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Assessment of the Effects of Waterbody Temperature in the Los Angeles River and Burbank Western Channel

Developed for:
CITY OF LOS ANGELES SANITATION AND ENVIRONMENT
CITY OF BURBANK PUBLIC WORKS DEPARTMENT

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Summary of Findings

The Donald C. Tillman (DCT or DCTWRP) and Los Angeles/Glendale (LAG or LAGWRP) Water Reclamation Plants (WRPs) operated by the City of Los Angeles, Bureau of Sanitation and Environment (LASAN), and the Burbank Water Reclamation Plant (BWRP), operated by the City of Burbank Public Works Department, discharge tertiary-treated disinfected wastewater effluent in the Los Angeles River (LA River or LAR) watershed. The DCT and LAG WRPs discharge into the mainstem of the LAR, while the BWRP discharges to Burbank Western Channel (BWC), which is a tributary to the LAR. The Los Angeles Regional Water Quality Control Board (Regional Board) reinterpreted the Water Quality Control Plan: Los Angeles Region Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties (Basin Plan)[1] water quality objective (WQO) for temperature and, consequently, lowered the effluent limits for temperature in the National Pollutant Discharge Elimination System (NPDES) discharge permits issued to the WRPs.[2] The NPDES permits for the three WRPs now include a maximum temperature effluent limitation of 80 degrees Fahrenheit (°F) as well as a receiving water limitation that requires that WRP effluent not raise receiving water temperatures by more than 5°F (herein referred to as delta 5°F).

In recognition that effluent temperatures from the WRPs can sometimes exceed the new 80°F limit, particularly during summer months when ambient air temperatures are warmest and solar radiation levels are highest, the Cities of Los Angeles and Burbank (Cities) requested and were granted in-permit compliance schedules that include the development and implementation of a special study to identify the potential impacts of the WRPs' effluent temperature on the WARM beneficial use and evaluate control measures to address those potential impacts. A final Workplan that incorporated input from Regional Board staff and a Technical Advisory Committee (TAC), comprised of subject matter specialists, was submitted in May 2024. To support the completion of the studies, the Cities worked with the TAC to identify six study objectives:

1. Determine the wholly or partially aquatic-dependent[3] taxa that are present, were historically present, or could be present given the current habitat conditions in the Los Angeles River.
2. For each taxon identified in Objective 1, describe the relationship between waterbody temperatures and the probability (or likelihood) that different aquatic life stages are supported.
3. Determine how the relationships between waterbody temperature and the support of aquatic life vary based on the taxon's location in the river and seasonality.
4. Determine the critical exposure times, durations, and/or frequencies associated with the temperature relationships described in Objectives 1 through 3.
5. Evaluate how other physical factors (e.g., shading, groundwater discharge, availability of substrate, flow, etc.) and climate change could potentially influence temperature effects on biological communities.
6. Analyze relationships between effluent discharge temperature and in-river temperature, including how river temperature changes as a function of distance from the discharge location and downstream physical characteristics.

[1] Los Angeles Region Basin Plan can be accessed here: https://www.waterboards.ca.gov/losangeles/water_issues/programs/basin_plan/basin_plan_documentation.html

[2] DCTWRP NPDES No. CA0056227 Order R4-2022-0341 and LAGWRP NPDES No. CA0053953 Order R4-2022-0343;BWRP NPDES No. CA0055531 Order R4-2023-0358

[3] Aquatic-dependent is defined as a major life stage that resides in the river or relies on the river for food and forage.

The following briefly summarizes the findings and key conclusions of the Study. For **Study Objective #1**, taxa presence is based on historical, recent, and new biological surveys (benthic macroinvertebrates and benthic algae) and other data collected not only upstream and downstream of WRP outfalls, but also in urbanized tributaries to the LA River with similar physical characteristics but without WRP flow. In addition, thermistor probes were used to measure WRP discharge and receiving water temperatures from May to October 2024. From this data four thermal metrics were calculated to directly address **Study Objectives #2-4**. Comprehensive modeling of water temperature was also conducted to understand the influence of physical factors and climate change on temperature effects on biological communities (**Study Objective #5**) and the relationships between effluent discharge temperature and receiving water temperature and estimated distance downstream potentially influenced by heat addition from the WRPs' effluent (**Study Objective #6**). The key Study conclusion is that alterations to receiving water temperatures due to WRP effluent temperatures does not adversely affect the WARM beneficial use. Additional conclusions are briefly summarized below:

- Temperatures in the LA River and BWC routinely exceed 80°F irrespective of WRP flow or location upstream or downstream of a WRP discharge.
- Temperatures in the LA River and BWC routinely increase by more than 5°F over the course of a day from May through October, irrespective of WRP flow.
- There is no significant or meaningful difference in BMI and benthic algae composition upstream and downstream of the WRPs.
- The BMI and benthic algal communities downstream of WRP discharges are not unique and can be found throughout the Study area including at locations upstream of WRP discharges or in tributaries, indicating that there is no clear impact of WRP effluent temperatures on the biological community.
- The number of fish taxa are highest in LAR3 and LAR5, downstream of the discharges of the LAG and DCT WRPs due to these reaches having the most suitable habitat for fish in the Study area.
- Study-derived continuous temperature results indicate that locations downstream of the WRPs are able to support the most temperature sensitive species that are present or could be present in the Study area based on literature-derived thermal tolerances.
- Modeling demonstrated that chilling effluent, reducing effluent flows, providing shading, or combinations of the three will not result in the LA River or BWC consistently meeting 80°F or keeping receiving water temperatures from increasing by more than 5°F due to factors outside of the WRPs control (e.g., solar radiation, air temperature, concrete lining of channels).
- Chillers are the only technology that could consistently and reliably attain the new NPDES permit limits with total capital costs for all three WRPs of at least $457 million, O&M costs of approximately $15 million annually, and increases in greenhouse gas (GHG) emissions by approximately 44% at the DCTWRP, 18% at the BWRP, and 59% at the LAGWRP.
- Due to space constraints at all three WRPs, installation of chillers will impair the ability to complete other capital improvements to address additional treatment capacity required for state-mandated housing units and for additional recycled water and advanced treatment.

In summary, alterations to receiving water temperatures due to WRP effluent temperatures do not adversely affect the WARM beneficial use. Even if the WRPs implemented measures to chill their effluent to meet the new temperature limits, at a significant expense in terms of cost, energy, and GHG impacts and negative impact to the environment, temperatures in the LA River and BWC downstream of the WRPs would quickly return to baseline/ambient temperatures as if the effluent had never been chilled before being discharged.

Executive Summary

The Donald C. Tillman (DCT or DCTWRP) and Los Angeles/ Glendale (LAG or LAGWRP) Water Reclamation Plants (WRPs) operated by the City of Los Angeles, Bureau of Sanitation and Environment (LASAN), and the Burbank Water Reclamation Plant (BWRP), operated by the City of Burbank Public Works Department, discharge tertiary-treated disinfected wastewater effluent in the Los Angeles River (LA River or LAR) watershed. The DCT and LAG WRPs discharge into the mainstem of the LAR, while the BWRP discharges to Burbank Western Channel (BWC), which is a tributary to the LAR. The Los Angeles Regional Water Quality Control Board (Regional Board) reinterpreted the Water Quality Control Plan: Los Angeles Region Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties (Basin Plan)[4] water quality objective (WQO) for temperature and, consequently, lowered the effluent limits for temperature in the National Pollutant Discharge Elimination System (NPDES) discharge permits issued to the WRPs.[5] The NPDES permits for the three WRPs now include a maximum temperature effluent limitation of 80 degrees Fahrenheit (°F) as well as a receiving water limitation that requires that WRP effluent not raise receiving water temperatures by more than 5°F (herein referred to as delta [Δ] 5°F). The prior permits[6] contained 86°F as a temperature effluent limitation and stated that "[t]he temperature of wastes discharged shall not exceed 86°F except as a result of external ambient temperature." The limits are based on the Regional Board's new interpretation and implementation of the WQO for temperature contained in the Basin Plan, which states:

> *The natural receiving water temperature of all regional waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Board that such alteration in temperature does not adversely affect beneficial uses. Alterations that are allowed must meet the requirements below.*
>
> *For waters designated WARM, water temperature shall not be altered by more than 5°F above the natural temperature. At no time shall these WARM-designated waters be raised above 80°F as a result of waste discharges.*

In recognition that effluent temperatures from the WRPs can, at times, exceed the new 80°F limit, particularly during summer months when ambient air temperature is at its warmest and solar radiation is at peak levels, the Cities of Los Angeles and Burbank (Cities) requested and were granted in-permit compliance schedules that include the development and implementation of a special study to identify the potential impacts of the WRPs' effluent temperature on the WARM beneficial use and evaluate control measures to address those potential impacts. A Workplan (LWA 2024) was developed by the Cities and revised based on input from a Technical Advisory Committee (TAC), which was comprised of subject matter specialists including Regional Board staff. The Cities worked cooperatively to implement the Los Angeles River Temperature Study (Study).

As presented in the fact sheets of the WRPs' NPDES permits, the Federal Clean Water Act (CWA) requires point source dischargers to control the amount of conventional, non-conventional, and toxic pollutants that

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[4] Los Angeles Region Basin Plan can be accessed here:
https://www.waterboards.ca.gov/losangeles/water_issues/programs/basin_plan/basin_plan_documentation.html

[5] DCTWRP NPDES No. CA0056227 Order R4-2022-0341 and LAGWRP NPDES No. CA0053953 Order R4-2022-0343; BWRP NPDES No. CA0055531 Order R4-2023-0358

[6] DCTWRP NPDES No. CA0056227 Order R4-2017-0062 and LAGWRP NPDES No. CA0053953 Order R4-2017-0063; BWRP NPDES No. CA0055531 Order R4-2017-0064

are discharged into the waters of the United States. The control of pollutants is intended to protect beneficial uses of waterbodies through establishing limitations for temperature included in the WRPs' NPDES permits. Other factors not addressed through NPDES permits can impact beneficial uses in the Study area, such as ambient air temperatures and habitat modifications for flood control purposes. However, those factors are outside of the Cities' control as they cannot take unilateral action to address habitat modifications or ambient air temperatures in the Study area. As such, the Study is intended to develop a better understanding of the relationship between effluent temperature, which is regulated by the Cities' NPDES permits, and potential impacts to the WARM beneficial use in the LA River downstream of the DCTWRP, LAGWRP, and BWRP discharges. Additionally, the Study identifies and evaluates different types of potential control measures (including nature-based solutions) to determine if those control measures could meet the limits while also considering the potential adverse implications related to energy use and greenhouse gas (GHG) emissions.

Study Objectives

To support the completion of the studies, the Cities worked with the TAC to identify six study objectives:

1. Determine the wholly or partially aquatic-dependent[7] taxa that are present, were historically present, or could be present given the current habitat conditions in the Los Angeles River.
2. For each taxon identified in Objective 1, describe the relationship between waterbody temperatures and the probability (or likelihood) that different aquatic life stages are supported.
3. Determine how the relationships between waterbody temperature and the support of aquatic life vary based on the taxon's location in the river and seasonality.
4. Determine the critical exposure times, durations, and/or frequencies associated with the temperature relationships described in Objectives 1 through 3.
5. Evaluate how other physical factors (e.g., shading, groundwater discharge, availability of substrate, flow, etc.) and climate change could potentially influence temperature effects on biological communities.
6. Analyze relationships between effluent discharge temperature and in-river temperature, including how river temperature changes as a function of distance from the discharge location and downstream physical characteristics.

Data Review and Study Monitoring

Historical air and water temperature, flow, bioassessment (i.e., benthic macroinvertebrate and algae), fish, and habitat data were compiled and reviewed for this Study. Temperature and flow data in the LA River and BWC adjacent to each WRP were obtained by daily monitoring conducted by the Cities from January 1, 2000 to October 31, 2024. Bioassessment data were aggregated from public databases including California Environmental Data Exchange Network (CEDEN) and the Southern California Stormwater Monitoring Coalition (SMC) data portals, and information provided by the Los Angeles River Watershed Monitoring Program (LARWMP). The collective bioassessment data represented multiple surveys spanning from 2005 to 2024.

[7] Aquatic-dependent is defined as a major life stage that resides in the river or relies on the river for food and forage.

Critical data gaps were filled by monitoring efforts conducted by the Cities explicitly for this study. Temperature data was collected at 22 locations that bracketed WRP outfalls from late April through October 31, 2024. Nearly 190,000 individual in-water temperature values were recorded during the 27-week deployment period to supplement the historic data in evaluating thermal conditions. Bioassessment monitoring was also conducted at 13 stations in June 2024, collecting benthic macroinvertebrate (BMI) and diatoms and algae samples following standard procedures (Ode et al. 2016, 2025).

Results and Data Analysis

Maximum daily water temperatures upstream of the DCTWRP and LAGWRP (i.e., without WRP influence) consistently exceeded 80°F in the warmer months. Maximum daily water temperatures upstream of the BWRP also exceeded 80°F, though less frequently than for DCTWRP and LAGWRP. The influence of heat from WRP effluent on receiving water temperature downstream is seasonally dependent, with indications of WRP-specific thermal inputs residing for a slightly longer downstream distance in winter, and much shorter downstream distances beginning late spring through summer. The influence of heat from WRP effluent on downstream receiving water temperatures is also location dependent, with slightly longer downstream distances in the BWC below BWRP and much shorter distances below the DCTWRP in LA River Reaches 5 and 4 (LAR5 and LAR4), and even shorter distances below LAGWRP in LA River Reach 3 (LAR3). However, the influence of other temperature modulating factors (i.e., primarily ambient air temperature but with smaller contributions from concrete substrate, solar heating, and groundwater input in LAR3) is much greater in the BWC compared to both LAR4 downstream of DCTWRP and LAR3 downstream of LAGWRP, and thus greatly ameliorates the influence of heat from BWRP effluent in the BWC.

All fish that are present in the Study area are non-native warmwater taxa tolerant of temperatures common in the Study area. The number of fish taxa are highest in LAR3 and LAR5, downstream of the discharges of the LAG and DCT WRPs, respectively, due to these reaches having the most suitable habitat for fish in the Study area. Based on quantitative analyses of upstream versus downstream bioassessment stations, the data demonstrate no significant or meaningful differences upstream and downstream of the WRP discharges in the Benthic Macroinvertebrate (BMI) or diatom taxa and taxa count, soft-bodied algae taxa and biovolume, or California's standardized bioassessment indices (i.e., California Stream Condition Index [CSCI] and Algal Stream Condition Index [ASCI] scores). Furthermore, a cluster analysis indicated that the BMI and benthic algal communities downstream of WRP discharges are not unique and can be found throughout the Study area, including at locations upstream of WRP discharges or in tributaries. This indicates that there is no clear impact of WRP effluent temperatures on the biological community. The supposition that effluent temperature adversely affects BMI and benthic algae and their corresponding community health index scores is not supported.

Answers to Study Objectives

For **Study Objective #1**, the wholly or partially aquatic-dependent taxa that are present, were historically present, or could be present in the Study area (LA River Reaches 1-5 and the BWC) given the current habitat conditions includes 276 diatom taxa, 249 soft bodied algae taxa, 117 BMI taxa, 16 freshwater fish, and two native and two non-native frog species. All of the fish that are present in the Study area are non-native species, introduced either intentionally or accidentally. The fish species reported in the Study are considered to be representative of any fish species that could potentially become established under current habitat conditions.

For each taxon identified as present or that could be present, the relationship between waterbody temperature and the probability (or likelihood) that different aquatic life stages are supported (**Study Objective #2**), how the relationships vary based on the taxon's location in the river and seasonality (**Study Objective #3**), and the critical exposure times, durations, and/or frequencies associated with the relationships (**Study Objective #4**) is described simultaneously using the combination of reach and location-specific stream temperature data and thermal tolerance values for the most temperature-sensitive taxa present or could be present given current habitat conditions in the Study area.

Laboratory-derived temperature tolerance information from the literature for the most temperature-sensitive fish species in the Study area were used to represent temperature tolerance for all other less temperature-sensitive vertebrate species based on both short (acute) and longer (chronic) exposure times and critical life stages. These values are also used to represent the thermal tolerance of the BMI and benthic algae in the Study area, which are similar to or higher than the corresponding lowest thermal tolerance limits for chronic survival for freshwater fish in the Study area for the Summer dry season (June through October). It is worth noting here that while conservative laboratory-derived temperature tolerance values are useful for an initial assessment of potential for effects, these values do not reflect the physiological and behavioral relief strategies developed by aquatic organisms in response to local temperature profiles and extremes, particularly the aquatic organisms present in the Study area that regularly experience extreme diel temperature fluctuations during summer. These strategies, along with site-specific generational adaptations in response to years of exposure to local temperature and habitat conditions on a long-term basis and heat-hardening on a short-term basis (i.e., a rapid acclimation response that increases their tolerance to sudden, acute heat stress), explain why literature-based upper thermal tolerance limits generally underestimate taxa-specific critical thermal limits in the real world.

The lowest, highly conservative temperature tolerance values presented in **Table ES-1** were compared against actual (measured) receiving water temperatures, expressed as different temperature metrics reflecting different exposure magnitudes (average and maximum) and durations (short term, acute daily and longer term, chronic weekly), according to location within the Study area on a seasonal basis (i.e., late spring and summer). A comparison of the lowest literature-derived thermal tolerance limits for freshwater fish against four temperature metrics, based on the thermistor Study results from continuous monitoring data collected at 16 receiving water temperature monitoring stations, was used to evaluate the likelihood that different life stages are supported during acute and chronic exposure over the Summer dry season and Spring spawning season (March through May). This describes the relationship between waterbody temperatures and different aquatic life stages that could be supported based on literature values. The results also provide insights into how that support varies based on seasonality, and the critical exposure times, durations, and/or frequencies associated with the temperature relationships.

Overall, the results of this analysis presented in **Table ES-1** indicate that the taxa that are present or could be present in the Study area are not adversely affected by alterations to receiving water temperatures due to WRP effluent temperatures. Any purported need to modify the discharges to reduce thermal effects of the

WRP discharges on the biological communities that are present or could be present in the LA River and BWC is not supported.

Table ES-1. Do Receiving Water Temperatures Immediately Downstream of the WRP Discharges Support the Thermally Most-Sensitive Fish Species Based on Recorded Temperatures in the Study Area?

Findings presented where the temperature tolerance metrics of the most sensitive species are supported based on literature values (black text) or where the most sensitive biota are supported as described in the discussion provided above this table (green text)

Season	Life Stage / Metric	Species Common Name	Thermal Tolerance (°F) From Literature[2]	Could Temperatures in the Post-WRP Discharge Stream Support the Most Sensitive Species for this Metric?		
				LAGWRP	DCTWRP	BWRP
Summer (Dry Season) June - October	Chronic Growth	Goldfish	83.4°F	YES	YES	YES[1]
	Chronic Survival	Pacu	89.6°F	YES	YES	YES[2]
	Acute Daily Survival	Fathead Minnow	89.6°F	YES	YES	YES[1]
	Acute Daytime Survival	Golden Shiner	98.0°F	YES	YES	YES[2]
Spring (Spawning Season) May	Chronic Reproduction	Common Carp & Largemouth Bass	70.0°F	YES	YES	NA[3]
	Acute Daily Embryo Survival	Black Bullhead	81.0°F	YES	YES	NA[3]

1. This metric was met at all three stations in BWC during the 2024 Summer thermistor study.
2. This metric was met at the two stations bracketing the BWRP discharge during the 2024 Summer thermistor study.
3. NA = Not Applicable. Indicative of the situation where biota is supported in the BWC using temperature tolerance metrics, but where the concrete channel does not support early life stages of fish (RWQCB 2019) so findings for the life stage are excluded from the evaluation.

To address **Study Objectives #5** and **#6**, the continuous monitoring data collected during this Study at locations upstream and downstream of WRP discharges were utilized. Additionally, the temperature model developed as part of this Study was utilized to evaluate conditions where WRP discharge temperatures are set to the same temperature as upstream receiving waters to allow for an estimation of the effect of other factors (e.g., air temperature) on receiving water temperatures. Several key findings of these analyses include:

1) Maximum daily water temperatures above the DCTWRP and LAGWRP (i.e., without WRP influence) consistently exceeded 80°F in the warmer months, while temperatures above the BWRP also exceeded 80°F, but less frequently than DCTWRP and LAGWRP.
2) Except in the area immediately downstream of the WRP discharges, receiving water temperatures in the majority of the LA River and lower portion of the BWC are the result of ambient air temperature and other factors rather than WRP effluent temperature.
3) Using the model to evaluate how receiving water temperatures downstream of the WRPs change when WRP effluent temperatures are set equal to the upstream receiving water temperature it was determined that:

a. The distance downstream in the LA River and BWC of discharge under the influence of thermal input from each WRP is relatively short and depends on both season and location.
b. The influence of heat from WRP effluent resides for a slightly longer downstream distance in winter (2-5 miles) as compared to late spring through summer (2 miles or less).
c. The influence of heat from WRP effluent on receiving water temperature downstream in summer months is slightly longer (1 to 2 miles) below the BWRP, shorter below the DCTWRP (0.5 to 1 mile), and much shorter below LAGWRP (less than 0.5 miles).
d. The influence of other temperature modulating factors (primarily ambient air temperature but with additional contributions from concrete substrate, solar heating) appears to be significant, most notably in the BWC.
e. Rising groundwater in LA River Reach 3, which is unlined, has the potential to reduce receiving water temperatures upstream and downstream of the LAGWRP discharge; however, receiving water temperatures were regularly greater than 80°F upstream and downstream of the LAGWRP discharge in the summer months.

Summary of Modeling

A temperature model for the LA River and BWC was developed to evaluate potential control measures, climate change effects, and water temperature changes downstream of the WRPs. The backbone for the model was the LA River Environmental Flows HEC-RAS hydraulic model, which was updated to include the BWC and the three WRPs as explicit boundary conditions. The temperature model was used to evaluate three potential measures to control the effect of WRP discharge temperature on the temperatures in the LA River and the BWC: effluent temperature reduction, effluent flowrate reduction, and riparian shading.

To conduct the modeling analysis of effluent temperature reduction, effluent temperatures in the model were reduced so that the limits were met with all other conditions remaining constant (e.g., flow, air temperature, etc.). The model was then rerun to generate hourly receiving water temperatures and compared to the current condition (e.g., baseline receiving water temperatures). **Figure ES-1** presents a comparison of the baseline to the receiving water temperatures if the WRPs' effluent temperatures were reduced to comply with limits (i.e., effluent temperatures are not more than 80°F and receiving waters are not raised by more than 5°F). The figure represents temperatures on August 6, 2024 as an example date, see **Attachment A** for additional example dates and time series plots. As shown in **Figure ES-1**, when effluent is cooled to meet the limits:

- Downstream receiving water temperatures are negligibly different (i.e., within ± 1°F) from the baseline conditions less than 1 mile of the DCTWRP, less than 2 miles of the BWRP, and less than 0.5 miles of the LAGWRP.
- Receiving water temperatures will still exceed the 80°F objective downstream of all WRPs, even though the WRPs' effluent is cooled to meet the limits. Note that LA River temperatures upstream of the DCTWRP and LAGWRP discharges already exceeded the 80°F objective and that water temperatures in the BWC increase by more than 5°F downstream of the BWRP discharge on the example day.

WRP heat addition (baseline) or subtraction (effluent cooling) is demonstrated to not be as significant a factor as the local meteorological conditions (air temperature and solar radiation) on receiving water temperatures.

In colder months, the receiving water temperature generally returns to baseline further downstream. However, regardless of the time of year, the modeling demonstrates that when cooling effluent temperatures to meet the permit limits that: 1) receiving water temperatures return to baseline not far downstream of the WRPs, 2) temperatures upstream and downstream of the WRPs can exceed the 80°F objective, and 3) temperatures downstream of the WRPs can still increase more than 5°F due to air temperature and solar radiation. Reduction of effluent flow rates, have little effect on receiving water temperatures in summer months. Similar to effluent cooling, in colder months, receiving water temperatures return to baseline slightly further downstream. To determine the effect of shading on receiving water temperature, the reduction of solar radiation was simulated assuming 100% cover outside of the established channel. Additionally, shading from in-channel vegetation in the unlined reaches (LAR 3 and LAR 5) was also evaluated. The results indicate that shading does not reduce receiving water temperatures downstream of the WRPs below 80°F. In summary, modeling of the individual control measures shows that either receiving water temperatures are not affected, or they are minimally affected and quickly return to baseline conditions (i.e., downstream temperatures are essentially no different than if the control measure had not been implemented) due to factors outside of the control of the WRPs.

Scenarios comprising multiple control measures were also analyzed. **Figure ES-2** presents a scenario that compares the baseline to a combination of all three control measures (WRP effluent temperature reduction, WRP flow reduction, and riparian shading), on August 6, 2024 (see **Attachment A** for additional example dates and time series plots). As shown in **Figure ES-2**, the temperatures downstream of the WRPs reach baseline temperatures at a distance similar to effluent reduction alone and still exceed the 80°F objective even though the WRPs' effluent is meeting limits, effluent discharge is reduced, and riparian shading is added. The results for other scenarios were similar where either receiving water temperatures are not affected, or they are minimally affected and quickly return to baseline conditions due to factors outside of the control of the WRPs. In summary, none of the individual or combinations of control measures result in the consistent attainment of the 80°F objective downstream of the WRPs and temperatures downstream of the WRPs can still increase more than 5°F due to factors outside of the control of the WRPs. The potential effect of climate change was also assessed using predicted air temperatures projected 30 years into the future. The results indicated that receiving water temperatures would increase by a few degrees.

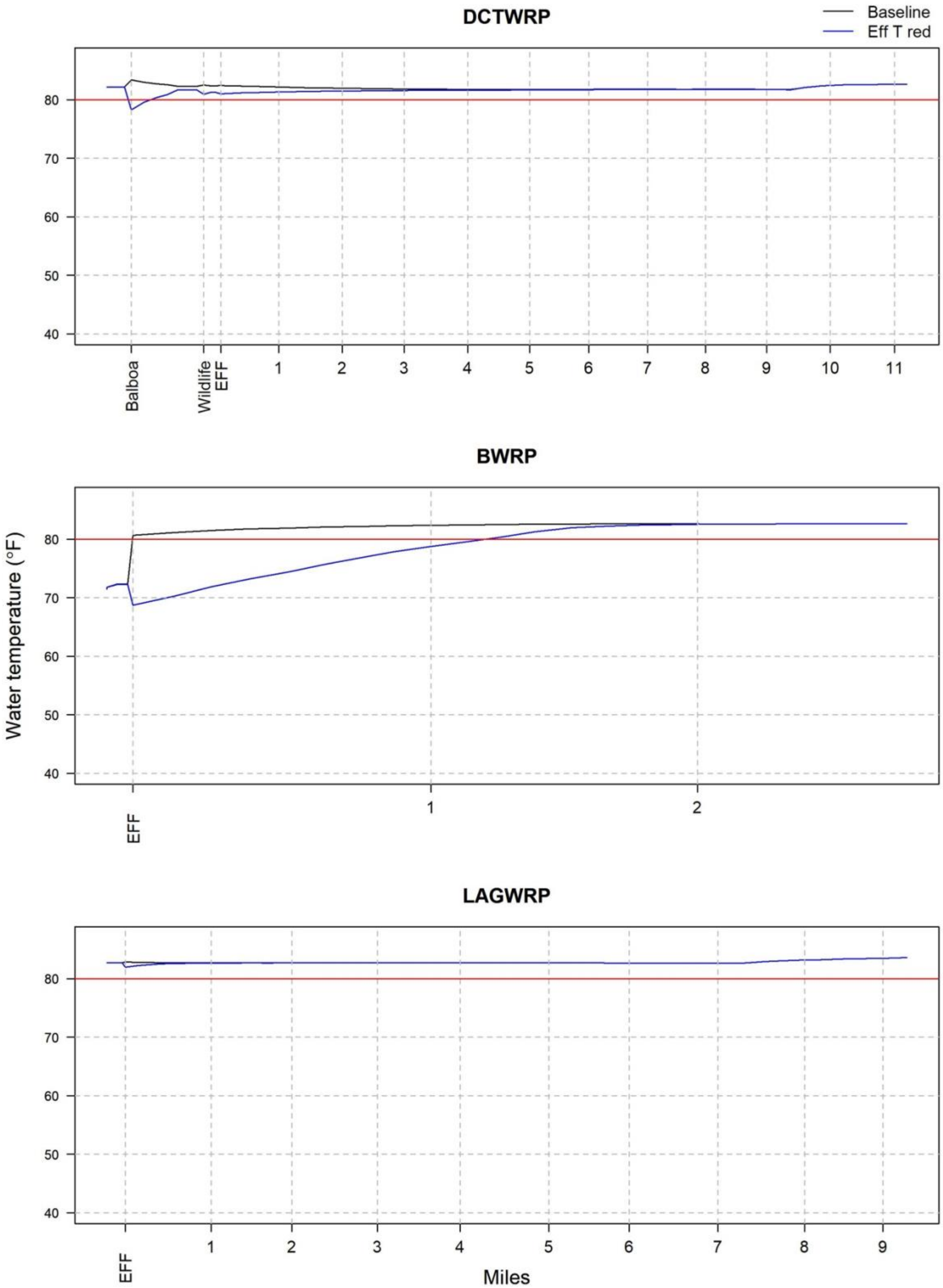


Figure ES-1. Receiving Water Temperatures at and Downstream from WRPs for Current condition and with Effluent Cooling on August 6, 2024

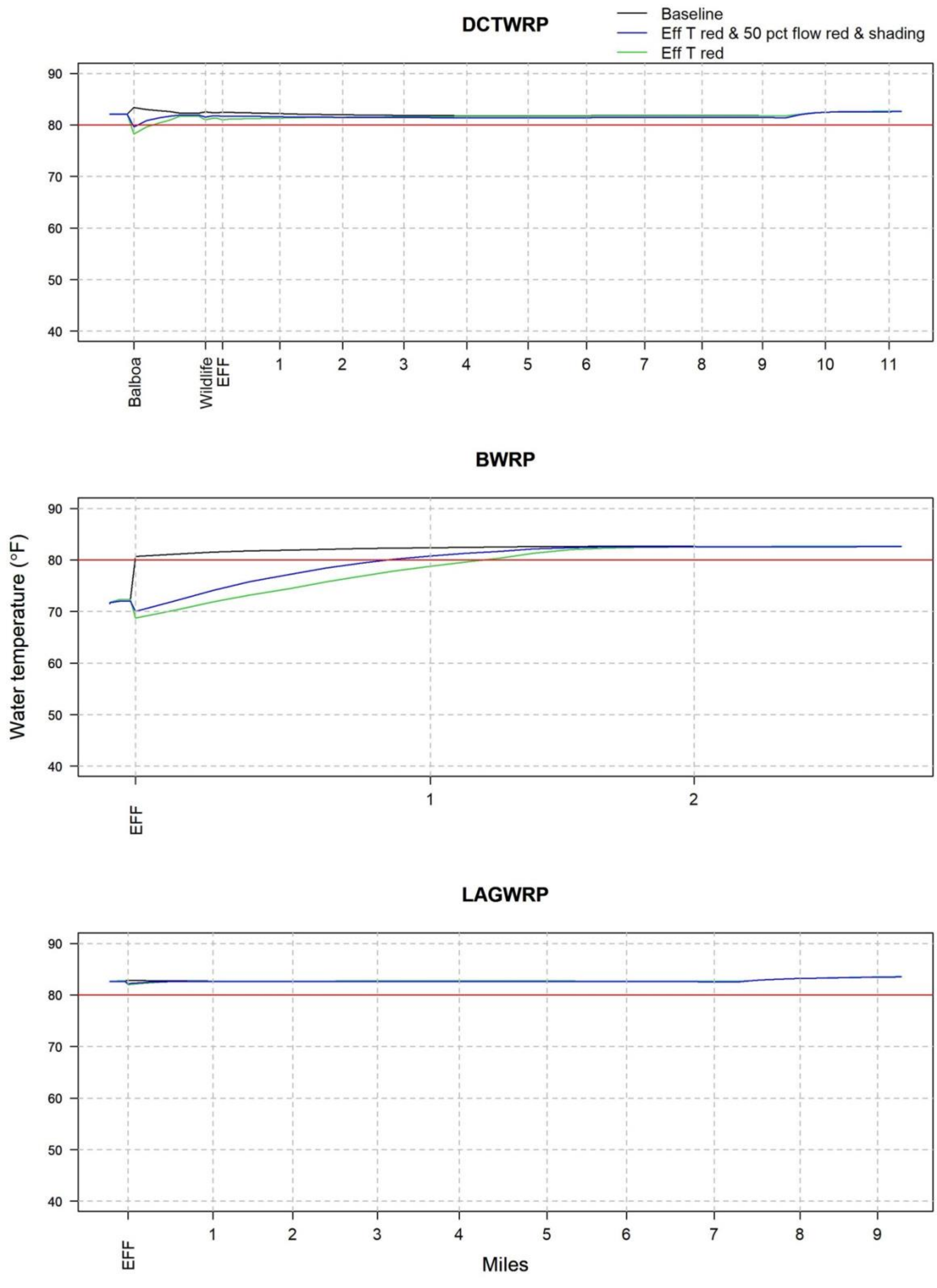


Figure ES-2. Receiving Water Temperatures Downstream of WRPs for a Scenario with all Three Control Measures Implemented Concurrently on August 6, 2024

Summary of Potential Control Measures

Several non-traditional effluent cooling measures were reviewed to evaluate their ability to consistently and reliably attain the 80°F and delta 5°F limits. The non-traditional control measures considered included processes that utilize natural heat flow or evaporative cooling as well as source control and in-plant process changes. The results of the screening analysis indicated that none of the non-traditional measures can meet the temperature limits. Additional non-traditional options (i.e., reducing effluent discharge and shading of the receiving water) were considered as part of the modeling efforts described above.

Two traditional effluent cooling options were also evaluated: cooling towers and mechanical chillers. Cooling tower performance is dependent on ambient wet bulb temperatures, and it was determined that, given the historical estimates of wet bulb temperatures in the Study area, cooling towers would likely be able to consistently meet the 80°F limit for the majority of the year. However, as the delta 5°F limit requires effluent temperatures below the wet bulb temperature, cooling towers cannot meet the delta 5°F limit and therefore were not considered for further analysis.

Chillers use mechanical cooling to provide more consistent performance to reliably attain both limits. Siting chillers at any of the WRPs is problematic as the facilities have plans for future capital improvements to address additional treatment capacity required for state-mandated housing units and for additional recycled water and advanced treatment. Installing chillers that will take up the limited available open areas at the WRPs will impair the ability of the Cities to implement such capacity improvements. There are additional structures that will need to be constructed to support the chillers. New electrical infrastructure, including buildings, would likely be required to power and control the cooling equipment and, as standard chillers are not suitable for exposure to the elements, new buildings would be needed to house the chillers. Pump stations will be needed to convey plant effluent to the cooling equipment. To accommodate this new energy-intensive infrastructure, the power feed(s) to the WRPs will have to be increased by up to 100%. The total capital costs for all three WRPs is estimated to be at least $457 million with annual O&M costs of approximately $15 million. Additionally, due to the energy intensive nature of chillers, GHG emissions associated with the Cities' WRPs will increase by approximately 44% at the DCTWRP, 18% at the BWRP, and 59% at the LAGWRP.

Study Conclusions

The following briefly summarizes the findings and key conclusions of the Study. For **Study Objective #1**, taxa presence is based on historical, recent, and new biological surveys (BMI and benthic algae) and other data collected not only upstream and downstream of WRP outfalls, but also in urbanized tributaries to the LA River with similar physical characteristics but without WRP flow. Additionally, four thermal metrics were calculated to directly address **Study Objectives #2-4**. Comprehensive modeling of water temperature was also conducted to understand the influence of physical factors and climate change on temperature effects on biological communities (**Study Objective #5**) and the relationships between effluent discharge temperature and receiving water temperature and estimated distance downstream potentially influenced by heat addition from the WRPs (**Study Objective #6**). The key Study conclusion is that alterations to receiving water temperatures due to WRP effluent temperatures does not adversely affect the WARM beneficial use. The Study conclusions are briefly summarized below, with additional conclusions presented in **Table ES-2**:

- Temperatures in the LA River and BWC routinely exceed 80°F irrespective of WRP flow or location upstream or downstream of a WRP discharge.
- Temperatures in the LA River and BWC routinely increase by more than 5°F over the course of a day from May through October, irrespective of WRP flow.
- There is no significant or meaningful difference in BMI and benthic algae composition upstream and downstream of the WRPs.
- The BMI and benthic algal communities downstream of WRP discharges are not unique and can be found throughout the Study area including at locations upstream of WRP discharges or in tributaries, indicating that there is no clear impact of WRP effluent temperatures on the biological community.
- The number of fish taxa are highest in LAR3 and LAR5, downstream of the discharges of the LAG and DCT WRPs due to these reaches having the most suitable habitat for fish in the Study area.
- Study-derived continuous temperature results indicate that locations downstream of the WRPs are able to support the most temperature sensitive species that are present or could be present in the Study area based on literature-derived thermal tolerances.
- Modeling demonstrated that chilling effluent, reducing effluent flows, providing shading, or combinations of the three will not result in the LA River or BWC consistently meeting 80°F or keeping receiving water temperatures from increasing by more than 5°F due to factors outside of the WRPs control (e.g., solar radiation, air temperature, concrete lining of channels).
- Chillers are the only technology that could consistently and reliably attain the new NPDES permit limits with total capital costs for all three WRPs of at least $457 million, O&M costs of approximately $15 million annually, and increases in GHG emissions by approximately 44% at the DCTWRP, 18% at the BWRP, and 59% at the LAGWRP.
- Due to space constraints at all three WRPs, installation of chillers will impair the ability to complete other capital improvements to address additional treatment capacity required for state-mandated housing units and for additional recycled water and advanced treatment.

In summary, alterations to receiving water temperatures due to WRP effluent temperatures do not adversely affect the WARM beneficial use. Even if the WRPs implemented measures to chill their effluent to meet the new temperature limits, at a significant expense in terms of cost, energy, and GHG impacts and negative impact to the environment, temperatures in the LA River and BWC downstream of the WRPs would quickly return to baseline/ambient temperatures as if the effluent had never been chilled before being discharged.

Table ES-2. Summary of Study Conclusions

Habitat	• The habitat in the Study area (LAR Reaches 1-5 and BWC) has been highly modified and concrete lined in most areas for almost a century to support flood control purposes. • Bottom substrate type, channel width and depth, riparian vegetation, stream flow, and groundwater influx, are all significant factors affecting surface water temperature, which varies depending on location.
Water Temperature	• Daily and weekly average and maximum water temperatures in the Study area exceed 80°F in spring/summer months (May through October) regardless of location (upstream or downstream) in relation to a WRP discharge, or local habitat (i.e., concrete lined vs. unlined bottom, or open channels vs. riparian habitat). • Exceedances of 80°F in receiving waters increase in magnitude, duration, and severity in areas where water flows over concrete lined channel bottoms and where channels are wide and open (no canopy cover) versus unlined channels with some canopy cover. • Diel water temperature fluctuations greater than 5°F are common May through September regardless of location and WRP flow. • The influence of heat from WRP effluent on receiving river temperature is seasonally dependent, with indications of WRP-specific thermal inputs residing for a slightly longer downstream distance in winter, and much shorter downstream distances beginning late spring through summer. • The influence of other temperature modulating factors (primarily ambient air temperature but with additional contributions from concrete substrate, and solar heating) appears to be significant, most notably in the BWC. • The estimated distance downstream in the LA River and BWC of discharge under the influence of thermal input from each WRP is expected to be less than 0.5 to 2 miles in summer and between 2 and 5 miles in the winter; receiving water temperature in other portions of the LA River is the result of ambient air temperature and other factors affecting receiving water temperature besides WRP effluent temperature.
Biology	• The wholly or partially aquatic-dependent taxa that are present, were historically present, or could be present in the Study area given the current habitat conditions includes 276 diatom taxa, 249 soft bodied algae taxa, 117 BMI taxa, 16 non-native freshwater fish, and two native and two non-native frog species. • All fish present in the Study area are non-native warmwater taxa tolerant of temperatures common in the Study area. • The number of fish taxa are highest in LAR3 and LAR5, downstream of the discharges of the LAG and DCT WRPs, respectively, due to these reaches having the most suitable habitat for fish in the Study area. • BMI and benthic algae taxa currently present or could be present are adaptable eurythermal or temperature-generalist taxa, based on literature or by virtue of being found present both above and below WRP discharge. • No significant or meaningful differences were seen in the BMI or diatom taxa and taxa count, soft-bodied algae taxa and biovolume, or CSCI or ASCI scores upstream and downstream of the WRP discharges based on quantitative analysis. Similarly, cluster analysis indicates no unique BMI or benthic algal communities exist below WRP discharges that are not found elsewhere in the Study area and in other tributaries without WRP flow, indicating that there is no clear impact of WRP effluent temperatures on the biological community.

	• The most sensitive thermal tolerance values for freshwater fish and life stages present or that could be present in the Study area appear to represent the lowest thermal tolerance approximations for other taxa including BMI and algae. • For the fish community, the Study-derived continuous temperature results indicate that locations downstream of the WRPs support the most sensitive species based on literature-derived thermal limits. • Current habitat conditions indicate taxa present have capacity for temperature acclimation, use of refugia, and adaptation to local habitat and climatic conditions.
Modeling	• Modeling of all three potential control measures individually (effluent temperature control, effluent flowrate reduction, and riparian shading) demonstrated that either receiving water temperatures are not affected or they are minimally affected and quickly return to baseline conditions (i.e., downstream temperatures are no different than if the control measure had not been implemented). • Scenarios comprised of multiple potential control measures were also analyzed, but did not show synergetic gains in temperature reduction, with results similar to those for the individual control measures. • None of the individual control measures or combinations of control measures result in the consistent attainment of the 80°F objective downstream of the WRPs. • Climate change was assessed for 30-years in the future, where the model indicated the receiving water temperatures would increase by a few degrees.
Treatment Controls	• Non-traditional cooling options (i.e., natural heat flow, evaporative cooling, source control, in-plant process changes, shading, and effluent flow reduction) cannot meet the new temperature limits. • Cooling towers may be able to meet the 80°F limit for the majority of the year, but cannot meet the delta 5°F limit. • Chillers could reliably attain both the 80°F and delta 5°F limits; however, siting chillers at any of the WRPs is problematic as all facilities have plans for improvements that take up the available open areas on-site and will require the Cities to make tough decisions about the potential need to forgo other improvements. • The total capital costs for all three WRPs is estimated to be at least $457 million with annual O&M costs of approximately $5 million. • Due to the energy intensive nature of chillers, GHG emissions from the WRPs will go up by approximately 44% at the DCTWRP, 18% at the BWRP, and 59% at the LAGWRP.
Summary of Findings	• Diel variation in receiving water temperatures often fluctuates more than 5°F as a result of ambient air temperature and solar radiation. • Based on conservative literature-based thermal tolerances for sensitive species and life stages and receiving water temperature measurements, biota that reside in the LA River and BWC in the vicinity of the discharges are not adversely affected by the thermal component of the WRP discharges. • Alterations to receiving water temperatures due to WRP effluent temperatures do not adversely affect the WARM beneficial use. • Chillers would be needed at all three WRPs to meet the limits at a significant expense in terms of cost, energy, and GHG impacts and negative impact to the environment, temperatures in the LA River and BWC downstream of the WRPs would quickly return to baseline/ambient temperatures as if the effluent had never been chilled before being discharged.

