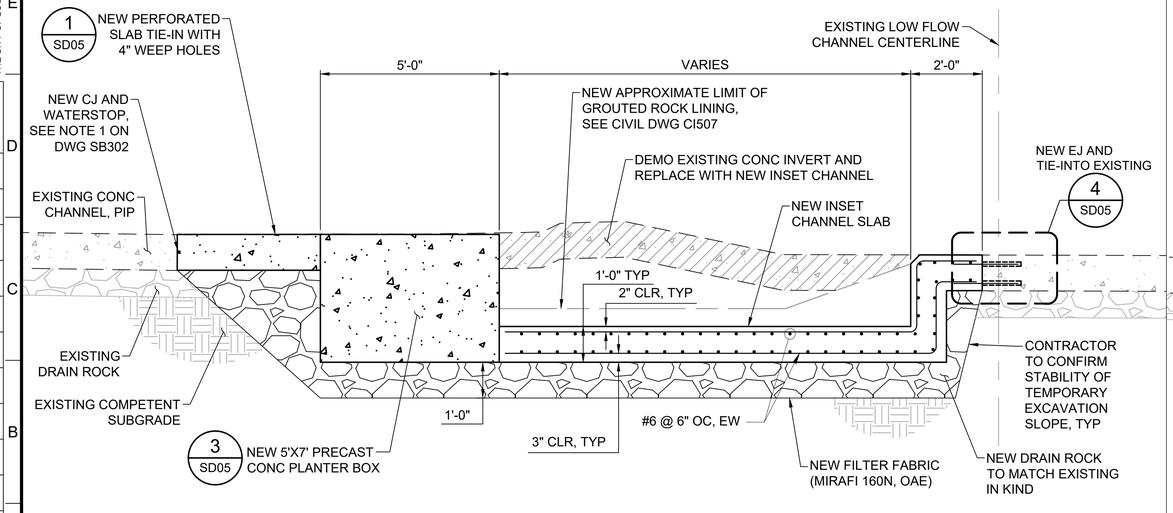


"REACH 8A" TYPICAL CHANNEL CROSS SECTION

A SB04 SECTION
SCALE: 1"=1'-0"

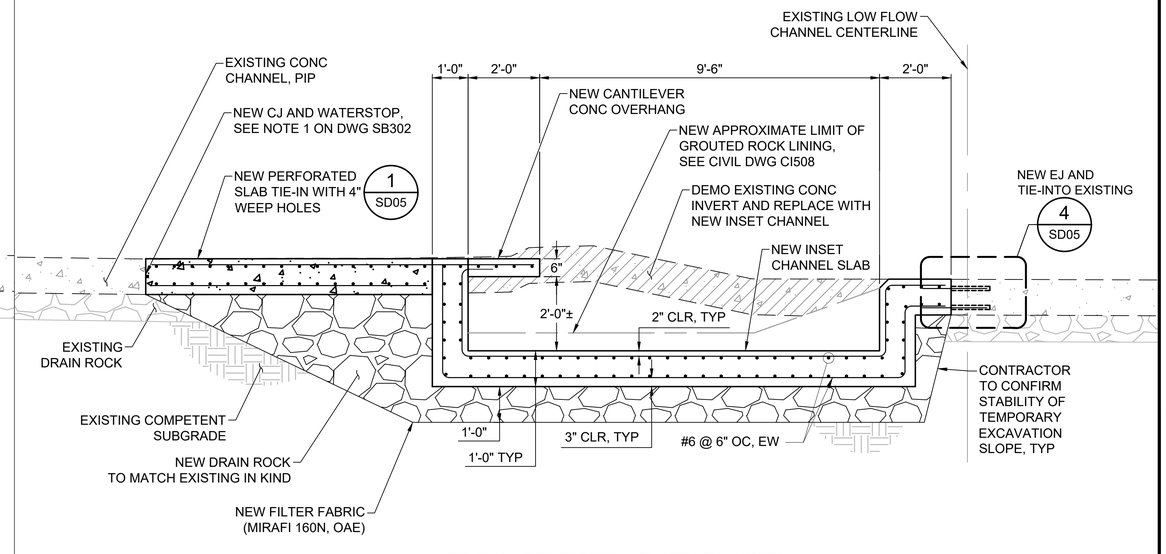
NOTE
1. SEE CIVIL DWG CI506 FOR ADDITIONAL INFORMATION ON "REACH 8A" TYPICAL CHANNEL CROSS SECTION.



"REACH 8A" TYPE "A" OR TYPE "C" RESTING POCKET CROSS SECTION

B SB04 SECTION
SCALE: 1"=2'-0"

NOTE
1. SEE CIVIL DWGS CI507 OR CI509 FOR ADDITIONAL INFORMATION ON "REACH 8A" TYPE "A" OR TYPE "C" RESTING POCKET CROSS SECTION.



"REACH 8A" TYPE "B" RESTING POCKET CROSS SECTION

C SB04 SECTION
SCALE: 1"=2'-0"

NOTE
1. SEE CIVIL DWG CI508 FOR ADDITIONAL INFORMATION ON "REACH 8A" TYPE "B" RESTING POCKET CROSS SECTION.

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VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: "REACH 8A" TYPICAL CHANNEL SECTION & RESTING POCKET SECTIONS

PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN

ADDRESS: LOS ANGELES, CALIFORNIA

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ARCHITECT:		
DESIGNED BY:	C. REILLY	22/05/04
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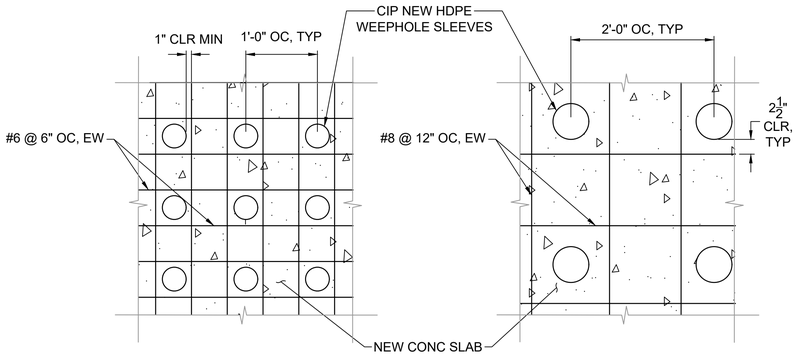
CHECKED BY:	J. ALLEN	22/05/04
APPROVED BY:	T. SELL	22/05/04

WORK ORDER
E1908721

SHEET NAME
SB304

SHEET 40 OF 41 SHEETS



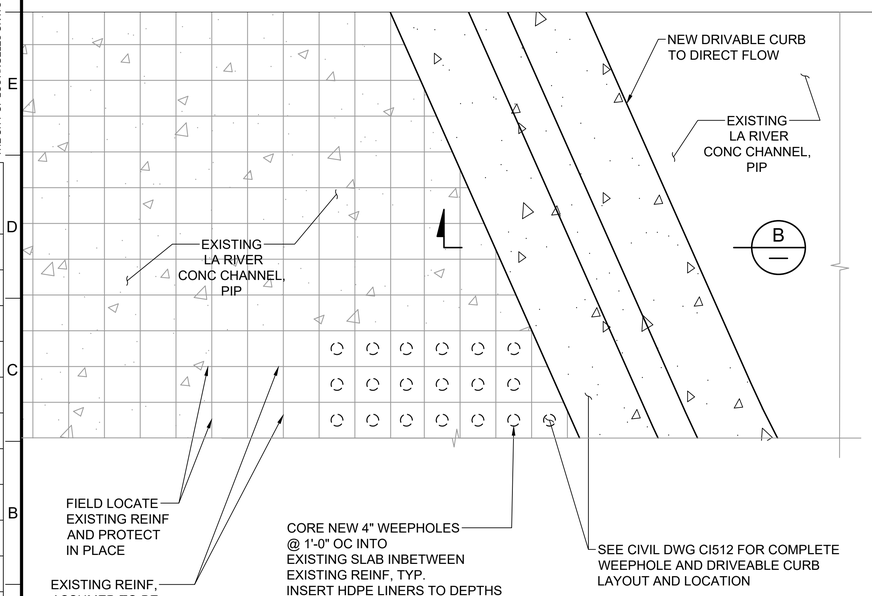
4" WEEPHOLES CAST-IN-PLACE

6" WEEPHOLES CAST-IN-PLACE

4.8-MILE REACH & "REACH 8A" PERFORATED SLAB TIE-IN

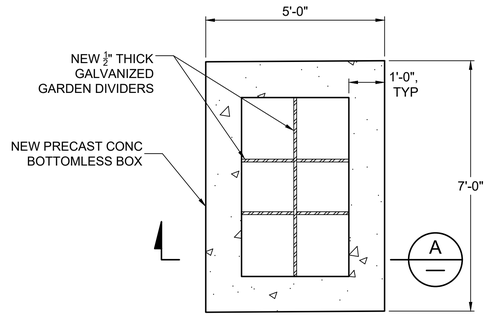
1 SD05 PARTIAL PLANS
SCALE: 1"=1'-0"

NOTE:
SEE CIVIL DRAWINGS FOR VARIOUS LAYOUTS AND LOCATIONS ALONG 4.8-MILE REACH AND "REACH 8A".



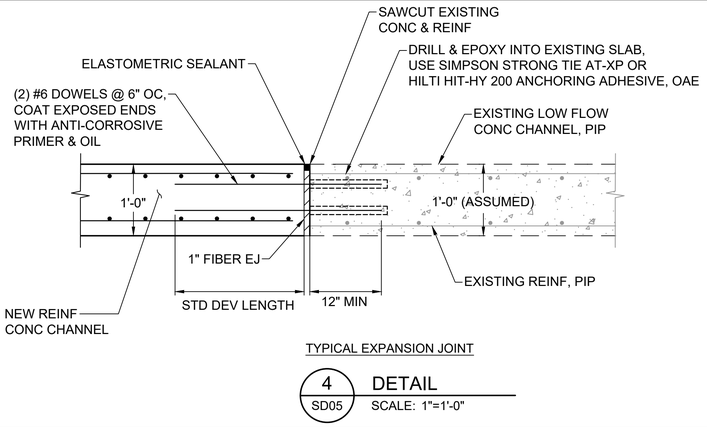
"REACH 8A" STORMDRAIN CONNECTION WITH VEGETATED WEEPHOLES

2 SD05 PARTIAL PLAN
SCALE: 1"=2'-0"



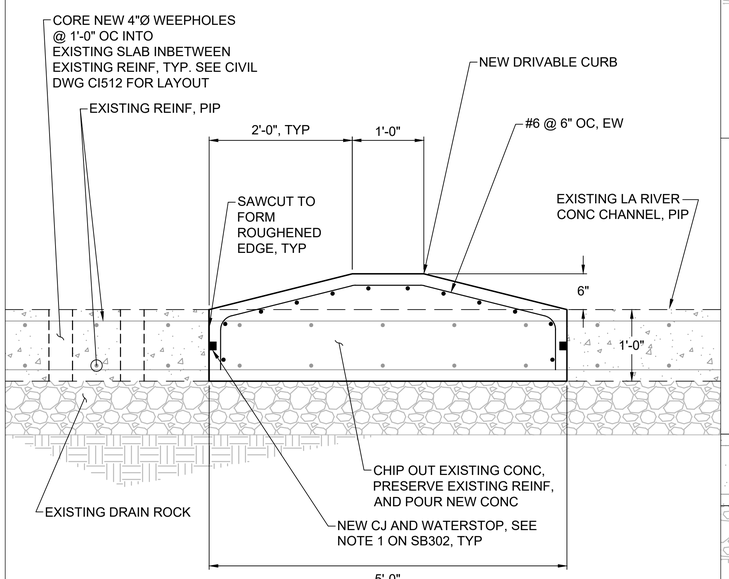
4.8-MILE REACH & "REACH 8A" TYPICAL PRE-CAST CONCRETE PLANTER BOX

3 SD05 PLAN
SCALE: 1"=3'-0"



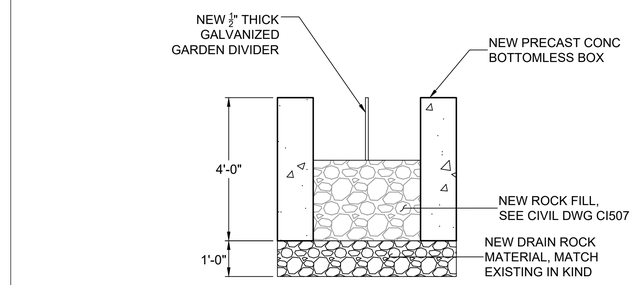
TYPICAL EXPANSION JOINT

4 SD05 DETAIL
SCALE: 1"=1'-0"



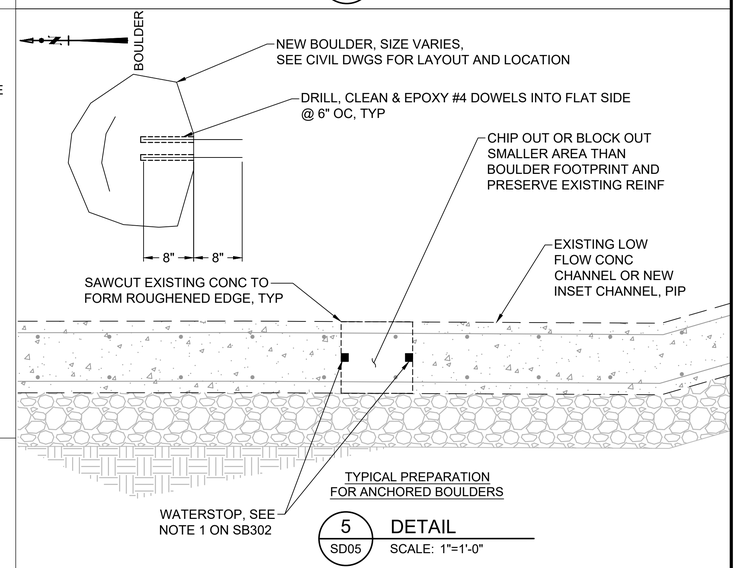
"REACH 8A" STORMDRAIN CONNECTION WITH VEGETATED WEEPHOLES

B SD05 SECTION
SCALE: 1"=1'-0"



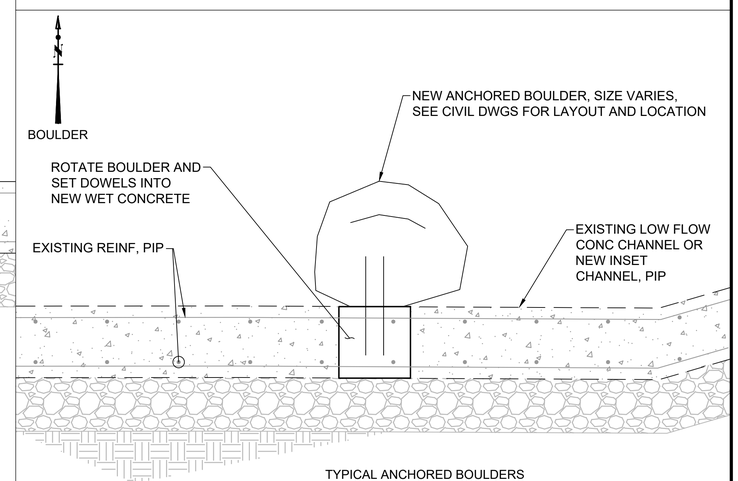
4.8-MILE REACH & "REACH 8A" TYPICAL PRE-CAST CONCRETE PLANTER BOX

A SD05 SECTION
SCALE: 1"=3'-0"



TYPICAL PREPARATION FOR ANCHORED BOULDERS

5 SD05 DETAIL
SCALE: 1"=1'-0"



TYPICAL ANCHORED BOULDERS

6 SD05 DETAIL
SCALE: 1"=1'-0"

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ENGINEERING CITY OF LOS ANGELES

VERTICAL CONTROL: NAVD88
HORIZONTAL CONTROL: NAD83 CALIFORNIA STATE PLANE, ZONE V

SHEET TITLE: ANCHORED BOULDERS, PLANTED WEEP HOLE, & PERFORATED SLAB TIE-IN DETAILS

PROJECT: LA RIVER FISH PASSAGE & HABITAT STRUCTURES 60% DESIGN

ADDRESS: LOS ANGELES, CALIFORNIA

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CIP NO. XXXX

INDEX NO. D-XXXXX

CITY ENGINEER: GARY LEE MOORE, P.E., ENV SP — DATE: 22/05/04

DESIGN GROUP

ENGINEER:	TOM SELL	22/05/04
ARCHITECT:		
DESIGNED BY:	C. REILLY	22/05/04
DRAWN BY:	C. REILLY	22/05/04
CHECKED BY:	J. ALLEN	22/05/04
APPROVED BY:	T. SELL	22/05/04

CITY OF LOS ANGELES DEPARTMENT OF PUBLIC WORKS

WORK ORDER: E1908721

SHEET NAME: SD505

SHEET 41 OF 41 SHEETS

SHEET VERSION 4.0.1 FILE PATH: C:\USERS\PBARBER\ONEDRIVE - GANNETT FLEMING INC\504-CADD - 066976-LA RIVER FISH PASSAGE\066976-S-DT-S05.DWG PLOT DATE: 5/3/2022 9:44 AM SAVED: 5/3/2022 9:42 AM SAVED BY:PBARBER

Appendix B

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01 General Requirements

01000 Master General Requirements Cover

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03300 Cast-In-Place Concrete
03314 Surface Cleaning and Preparation
03315 Grout
03400 Precast Concrete
03740 Concrete Repair

05 Metals

05120 Structural Steel
05500 Miscellaneous Metalwork

11 Equipment

11000 Equipment General Provisions

Appendix C

Cost Estimates

Los Angeles River Fish Passage and Habitat Structures Design Project

Engineer's Opinion of Probable Construction Cost - 60% Estimate

Prepared by: JA & SW

Reviewed by:

Project Reach: 4.8-mile Project Reach

Project Description: Improve upstream fish passage within the LA River flood control channel through increased channel depth, where necessary, and lower flow velocities for fish passage flows without significant impact to flood conveyance. The proposed modifications within the 4.8-mile Project Reach and costs presented in this estimate are referred to as the 4.8-mile Reach Project. The 4.8-mile Reach Project proposes to achieve the objectives of increased channel depth and lower velocities without significant impacts to flood conveyance by adding a deeper inset channel and roughness (roughly 44 ft wide and 5 ft deep) that replaces the existing low-flow channel. Because the inset channel will add flow conveyance area to the channel cross section, the increased area can be used to offset the reduced flood capacity effects of increased roughness. Additional channel modifications at selected bridge crossings are necessary to reduce flood risk impacts. In addition to lowering average velocities at fish passage flows, the design aims to increase hydraulic diversity in the channel to simulate natural conditions. This design objective is achieved not only by the inset channel but also by additional habitat components including boulder clusters, resting pockets, holding pools, a roughened chute, and vegetation features. The 60% level design drawings provide additional detail on the fish passage and habitat structures design for the 4.8-mile Reach Project.

3 Year Construction, 4.8 miles

Reach Length (LF) 25,344

	Construction Items	Year 1: 4.8-mile Reach Project				Year 2: 4.8-mile Reach Project				Year 3: 4.8-mile Reach Project			
		2024				2025				2026			
		Quantity	Units	Unit Cost	Item Cost	Quantity	Units	Unit Cost	Item Cost	Quantity	Units	Unit Cost	Item Cost
1	Traffic Control (City of LA - Typ Allowance)	1	LS	$75,000	$75,000	1	LS	$75,000	$75,000	1	LS	$75,000	$75,000
2	Water Control (Allowance)	1	LS	$1,302,560	$1,302,560	1	LS	$1,302,560	$1,302,560	1	LS	$1,302,560	$1,302,560
3	Construction Site BMPs	8,448	LF	$70	$590,515	8,448	LF	$70	$590,515	8,448	LF	$70	$590,515
	SUBTOTAL (CONSTRUCTION SOFT COSTS)				**$1,968,075**				**$1,968,075**				**$1,968,075**
4	Inset Channel	7,884	LF	$3,000	$23,652,000	8,072	LF	$3,000	$24,216,000	8,072	LF	$3,000	$24,216,000
5	Holding Pools	6	EA	$365,700	$2,194,200	4	EA	$365,700	$1,462,800	4	EA	$365,700	$1,462,800
6	Resting Pocket	8	EA	$12,000	$94,608	8	EA	$12,000	$96,864	8	EA	$12,000	$96,864
7	Planter boxes	32	EA	$3,340	$106,493	24	EA	$3,340	$80,400	24	EA	$3,340	$80,400
8	Perforated Slab Tie In (new concrete)	1,530	SF	$61	$93,337	1,406	SF	$61	$85,758	1,406	SF	$61	$85,758
9	Testing concrete	1	LS	$13,000	$13,000	1	LS	$13,000	$13,000	1	LS	$13,000	$13,000
10	Performance monitoring instrumentation	-	LS	$15,000	$0	-	LS	$15,000	$0	1	LS	$15,000	$15,000
11	Split Flow at Riverside Bridge	200	LF	$1,400	$280,000	-	LF	$1,400	$0	-	EA	$1,400	$0
12	Vertical Wall at Bridges	1	EA	$278,400	$278,400	1	EA	$278,400	$278,400	1	EA	$278,400	$278,400
	SUBTOTAL (HARD COSTS)				**$26,712,037**				**$26,233,222**				**$26,248,222**
	Subtotal: 2022 Costs				$28,680,112				$28,201,297				$28,216,297
	Mobilization & Demobilization: 7.5% (Typ)*			7.5%	$2,151,008			7.5%	$2,115,097			7.5%	$2,116,222
	Escalation: 3% per year		2	3%	$32,708,736		3	3%	$33,127,543		4	3%	$34,139,518
	Total Construction Cost per Year			**2024**	**$32,709,000**			**2025**	**$33,128,000**			**2026**	**$34,140,000**
	Total Project Construction Costs				$99,977,000								
	Planning Engineering Design: 11%**			11.0%	$10,997,470								
	Construction Management: 25%			7.0%	$6,998,390								
	Contingency: 30%			30.0%	$29,993,100								
	3 Year Construction, 4.8 miles				**$147,966,000**								

*Mobilization shall include all activites and associated costs for transportation of Contractor's personnel, equipment, and operating supplies to the site; establishment of offices, buildings, and other necessary general facilites for the Contractor's operations onsite; premiums paid for performance and payment bonds, including coinsurance and reinsurance agreeements as applicable. Demobilization shall include all activites and costs for transportation of personnel, equiptment, and supplies not required or included in the contract from the site; including the disassembly, removal and site cleanup of offices, buildings, and other facilities assembled on the site specifically for this contract. Does not include costs associated with acquisition or leasing of land for construction staging and access areas.

**Does not include: Physical model, permitting, media/public outreach, modification of the storm drain, construction bio monitoring, or annual costs for maintenance or monitoring after project completion

Los Angeles River Fish Passage and Habitat Structures Design Project

Engineer's Opinion of Probable Construction Cost - 60% Estimate

Prepared by: JA & SW

Reviewed by:

Project Reach: LARERR Reach 8A

Project Description: Improve upstream fish passage within the LA River flood control channel through increased channel depth, where necessary, and lower flow velocities for fish passage flows without significant impact to flood conveyance. The proposed modifications within LARERR Reach 8A and costs presented in this estimate are referred to as the LARERR Reach 8A Pilot Project. The LARERR Reach 8A Pilot Project proposes to achieve the objectives of increased channel depth and lower velocities without significant impacts to flood conveyance by adding a deeper inset channel and roughness to the existing low-flow channel. Because the inset channel will add flow conveyance area to the channel cross section, the increased area can be used to offset the reduced flood capacity effects of increased roughness. In addition to lowering average velocities at fish passage flows, the design aims to increase hydraulic diversity in the channel to simulate natural conditions. This design objective is achieved not only by the inset channels but also by additional habitat components including resting pockets, scour pools, anchored boulders, and planter features. The 60% level design drawings provide additional detail on the fish passage and habitat structures design for the LARERR Reach 8A Pilot Project.

1 Year Construction, 0.24 miles

Reach Length (LF) 1,274

	Construction Items	LARERR Reach 8A Pilot Project			
		2024			
		Quantity	Units	Unit Cost	Item Cost
1	Traffic Control (City of LA - Typ Allowance)	1	LS	$75,000	$75,000
2	Water Control (Bypass Allowance)	1274	LF	$100	$127,400
3	Water Control (Dewatering Allowance)	936	LF	$500	$468,000
4	Construction Site BMPs	1274	LF	$70	$89,053
	SUBTOTAL (CONSTRUCTION SOFT COSTS)				**$759,453**
5	Inset Channel	698	LF	$1,100	$767,800
6	Scour Pools	7	EA	$5,900	$41,300
7	Resting Pocket	10	EA	$8,900	$89,000
8	Anchored boulders on existing LFC	83	EA	$570	$47,310
9	Planter boxes	14	EA	$3,340	$46,760
10	Perforated Slab Tie In (new concrete)	3190	SF	$64	$204,160
11	Vegetated Weepholes (existing concrete)	1870	SF	$26	$48,620
12	Testing concrete for vegetated weepholes	1	LS	$13,000	$13,000
13	Performance monitoring instrumentation	1	LS	$5,000	$5,000
14	Drivable Curb	100	LF	$280	$28,000
	SUBTOTAL (HARD COSTS)				**$1,290,950**
	Subtotal: 2022 Costs				$2,050,403
	Mobilization & Demobilization: 7.5% (Typ)*			7.5%	$153,780
	Escalation: 3% per year		2	3%	$2,338,418
	Total Construction Cost per Year			**2024**	**$2,339,000**
	Total Project Construction Costs				$2,339,000
	Planning Engineering Design: 25%**			25.0%	$584,750
	Construction Management: 20%			20.0%	$467,800
	Contingency: 30%			30.0%	$701,700
	1 Year Construction, 0.24 miles				**$4,094,000**

*Mobilization shall include all activites and associated costs for transportation of Contractor's personnel, equipment, and operating supplies to the site; establishment of offices, buildings, and other necessary general facilites for the Contractor's operations onsite; premiums paid for performance and payment bonds, including coinsurance and reinsurance agreeements as applicable. Demobilization shall include all activites and costs for transportation of personnel, equiptment, and supplies not required or included in the contract from the site; including the disassembly, removal and site cleanup of offices, buildings, and other facilities assembled on the site specifically for this contract. Does not include costs associated with acquisition or leasing of land for construction staging and access areas.

**Does not include: Physical model, permitting, media/public outreach, modification of the storm drain, construction bio monitoring, or annual costs for maintenance or monitoring after project completion

Appendix D

HEC-RAS Output

Existing Conditions

USACE Regulatory Model STA	100-year flow	Channel Thalweg	100-year water surface elevation	Critical water surface elevation	Velocity	Froude Number	Left Freeboard	Right Freeboard
(ft)	(cfs)	(NAVD 88, ft)	(NAVD 88, ft)	(NAVD 88, ft)	(ft/s)	N/A	(ft)	(ft)
129700	93,800	299.7	327.4	316.2	11.2	0.4	1.3	1.3
129500	93,800	298.7	326.7	316.4	12.9	0.5	1.3	1.3
129300	93,800	297.7	325.4	317.0	15.8	0.6	2.0	2.0
129100	93,800	296.7	321.5	318.1	22.2	0.8	5.2	5.2
129047	93,800	296.5	318.5	318.5	26.1	1.0	8.2	8.2
128915	93,800	296.1	315.0	317.8	29.8	1.2	11.7	11.7
128734	93,800	295.4	313.5	316.9	30.9	1.3	11.7	11.7
128553	93,800	294.8	312.7	316.3	31.3	1.3	11.8	11.8
128336	93,800	294.1	313.8	316.2	29.5	1.2	10.7	10.7
128276	93,800	293.9	313.5	316.0	29.7	1.2	11.0	11.0
128214	93,800	293.7	311.2	315.1	31.9	1.4	13.3	13.3
128011	93,800	292.9	309.6	314.1	32.9	1.5	14.9	14.9
127968	93,800	292.7	309.1	313.8	33.3	1.5	15.5	15.5
127743	93,800	291.9	305.7	311.5	35.5	1.7	18.8	18.8
127721	93,800	291.8	305.5	311.3	35.6	1.8	19.0	19.0
127479	93,800	290.9	303.5	309.5	36.4	1.9	19.4	19.4
127310	109,000	290.1	305.8	310.7	33.7	1.6	16.4	16.4
127250	109,000	289.9	305.5	310.4	33.8	1.6	16.4	16.4
127050	109,000	289.0	305.5	310.3	33.2	1.5	15.4	15.4
126850	109,000	288.2	305.3	310.1	32.8	1.5	14.5	14.5
126650	109,000	287.3	304.9	309.8	32.6	1.5	13.9	13.9
126476	109,000	286.5	304.0	309.0	33.1	1.5	14.1	14.1
126303	109,000	285.8	303.1	308.3	33.5	1.6	14.2	14.2
126130	109,000	285.0	302.2	307.5	33.8	1.6	14.4	14.4
125957	109,000	284.3	301.3	306.8	34.2	1.6	14.5	14.5
125784	109,000	283.5	300.4	306.0	34.4	1.6	14.6	14.6
125611	109,000	282.8	300.4	305.7	33.9	1.5	14.6	14.6
125589	109,000	282.7	300.3	305.7	34.0	1.5	14.7	14.7
125414	109,000	281.9	298.6	304.5	35.0	1.7	14.9	14.9

Existing Conditions (continued)

***Shaded rows correspond to Reach 8A**

USACE Regulatory Model STA	100-year flow	Channel Thalweg	100-year water surface elevation	Critical water surface elevation	Velocity	Froude Number	Left Freeboard	Right Freeboard
(ft)	(cfs)	(NAVD 88, ft)	(NAVD 88, ft)	(NAVD 88, ft)	(ft/s)	N/A	(ft)	(ft)
125239	109,000	281.2	297.9	303.8	35.2	1.7	15.0	15.0
125065	109,000	280.4	297.2	303.1	35.3	1.7	15.1	15.1
124891	109,000	279.7	298.8	303.8	33.2	1.5	13.4	13.4
124818	109,000	279.4	298.7	303.6	33.1	1.5	13.6	13.6
124700	109,000	278.9	295.6	301.7	35.6	1.7	15.3	15.3
124551	109,000	278.3	295.0	301.1	35.6	1.7	15.4	15.4
124404	109,000	277.7	295.5	301.2	34.5	1.6	14.8	14.8
124356	109,000	277.5	295.3	301.0	34.6	1.6	15.0	15.0
124167	109,000	276.8	293.3	299.3	35.8	1.7	15.6	15.6
123979	109,000	275.6	292.4	298.4	35.9	1.7	14.5	14.6
123791	109,000	274.9	291.4	297.4	36.2	1.7	15.7	16.4
123623	109,000	273.9	290.6	296.6	36.3	1.8	16.4	16.1
123454	109,000	273.6	290.0	296.1	36.2	1.8	17.1	16.9
123287	109,000	272.5	291.3	296.6	34.5	1.6	15.9	15.7
123213	109,000	272.1	291.0	296.3	34.5	1.6	8.4	7.8
122968	109,000	270.8	287.4	293.9	36.7	1.8	10.7	10.5
122920	109,000	270.6	287.2	293.7	36.8	1.8	10.7	10.7
122914	109,000	269.8	287.1	293.5	36.9	1.8	10.9	10.9
122811	109,000	269.5	286.6	293.1	36.9	1.8	10.5	11.2
122656	109,000	268.9	285.9	292.5	37.0	1.8	11.8	11.9
122500	109,000	268.1	285.1	291.8	37.1	1.8	12.8	12.6
122316	109,000	267.3	284.3	291.0	37.2	1.8	14.0	13.4
122133	109,000	266.6	283.5	290.2	37.2	1.8	14.6	14.4
121950	109,000	265.9	282.6	289.3	37.4	1.8	15.8	15.2
121766	109,000	265.2	281.7	288.5	37.4	1.8	15.9	16.0
121583	109,000	264.3	280.9	287.7	37.5	1.8	17.0	16.9
121400	109,000	263.6	280.1	286.9	37.6	1.8	17.7	17.7
121211	109,000	262.6	281.9	287.6	35.2	1.6	11.1	15.8
121169	109,000	262.4	281.7	287.4	35.2	1.6	11.0	11.5

Existing Conditions (continued)

USACE Regulatory Model STA	100-year flow	Channel Thalweg	100-year water surface elevation	Critical water surface elevation	Velocity	Froude Number	Left Freeboard	Right Freeboard
(ft)	(cfs)	(NAVD 88, ft)	(NAVD 88, ft)	(NAVD 88, ft)	(ft/s)	N/A	(ft)	(ft)
120959	109,000	261.6	280.7	286.4	35.2	1.6	11.4	11.0
120932	109,000	261.4	280.7	286.3	35.2	1.6	11.3	10.9
120773	109,000	260.7	277.4	284.0	37.4	1.8	12.8	13.5
120615	109,000	260.0	277.4	283.8	36.9	1.8	12.9	12.8
120458	109,000	259.3	276.8	283.2	36.9	1.8	12.8	12.9
120300	109,000	260.3	277.2	283.3	36.0	1.7	9.6	9.6
120133	109,000	259.5	276.2	282.5	36.3	1.7	9.9	9.9
119966	109,000	258.8	275.3	281.7	36.6	1.7	10.3	10.3
119800	109,000	258.0	274.4	280.9	36.8	1.8	10.6	10.6
119633	109,000	257.3	273.5	280.0	37.0	1.8	10.9	10.9
119466	109,000	256.6	272.6	279.2	37.2	1.8	11.2	11.2
119300	109,000	255.8	271.7	278.4	37.4	1.8	11.5	11.5
119097	109,000	254.9	270.6	277.2	37.6	1.8	11.6	11.6
118893	109,000	254.0	269.5	276.1	37.8	1.9	11.7	11.7
118690	109,000	253.1	268.3	274.9	38.1	1.9	11.8	11.8
118488	109,000	252.2	267.2	273.9	38.2	1.9	12.9	12.9
118417	109,000	251.9	266.8	273.5	38.3	1.9	11.2	11.2
118277	109,000	251.3	266.0	272.6	38.4	2.0	12.0	12.0
118138	109,000	250.7	265.2	271.9	38.5	2.0	12.1	12.1
118000	109,000	250.0	264.4	271.1	38.5	2.0	12.2	12.2
117803	109,000	249.2	263.9	270.5	38.1	2.0	11.8	11.8
117606	109,000	248.3	263.4	269.9	37.8	1.9	11.4	11.4
117410	109,000	247.4	262.8	269.3	37.5	1.9	11.1	11.1
117407	109,000	247.4	262.8	269.3	37.5	1.9	11.1	11.1
117193	109,000	246.0	261.6	268.5	37.7	1.8	12.3	12.3
116994	109,000	245.1	260.7	267.6	37.7	1.8	13.9	13.9
116795	109,000	244.2	259.8	266.7	37.8	1.8	13.9	13.9
116596	109,000	243.3	258.9	265.8	37.8	1.8	13.9	13.9
116397	109,000	242.4	258.0	265.0	37.9	1.9	13.9	13.9

Existing Conditions (continued)

USACE Regulatory Model STA	100-year flow	Channel Thalweg	100-year water surface elevation	Critical water surface elevation	Velocity	Froude Number	Left Freeboard	Right Freeboard
(ft)	(cfs)	(NAVD 88, ft)	(NAVD 88, ft)	(NAVD 88, ft)	(ft/s)	N/A	(ft)	(ft)
116198	109,000	241.5	257.1	264.1	37.9	1.9	13.9	13.9
116000	109,000	240.7	256.2	263.2	37.9	1.9	13.9	13.9
115757	109,000	239.6	256.6	263.2	36.7	1.7	13.6	13.6
115687	109,000	239.3	256.3	262.9	36.7	1.7	13.9	13.9
115501	109,000	238.4	254.0	260.9	38.0	1.9	13.9	13.9
115315	109,000	237.5	253.1	260.0	38.0	1.9	14.0	14.0
115129	109,000	236.6	252.2	259.2	38.1	1.9	14.0	14.0
114944	109,000	235.7	251.4	258.3	38.1	1.9	14.1	14.1
114758	109,000	234.8	250.5	257.5	38.2	1.9	14.1	14.1
114572	109,000	233.9	249.6	256.6	38.2	1.9	14.2	14.2
114387	109,000	233.1	248.8	255.8	38.2	1.9	14.2	14.2
114202	109,000	232.2	247.9	254.9	38.3	1.9	14.3	14.3
114200	109,000	232.2	247.9	254.9	38.3	1.9	14.3	14.3
114001	109,000	231.3	247.0	254.0	38.3	1.9	14.3	14.3
113802	109,000	230.4	246.1	253.2	38.3	1.9	14.3	14.3
113604	109,000	229.5	245.2	252.3	38.3	1.9	14.3	14.3
113406	109,000	228.6	244.4	251.4	38.3	1.9	14.3	14.3
113390	109,000	228.5	244.3	251.4	38.3	1.9	14.3	8.0
113384	109,000	228.5	244.3	251.4	38.3	1.9	14.3	8.0
113302	109,000	228.2	243.9	251.0	38.3	1.9	14.6	8.4
113284	109,000	228.1	243.8	250.9	38.3	1.9	7.9	14.5
113280	109,000	228.1	243.8	250.9	38.3	1.9	14.5	14.5
113110	109,000	227.3	243.1	250.1	38.3	1.9	15.1	15.1
112941	109,000	226.6	242.3	249.4	38.3	1.9	15.7	15.7
112772	109,000	225.8	241.5	248.6	38.3	1.9	16.3	16.3
112603	109,000	225.1	240.8	247.9	38.3	1.9	16.9	16.9
112435	109,000	224.3	240.0	247.1	38.3	1.9	17.5	17.5
112376	109,000	224.0	239.8	246.8	38.3	1.9	17.7	17.7
112314	109,000	223.8	239.5	246.6	38.3	1.9	17.9	17.9

Existing Conditions (continued)

USACE Regulatory Model STA	100-year flow	Channel Thalweg	100-year water surface elevation	Critical water surface elevation	Velocity	Froude Number	Left Freeboard	Right Freeboard
(ft)	(cfs)	(NAVD 88, ft)	(NAVD 88, ft)	(NAVD 88, ft)	(ft/s)	N/A	(ft)	(ft)
112306	109,000	223.7	239.5	246.5	38.3	1.9	17.9	17.9
112255	109,000	223.5	237.6	244.9	39.6	2.1	19.8	19.8
112180	109,000	223.2	238.9	246.0	38.2	1.9	18.5	18.5
112121	109,000	222.9	238.7	245.7	38.2	1.9	12.6	11.2
112104	109,000	222.8	238.6	245.6	38.2	1.9	12.6	11.2
112059	109,000	222.6	238.4	245.4	38.2	1.9	11.2	11.2
112000	109,000	222.4	238.1	245.2	38.2	1.9	11.2	11.2
111828	109,000	221.6	237.4	244.4	38.2	1.9	11.3	11.3
111656	109,000	220.8	236.6	243.6	38.2	1.9	11.3	11.3
111484	109,000	220.1	235.8	242.9	38.3	1.9	11.3	11.3
111313	109,000	219.3	235.1	242.1	38.3	1.9	11.3	11.3
111176	109,000	218.7	234.5	241.5	38.3	1.9	11.9	11.9
111041	109,000	218.1	233.9	240.9	38.3	1.9	12.5	12.5
110905	109,000	217.5	233.3	240.3	38.3	1.9	13.1	13.1
110813	109,000	213.8	228.5	236.6	41.7	2.1	17.8	17.8
110805	109,000	213.5	228.1	236.3	42.0	2.1	18.2	12.8
110786	109,000	213.4	229.6	237.4	40.7	2.0	16.7	11.3
110715	109,000	213.2	229.4	237.1	40.5	2.0	3.9	10.8
110690	109,000	213.1	227.8	235.8	41.6	2.1	5.2	12.3
110491	109,000	212.4	227.3	235.2	41.2	2.1	6.2	12.2
110293	109,000	211.8	226.7	234.5	40.8	2.0	7.3	12.1
110095	109,000	211.1	226.2	233.9	40.4	2.0	8.4	11.9
109896	109,000	210.4	225.6	233.2	40.0	2.0	9.4	11.8
109698	109,000	209.8	225.0	232.6	39.7	2.0	10.5	11.7
109500	109,000	209.1	224.5	231.9	39.3	1.9	11.6	11.6
109311	109,000	208.4	223.9	231.2	39.0	1.9	12.0	12.0
109122	109,000	207.8	223.4	230.6	38.8	1.9	12.3	12.3
108933	109,000	207.2	223.6	230.6	37.8	1.8	12.1	12.1
108744	109,000	206.5	223.1	230.0	37.5	1.8	12.6	12.6