1 Introduction

The Donald C. Tillman (DCT or DCTWRP) and Los Angeles/ Glendale (LAG or LAGWRP) Water Reclamation Plants (WRPs) operated by the City of Los Angeles, Bureau of Sanitation and Environment (LASAN), and the Burbank Water Reclamation Plant (BWRP), operated by the City of Burbank Public Works Department, discharge tertiary-treated disinfected wastewater effluent in the Los Angeles River (LA River or LAR) watershed. The DCT and LAG WRPs discharge into the mainstem of the LAR, while the BWRP discharges to Burbank Western Channel (BWC), which is a tributary to the LAR. The Los Angeles Regional Water Quality Control Board (Regional Board) reinterpreted the Water Quality Control Plan: Los Angeles Region Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties (Basin Plan)[8] water quality objective (WQO) for temperature and, consequently, lowered the effluent limits for temperature in the National Pollutant Discharge Elimination System (NPDES) discharge permits issued to the WRPs.[9] The NPDES permits for the three WRPs now include a maximum temperature effluent limitation of 80 degrees Fahrenheit (°F) as well as a receiving water limitation that requires that WRP effluent not raise receiving water temperatures by more than 5°F (herein referred to as delta 5°F). The prior permits[10] contained 86°F as a temperature effluent limitation and stated that "[t]he temperature of wastes discharged shall not exceed 86°F except as a result of external ambient temperature." The new limits are based on the Regional Board's new interpretation and implementation of the WQO for temperature contained in the Basin Plan, which states:

> *The natural receiving water temperature of all regional waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Board that such alteration in temperature does not adversely affect beneficial uses. Alterations that are allowed must meet the requirements below.*
>
> *For waters designated WARM, water temperature shall not be altered by more than 5°F above the natural temperature. At no time shall these WARM-designated waters be raised above 80°F as a result of waste discharges.*

In recognition that effluent temperatures from the WRPs can sometimes exceed the new 80°F limit, particularly during summer months when ambient air temperatures are warmest and solar radiation levels are highest, the Cities of Los Angeles and Burbank (Cities) requested and were granted in-permit compliance schedules that include the development and implementation of a special study to identify the potential impacts of the WRPs' effluent temperature on the WARM beneficial use and evaluate control measures to address those potential impacts. **Table 1** presents the compliance schedule and milestone dates for the respective Cities. The Cities worked cooperatively to implement the Los Angeles River Temperature Study (Study).

A Workplan was submitted to the Regional Board to address the requirements of the City of Los Angeles' WRP Permits in November 2023 and revised in February 2024 based on input from the Technical Advisory

[8] Los Angeles Region Basin Plan can be accessed here: https://www.waterboards.ca.gov/losangeles/water_issues/programs/basin_plan/basin_plan_documentation.html

[9] DCTWRP NPDES No. CA0056227 Order R4-2022-0341 and LAGWRP NPDES No. CA0053953 Order R4-2022-0343;BWRP NPDES No. CA0055531 Order R4-2023-0358

[10] DCTWRP NPDES No. CA0056227 Order R4-2017-0062 and LAGWRP NPDES No. CA0053953 Order R4-2017-0063; BWRP NPDES No. CA0055531 Order R4-2017-0064

Committee (TAC), which was initially formed in June 2023 by the City of Los Angeles and expanded in February 2024 to add members in response to the City of Burbank joining the Study. The TAC was comprised of subject matter specialists including Regional Board staff. A revised draft of the Workplan was submitted to the Regional Board on April 26, 2024 to incorporate the requirements of the City of Burbank's WRP Permit and sampling efficiencies through coordination with monitoring conducted by the Los Angeles River Watershed Monitoring Program (LARWMP). The Workplan was revised based on comments received by Regional Board staff and resubmitted in May 2024 (LWA 2024). Submittals of the Workplan were submitted consistent with the schedule presented in **Table 1**.

The mainstem of the LA River is a 51-mile-long urban river that flows through 14 cities and unincorporated areas in LA County. **Figure 1** presents the location of the three WRPs operated by the Cities in the LA River watershed. The Study area encompasses the waterbodies potentially impacted by the thermal component of the WRPs' discharges (LA River reaches 1 through 5, Bull Creek, and BWC). **Table 2** lists the waterbodies in the LA River that receive effluent from the three WRPs and their associated beneficial uses identified in Chapter 2 of the Basin Plan. Approximately 94% of the mainstem of the LA River (or 48 miles) is contained in concrete flood control channels, with the remaining approximately three miles of the Sepulveda Flood Control Basin (Sepulveda Basin) in LA River Reach 5 being the only portion not fully contained in concrete flood control channels. There are approximately nine miles of river with unlined channels, which occur at in the Glendale Narrows in LA River Reach 3 and the Sepulveda Flood Control Basin in LA River Reach 5 (**Figure 1**).

Coastal southern California is a semi-arid region with a Mediterranean climate dominated by long, dry summers and brief winters with short, sometimes intense cyclonic winter storms (USFWS 2015). The taller mountains in the region receive a portion of their precipitation as snow, which typically contributes water to streams until mid- to late-summer. Much of the higher elevations of the region are undeveloped and remain partially protected in national forests and a network of national, state, and county parks. The lower elevations in the region have been pervasively altered by urbanization (Mazor et al. 2011). Flowing waterbodies in the region fall into two basic categories: 1) short coastal streams draining mountain ranges immediately adjacent to the coast, and 2) larger river systems, such as the LA River, which extend inland through gaps in the coastal ranges (USFWS 2015).

The LA River watershed dominates the geographical setting of the nation's second largest but most densely populated urban area (2020 Census Urban Areas Facts[11]). As of 2020, approximately 25 percent of California's residents live in LA County. Until the completion of the Los Angeles Aqueduct for the importation of water, the LA River was the primary agricultural, industrial, and domestic water source for the Los Angeles region, through river surface water diversions and groundwater pumping (USFWS 2015). Periodic, severe floods affected the partially developed floodplain areas along the LA River up until the 1930s when the US Army Corp of Engineers (USACE) began to channelize the LA River. Since completion of the channelization, the LA River serves primarily as a flood control channel (USFWS 2015). The conversion of the LA River to a flood control channel has eliminated most of the adjacent riverine and riparian natural communities, greatly reducing plant and wildlife diversity. The entire LA River corridor is now ecologically degraded (USFWS 2015).

[11] 2020 Census Urban Areas Facts: https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural/2020-ua-facts.html

With the exception of the Glendale Narrows, the LA River's historical surface flow was reportedly intermittent in stretches in the San Fernando Valley (LAR Reaches 4, 5, and 6) and downstream of downtown Los Angeles (Gumprecht 1999). Today, the mostly concrete channel of the LA River carries a relatively constant low-flow year-round (LARRC 2011). As described in the 2022 LA River Master Plan, the Los Angeles County Flood Control District (LACFCD) and the United States Army Corps of Engineers (USACE) are responsible for maintaining the mainstem of the LA River, with each maintaining approximately half of the LA River. Permits for projects along and in the right-of-way are issued by these two entities depending on the project type and location.

Apart from the Sepulveda Basin, the San Fernando Valley area of the LA River (upstream of Glendale Narrows), including the BWC, is characterized by large segments of channel that are almost entirely concrete-lined, with dense urban development along the former floodplain. The lower reaches of the LA River (downstream of Glendale Narrows) are also heavily constrained by development, including downtown Los Angeles and an adjacent heavy industrial corridor that contains a major power transmission line and a freeway system running alongside the River. Due to the intensity of surrounding development, the BWC and the reaches of the LA River above and below Glendale Narrows have lower potential for ecological connectivity to regional "core areas" (e.g., the Santa Monica Mountains) (USFWS 2015). **Table 3** summarizes channel characteristics of the Study area (LA River reaches 1 through 5 and BWC) as well as other major waterbodies (LA River Reach 6 and major tributaries along reaches 1 through 6).

The San Fernando groundwater basin underlies the Study area, bounded on the east and northeast by the San Rafael Hills, Verdugo Mountains, and San Gabriel Mountains, and on the north by the San Gabriel Mountains and the eroded south limb of the Little Tujunga Syncline.[12] Rising groundwater occurs in the Study area in LA River Reach 3, which is unlined for that reason.

[12] Visited on September 8, 2025: www.ularawatermaster.com/groundwater-basins/san-fernando-basin

Table 1. Compliance Schedule and Milestone Dates Contained in the DCTWRP, LAGWRP, and BWRP Permits (Orders R4-2022-0341, R4-2022-0343, and R4-2023-0358, respectively)

Task[1]		Completion Date	
		DCTWRP and LAGWRP Permits	BWRP Permit
1	Submit and Begin Implementation of Pollution Prevention Plan (PPP) for Source Control	April 1, 2023	February 1, 2024
2	Select members for the Technical Advisory Committee and Stakeholder Committee and regularly convene the committee members to initiate the development of a Technical Workplan that includes a temperature study that identifies the potential impacts of the WRP's effluent temperature and potential control measures (including nature-based solutions) that can be implemented to protect beneficial uses.	May 1, 2023	March 1, 2024
3	Finalize and submit a Technical Workplan for the Los Angeles Water Board Approval, secure the necessary permits for Los Angeles River Channel access and deployment of in-situ monitoring devices, and initiate bidding and procurement for any necessary equipment and/or services.	November 1, 2023	September 1, 2024
4	Implement the Technical Workplan, initiate testing and deployment of any necessary equipment, and continue securing the necessary permits for Los Angeles River Channel access and deployment of in-situ monitoring devices.	April 1, 2024	February 1, 2025
5	Implement the Technical Workplan and begin drafting a Final Technical Report.	December 1, 2024	October 1, 2025
6	Complete and submit the Final Technical Report	December 1, 2025	October 1, 2026
7	Notify Los Angeles Water Board of Selected Preferred Project and Identify Regulatory Approval Process (if appropriate given the study findings), Present Results of Technical Workplan at Next Scheduled Los Angeles Water Board Meeting	February 1, 2026	December 1, 2026
8	Begin Preliminary Design and Environmental Review	July 1, 2026	May 1, 2027
9	Complete Preliminary Design	April 30, 2027	February 28, 2028
10	Complete Environmental Review	April 30, 2028	February 28, 2029
11	Design Preferred Project	April 30, 2029	February 28, 2030
12	Issue Notice to Proceed for Project Work	April 30, 2030	February 28, 2031
13	Complete Preferred Project	February 1, 2031	December 1, 2031

1. Tasks 2 through 6 are relevant to the Study and this report.

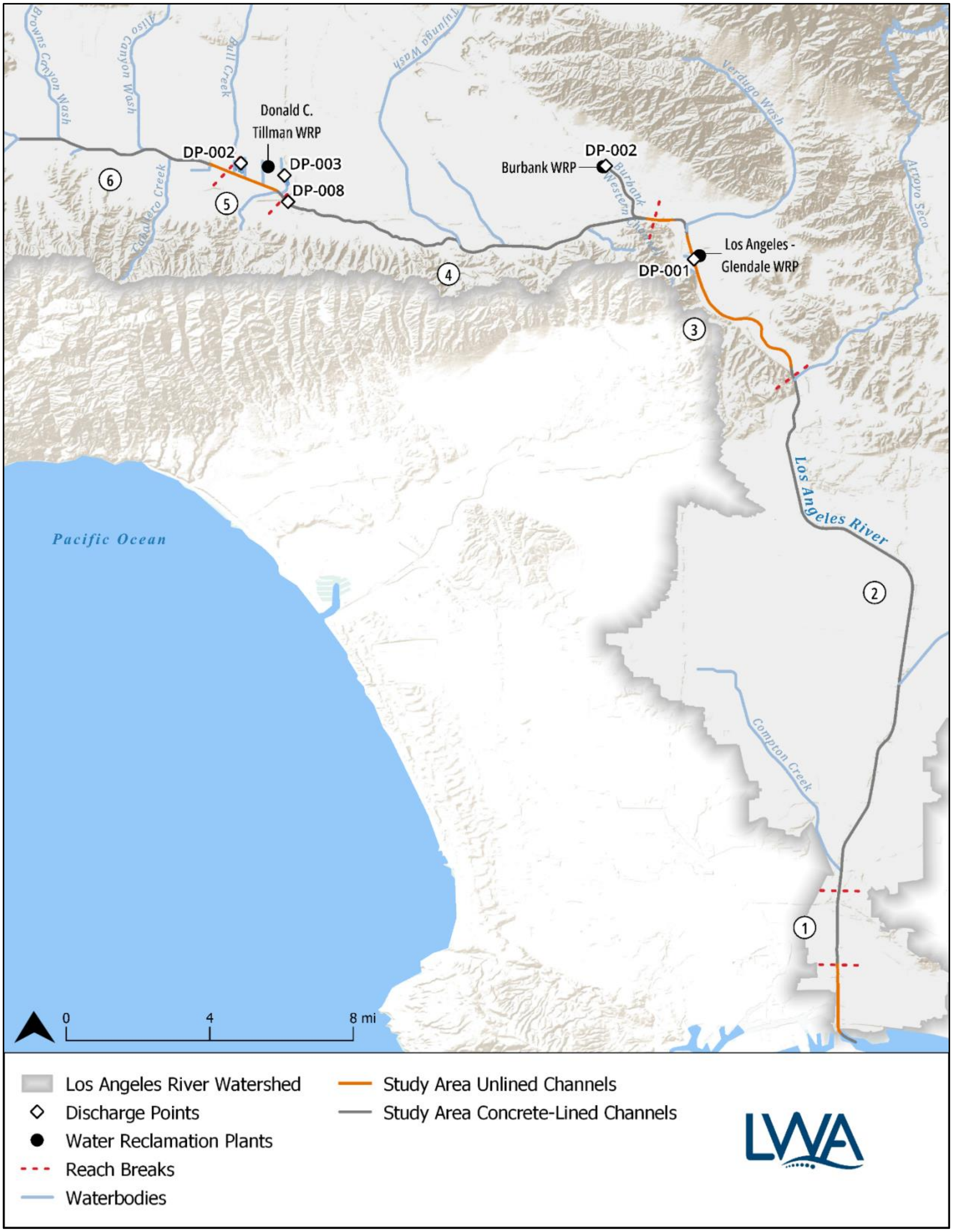


Figure 1. Cities of Los Angeles and Burbank Operated Water Reclamation Plants in the Los Angeles River Watershed

Table 2. Los Angeles River Watershed Waterbodies Identified in the Basin Plan that Receive Effluent from the Donald C. Tillman (DCT), Los Angeles Glendale (LAG), and Burbank Water Reclamation Plants (WRPs)[1] and Associated Beneficial Uses

Waterbody	WRP Direct Discharge	Beneficial Use														
		MUN	IND	PROC	GWR	WARM	MAR	WILD	RARE	MIGR	SPWN	SHELL	WET	REC1	REC2	High Flow Suspension
Los Angeles River Reach 1		P*	P	P	E	E	E	E	E	P	P	P[2]		E[2]	E	Y[3]
Los Angeles River Reach 2		P*	P		E	E		P						E[2]	E	Y[3]
Los Angeles River Reach 3	LAG	P*	P		E	E		E					E	E	E	Y[3]
Los Angeles River Reach 4	DCT	P*	P		E	E		E					E	E	E	Y[3]
Los Angeles River Reach 5	DCT Indirect[4]	P*	P		E	E		E					E	E	E	Y[3]
Sepulveda Flood Control Basin		P*			E	E		E					E	E	E	
Bull Creek		P*			I	I		E						I[5]	I	
Burbank Western Channel	BWRP	P*				P		P						P[5]	I	Y[3]

E: Existing beneficial use. P: Potential beneficial use. I: Intermittent beneficial use.

* Asterisked MUN designations are designated under SB 88-63 and RB 89-03. However, the Los Angeles Regional Water Quality Control Board has only conditionally designated the MUN beneficial use.

1. See Chapter 2 of the Water Quality Control Plan: Los Angeles Region Basin Plan for the Coastal Watersheds of Los Angeles and Ventura Counties for definitions of the beneficial uses.
2. Access is prohibited by Los Angeles County Department of Public Works.
3. The High Flow Suspension only applies to water contact recreational activities associated with the swimmable goal as expressed in the federal Clean Water Act section 101(a)(2) and regulated under the REC-1 use, non-contact water recreation involving incidental water contact regulated under the REC-2 use, and the associated bacteriological objectives set to protect those activities. Water quality objectives set to protect (1) other recreational uses associated with the fishable goal as expressed in the federal Clean Water Act section 101(a)(2) and regulated under the REC-1 use and (2) other REC-2 uses (e.g., uses involving the aesthetic aspects of water) shall remain in effect at all times for waters where this footnote appears.
4. The DCTWRP directly discharges to LA River Reach 4 through discharge point 008 immediately downstream of the Sepulveda Dam. The DCTWRP indirectly discharges to LA River Reach 5 through Lake Balboa and Wildlife Lake, Bull Creek and Hayvenhurst Channel through Lake Balboa, and Haskell Flood Control Channel through Wildlife Lake. The DCTWRP also discharges to the Japanese Gardens, which drains through discharge point 008 to LA River Reach 4. Note that Hayvenhurst Channel and Haskell Flood Control Channel are not named waterbodies in the Basin Plan and do not have designated uses or associated water quality objectives.
5. Access prohibited by the Los Angeles County Department of Public Works in the concrete-channelized areas.

Table 3. Physical Characteristics of Waterbodies in the Los Angeles River Watershed

Waterbody	WRP Direct Discharge	Bottom Substrate[1]	Channel Width[2]	Channel Shape	Low Flow Channel	Canopy Cover
Waterbodies Influenced by City of Burbank and Los Angeles WRP Discharges						
Los Angeles River Reach 1	No	Concrete	VL	Trapezoidal	Yes	Open
Los Angeles River Reach 2	No	Concrete	L-VL	Trapezoidal	Partial	Open
Los Angeles River Reach 3	LAG	Concrete/ Unlined	L-VL	Trapezoidal	Partial	Open
Los Angeles River Reach 4	DCT	Concrete/ Unlined	M-L	Box and Trapezoidal	Partial	Open
Los Angeles River Reach 5	DCT Indirect[3]	Concrete/ Unlined	M-L	Other	No	Partial
Bull Creek		Concrete/ Unlined	S	Trapezoidal and Other	No	Partial
Burbank Western Channel	BWRP	Concrete	S-M	Box	No	Open
Other Major Waterbodies						
Los Angeles River Reach 6	No	Concrete/ Unlined	S-L	Trapezoidal	Yes	Open
Compton Creek	No	Concrete/ Unlined	S-M	Trapezoidal	No	Open
Rio Hondo	No	Concrete/ Unlined	M-VL	Trapezoidal and Other	No	Partial
Arroyo Seco	No	Concrete	S-VL	Trapezoidal	Partial	Open
Verdugo Wash	No	Concrete	S-M	Box	No	Open
Tujunga Wash	No	Concrete	S-M	Box	No	Open

1. With the exception of LAR Reaches 3 and 5, the remaining waterbodies noted as concrete/unlined are almost entirely concrete bottoms.
2. Based on width at the bottom of the channel: S (Small <50 feet); M (Medium 50-100 feet); L (Large 100-200 feet); VL (Very Large >200 feet).
3. DCTWRP indirectly discharges to LAR Reach 5 through Lake Balboa and Wildlife Lake, Bull Creek and Hayvenhurst Channel through Lake Balboa, and Haskell Flood Control Channel through Wildlife Lake.

2 Study Objectives and Document Overview

As presented in the fact sheets of the WRPs' NPDES permits, the Federal Clean Water Act (CWA) requires point source dischargers to control the amount of conventional, non-conventional, and toxic pollutants that are discharged into the waters of the United States. The control of pollutants is intended to protect beneficial uses of waterbodies through establishing limitations for temperature included in the WRPs' NPDES permits. Other factors not addressed through NPDES permits can impact beneficial uses in the Study area, such as ambient air temperatures and habitat modifications for flood control purposes. However, those factors are outside of the Cities' control as they cannot take unilateral action to address ambient air temperatures and habitat modifications in the Study area. As such, this study is intended to develop a better understanding of the relationship between effluent temperature, which is regulated by the Cities' NPDES permits, and potential impacts to the WARM beneficial use in the LA River downstream of the DCTWRP, LAGWRP, and BWRP discharges. Additionally, the Study identifies and evaluates different types of potential control measures (including nature-based solutions) to determine if those control measures could meet the temperature limits while also considering the potential adverse implications related to energy use and greenhouse gas (GHG) emissions.

The Study is focused on the WARM beneficial use because the temperature limits in the WRPs' permits are based on the water quality objectives established for the protection of the WARM beneficial use, which is defined in the Basin Plan as:

> *Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates*.

To support the Study, the Cities, in consultation with the TAC, identified the following Study Objectives:

1. Determine the wholly or partially aquatic-dependent[13] taxa that are present, were historically present, or could be present given the current habitat conditions in the Los Angeles River.
2. For each taxon identified in Objective 1, describe the relationship between waterbody temperatures and the probability (or likelihood) that different aquatic life stages are supported.
3. Determine how the relationships between waterbody temperature and the support of aquatic life vary based on the taxon's location in the river and seasonality.
4. Determine the critical exposure times, durations, and/or frequencies associated with the temperature relationships described in Objectives 1 through 3.
5. Evaluate how other physical factors (e.g., shading, groundwater discharge, availability of substrate, flow, etc.) and climate change could potentially influence temperature effects on biological communities.
6. Analyze relationships between effluent discharge temperature and in-river temperature, including how river temperature changes as a function of distance from the discharge location and downstream physical characteristics.

[13] Aquatic-dependent is defined as a major life stage that resides in the river or relies on the river for food and forage.

This Final Study Report is intended to document the efforts outlined in the Workplan (LWA 2024) that were completed to fill data gaps identified as critical to addressing the Study Objectives including identifying the wholly or partially aquatic and aquatic-dependent taxa that are present, were historically present, or could be present given the current habitat conditions (including considerations for organism life stages and seasonal flow conditions) in the Study waterbodies (**Table 1**), and assisting in characterizing the effects of waterbody temperatures on the biological needs of those taxa.

This Final Study Report provides background information useful for understanding the Study area. The report also includes a description of the technical study methodologies and the results of those investigations. Findings from the study-acquired data and existing sources were integrated to address and evaluate the Study Objectives and were utilized to develop a better understanding of temperatures protective of the WARM beneficial use in the Study area (**Table 1**). The ensuing sections provide the following:

- Overview of Data Reviewed (**Section 3**)
- Summary of Study Monitoring (**Section 4**)
- Results and Analysis (**Section 5**)
- Answers to Study Objectives (**Section 6**)
- Watershed Modeling (**Section 7**)
- Potential Control Measures (**Section 8**)
- Study Conclusions (**Section 9**)
- References (**Section 10**)

3 Overview of Data Reviewed

As part of Workplan development, existing data related to water temperature and flow, air temperature and solar radiation, instream and riparian habitat, and biology were compiled. The sources and data gathered, including indication of spatial and temporal coverage within the Study area, are as described by data type in the following subsections.

3.1 Temperature and Flow Data

Highly treated effluent discharges from the DCTWRP, LAGWRP, and BWRP account for the majority of the LA River's dry weather base flow (Ackerman et al 2003) which also includes urban runoff, groundwater upwelling, and other natural sources. During the winter months, stormwater runoff accounts for the majority of the water flowing through the concrete channels designed for flood control (Mongolo et al. 2017). However, following storm events, flows in the LA River return to being dominated by WRP discharges.

3.1.1 Temperature and Flow Data Bracketing the LAGWRP

Influent temperature, effluent discharge (flow), and temperature are monitored daily at the LAGWRP, and receiving water temperatures are monitored upstream and downstream on a weekly basis. **Table 4** summarizes the relevant monitoring locations associated with the LAGWRP, which are displayed on **Figure 2**. Discharge and temperature data were compiled for the period January 1, 2000 through October 31, 2024. Influent temperatures were reported for the period of May 1, 2007 through October 31, 2024.

Table 4. Locations and Frequency of Water Temperature and Flow Data Collected Bracketing the LAGWRP on Los Angeles River Reach 3

Site Name	Description	Frequency
LAG INFLUENT	LAG Influent	Daily temperature
LAG EFFLUENT	LAG Effluent (001A)	Daily flow and temperature
LAGT650	Los Angeles River, approximately 214 feet upstream of Discharge Point 001 (Previously designated as R-4).	Weekly temperature
LAGT654	Los Angeles River at Los Feliz Boulevard upstream from Los Feliz Boulevard (Previously designated as R-7).	Weekly temperature

3.1.2 Temperature and Flow Data Bracketing the DCTWRP

Influent temperature, effluent discharge, and temperature are also monitored daily at the DCTWRP and receiving water temperatures are monitored weekly at multiple nearby locations in the LA River, as well as Lake Balboa (Rec Lake), Wildlife Lake, and Bull Creek. **Table 5** summarizes the relevant monitoring locations associated with the DCTWRP, which are also displayed on **Figure 2**. Discharge and temperature data were compiled for the period January 1, 2000 through October 31, 2024.

Table 5. Locations and Frequency of Water Temperature and Flow Data Collected Bracketing the DCTWRP on Los Angeles River Reaches 4 and 5

Site Name	Waterbody	Description	Frequency
DCT INFLUENT	NA	DCT Influent	Daily temperature
DCT EFFLUENT	N/A	DCT Effluent (001A)	Daily flow and temperature
RSW-4 (4)	Lake Balboa (also referred to as Rec Lake)	400 feet upstream from the outlet spillway.	Daily temperature
RSW-W2 (W-2)	Wildlife Lake	South of the island, near the westerly lake shoreline at a 2-foot water depth.	Daily temperature
RSW-LATT612 (I)	LAR Reach 5	Upstream of Bull Creek.	Weekly temperature
RSW-LATT616 (J)	Bull Creek	100 feet downstream of Lake Balboa weir outlet.	Weekly temperature
RSW-LATT614 (K)	Bull Creek	Upstream of Lake Balboa discharge (250 feet upstream of Lake Balboa upper discharge, near the corner of Victory Blvd. and Petit Ave).	Weekly temperature
RSW-LATT622 (D)	LAR Reach 5	100 yards downstream of the confluence of the Los Angeles River and Hayvenhurst Channel.	Weekly temperature
RSW-LATT628 (W-E)	LAR Reach 5	300 ft downstream of the Haskell Flood Control Channel.	Weekly temperature
RSW-LATT630 (R-7)	LAR Reach 4	1800 feet downstream of RSW-LATT628 and below Sepulveda Dam	Weekly temperature

3.1.3 Temperature and Flow Data Bracketing the BWRP

Effluent discharge and temperature are monitored daily at the BWRP, and receiving water temperatures are monitored upstream and downstream on a weekly basis. **Table 6** summarizes the relevant monitoring locations associated with the BWRP, which are displayed on **Figure 2**. Discharge and temperature data were compiled for the period January 1, 2000 through October 31, 2024.

Table 6. Locations and Frequency of Water Temperature and Flow Data Collected Bracketing the BWRP on the Burbank Western Channel (BWC)

Site Name	Description	Frequency
BWRP EFFLUENT	BWRP Effluent (002)	Daily flow and temperature
RSW-002U	300 feet upstream from Discharge Point 002 (Previously designated as R-1)	Weekly flow and temperature
RSW-002D	Verdugo Ave (Previously designated as R-2)	Weekly flow and temperature

3.1.4 Additional Relevant Temperature Data

In general, continuous river temperature data is rare on the LA River (Abdi et al. 2022). Major contemporary studies of temperature in the LA River have relied upon continuous (0.5- or 4-hour intervals) data collected at 13 locations from June-October of 2016 by Mongolo et al. (2017). **Table 7** summarizes the monitoring locations associated with the study, which are displayed on **Figure 2**.

A source of more recent continuous (0.5 hour) river temperature data is the Heal the Bay (HtB) monitoring conducted between 2021 and 2022, as summarized in **Table 8** and displayed on **Figure 2**. Additionally, the U.S. Geological Survey (USGS) has continuously monitored river temperature at two locations on the LA River (USGS 341015118284001) and Bull Creek (USGS 341049118295201) as summarized in **Table 9** and displayed on **Figure 2**.

Table 7. Los Angeles River Watershed Water Temperature Monitoring Locations: Mongolo et al. 2017

Site Location	Waterbody	Start Date	End Date
Above Devils Gate Dam	Arroyo Seco	6/4/2016	10/28/2016
Rose Bowl	Arroyo Seco	6/4/2016	10/30/2016
Balboa	LAR Reach 5	6/4/2016	10/26/2016
Burbank	LAR Reach 5	6/4/2016	10/26/2016
Atwater Park	LAR Reach 3	6/4/2016	8/18/2016
L.A. State Historic Park	LAR Reach 3	6/9/2016	7/19/2016
Hollydale Park	LAR Reach 2	6/4/2016	10/30/2016
DeForest Park	LAR Reach 2	6/4/2016	10/30/2016
Compton Creek	Compton Creek	6/4/2016	9/17/2016
Willow St. Bridge (upstream)	LAR Reach 1	6/4/2016	10/30/2016
Willow St. Bridge (downstream)	LAR Reach 1	6/4/2016	10/30/2016

Table 8. Los Angeles River Watershed Water Temperature Monitoring Locations: Heal the Bay

Site Name	Waterbody	Start Date	End Date
Willow Street	LAR Reach 1	4/21/2022	5/31/2022
Riverfront Park	LAR Reach 2	4/21/2022	5/6/2022
Lower Compton Creek Site	Compton Creek	8/25/2021	5/31/2022
Steelhead Park	LAR Reach 3	8/20/2021	11/30/2021
Benedict Street	LAR Reach 3	8/20/2021	11/30/2021
Rattlesnake Park	LAR Reach 3	8/20/2021	5/30/2022
Burbank Blvd	LAR Reach 5	8/20/2021	10/20/2021

Table 9. Los Angeles River Watershed Water Temperature Monitoring Locations: USGS

Site Name	Waterbody	Start Date	End Date
USGS 341015118284001	LAR Reach 5	1/25/2022	4/18/2023
USGS 341049118295201	Bull Creek	1/6/2022	9/5/2023

3.1.5 Relevant Flow Data

The USGS has measured streamflow on the LA River at Sepulveda Dam (USGS 11092450) since October of 2002. Streamflow is based on gage height, which is recorded every 15 minutes. There are also four Los Angeles County Department of Public Works (LACDPW) stream gaging stations located along the LA River that are displayed on **Figure 2**. These gages were previously maintained by the USGS but are now under the operation of LACDPW. The LA River gages from upstream to downstream are:

- Los Angeles River at Tujunga Ave., Station no. F300-R (1950-present)
- Los Angeles River above Arroyo Seco, Station no. F57C-R (1929-present)
- Los Angeles River below Firestone Blvd., Station no. F34D-R (1928-present)
- Los Angeles River below Wardlow Rd., Station no. F319 (1931-present)

3.2 Air Temperature and Solar Radiation Data

In rivers like the LA River that are maintained for flood control, channelization itself can be a strong driver of the thermal regime (Mongolo et al. 2017). Channelization of a river can eliminate natural thermal buffers and insulators, causing water temperature to be even more vulnerable to fluctuations in ambient air temperature and solar radiation (Poole and Berman 2001), particularly when concrete-lining of the channel is involved. Confining a stream to a concrete channel also eliminates the stream's connection with soil and groundwater, resulting in loss of the natural buffering effect that groundwater has on stream temperatures – a process that currently only occurs in the unlined portion of the LA River at the Glendale Narrows in Reach 3. In addition, concrete lining on the streambanks absorbs solar energy and radiates heat due to the thermal mass of the construction materials (Hester and Doyle 2011).

Hourly and daily air temperature and solar radiation were obtained from several California Irrigation Management Information System (CIMIS) weather stations in the LA River watershed. Data are available from four CIMIS stations in the watershed including #216 - Arleta (January 1, 2018 through October 31, 2024), #219 - West Hills (January 1, 2018 through October 31, 2024), #174 - Long Beach (January 1, 2018 through

October 31, 2024), #223 – North Hollywood (January 30, 2018 through October 31, 2024). **Figure 2** presents stations #216 - Arleta and #223 - North Hollywood. Stations #174 - Long Beach (6.4 miles west of LAR Reach 1) and #219 - West Hills (2.8 miles northeast of the confluence of LAR Reach 5 and Bull Creek) do not appear on **Figure 2** due to the map scale. Additional temperature data was obtained on an hourly, or more frequent, basis from 16 National Weather Service (NWS) southern California regional stations between 1997 and 2024 (**Figure 2**), although four stations do not appear on **Figure 2** due to the map scale.

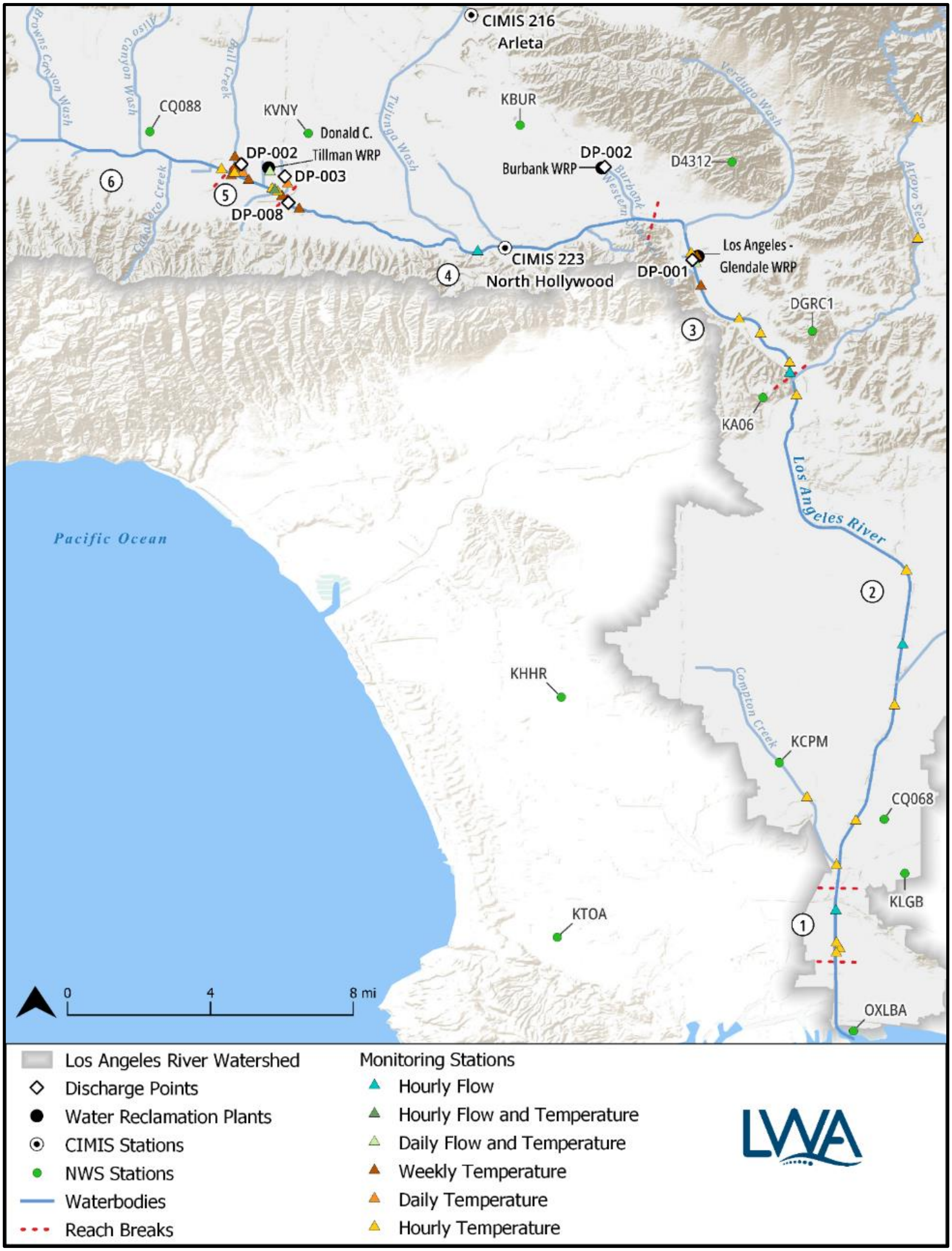


Figure 2. Reviewed Monitoring Locations by Type in the Los Angeles River Watershed

3.3 Habitat Data

3.3.1 Riparian and Instream Habitat

For the most part, the LA River is channelized and concrete-lined. However, riparian and more natural instream habitats that do occur along the LA River have been the subject of several large-scale studies, generally associated with assessment of environmental conditions for specific projects or in support of long-term planning. These reports are comprehensive and representative of the habitats in the areas of concern for this Study. The following key sources of riparian and instream habitat data were considered as part of the Study and are summarized in **Appendix 1**:

- USACE, 2015. LA River Ecosystem Restoration Integrated Feasibility Report.
- Environmental Science Associates (ESA), 2017. Burbank Wastewater Change Petition and Recycled Water Distribution Project Biological Resources Assessment.
- ESA, 2018. Glendale Water and Power Wastewater Change Petition and Recycled Water Distribution Project Biological Resources Assessment.
- LASAN, 2021. D.C. Tillman Water Reclamation Plant: Japanese Garden Discharge Reuse Initial Study/Negative Declaration
- Stein et al. 2021a. Assessment of Aquatic Life Use Needs for the Los Angeles River: Los Angeles River Environmental Flows Project.
- Cooper et al. 2022. Biological Resources Survey and Report for Baseline Dry Season In-Channel Vegetation Mapping and Appendices

3.3.2 Other Habitat Data

Riparian condition has also been assessed in the LA River system as reported in the Los Angeles River Watershed Monitoring Program using the California Rapid Assessment Method (CRAM; Collins et al. 2008). CRAM assesses four attributes of wetland condition: buffer and landscape, hydrologic connectivity, physical structure, and biotic structure. CRAM is unique by being frequently used as both a biotic index and a surrogate for abiotic stress in the riparian zone. Physical habitat (PHAB) has also been surveyed in the LA River in conjunction with bioassessment monitoring using the protocol from Ode et al. (2016), which was adapted from the USEPA's Environmental Monitoring and Assessment Program (Peck et al. 2006). Using this protocol, at each transect within a reach, physical habitat quality is determined by observing substrate complexity, consolidation, embeddedness, the presence of coarse particulate organic material (CPOM), human influence, instream habitat complexity, bank stability, surrounding vegetative protection, canopy cover, habitat flow type, stream gradient, sinuosity, channel engineering, hydromodification, bank-full, and wetted widths. Each sampling reach is scored using a subjective, reach-wide approach based on epifaunal substrate, sediment deposition, and channel alteration (Qualitative Physical Habitat Score). In addition to the Qualitative Physical Habitat Score, Stream Habitat Characterization Form data are used to generate first order metrics to characterize riparian disturbance and instream natural habitat complexity. At each point where substrate size is determined along a transect, the presence or absence of microalgae, macroalgae, and aquatic macrophytes was recorded. If microalgae are present, it is given a thickness score. These data are used to determine the percentage of algal cover within a stream reach. Habitat information reviewed in this section is summarized in **Appendix 1**.

3.4 Bioassessment Data

As early as 2003, California, like several other state and federal agencies, began utilizing standardized sampling and analysis protocols to assess the biological and physical condition of streams and rivers. Specific protocols were established to collect certain types of biological data that together represent different attributes (metrics) of assemblage composition, structure, and function such as species richness, tolerance guilds, and trophic guilds. Metrics based on the biological data collected were selected for inclusion in an index of biotic integrity (IBI) based on the responsiveness of the metric to anthropogenic stressor gradients and/or their ability to discriminate between minimally disturbed reference sites and test sites known or suspected to have been exposed to stressors of interest. The standardized protocols, which have since been updated and adapted based on years of continued use, quickly became the backbone of California's current bioassessment program (Surface Water Ambient Monitoring Program or SWAMP), which utilizes benthic macroinvertebrate (BMI) and diatom and algal communities along with physical/habitat characteristics to determine biological and physical integrity in California streams.

3.4.1 Benthic Macroinvertebrates (BMI)

BMI taxa lists were aggregated from publicly searchable databases including the California Environmental Data Exchange Network (CEDEN)[14] and the Southern California Stormwater Monitoring Coalition (SMC)[15] data portals. Both sites aggregate survey data from multiple survey programs, including:

- California Department of Fish and Wildlife Aquatic Bioassessment Laboratory Monitoring
- USEPA Environmental Monitoring & Assessment Programs
- California Water Resources Control Board State-wide Surveys
- Los Angeles County Department of Public Works/Los Angeles County Flood Control District Bioassessment Monitoring Program
- Los Angeles Regional Water Quality Control Board Watershed Surveys
- Los Angeles River Watershed Monitoring Program
- Harbor Toxics TMDL Compliance Monitoring
- Southern California Coastal Water Research Project (SCCWRP) Depressional Wetlands Pilot Study Monitoring
- Southern California SMC Monitoring

Additional BMI data were gathered from multiple years of sampling at recurring stations in the region conducted by the Los Angeles County Department of Public Works (LACDPW) and the Los Angeles County Flood Control District (LACFCD). All the monitoring programs listed utilize similar data collection and laboratory analysis methodologies based on SWAMP or SWAMP precursor procedures to collect BMI data used to estimate the biological condition in California inland waters. The sampling procedures used in the last seven years follow *the Standard Operating Procedures for the Collection of Field Data for Bioassessments of California Wadeable Streams: Benthic Macroinvertebrates, Algae, and Physical Habita*t (Ode et al. 2016). The BMIs collected are identified to Level 2A as specified by the Southwest Association of Freshwater Invertebrate Taxonomists, Standard Taxonomic Effort (SAFIT; Richards and Rogers 2011), and taxonomic

[14] https://ceden.waterboards.ca.gov/AdvancedQueryTool
[15] https://smc.sccwrp.org/

identification is standardized with Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT)[16] usage. A summary of historical data is presented in **Section 5.3** and **Appendix 2**.

3.4.2 Diatoms and Algae

The primary sources of algae and diatom data are similar to that for BMI. Benthic algae samples have been required at all monitoring locations in conjunction with BMI samples since 2016. At each transect, algae are sampled a quarter meter upstream of the BMI sample in accordance with the protocol (Ode et al. 2016). The algae samples are split for analysis of different indicators (e.g., biomass and community composition). Diatoms and soft-bodied algae (including cyanobacteria) are identified to the lowest taxonomic resolution possible, which is typically species. At each point where substrate size is determined along a transect, the presence or absence of microalgae, macroalgae, and aquatic macrophytes are also recorded. If microalgae are present, the site is given a thickness score. These data are used to determine the percentage of algal cover within a stream reach. A summary of historical data are presented in **Section 5.3** and **Appendix 2**.

3.5 Other Biological Data

Occurrence information for vertebrates (fish, amphibian, or reptile) in the LA River is available from professional and community-contributed observation reporting for academic research and on-going initiatives on the LA River, or from academic and government research related to native species conservation and recovery. Additional information is available through collaborative studies that use environmental DNA (eDNA) methodologies to evaluate riverine communities.

Aquatic vertebrate communities of the LA River are well documented, and it was determined during the Workplan (LWA 2024) process that sufficient data to characterize historical and current aquatic vertebrate communities of the LA River and additional surveys were not required. A summary of the available information is presented in **Section 5.3**.

Similarly, information on the use of the LA River by aquatic-dependent birds, including both habitats available and bird species occurrence, is well characterized. A summary of this information is also presented in **Section 5.3**.

[16] https://www.safit.org/ste.html

4 Summary of Study Monitoring

The collection of additional temperature and bioassessment (BMI, algae, and diatoms) data upstream and downstream of the DCTWRP, LAGWRP, and BWRP discharges was conducted to allow a finer-scale analysis of the relationships between effluent discharge temperature, receiving water temperature, and the associated biological community. This section describes the monitoring completed as part of the Study.

4.1 Water Temperature Monitoring

During the development of the Workplan (LWA 2024), sufficient data were determined to be available to characterize water temperature and flow conditions in the mainstem of the LA River in general, but not enough data to allow a finer-scale analysis of the relationships between effluent discharge temperature and receiving water temperature. Specifically, data were available to accurately characterize how river temperature changes as a function of distance from the discharge location and downstream physical characteristics. Such data are necessary for ensuring potential influence of the WRPs' effluent temperature are well understood and any temperature control measures implemented will achieve the intended outcome. Given the importance of understanding the influence of temperature near the WRPs' discharges during the summer months, nearly continuous water temperature monitoring of both receiving stream and effluent temperature was needed. To provide this information, continuous (every 30 minutes) diel (24-hour) ambient water temperature data was collected in LA River Reaches 3, 4, and 5 above and below WRP outfalls during the critical summer months of 2024. Temperature data loggers were deployed at the locations listed in **Table 10** and presented in **Figure 3**, **Figure 4**, and **Figure 5**, which bracket discharges from the DCTWRP, BWRP, and LAGWRP outfalls, respectively. Pictures of the monitoring stations listed in **Table 10** can found in **Appendix 3**.

Continuous temperature probes (thermistors) were deployed in late April 2024 and were retrieved on October 31, 2024 at 18 receiving water locations and four WRP discharge locations (**Table 10**). Eight stations were located in LA River Reaches 4 and 5, as well as one each in Lake Balboa and Wildlife Lake[17], to evaluate thermal conditions upstream and downstream of the DCTWRP discharge (**Figure 3**). Five stations were located in the BWC and LA River Reaches 3 and 4 to evaluate the thermal influence of the BWRP discharge on the BWC and the LA River (**Figure 4**). Five stations were located in Reaches 2 and 3 to evaluate the thermal influence of the LAGWRP discharge on the LA River (**Figure 5**).

In preparation for deployment, the thermistors were attached to cinderblocks to prevent movement caused by water flow. The anchor blocks were broken to reduce their usefulness if discovered and some were camouflaged to look aged. The blocks were installed so that the thermistors were not obvious from above while still allowing for continuous flow of water over the logger and minimizing exposure to direct sunlight. The thermistors were set to record water temperatures every 30 minutes (on the hour and the half-hour). In addition, the thermistors recorded in- and out-of-water events to allow filtering of data to remove data collected when the thermistor was reading air temperature rather than water temperature.

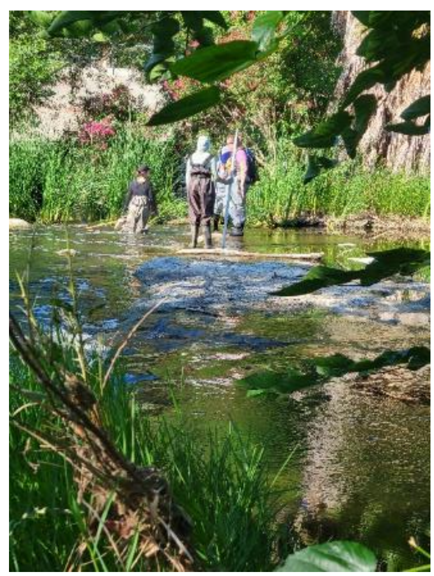
[17] The locations of the two lake station thermistors were modified slightly from the planned Workplan locations due to access concerns in the lakes. Both thermistors were located in the respective spillways between the lakes and the LA River and the new locations updated in in this report.

Thermistors were visited and downloaded on an approximately two-week schedule to maintain data integrity and to minimize data loss in the event a thermistor was lost. Data were reviewed after every download. Constraints to data collection appeared to be limited to variable water levels and tampering. Occasional slight adjustments were made at some locations to optimize the thermistor within the local flow regime and reduce the effects of variable water levels. Of the 22 thermistors installed for the Study, only two were lost and needed to be replaced during revisits. Two additional thermistors were installed as backup loggers at locations where repeated tampering was evident (usually in the form of removal from the water at some point between download visits but typically found nearby out of the water). It was found that these backup loggers improved consistency of data collection at these locations.

Nearly 190,000 individual in-water temperature values were recorded during the 27-week deployment. Only 3% of all potential data was lost as a result of missing thermistors or out-of-water readings during the field Study. Results of the water temperature monitoring are presented in **Section 5.2**.

4.2 Bioassessment Monitoring

During the development of the Workplan (LWA 2024), it was determined that the spatial and temporal extent of existing BMI data was sufficient to generally determine the BMI likely present now and over the last 20 years in the majority of the lower LA River. Sufficient data were also available to at least qualitatively-determine how the relationships between waterbody temperature and the support of BMI vary based on a taxon's location in the LA River. However, it was determined not enough data were available at a finer scale to support an assessment of the potential impacts of the WRPs' effluent temperature immediately upstream and downstream of the discharge. Specifically, a lack of sufficient BMI data prevented the investigation of the following pertinent questions: Is the BMI community different upstream and downstream of the WRPs in the relevant, WRP-associated reaches of the LA River? If biology is different, is it because of water temperature, habitat, or something else? If it is water temperature, is it because of the WRP discharge or something else? The answers to these questions, combined with knowledge of the known or expected temperature tolerance of BMI taxa present under current conditions, align with the overall Study objective and Study-specific question. The same data deficiency applied to algal communities upstream and downstream of the WRPs.



To effectively fill these data gaps, additional BMI and diatom and algae data were collected at locations upstream and downstream of the WRPs at stations where temperature data was also collected during the Study, following standard SWAMP procedures. In addition, where possible, bioassessment stations previously sampled by the Los Angeles River Watershed Monitoring Program (LARWMP) were incorporated into the 2024 Study design to evaluate local community trends and to help integrate the current Study findings with historical information. The locations of the 13 BMI and diatoms and alga sampling stations are provided in **Table 10** and presented in **Figure 3**, **Figure 4**, and **Figure 5**.

BMI and diatoms and algae were sampled in June 2024. At one station it was not possible to collect algae samples because of the water depth, but physical and BMI data were collected at all 13 stations. Results are presented in **Appendix 2** and summarized in **Section 5.3**.

Table 10. Temperature and Bioassessment Monitoring Stations

Waterbody	Description	Station ID	Latitude	Longitude	Bio-assessment	Temperature
DCTWRP Stations						
LAR Reach 5	LAR Reach 5 @ Balboa Blvd	LAR5 Balboa	34.1795	-118.5003	X	X
Lake Balboa	Lake Balboa Spillway	Lake Balboa Spillway	34.1774	-118.4928		X
LAR Reach 5	LAR Reach 5 downstream of Hayvenhurst Channel	LAR5 Hayvenhurst	34.1757	-118.4908	X	X
LAR Reach 5	LAR Reach 5 @ Burbank Blvd	LAR5 Burbank	34.1709	-118.4778		X
Wildlife Lake	Wildlife Lake Spillway	Wildlife Lake Spillway	34.1725	-118.4722		X
LAR Reach 5	LAR Reach 5 @ downstream of Haskell Flood Control Channel	LAR5 Haskell	34.1673	-118.4740		X
N/A	DCTWRP Effluent (001A)	DCT Eff 001	34.1803	-118.4803		X
N/A	DCTWRP Effluent (008)	DCT Eff 008	34.1648	-118.4718		X
LAR Reach 4	LAR Reach 4 @ Kester (LARWMP LAR0232)	LAR4 Kester	34.1591	-118.4562	X[1]	X
LAR Reach 4	LAR Reach 4 @ Van Nuys Blvd	LAR4 Van Nuys	34.1578	-118.4489		X
BWRP Stations						
BWC	BWC Upstream	BWC Up	34.1832	-118.3184	X	X
N/A	BWRP Effluent	BWRP Eff 001	34.1825	-118.3183		X
BWC	BWC Near Downstream	BWC Down	34.1819	-118.3176	X	X
BWC	BWC @ Riverside upstream of LAR Confluence	BWC Riverside	34.1591	-118.3049	X	X
LAR Reach 4	LAR Reach 4 @ LA Zoo, upstream of BWC Confluence (LARWMP LAR08695)	LAR4 Zoo	34.1563	-118.3074	X[1]	X
LAR Reach 3	LAR Reach 3 @ Griffith downstream of BWC Confluence (LARWMP LAR04532)	LAR3 Griffith	34.1560	-118.2877	X[1]	X
LAGWRP Stations						
LAR Reach 3	LAR Reach 3 @ Electronics Place	LAR3 Electronics	34.1447	-118.2777	X	X
N/A	LAGWRP Effluent	LAG Eff 001	34.1372	-118.2742		X
LAR Reach 3	LAR Reach 3 @ North Atwater (LARWMP LAR10210)	LAR3 N. Atwater	34.1322	-118.2741	X[1]	X
LAR Reach 3	LAR Reach 3 @ Greenway (LARWMP LAR08599)	LAR3 Greenway	34.1060	-118.2434	X[1]	X
LAR Reach 3	LAR Reach 3 @ Riverside Dr at the end of natural bottom	LAR3 Riverside	34.0851	-118.2279	X	X
LAR Reach 2	LAR Reach 2 downstream of Washington Blvd (LARWMP LAR03902)	LAR2 Washington	34.0108	-118.2196	X[1]	X

1. Bioassessment data collected at this site by the Los Angeles River Watershed Monitoring Program (LARWMP).

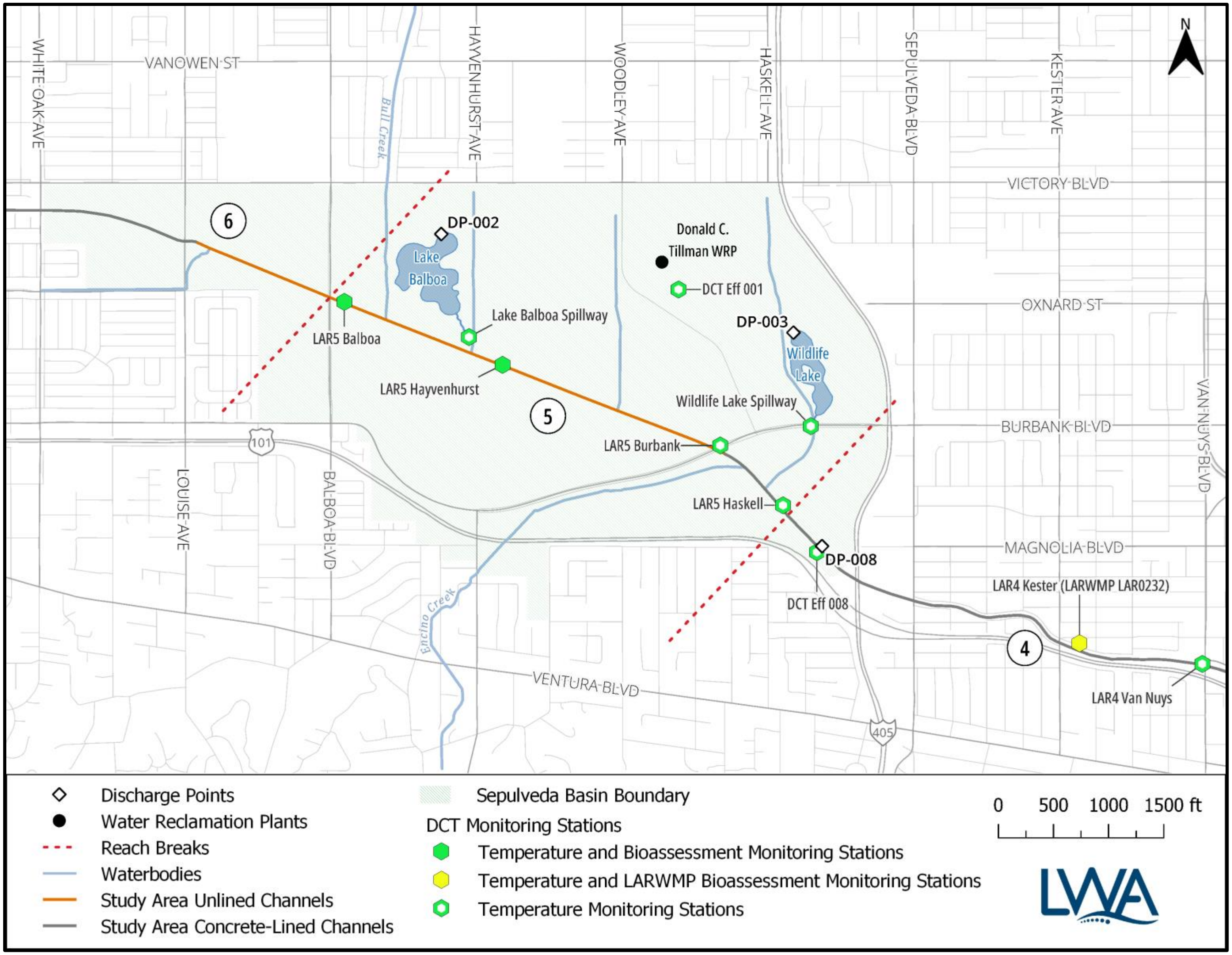


Figure 3. Monitoring Locations in the Vicinity of Donald C. Tillman WRP

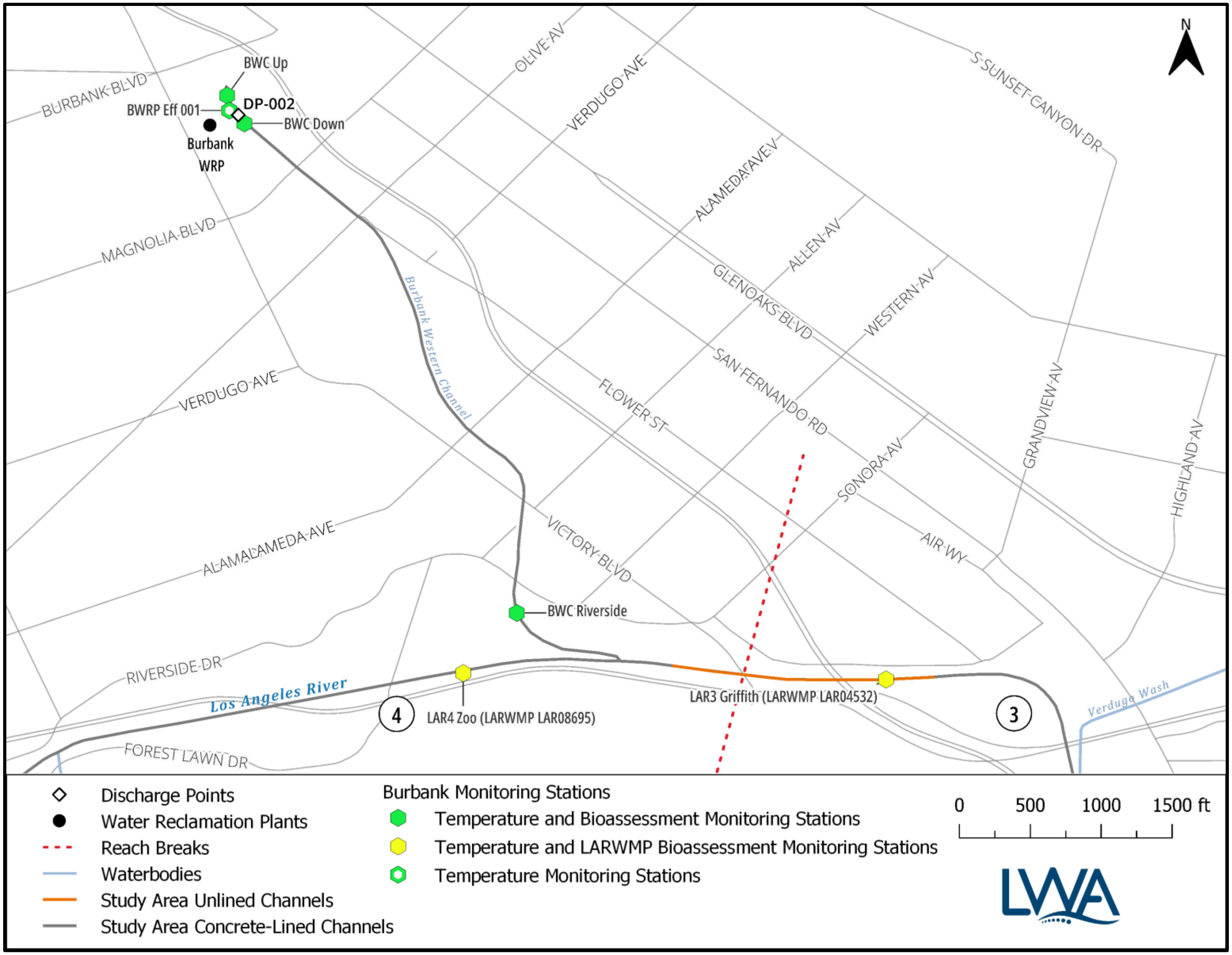


Figure 4. Monitoring Locations in the Vicinity of Burbank WRP

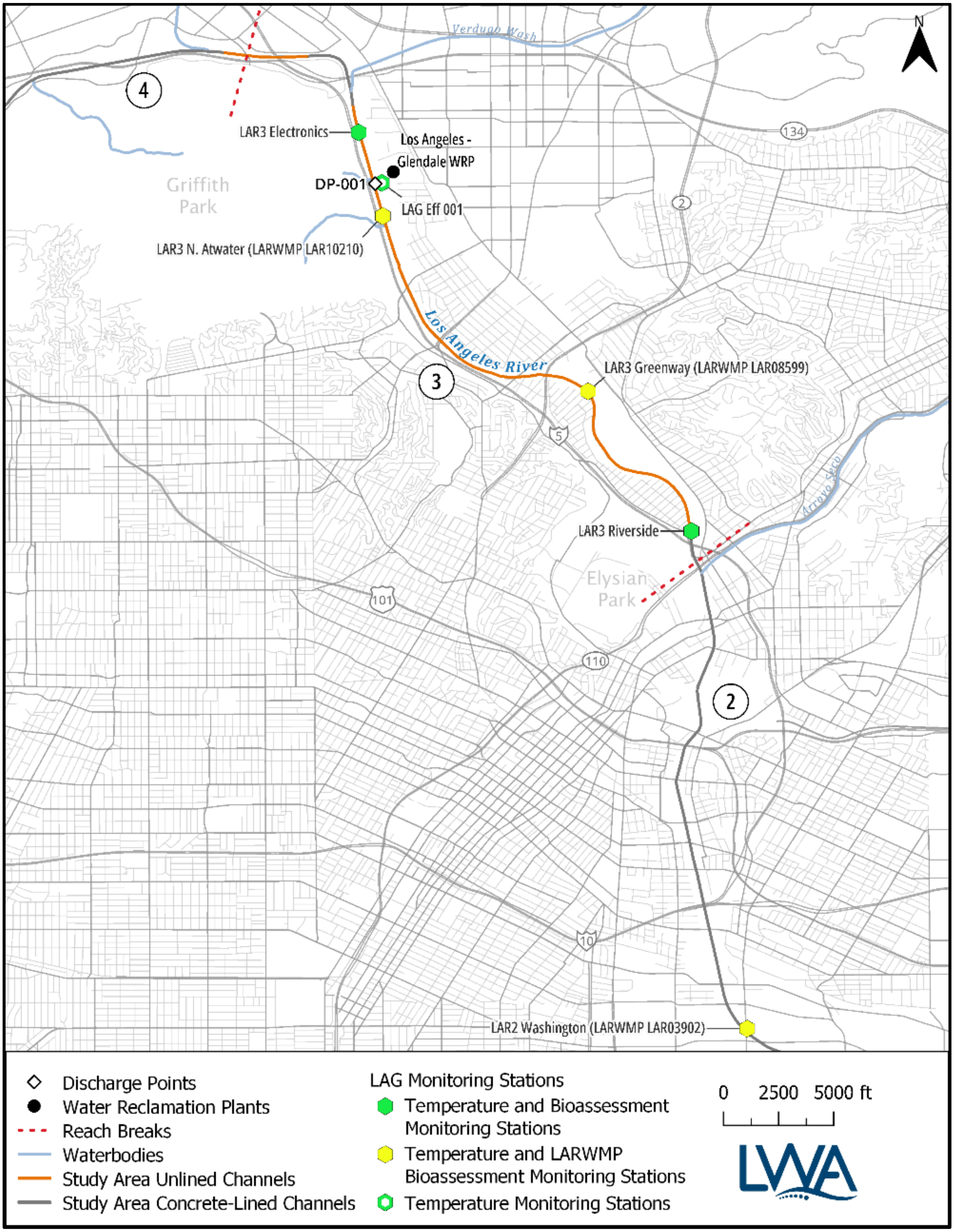


Figure 5. Monitoring Locations in the Vicinity of Los Angeles - Glendale WRP

5 Results and Analysis

As discussed above, the Workplan (LWA 2024) called for additional temperature monitoring and biological studies to fill data gaps and supplement existing bioassessment data collected under various programs in the LA River watershed as described in **Section 1**, as well as to assist in fully characterizing effluent and ambient receiving water temperature and biology in the Study area. The section begins with a summary of climate conditions during the Study, followed by an overview of Study data and related data and observations regarding effluent temperature, stream temperature, and biology in reaches associated with each of the three WRPs discharging to the LA River Mainstem or BWC. The characterization of stream temperature is based on continuous temperature recordings collected from thermistors deployed from May through October 2024 at strategically located monitoring stations upstream and downstream of the WRPs, to address specific Study Objectives. The characterization of biology utilized both newly collected Study data and historical data for the LA River Mainstem and BWC, as well as for nearby tributaries throughout the heavily urban, commercial, and industrialized LA River watershed Study area. This was done because the physical characteristics and channel features in the tributaries and drainages are similar to, and therefore representative of, the LA River mainstem reaches of primary focus in the Study, maximizing the use of such relevant data.

5.1 Climate Conditions

According to the National Weather Service, the overall climate in the Study area in 2024 was characterized by extremely wet winter and spring conditions followed almost immediately by parched weather patterns and above average temperatures from May to December. In downtown Los Angeles, for example, less than 0.16 inches of rain fell between May 6, 2024 and October 31, 2024, compared to the historical average of greater than 4 inches[18]. At Los Angeles LAX Airport, less than 0.04 inches of rainfall were recorded over the same period. The six-month period ending December 2024 was the Study area's second driest on record. Historically, the annual average precipitation in the Study area is 18.63 inches.

Hourly and daily weather conditions, including air temperature and solar radiation, were obtained from three CIMIS weather stations in the region (Station 216, Arleta; Station 223, North Hollywood; and Station 174, Long Beach), as described in **Section 3.2**. **Figure 6** through **Figure 8** present the CIMIS data, including continuous daily minimum, maximum, and average air temperature, along with daily maximum and average solar radiation from May through October 2024 for each of the three weather stations. Air temperature rises beginning May until peak air temperatures occurred in the middle of July through the middle of August. An extremely warm-weather event occurred in early September when maximum air temperature exceeded 113.2 and 113.9°F near the Arleta and North Hollywood stations (and 105°F near the Long Beach station) before beginning to gradually decline with occasional higher-than-average warm spells in October and November. Large diurnal (diel) variability occurs with ambient air temperature, particularly at inland locations (e.g., near Arleta and North Hollywood stations) compared to areas under direct coastal influence where overall air temperature generally reaches lower daily maxima (e.g., Long Beach station; see profiles provided in **Figure 6** and **Figure 7** compared against the profiles in **Figure 8**). Solar radiation reaches peak levels May through July, with maximum daily solar radiation attaining higher levels inland. Solar radiation was at its peak

[18] https://www.usclimatedata.com/climate/los-angeles/california/united-states/usca1339

in May and June and was commensurate with the beginning of surface water temperatures increasing above 80°F throughout the entire Study area, regardless of WRP effluent temperatures. Solar radiation was also more variable and slightly lower at the coastal (Long Beach) CIMIS station compared to the two inland stations.

The influence of the combination of air temperature and solar radiation in the Study area, together with the influence of reach-specific physical habitat features, is illustrated using examples in the following section.

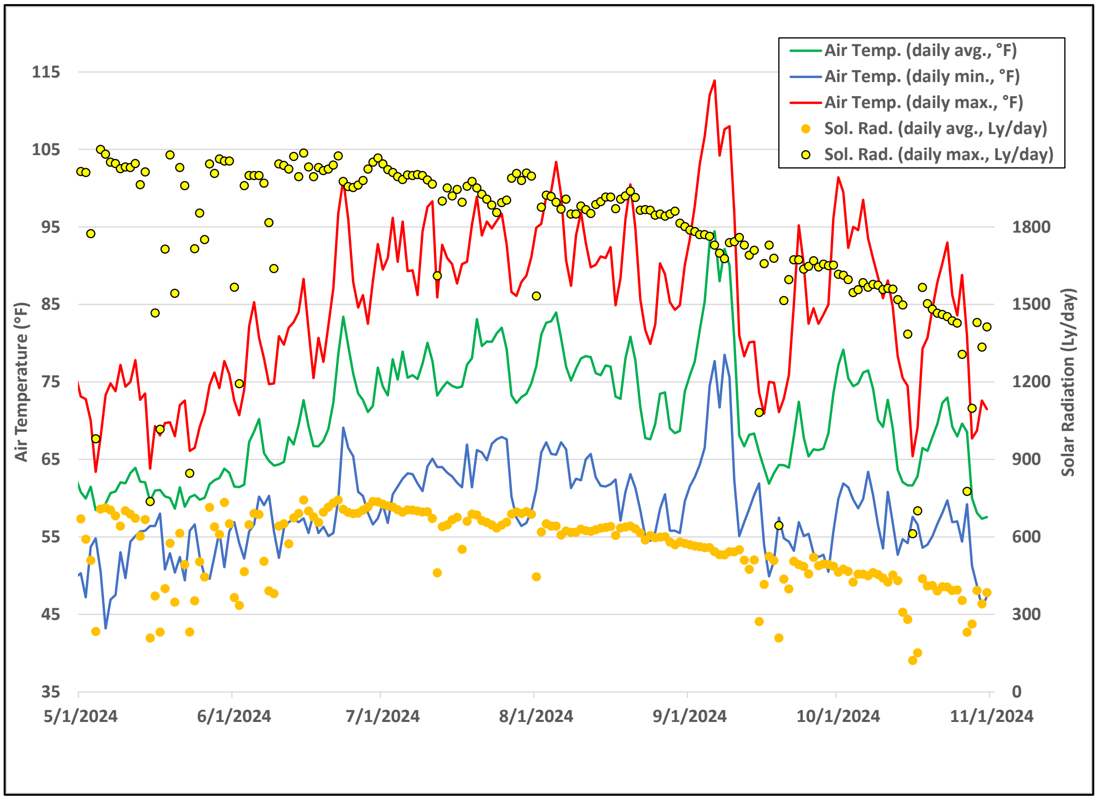


Figure 6. Measured Air Temperature and Solar Radiation from CIMIS Weather Station 216 (Arleta)

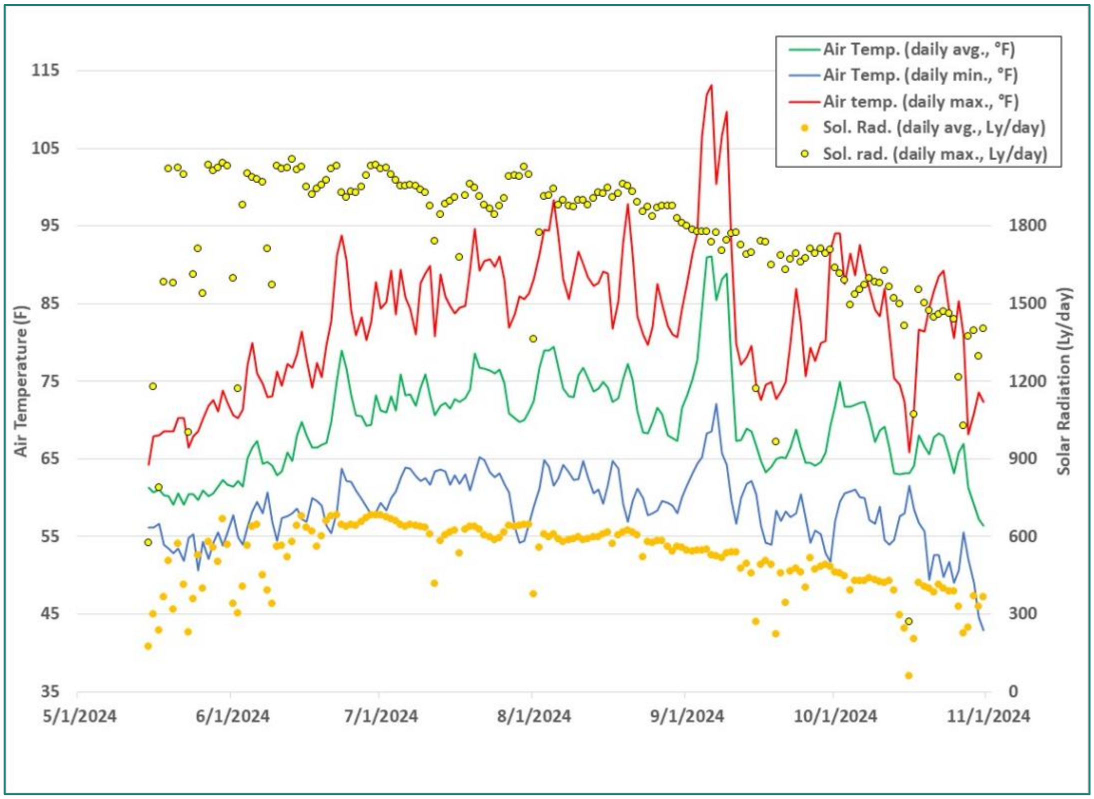


Figure 7. Measured Air Temperature and Solar Radiation from CIMIS Weather Station 223 (North Hollywood)

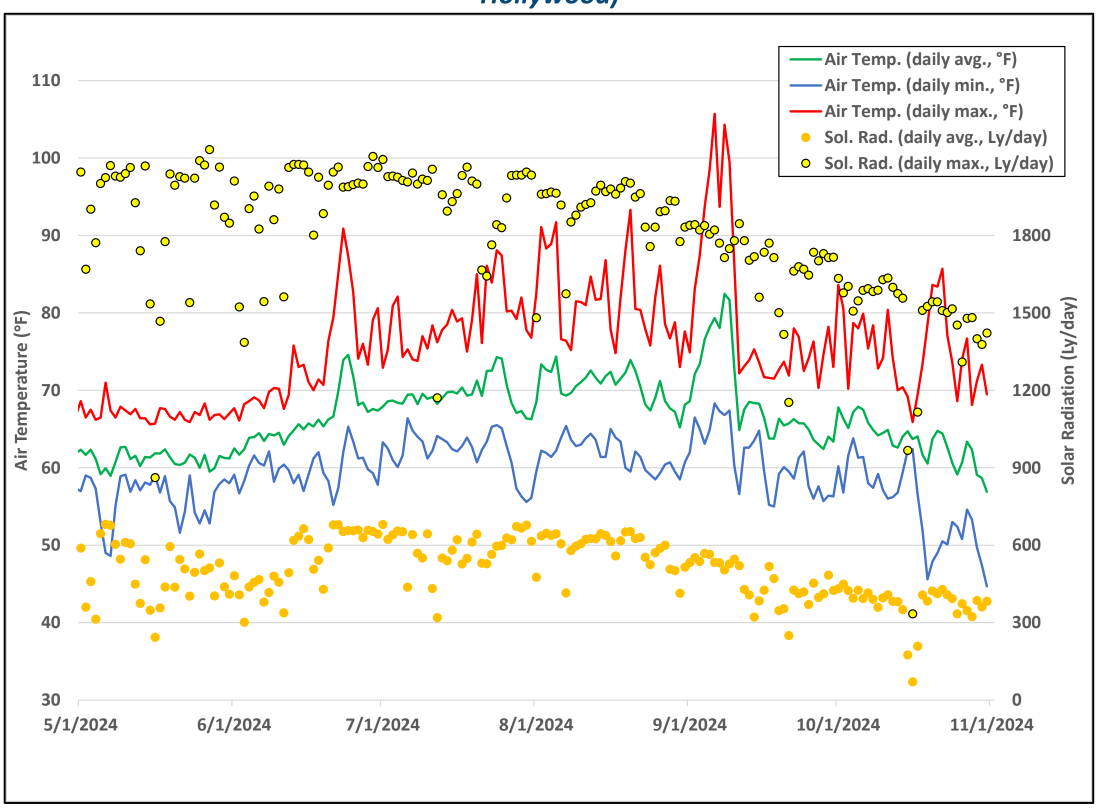


Figure 8. Measured Air Temperature and Solar Radiation from CIMIS Weather Station 174 (Long Beach)

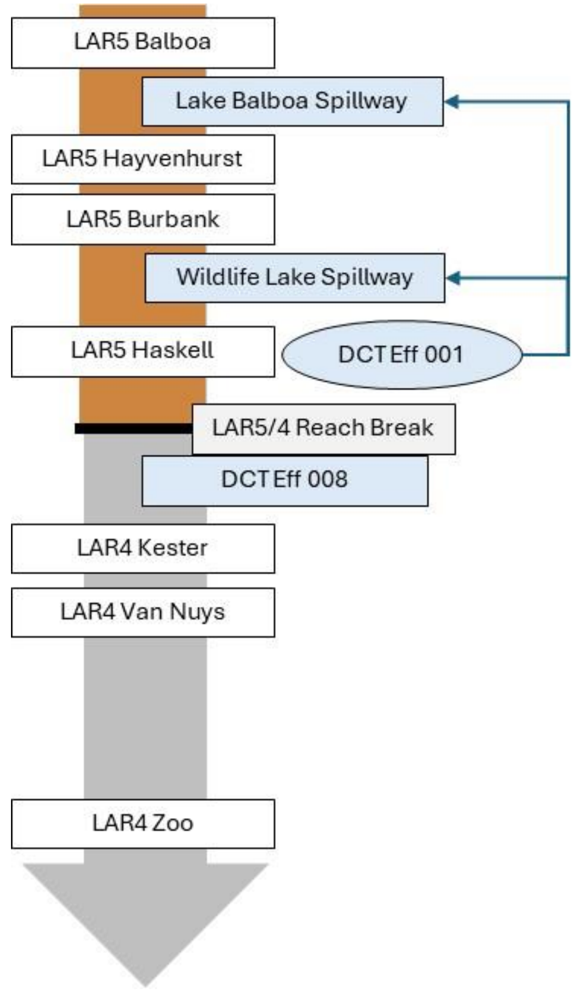
5.2 Temperature

As described in the Workplan (LWA 2024), this Study was implemented to better understand and characterize the relationship between effluent temperature and temperature impacts to the WARM beneficial use in the LA River downstream of the DCTWRP, LAGWRP, and BWRP discharges. It is therefore necessary to characterize both WRP effluent temperature and the receiving water temperatures bracketing WRP discharges so that the magnitude and spatial extent of any influence of thermal input from WRP effluent is definitively determined. This section summarizes the continuous WRP effluent temperature and receiving waterbody water temperature in the LA River mainstem and BWC where thermistors were deployed bracketing WRP outfalls discharging to the LA River and BWC. It is followed by analysis of the factors affecting water temperature using a modeling system developed for the study. The temperature modeling conducted (with and without the influence of thermal input from WRPs) allowed for the quantification of the magnitude and extent of differences and similarities receiving water temperatures measured at various locations within the Study area in relation to not only WRP discharges, but also against the widely fluctuating diel and seasonal atmospheric temperature changes that occur in the Study area, as well as the complex physical characteristics and channel features in the highly urbanized portion of the LA River system (e.g., substrate type, channel shape and width, canopy cover, etc.). The section ends with a summary of findings and key observations.

5.2.1 Continuous Temperature Monitoring Data

Summarized below is the continuous WRP effluent temperature and receiving waterbody water temperature in the LA River mainstem and BWC where thermistors were deployed. The section is organized on a WRP and reach by reach basis, beginning with stations immediately upstream of the DCTWRP's discharge (Reach 5) and progressing downstream in the LA River mainstem (Reach 4) to the confluence of the BWC (**Figure 3**). Next are stations beginning immediately above BWRP and progressing to the lower BWC just before its entry into the LA River (**Figure 4**). These are followed by the stations located at the beginning of LA River Reach 3 (just below the confluence with BWC) and bracketing the LAGWRP before progressing downstream to LA River Reach 2 (just below the confluence with Arroyo Seco) (**Figure 5**). As noted in **Section 4.1**, 3% of all potential data was not obtained as a result of missing thermistors or out-of-water readings, which appear as gaps on the graphs presented in the following subsections.

5.2.1.1 DCT and LA River Reaches 5 and 4



The DCTWRP *directly* discharges to LA River Reach 4 (LAR4) through discharge point DCT Eff 008 immediately downstream of the Sepulveda Dam. The DCTWRP *indirectly* discharges from discharge point DCT Eff 001 to LA River Reach 5 (LAR5) through Bull Creek and Hayvenhurst Channel via effluent discharged to Lake Balboa, and Haskell Flood Control Channel via effluent discharged to Wildlife Lake (**Figure 3**). The DCTWRP also discharges to the Japanese Gardens, which drains through outfall DCT Eff 008 to LAR4. Seven stations were located in LAR4 and LAR5, as well as one each in the spillways from Lake Balboa and Wildlife Lake, to evaluate thermal conditions upstream and downstream of the DCTWRP discharge (as depicted in the schematic diagram to the right – with brown and gray shading denoting unlined and concrete channel bottom, respectively). Note that Hayvenhurst Channel and Haskell Flood Control Channel are not named waterbodies in the Basin Plan and do not have assigned designated uses or associated water quality objectives.

5.2.1.1.1 DCT Effluent Temperature Profile and Metrics

Daily average, minimum and maximum effluent temperatures based on continuous measurements collected at two locations at the DCTWRP during the Study period are plotted along with maximum daily air temperature in **Figure 9** (DCT Eff 001, located within the WRP) and **Figure 10** (DCT Eff 008, located at the discharge to LA River Reach 4), as well as in the Lake Balboa (**Figure 11**) and Wildlife Lake (**Figure 12**) spillways. These are followed by figures depicting the paired average daily and maximum daily temperature differences between water temperature measured at the Lake Balboa Spillway and DCT Eff 001 (**Figure 13**), and between water temperature measured at the Wildlife Lake Spillway and DCT Eff 001 (**Figure 14**). **Table 11** provides various temperature metrics by month for effluent discharged from the two DCTWRP outfalls and effluent discharged indirectly from the Lake Balboa and Wildlife Lake spillways to LAR5. Temperature metrics are defined as:

- Maximum daily average temperature (MDAT): This value represents the highest average temperature from continuous measurements recorded over a 24-hour (1-day) period.
- Maximum daily maximum temperature (MDMT): This represents the highest maximum temperature recorded over a 24-hour (1-day) period.
- Maximum weekly average temperature (MWAT): This is the maximum average of average daily temperatures over any seven-day period.
- Maximum weekly maximum temperature (MWMT): This is the maximum average of maximum daily temperatures over any seven-day period; typically referred to as 7DADM.

Temperatures of effluent at DCT Eff 001 (**Figure 9**) and DCT Eff 008 (**Figure 10**) exceed 80°F beginning in June and remained above 80°F through October, with Maximum Daily Average Temperatures (MDATs) and Maximum Daily Maximum Temperatures (MDMTs) reaching 85.5 to 85.7°F and 85.1 to 86.9°F, respectively, and Maximum Weekly Average Temperatures (MWATs) and Maximum Weekly Average of Daily Maximum Temperatures (MWMT or, more typically referred to as 7DADM) reaching 85.1 to 85.5°F and 84.7 to 86.0°F (**Table 11**). There are nominal differences in temperature magnitude between the two locations, with a common trend of increasing effluent temperature from May through September before decreasing in October, which corresponds to increases and decreases in air temperatures.

Similarly, water temperatures in the Lake Balboa (**Figure 11**) and Wildlife Lake (**Figure 12**) spillways exceed 80°F in June through September, but average daily temperatures were slightly higher (by 0 to 2.4°F) in Lake Balboa Spillway compared to DCT Eff 001 from mid-June through July and again in early September (**Figure 13**). Water temperatures in Lake Balboa Spillway were also comparatively higher relative to Wildlife Lake Spillway. The highest MDAT and MDMT in Lake Balboa Spillway were 86.7°F and 91.9°F, and highest MWAT and 7DADM were 85.7 and 90.6°F (**Table 11**). The highest MDAT and MDMT in Wildlife Lake Spillway were 84.8 and 87.8°F, and highest MWAT and 7DADM were 84.1 and 86.8°F. Changes to water temperatures in the Lake Balboa spillway closely corresponded to changes in air temperature.

The water temperatures in both lakes were occasionally above the temperature measured at DCT Eff 001 in June and July, but the phenomenon occurs more frequently and for a longer period (into September) in Lake Balboa. Average daily water temperature in Lake Balboa varied between 4.0°F lower to 2.4°F greater compared to DCT Eff 001 temperature at any given time from May through mid-September, and between 0.1 to 9.8°F lower for the remainder of September through October (**Figure 13**). Average daily water temperature in Wildlife Lake varied between 6.8°F lower to 2.1°F greater compared to outfall DCT Eff 001 effluent temperature at any given time from May through mid-July, and between 0.1 to 14.5°F lower the remainder of July through October (**Figure 14**). Maximum daily water temperature in Lake Balboa, on the other hand, varied between 2.9°F lower to 6.5°F greater compared to DCT Eff 001 temperature at any given time from May through mid-September, and generally between 0.1 to 7°F lower for the remainder of September through October (**Figure 13**). Maximum daily water temperature in Wildlife Lake varied between 5.6°F lower to 4.0°F greater compared to outfall DCT Eff 001 effluent temperature at any given time from May through mid-July, and generally between 0.1 to 11.6°F lower for the remainder of July through October (**Figure 14**).