Existing Conditions (continued)

USACE Regulatory Model STA	100-year flow	Channel Thalweg	100-year water surface elevation	Critical water surface elevation	Velocity	Froude Number	Left Freeboard	Right Freeboard
(ft)	(cfs)	(NAVD 88, ft)	(NAVD 88, ft)	(NAVD 88, ft)	(ft/s)	N/A	(ft)	(ft)
108555	109,000	205.9	222.6	229.3	37.1	1.8	13.1	13.1
108366	109,000	205.2	221.2	228.0	37.6	1.8	13.8	13.8
108177	109,000	204.6	220.6	227.4	37.4	1.8	14.1	14.1
107988	109,000	204.0	220.1	226.8	37.2	1.8	14.5	14.5
107800	109,000	203.3	219.5	226.1	37.1	1.8	14.9	14.9
107643	109,000	202.8	219.0	225.6	37.0	1.8	15.3	15.3
107486	109,000	202.3	218.5	225.0	36.8	1.8	15.6	15.6
107462	109,000	202.2	221.1	226.7	34.5	1.6	13.1	13.1
107392	109,000	201.9	220.8	226.4	34.4	1.6	10.9	11.0
107368	109,000	201.8	218.3	224.7	36.6	1.7	13.3	13.5
107351	109,000	201.7	218.0	224.5	36.8	1.8	8.7	8.7
107178	109,000	200.9	217.2	223.8	36.9	1.8	8.8	8.8
107006	109,000	200.2	216.4	223.0	37.0	1.8	8.8	8.8
106833	109,000	199.4	215.6	222.2	37.1	1.8	8.8	8.8
106661	109,000	198.6	214.8	221.5	37.2	1.8	8.9	8.9
106488	109,000	197.9	214.0	220.7	37.3	1.8	8.9	8.9
106316	109,000	197.1	213.2	219.9	37.3	1.8	8.9	8.9
106144	109,000	196.3	212.4	219.2	37.4	1.8	9.0	9.0
105975	109,000	195.6	211.6	218.4	37.5	1.8	9.7	10.1
105806	109,000	194.8	210.8	217.6	37.6	1.8	10.5	11.3
105637	109,000	194.1	210.1	216.9	37.6	1.8	11.3	12.5
105468	109,000	193.3	209.3	216.1	37.7	1.8	12.1	13.7
105300	109,000	192.6	208.5	215.4	37.7	1.8	12.8	14.8
104796	109,000	191.3	200.7	208.1	41.7	2.4	20.7	20.7
104763	109,000	191.2	201.4	208.7	40.9	2.3	20.0	20.0
104700	109,000	190.9	201.2	208.5	40.6	2.2	20.2	20.2
104500	109,000	190.0	199.7	206.7	40.4	2.3	20.4	20.4
104427	109,000	189.7	200.5	207.5	39.3	2.1	16.5	16.5
104354	109,000	189.4	200.3	207.2	38.9	2.1	16.7	16.7

4.8-mile Reach Project

USACE Regulatory Model STA	100-year flow	Channel Thalweg	100-year water surface elevation	Critical water surface elevation	Velocity	Froude Number	Left Freeboard	Right Freeboard
(ft)	(cfs)	(NAVD 88, ft)	(NAVD 88, ft)	(NAVD 88, ft)	(ft/s)	N/A	(ft)	(ft)
129700	93,800	298.8	327.0	316.1	11.4	0.4	1.7	1.7
129586	93,800	298.4	326.8	316.1	11.7	0.4	1.9	1.9
129500	93,800	297.4	326.1	316.4	13.3	0.5	1.9	1.9
129300	93,800	295.1	324.6	316.9	16.3	0.6	2.8	2.8
129100	93,800	292.7	320.9	317.5	22.1	0.8	5.8	5.8
129047	93,800	292.5	317.9	317.9	26.1	1.0	8.8	8.8
128915	93,800	292.1	314.7	317.1	29.3	1.2	12.0	12.0
128734	93,800	291.4	313.5	316.3	29.8	1.3	11.7	11.7
128553	93,800	290.8	313.0	315.7	29.7	1.2	11.5	11.5
128336	93,800	290.1	315.4	315.4	26.1	1.0	9.1	9.1
128276	93,800	289.9	314.4	315.2	27.1	1.1	10.1	10.1
128214	93,800	289.7	311.6	314.6	30.1	1.3	12.9	12.9
128011	93,800	288.9	310.1	313.6	30.8	1.3	14.4	14.4
127968	93,800	288.7	309.5	313.2	31.3	1.4	15.1	15.1
127743	93,800	287.9	305.9	311.0	33.6	1.6	18.6	18.6
127721	93,800	287.8	305.7	310.8	33.6	1.6	18.8	18.8
127479	93,800	286.9	303.8	309.1	34.0	1.7	19.0	19.0
127310	109,000	286.1	307.1	310.2	30.0	1.3	15.0	15.0
127222	109,000	285.8	306.6	309.9	30.1	1.3	15.1	15.1
127050	109,000	285.0	307.3	309.8	28.9	1.2	13.6	13.6
126850	109,000	284.2	307.3	309.6	28.1	1.2	12.5	12.5
126650	109,000	282.8	306.6	309.3	28.3	1.2	12.2	12.2
126476	109,000	282.0	305.5	308.5	29.0	1.3	12.6	12.6
126303	109,000	281.3	304.4	307.8	29.6	1.3	12.9	12.9
126130	109,000	280.5	303.4	307.0	30.0	1.3	13.1	13.1
125957	109,000	279.8	302.5	306.3	30.4	1.4	13.3	13.3
125784	109,000	279.0	301.6	305.5	30.7	1.4	13.4	13.4
125611	109,000	278.3	302.4	305.2	29.2	1.2	12.6	12.6
125589	109,000	278.2	302.3	305.1	29.2	1.2	12.7	12.7

4.8-mile Reach Project (continued)

USACE Regulatory Model STA	100-year flow	Channel Thalweg	100-year water surface elevation	Critical water surface elevation	Velocity	Froude Number	Left Freeboard	Right Freeboard
(ft)	(cfs)	(NAVD 88, ft)	(NAVD 88, ft)	(NAVD 88, ft)	(ft/s)	N/A	(ft)	(ft)
125414	109,000	277.4	299.8	304.0	31.3	1.4	13.8	13.8
125239	109,000	276.7	299.0	303.2	31.3	1.4	13.8	13.8
125065	109,000	275.9	298.2	302.5	31.4	1.4	14.0	14.0
124891	109,000	275.1	300.5	302.7	28.3	1.2	11.8	11.8
124818	109,000	274.8	300.4	302.5	28.1	1.2	11.8	11.8
124700	109,000	274.4	296.8	301.1	31.5	1.4	14.0	14.0
124551	109,000	273.8	296.2	300.5	31.4	1.4	14.1	14.1
124404	109,000	273.2	297.4	300.7	29.5	1.3	12.9	12.9
124356	109,000	273.0	297.1	300.5	29.6	1.3	13.2	13.2
124167	109,000	272.3	294.5	298.9	31.6	1.4	14.3	14.3
123979	109,000	271.6	293.7	297.8	31.7	1.4	13.3	13.3
123791	109,000	270.8	292.9	297.0	31.8	1.4	14.3	15.0
123623	109,000	270.2	292.1	296.3	31.9	1.5	14.9	14.6
123454	109,000	269.5	291.3	295.6	31.9	1.5	15.8	15.6
123287	109,000	268.9	294.2	296.3	28.1	1.2	12.9	12.7
123213	109,000	268.6	294.3	296.1	27.7	1.2	5.0	4.4
122968	109,000	267.7	289.0	293.6	32.4	1.5	9.1	8.9
122811	109,000	267.0	288.3	292.9	32.4	1.5	8.8	9.5
122656	109,000	266.3	287.6	292.2	32.4	1.5	10.1	10.1
122500	109,000	265.6	287.0	291.6	32.4	1.5	10.9	10.8
122316	109,000	264.8	286.1	290.8	32.4	1.5	12.2	11.5
122133	109,000	263.9	285.3	290.0	32.4	1.5	12.7	12.5
121950	109,000	263.1	284.5	289.2	32.4	1.5	13.8	13.3
121766	109,000	262.3	283.7	288.4	32.4	1.5	14.0	14.1
121583	109,000	261.5	282.9	287.6	32.4	1.5	15.0	14.9
121400	109,000	260.7	282.1	286.7	32.4	1.5	15.7	15.7
121211	109,000	259.8	285.7	287.7	27.7	1.2	7.3	12.0
121169	109,000	259.6	285.6	287.5	27.7	1.2	7.1	7.6

4.8-mile Reach Project (continued)

USACE Regulatory Model STA	100-year flow	Channel Thalweg	100-year water surface elevation	Critical water surface elevation	Velocity	Froude Number	Left Freeboard	Right Freeboard
(ft)	(cfs)	(NAVD 88, ft)	(NAVD 88, ft)	(NAVD 88, ft)	(ft/s)	N/A	(ft)	(ft)
120959	109,000	258.7	285.0	286.8	27.5	1.2	7.1	6.7
120932	109,000	258.6	285.0	286.7	27.5	1.2	7.0	6.6
120773	109,000	257.9	279.9	284.5	32.4	1.5	10.4	11.1
120615	109,000	257.2	279.4	283.9	32.2	1.5	10.9	10.8
120458	109,000	256.5	278.9	283.3	32.0	1.5	10.6	10.8
120300	109,000	255.8	278.5	282.7	31.8	1.4	8.3	8.3
120133	109,000	255.0	277.5	282.0	32.1	1.5	8.7	8.7
119966	109,000	254.3	276.6	281.2	32.3	1.5	9.0	9.0
119800	109,000	253.5	275.6	280.4	32.6	1.5	9.4	9.4
119633	109,000	252.8	274.7	279.6	32.7	1.5	9.7	9.7
119466	109,000	252.1	273.8	278.7	32.9	1.5	10.0	10.0
119300	109,000	251.3	272.9	277.9	33.0	1.5	10.3	10.3
119097	109,000	250.4	271.8	276.7	33.3	1.5	10.4	10.4
118893	109,000	249.5	270.6	275.6	33.5	1.6	10.5	10.5
118690	109,000	248.6	269.4	274.4	33.6	1.6	10.7	10.7
118488	109,000	247.7	268.3	273.4	33.8	1.6	11.8	11.8
118417	109,000	247.4	267.8	273.0	33.8	1.6	10.1	10.1
118277	109,000	246.8	267.0	272.1	33.9	1.6	10.9	10.9
118138	109,000	246.2	266.2	271.4	34.0	1.6	11.0	11.0
118000	109,000	245.5	265.4	270.6	34.0	1.6	11.1	11.1
117803	109,000	244.7	265.1	270.0	33.4	1.6	10.6	10.6
117606	109,000	243.8	264.7	269.4	32.9	1.6	10.1	10.1
117410	109,000	242.9	264.2	268.8	32.4	1.5	9.7	9.7
117407	109,000	242.9	264.2	268.9	32.4	1.5	9.7	9.7
117193	109,000	241.5	263.1	268.0	32.6	1.5	10.8	10.8
116994	109,000	240.6	262.2	267.1	32.6	1.5	12.4	12.4
116795	109,000	239.7	261.3	266.2	32.6	1.5	12.4	12.4
116596	109,000	238.8	260.4	265.3	32.6	1.5	12.4	12.4

4.8-mile Reach Project (continued)

USACE Regulatory Model STA	100-year flow	Channel Thalweg	100-year water surface elevation	Critical water surface elevation	Velocity	Froude Number	Left Freeboard	Right Freeboard
(ft)	(cfs)	(NAVD 88, ft)	(NAVD 88, ft)	(NAVD 88, ft)	(ft/s)	N/A	(ft)	(ft)
116397	109,000	237.9	259.6	264.4	32.7	1.5	12.4	12.4
116198	109,000	237.0	258.7	263.6	32.7	1.5	12.4	12.4
116000	109,000	236.2	257.8	262.7	32.7	1.5	12.4	12.4
115757	109,000	235.1	258.4	262.4	30.9	1.4	11.7	11.7
115687	109,000	234.8	258.1	262.1	31.0	1.4	12.0	12.0
115501	109,000	233.9	255.4	260.4	32.9	1.5	12.4	12.4
115315	109,000	233.0	254.6	259.5	32.9	1.5	12.5	12.5
115129	109,000	232.1	253.7	258.6	32.9	1.5	12.5	12.5
114944	109,000	231.2	252.9	257.8	32.9	1.5	12.6	12.6
114758	109,000	230.3	252.0	256.9	33.0	1.5	12.6	12.6
114572	109,000	229.4	251.1	256.1	33.0	1.5	12.7	12.7
114387	109,000	228.6	250.3	255.2	33.0	1.5	12.7	12.7
114202	109,000	227.7	249.4	254.4	33.0	1.5	12.7	12.7
114200	109,000	227.7	249.4	254.4	33.0	1.5	12.7	12.7
114001	109,000	226.8	248.5	253.5	33.0	1.5	12.7	12.7
113802	109,000	225.9	247.7	252.6	33.0	1.5	12.7	12.7
113604	109,000	225.0	246.8	251.7	33.0	1.5	12.7	12.7
113406	109,000	224.1	245.9	250.9	32.9	1.5	12.7	12.7
113390	109,000	224.0	245.8	250.9	32.9	1.5	12.7	6.4
113384	109,000	224.0	245.8	250.8	32.9	1.5	12.7	6.5
113302	109,000	223.7	245.5	250.5	32.9	1.5	13.1	6.8
113284	109,000	223.6	245.4	250.4	32.9	1.5	6.3	12.9
113280	109,000	223.6	245.4	250.4	32.9	1.5	12.9	12.9
113110	109,000	222.8	244.6	249.6	32.9	1.5	13.5	13.5
112941	109,000	222.1	243.9	248.9	32.9	1.5	14.1	14.1
112772	109,000	221.3	243.1	248.1	32.9	1.5	14.7	14.7
112603	109,000	220.6	242.4	247.4	32.9	1.5	15.3	15.3
112435	109,000	219.8	241.6	246.6	32.9	1.5	15.9	15.9

4.8-mile Reach Project (continued)

USACE Regulatory Model STA	100-year flow	Channel Thalweg	100-year water surface elevation	Critical water surface elevation	Velocity	Froude Number	Left Freeboard	Right Freeboard
(ft)	(cfs)	(NAVD 88, ft)	(NAVD 88, ft)	(NAVD 88, ft)	(ft/s)	N/A	(ft)	(ft)
112376	109,000	219.5	241.4	246.4	32.9	1.5	16.1	16.1
112314	109,000	219.3	241.1	246.1	32.9	1.5	16.3	16.3
112306	109,000	219.2	241.1	246.0	32.9	1.5	16.4	16.4
112255	109,000	219.0	238.7	244.4	34.9	1.7	18.7	18.7
112180	109,000	218.7	240.6	245.5	32.7	1.5	16.9	16.9
112121	109,000	218.4	240.3	245.2	32.7	1.5	10.9	9.6
112104	109,000	218.3	240.2	245.1	32.7	1.5	10.9	9.6
112059	109,000	218.1	240.0	244.9	32.7	1.5	9.6	9.6
112000	109,000	217.9	239.8	244.7	32.7	1.5	9.6	9.6
111828	109,000	217.1	239.0	243.9	32.7	1.5	9.6	9.6
111656	109,000	216.3	238.2	243.1	32.7	1.5	9.6	9.6
111484	109,000	215.6	237.5	242.4	32.8	1.5	9.6	9.6
111313	109,000	214.8	236.7	241.6	32.8	1.5	9.6	9.6
111176	109,000	214.2	236.1	241.0	32.8	1.5	10.2	10.2
111041	109,000	213.6	235.5	240.4	32.8	1.5	10.8	10.8
110905	109,000	213.0	234.9	239.8	32.8	1.5	11.4	11.4
110813	109,000	209.3	229.3	236.1	37.4	1.8	17.0	17.0
110805	109,000	209.0	228.9	235.8	37.7	1.8	17.4	11.9
110786	109,000	208.9	230.7	237.0	36.0	1.7	15.6	10.1
110715	109,000	208.7	230.6	236.6	35.7	1.6	2.7	9.6
110690	109,000	208.6	228.7	235.3	37.2	1.8	4.3	11.4
110491	109,000	207.9	228.3	234.7	36.5	1.7	5.2	11.1
110293	109,000	207.3	227.9	234.0	35.8	1.7	6.1	10.9
110095	109,000	206.6	227.5	233.4	35.1	1.7	7.1	10.6
109896	109,000	205.9	227.0	232.7	34.6	1.6	8.0	10.4
109698	109,000	205.3	226.6	232.1	34.0	1.6	9.0	10.2
109500	109,000	204.6	226.1	231.4	33.6	1.6	10.0	10.0
109311	109,000	203.9	225.6	230.8	33.2	1.5	10.3	10.3

4.8-mile Reach Project (continued)

USACE Regulatory Model STA	100-year flow	Channel Thalweg	100-year water surface elevation	Critical water surface elevation	Velocity	Froude Number	Left Freeboard	Right Freeboard
(ft)	(cfs)	(NAVD 88, ft)	(NAVD 88, ft)	(NAVD 88, ft)	(ft/s)	N/A	(ft)	(ft)
109122	109,000	203.3	225.2	230.1	32.8	1.5	10.5	10.5
108933	109,000	202.7	225.8	230.1	31.3	1.4	9.9	9.9
108744	109,000	202.0	225.4	229.4	30.9	1.4	10.3	10.3
108555	109,000	201.4	224.9	228.8	30.6	1.4	10.8	10.8
108366	109,000	200.7	223.1	227.5	31.7	1.4	11.9	11.9
108177	109,000	200.1	222.6	226.9	31.5	1.4	12.2	12.2
107988	109,000	199.5	222.0	226.3	31.3	1.4	12.6	12.6
107800	109,000	198.8	221.5	225.6	31.1	1.4	13.0	13.0
107643	109,000	198.3	221.0	225.1	31.0	1.4	13.3	13.3
107462	109,000	197.7	223.7	225.4	27.3	1.1	10.6	10.6
107392	109,000	197.4	223.2	225.1	27.6	1.2	8.5	8.6
107368	109,000	197.3	220.4	224.2	30.6	1.4	11.2	11.4
107351	109,000	197.2	219.9	224.0	31.1	1.4	6.9	6.9
107178	109,000	196.4	219.0	223.2	31.4	1.4	7.0	7.0
107006	109,000	195.7	218.1	222.4	31.5	1.4	7.1	7.1
106833	109,000	194.9	217.3	221.7	31.7	1.4	7.1	7.1
106661	109,000	194.1	216.4	220.9	31.9	1.5	7.2	7.2
106488	109,000	193.4	215.6	220.1	32.0	1.5	7.3	7.3
106316	109,000	192.6	214.8	219.4	32.1	1.5	7.3	7.3
106144	109,000	191.8	214.0	218.6	32.2	1.5	7.4	7.4
105975	109,000	191.1	213.2	217.8	32.3	1.5	8.1	8.5
105806	109,000	190.3	212.4	217.1	32.3	1.5	8.9	9.7
105637	109,000	189.6	211.6	216.3	32.4	1.5	9.7	10.9
105468	109,000	188.8	210.9	215.6	32.4	1.5	10.5	12.1
105300	109,000	188.1	210.1	214.8	32.5	1.5	11.3	13.3
104796	109,000	191.3	201.6	208.1	37.8	2.1	19.7	19.7
104763	109,000	191.2	202.5	208.7	36.9	1.9	18.9	18.9
104700	109,000	190.9	202.2	208.5	36.7	1.9	19.1	19.1