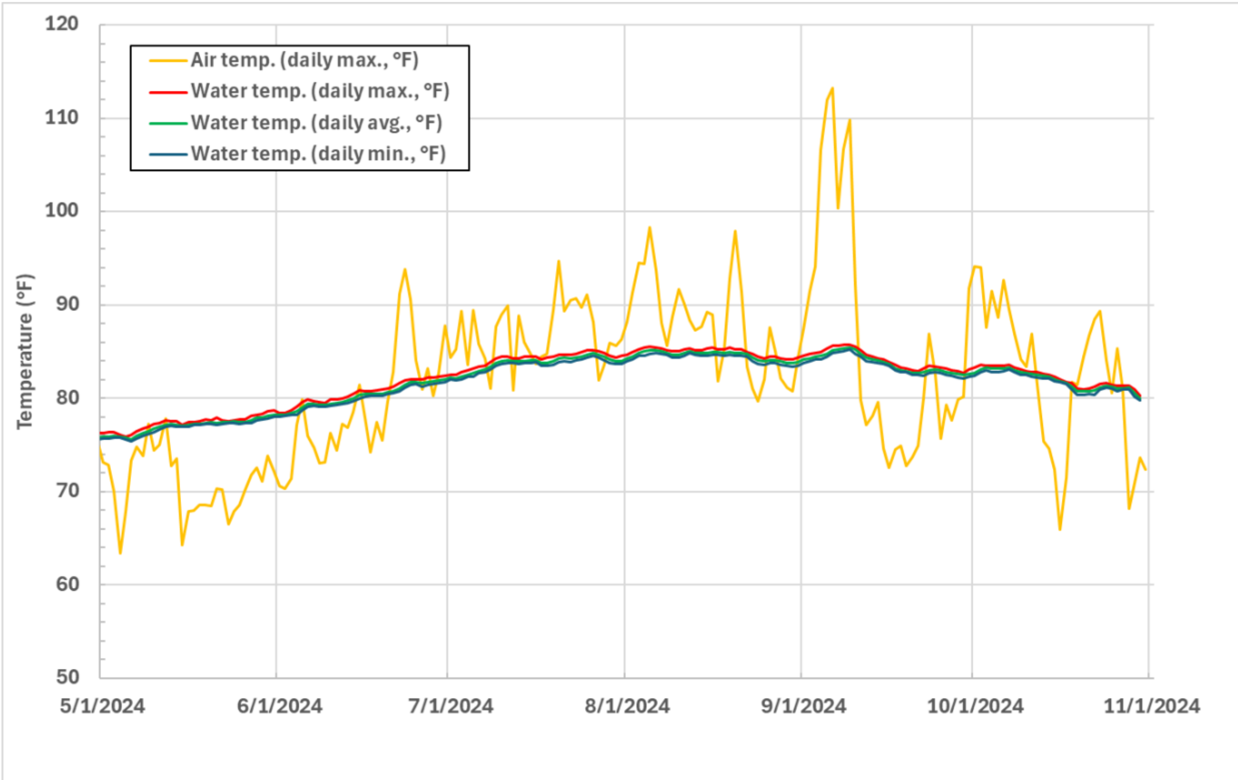


Figure 9. Continuous Temperature at DCT 001 Eff

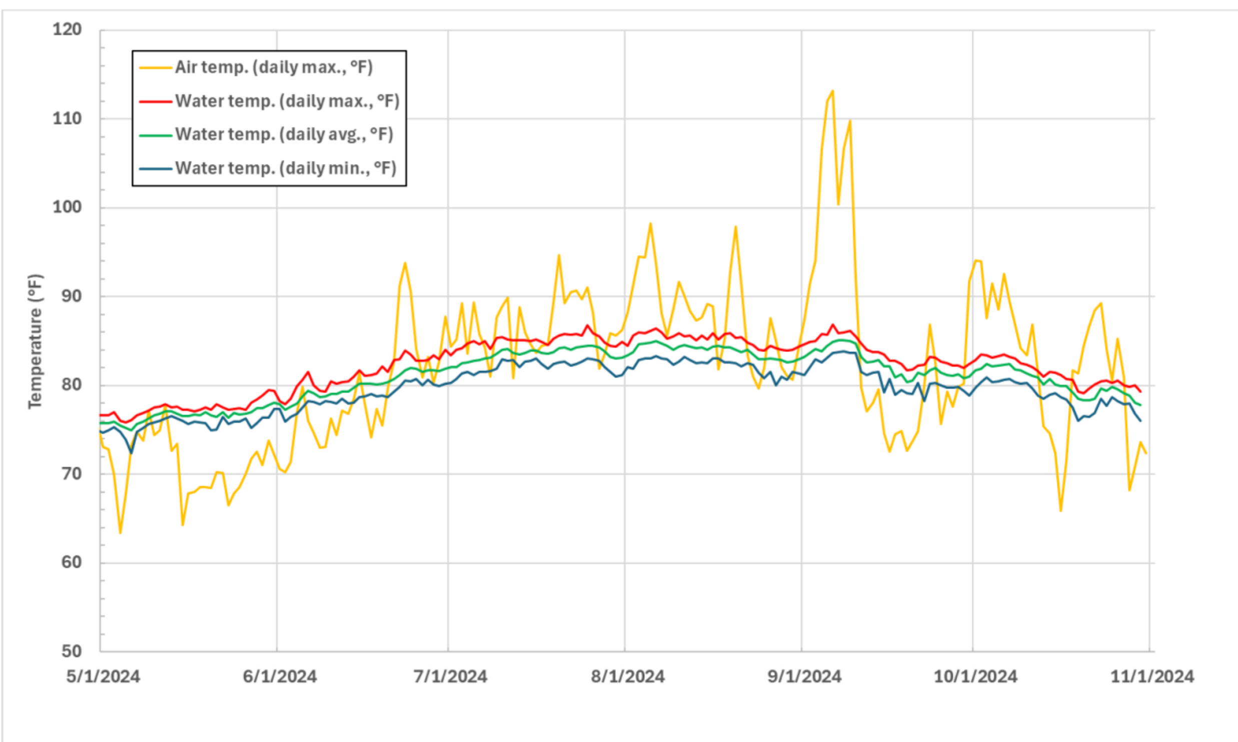


Figure 10. Continuous Temperature at DCT 008 Eff

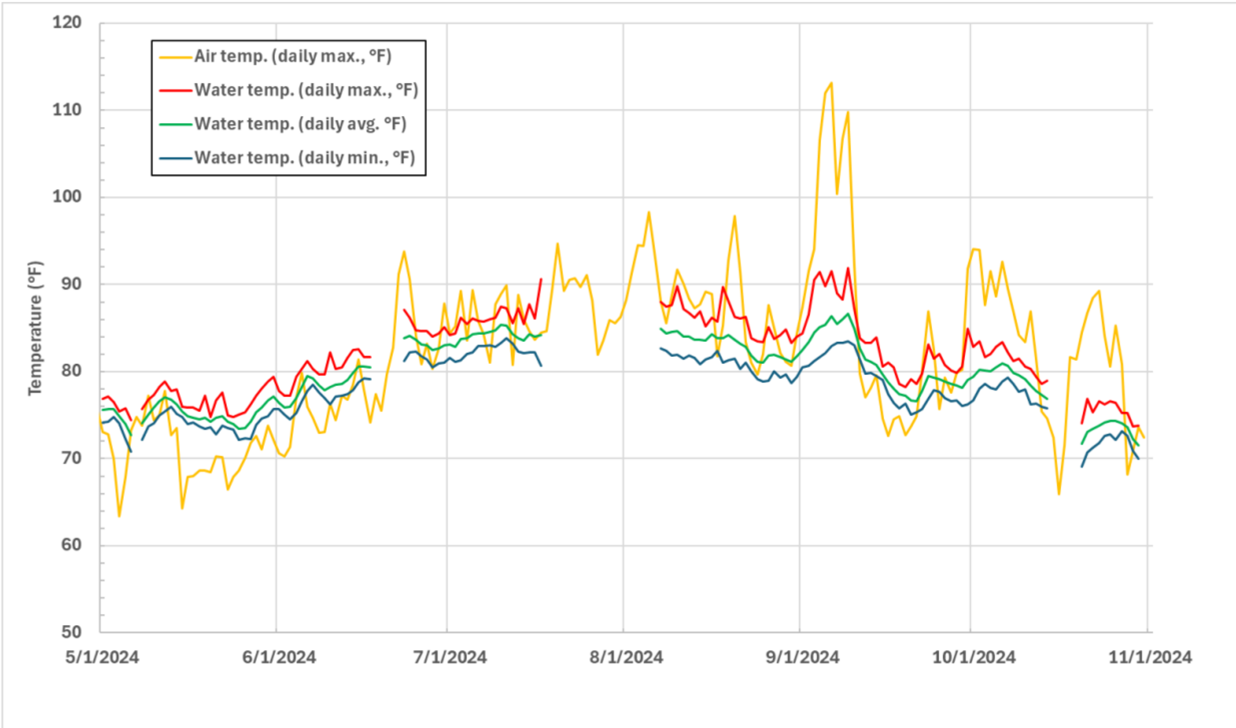


Figure 11. Continuous Temperature Measured in Lake Balboa Spillway

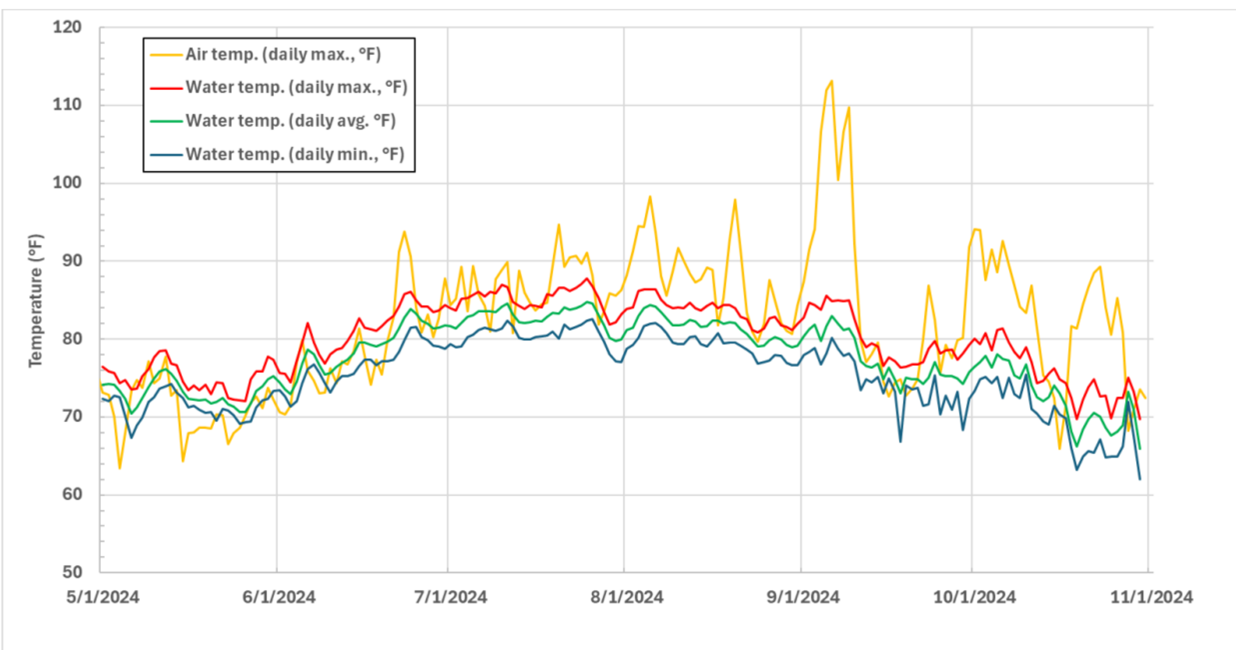


Figure 12. Continuous Temperature Measured in Wildlife Lake Spillway

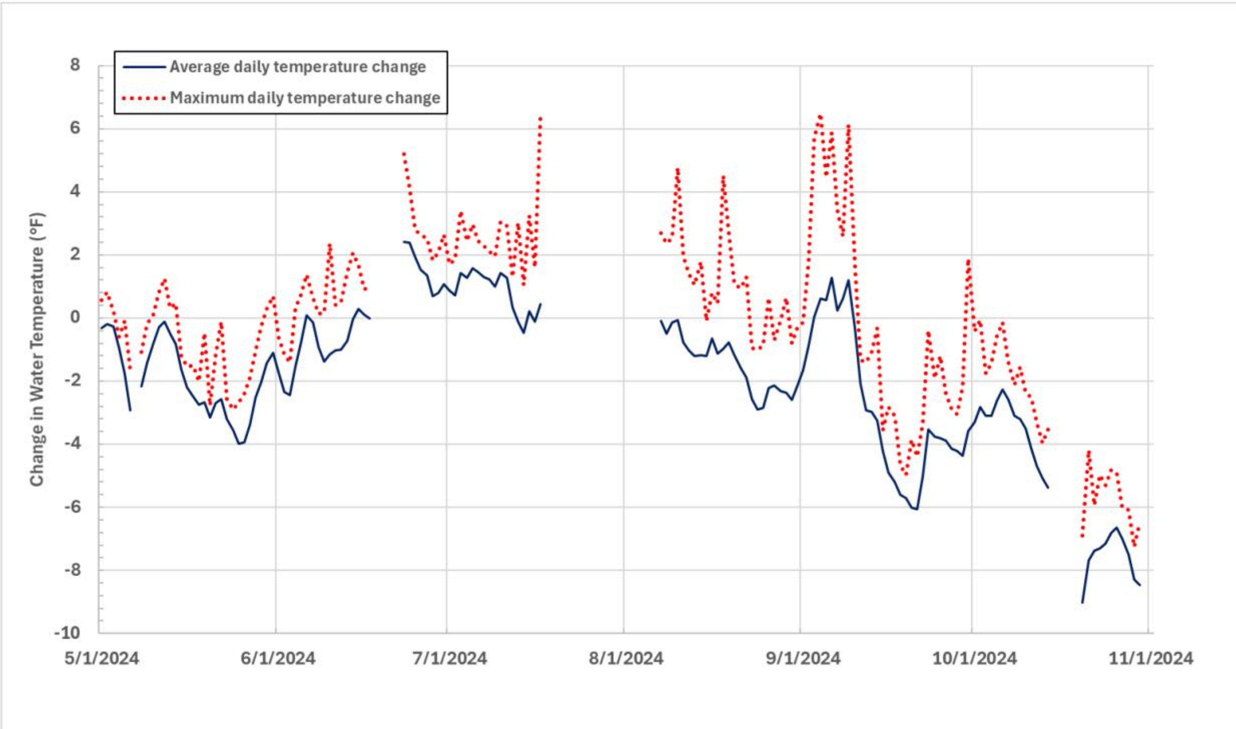


Figure 13. Temperature Difference Between Lake Balboa Spillway and DCT Eff 001

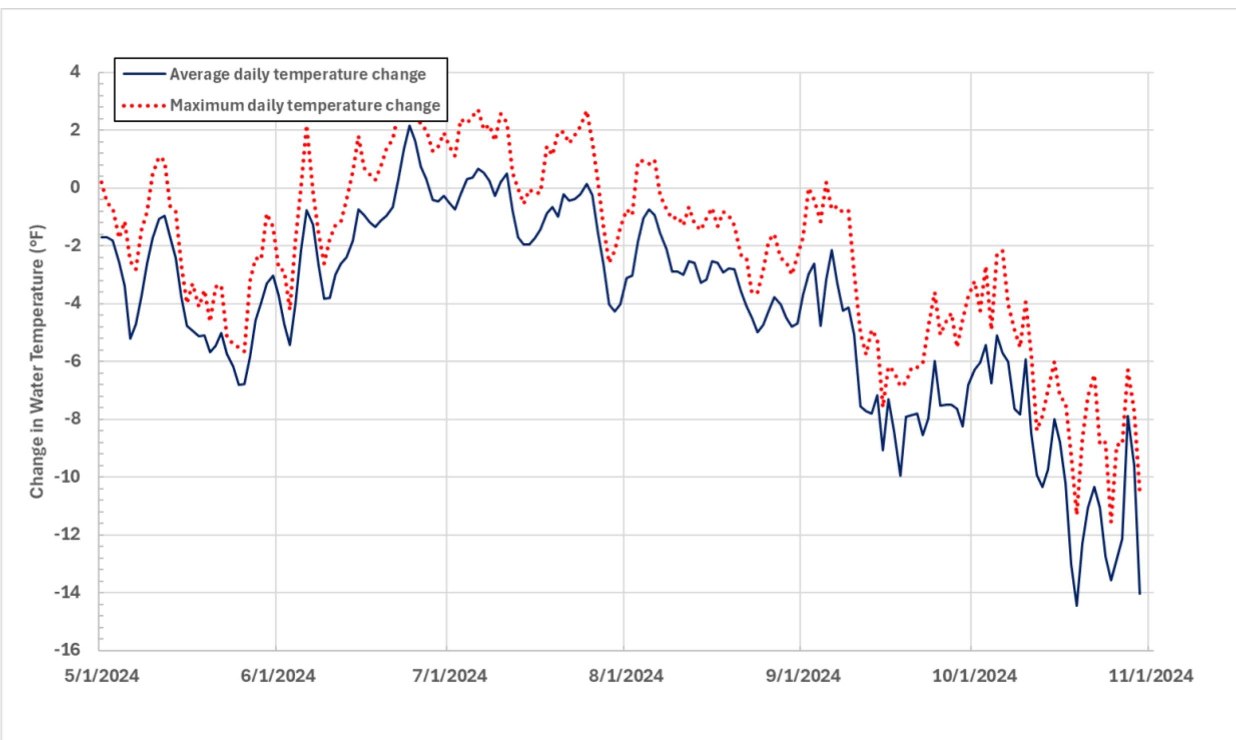


Figure 14. Temperature Difference Between Wildlife Lake Spillway and DCT Eff 001

Table 11. Summary of Temperature Metrics for DCTWRP Effluent and Lakes

Outfall/ Discharge	Month	Number of days	Avg. daily water temp for month (°F)	Avg. daily max water temp (°F)	Max. daily avg. temp (MDAT, °F)	Max. daily max temp (MDMT, °F)	Max. 7-d daily water temp (MWAT, °F)	Max. 7-d daily max water temp (7DADM, °F)
DCT Eff 001	5/2024	31	77.0	77.3	78.2	78.7	78.1	78.5
	6/2024	30	80.2	80.6	82.0	82.4	82.0	82.4
	7/2024	31	83.8	84.2	84.8	85.2	84.5	84.9
	8/2024	31	84.6	85.0	85.2	85.6	85.0	85.3
	9/2024	30	83.8	84.1	85.5	85.7	85.1	85.5
	10/2024	31	81.8	82.1	83.3	83.6	83.2	83.5
DCT Eff 008	5/2024	31	76.6	77.4	78.1	79.5	77.6	78.7
	6/2024	30	80.0	81.3	82.0	84.0	81.9	83.6
	7/2024	31	83.6	85.1	84.5	86.8	84.3	85.9
	8/2024	31	83.9	85.2	85.0	86.4	84.6	85.9
	9/2024	30	82.6	83.8	85.1	86.9	84.7	86.0
	10/2024	31	80.2	81.3	82.4	83.5	82.2	83.3
Lake Balboa Spillway	5/2024	31	75.0	76.6	77.1	79.4	76.2	78.0
	6/2024	30	80.2	82.1	84.1	87.1	83.3	85.4
	7/2024	17	84.2	86.3	85.4	90.6	84.7	90.6
	8/2024	25	83.1	86.0	84.9	89.9	84.9	88.2
	9/2024	30	81.0	83.8	86.7	91.9	85.7	90.4
	10/2024	28	76.3	78.2	80.9	83.5	80.4	83.0
Wildlife Lake Spillway	5/2024	31	73.1	75.0	76.2	78.6	74.9	77.1
	6/2024	30	78.8	81.0	83.9	86.1	82.5	84.7
	7/2024	31	82.8	85.2	84.8	87.8	84.1	86.8
	8/2024	31	81.5	83.7	84.4	86.4	83.4	85.5
	9/2024	30	77.4	80.2	83.0	85.6	81.5	84.8
	10/2024	31	72.3	75.3	78.1	81.3	77.2	80.1

5.2.1.1.2 Receiving Waterbody Temperature in Stations Bracketing DCT Effluent Discharges

The following subsection presents the continuous receiving water temperatures measured starting at the upstream end of LA River Reach 5 (LAR5) and progressing past the various direct and indirect discharges of effluent from DCTWRP through Sepulveda Dam before continuing downstream to the bottom of LA River Reach 4 (LAR4) just before the confluence with the BWC (**Figure 3**). The placement of the temperature monitoring stations was designed specifically to evaluate thermal conditions upstream and downstream of the DCTWRP discharge and the primary factors affecting thermal conditions.

Figure 15 and **Figure 16** depict the continuous receiving water and air temperatures for the two stations (LAR5 Balboa and LAR5 Hayvenhurst) bracketing the indirect DCTWRP discharges of Bull Creek and Lake Balboa. **Figure 17** displays the temperature change between the downstream (LAR5 Hayvenhurst) and upstream (LAR5 Balboa) stations.

At the upstream LAR5 Balboa station, which is not influenced by any WRP discharge, MDMT exceeds 80°F beginning in May and remains above 80°F until mid-September (**Figure 15**), which corresponds to increases in air temperatures. MDAT and MWAT do not exceed 80°F until June and July, respectively, although 7DADM exceeds this threshold in June (**Table 12**). The findings are similar at LAR5 Hayvenhurst, which is influenced by indirect WRP discharges from Bull Creek and Lake Balboa, but where the 80°F threshold is exceeded beginning in June for MDAT, MDMT, MWAT, and 7DADM and lasting, for MDMT, into the beginning of October (**Figure 16** and **Table 12**) , which again corresponds to increases in air temperatures. The highest MDAT and MDMT upstream at LAR5 Balboa are 82.3°F and 86.1°F, and highest MWAT and 7DADM are 81.5 and 84.7°F (**Table 12**). The highest MDAT and MDMT at LAR5 Hayvenhurst are 83.6°F and 88.5°F, respectively, and highest MWAT and 7DADM are 82.9 and 86.0°F.

Average daily stream temperature at LAR5 Hayvenhurst varies between 0.1°F to 4.5°F greater than at the upstream LAR5 Balboa station at any given time from May through September and between 0.1°F to 6.7°F greater in October (**Figure 17**). In contrast, maximum daily stream temperature at LAR5 Hayvenhurst varies between 6.2°F lower to 2.0°F greater than at the upstream LAR5 Balboa station at any given time from May through June, and generally between 0.1°F to as much as 7.5°F greater July through October (**Figure 17**).

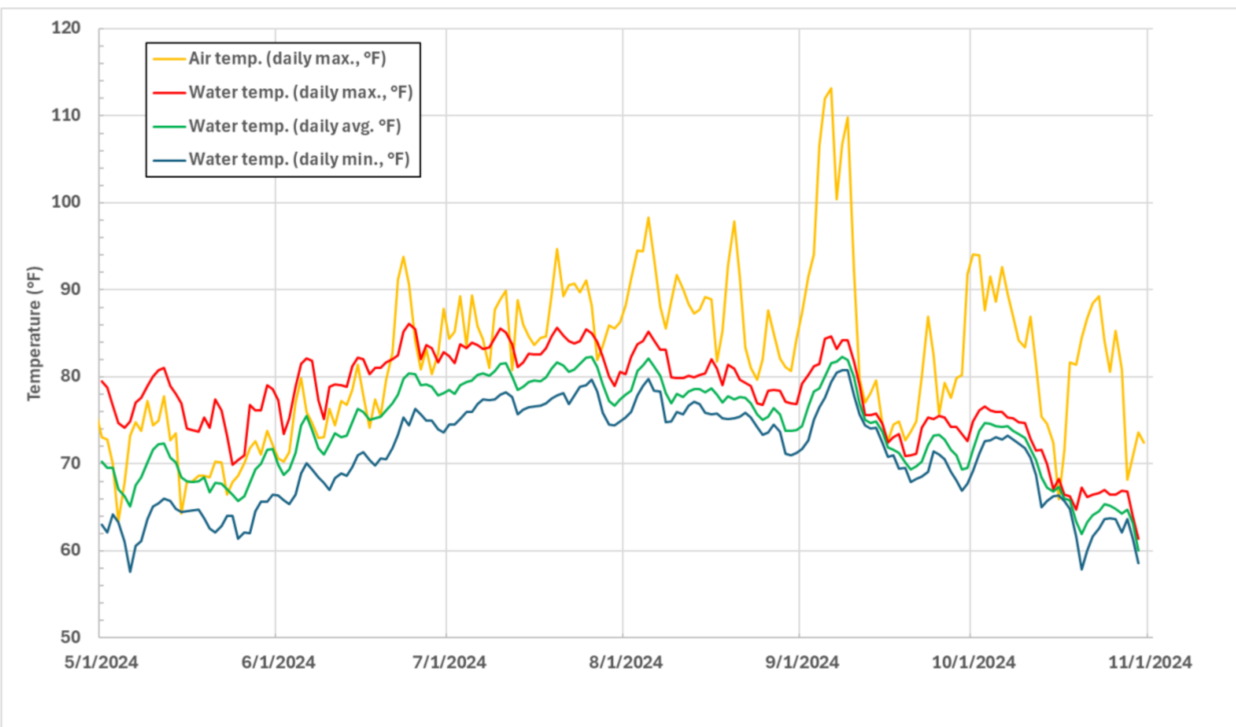


Figure 15. Continuous Temperature Measured at LAR5 Balboa Station in LAR Reach 5

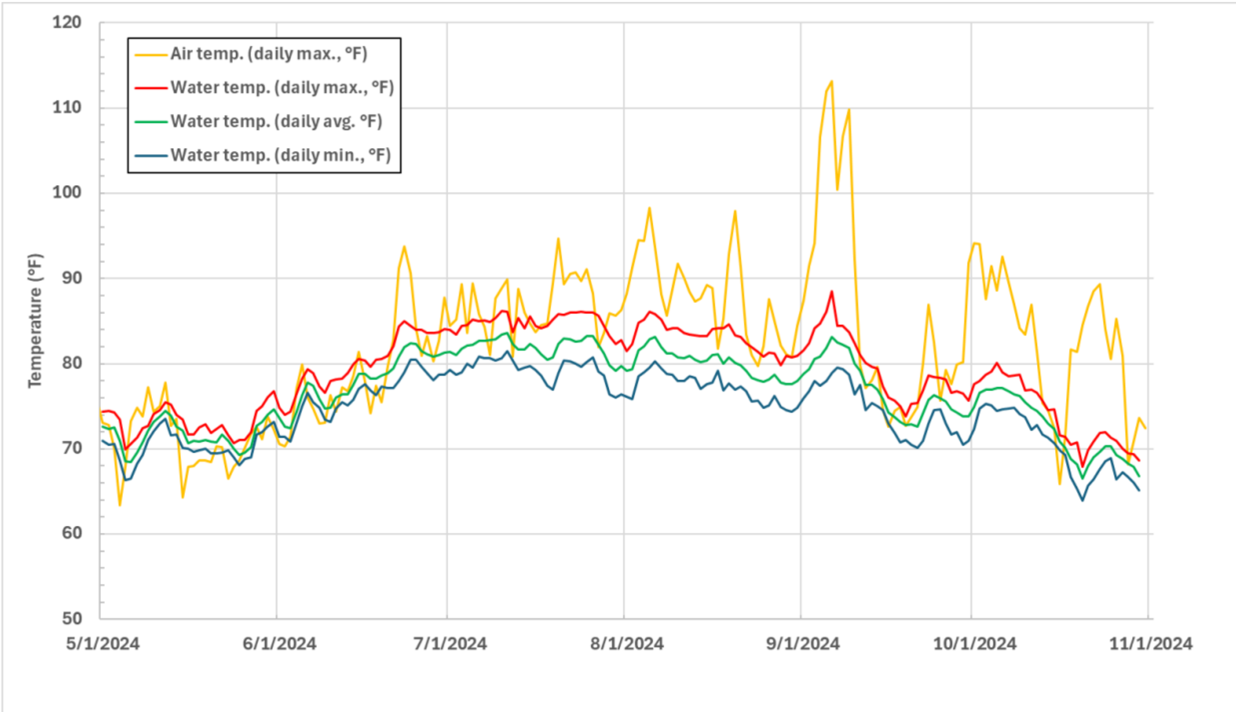


Figure 16. Continuous Temperature Measured at LAR5 Hayvenhurst Station in LAR Reach 5

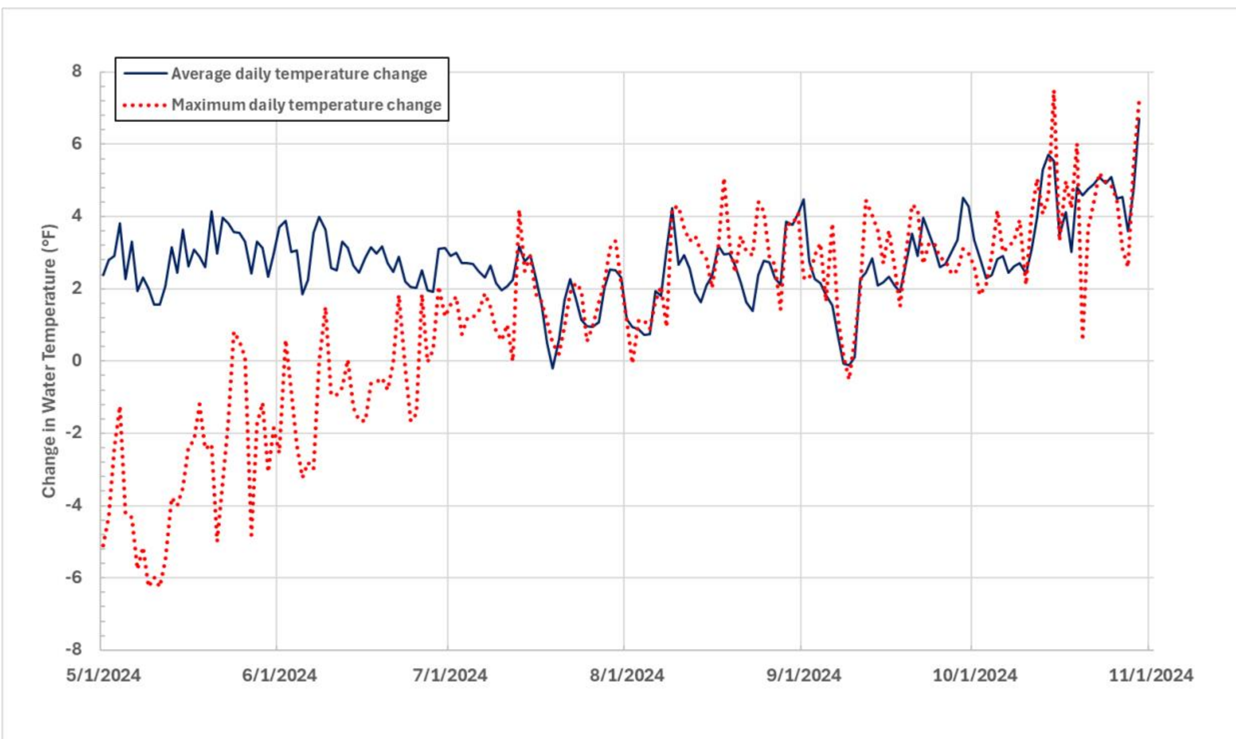


Figure 17. Temperature Difference Between LAR5 Hayvenhurst and LAR5 Balboa Stations

Table 12. Summary of Temperature Metrics at LAR5 Balboa and LAR5 Hayvenhurst Stations in LAR Reach 5

Temperature Monitoring Station	Month	Number of days	Avg. daily water temp for month (°F)	Avg. daily max water temp (°F)	Max. daily avg. temp (MDAT, °F)	Max. daily max temp (MDMT, °F)	Max. 7-d daily water temp (MWAT, °F)	Max. 7-d daily max water temp (7DADM, °F)
LAR5 Balboa	5/2024	31	68.7	76.3	72.4	81.0	70.8	79.4
	6/2024	30	75.2	80.8	80.4	86.1	79.3	84.0
	7/2024	31	79.9	83.3	82.3	85.6	81.5	84.7
	8/2024	31	77.7	80.3	82.2	85.2	80.3	83.7
	9/2024	30	74.6	76.9	82.3	84.7	80.9	83.4
	10/2024	31	67.9	69.7	74.7	76.6	74.3	75.9
LAR5 Hayvenhurst	5/2024	31	71.6	73.1	74.7	76.7	73.3	75.1
	6/2024	30	78.0	80.2	82.4	85.0	81.6	84.1
	7/2024	31	82.0	84.9	83.6	86.2	82.9	86.0
	8/2024	31	80.0	83.1	83.1	86.1	82.0	85.1
	9/2024	30	77.1	79.6	83.2	88.5	81.9	85.1
	10/2024	31	72.0	73.7	77.2	80.1	76.9	79.0

Figure 18 depicts the continuous receiving water and air temperatures for the LAR5 Burbank station, downstream of LAR5 Hayvenhurst. **Figure 19** depicts the temperature change between the two stations. As at LAR5 Hayvenhurst and further upstream at LAR5 Balboa, all four temperature metrics (MDAT, MDMT, MWAT, 7DADM) exceed 80°F June through mid-September at LAR5 Burbank (**Figure 18** and **Table 13**), which corresponds to increases in air temperatures. The highest MDAT and MDMT at LAR5 Burbank are 83.8°F and 87.1°F, and highest MWAT and 7DADM are 83.3 and 86.8°F, similar to LAR5 Hayvenhurst. Minimal difference exists in average daily stream temperature at LAR5 Burbank compared to LAR5 Hayvenhurst from May through June. A slightly larger difference of between 0.5°F lower to 1.3°F higher temperature difference (a mostly positive increase) from July through August, and similar difference of between 0.6°F greater to 1.5°F lower temperature (a mostly negative decrease) in September and October, indicate only a minimal effect of flows from Bull Creek and Lake Balboa over summer (June through September) on receiving water temperature at this location (**Figure 19**).

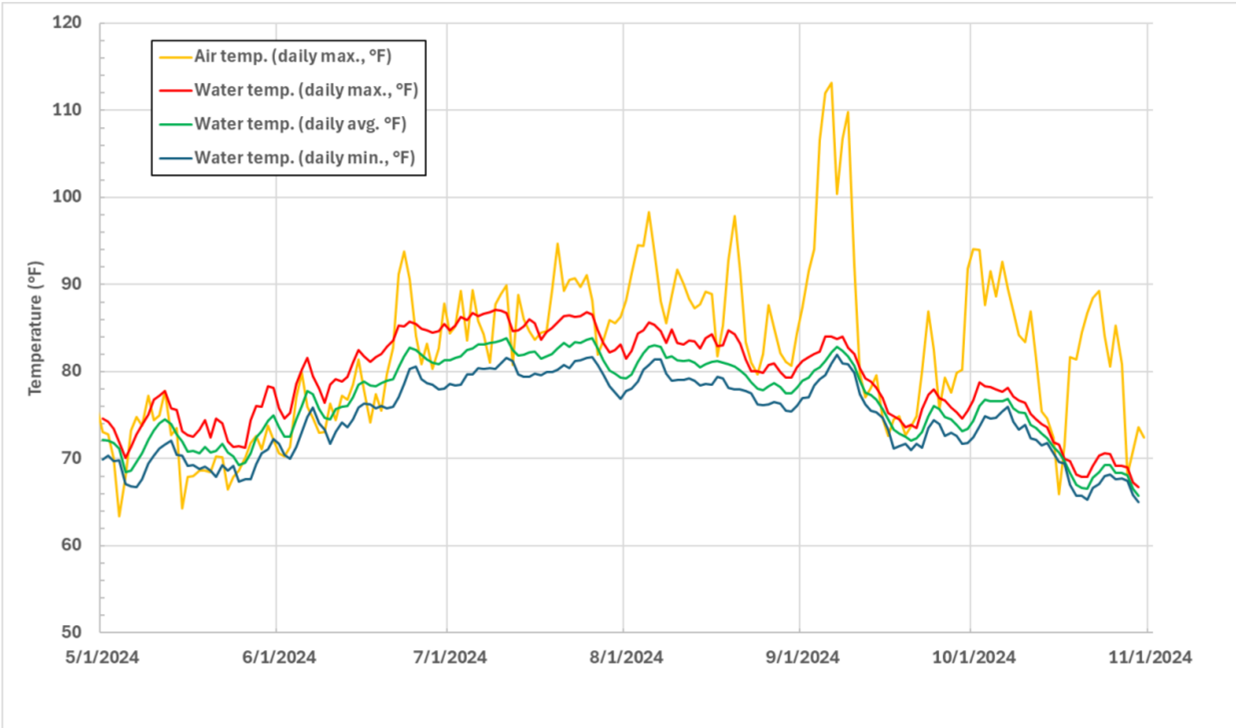


Figure 18. Continuous Temperature Measured at the LAR5 Burbank Station in LAR Reach 5

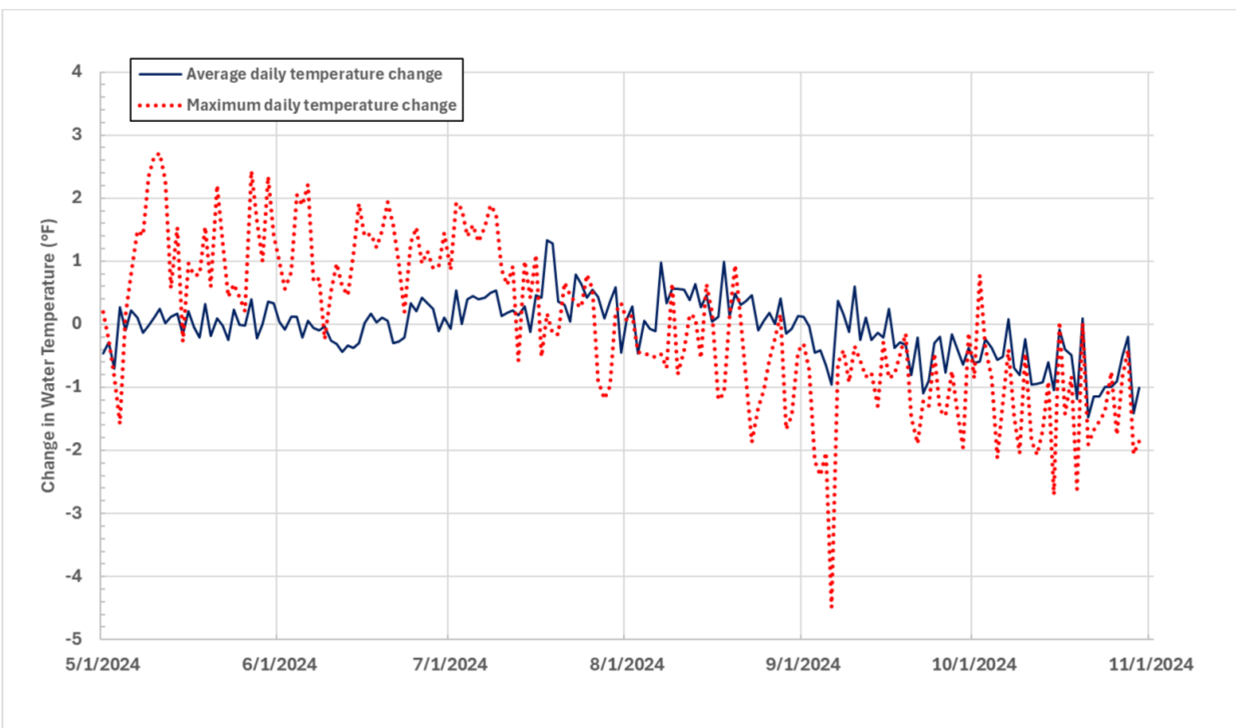


Figure 19. Temperature Difference Between LAR5 Burbank and LAR5 Hayvenhurst Stations

Table 13. Summary of Temperature Metrics at LAR5 Burbank Station in LAR Reach 5

Temperature Monitoring Station	Month	Number of days	Avg. daily water temp for month (°F)	Avg. daily max water temp (°F)	Max. daily avg. temp (MDAT, °F)	Max. daily max temp (MDMT, °F)	Max. 7-d daily water temp (MWAT, °F)	Max. 7-d daily max water temp (7DADM, °F)
LAR5 Burbank	5/2024	31	71.6	74.1	75.0	78.4	73.4	76.3
	6/2024	30	78.0	81.3	82.8	85.8	81.8	85.1
	7/2024	31	82.3	85.5	83.8	87.1	83.3	86.8
	8/2024	31	80.3	82.6	83.0	85.6	82.2	84.7
	9/2024	30	76.8	78.4	82.9	84.0	81.6	83.3
	10/2024	31	71.3	72.5	76.9	78.8	76.5	78.0

Figure 20 depicts the continuous receiving water and air temperatures for the LAR5 Haskell station, which is the furthest downstream station in LAR5. **Figure 21** displays the temperature change between LAR5 Haskell the LAR5 Burbank stations. Note that discharge from Wildlife Lake enters the LA River between these two stations. As with the other stations upstream, all four temperature metrics (MDAT, MDMT, MWAT, 7DADM) exceed 80°F from June through September (**Figure 20** and **Table 14**), which corresponds to increases in air temperatures. The highest MDAT and MDMT at LAR5 Haskell are 83.3°F and 88.7°F, and highest MWAT and 7DADM are 82.3 and 86.1°F, generally lower than at the LAR5 Burbank station. Average daily stream temperature at LAR5 Haskell compared to the LAR5 Burbank station is between 0.9°F lower to 1.9°F higher in May, with predominantly negative differences (0.1 to 2.3°F lower) but occasional positive increases (0.1 to 1.5°F higher) from June through October (**Figure 21**). Maximum daily stream temperature at LAR5 Haskell compared to the LAR5 Burbank station, on the other hand, is between 1.3°F lower to 2.7°F higher in May, with predominantly negative differences (0.1 to 2.7°F lower) but occasional small positive increases (0.1 to 0.9°F higher) from June through Augst, followed by mostly positive increases (0.1 to 4.7°F higher) September through November (**Figure 21**). The overnight drop in ambient air temperature has an effect on the magnitude of temperature change when expressed on an average versus maximum daily basis, at this location and throughout the Study area.

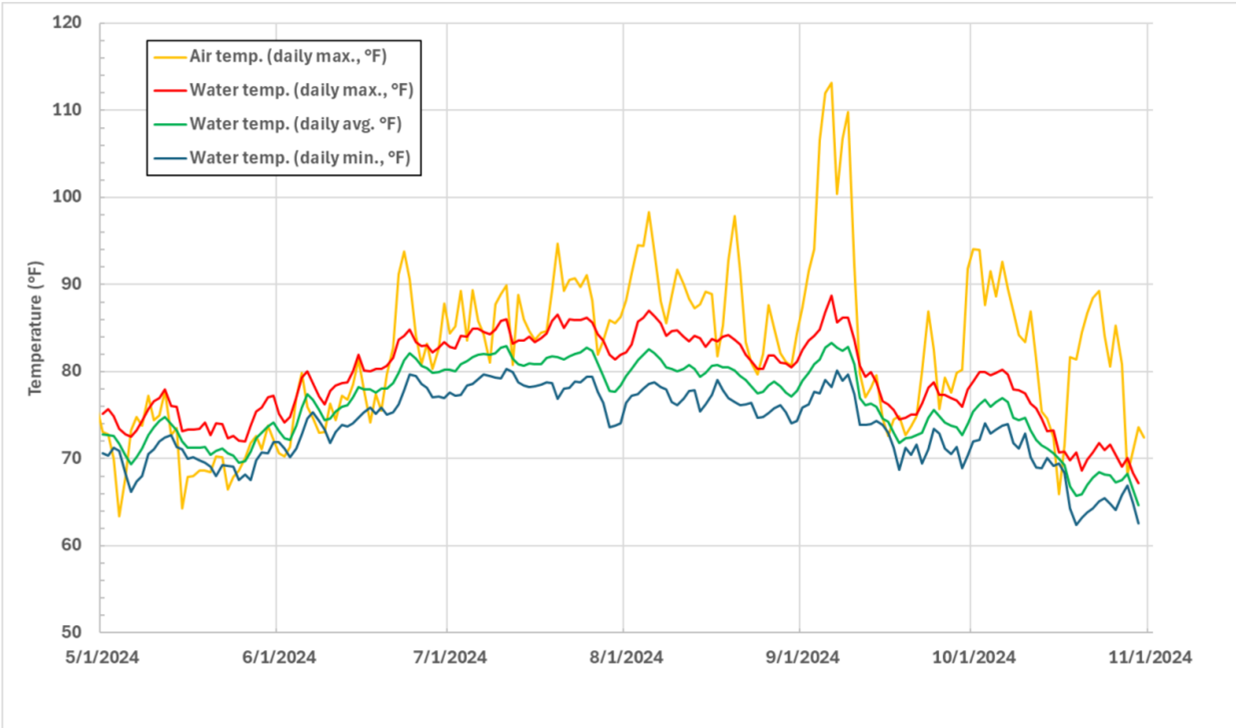


Figure 20. Continuous Temperature Measured at the LAR5 Haskell Station in LAR Reach 5

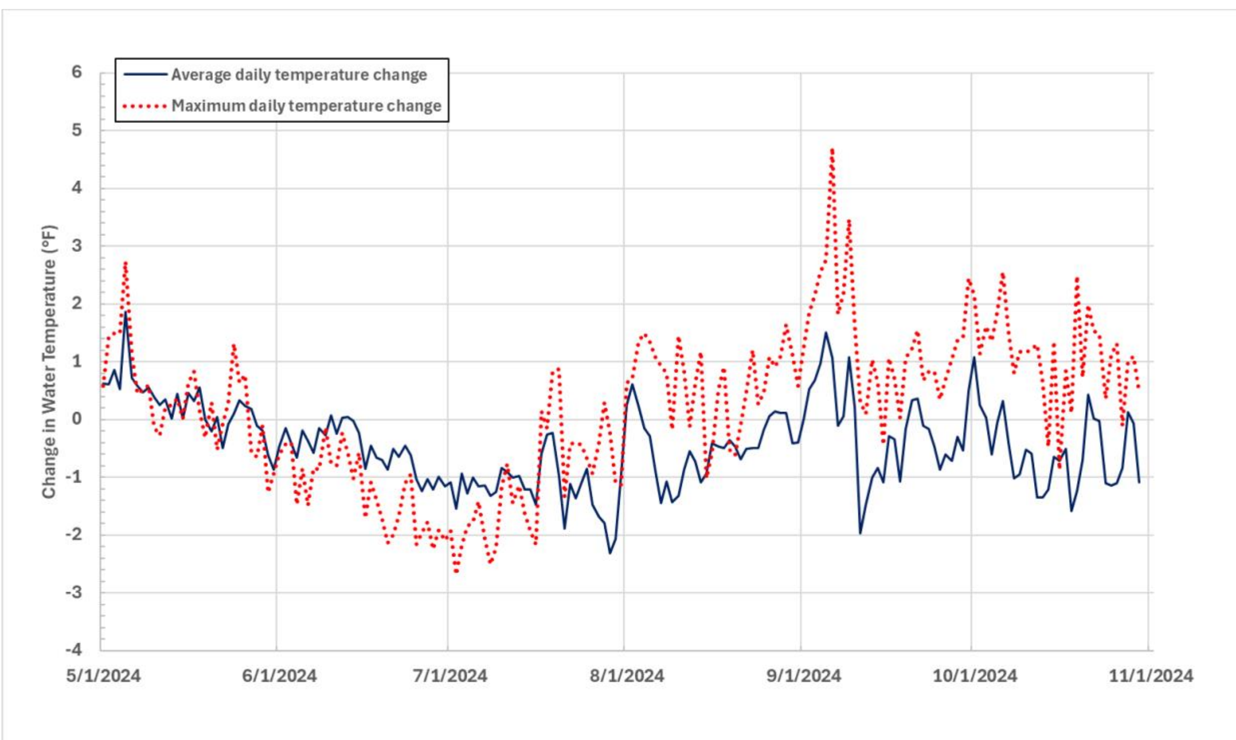


Figure 21. Temperature Difference Between LAR5 Haskell and LAR5 Burbank Stations

Table 14. Summary of Temperature Metrics at LAR5 Haskell Station in LAR Reach 5

Temperature Monitoring Station	Month	Number of days	Avg. daily water temp for month (°F)	Avg. daily max water temp (°F)	Max. daily avg. temp (MDAT, °F)	Max. daily max temp (MDMT, °F)	Max. 7-d daily water temp (MWAT, °F)	Max. 7-d daily max water temp (7DADM, °F)
LAR5 Haskell	5/2024	31	71.9	74.5	74.8	78.0	73.5	76.2
	6/2024	30	77.4	80.1	82.1	84.8	80.8	83.4
	7/2024	31	81.1	84.4	82.9	86.5	82.2	85.9
	8/2024	31	79.8	83.3	82.6	87.0	81.5	85.7
	9/2024	30	76.6	79.8	83.3	88.7	82.3	86.1
	10/2024	31	70.7	73.5	77.0	80.3	76.3	79.7

Figure 22 depicts the continuous receiving water and air temperatures for the LAR4 Kester station that lies downstream of Sepulveda Dam and DCTWRP outfall DCT Eff 008 at the top of LAR Reach 4 (LAR4). **Figure 23** displays the temperature change between LAR4 Kester the LAR5 Haskell stations. One or more of the temperature metrics exceed 80°F at the LAR4 Kester station from May through October (**Figure 22** and **Table 15**), which corresponds to increases in air temperatures. The highest MDAT and MDMT at the Kester station are 85.7°F and 92.1°F and highest MWAT and 7DADM are 85.7 and 90.9°F, all higher than at LAR5 Haskell. This station is influenced by the temperature of the effluent from outfall DCT Eff 008, in addition to the station being located on concrete substrate with wide open channel and no shading. All of these factors contribute to the stream temperature profile at this station. Average daily stream temperature at LAR4 Kester varies between 0.4°F lower to 1.9°F greater than at LAR5 Haskell at any given time from May through mid-July, and generally between 0.1 to 5.3°F higher in September and October (**Figure 23**). Maximum daily stream temperature at LAR4 Kester varies between 1.2 and 3.9°F higher from May through mid-July and is generally between 2.5°F and up to 8.5°F higher than at LAR5 Haskell at any given time from August through October (**Figure 23**).

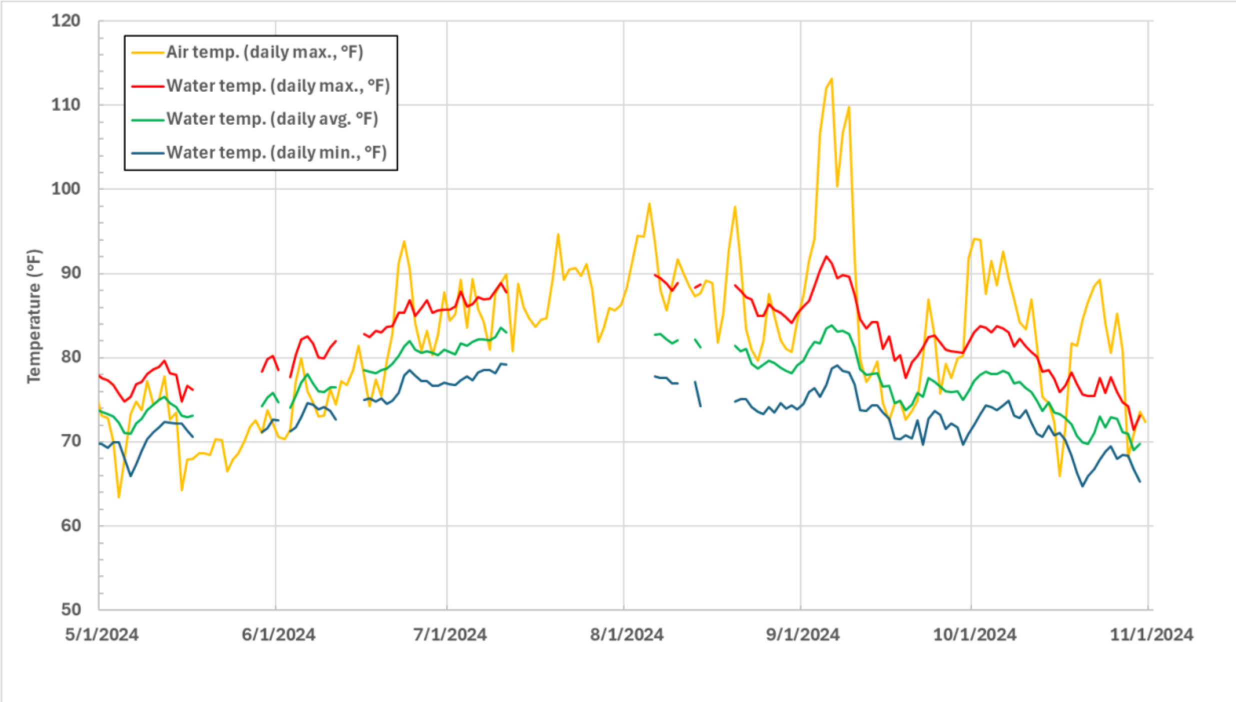


Figure 22. Continuous Temperature Measured at the LAR4 Kester Station in LAR Reach 4

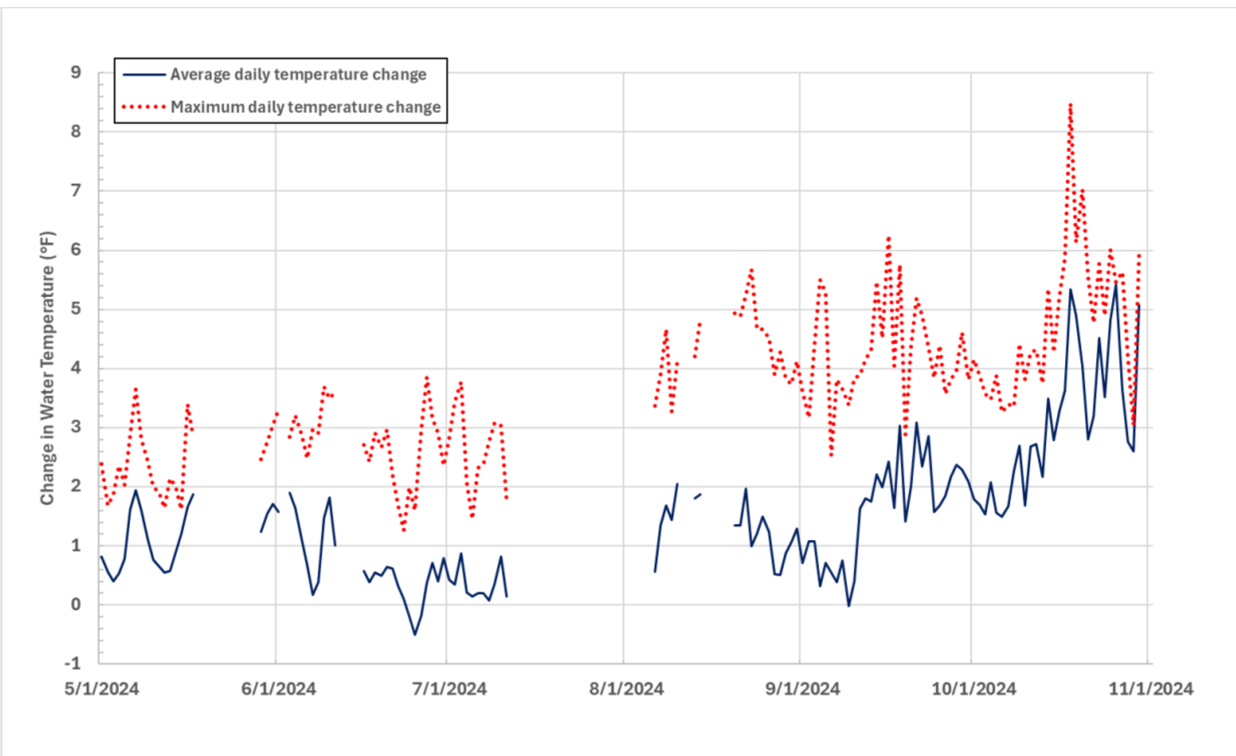


Figure 23. Temperature Difference Between LAR4 Kester and LAR5 Haskell Stations

Table 15. Summary of Temperature Metrics at LAR4 Kester Station in LAR Reach 4

Temperature Monitoring Station	Month	Number of days	Avg. daily water temp for month (°F)	Avg. daily max water temp (°F)	Max. daily avg. temp (MDAT, °F)	Max. daily max temp (MDMT, °F)	Max. 7-d daily water temp (MWAT, °F)	Max. 7-d daily max water temp (7DADM, °F)
LAR4 Kester	5/2024	24	73.7	77.4	76.4	80.3	75.1	79.1
	6/2024	29	78.1	82.2	81.9	86.9	80.9	86.2
	7/2024	15	81.7	86.5	83.6	88.9	82.5	87.5
	8/2024	27	81.1	87.5	85.7	91.9	85.7	90.9
	9/2024	30	78.2	84.1	83.8	92.1	82.9	90.2
	10/2024	31	73.8	78.3	78.5	83.8	78.0	83.4

Figure 24 depicts the continuous receiving water and air temperatures for the LAR4 Van Nuys station, which is 700 meters downstream of the LAR4 Kester station. **Figure 25** displays the temperature difference between the two stations. Similar to the LAR4 Kester station, one or more temperature metrics exceed 80°F at the LAR4 Van Nuys station from May through October (**Figure 24** and **Table 16**), which corresponds to increases in air temperatures. The highest MDAT and MDMT at LAR4 Van Nuys are 82.4°F and 90.4°F, and highest MWAT and 7DADM are 81.4 and 88.9°F. Average daily stream temperature at LAR4 Van Nuys is always less than at LAR4 Kester from May through October, varying by anywhere from 0.7 to 4.6°F lower at LAR4 Van Nuys compared to LAR4 Kester over this time period (**Figure 25**). Maximum daily stream temperature at LAR4 Van Nuys, however, frequently exceeded that at LAR4 Kester by as much as 1.4 °F between mid-June through mid-July, corresponding with the increase in air temperature and maximum solar radiation, after which there was little difference between average and maximum daily temperature change from September through October (**Figure 25**).

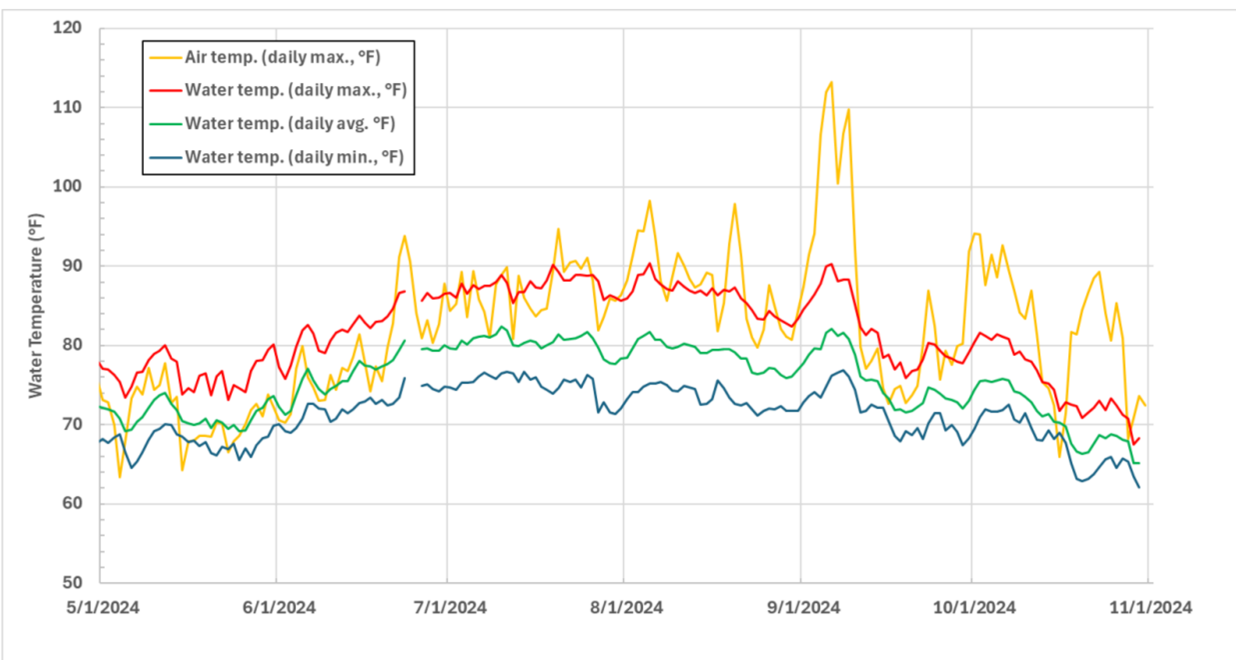


Figure 24. Continuous Temperature Measured at the LAR4 Van Nuys Station in LAR Reach 4

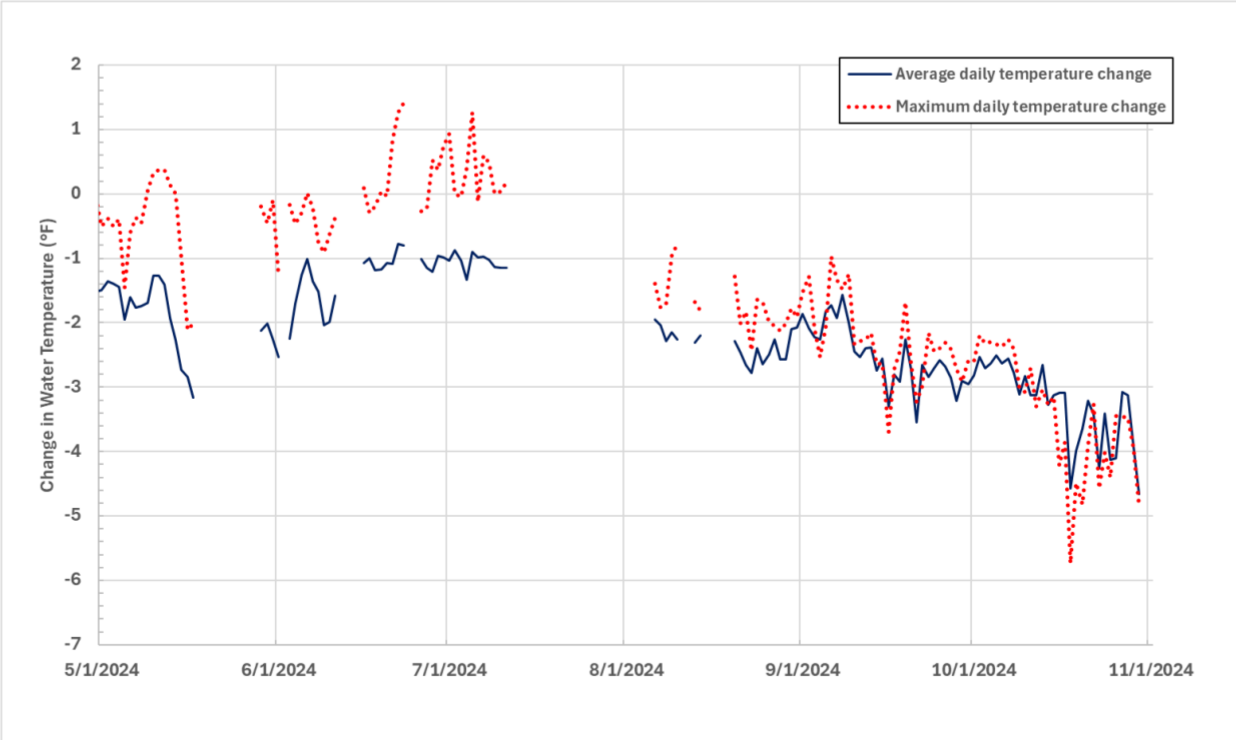


Figure 25. Temperature Difference Between LAR4 Van Nuys and LAR4 Kester Stations

Table 16. Summary of Temperature Metrics at LAR4 Van Nuys Station in LAR Reach 4

Temperature Monitoring Station	Month	Number of days	Avg. daily water temp for month (°F)	Avg. daily max water temp (°F)	Max. daily avg. temp (MDAT, °F)	Max. daily max temp (MDMT, °F)	Max. 7-d daily water temp (MWAT, °F)	Max. 7-d daily max water temp (7DADM, °F)
LAR4 Van Nuys	5/2024	31	71.1	76.5	74.0	80.2	72.6	78.5
	6/2024	30	76.8	82.7	80.6	86.8	79.7	86.5
	7/2024	31	80.4	87.6	82.4	90.2	81.4	88.9
	8/2024	31	78.8	86.1	81.7	90.4	80.7	88.3
	9/2024	30	75.7	81.8	82.1	90.3	80.9	88.5
	10/2024	31	70.5	74.9	75.8	81.6	75.4	81.0

Figure 26 depicts the continuous receiving water and air temperatures for the LAR4 Zoo station that lies far downstream of LAR4 Van Nuys. **Figure 27** displays the temperature difference between the two stations. Note that LAR4 Zoo station also lies below the confluence of Tujunga Wash with the LA River. Stream temperatures at the LAR4 Zoo station are elevated compared to the LAR4 Van Nuys station. Two of the four temperature metrics exceed 80°F May through October, but by much greater margins compared to LAR4 Van Nuys (**Figure 26** and **Table 17**). This corresponds with the increases in air temperatures in the area over that same time period. The change in average daily temperature between the LAR4 Zoo and LAR4 Van Nuys stations oscillates relatively narrowly from 0.1 to 2°F above and below zero. The change in maximum daily temperature, however, most commonly oscillates from 0.1 to 9.0°F greater at LAR4 Zoo compared to LAR4 Van Nuys from May through October, likely due to air temperatures, solar radiation and thermal addition from concrete heating (**Figure 27**).

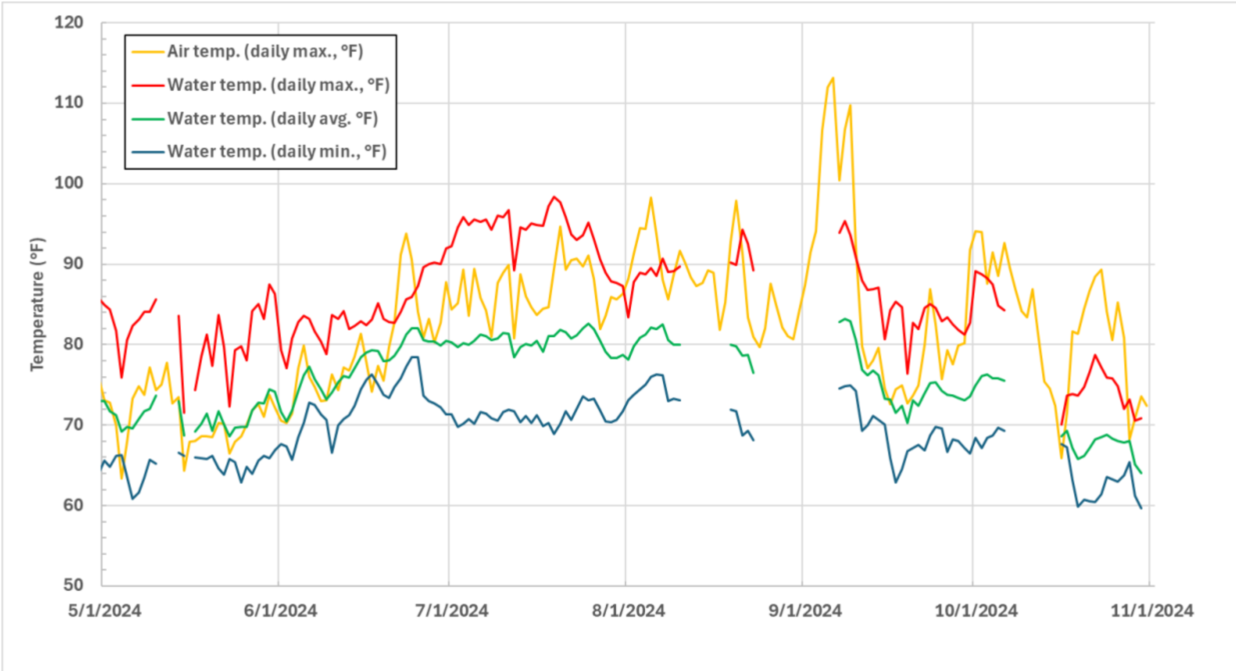


Figure 26. Continuous Temperature Measured at LAR4 Zoo Station in LAR Reach 4

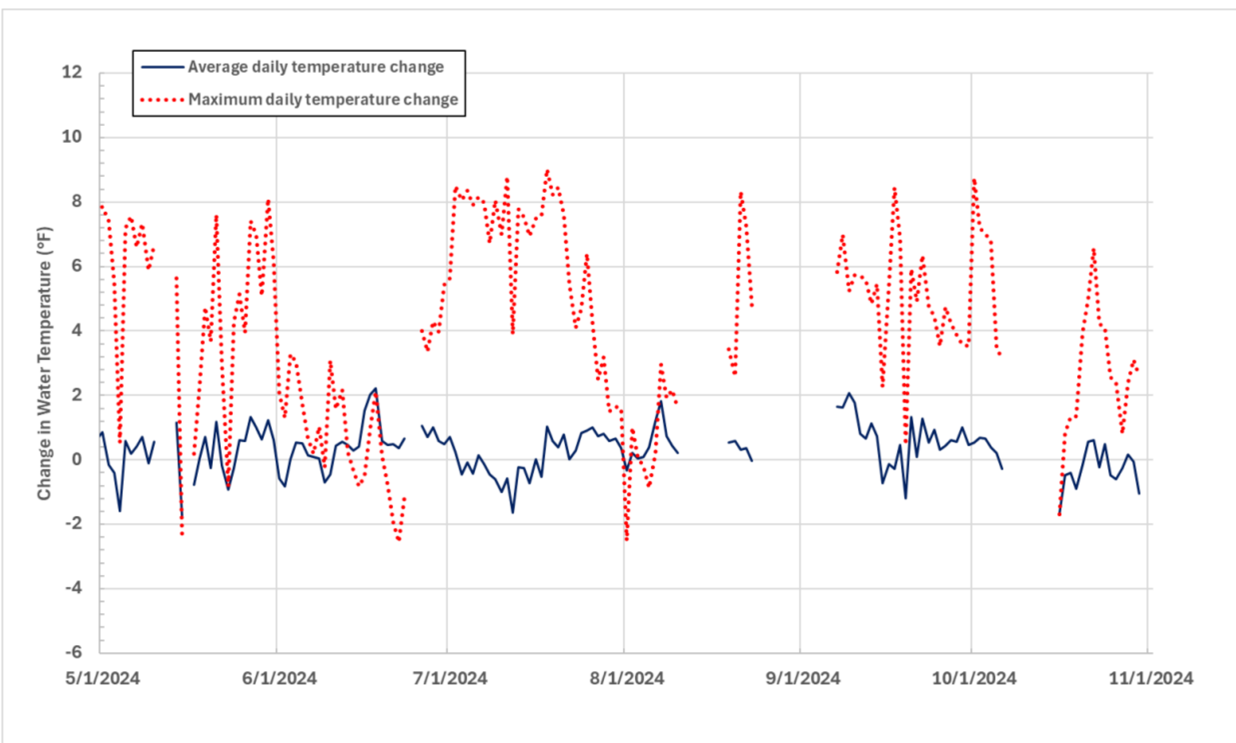


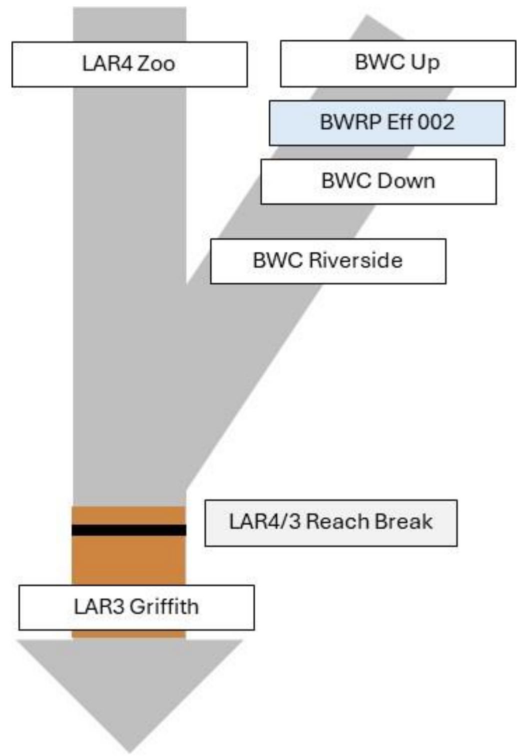
Figure 27. Temperature Difference Between LAR4 Zoo and LAR4 Van Nuys Stations

Table 17. Summary of Temperature Metrics at LAR4 Zoo Station in LAR Reach 4

Temperature Monitoring Station	Month	Number of days	Avg. daily water temp for month (°F)	Avg. daily max water temp (°F)	Max. daily avg. temp (MDAT, °F)	Max. daily max temp (MDMT, °F)	Max. 7-d daily water temp (MWAT, °F)	Max. 7-d daily max water temp (7DADM, °F)
LAR4 Zoo	5/2024	30	71.1	80.8	74.5	87.5	72.6	83.5
	6/2024	30	77.4	84.0	82.1	91.9	80.9	92.1
	7/2024	31	80.5	93.9	82.6	98.4	81.7	96.3
	8/2024	21	79.8	89.3	86.4	94.3	87.2	91.6
	9/2024	29	77.0	87.1	88.0	100.4	85.5	96.3
	10/2024	24	69.7	77.1	76.3	89.2	75.4	86.5

5.2.1.2 BWRP and BWC and LA River Reach 3 and 4

The BWRP directly discharges to the BWC through discharge point BWRP Eff 002. Three stations were located in the BWC to evaluate thermal conditions upstream and downstream of the BWRP discharge, as well as two stations in the LA River bracketing the confluence of the BWC and the LA River (**Figure 4**): LAR4 Zoo (upstream of the confluence) and LAR3 Griffith (downstream of the confluence) (as depicted in the schematic diagram to the right – with brown and gray shading denoting unlined and concrete channel bottom, respectively).



5.2.1.2.1 BWRP Effluent Temperature Profile and Metrics

Daily average, minimum, and maximum effluent temperatures based on continuous measurements collected at the BWRP outfall (BWRP Eff 002) during the Study period are plotted along with maximum daily air temperature in **Figure 28**. Temperature of effluent discharged from the BWRP exceeds 80°F beginning in June and remains above 80°F through October, with MDAT and MDMT reaching 84.7°F and 85.3°F and MWAT and 7DADM reaching 84.2 and 84.9°F (**Table 18**). As with the other WRP discharges evaluated in this Study, a trend of increasing effluent temperature occurs from May through early September before decreasing in the remainder of September and October, which corresponds to increases and decreases in air temperatures.

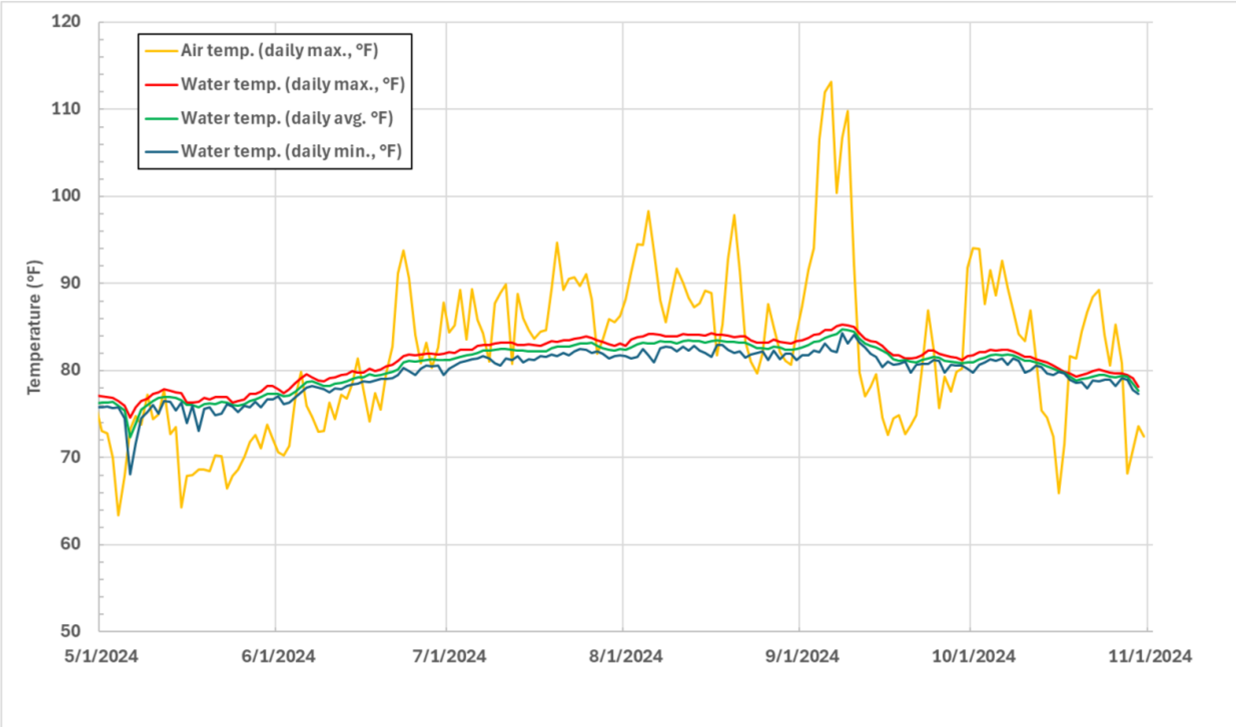


Figure 28. Continuous Temperature of BWRP Outfall Eff 002 Effluent

Table 18. Summary of Temperature Metrics in Effluent from the Outfall Associated with BWRP

Temperature Monitoring Station	Month	Number of days	Avg. daily water temp for month (°F)	Avg. daily max water temp (°F)	Max. daily avg. temp (MDAT, °F)	Max. daily max temp (MDMT, °F)	Max. 7-d daily water temp (MWAT, °F)	Max. 7-d daily max water temp (7DADM, °F)
BWRP Eff 002	5/2024	31	76.2	76.9	77.3	78.2	77.1	77.8
	6/2024	30	79.4	80.1	81.3	81.9	81.3	82.0
	7/2024	31	82.4	83.1	83.2	83.9	83.0	83.6
	8/2024	31	83.0	83.8	83.5	84.3	83.4	84.1
	9/2024	30	82.4	83.0	84.7	85.3	84.2	84.9
	10/2024	31	80.1	80.6	81.9	82.4	81.7	82.3

5.2.1.2.2 Receiving Waterbody Temperature in Stations Bracketing BWRP Effluent Discharge

Figure 29 and **Figure 30** depict the continuous receiving water and air temperatures for the two stations immediately upstream (Up) and downstream (Down) of the BWRP discharge. **Figure 31** depicts the temperature change between the two stations. MDMT at the BWC Up station, without any influence from WRP discharge, exceeds 80°F in July and August, while the 7DADM also exceeds 80°F in August (**Figure 29** and **Table 19**), which corresponds to increases in air temperatures. MDAT and MWAT were not observed exceeding 80°F at any time. The highest MDAT and MDMT at the BWC Up station were 75.4°F and 83.4°F, and highest MWAT and 7DADM are 74.1°F and 80.4°F. At the BWC Down station, the 80°F threshold was exceeded beginning in June for MDAT, MDMT, and 7DADM through October (**Figure 30** and **Table 19**). MWAT, however, only exceeded the 80°F threshold in August, September, and October, which corresponds to increases in air temperatures. The highest MDAT and MDMT at BWC Down were 83.9°F and 89.5°F, and highest MWAT and 7DADM were 82.4°F and 86.1°F (**Table 19**).

Average daily stream temperature immediately downstream of the BWRP discharge at BWC Down varied by 4.0°F to over 13.0°F greater than at the BWC Up station at any given time from May through September, and between 8.3 to 17.5°F in October (**Figure 31**). Maximum daily stream temperature immediately downstream of the BWRP discharge at BWC Down varied by slightly less than average daily temperature from 2.7 to 13.0°F from May through September, and between 5.4 to 14.9°F in October (**Figure 31**). This suggests an equally strong influence of diel air temperature swing on both average and maximum daily water temperature.

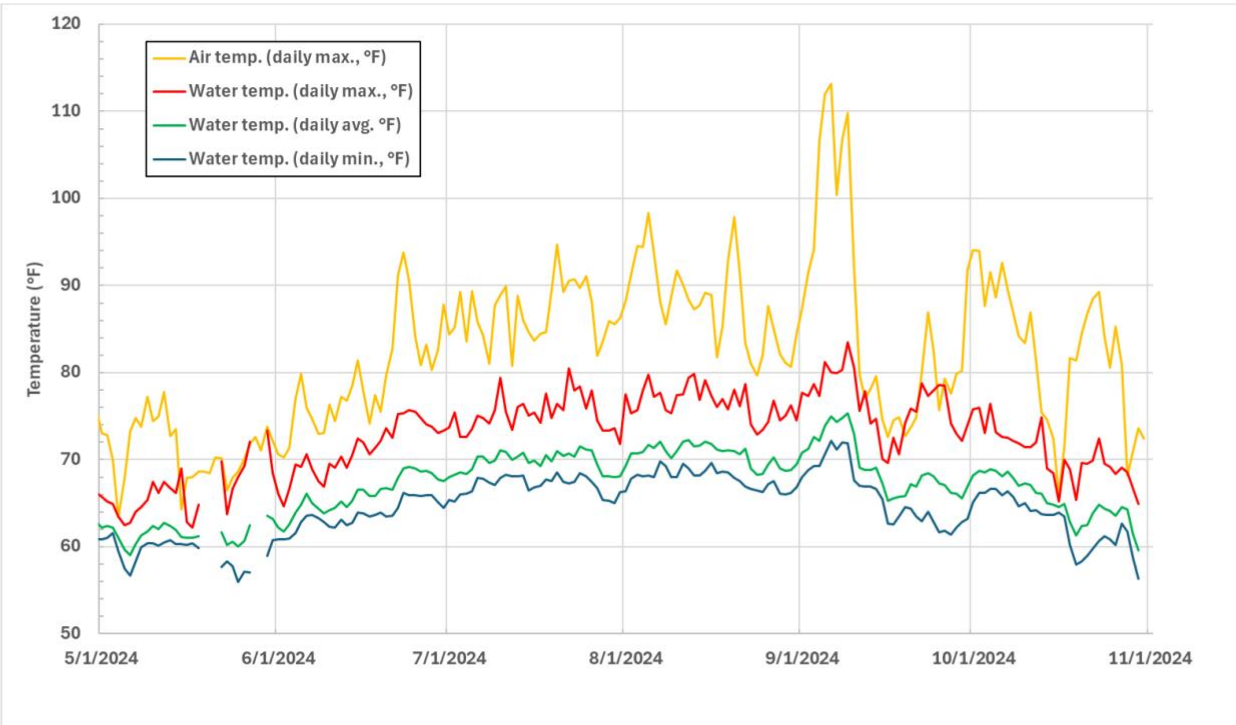


Figure 29. Continuous Temperature Measured at the BWC Up Station in the BWC

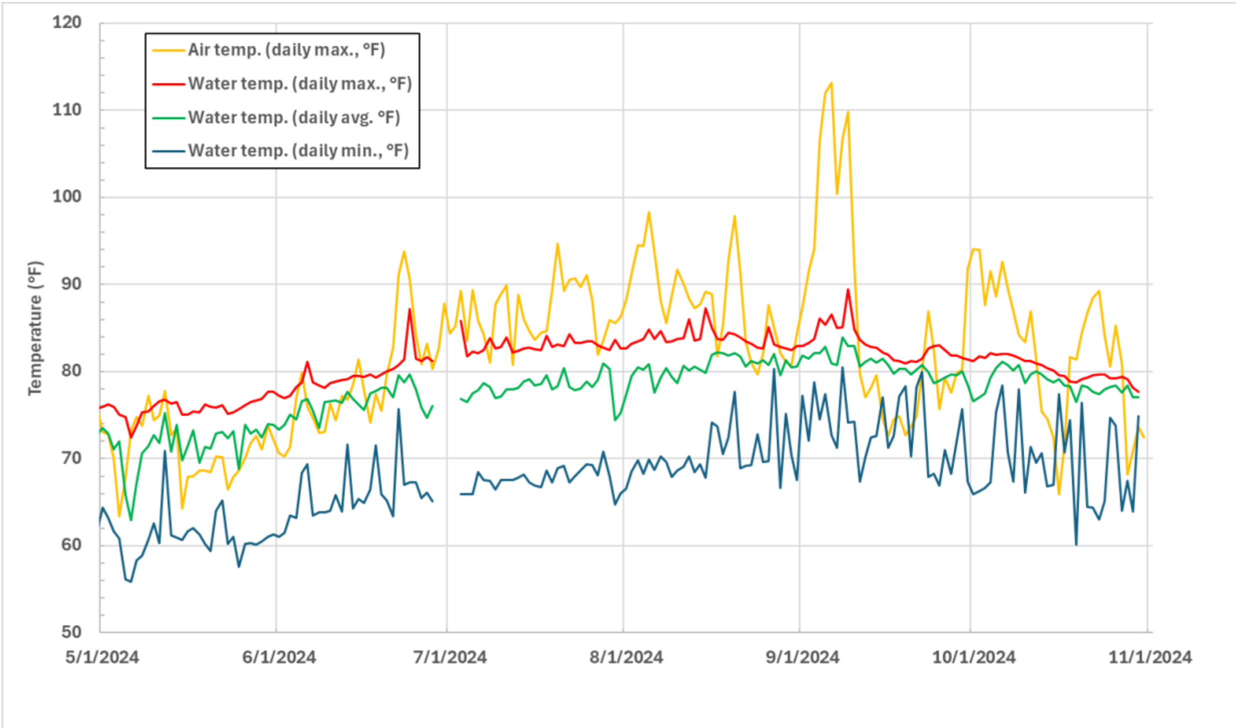


Figure 30. Continuous Temperature Measured at the BWC Down Station in the BWC

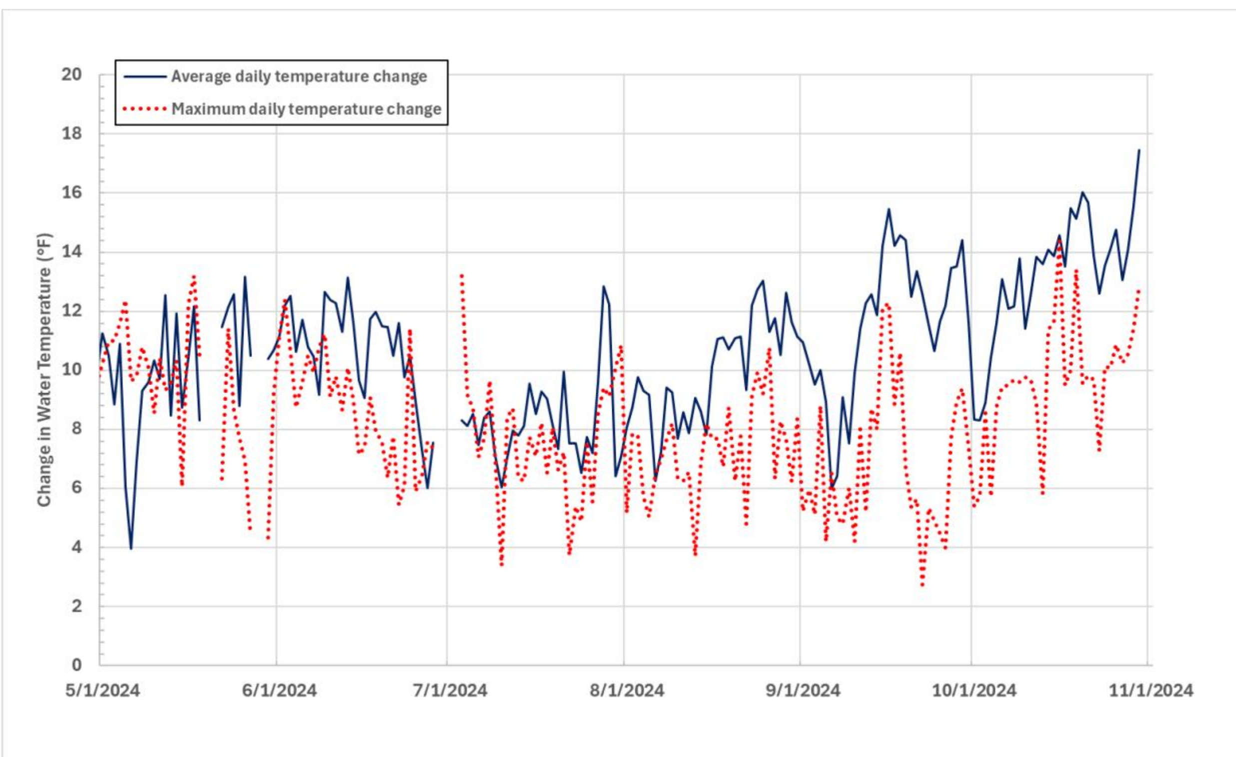


Figure 31. Temperature Difference Between BWC Up and BWC Down Stations

Table 19. Summary of Temperature Metrics at BWC Up and BWC Down of BWRP Eff 002

Outfall/ Discharge	Month	Number of days	Avg. daily water temp for month (°F)	Avg. daily max water temp (°F)	Max. daily avg. temp (MDAT, °F)	Max. daily max temp (MDMT, °F)	Max. 7-d daily water temp (MWAT, °F)	Max. 7-d daily max water temp (7DADM, °F)
BWC Up	5/2024	30	66.0	71.1	69.2	75.7	68.7	74.9
	6/2024	31	69.8	75.3	71.5	80.5	70.9	77.6
	7/2024	31	70.6	76.6	72.3	79.9	71.8	78.2
	8/2024	30	69.2	76.4	75.4	83.4	74.1	80.4
	9/2024	31	65.1	70.3	68.9	76.4	68.6	74.4
	10/2024	30	66.0	71.1	69.2	75.7	68.7	74.9
BWC Down	5/2024	31	71.6	75.8	75.2	77.7	73.7	77.2
	6/2024	30	76.8	79.9	80.0	87.2	78.5	82.8
	7/2024	31	78.3	83.1	80.9	85.8	79.0	83.4
	8/2024	31	80.5	83.8	82.2	87.3	81.8	84.7
	9/2024	30	80.8	83.1	83.9	89.5	82.4	86.1
	10/2024	31	78.5	80.1	81.2	82.1	80.2	81.9

Figure 32 depicts the continuous receiving water and air temperatures for the BWC Riverside station that lies farther downstream of the BWC Down station (approximately 1.8 miles). **Figure 33** depicts the temperature change between the two stations. Note that the BWC Riverside station is located just upstream of the confluence of the BWC with the LA River. The thermistors deployed at BWC Riverside recorded frequent, short periods in- and out-of-water events suggesting shallow water levels and the influence of solar heating, from the beginning of July through October. Stream temperatures at BWC Riverside were greatly elevated compared to immediately below the BWRP discharge at BWC Down, likely due to factors such as air temperature, solar radiation, and thermal addition from concrete heating (i.e., daily maximum water temperatures generally exceeded daily maximum air temperatures). Maximum stream temperatures at BWC Riverside remained above 90°F in July through mid-September (**Figure 32**). Both MDMT and 7DADM also exceed 80°F May through October (**Table 20**), which corresponds to increases in air temperatures. The highest MDAT and MDMT at BWC Riverside were 84.6°F and 104.7°F, and highest MWAT and 7DADM were 82.0°F and 101.2°F (**Table 20**).