4.8-mile Reach Project (continued)

USACE Regulatory Model STA	100-year flow	Channel Thalweg	100-year water surface elevation	Critical water surface elevation	Velocity	Froude Number	Left Freeboard	Right Freeboard
(ft)	(cfs)	(NAVD 88, ft)	(NAVD 88, ft)	(NAVD 88, ft)	(ft/s)	N/A	(ft)	(ft)
104500	109,000	190.0	200.5	206.8	37.1	2.0	19.5	19.5
104427	109,000	189.7	201.5	207.5	35.8	1.8	15.5	15.5
104354	109,000	189.4	201.4	207.2	35.5	1.8	15.7	15.7

Reach 8A Pilot Project

USACE Regulatory Model STA	100-year flow	Channel Thalweg	100-year water surface elevation	Critical water surface elevation	Velocity	Froude Number	Left Freeboard	Right Freeboard
(ft)	(cfs)	(NAVD 88, ft)	(NAVD 88, ft)	(NAVD 88, ft)	(ft/s)	N/A	(ft)	(ft)
123623	109,000	273.9	290.4	296.6	36.9	1.8	16.6	16.3
123454	109,000	273.6	289.8	296.1	36.8	1.8	17.3	17.1
123287	109,000	272.5	291.0	296.6	35.1	1.6	16.1	15.9
123213	109,000	272.1	290.7	296.3	35.1	1.6	8.6	8.0
123152	109,000	270.2	288.1	294.6	36.9	1.8	10.0	9.8
123100	109,000	270.0	287.7	294.2	37.1	1.8	10.4	10.2
123028	109,000	269.6	287.7	294.0	36.5	1.8	10.4	10.2
122968	109,000	269.4	287.5	293.8	36.4	1.8	10.7	10.4
122932	109,000	269.2	287.3	293.6	36.4	1.8	10.9	10.6
122911	109,000	269.1	287.2	293.5	36.5	1.8	11.0	10.7
122894	109,000	269.4	287.1	293.4	36.5	1.8	11.1	10.8
122857	109,000	269.6	287.0	293.3	36.4	1.8	11.2	10.9
122793	109,000	269.4	286.7	293.1	36.4	1.8	11.5	11.2
122656	109,000	268.9	286.1	292.5	36.3	1.8	12.1	11.8
122500	109,000	268.1	285.4	291.8	36.4	1.8	12.9	12.5
122310	109,000	266.7	284.5	291.0	36.4	1.8	13.8	13.3
122136	109,000	265.4	283.8	290.2	36.4	1.8	14.6	14.1
121950	109,000	265.9	282.9	289.4	36.5	1.8	15.5	14.9
121766	109,000	265.2	282.0	288.5	36.6	1.8	15.7	15.8
121583	109,000	264.3	281.2	287.7	36.7	1.8	16.7	16.6
121400	109,000	263.6	280.3	286.9	36.8	1.8	17.4	17.4
121211	109,000	262.6	282.3	287.6	34.3	1.6	10.7	15.4
121169	109,000	262.4	282.1	287.4	34.4	1.6	10.7	11.2
120959	109,000	261.6	281.0	286.4	34.5	1.6	11.1	10.7
120932	109,000	261.4	281.0	286.3	34.5	1.6	11.0	10.6
120773	109,000	260.7	277.6	283.9	36.9	1.8	12.6	13.4
120615	109,000	260.0	277.6	283.8	36.4	1.7	12.7	12.6

Appendix E

SRH-2D Output

LARERR Reach 8A Pilot Project

Reach 8A 60% Design: 2D Hydraulic Results for Fish Passage Suitability

Discharge = 25 cfs

Upstream	USACE 2008 STA 1231+70 to 1228+40	USACE 2008 STA 1229+00 to 1225+70	Middle	USACE 2008 STA 1225+90 to 1222+60	USACE 2008 STA 1223+00 to 1219+70	Downstream

Flow

Flow

Flow

Flow

Depth is about 0.8 ft throughout middle section with no inset channel

60% Design - 25 cfs

Velocity Classes for Depth > 1 ft

- Resting: 0 - 2 ft/s
- Favorable: 2 - 4 ft/s
- Suitable: 4 - 6 ft/s
- Acceptable: 6 - 8 ft/s
- Marginal: 8 - 10 ft/s
- Inundated Area

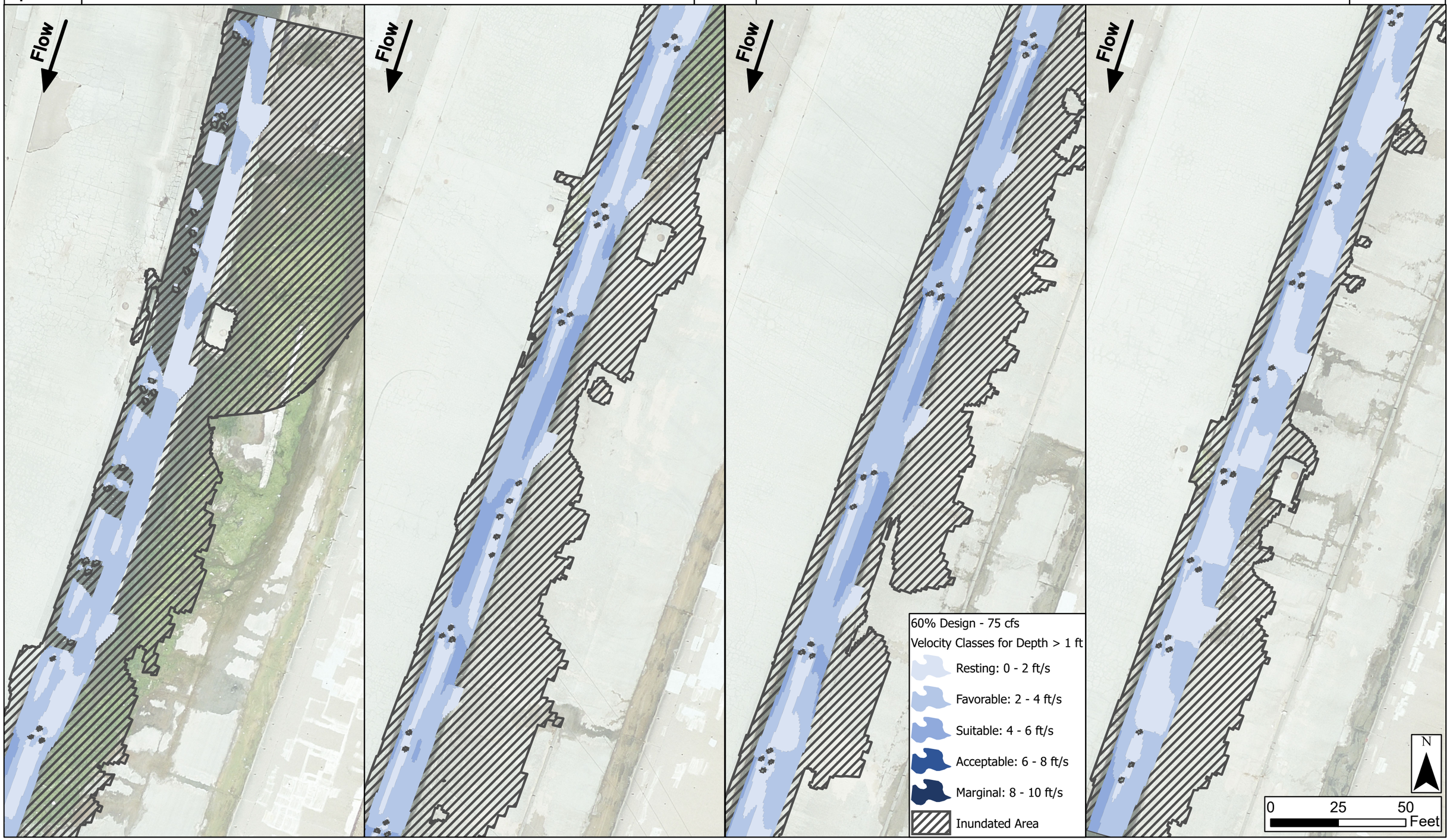
N

0 25 50 Feet

Reach 8A 60% Design: 2D Hydraulic Results for Fish Passage Suitability

Discharge = 75 cfs

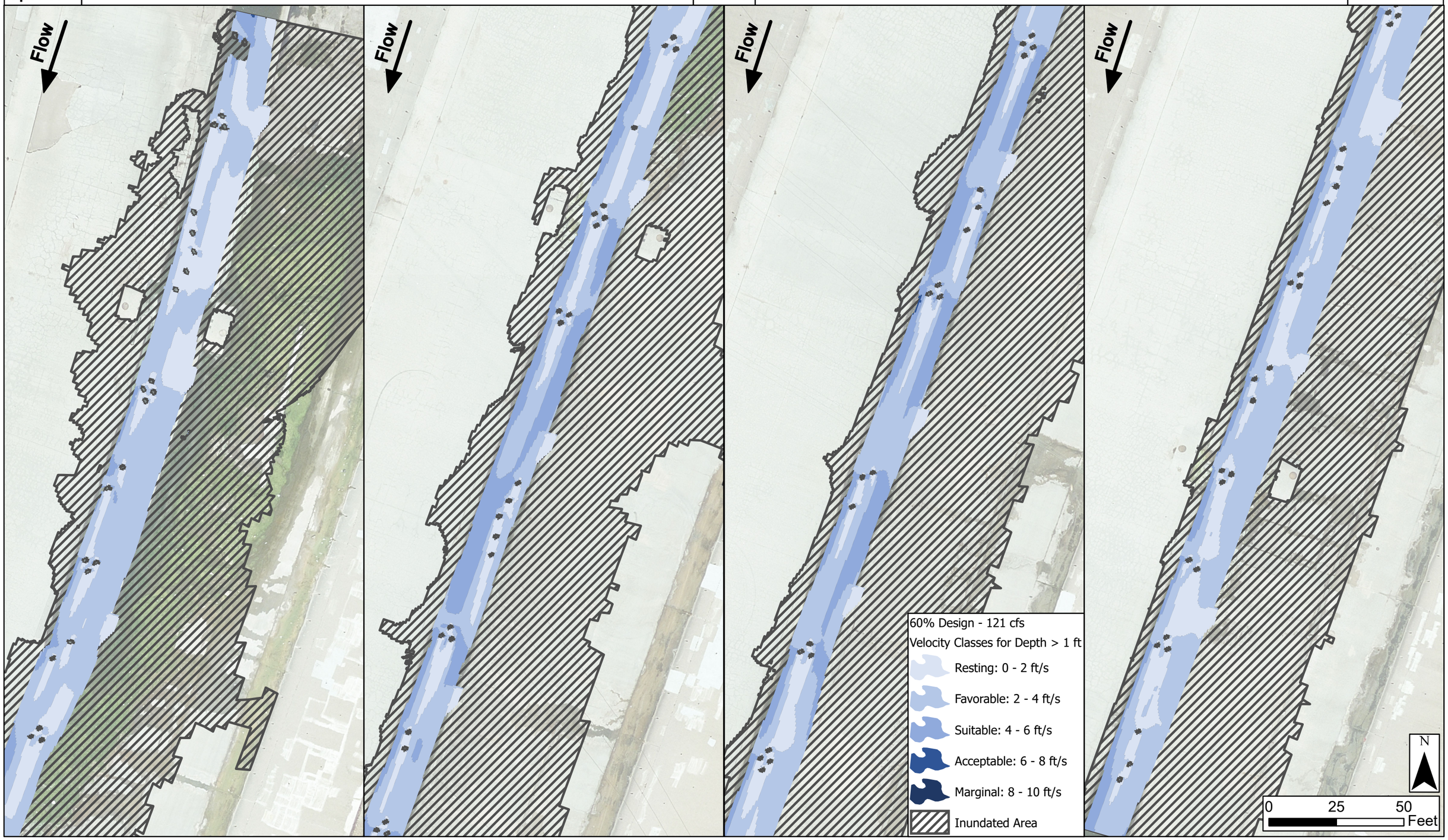
Upstream	USACE 2008 STA 1231+70 to 1228+40	USACE 2008 STA 1229+00 to 1225+70	Middle	USACE 2008 STA 1225+90 to 1222+60	USACE 2008 STA 1223+00 to 1219+70	Downstream



Reach 8A 60% Design: 2D Hydraulic Results for Fish Passage Suitability

Discharge = 121 cfs

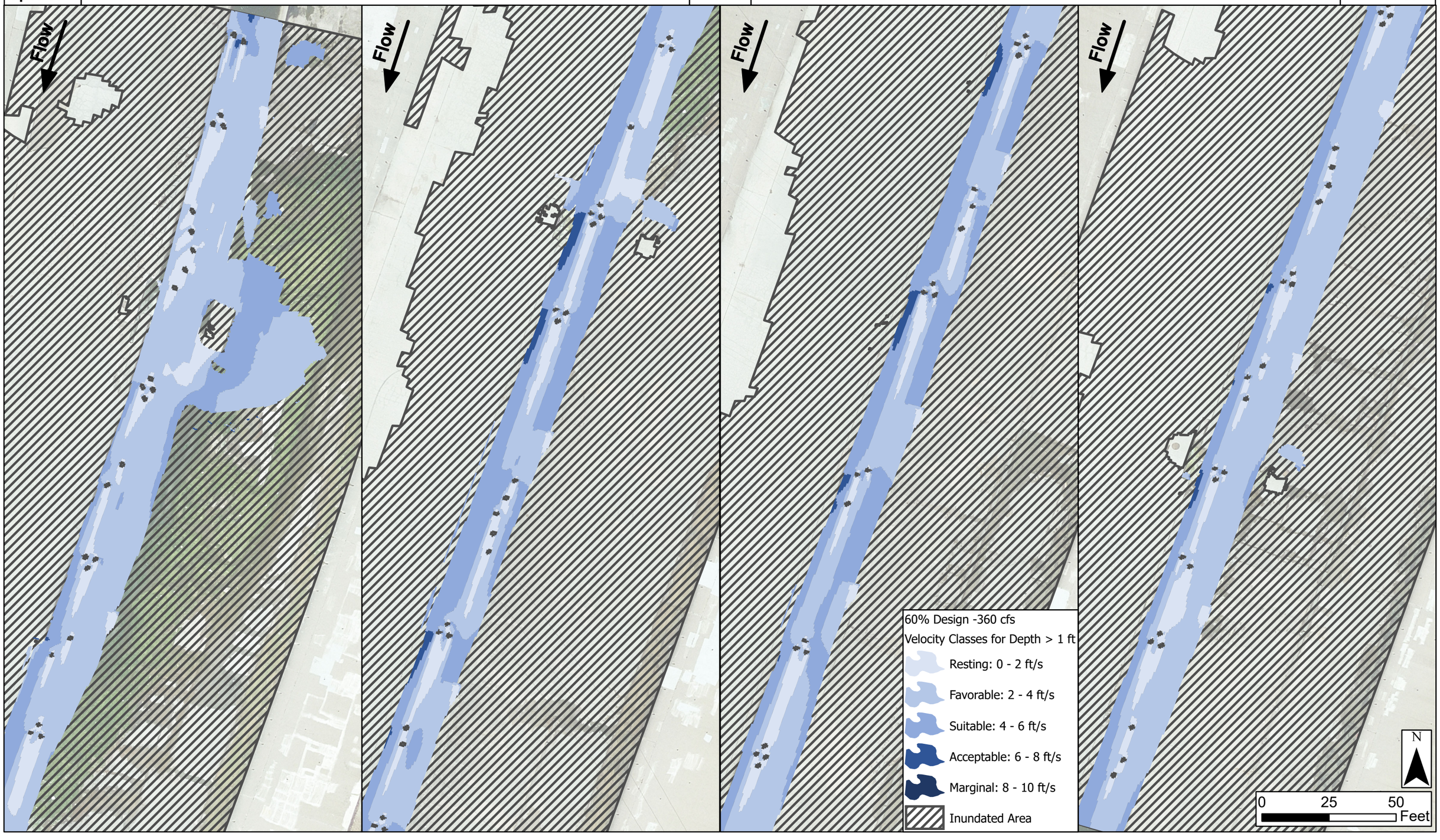
Upstream	USACE 2008 STA 1231+70 to 1228+40	USACE 2008 STA 1229+00 to 1225+70	Middle	USACE 2008 STA 1225+90 to 1222+60	USACE 2008 STA 1223+00 to 1219+70	Downstream



Reach 8A 60% Design: 2D Hydraulic Results for Fish Passage Suitability

Discharge = 360 cfs

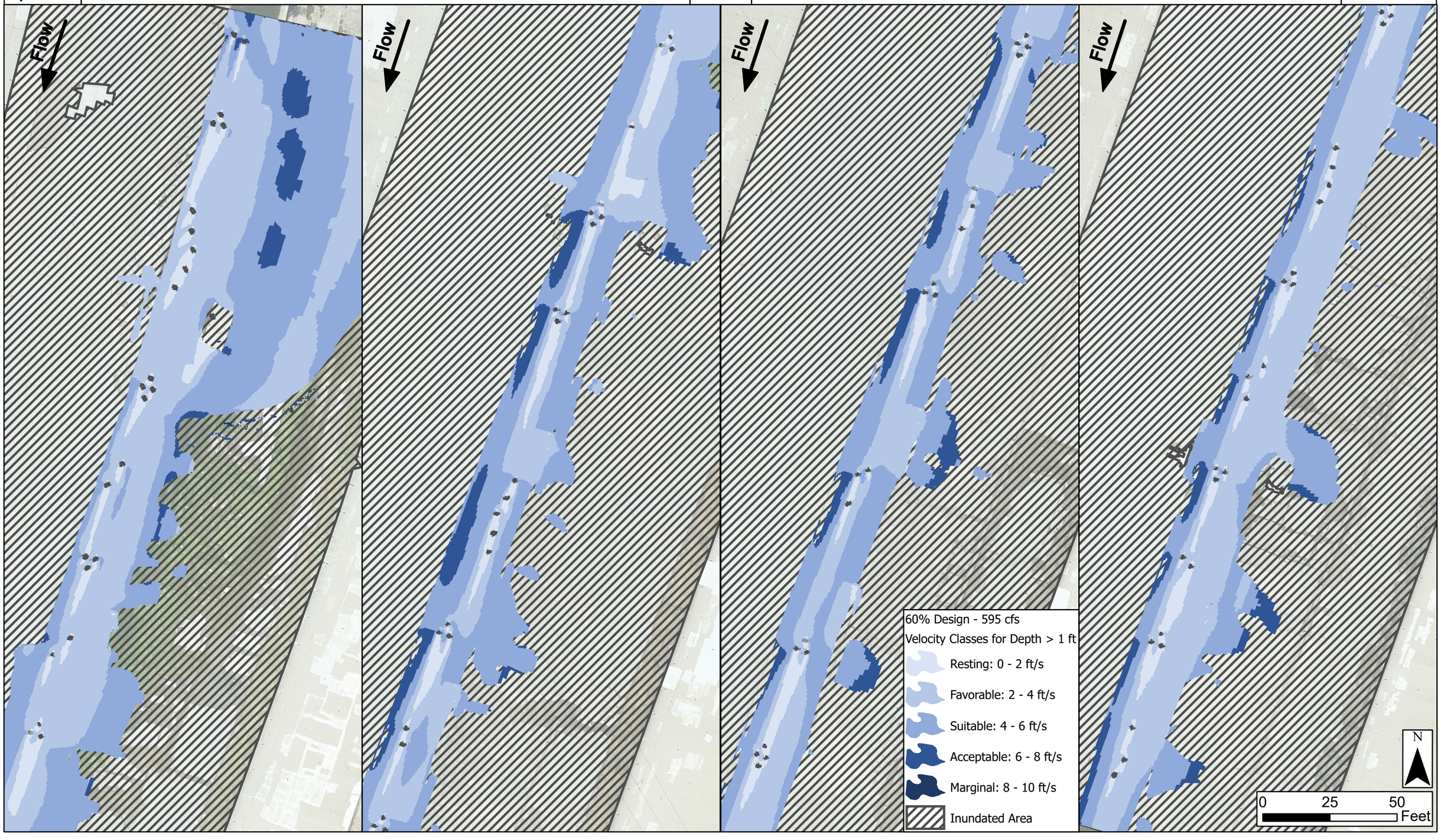
Upstream	USACE 2008 STA 1231+70 to 1228+40	USACE 2008 STA 1229+00 to 1225+70	Middle	USACE 2008 STA 1225+90 to 1222+60	USACE 2008 STA 1223+00 to 1219+70	Downstream