Average daily stream temperature at BWC Riverside varied between 6.0°F lower to 2.5°F greater than BWC Down at any given time from May through August, and, with a single exception in the first week of September, between 0.1°F to 11.5°F lower the remainder of September and through October (**Figure 33**). Conversely, maximum daily stream temperature at BWC Riverside varied primarily from 0.1°F to as much as 18°F greater than BWC Down at any given time from May through October, with only a few exceptions in May and again in September and October where the change in temperature dropped to between 0.1°F to as low as 6.0°F lower at BWC Riverside versus at BWC Down (**Figure 33**).

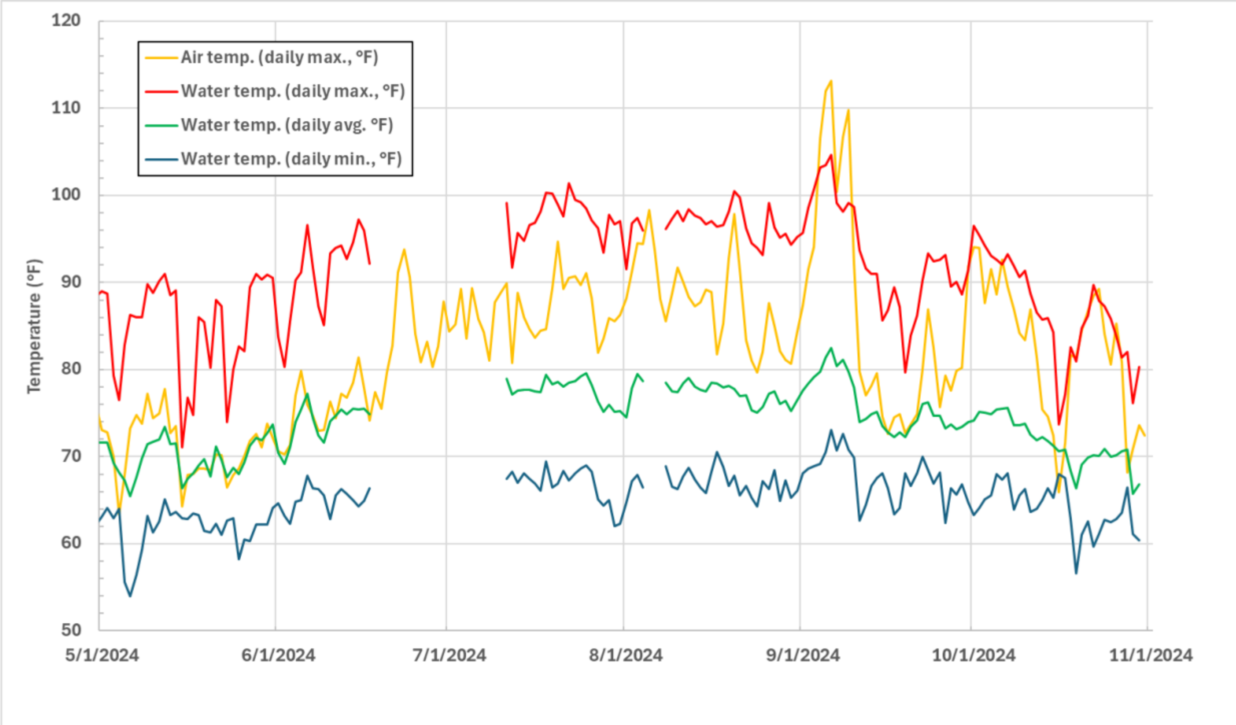


Figure 32. Continuous Temperature Measured at the BWC Riverside Station in the BWC

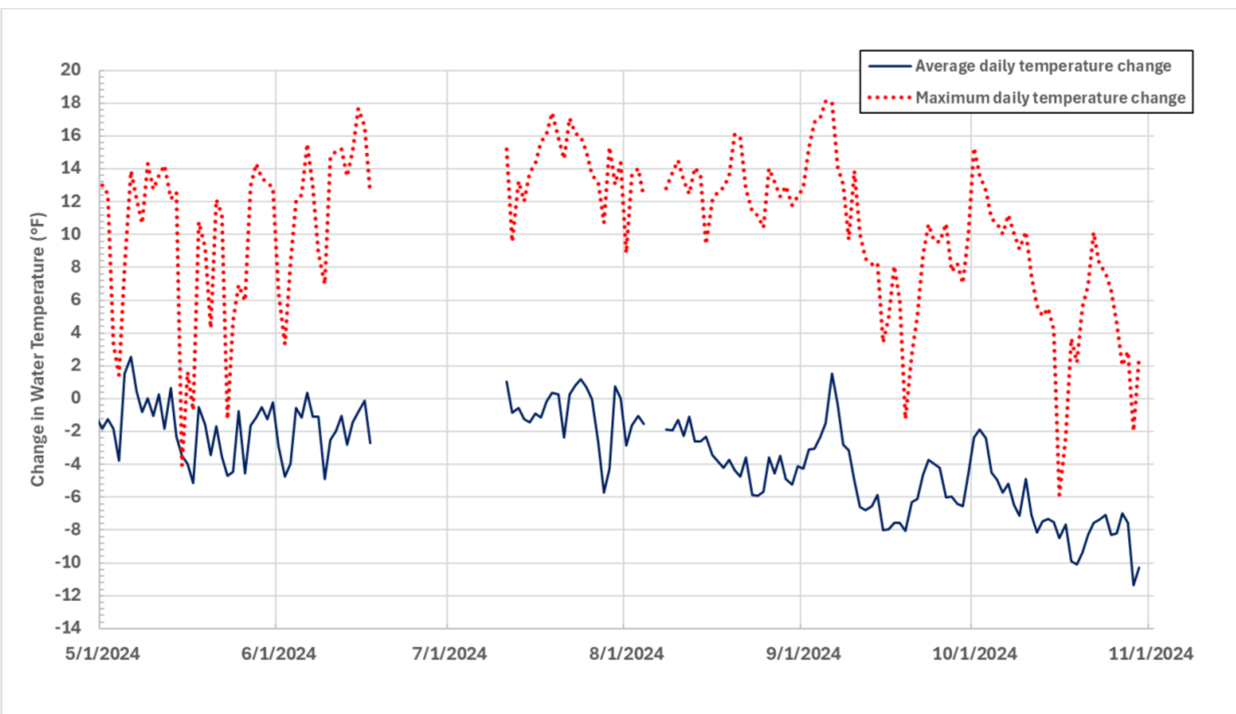


Figure 33. Temperature Difference Between BWC Riverside and the BWC Down Stations in the BWC

Table 20. Summary of Temperature Metrics at BWC Riverside Station in BWC

Temperature Monitoring Station	Month	Number of days	Avg. daily water temp for month (°F)	Avg. daily max water temp (°F)	Max. daily avg. temp (MDAT, °F)	Max. daily max temp (MDMT, °F)	Max. 7-d daily water temp (MWAT, °F)	Max. 7-d daily max water temp (7DADM, °F)
BWC Riverside	5/2024	31	69.9	84.9	73.7	91.0	71.7	89.1
	6/2024	18	73.6	90.0	77.3	97.2	80.9	98.8
	7/2024	30	78.7	98.0	84.6	101.4	82.0	99.6
	8/2024	31	77.6	96.5	84.6	100.6	79.3	97.9
	9/2024	30	75.9	93.0	82.5	104.7	80.6	101.2
	10/2024	31	71.2	86.1	75.6	96.5	75.1	93.9

Figure 34 depicts the continuous receiving water and air temperatures for the LAR3 Griffith station. **Figure 35** and **Figure 36** depict the temperature change between LAR3 Griffith and the BWC Riverside station at the bottom of BWC upstream of the confluence with the LA River and LAR4 Zoo station at the bottom of LAR4, respectively. The LAR3 Griffith station lies on the LA River just downstream of the confluence of the LA River with the BWC at the top of LAR Reach 3 and above the confluence with Verdugo Wash. All four temperature metrics exceed 80°F at this station June through September, but MDMT and 7DADM also exceed 80°F in May and October (**Figure 34** and **Table 21**), which corresponds to increases in air temperatures. Stream temperature is generally lower at LAR3 Griffith station compared to BWC Riverside, and, except for 7DADM, mostly lower than at the LAR4 Zoo station at the bottom of LAR Reach 4. The highest MDAT and MDMT at LAR Griffith were 84.0°F and 98.7°F, and highest MWAT and 7DADM were 82.0°F and 96.7°F (**Table 21**). Average daily stream temperature at LAR3 Griffith varied widely between 2.3°F lower to nearly 4.0°F greater compared to BWC Riverside at any given time from May through September and between 0.1 to 4.2°F lower in October (**Figure 35**), whereas average daily stream temperature at LAR3 Griffith was typically between 0.1 to 3.0°F lower than at LAR4 Zoo(**Figure 36**). Maximum daily stream temperature was predominantly lower by 0.1 to 8.0°F at any given time from May through October at LAR3 Griffith compared to BWC Riverside (**Figure 35**), whereas maximum daily stream temperature at LAR3 Griffith was typically between 0.1 to up to 11.0°F greater than at LAR4 Zoo (**Figure 36**).

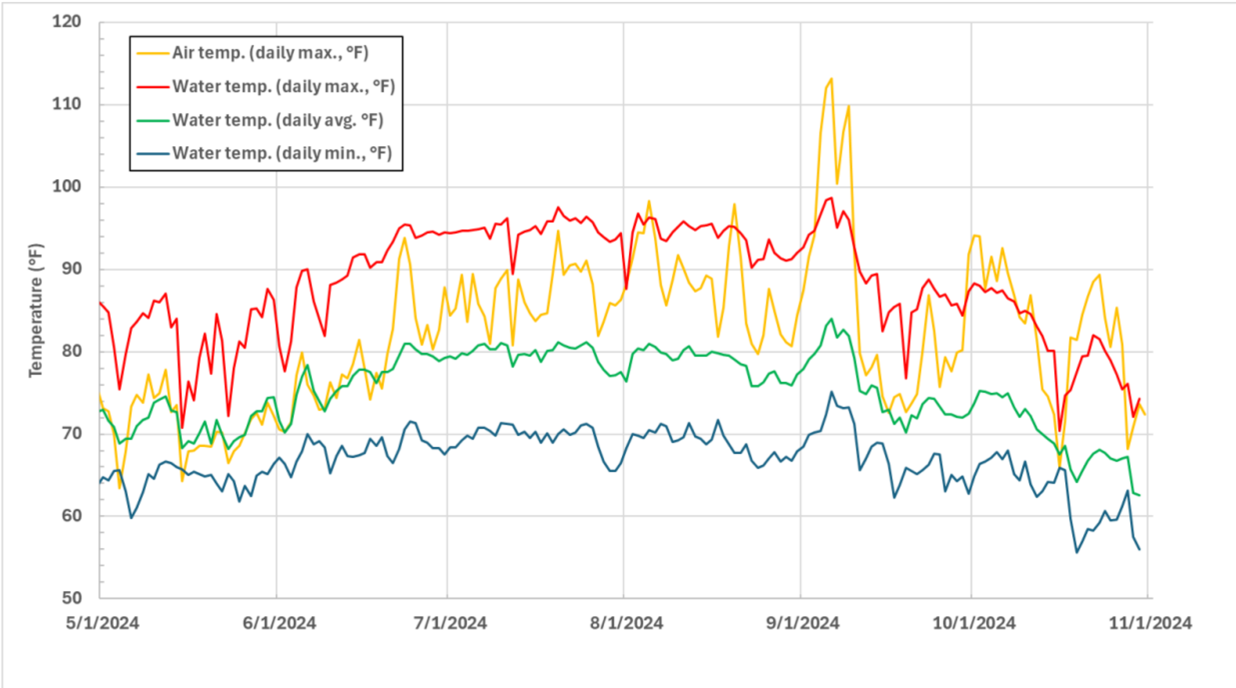


Figure 34. Continuous Temperature Measured at LAR3 Griffith Station in LAR Reach 3

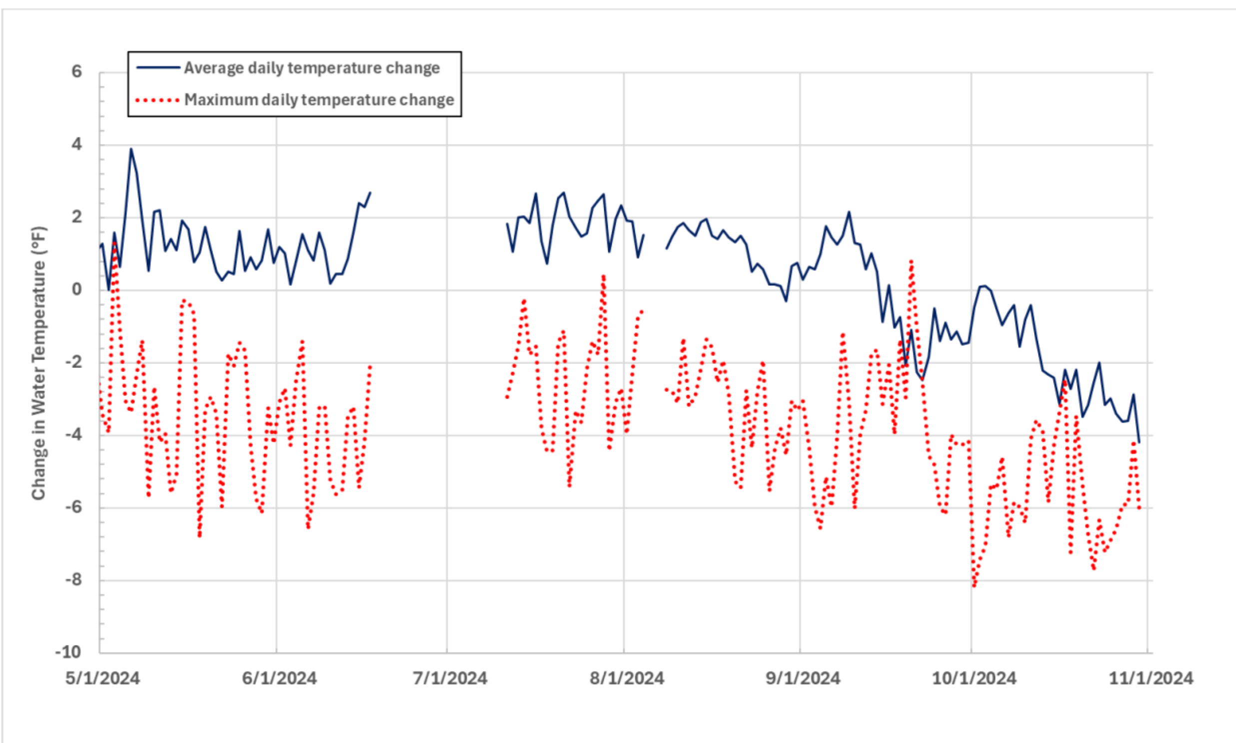


Figure 35. Temperature Difference Between LAR3 Griffith and BWC Riverside Stations

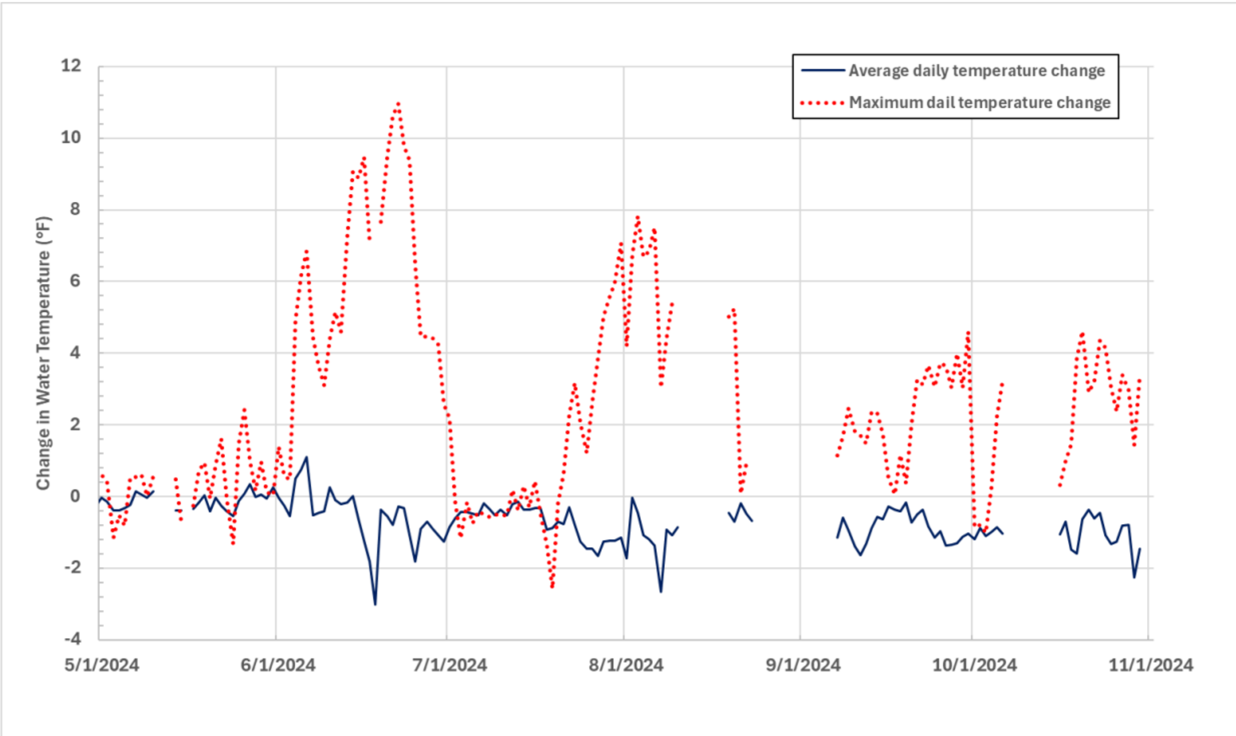


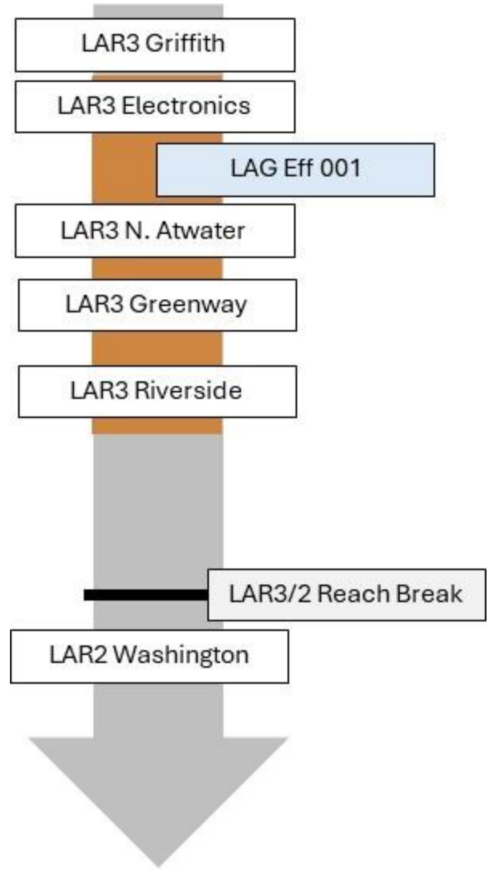
Figure 36. Temperature Difference Between LAR3 Griffith and LAR4 Zoo Stations

Table 21. Summary of Temperature Metrics at LAR3 Griffith Station in LAR Reach 3

Temperature Monitoring Station	Month	Number of days	Avg. daily water temp for month (°F)	Avg. daily max water temp (°F)	Max. daily avg. temp (MDAT, °F)	Max. daily max temp (MDMT, °F)	Max. 7-d daily water temp (MWAT, °F)	Max. 7-d daily max water temp (7DADM, °F)
LAR3 Griffith	5/2024	31	71.2	81.7	74.5	87.6	73.1	85.0
	6/2024	30	76.8	89.9	80.9	95.4	80.1	94.7
	7/2024	31	79.7	94.9	81.2	97.5	80.7	96.3
	8/2024	31	78.7	93.7	80.9	96.7	80.2	95.3
	9/2024	30	75.7	89.3	84.0	98.7	82.0	96.7
	10/2024	31	69.2	80.5	75.3	88.3	74.8	87.6

5.2.1.3 LAG and LA River Reaches 2 and 3

The LAGWRP directly discharges to the LA River in Reach 3 (LAR3). The stations bracketing the LAGWRP outfall (LAG Eff 001) were included to evaluate thermal conditions upstream and downstream of the LAGWRP discharge (**Figure 5**), including one station at the top of LA River Reach 2 (LAR2 Washington) (as depicted in the schematic diagram to the right – with brown and gray shading denoting unlined and concrete channel bottom, respectively).



5.2.1.3.1 LAG Effluent Temperature Profile

Daily average, minimum, and maximum effluent temperatures based on continuous measurements collected at the LAGWRP outfall LAG Eff 001 during the Study period are plotted along with maximum daily air temperature in **Figure 37**. Similar to both DCTWRP and BWRP, temperature of effluent discharged from LAGWRP exceeded 80°F beginning in June and remained above 80°F through October, with MDAT and MDMT reaching 85.3°F and 85.9°F, and MWAT and 7DADM reaching 85.1°F and 85.6°F (**Table 22**), and with a trend of increasing effluent temperature from May through early September before decreasing in the remainder of September and October, which corresponds to increases and decreases in air temperatures.

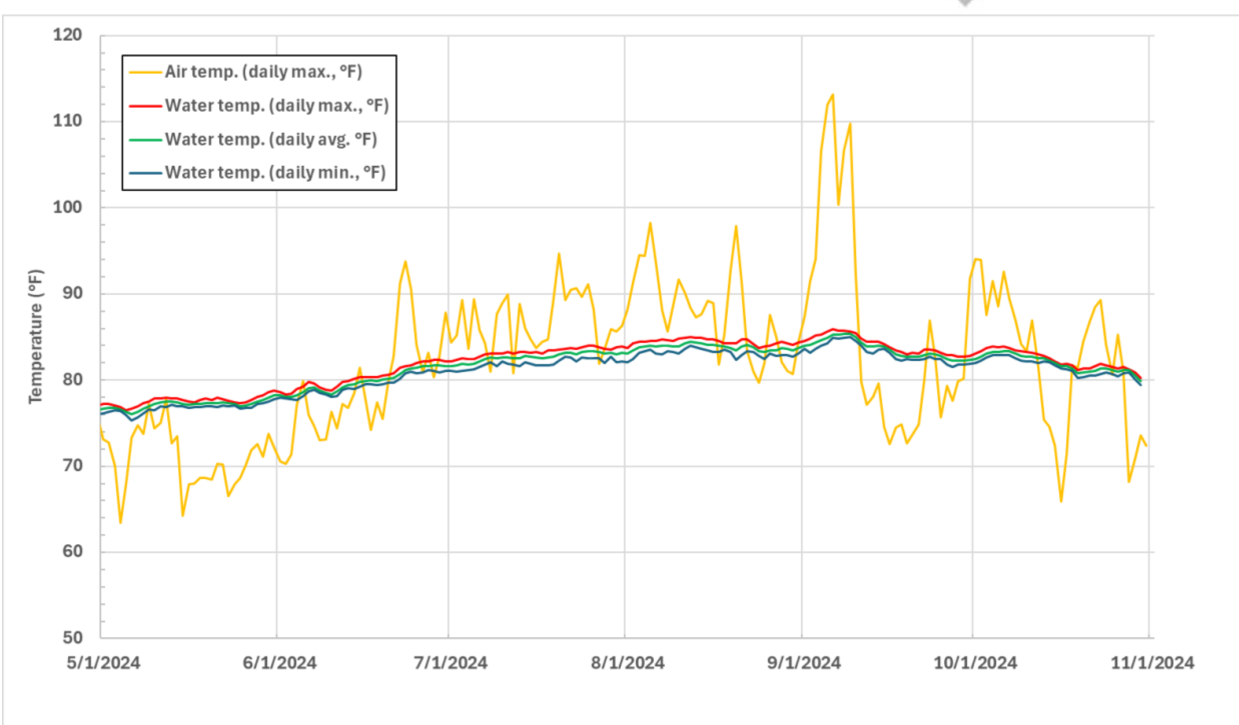


Figure 37. Continuous Temperature of LAG Outfall Eff 001 Effluent

Table 22. Summary of Temperature Metrics for LAGWRP Effluent

Outfall/ Discharge	Month	Number of days	Avg. daily water temp for month (°F)	Avg. daily max water temp (°F)	Max. daily avg. temp (MDAT, °F)	Max. daily max temp (MDMT, °F)	Max. 7-d daily water temp (MWAT, °F)	Max. 7-d daily max water temp (7DADM, °F)
LAG Eff 001	5/2024	31	77.2	77.6	78.3	78.8	78.0	78.4
	6/2024	30	79.8	80.3	81.7	82.3	81.7	82.3
	7/2024	31	82.7	83.3	83.4	84.0	83.2	83.9
	8/2024	31	83.8	84.4	84.5	85.0	84.2	84.8
	9/2024	30	83.6	84.1	85.3	85.9	85.1	85.6
	10/2024	31	81.9	82.3	83.4	83.9	83.2	83.7

5.2.1.3.2 Receiving Waterbody Temperature in Stations Bracketing LAG Effluent Discharge

Figure 38 and **Figure 39** depict continuous receiving water and air temperatures for the two stations (LAR3 Electronics and LAR3 N. Atwater) bracketing the LAGWRP discharge to LAR3. **Figure 40** and **Figure 41** depict the temperature change between LAR3 Electronics and LAR3 N. Atwater stations bracketing LAGWRP and between LAR3 Electronics and the LAR3 Griffith station above the confluence of the LA River with Verdugo Wash, respectively.

Three of the four temperature metrics at the LAR3 Electronics station exceed 80°F June through September, with MWAT exceeding only in September and MDMT and 7DADM also exceeding 80°F in May and October (**Figure 38** and **Table 23**), which corresponds to increases in air temperatures. The highest MDAT and MDMT at the LAR3 Electronics station were 83.2°F and 97.3°F, and highest MWAT and 7DADM were 81.0°F and 95.5°F (**Table 23**). Stream temperature at the LAR3 Electronics station (**Figure 38**) was warmer compared to the LAR3 N. Atwater station (**Figure 39**) immediately below the LAGWRP effluent discharge location. At LAR3 N. Atwater, MDMT and 7DADM exceed the 80°F threshold May through October, but MDAT and MWAT only exceed the threshold in September, which also corresponds to increases in air temperatures (**Table 23**). The highest MDAT and MDMT at LAR3 N. Atwater are 81.8°F and 91.2°F, and highest MWAT and 7DADM were 80.6°F and 90.3°F (**Table 23**). The values for these metrics were lower than their counterparts at the LAR3 Electronics station immediately above LAGWRP effluent (LAG Eff 001) discharge.

From May through mid-August the average daily stream temperature at the LAR3 N. Atwater station immediately downstream of LAGWRP was consistently lower by between 0.1 to 2.3°F compared to LAR3 Electronics station immediately upstream of the WRP (**Figure 40**). Beginning mid-September, the opposite occurs except between the middle and end of September. In October, the average daily stream temperature at the LAR3 N. Atwater station was consistently higher (by between 1.0 to 5.2°F) compared to LAR3 Electronics station above the WRP (**Figure 40**). The same general trend occurs for maximum daily temperature change between the two stations, but to a greater extent and particularly from mid-June through mid-August (i.e., greater change in magnitude between stations). In contrast, average daily stream temperature at LAR3 Electronics was typically between 0°F to 2°F lower than at LAR3 Griffith above the confluence with Verdugo Wash and below the confluence with the BWC, while maximum daily temperature change between the two stations was less pronounced mid-June through mid-August, but with more pronounced changes in the negative direction between LAR3 Electronics and LAR3 Griffith occurring in early June, early September, and early October (**Figure 41**).

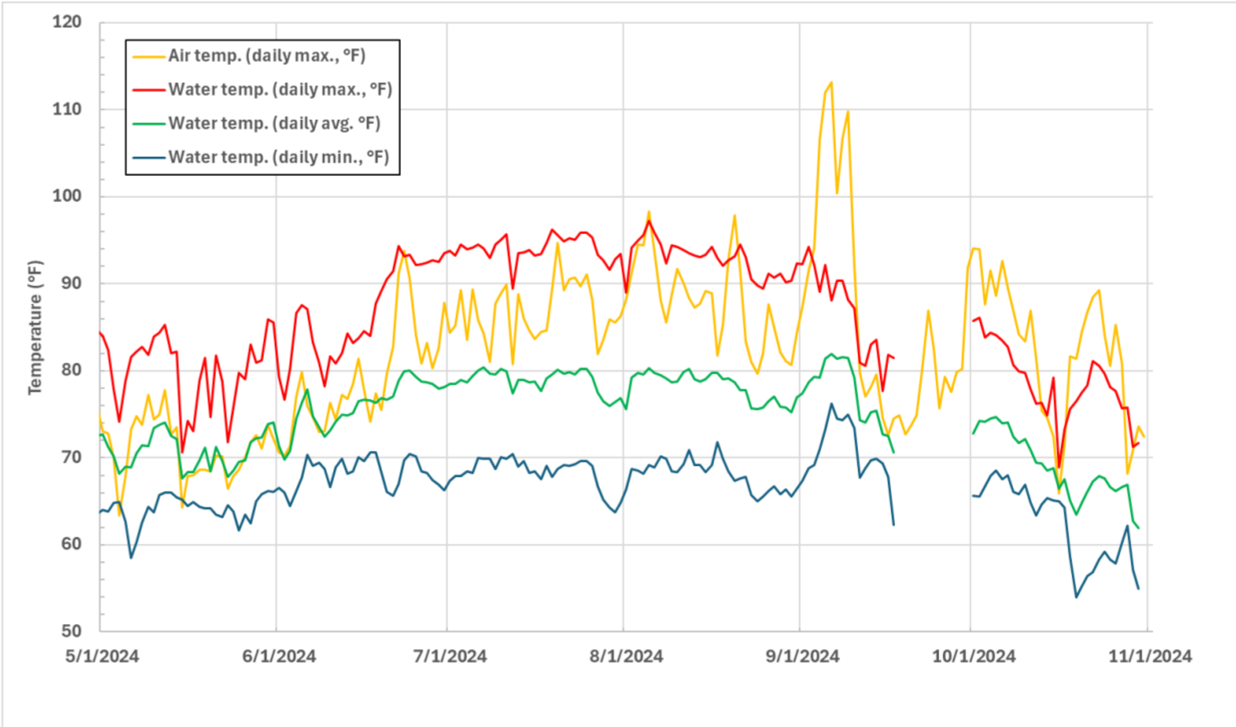


Figure 38. Continuous Temperature Measured at the LAR3 Electronics Station in LAR Reach 3

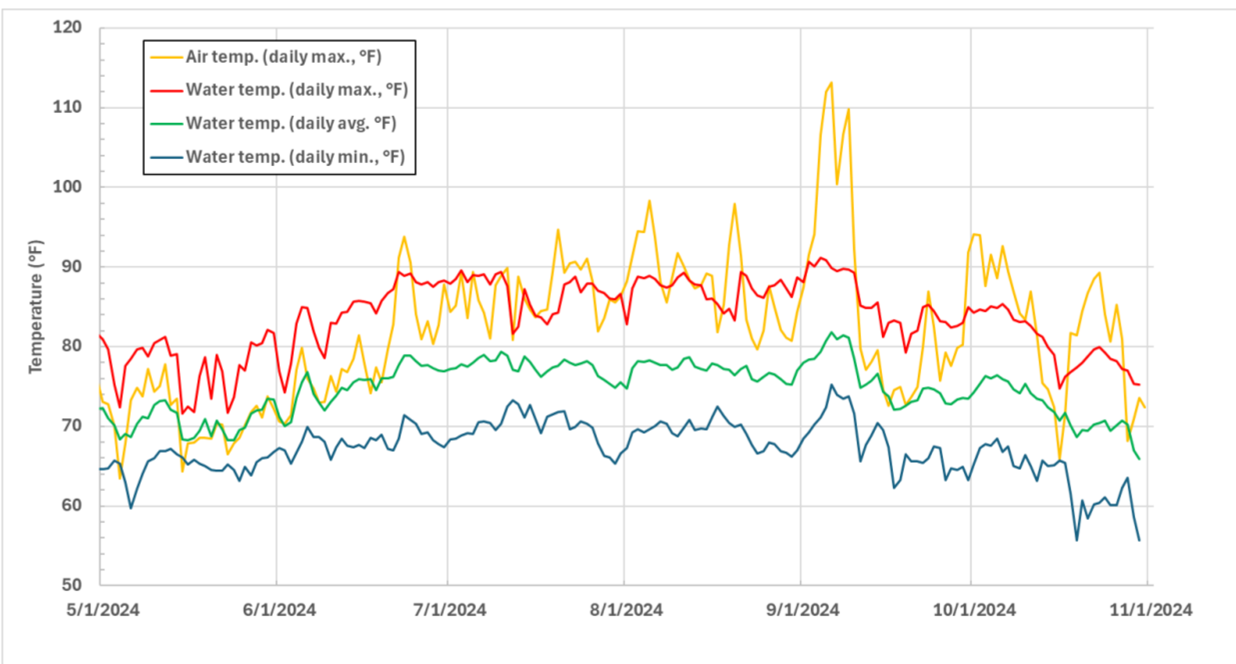


Figure 39. Continuous Temperature Measured at the LAR3 N. Atwater Station

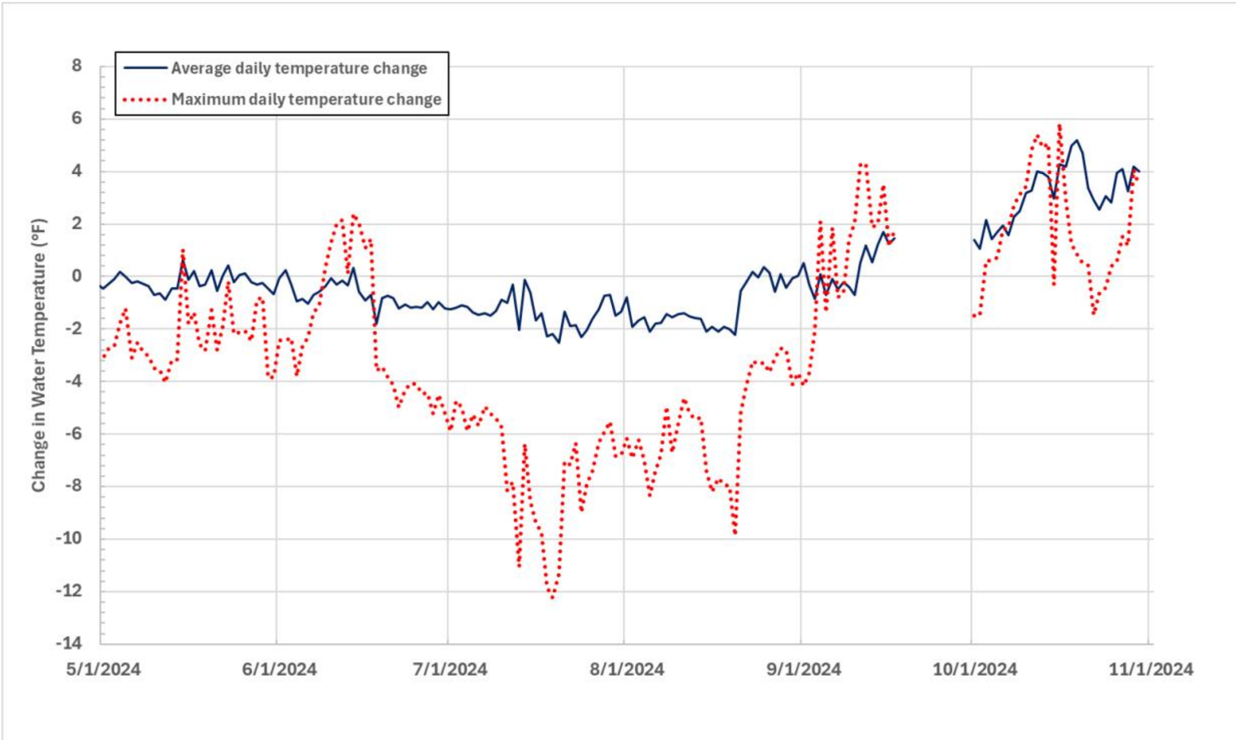


Figure 40. Temperature Difference Between LAR3 N. Atwater and LAR3 Electronics

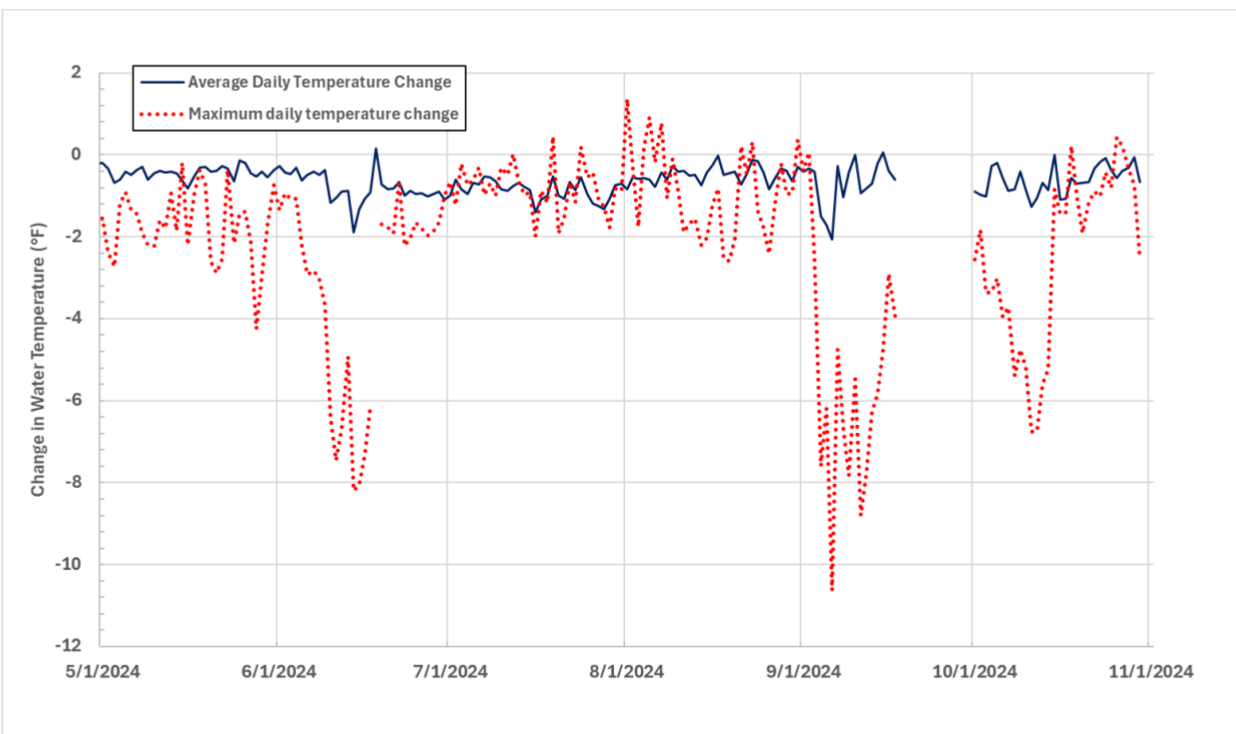


Figure 41. Temperature Difference Between Stations LAR3 Electronics and LAR3 Griffith Stations

Table 23. Summary of Temperature Metrics at LAR3 Electronics and LAR3 N. Atwater Stations in LAR Reach 3

Temperature Monitoring Station	Month	Number of days	Avg. daily water temp for month (°F)	Avg. daily max water temp (°F)	Max. daily avg. temp (MDAT, °F)	Max. daily max temp (MDMT, °F)	Max. 7-d daily water temp (MWAT, °F)	Max. 7-d daily max water temp (7DADM, °F)
LAR3 Electronics	5/2024	31	70.8	80.0	74.1	85.9	72.7	83.2
	6/2024	30	76.0	86.7	80.1	94.4	79.2	93.3
	7/2024	31	78.9	94.1	80.4	96.3	79.9	95.5
	8/2024	31	78.2	92.8	80.3	97.3	79.6	95.0
	9/2024	24	78.0	85.2	83.2	94.3	81.0	91.8
	10/2024	31	68.6	78.0	74.7	86.2	74.8	84.4
LAR3 N. Atwater	5/2024	31	70.6	77.7	73.4	82.1	72.2	80.0
	6/2024	30	75.3	84.6	78.9	89.4	78.0	88.4
	7/2024	31	77.5	86.8	79.3	89.5	78.6	88.8
	8/2024	31	77.1	87.2	78.7	89.4	77.9	88.5
	9/2024	30	75.9	85.6	81.8	91.2	80.6	90.3
	10/2024	31	71.8	79.9	76.4	85.3	75.8	84.8

Figure 42 depicts continuous receiving water and air temperatures for the LAR3 Greenway station located downstream of the LAR3 N. Atwater station. **Figure 43** depicts the temperature change between the two stations. Stream temperature and temperature metrics at LAR3 Greenway station were similar to, slightly higher, or slightly lower (variable) compared to LAR3 N. Atwater temperature metrics, depending on the metric (**Figure 42** and **Table 24**). All metrics except MWAT exceed 80°F June through September, which corresponds to increases in air temperatures. MDMT and 7DADM also exceed 80°F in May, but only MDMT exceeds 80°F in October. Maximum stream temperatures at LAR3 Greenway remained above 80°F, but below 90°F, from June through mid-September (**Figure 42**). The highest MDAT and MDMT at LAR3 Greenway were 82.6°F and 89.5°F, and highest MWAT and 7DADM were 81.2°F and 87.7°F (**Table 24**). MDMT and 7DADM were lower at LAR3 Greenway compared to LAR3 N. Atwater, but MDAT and MWAT were nominally higher. Average daily stream temperature at LAR3 Greenway generally was 0.1 to 2.6°F greater than at LAR3 N. Atwater at any given time from May through mid-September, but consistently lower by 0.1 to 2.1°F in October (**Figure 43**). Maximum daily temperature, on the other hand, was primarily lower at LAR3 Greenway than at LAR3 N. Atwater except for a few sporadic instances in May through August.