Reach 8A 60% Design: 2D Hydraulic Results for Fish Passage Suitability

Discharge = 595 cfs

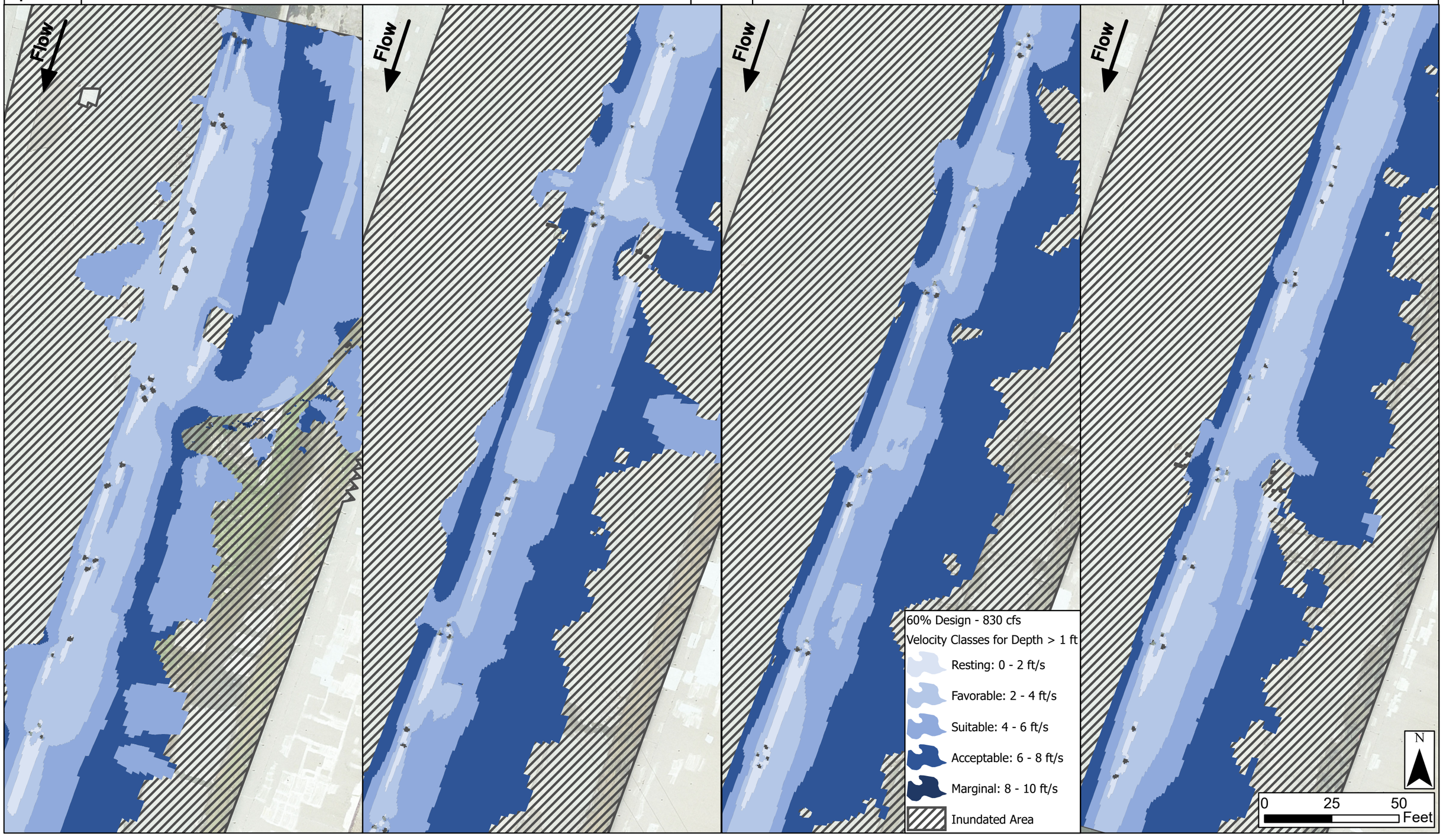
Upstream	USACE 2008 STA 1231+70 to 1228+40	USACE 2008 STA 1229+00 to 1225+70	Middle	USACE 2008 STA 1225+90 to 1222+60	USACE 2008 STA 1223+00 to 1219+70	Downstream



Reach 8A 60% Design: 2D Hydraulic Results for Fish Passage Suitability

Discharge = 830 cfs

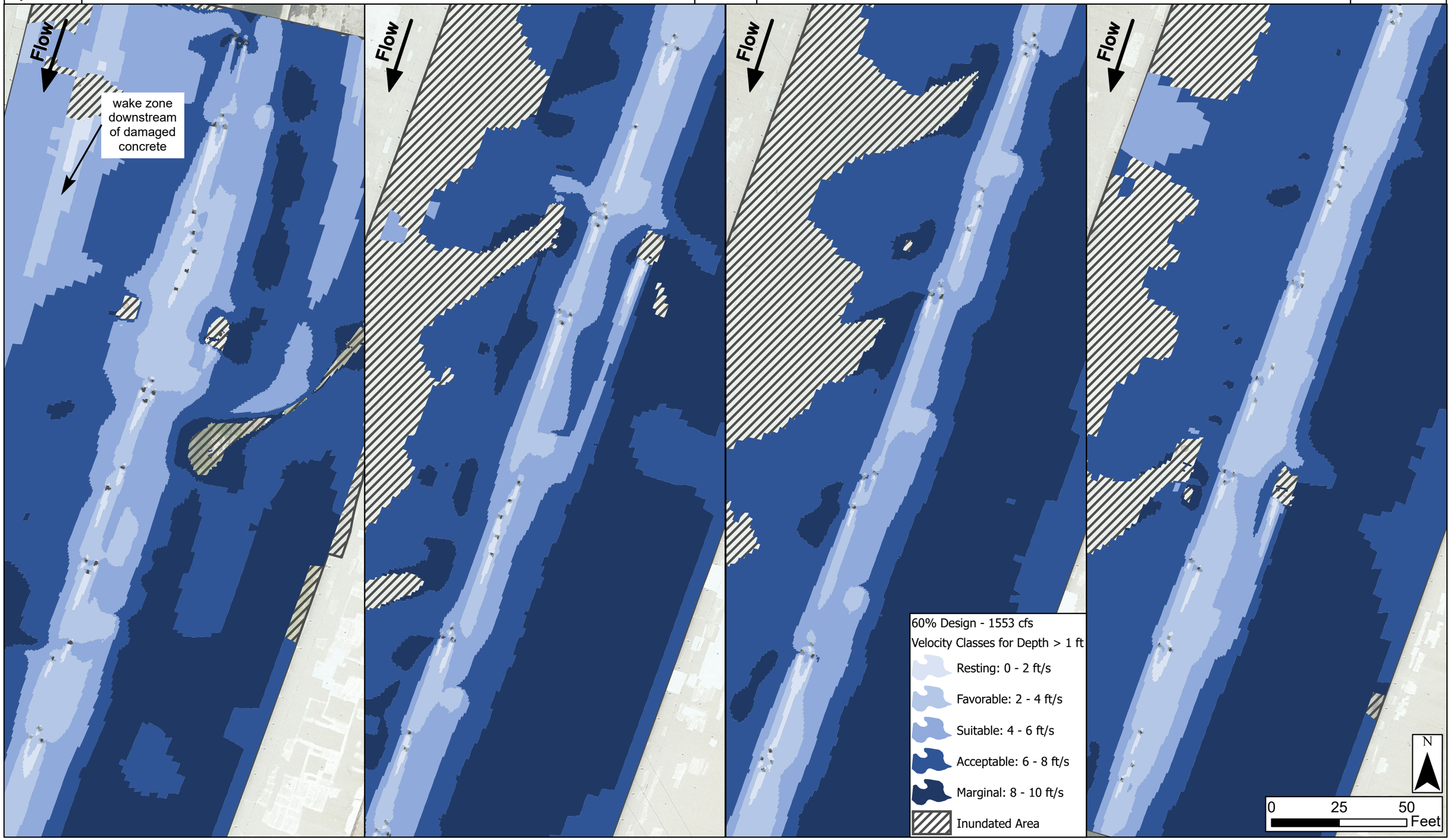
Upstream	USACE 2008 STA 1231+70 to 1228+40	USACE 2008 STA 1229+00 to 1225+70	Middle	USACE 2008 STA 1225+90 to 1222+60	USACE 2008 STA 1223+00 to 1219+70	Downstream



Reach 8A 60% Design: 2D Hydraulic Results for Fish Passage Suitability

Discharge = 1553 cfs

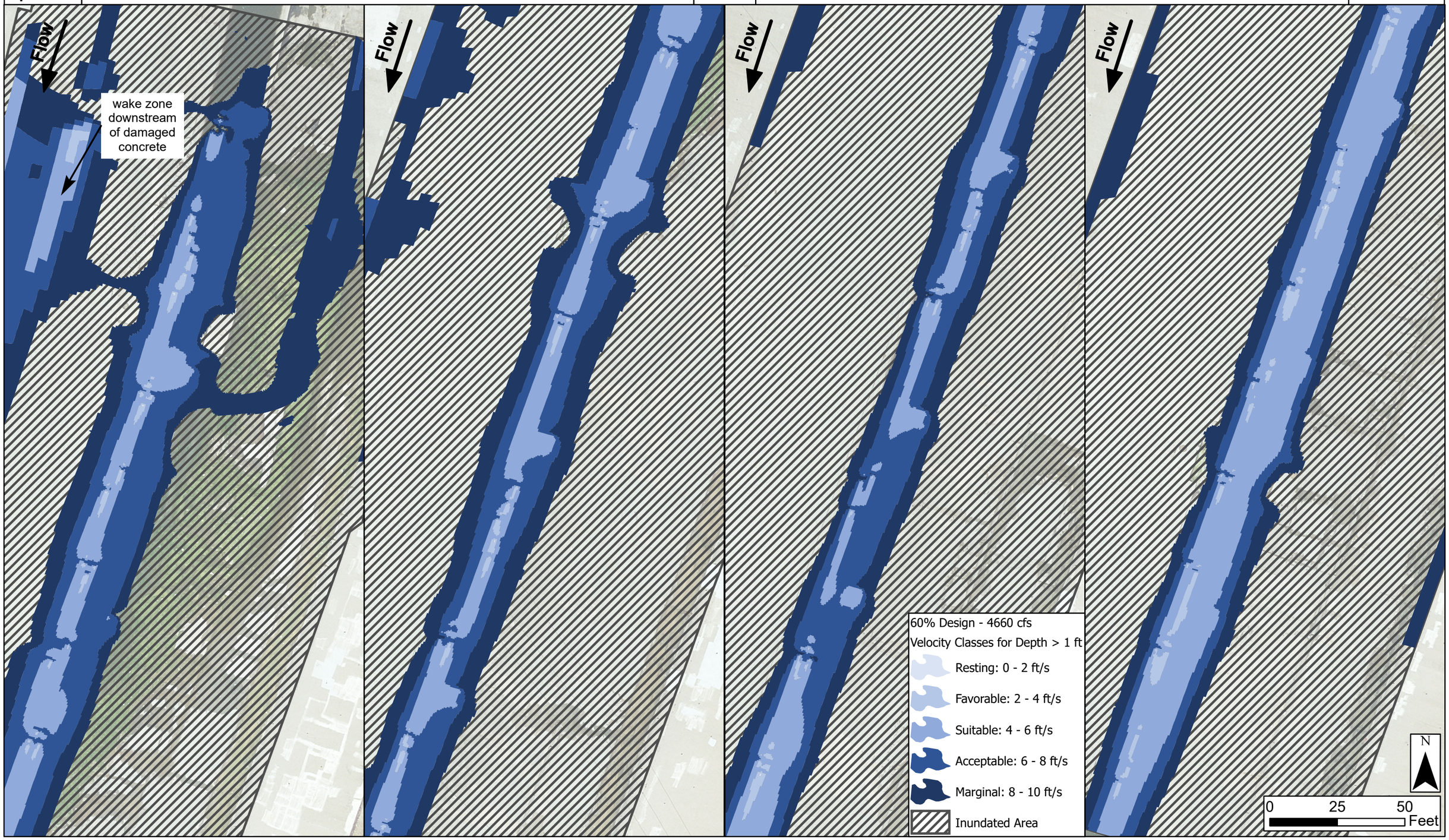
Upstream	USACE 2008 STA 1231+70 to 1228+40	USACE 2008 STA 1229+00 to 1225+70	Middle	USACE 2008 STA 1225+90 to 1222+60	USACE 2008 STA 1223+00 to 1219+70	Downstream



Reach 8A 60% Design: 2D Hydraulic Results for Fish Passage Suitability

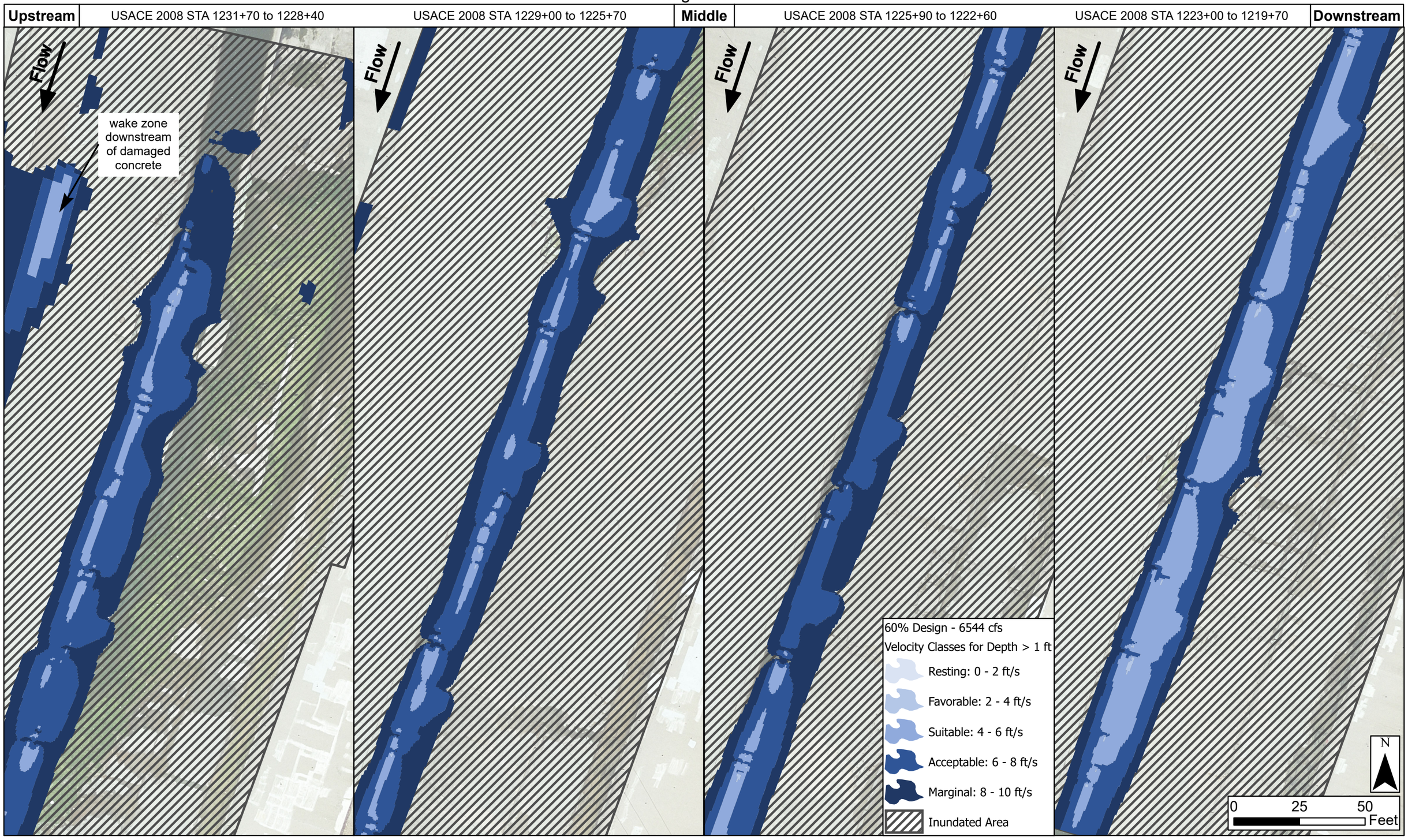
Discharge = 4660 cfs

Upstream | USACE 2008 STA 1231+70 to 1228+40 | USACE 2008 STA 1229+00 to 1225+70 | **Middle** | USACE 2008 STA 1225+90 to 1222+60 | USACE 2008 STA 1223+00 to 1219+70 | **Downstream**



Reach 8A 60% Design: 2D Hydraulic Results for Fish Passage Suitability

Discharge = 6544 cfs



Appendix F

SRH-2D Output

4.8-Mile Reach Project

Map Book of 2D Hydraulic Model Results for LA River Fish Passage Analysis

A total of nine steady-state discharges (25, 75, 128, 360, 595, 1,553, 4,660, and 6,544 cfs) were modeled for two reaches using the Concept A design (Concept A at 1st to 4th Street reach and Arroyo Seco reach). The following maps display model results filtered to only show areas where depth is greater than 1 ft, which is the minimum depth fish passage design target. The fish passage suitability is plotted based on classifying the velocity into 2 ft/s increments: resting (0 – 2 ft/s), favorable (2 – 4 ft/s), suitable (4 – 6 ft/s), acceptable (6 – 8 ft/s), and marginal (8 – 10 ft/s). Each reach is divided into two panels for each modeled discharge: upstream section on the left and downstream on the right. Flow is from the top of the page to the bottom.

Design surfaces were developed by Stillwater Sciences and 2D modeling was completed by the Bureau of Reclamation, Sedimentation and River Hydraulics Group.