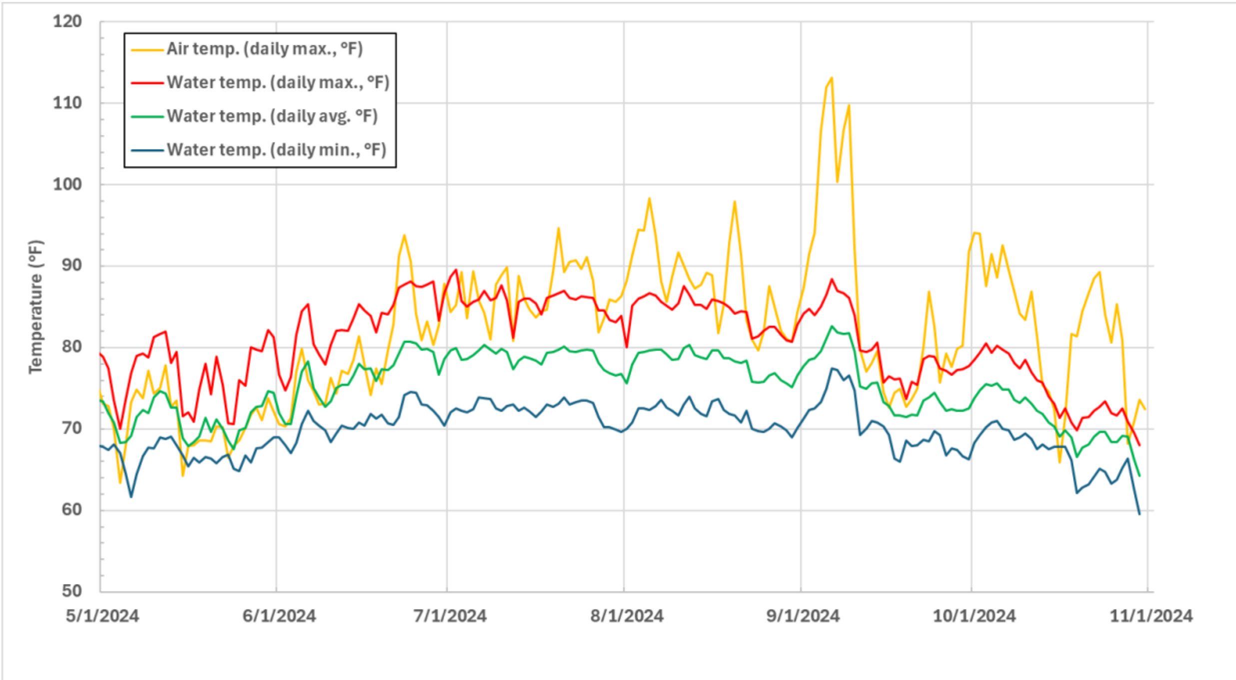


Figure 42. Continuous Temperature Measured at LAR3 Greenway Station in LAR Reach 3

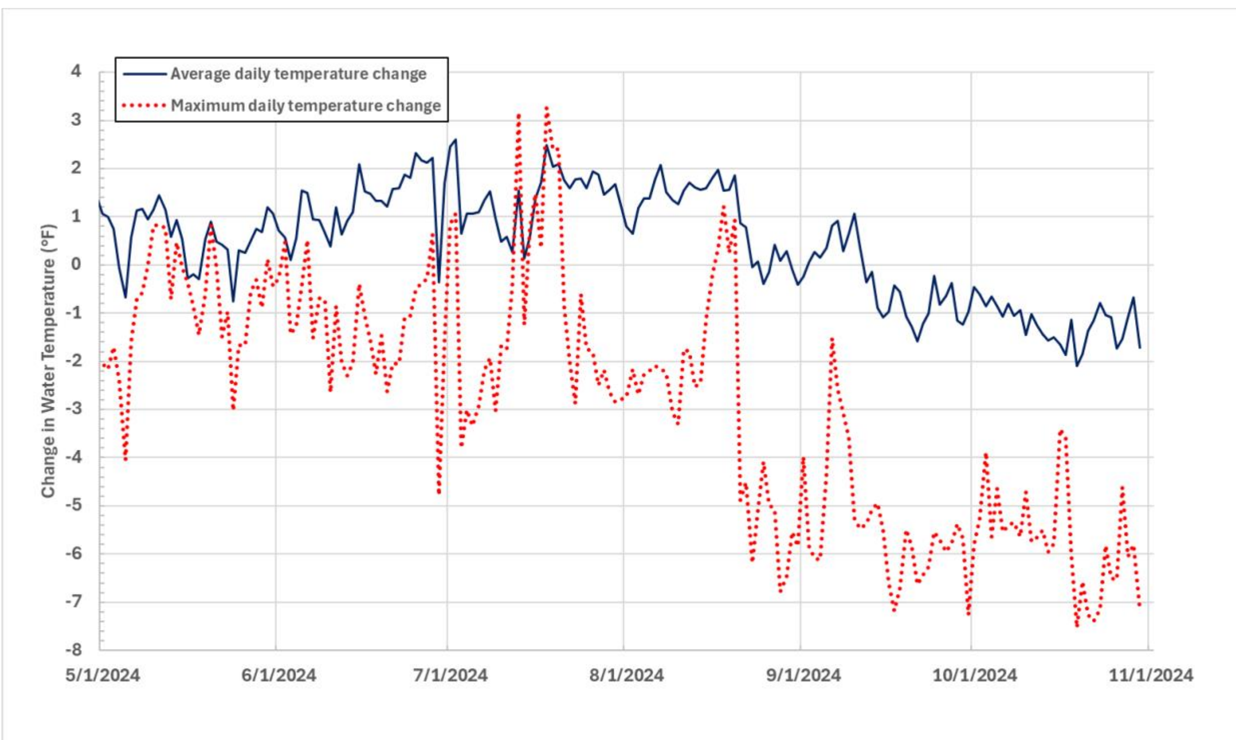


Figure 43. Temperature Difference Between LAR3 Greenway and LAR3 N. Atwater Stations

Table 24. Summary of Temperature Metrics at LAR3 Greenway Station in LAR Reach 3

Temperature Monitoring Station	Month	Number of days	Avg. daily water temp for month (°F)	Avg. daily max water temp (°F)	Max. daily avg. temp (MDAT, °F)	Max. daily max temp (MDMT, °F)	Max. 7-d daily water temp (MWAT, °F)	Max. 7-d daily max water temp (7DADM, °F)
LAR3 Greenway	5/2024	31	71.1	76.8	74.6	82.2	73.2	80.1
	6/2024	30	76.6	83.4	80.7	88.2	80.0	87.7
	7/2024	31	78.9	85.7	80.3	89.5	79.7	86.8
	8/2024	31	78.1	84.2	80.4	87.5	79.5	85.9
	9/2024	30	75.5	80.2	82.6	88.4	81.2	86.2
	10/2024	31	70.7	74.3	75.6	80.6	74.9	79.6

Figure 44 depicts continuous receiving water and air temperatures for the LAR3 Riverside station located downstream of LAR3 Greenway station. **Figure 45** depicts the temperature change between the two stations. Stream temperature and temperature metrics at LAR3 Riverside station were the same or slightly lower compared to LAR3 Greenway stream temperature metrics (**Figure 44** and **Table 25**). Again, all metrics except MWAT slightly exceed 80°F June through September, but the available data shows that no metric exceeds 80°F in May or October (**Table 25**), which corresponds to increases and decreases in air temperatures. Maximum stream temperatures at LAR3 Greenway remained at or near 80°F or a few degrees above from June through mid-September (**Figure 44**). The highest MDAT and MDMT at LAR3 Riverside were 82.1°F and 85.0°F, and the highest MWAT and 7DADM were 81.1°F and 83.6°F (**Table 25**). There was minimal difference in average daily temperature (less than a 1.5°F positive or negative difference) between LAR3 Riverside and upstream at LAR3 Greenway for the entire Study period of May through October, but a much more pronounced difference in maximum daily temperature (**Figure 45**). Maximum daily stream temperature at LAR3 Riverside generally was 0.1 to 4°F lower than at LAR3 Greenway at any given time from May through October, but with infrequent occasions where maximum daily temperature was up to 2.0°F greater and, at the end of June through early July, was up 6.5 °F lower (**Figure 45**).

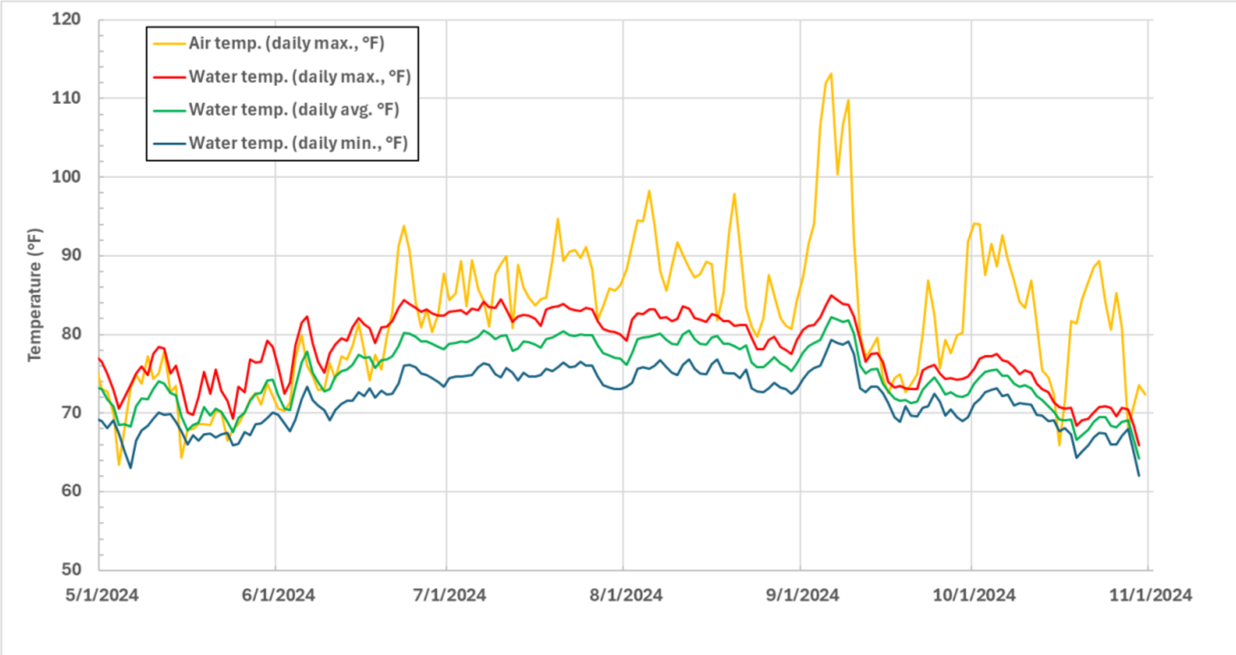


Figure 44. Continuous Temperature Measured at LAR3 Riverside Station in LAR Reach 3

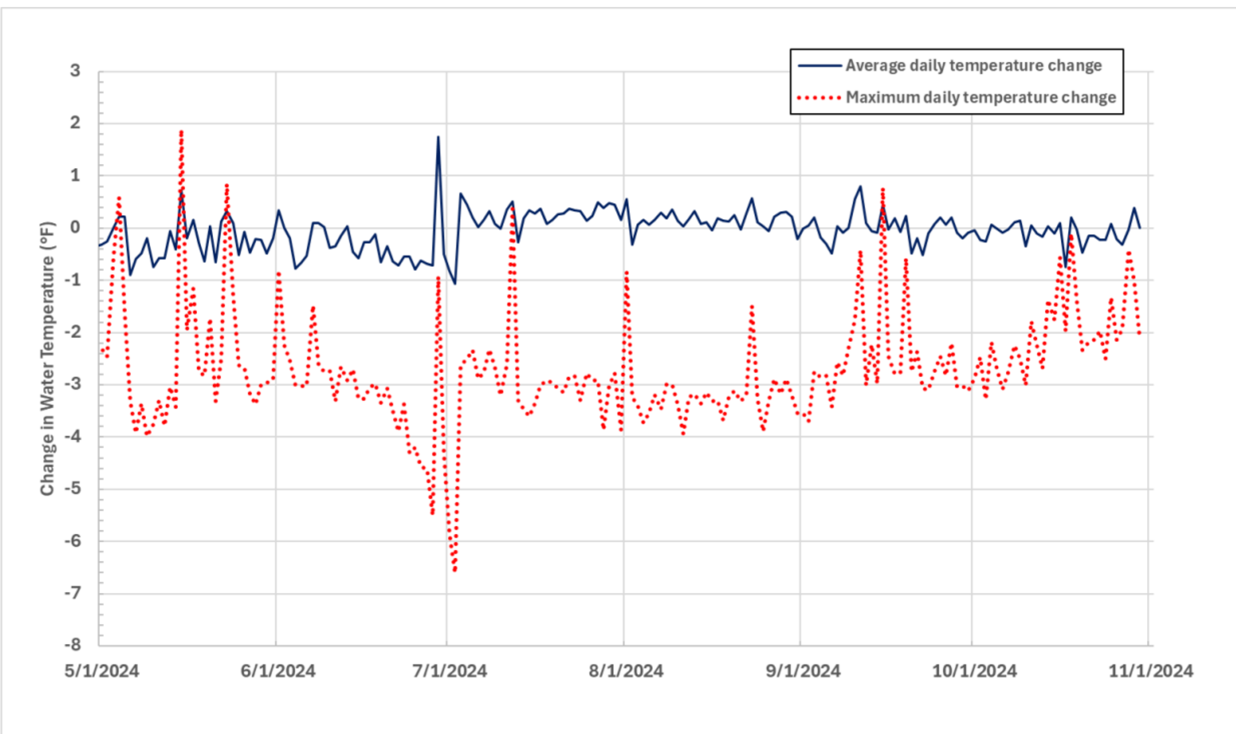


Figure 45. Temperature Difference Between LAR3 Riverside and LAR3 Greenway Stations

Table 25. Summary of Temperature Metrics at LAR3 Riverside Station in LAR Reach 3

Temperature Monitoring Station	Month	Number of days	Avg. daily water temp for month (°F)	Avg. daily max water temp (°F)	Max. daily avg. temp (MDAT, °F)	Max. daily max temp (MDMT, °F)	Max. 7-d daily water temp (MWAT, °F)	Max. 7-d daily max water temp (7DADM, °F)
LAR3 Riverside	5/2024	31	70.9	74.4	74.3	79.2	72.8	76.6
	6/2024	30	76.3	80.2	80.2	84.4	79.4	83.4
	7/2024	31	79.1	82.6	80.5	84.5	80.0	83.6
	8/2024	31	78.2	81.1	80.5	83.6	79.6	82.6
	9/2024	30	75.5	77.7	82.1	85.0	81.1	83.6
	10/2024	31	70.6	72.3	75.6	77.5	74.9	76.9

Figure 46 depicts continuous receiving water and air temperatures for the LAR2 Washington station in LAR2. **Figure 47** depicts the temperature change between LAR2 Washington and LAR3 Riverside stations. Note that the LAR2 Washington station lies just below the confluence of the LA River with Arroyo Seco with 5.3 miles of concrete channel between that station and the upstream LAR3 Riverside station. The thermistors deployed at LAR2 Washington recorded many in- and out-of-water events suggesting shallow water levels (or potential tampering with the device), especially in late July. Stream temperature and temperature metrics at the LAR2 Washington station were substantially higher compared to the LAR3 Riverside station (**Figure 46** and **Table 26**). Maximum stream temperatures at LAR2 Washington exceed 98°F and were well above the 80.0°F threshold May through mid-October (**Figure 46**), which corresponds to increases in air temperatures. The highest MDAT and MDMT at LAR2 Washinton were 92.1°F and 98.8°F, and highest MWAT and 7DADM were 90.2°F and 98.8°F (**Table 26**). Change in average daily temperature between LAR2 Washington and LAR3 Riverside stations was generally small (by less than between 2°F lower or higher). In stark contrast, change in maximum daily temperature was much higher where daily maximum temperature was frequently 8°F greater at LAR2 Washington compared to LAR3 Riverside to up to 19°F higher (**Figure 47**).

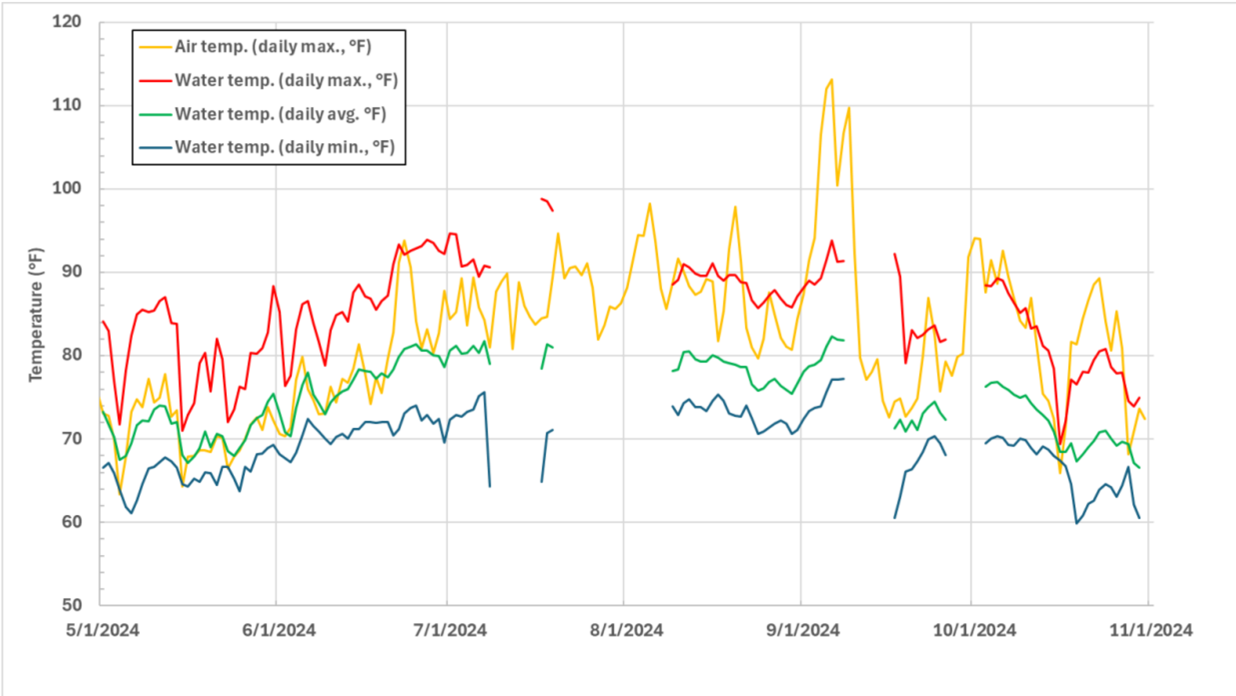


Figure 46. Continuous Temperature Measured at LAR2 Washington Station in LAR Reach 2

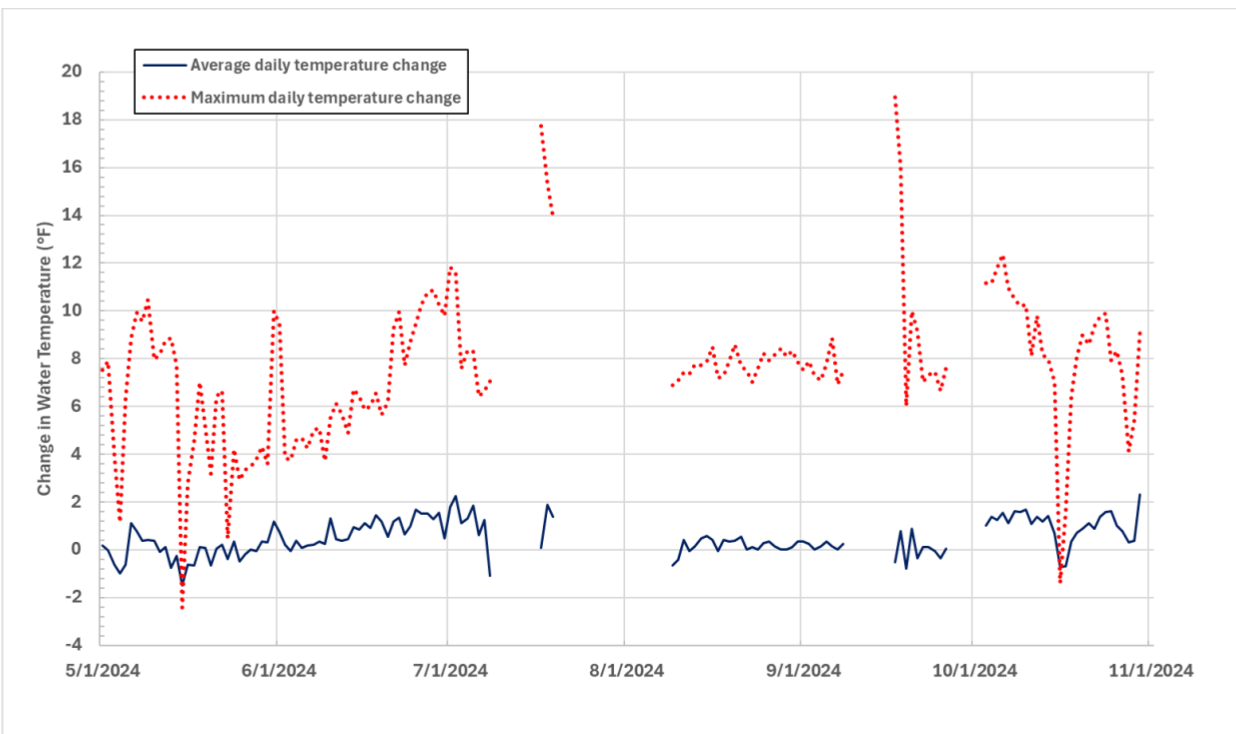


Figure 47. Temperature Difference Between LAR2 Washington and LAR3 Riverside Stations

Table 26. Summary of Temperature Metrics at LAR2 Washington Station in LAR Reach 2

Temperature Monitoring Station	Month	Number of days	Avg. daily water temp for month (°F)	Avg. daily max water temp (°F)	Max. daily avg. temp (MDAT, °F)	Max. daily max temp (MDMT, °F)	Max. 7-d daily water temp (MWAT, °F)	Max. 7-d daily max water temp (7DADM, °F)
LAR2 Washington	5/2024	31	70.9	80.1	75.4	88.4	73.0	85.5
	6/2024	30	77.1	87.1	81.4	94.0	80.7	93.5
	7/2024	14	81.9	92.8	92.1	98.8	90.2	98.8
	8/2024	23	78.1	88.5	80.5	91.1	79.9	90.2
	9/2024	21	75.3	84.6	82.3	93.8	81.2	90.7
	10/2024	30	71.7	80.6	81.0	89.7	78.0	89.0

5.2.1.4 Summary

Prior to continuous temperature monitoring, limited information existed showing diel receiving water temperature changes during summer months, in general, and at locations bracketing WRP discharges, in particular. As a result of the monitoring completed as part of this Study, two important facts came to light. First, and perhaps most important for this Study, is the fact that the water quality objectives upon which the WRPs' limits are based (temperature not to exceed 80°F and ΔT not to exceed 5°F) are often exceeded both upstream and downstream of WRP discharges. This is significant because, despite any operational or management actions that might be implemented by the WRPs to meet temperature limits, upstream receiving water temperature will still exceed the water quality objectives and effluent limitations, regardless of WRP discharge. Second, the extent of temperature increase below WRP discharge appears to be extremely limited spatially. Thus, the influence of elevated temperature from WRP discharge on biological communities is also limited and restricted to very small portions of the LA River as a whole. From the results summarized above, it is clear the extent of temperature increase from WRP discharge is location and seasonally dependent. The following subsection discusses how river temperatures change as a function of distance from the discharge location and downstream physical characteristics and channel features, which encompass all other factors affecting temperature in the Study area.

5.2.2 Influence of Factors Affecting Receiving Water Temperatures

A key challenge in describing relationships between water temperature and biology in a complex, highly dynamic, and urbanized riverine system such as the LA River is understanding how natural receiving water temperature variation is influenced by physical characteristics and channel features (e.g., substrate type, channel shape and width, canopy cover, groundwater input, flow, and more), in addition to understanding how river temperature changes with distance from the discharge location. In all cases, the observations below are inextricably tied to the ambient air temperature and solar radiation as shown in **Section 5.1**.

The following subsection relies on the HEC-RAS modeling effort developed for the Study (**Section 7**) to directly analyze the relationship between effluent discharge temperature and receiving water temperature, including how receiving water temperature changes with distance from the discharge location. Receiving water temperature variation is influenced by factors including downstream channel physical characteristics, hydraulic characteristics, radiation of heat to and from the atmosphere, and solar radiation. To isolate the thermal effect of each of the WRP's discharge on downstream water temperatures for the purposes of this evaluation, effluent temperatures were set in the model to equal to the respective upstream receiving water temperature on randomly selected days in January, June, July, and August. Effluent flowrate was maintained so there would be no influence of changed river flow on temperature dynamics downstream of the discharge. These model inputs created a hypothetical scenario where any influence of heat addition from WRP discharges was removed thereby estimating the cumulative influence of other factors on receiving water temperatures. The difference between baseline receiving water temperature and the modeled receiving water temperature determines the effect of WRP thermal discharge. Where that temperature difference reduces to a negligible level (i.e., ± 1°F) defines the extent of the potential WRP thermal effect on the receiving waters. This analysis is used to directly address Study Question #6.

As noted in the Introduction (**Section 1**), the mainstem of the LA River is 51-miles long where approximately 94% (48 miles) is contained in concrete flood control channels, with the remaining approximately three miles of the Sepulveda Flood Control Basin (Sepulveda Basin) in LA River Reach 5 being the only portion not contained in concrete flood control channels. There are approximately nine miles of river with unlined channels, which occur at in the Glendale Narrows in LA River Reach 3 and the Sepulveda Flood Control Basin in LA River Reach 5. The physical characteristics and channel features surrounding all LA River reaches in the Study area have been significantly altered by urbanization. The conversion of the LA River to a flood control channel eliminated almost all natural riverine and riparian habitat, greatly reducing actual and potential plant and wildlife diversity and abundance. Apart from the Sepulveda Basin and the Glendale Narrows, the Study area and other tributaries in the Watershed have large segments of channel that are almost entirely concrete-lined, with dense adjacent development of the former floodplain and little to no canopy cover for shading.

Table 3 presents a summary of channel features (bottom substrate, channel type and shape, etc.) that influence stream water temperature, along with an estimation of the relative amount of canopy cover (based on satellite images and direct observation) and indication of whether a waterbody receives direct WRP discharge. Such descriptive information, paired with the Study model described in **Section 7**, allowed for an evaluation and semi-quantification of the factors affecting receiving water temperatures.

5.2.2.1 Estimated Thermal Effects of DCTWRP Effluent

The estimated extent of the thermal effect of effluent from the DCTWRP in January, June, July, and August 2024 are shown in **Figure 48**, panels A-D, respectively. The evaluated downstream distance from the DCTWRP discharge extends over 10 miles in LAR4 to the confluence with the BWC. The baseline condition depicted by the black line in each figure panel indicates modeled downstream river temperature on the day shown based on average daily temperature and flow of the DCTWRP discharges on that day. The blue line (or "scenario") indicates the modeled receiving water temperature when the effluent temperature on that day is set to the upstream receiving water temperature, but flow is maintained, thus removing any thermal effect of effluent from the DCTWRP downstream of the discharges. The modeling scenario allows visualization of other non-effluent temperature modulating factors on receiving water temperature downstream of the DCTWRP, which in this case, includes mixed substrate with some shading and unimproved channel in LAR5 to Sepulveda Dam, followed by concrete with an open box channel.

On January 9, 2024, under the ambient conditions on that day, baseline upstream receiving water temperature was 51°F (**Figure 48**). After the addition of temperature and flow from the multiple discharges to LAR5 from the DCTWRP that day, receiving water temperature in the LA River throughout LAR4 below

Sepulveda Dam was 56°F, resulting in an estimated "apparent WRP-influenced ΔT" of 5°F relative to the water temperature in the river above all DCTWRP's discharges. When effluent temperature is set to the upstream receiving water temperature effectively removing any heat added by WRP effluent and flow is maintained, however, river temperature steadily increases from 51°F (the upstream temperature) immediately below the Sepulveda Dam to 55°F by the confluence with Tujunga Wash, approximately 5 miles downstream of the dam, before slowly equilibrating another degree to 56°F by the end of LAR4. Thus, the "natural ΔT" between upstream and downstream of DCTWRP discharge is 4°F without thermal addition from the DCTWRP. The natural ΔT of 4°F is believed to be primarily due to heat addition from ambient air temperature with smaller contributions from the concrete substrate and solar heating. Therefore, based on the model results, the estimated distance downstream of DCTWRP discharge under the influence of thermal addition by the WRP (i.e., where the baseline and model scenario lines converge to less than a degree difference) is approximately 5 miles in January, and the actual ΔT [equal to the apparent WRP-influenced ΔT (5°F) minus natural ΔT (4°F)] is only approximately 1°F.

On June 18, 2024, baseline upstream receiving water temperature in LAR5 prior to any discharge from the DCTWRP was 74°F with a temperature of 75°F in LAR4 below Sepulveda Dam, or an apparent WRP-influenced ΔT of 1°F (**Figure 48**). When effluent temperature is set to the upstream receiving water temperature and flow is maintained, LA River temperature quickly increases to 75°F within about 2 miles between Van Nuys Blvd and Fulton Avenue. Thus, natural ΔT is also 1°F without thermal addition from the DCTWRP. Based on the model results, the estimated distance downstream of the DCTWRP discharge under the influence of temperature addition by the WRP is less than 2 miles in June, and the actual ΔT below DCTWRP, considering the other factors affecting stream temperature, is estimated to be 0°F (negligible).

In July (16th) and August (6th), baseline upstream receiving water temperatures were 78°F and 82°F, respectively. The apparent WRP-influenced ΔT of both months was less than 1°F in LAR4 below the Sepulveda Dam (**Figure 48**). Without thermal addition from the DCTWRP, there is virtually no effect of other temperature modulating factors in LAR4 during these months: receiving water temperature remains within one degree or less of 78°F and 82°F, respectively, in the LA River from above the DCTWRP all the way to its confluence with the BWC in both July and August. The estimated distance downstream of the DCTWRP discharge under the influence of heat addition by the WRP July and August is less than 1 mile.

5.2.2.2 Estimated Thermal Effects of BWRP Effluent

The estimated extent of thermal effect of effluent from the BWRP in January, June, July, and August 2024 are shown in **Figure 49**, panels A-D, respectively. The downstream distance evaluated extends approximately 2.7 miles in the BWC to the confluence with the LA River between LAR4 and LAR3. The BWC above and below BWRP EFF 001 to the confluence with the LA River is concrete with an open (or minimally shaded) box channel.

On January 9, 2024, baseline upstream receiving water temperature was 52°F (**Figure 49**). Immediately below the BWRP outfall, receiving water temperature increased to 63°F after the addition of the effluent from the WRP (apparent WRP-influenced ΔT of approximately 11°F), then gradually declined to 55°F after 2 miles just before the confluence with LA River (ΔT of approximately 3°F). Without thermal addition from BWRP, there is little effect of other temperature modulating factors in the BWC during January: receiving water temperature declines slightly to 51°F in the BWC from above the BWRP all the way to its confluence with the

LA River (natural ΔT of approximately -1°F). The estimated distance downstream of BWRP discharge under the influence of heat addition by the WRP is the 2 miles of the BWC in January.

On June 18, 2024, baseline upstream receiving water temperature was 67°F (**Figure 49**). Immediately below the BWRP outfall, receiving water temperature increased to 76°F after the addition of the effluent from the WRP (apparent WRP-influenced ΔT of approximately 9°F), then gradually declined to between 72 and 73°F after a little over 1 mile (ΔT of approximately 5 - 6°F). Without any thermal addition from BWRP, receiving water temperature increases by approximately 5°F from above the BWRP outfall to a little over 1 mile below it due to heat addition from ambient air temperature, concrete substrate, and solar heating (natural ΔT of approximately 5°F). Based on the model results, the estimated distance downstream of BWRP discharge under the influence of heat addition by the WRP is a little over 1 mile in June, and the actual ΔT (apparent WRP-influenced ΔT minus natural ΔT) is estimated to be approximately 4°F.

Results were similar in July, but where baseline upstream receiving water temperature was 70°F and 79°F after the addition of the effluent from the BWRP (apparent WRP-influenced ΔT of approximately 9°F), after which river temperature gradually declined to 78°F after a little over 1 mile (ΔT of 8°F) (**Figure 49**). In July, without thermal addition from BWRP, river temperature increases by approximately 7°F from above the BWRP outfall to 1 mile below it, suggesting natural ΔT is approximately 7°F when taking into account heat addition from ambient air temperature, concrete substrate, and solar heating in the BWC that month. Based on the model results, the estimated distance downstream of BWRP discharge under the influence of heat addition by the WRP is also a little over 1 mile in July, and the actual ΔT is estimated to be only 2°F.

In August, baseline upstream receiving water temperature was 72°F and 81°F after the addition of the effluent from the BWRP (apparent WRP-influence ΔT of 9°F), but then increased to 82°F approximately 1.5 miles farther downstream (**Figure 49**). In August, without thermal addition from BWRP, river temperature increases by approximately 10°F when taking into account heat addition from ambient air temperature, concrete substrate, and solar heating in the BWC that month. Based on the model results, the estimated distance downstream of BWRP discharge under the influence of heat addition by the WRP is about 1.5 miles in August, and the actual ΔT is estimated to be negligible.

5.2.2.3 Estimated Thermal Effects of LAGWRP Effluent

The estimated extent of thermal effect of effluent from LAGWRP in January, June, July, and August 2024 is shown in **Figure 49**, panels A-D, respectively. The downstream distance evaluated extends past the boundary between LAR3 and LAR2 to approximately 3 miles below the confluence of the LA River with Arroyo Seco; nearly 8 miles in total. The substrate in part of LAR3 is unlined with an open trapezoidal improved channel and with relatively good riparian corridor for the first 1 to 2 miles below LAGWRP, before transition in LAR2 back to an all concrete substrate with an open trapezoidal channel.

On January 9, 2024, baseline upstream receiving water temperature was 52°F (**Figure 50**). Immediately below the LAGWRP outfall, receiving water temperature increased to 54°F after the addition of the effluent from the WRP, then gradually re-equilibrated back to between 51 and 52°F after 2 miles (WRP-influenced ΔT of <1°F). Based on the model results, the estimated distance downstream of LAGWRP discharge under the influence of heat addition by the WRP is 2 miles in January. Without thermal addition from LAGWRP, there is a very slight (roughly 0.5°F) decline in river temperature up to 4 miles downstream, possibly due to the influence of groundwater infusion over this stretch of the reach. No other apparent effect of heating from ambient air temperature or concrete or solar radiation was observed in January.

On June 18, 2024, baseline upstream receiving water temperature was 72°F (**Figure 50**). Immediately below the LAGWRP outfall, receiving water temperature increased to 73°F after the addition of the effluent from the WRP, then rapidly declined back to 72°F after less than 0.5 mile. The estimated distance downstream of LAGWRP discharge under the influence of heat addition by the WRP is less than 0.5 mile. In June, without thermal addition from LAGWRP, river temperature does not change from below the WRP outfall to over 6 miles below it. No influence of any other temperature modulating factor was observed in the LA River over the stretch.

Results are similar in July, but where baseline upstream receiving water temperature was 77°F and where immediately below the LAGWRP outfall, ΔT is less than 0.5°F after only several hundred yards (**Figure 50**). In July, without thermal addition from LAGWRP, a negligible increase in river temperature occurs below the LAGWRP outfall to over 6 miles below it. Also, no influence of any other temperature modulating factor was observed in the LA River over the stretch.

In August, baseline upstream receiving water temperature was 83°F and no thermal effect was observed immediately below the LAGWRP to over 6 miles below it (**Figure 50**). Also, no influence of any other temperature modulating factor occurred in the LA River over the stretch.

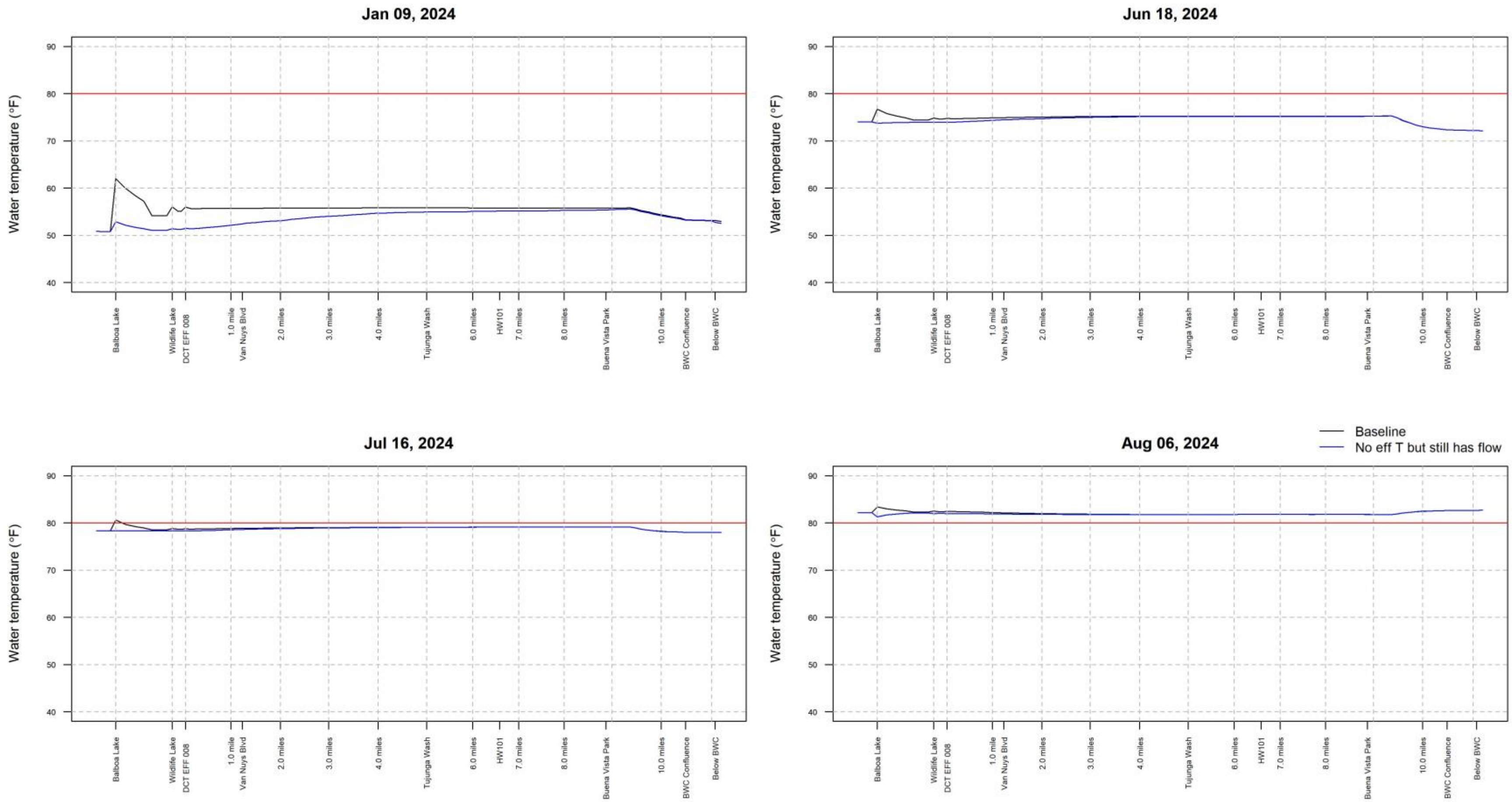


Figure 48. Current Thermal Effect Downstream of DCTWRP Effluent

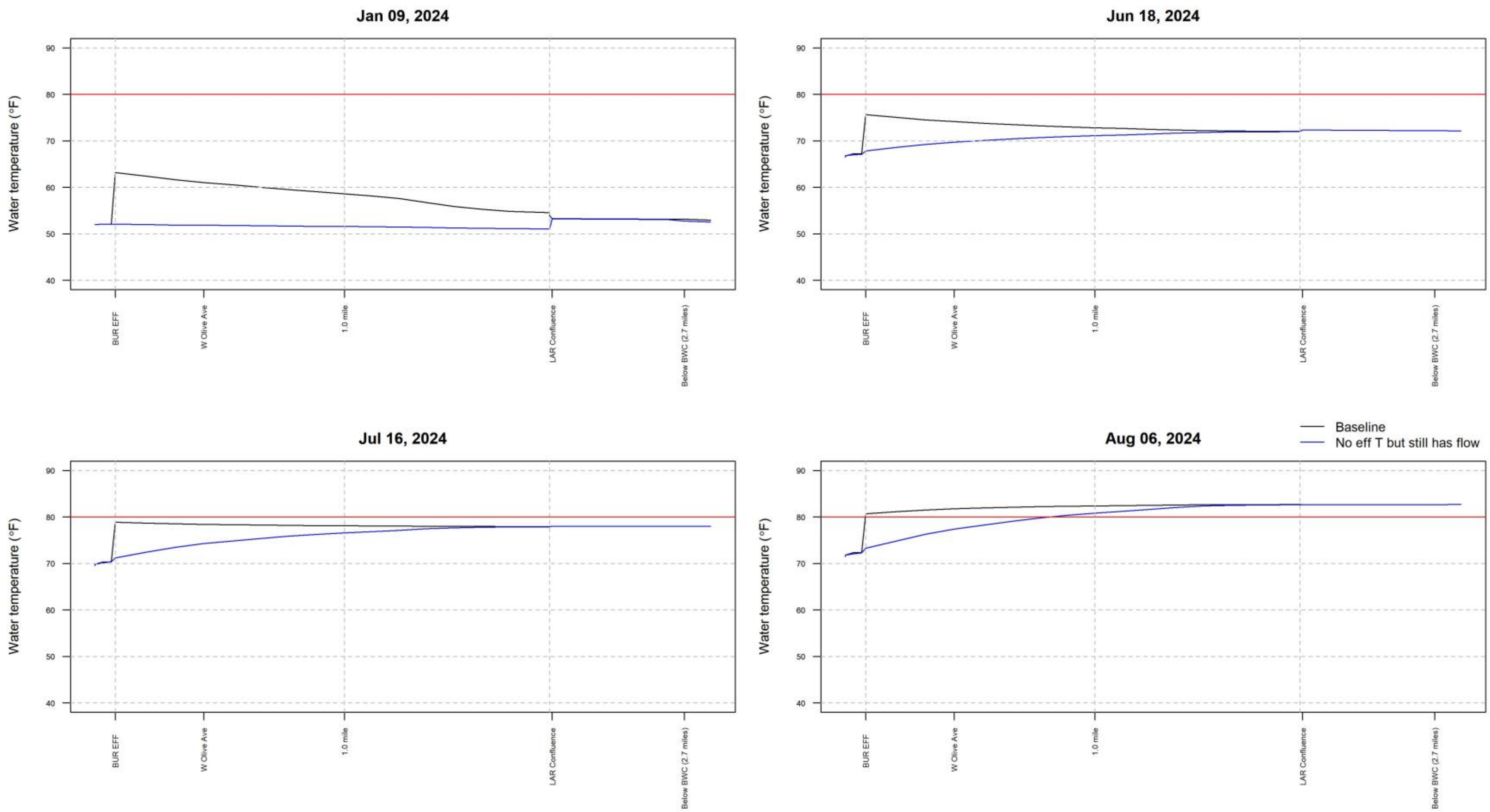


Figure 49. Current Thermal Effect Downstream of BWRP Effluent

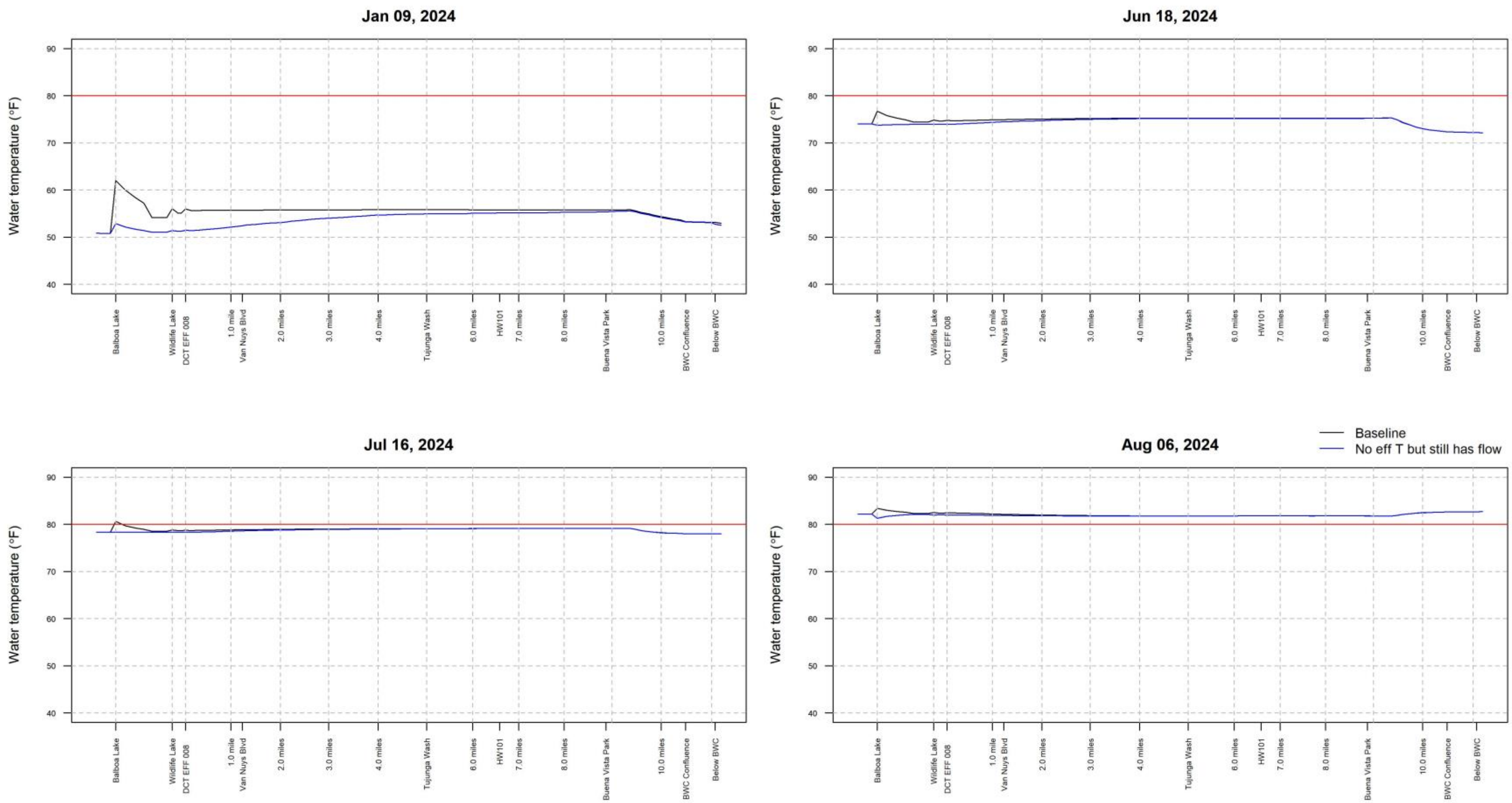


Figure 50. Current Thermal Effect Downstream of LAGWRP Effluent

5.2.3 Findings: Temperature Data

Maximum daily water temperatures above the DCTWRP and LAGWRP (i.e., without WRP influence) consistently exceeded 80°F in late spring through early fall. Maximum daily water temperatures above the BWRP also exceeded 80°F, though less frequently than DCTWRP and LAGWRP. Data from this Study shows the influence of heat from WRP effluent on receiving water river temperature downstream is seasonally dependent, with indications of WRP-specific thermal inputs residing for a slightly longer downstream distance in winter, and much short downstream distances beginning late spring through summer. The influence of heat from WRP effluent on downstream receiving water temperature is also location dependent, with slightly longer downstream distances in the BWC below BWRP and much shorter distances below the DCTWRP in LAR5 and LAR4, and even shorter distances below LAGWRP in LAR3. However, the influence of other temperature modulating factors (i.e., primarily ambient air temperature but with smaller contributions from concrete substrate, solar heating, and groundwater input in LAR3) is also much greater in the BWC compared to both LAR4 below DCTWRP and LAR3 below LAGWRP.