Concept A

Upstream

Flow = 25 cfs

Downstream

Concept A

Upstream

Flow = 75 cfs

Downstream

Concept A

Upstream

Flow = 128 cfs

Downstream

Concept A

Upstream

Flow = 360 cfs

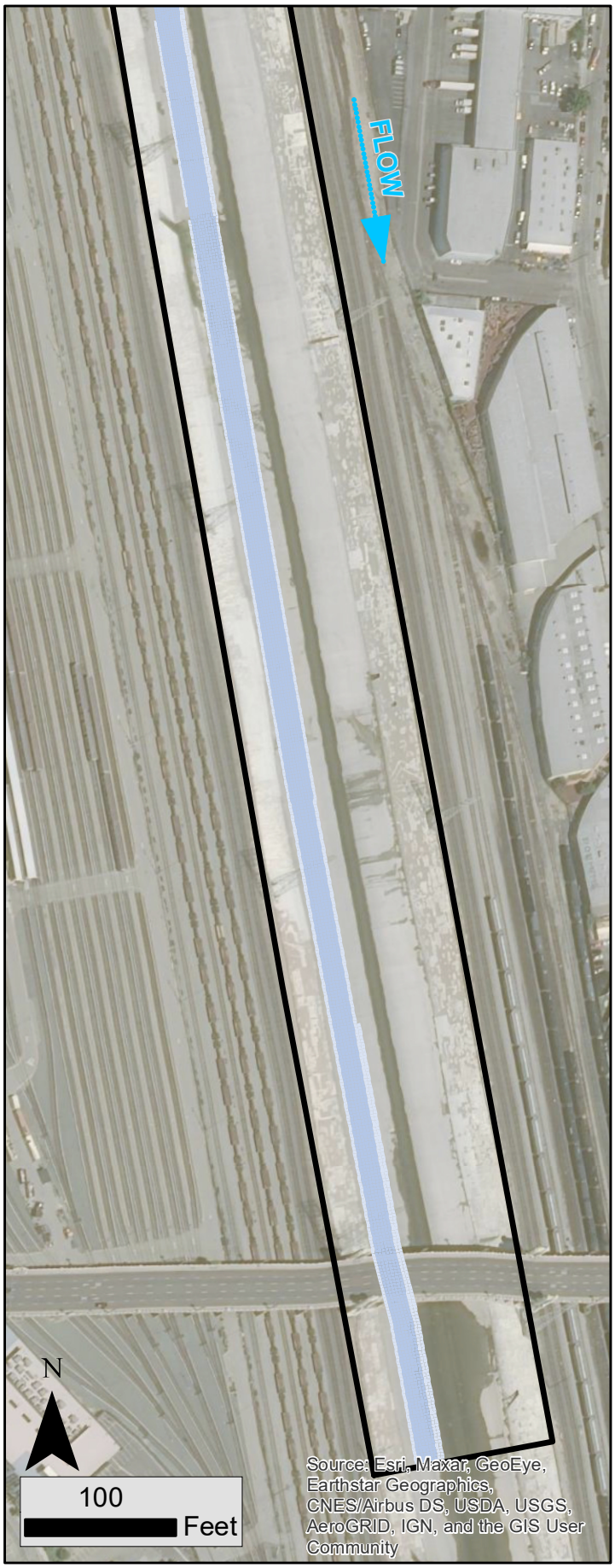
Downstream

Concept A

Upstream

Flow = 595 cfs

Downstream



Concept A

Upstream

Flow = 830 cfs

Downstream

Concept A

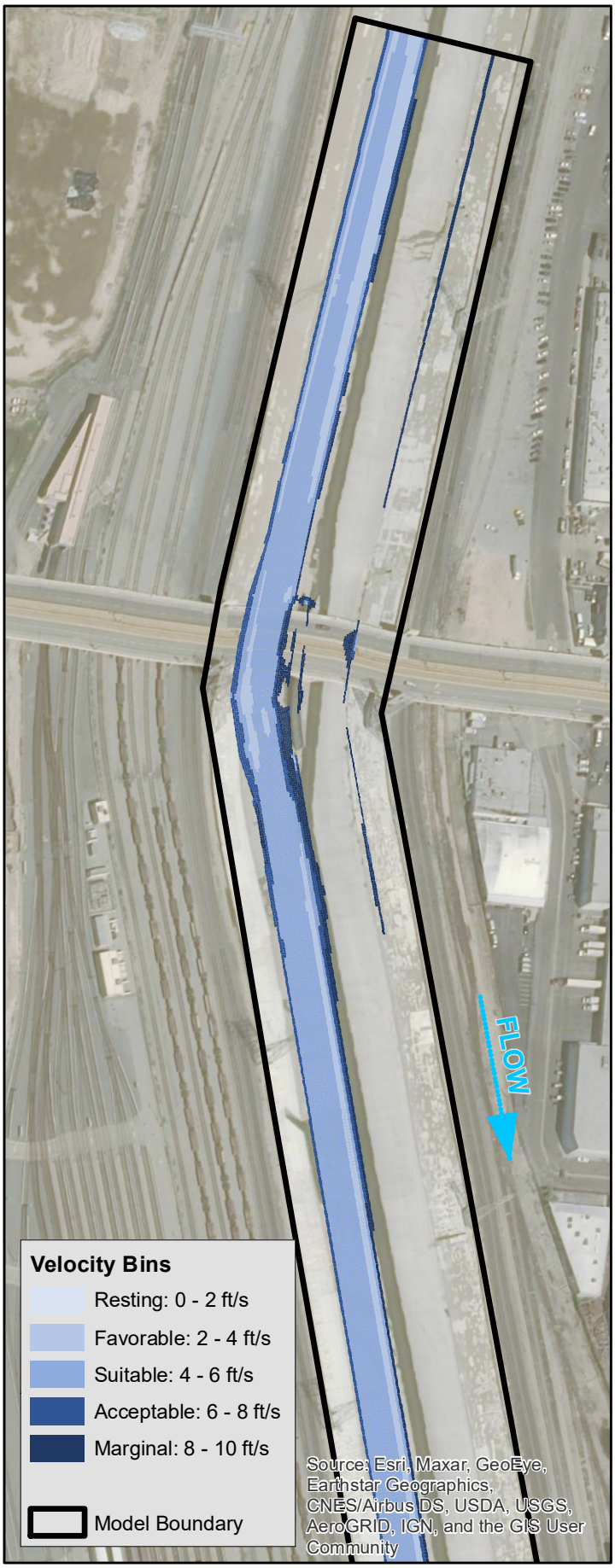
Upstream Flow = 1,553 cfs Downstream

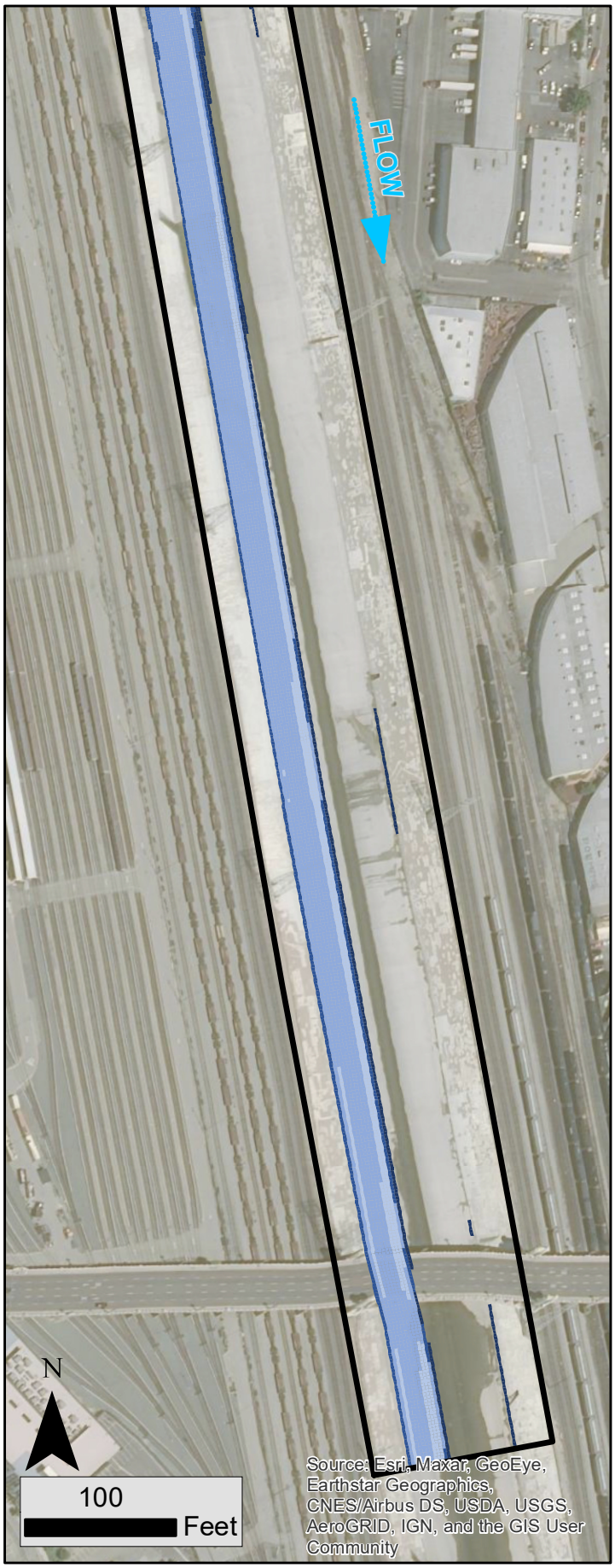
Concept A

Upstream

Flow = 4,660 cfs

Downstream





Concept A

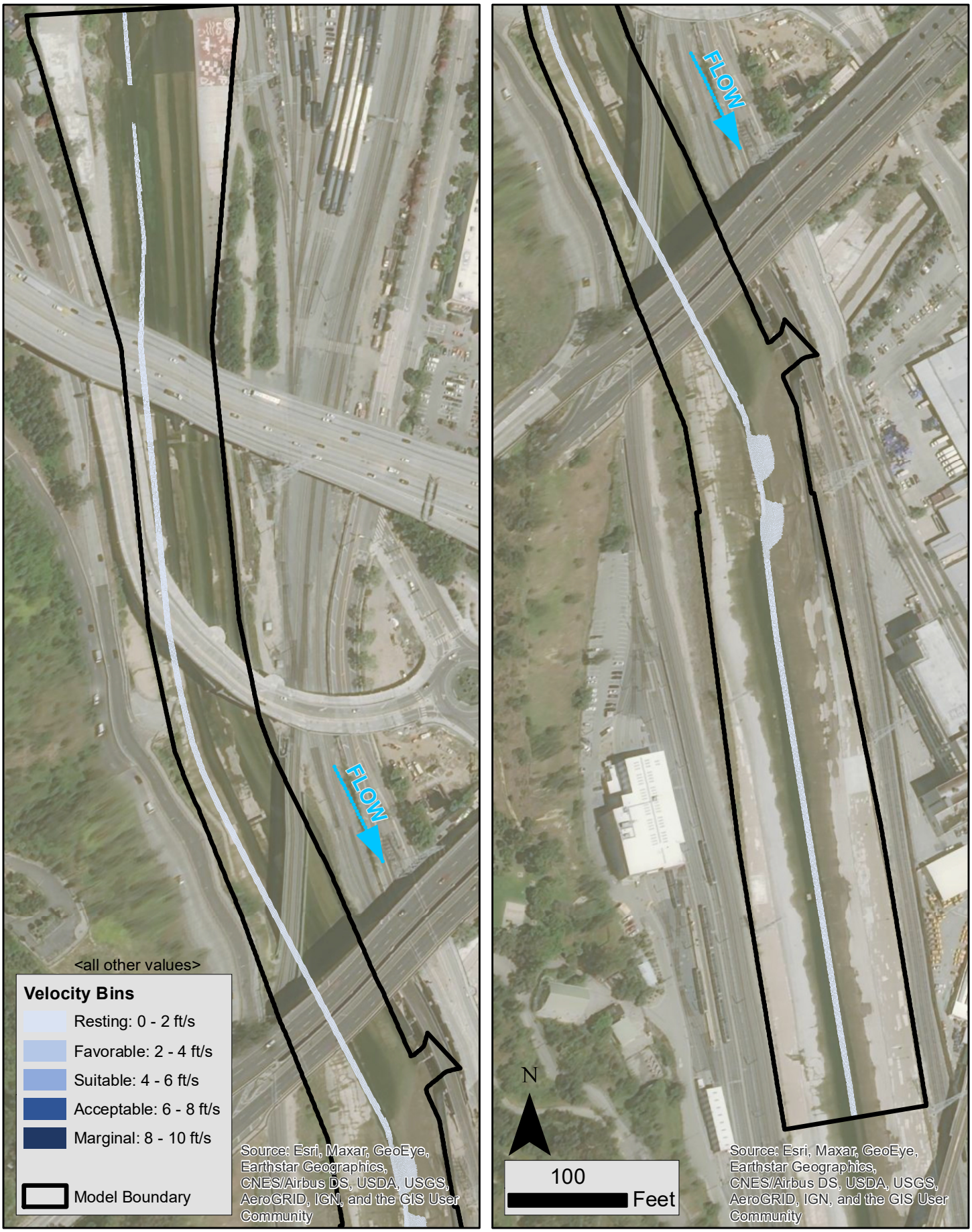
Upstream

Flow = 6,554 cfs

Downstream

Arroyo Seco

Upstream | Flow = 25 cfs | Downstream

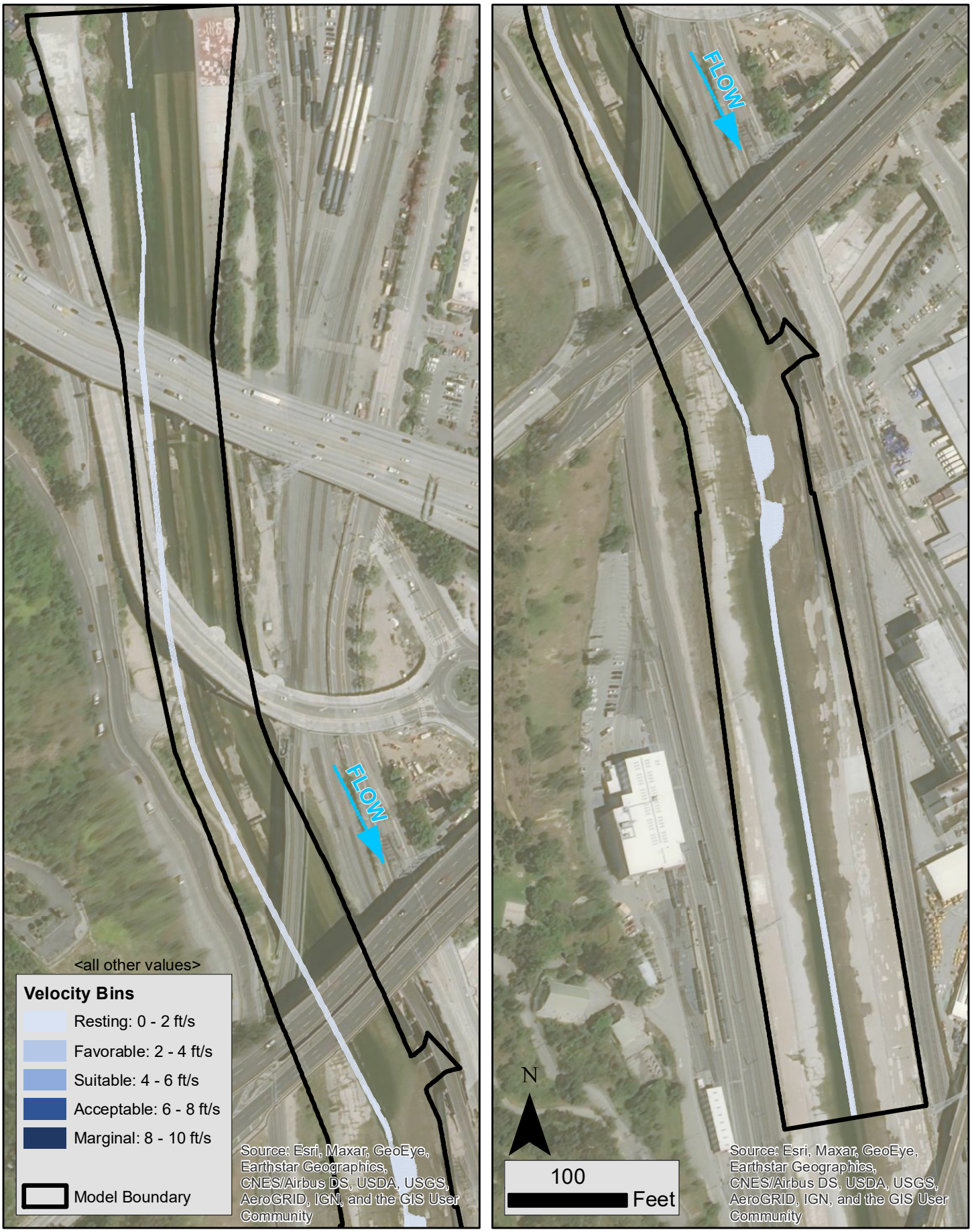


Arroyo Seco

Upstream

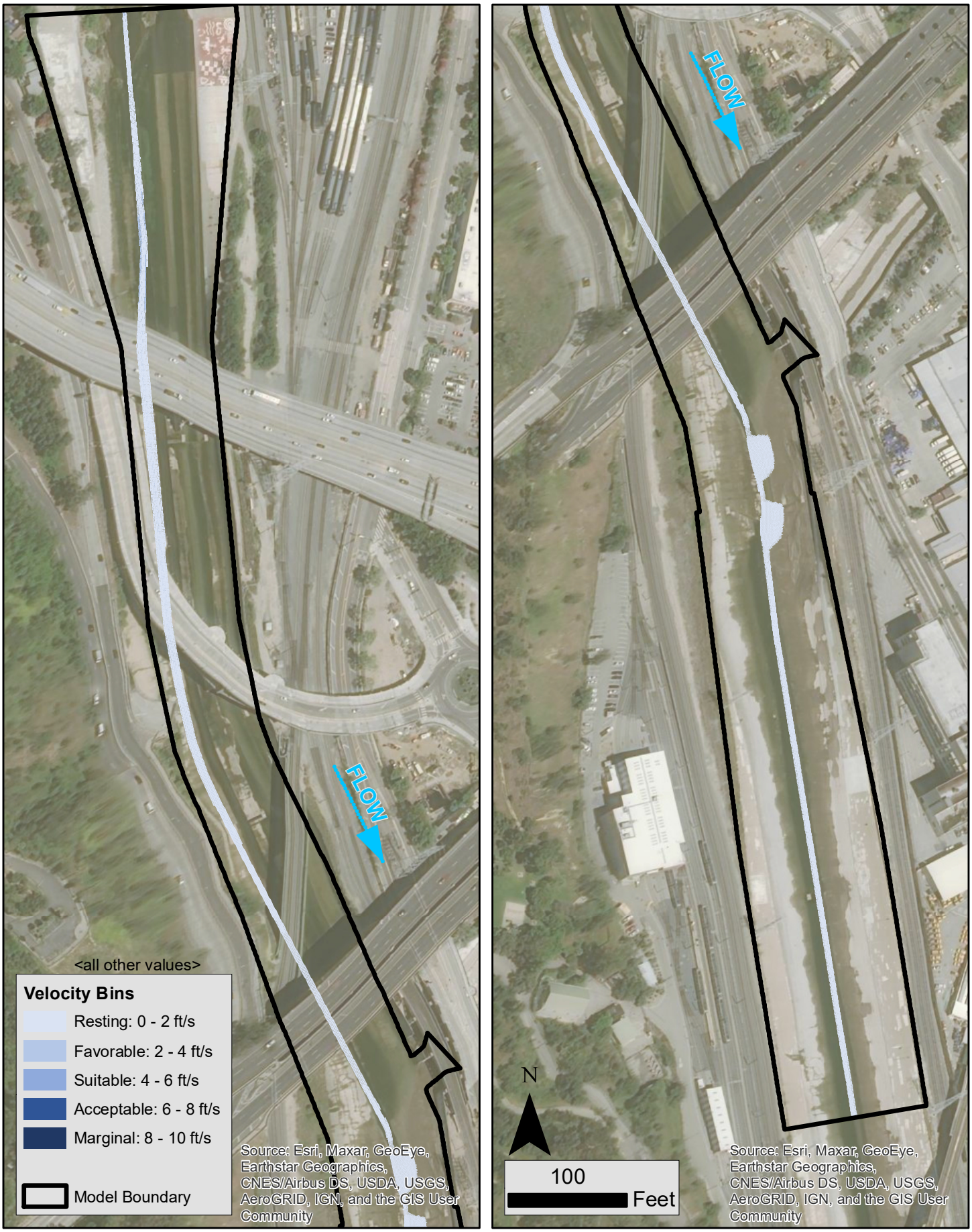
Flow = 75 cfs

Downstream



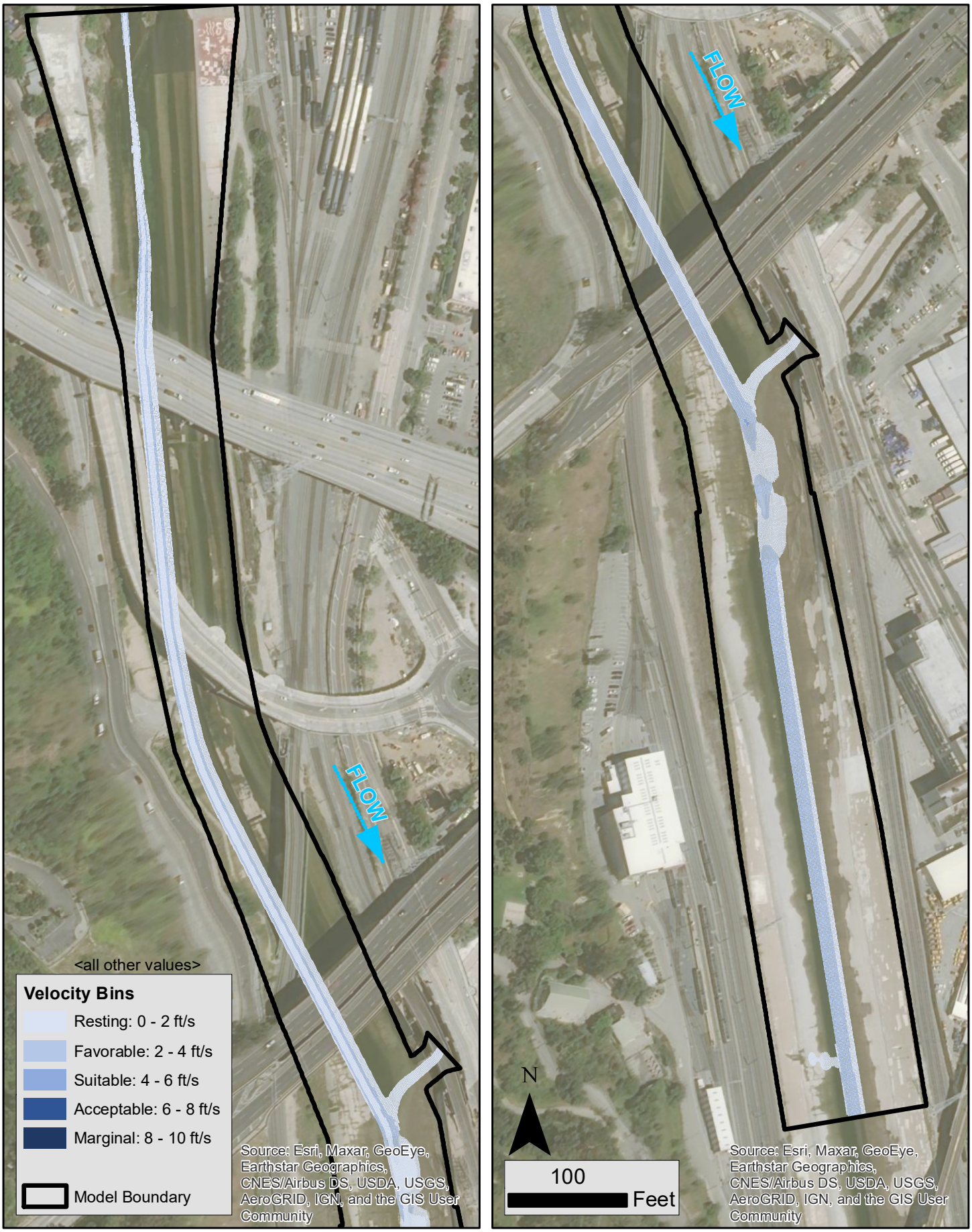
Arroyo Seco

Upstream Flow = 128 cfs Downstream



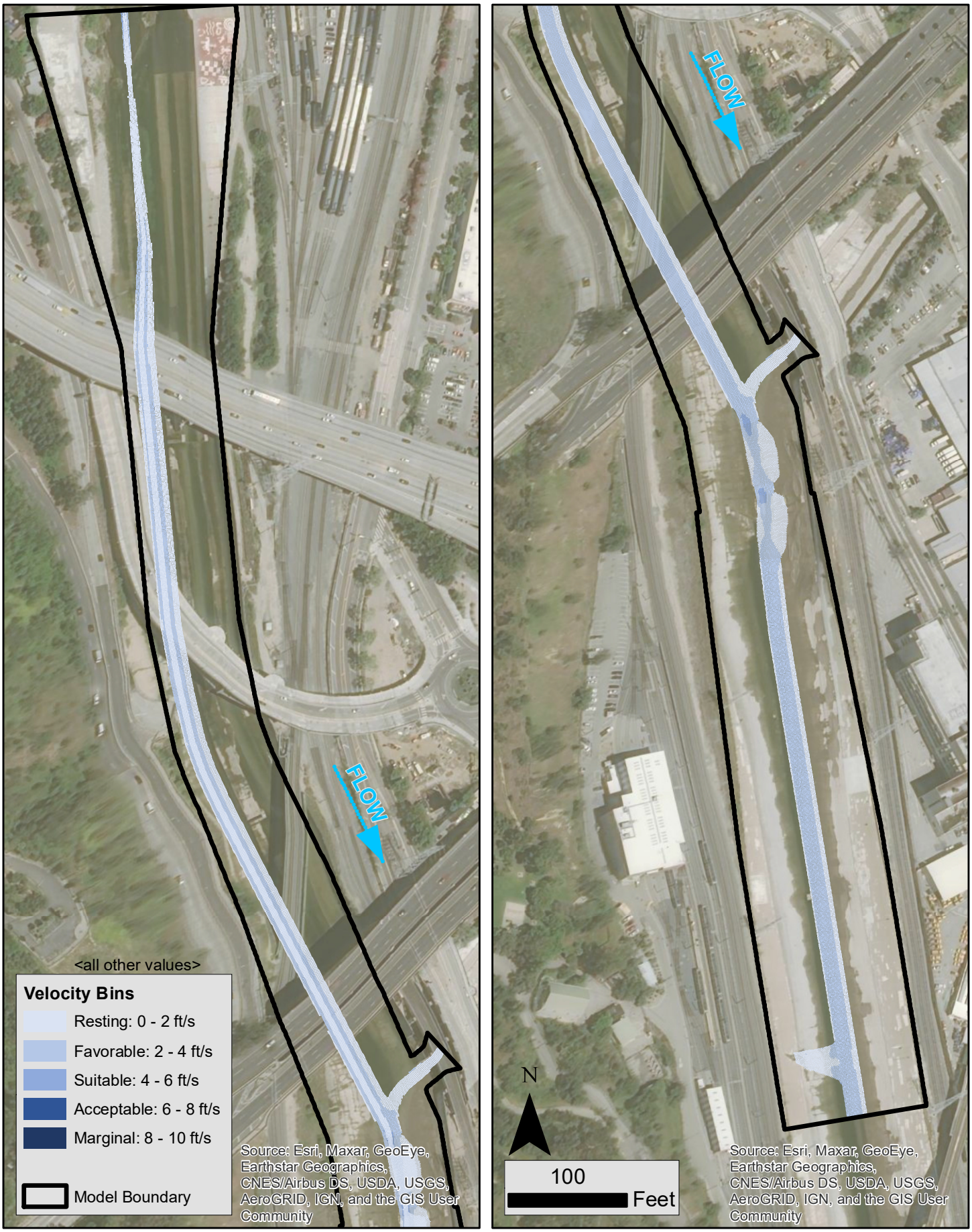
Arroyo Seco

Upstream Flow = 360 cfs Downstream



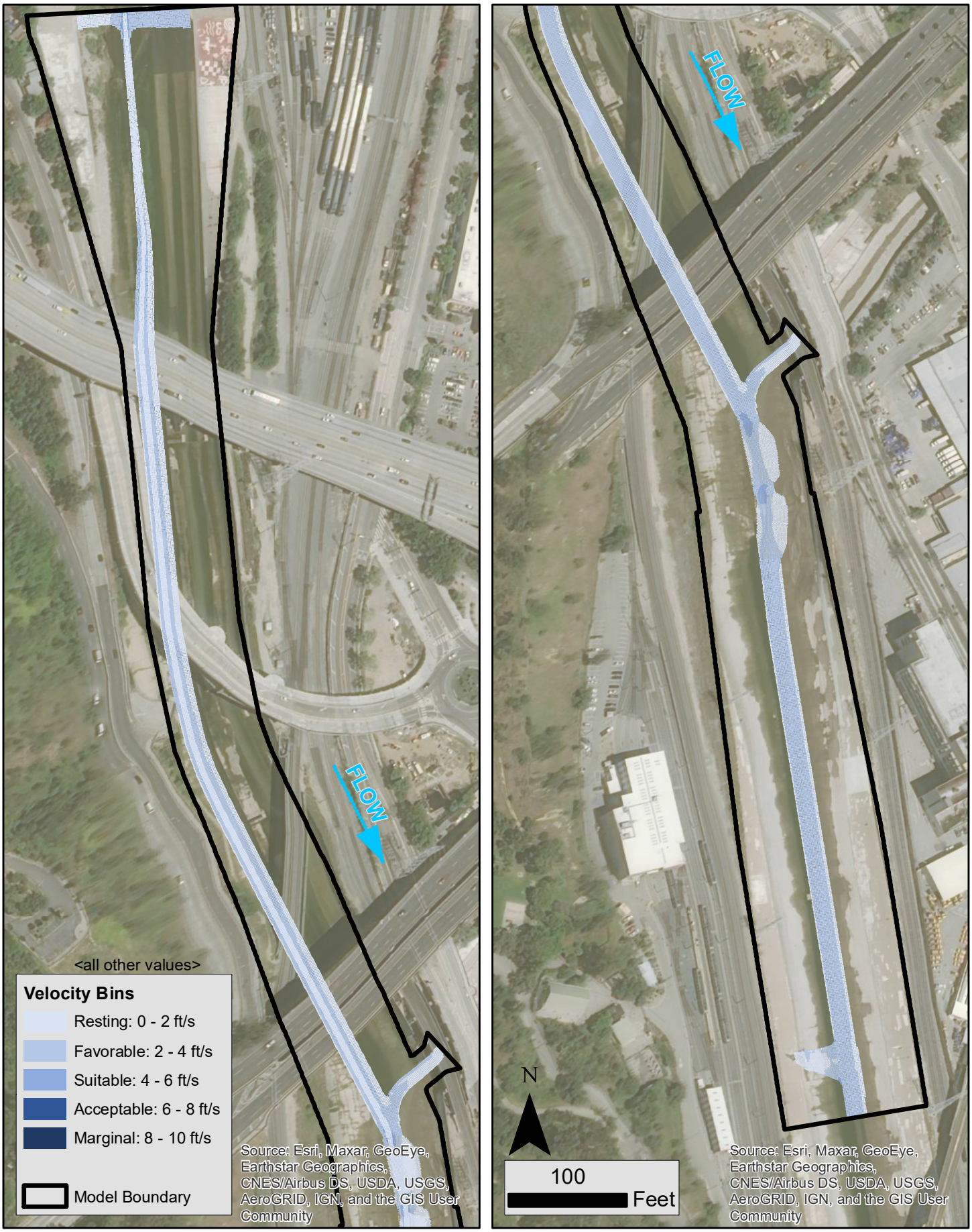
Arroyo Seco

Upstream Flow = 595 cfs Downstream



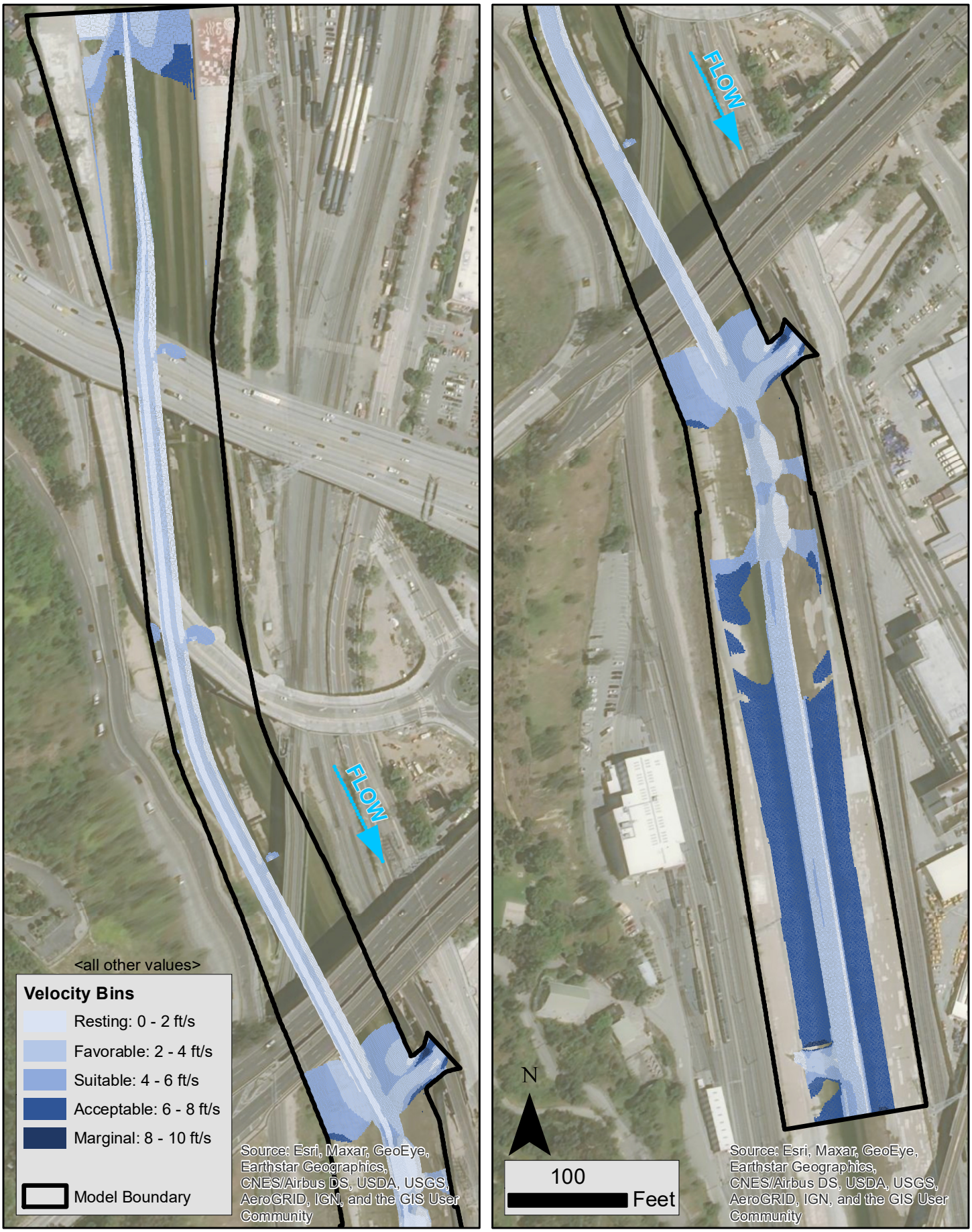
Arroyo Seco

Upstream | Flow = 830 cfs | Downstream



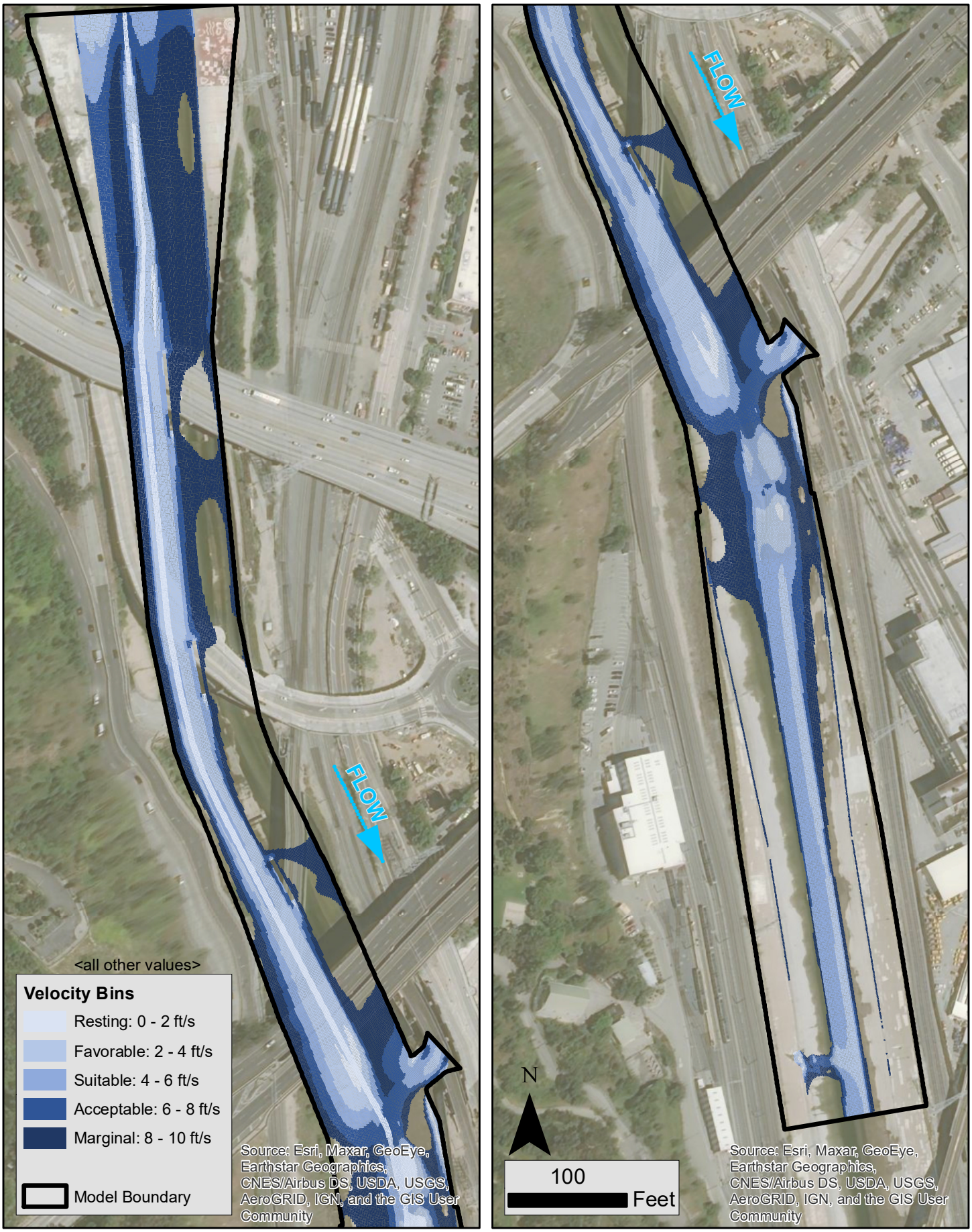
Arroyo Seco

Upstream | Flow = 1,553 cfs | Downstream



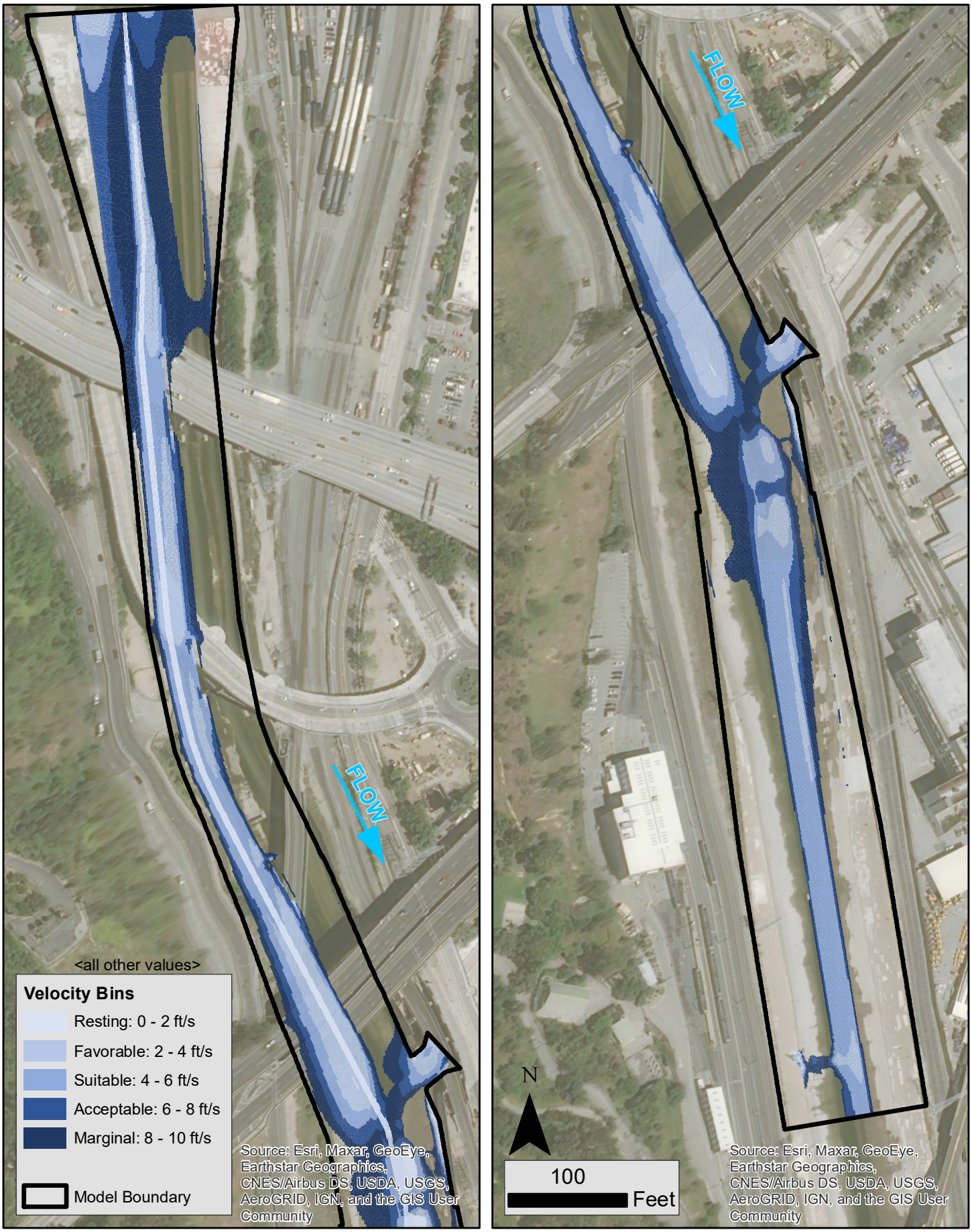
Arroyo Seco

Upstream | Flow = 4,660 cfs | Downstream



Arroyo Seco

Upstream | Flow = 6,544 cfs | Downstream



Appendix G

Risk and Uncertainty Analysis

LARERR Reach 8A Pilot Project

nhc
northwest hydraulic consultants

May 5, 2022

NHC Reference 5007204

Stillwater Sciences
304 South Broadway, Suite 202
Los Angeles, CA 90013

Attention: Samuel Ward, Project Manager

Via email: sward@stillwatersci.com

Re: Los Angeles River Fish Passage and Habitat Structures Project
Risk and Uncertainty Analysis Draft Letter Report

Dear Ms. Tanaka:

1 Introduction

Stillwater Sciences (Stillwater) is leading a team of consultants for the Los Angeles River Fish Passage and Habitat Structures Project. This project intends to modify a segment of the concrete-lined Los Angeles River to enhance suitability for fish passage and habitat. Northwest Hydraulic Consultants (NHC) is supporting this project by providing hydraulic analysis and fish passage design services.

This document describes the procedures and results of a risk and uncertainty (R&U) analysis performed to assess flood performance of proposed pilot improvements in Los Angeles River Ecosystem Restoration and Recreation (LARERR) Reach 8A Pilot Project, an approximately 1300-ft long section of channel south of North Main Street in Los Angeles. The R&U process involves estimating the likelihood of water levels exceeding a target threshold for a given flood event, considering uncertainty in both hydrology and hydraulics. Best estimates of the hydrologic and hydraulic parameters, as well as estimates of uncertainty surrounding each, were entered into the HEC-FDA (version 1.4.3) computer program (USACE, 2021). The program then performs a Monte-Carlo analysis of the input parameters to estimate the LARERR Reach 8A Pilot Project (pilot project) performance. This analysis was performed for both existing and proposed conditions to identify any impacts from the pilot project.

The R&U analysis was conducted at four index points. Two points were chosen within the Reach 8A pilot project reach; the other two points were chosen near the bridges upstream and downstream of Reach 8A. The analysis described herein follows the procedures of the U.S. Army Corps of Engineers (USACE) Engineering Manual (EM) 1110-2-1619 (USACE, 1996).

2 Hydrology

The hydrology adopted for this analysis was completed as part of the *Los Angeles County Drainage Area Final Feasibility Interim Report* (USACE,1991). The values were developed using a rainfall-runoff-routing model, calibrated to notable events. NHC utilized the published flow values at Concentration Point 21

(Los Angeles River below Arroyo Seco, drainage area 561 square miles) to represent recurrence interval flows for Reach 8A.

Table 1: Discharge frequency

Return Period (years)	Annual Exceedance Probability	Flow Rate (cfs)
2	0.5	22,900
5	0.2	44,200
10	0.1	53,600
25	0.04	79,800
50	0.02	94,400
100	0.01	109,000
200	0.005	124,000
500	0.002	141,000

To estimate the uncertainty in these discharges, NHC utilized the graphical approach described in EM-1110-2-1619. Table 4-5 in the EM provides equivalent record length guidelines to use with this approach. An equivalent record length of 20-30 years is recommended for flow estimates derived from a calibrated rainfall-runoff-routing model such as the USACE used to develop the flow estimates above. Because the USACE flow estimates are now over 30 years old, uncertainty in their current validity is higher. Therefore, NHC adopted 20 years as the equivalent record length for these discharges; the minimum value from the recommended range.

3 Hydraulics

Estimates of stage as well as stage uncertainty are required inputs to HEC-FDA at each of the four Index Locations, for both existing and proposed conditions. NHC was provided with an existing conditions hydraulic model (HEC-RAS, version 5.0.7) of the relevant reach of river developed by Stillwater Sciences for the Project Design Development Technical Memorandum (Stillwater, 2022). Model stations are based on the USACE Los Angeles River Regulatory Model alignment, and topographic information is based on USACE (2019) LiDAR data referenced to the NAVD 88 vertical datum. NHC developed a proposed conditions HEC-RAS model by adding additional cross-sections in locations to represent pilot project features and adjusting Manning's n values to represent proposed channel lining materials and vegetation. The additional cross-section locations were then added to the existing conditions model, so that both HEC-RAS models contained identical cross-section locations.

Roughness values adopted for this analysis are shown in the table below. Low and high bounding n-values were estimated by NHC using USACE Engineering Manual 1110-2-1601 (USACE, 1994) and professional judgment. The USACE document provides guidance on several methods to estimate

roughness - NHC used the Strickler and Limerinos methods, in addition to Chow (1959). This provided a range of results from which judgment was applied to select the final bounding n-values.

Table 2: Range of Manning n values used in HEC-RAS

Description	Base Value	Low Bound	High Bound
Concrete Trapezoidal Channel[1]	0.014	0.013	0.018
Vegetation (planter boxes, perforated slab, stormwater treatment area)[2]	0.03	0.025	0.035
Vegetation-affected corridor[2]	0.025	0.02	0.03
Low-flow channel (boulder-affected corridor)[2]	0.022	0.02	0.027
Inset channel (grouted rock lining)[2]	0.03	0.025	0.04
Overbanks within trapezoidal channel[2]	0.014	0.013	0.018

1. Utilized throughout existing conditions model, and upstream and downstream of the Reach 8A Pilot Project in the proposed model.
2. Utilized only in proposed model.

3.1 Stage-Discharge Relationship

The "Base" Manning n values in Table 2 were used to develop the stage-discharge data (i.e., rating curves) for each index location, for both existing and proposed conditions. The stage-discharge relationship includes a tabulation of stage for each flow described in Section 2, plus the stages for an upper bound discharge of 240,000 cfs. This upper bound was necessary to include because HEC-FDA's Monte-Carlo routine samples discharges several standard deviations above the specified 500-yr discharge, so it is important to define the rating curves to well-above the 500-yr flow level. A flow of 240,000 cfs was chosen as the upper bound for the rating curves because flows greater than this begin to trigger pressure flow at numerous bridges in the HEC-RAS model and it is unlikely that flows greater than this could be conveyed to the site. HEC-FDA automatically extends the rating curve above the highest entered value on a nearly flat slope, i.e., increasing discharge does not increase stage. This was judged to be a reasonable approximation for the capacity limited channel at these extremely rare events.

3.2 Stage Uncertainty

There are two sources of uncertainty in the stage-discharge relationship: natural uncertainty and model uncertainty. EM-1110-2-1619 provides guidance on how to estimate each of these uncertainty components. Total stage uncertainty is then computed using the following equation (equation 5-6 in EM-1110-2-1619):

$$S_t = \sqrt{(S_{natural}^2 + S_{model}^2)}$$

3.2.1 Natural Uncertainty

Natural uncertainty is a function of four parameter: the bed material, the drainage area, the 100-year discharge flow rate, and the stage range. Values for each parameter are input to the following equation

(equation 5-5 from USACE (1996)) to compute the natural uncertainty. Note that this equation uses metric values, therefore, the basin area is entered in square kilometers, the stage range is in meters, and the discharge is in cubic meters per second. The bed material is a unitless parameter.

$$S_{natural} = (0.07208 + 0.04936 * I_{bed} - 2.2626 * 10^{-7} * A_{basin} + 0.02164 * H_{range} + 1.4194 * 10^{-5} * Q_{100})\text{^}2$$

3.2.1.1 Bed Material

Table 5-1 in EM-1110-2-1619 provides values for I_{bed}. Higher values in this table relate to higher mobility, independent of roughness. For the existing condition a value of 0 was selected, indicating high confidence that the concrete bed will not deform during floods. For the proposed conditions a value of 1 was selected to account for the slight possibility of a grouted-in-place habitat boulder becoming dislodged.

3.2.1.2 Drainage Area

USACE (1996) reports that the basin area downstream of the Seco Arroyo confluence is 561 square miles. Therefore, 1,436km^2 was entered into the natural uncertainty equation for both existing and proposed conditions.

3.2.1.3 100-year Discharge

USACE reports a 100-year discharge of 109,000cfs in the study reach. Therefore, 3,086cms was entered into the natural uncertainty equation for both existing and proposed conditions.

3.2.1.4 Stage Range

The stage range is the maximum range of conceivable stages at a site. NHC interpreted this as the channel invert to the overtopping elevation. Because there is a high degree of uniformity in the channel shape and proposed modifications are minor, a typical value of 29 feet (8.77m) was used at all index locations, for both existing and proposed conditions.

3.2.2 Model Uncertainty

As defined in EM 1110-2-1619, model uncertainty is associated with the accuracy of the Manning n-values used in the hydraulic model. To calculate model uncertainty, modified hydraulic models of the existing and proposed conditions were created using the low bound and high bound n-values from Table 2, and the models were run using the stated channel design discharge of 104,000cfs (USACE, 1996).

Model uncertainty is defined in EM 1110-2-1619 as the standard deviation of the variation in water surface elevations between the low- and the high-n value results. To compute this, the difference between the high-n and low-n stage results was first calculated at each index location, for both existing and proposed conditions. An average difference between the upper and lower limits of the calculated stage (E_{mean}) was then calculated by averaging the difference results between the four index locations in accordance with EM 1110-2-1619. This averaging was done separately for the existing and proposed conditions. Lastly, because stage uncertainty represents the standard deviation of model error rather

than the actual range of results, the calculated E_{mean} values were divided by four according to equation 5-7 from EM 1110-2-1619. This equation recognizes that in a normal distribution, 95% of the possible results are within two standard deviations above or below the mean; therefore, the full range of plausible results represents a range of four standard deviations.

The results of these calculations yielded standard deviation of model stage uncertainty (S_{model}) values of 1.00 ft and 1.02 ft for the existing and proposed conditions, respectively.

3.2.2.1 Total Stage Uncertainty

The calculated natural uncertainties and model uncertainties were combined to calculate the total stage uncertainty using the equation below, from EM 1110-2-1619.

$$S_t = \sqrt{(S_{natural}^2 + S_{model}^2)}$$

The results indicate a total standard deviation of stage uncertainty of 1.04 ft and 1.10 ft for the existing and proposed conditions, respectively.

3.3 Target Stage

The USACE (1996) hydrology report notes that field observations of large floods in 1969, 1980, and 1983 confirmed that several feet of wave action can be associated with high flows in these channels. It also states that 2.5 feet of freeboard was recommended in 1970s-era USACE design guides for concrete trapezoidal channels, and that this height is generally adequate to contain the observed wave action. The uncertainty analysis described here does not explicitly account for the expected wave action but does include the top of bank minus 2.5 feet as a second target stage, in addition to the top of bank elevation. The target stages were extracted from the hydraulic model cross-sections at the index locations and are the same for existing and proposed conditions since no changes are proposed for the tops of banks. Target stages are shown in Table 3.

Table 3: Target stages at Index Points

Index Location	Model Station	Target Stage- Top of Bank	Target Stage- Top of Bank – 2.5 ft
1	1232+13.3	298.8	296.3
2	1229+32.2	298.0	295.5
3	1223+09.5	297.8	295.3
4	1212+11.4	293.0	290.5

4 Results

Index Location 1 is upstream of the pilot project, immediately downstream of the N. Main Street bridge. Index Locations 2 and 3 are approximately 281 and 904 feet further downstream, within the area of proposed improvements. Index Location 4 is downstream of the pilot project improvements at the Union Pacific railroad bridge. The with-pilot project conditions hydraulic model shows increases in water surface elevations over existing conditions of 0.1 to 0.4 feet at Index Locations 2 to 4, consistent with previous estimates in the Project Reach 8A Design Development Technical Memorandum. No change in water surface elevation is predicted at Index Location 1. The computed water surface elevations under with-pilot project conditions are 8 to 11 feet below the top of bank.

HEC-FDA was used to compute a conditional non-exceedance probability (CNP, i.e., the probability that for a given flood, the target stage will not be exceeded) and long-term risk (i.e., the cumulative risk of exceeding the target stage at least once, over longer time periods) at these four locations for both existing and proposed conditions, and for the two different target stages. The CNP results, shown in Table 4 and Table 5, indicate that the Reach 8A Pilot Project causes a slight increase in the chance of exceeding the target stage for a given flood at Index Locations 2, 3, and 4. There is no change in CNP at Index Location 1. These slight increases in risk for the proposed condition are expected given the slightly higher water surface predicted by the HEC-RAS model, and the slightly higher stage uncertainty described above. The CNP changes by less than 1% during the 100-yr flood, and by less than 2% during the 500-yr flood as a result of the Reach 8A Pilot Project.

Table 4: HEC-FDA results: CNP for existing and proposed conditions, with target stage equal to overtopping elevation

Scenario	Index Location	Model Station	Conditional Non-Exceedance Probability (CNP) by AEP Event					
			10%	4%	2%	1%	0.4%	0.2%
Existing	1	1232+13.3	1.0000	0.9969	0.9968	0.8719	0.7800	0.7088
	2	1229+32.2	1.0000	1.0000	1.0000	0.9993	0.9985	0.9981
	3	1223+09.5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	4	1212+11.4	1.0000	1.0000	0.9995	0.9952	0.9891	0.9846
Proposed	1	1232+13.3	1.0000	0.9969	0.9668	0.8719	0.7800	0.7088
	2	1229+32.2	1.0000	1.0000	1.0000	0.9990	0.9976	0.9965
	3	1223+09.5	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	4	1212+11.4	1.0000	1.0000	0.9987	0.9895	0.9771	0.9669

Table 5: HEC-FDA results: CNP for existing and proposed conditions, with target stage equal to overtopping minus 2.5ft elevation

Scenario	Index Location	Model Station	Conditional Non-Exceedance Probability (CNP) by AEP Event					
			10%	4%	2%	1%	0.4%	0.2%
Existing	1	1232+13.3	1.0000	0.9911	0.9361	0.8144	0.7006	0.6228
	2	1229+32.2	1.0000	1.0000	0.9952	0.9680	0.9355	0.9078
	3	1223+09.5	1.0000	1.0000	1.0000	0.9996	0.9993	0.9991
	4	1212+11.4	1.0000	0.9998	0.9913	0.9478	0.8972	0.8571
Proposed	1	1232+13.3	1.0000	0.9911	0.9361	0.8144	0.7006	0.6228
	2	1229+32.2	1.0000	1.0000	0.9944	0.9654	0.9300	0.9019
	3	1223+09.5	1.0000	1.0000	1.0000	0.9993	0.9984	0.9977
	4	1212+11.4	1.0000	0.9995	0.9896	0.9393	0.8835	0.8399

Table 6 and Table 7 show the long-term risk of stage exceedances under existing and proposed conditions for the two different target stage scenarios. This value represents the risk of exceeding the target stage at least once in the stated duration of 10, 30, or 50 years. The results show that the pilot project has a very modest increase in long-term risk, with the 50-year cumulative risk of exceedances increasing by less than 1% in all cases (0 to 0.73% increase in the overtopping scenario, and 0 to 0.98% increase in the overtopping-minus-2.5ft scenario).

Table 6: HEC-FDA results: long-term risk of exceeding target stage for existing and proposed conditions, with target stage equal to overtopping elevation

Scenario	Index Location	Model Station	Long-Term Risk (years)		
			10	30	50
Existing	1	1232+13.3	0.0336	0.0975	0.1572
	2	1229+32.2	0.0012	0.0036	0.0060
	3	1223+09.5	0.0010	0.0030	0.0050
	4	1212+11.4	0.0024	0.0073	0.0121
Proposed	1	1232+13.3	0.0336	0.0975	0.1572
	2	1229+32.2	0.0013	0.0040	0.0066
	3	1223+09.5	0.0010	0.0030	0.0050
	4	1212+11.4	0.0039	0.0117	0.0194

Table 7: HEC-FDA results: long-term risk of exceeding target stage for existing and proposed conditions, with target stage equal to overtopping minus 2.5ft elevation

Scenario	Index Location	Model Station	Long-Term Risk (years)		
			10	30	50
Existing	1	1232+13.3	0.0493	0.1407	0.2233
	2	1229+32.2	0.0094	0.0280	0.0462
	3	1223+09.5	0.0011	0.0032	0.0054
	4	1212+11.4	0.0146	0.0432	0.0709
Proposed	1	1232+13.3	0.0493	0.1407	0.2233
	2	1229+32.2	0.0101	0.0300	0.0495
	3	1223+09.5	0.0012	0.0036	0.0060
	4	1212+11.4	0.0167	0.0493	0.0807

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