Modeling analysis allowed estimation of the distance downstream in the LA River and BWC of discharge under the influence of thermal input from each WRP on a seasonal basis and before other factors affecting river temperature become more influential and controlling. The estimated distance downstream in the LA River and BWC of discharge under the influence of thermal input from each WRP is between 2 and 5 miles in the winter and less than 0.5 to 2 miles in the summer. Water temperature in other portions of these waterbodies is the result of ambient conditions and other factors affecting temperature besides WRP effluent temperature.

5.3 Biology

As described in the Workplan (LWA 2024), and as previously stated, this Study was implemented to better understand and characterize the relationship between effluent temperature and temperature impacts to the WARM beneficial use in the LA River downstream of the DCTWRP, LAGWRP, and BWRP discharges. Chief among the beneficial uses of water that support warm water ecosystems is the preservation or enhancement of warm water aquatic habitats and the associated warm water biological community. Ultimately, this Study is meant to help ensure the potential impacts of the WRPs' effluent temperature are well understood and any temperature control measures proposed or implemented will achieve the intended outcome in terms of beneficial use protection, while also considering the potential adverse implications related to climate change, energy use and GHG emissions, and impacts to the communities of Los Angeles.

This section summarizes the biological data collected in the LA River mainstem (Reaches 1 - 6), the BWC, and in several tributaries of relevance and applicability to the Study and Study area (**Figure 1**). Biology in the surrounding tributaries was included in the summary and analysis to maximize the use of all relevant biological data available and because habitat conditions and physical characteristics in these waterbodies are the same or similar to the LA River mainstem. The section is organized by taxa type in order of relative sensitivity to water temperature, beginning with vertebrates (freshwater fish and aquatic life stages of amphibians, emphasized), followed by invertebrates (i.e., benthic macroinvertebrates, or BMI), and then by diatoms and soft algae. The section ends with a summary of preliminary findings and key observations.

5.3.1 Vertebrates

Aquatic and aquatic-dependent vertebrate communities of the LA River watershed are well documented. Occurrence information for vertebrates (fish and aquatic-dependent amphibians, reptiles, and birds) in the Study area is available from professional and community-contributed observation reporting for academic research and on-going initiatives on the LA River, or from academic and government research related to native species conservation and recovery. Additional information is available through collaborative studies which use environmental DNA (eDNA) methodologies to evaluate riverine communities. The summary below includes reviews of information on current and historical occurrences of vertebrates in what are now the urbanized areas of the LA River to develop a list of current taxa in the LA River watershed.

5.3.1.1 Fish

Due to the Mediterranean climate, fish habitats in southern California change naturally due to highly variable water flow regimes and seasonally high water temperatures (Swift and Seigel 1993, USFWS 2015, Mongolo et al. 2017, Drill et al. 2023). The coastal lowlands of the Los Angeles region are no exception. The inland portions of the LA River were historically known to host a small and highly endemic native freshwater fish fauna composed of at least seven species: Pacific brook lamprey (*Lampetra pacifica*), Pacific lamprey (*Entosphenus tridentata*), unarmored three-spine stickleback (*Gasterosteus aculeatus williamsoni*), southern steelhead/rainbow trout (*Oncorhynchus mykiss irideus*)[19], arroyo chub (*Gila orcuttii*), Santa Ana sucker (*Catostomus santaanae*), and Santa Ana speckled dace (*Rhinichthys osculus*) (Swift and Seigel 1993). Five of the native fish species were permanent residents prior to substantial modification and channelization of the

[19] These are the same species; however, steelhead are anadromous, or sea-run trout, while rainbow trout spend their lives entirely in freshwater.

LA River to promote flood control. Two of the species, southern steelhead and Pacific lamprey, formerly migrated from the ocean in mid-winter to spawn in the main river and in its larger tributaries of Big Tujunga Creek and Arroyo Seco. Today, all of the native fish species are extirpated from the mainstem of LA River, although a couple of these native fish species (arroyo chub, Santa Ana sucker) reportedly persist in some of the tributaries. No native fish species of the LA River apparently remained extant for more than several years following the initial channelization of the LA River that occurred in 1938 (Hall and Litton 2008).

Prior to channelization, the LA River supported a seasonal recreational fishery, mainly comprised of an annual winter run of steelhead trout. As noted, following channelization of the LA River, steelhead trout and other native species of the fishery disappeared, with the last known steelhead caught in the LA River in 1940 (FOLAR 2008). Native fishes in the LA River have since been replaced by a variety of non-native species. In 2007, Friends of the Los Angeles River (FOLAR) surveyed the current fish population in the Glendale Narrows area, sampling on four occasions both before and after significant rainfall events in the late summer and fall. Of the 1,200 fish caught in the 2007 fish study within the targeted area all were non-native. Mosquitofish (*Gambusia affinis*) and tilapia (*Oreochromis* sp.) were the most abundant, and common carp (*Cyprinus carpio*), fathead minnow (*Pimephales promelas*), and green sunfish (*Lepomis cyanellus*) were also common (FOLAR 2008). The fish caught in this study were:

- Fathead minnow (*P. promelas*)
- Common carp (*C. carpio*)
- Black bullhead (*Ameiurus melas*)
- Amazon sailfin catfish (*Pteroplichthys pardalis*)
- Mosquitofish (*G. affinis*)
- Green sunfish (*L. cyanellus*)
- Largemouth bass (*Micropterus salmoides*)
- Goldfish (*Carasius auratus*)
- Tilapia (*Oreochromis* sp.)

Fathead minnow, goldfish, and mosquitofish have been present since the 1950s in southern California drainages, and tilapia have been found in California coastal drainages since the 1990s (Swift and Seigel 1993). Species also noted in the FOLAR study (2008) in the LA River include: bluegill (*Lepomis macrochirus*), brown bullhead (*Ameiurus nebulosus*), and channel catfish (*Ictalurus punctatus*).

Using a variety of approaches including field studies and other data sources to document fish species present in the LA River and basin (Drill et al. 2023), 29 species were documented (including four brackish and marine fish species) in 462 occurrences observed from 2007-2020. Additionally, Drill et al. 2023 conducted field studies extending from headwaters streams through hydrologically linked waterways to the LA River Estuary. Field studies conducted by the authors found 17 of the 29 documented species (**Table 27**). Three of four native freshwater species (rainbow trout, Santa Ana speckled dace, and Santa Ana sucker) were found in the upper (mountainous) headwater tributaries among 27 occurrences (5.8% of total) of the total 462 occurrences. Native species were not found in the middle reaches, tributaries, or main stem of the LA River, which included connected lakes.

It is worth noting that Lake Balboa, within the Sepulveda Basin, has previously been stocked with rainbow trout, largemouth bass, and other fish species (Los Angeles River Revitalization Corporation 2011).

Additional fish occurrence information was acquired through a query of results of coordinated Environmental DNA (eDNA) surveys conducted in the LA River between 2020-2021. Data from three sampling periods were accessed through the eDNA Explorer website.[20] During the study, 474 samples with a median of 36 samples per site were processed from 12 locations in the LA River watershed. During the query process, the following filters were selected for the eDNA data to generate a taxa list:

- Taxonomic Level: Genus
- Confidence Level (level of agreement of results with known eDNA results): 4 out of 5
- Read Filtering: 2 (removal of results with less than 2 reported reads), and
- Read Filtering: 1 (minimum number of overall reads per sample)

Due to the limitations of using eDNA to determine species presence (namely the reliance on reference databases against which new data is compared), it is common for eDNA reads to be misattributed to closely related, but incorrect, species (often a closely related taxon in a reference database). For this reason, results were retrieved at the genus level, which provides higher confidence in taxonomic assignment. For most fish known to occur in the LA River, and for all native fish species, the occurrence of the genus in the system is monospecific (the commonly occurring exceptions are non-natives: two species of bullheads [*Amereirus*], at least two species and hybrids of sunfish [*Lepomis*], and a complex of tilapia [*Oreochomis*] species).

The list of taxa generated by this process was refined using best professional judgment (BPJ). Marine taxa were removed from the list, and the freshwater taxa results were cross-referenced with previously documented fish occurrences in the LA River. Thirteen fish taxa previously reported in the LA River were also detected through eDNA analysis (**Table 27**). Five additional taxa were reported in the eDNA results, but due to the limited numbers of reads and sampling locations, these cannot be definitively included in the LA River's fish fauna. These taxa include: *Salmo* (most likely brown trout, historically stocked as game fish); *Corydoras* (a common aquarium taxa subject to hobbyist release), *Acanthogobius* (which includes the yellowfin goby, an invasive species throughout California); *Cottus* (sculpin, which could represent a native species but also includes non-native taxa including aquarium specimens); and *Eleotris* (sleeper, another species commonly kept as aquarium specimens). Further investigation is needed to confirm their presence in the Study area.

Combining the data sources, it appears that 24 species of freshwater fish in 22 genera, plus three genus-level taxa already represented are currently found in the LA River watershed, including mountainous, non-urbanized regions in the Upper Watershed and Headwaters for the river (**Table 27**). Of those, four (arroyo chub, rainbow trout/southern steelhead, Santa Ana speckled dace, and Santa Ana sucker) are native species. The occurrence of another five genera is suggested based on eDNA results but lack physical confirmation of presence. In the Study area, the number of fish taxa are highest in LAR3 and LAR5, downstream of the discharges of the LAG and DCT WRPs due to these reaches having the most suitable habitat (e.g., soft-bottom channel) for fish in the Study area.

[20] https://www.ednaexplorer.org/

Table 27. Freshwater Fish Species Known to Currently Occur in the LA River Watershed

Common Name	Taxa	Native	Reach/Tributary[1]															Sources[2]
			Study Area Waterbodies						Non Study Area Waterbodies									
			R1	R2	R3	R4	R5	BWC	R6	CC	RH	AS	VW	TW	UW	HW	L	
Alligator Gar	*Atractosteus spatula*											X					X	D
Arroyo Chub	*Gila orcutti*	X												X		X		S, D, E
Black Bullhead	*Ameiurus melas*				X		X									X	X	F, D
Bluegill	*Lepomis macrochirus*				X												X	F, D
Brown Bullhead	*Ameiurus nebulosus*				X													F
Bullhead	*Ameiurus*													X				E
Common Carp	*Cyprinus carpio*				X		X			X		X					X	F, D, E
Channel Catfish	*Ictalurus punctatus*			X	X							X					X	F, D, E
Convict Cichlid	*Amatitlania nigrofasciata*																X	D
Fathead Minnow	*Pimephales promelas*		X	X	X		X			X		X		X		X	X	S, F, D, E
Giant Gourami	*Osphronemus goramy*																X	D
Golden Shiner	*Notemigonus crysoleucas*						X											D
Goldfish	*Carassius auratus*				X		X									X	X	S, F, D, E
Green Sunfish	*Lepomis cyanellus*				X		X									X	X	F, D
Largemouth Bass	*Micropterus salmoides*				X		X							X			X	F, D, E
Mississippi Silverside	*Menidia audens*				X													D
Pacu	*Colossoma macropomum*				X												X	D
Pond Loach	*Misgurnus anguillicaudatus*				X						X			X				D, E
Rainbow Trout	*Oncorhynchus mykiss*	X										X		X		X	X	D, E
Santa Ana Speckled Dace	*Rhinichthys osculus ssp.*	X												X		X		D, E
Santa Ana Sucker	*Catostomus santaanae*	X														X		S, D
Silverside	*Menidia*																X	D
Sailfin Armored Catfish	*Pterygoplichthys*				X		X									X	X	F, D, E
Sunfish	*Lepomis*		X	X	X		X			X		X	X	X				D, E
Threadfin Shad	*Dorosoma petenense*																X	D
Tilapia	*Oreochromis*		X	X	X		X			X		X		X	X		X	S, F, D, E
Western Mosquitofish	*Gambusia affinis*		X	X	X	X	X		X	X	X	X		X	X	X		S, F, D, E

1. R = LA River Reach Number; BWC = Burbank Western Channel; CC = Compton Creek; RH = Rio Hondo; AS = Arroyo Seco; VW = Verdugo Wash; TW = Tujunga Wash; UW = Upper Watershed; HW= Headwaters; L = Lakes
2. S = Swift and Seigel 1993; F = FOLAR 2008; D = Drill et al. 2023; E = eDNA Explorer 2024

5.3.1.2 Aquatic-dependent Amphibians and Reptiles

Historically, the native aquatic or aquatic-dependent amphibian and reptile species found along the LA River included one salamander, seven frogs, one turtle, and one snake species (Bezy et al. 1993). Of these, two native frog species, Western toad (*Anaxyrus boreas*) and Baja California tree frog (*Pseudacris hypochondriaca*), are still observed in the urbanized portion of the LA River watershed in addition to two introduced frog species, American bullfrog (*Lithobates catesbeianus*) and African clawed frog (*Xenopus laevis*) (Bezy et al. 1993, iNaturalist 2023a). The remaining native frog species, the salamander, and the snake are still reported in the mountainous habitat of the LA River watershed, but not in the Study area. Western pond turtle (*Actinemys marmorata*) was considered extirpated (locally extinct) along the LA River by Bezy et al. (1993), but occasional observations of suspected western pond turtle individuals are made in Sepulveda Basin, and the California Natural Diversity Database (CNDDB) considers a local population to be present (CNDDB 2023, iNaturalist 2023b). Two other turtle taxa, pond sliders (*Trachemys scripta*), including red-eared slider (*T. s. elegans*) and spiny softshell turtle (*Apalone spinifera*), are observed frequently (iNaturalist 2023c), and have likely become naturalized in the LA River. Occasional reports of other non-native turtle species probably represent observations of released single individuals previously kept as exotic pets.

Findings from eDNA testing for aquatic or aquatic-dependent amphibians and reptiles, described above, were not definitive. The presence of Ranidae frogs, which includes American bullfrog, was indicated in the Sepulveda Basin and LA River Reach 3 (eDNA Explorer). The turtle genus *Trachemys* was detected at Sepulveda Basin, Bull Creek, Compton Creek and Tujunga Wash, which is consistent with observations of pond sliders in the LA River watershed.

5.3.1.3 Birds (Aquatic-dependent)

Aquatic-dependent birds supported along the LA River fall into broad groups and include: waterbirds, such as waterfowl (ducks and geese); wading birds (herons and egrets); shore birds (sandpipers and black-necked stilts [*Himantopus mexicanus*]); occasional seabird (gulls, terns, or cormorants); and marsh or riparian obligate bird species for which water-supported vegetation and habitat are essential. Aerial insectivores such as swallows and flycatchers may also take advantage of open-water habitat of the LA River.

Stein et al. (2021a) identified four broad habitat types that support bird communities along the LA River: wading shorebird habitat, freshwater marsh habitat, riparian habitat, and warm water habitat. While these habitat types have been refined and added to by other authors (Cooper et al. 2022), these habitats have been studied in the LA River and serve as an adequate baseline for initial evaluation of the aquatic-dependent bird community of the river. Each of these is described at a community level below. Extensive species lists from academic and environmental studies, as well as checklists of observations from birding community and naturalist's reporting groups, are available.

Wading shorebird habitat in non-estuarine regions of the LA River are found in areas with cement bottoms and a consistent, shallow water flow outside of the storm season that supports the formation of algal mats and biofilms in the stream flow. These mats support flying insects and other invertebrates whose aquatic life stages provide abundant foraging for shorebirds (Cooper 2006). Cooper (2006) observed 22 species of shorebirds in eight surveys of the lower LA River in Fall 2000, with more than 15,000 individuals observed in four of the surveys. Black-necked stilt, western sandpiper (*Calidris mauri*), least sandpiper (*Calidris minutilla*), American avocet (*Recurirostra americana*), and long-billed dowitcher (*Limnodromus scolopaceus*) were among the most observed species of shorebirds, mostly in the concrete-lined channel of the LAR near Long Beach, which represents an important resource to shorebirds during fall migration (Cooper 2006). This habitat also supports nesting populations of black-necked stilt, American avocet, and spotted sandpiper (*Actitis macularius*) through summer months and is an important foraging resource for other water birds including waterfowl, wading birds, gulls and terns, and swallows (Copper et al. 2022).

Freshwater marsh habitat is defined by emergent vegetation that grows in submerged sediments with leaves and stems that extend out of the water. In the Study area, this can occur anywhere where low flow is consistent, and sediments build up, and can include areas otherwise identified as concrete-lined (Stein et al. 2021a, Cooper et al. 2022). Freshwater marsh vegetation in the LA River watershed includes cattail (*Typha* spp), water-primrose (*Ludwigia* spp), common reed (*Phragmites australis*), and giant cane (*Arundo donax*), among other species. The protected (State-threatened) tricolored blackbird (*Agelaius tricolor*) nests in cattails and tules, although the nearest known population of the bird was reported to occur in Chatsworth Reservoir and not in the LA River (CNDDB 2023). Other birds that may be found in southern California freshwater marshes include red-winged blackbird (*Agelaius phoeniceus*), yellowthroat (*Geothlypis trichas*), wading birds, and waterfowl (Cooper et al. 2022, SDMMP 2023).

Riparian habitat in the LA River is found in parts of the Sepulveda Basin, on vegetated islands in the Glendale Narrows and Elysian Valley, and along some edges of the river near Willow Street and Compton Creek (Cooper et al. 2022). Because of the diversity of habitats generally found in riparian environments, a variety of birds may nest or forage there, including some without a strong affinity for riparian areas. Riparian-associated birds known to occur in the LA River include yellow warbler (*Setophaga petechia*), yellow-breasted chat (*Icteria virens*), and the protected (Federal and State Endangered) Least Bell's vireo (*Vireo bellii pusillus*), and could include the southwestern willow flycatcher (*Empidonax traillii extimus*; Federal and State Endangered), and several species of hawk (Cooper et al. 2021, CNDDB 2023).

Warm water habitat in the LA River is any flowing or standing water deeper than that which supports wading shorebird habitat (Stein et al. 2021a, Cooper et al. 2022). In the LAR, these areas are typically natural bottomed, and located in the Sepulveda Basin, Glendale Narrows, and the Estuary. These areas support large numbers of waterfowl and wading birds and are likely to be important forage for other fishing waterbirds such as cormorants and aerial insectivores.

5.3.2 Benthic Macroinvertebrates

As early as 2003, California, like several other state and federal agencies, began utilizing standardized sampling and analysis protocols to assess the biological and physical condition of streams and rivers. Specific protocols were established to collect certain types of biological data that together represent different attributes (metrics) of assemblage composition, structure, and function such as species richness, tolerance guilds and trophic guilds. Metrics based on the biological data collected were selected for inclusion in an index of biotic integrity (IBI) based on the responsiveness of the metric to anthropogenic stressor gradients and/or their ability to discriminate between minimally disturbed reference sites and sites known or suspected to have been exposed to stressors of interest. The standardized protocols, which have since been updated and adapted based on years of continued use, quickly became the backbone of California's current bioassessment program (Surface Water Ambient Monitoring Program or SWAMP), which utilizes BMI and diatom and algal communities along with physical/habitat characteristics to determine biological and physical integrity in California streams. In addition, the review considers California Stream Condition Index (CSCI) scores which use BMI data to evaluate the health of streams and rivers, with higher CSCI scores indicating a site is closer to a healthy, natural, or "reference-like" condition.

This section summarizes the BMI data aggregated from publicly searchable databases and results from the supplementary biological sampling implemented during this study, as described in the Workplan (LWA 2024). The combined data represent multiple years of sampling at several recurring stations in the LA River Mainstem (in Reaches 1, 2, 3, 4, and 6) and several tributaries (e.g., Arroyo Seco, Bull Creek, Compton Creek, Rio Hondo, Tujunga Wash, and several smaller tributaries to LAR6), as well as numerous one- or two-time sampling events at different stations scattered throughout the greater heavily urbanized and highly-developed, industrial, commercial, and residential Study area. Sample years date back to 2005. A total of 75 surveys from 42 unique stations with applicable BMI data were evaluated and analyzed for LA River mainstem Reaches 1, 2, 3, 4, and 6, along with a total of 80 surveys from 54 unique stations from 25 different tributaries of different stream orders (see **Appendix 4** for a list of stations, years with BMI data, and site characteristics). The location of BMI stations in the LA River mainstem and tributaries is shown in **Figure 51** and **Figure 52**.

All BMI data were collected using data collection and laboratory analysis methodologies based on SWAMP or SWAMP precursor procedures to estimate the biological condition in California inland waters, although the sampling procedures used since 2017 follow the procedures for the *Collection of Field Data for Bioassessments of California Wadeable Streams: Benthic Macroinvertebrates, Algae, and Physical Habitat* (Ode et al. 2016). The BMIs collected are identified to Level 2A as specified by the Southwest Association of Freshwater Invertebrate Taxonomists, Standard Taxonomic Effort (SAFIT; Richards and Rogers 2011), and taxonomic identification is standardized with Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT) usage. BMI taxa count and relative abundance were evaluated and analyzed at the family level, unless lowest identification was at a higher level, in which case the original identification was retained as reported (e.g., seed shrimp which are commonly identified to Order: Ostracoda). This was necessary because a much smaller set of observations was identified to genus/species, which dictated the use of the lowest common denominator to generate the highest record count. The use of BMI data at this level, denoted hereafter as Family+, was deemed appropriate and sufficient for both qualitative summary overview description and quantitative analysis.

Data was sufficient to determine the BMI present now and over the last 20 years in most of the Study area and to characterize the relationship between likelihood of BMI occurrence and waterbody temperature based on a taxon's location in the LA River.

As part of this study, critical questions to the Study objectives are: Is the BMI community different upstream and downstream of the WRPs in the relevant, WRP-associated reaches of the LA River? If biology is different, is it because of WRP effluent temperature? This section summarizes the available BMI data from the study area (2005 through 2024) to support assessment of BMI in the context needed for addressing Study objectives. **Appendix 5** provides descriptive summary tables of BMI in the LA River reaches and tributaries critical for addressing the objectives of the Study. The BMI data summarized in the appendix is normalized to the Family+ level, as described above. A full list of BMI taxa found present at all LA River stations and the years they were sampled is provided in **Appendix 2**, along with indication of expected temperature and general pollution tolerance based on the literature. Below is a descriptive (Qualitative) overview of BMI taxa found in LA River mainstem reaches followed by tributaries to the mainstem. Results of quantitative analysis of the BMI data are found in **Section 5.3.4**.

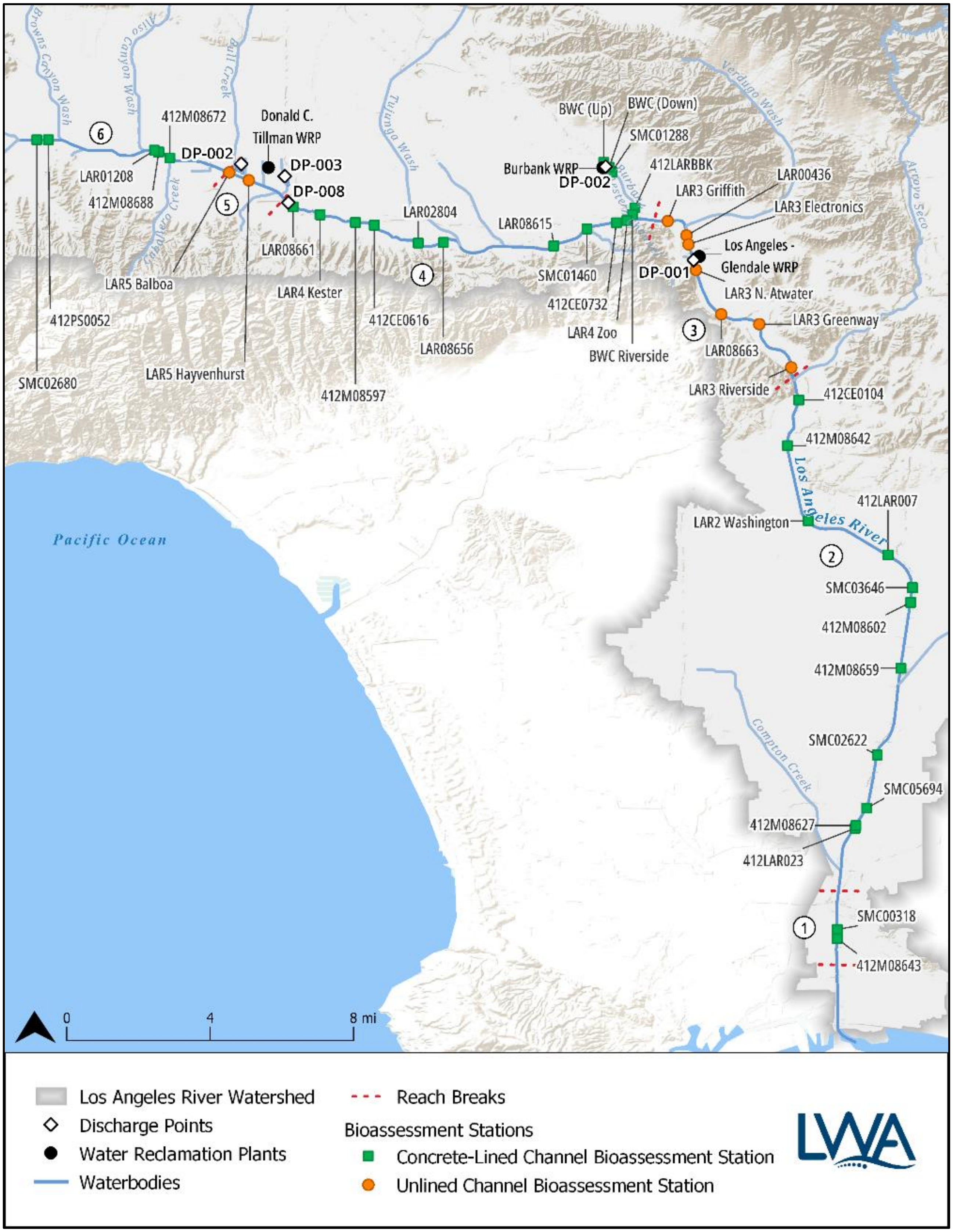


Figure 51. Bioassessment Stations on the LA River Mainstem and Burbank Western Channel

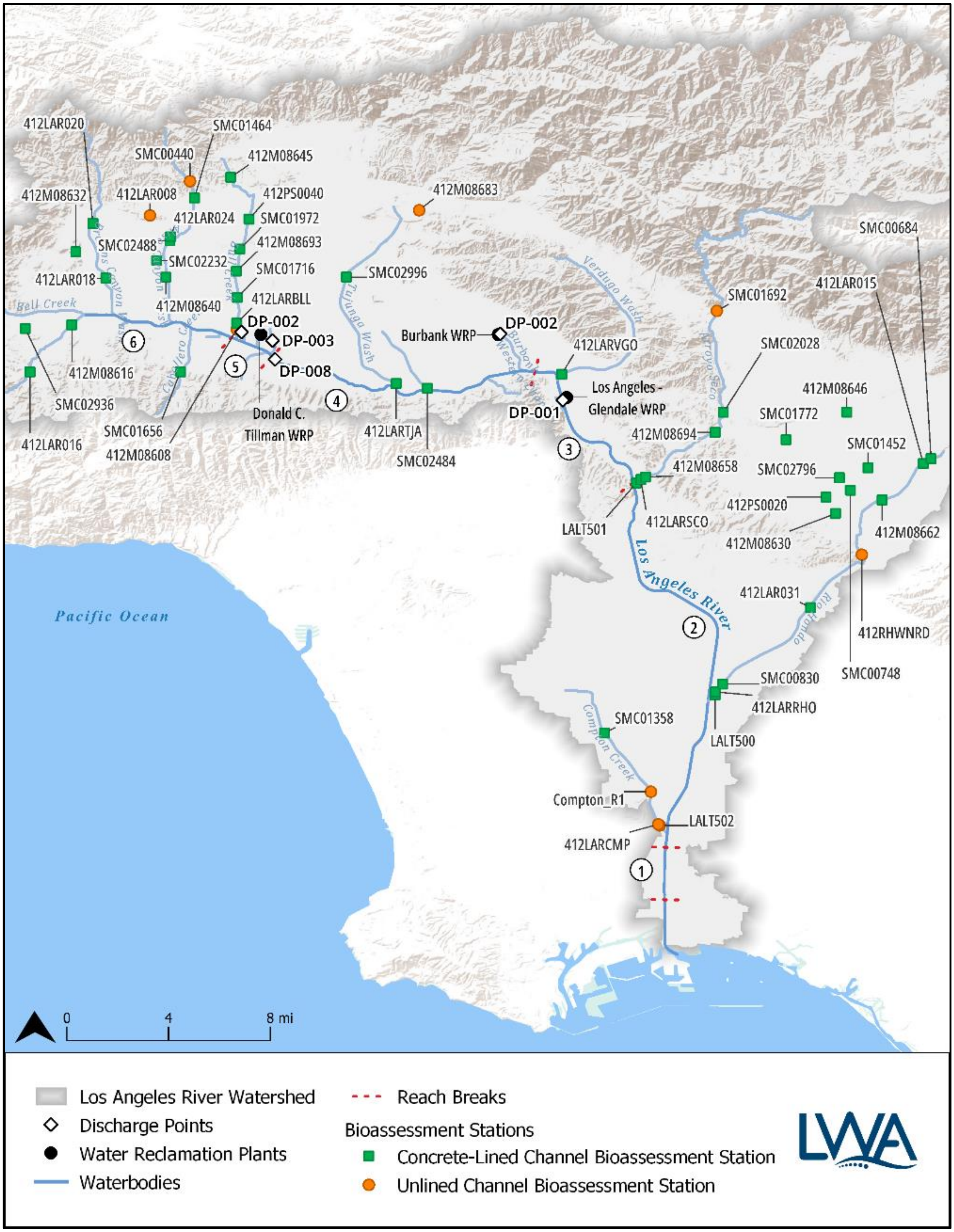


Figure 52. Bioassessment Stations on Tributaries to LA River

5.3.2.1 LA River Mainstem Reaches 1, 2, 3, 4, and 6 and BWC

BMI data for LAR1 exists for two stations. Station 412M08643 includes BMI data collected in 2018, while Station SMC00318 includes data collected in 2010, 2019, and 2021 through 2023 (**Figure 51**). The three most prevalent Family+ taxa at both stations and all years sampled included: Chironomidae, Ostracoda, and Oligochaeta. These three taxa consistently accounted for 97 to 100% of all BMI at these locations. The number of distinct taxa represented in LAR1 ranged from nine at Station 412M08643 in 2018 to 22 at Station SMC00318 sampled in 2023. The number of distinct taxa at Station SMC00318 varied from between 13 in 2010 to 22 in 2023. The average number of distinct taxa represented for the reach is 16. CSCI scores ranged from 0.33 at both Station 412M08643 in 2018 and Station SMC00318 in 2021 to 0.54 at Station SMC00318 in 2022 and averaged 0.41 overall for the six scores reported in the reach. The substrate in LAR1 is concrete with an open trapezoidal channel.

BMI data for LAR2 exists for 11 stations representing years spanning 2005 through 2024 (**Figure 51**). Only one Station LAR2 Washington (SMC03902) was sampled repeatedly over that period (in 2008 and 2024); BMI data for two stations (412CE0104 and SMC02228) were combined due to proximity. The most prevalent Family+ taxa occurring in the lower first half of the reach were the same as in LAR1: Chironomidae, Ostracoda, and Oligochaeta, with Baetidae, Hyalellidae, Hydroptilidae, and Simuliidae becoming more prevalent in the upper half of the reach ending at the confluence with Arroyo Seco. These seven taxa accounted for 93 to 100% of all BMI at these locations. The number of distinct taxa represented in LAR2 ranged from two at Station LAR4 Kester (412LAR023) in 2005 to 31 at Station LAR2 Washington sampled in 2024. The average number of distinct taxa represented for the reach is 19. CSCI scores ranged from 0.35 at Station 412M08627 in 2017 to 0.72 at Station 412M08642 in 2018 and averaged 0.56 overall for nine scores from in the reach. The substrate in LAR2 is concrete with an open trapezoidal channel.

BMI data for LAR3 exists for seven stations representing years spanning 2009 through 2024 (**Figure 51**). Station LAR3 Griffith (LAR04532) lies at the top of the reach above the confluence with Verdugo Wash and below the confluence with the BWC. Stations LAR00436 and LAR3 Electronics lie above LAGWRP and Station LAR3 N. Atwater (LAR10210) lays immediately below it. Stations LAR08663, LAR3 Riverside, and LAR3 Greenway (LAR08599) are all downstream of LAR3 N. Atwater by various distances and span the remaining portion of Glendale Narrows. The nine most prevalent Family+ taxa throughout the reach included: Baetidae, Chironomidae, Hyalellidae, Hydropsychidae, Leptohyphidae, Oligochaeta, Ostracoda, Pyralidae, and Turbellaria; four of the eight taxa differ from the most prevalent Family+ taxa found downstream in LAR2 (Hydropsychidae, Leptohyphidae, Pyralidae, Turbellaria). Species within these nine taxa accounted for 84 to 97% of all BMI at these locations, with Baetidae, Hyalellidae, Leptohyphidae, and Turbellaria dominating relative abundance immediately below LAGWRP and Chironomidae, Oligochaeta, and Ostracoda dominating immediately above LAGWRP. The number of distinct taxa represented in LAR3 ranges from 14 at Station LAR3 Greenway at the bottom of Glendale Narrows in 2018 to 45 at the same station sampled in 2020, indicating substantial variability in number of distinct taxa present between sample years at this station. The average number of distinct taxa represented for the reach was 26 both upstream and downstream of LAGWRP. CSCI scores ranged from 0.59 at Station LAR3 Greenway in 2018 to 0.84 at Station LAR08663 in 2021 and averaged 0.70 overall for the 20 reported scores in the reach. The substrate in LAR3 is mixed with an open trapezoidal improved channel.

The BWC discharges to the LA River at the boundary between LAR3 and LAR4. BMI data for the BWC is limited in comparison to the LA River mainstem. Data representing the years 2005 and 2024 exists for five stations (**Figure 51**). Stations 412LARBBK (sampled in 2005) and BWC Riverside (sampled in 2024) lie short distances above the confluence with the LA River mainstem at the bottom of the BWC. Station SMC01288 sampled in 2008 and BWC (Down) sampled in 2024 lie near one another and immediately below BWRP. Station BWC (Up), also sampled in 2024, lies immediately above BWRP. The Family+ taxa present at 412LARBBK was limited to just Chironomidae and Oligochaeta, while the Family+ taxa at BWC Riverside included Baetidae, Chironomidae, Simuliidae, Leptohyphidae, and Oligochaeta. Most prevalent Family+ taxa are similar above and below BWRP and included: Baetidae, Chironomidae, Hydroptilidae, and Oligochaeta. The taxa represented by these four Family+ taxa accounted for 97 to 100% of all BMI at these locations. The average number of distinct taxa represented for the BWC is 13. Based on the number of distinct taxa determined in 2024 alone, taxa numbers increased from 11 far downstream at BWC Riverside to 18 just below the BWRP at BWC (Down) followed by 23 above the BWRP at BWC (Up). CSCI scores ranged from 0.56 at Station BWC Riverside to 0.66 at Stations BWC (Down) and BWC (Up) in 2024 and averaged 0.63 overall for the three reported scores in the reach. The substrate in the BWC is concrete with an open box channel.

BMI data for LAR4 exists for 10 stations representing years spanning 2006 through 2024 (**Figure 51**). Four stations (412M08659, 412CE0732, 412CE0616, and LAR4 Kester [LAR0232]) include repeat sampling. Station LAR4 Zoo (412M08659) includes consecutive sampling in 2023 and 2024, while stations 412CE0732 and 412CE0616 include sampling eight years apart in 2007 and 2015. Farther upstream, Station LAR4 Kester includes repeat sampling beginning in 2006 with consecutive annual sampling from 2015 to 2021 and most recently in 2024 (for this Study). Station LAR08661 lies at the top of the reach below the discharge of DCTWRP outfall Eff 008, and is followed by five stations: LAR4 Kester, 412M08597, 412CE0616, LAR02804, and LAR08656 traveling downstream and ending just above the confluence with Tujunga Wash. These are followed by four more stations: LAR08615, SMC01460, 412CE0732, LAR4 Zoo ending just above the confluence with the BWC. LAR4 is the most characterized LA River reach in the Study area in terms of both spatial and temporal sampling. The nine most prevalent Family+ taxa throughout the reach included: Baetidae, Chironomidae, Corixidae, Hyalellidae, Oligochaeta, Ostracoda, Psychodidae, Pyralidae, and Simuliidae; two of the nine taxa differ from the most prevalent Family+ taxa found downstream in LAR3 (Corixidae and Psychodidae). The nine taxa accounted for 85 to 100% of all BMI at these locations. The number of distinct taxa represented in LAR4 ranged from 15 at Station 412CE0732 near the bottom of LAR4 in 2007 to 63 at Station 412M08597 near Hazeltine Ave just below Van Nuys Blvd sampled in 2015. The average number of distinct taxa represented for the reach is 25. The number of distinct taxa represented at Station LAR4 Kester, which lies a short distance below DCTWRP outfall 008, also averages 25 but has varied historically from a low of 17 in 2020 to 35 in 2024 and 38 in 2006, again indicating substantial variability in number of distinct taxa present among sample years. CSCI scores ranged from 0.59 at Station LAR4 Kester in 2020 to 0.82 at the same station in 2024 and averaged 0.68 overall for 17 reported scores in the reach. The substrate in LAR4 is concrete with an open (or minimally shaded) box channel.

Until 2024, no BMI data was available using current methodology (i.e., since 2005) for LAR5. Two stations were sampled in 2024 as part of this Study: LAR5 Balboa and LAR5 Hayvenhurst, which lie above and below Lake Balboa Spillway, respectively. Different methods were used for sampling BMI at LAR5 Hayvenhurst due to water depth (i.e., this portion of the reach is deep and generally non-wadeable). The three most prevalent Family+ taxa at LAR5 Balboa included: Baetidae, Chironomidae, and Simuliidae, while the three most prevalent at LAR5 Hayvenhurst were Hyalellidae, Oligochaeta, and Chironomidae (**Figure 51**). These taxa accounted for 88% of all BMI at LAR5 Hayvenhurst but only 68% at LAR5 Balboa. The number of distinct taxa represented for the stations also differs from 21 at LAR5 Hayvenhurst to 43 at LAR5 Balboa, which is likely due, in part, to the different sampling methodology used at each station. The CSCI score for Station LAR5 Balboa was 0.81, while CSCI was not calculable for LAR5 Hayvenhurst. The substrate in LAR5 is mixed with some shading and unimproved channel.

BMI data for LAR6 exists for five stations representing years spanning from 2008 through 2023 (**Figure 51**). The five stations are spread out several miles upstream of LAR5, where there is no WRP flow. Flow is from the headwaters and dry weather urban runoff. The four most prevalent Family+ taxa throughout the reach include: Chironomidae, Oligochaeta, Ostracoda, and Stratiomyidae. Of these, only Stratiomyidae differs from taxa found downstream in the lower LA River reaches. These four Family+ taxa accounted for 96 to 99% of all BMI at the locations. The number of distinct taxa represented in LAR6 ranges from 15 at Station SMC02680 (western most station in LAR6) in 2014 to 30 at Station 412PS0052 (which lies close in proximity to SMC02680) sampled in 2008. The average number of distinct taxa represented for the reach is 19, like in LAR2. CSCI scores ranged from 0.38 at Station 412M08688 in 2022 to 0.54 at Station LAR01208 in 2010 and averaged 0.45 overall for eight reported scores in the reach. The substrate in LAR6 is concrete with an open trapezoidal channel.

5.3.2.2 LA River Tributaries

Compton Creek discharges into the LA River at the bottom of LAR2 (**Figure 52**). BMI data for Compton Creek exists for four stations. Station LALT502 includes BMI data collected in 2012 and 2016 through 2019, Station 412LARCMP includes data collected in 2005, Station Compton_R1 includes data collected in 2023, and Station SMC01358 includes data collected in 2011. The five most prevalent Family+ taxa throughout Compton Creek included: Chironomidae, Coenagrionidae, Hyalellidae, Ostracoda, and Oligochaeta. These five Family+ taxa accounted for 87 to 100% of all BMI at these locations. The number of distinct taxa represented in Compton Creek ranges from four at Station 412LARCMP in 2005 to 26 at Station LALT502 in 2017. The average number of distinct taxa represented for the tributary was 16. CSCI scores ranged from 0.37 at Station SMC01358 in 2011 to 0.69 at Station LALT502 in 2011 and averaged 0.51 overall for 11 reported scores. Substrate in Compton Creek includes both unlined (in the lower part of creek) and concrete bottom with an open trapezoidal channel.

Rio Hondo discharges into the LA River near the middle of LAR2 (**Figure 52**). BMI data for Rio Hondo and its tributaries (e.g., Alhambra Wash, Eaton Wash, Rubio Wash) exists for 15 stations representing years spanning from 2005 through 2021. Station LALT500 includes repeat sampling beginning in 2012 with consecutive annual sampling from 2016 to 2019. Station 412RHWNRD in 2005 represents the most comprehensive BMI sampling in the entire Study area due to the methodical and repeat (duplicate) sampling of all available habitats. Station 412RHWNRD also represents the only non-BWC tributary station with WRP flow due to its location below the Whittier Narrows WRP. Rio Hondo is a well characterized tributary in the Study area in terms of both spatial and temporal sampling, as well as by the diversity of site characteristics represented by the stations. The 12 most prevalent Family+ taxa throughout the tributary included: Baetidae, Ceratopogonidae, Chironomidae, Corixidae, Culicidae, Glossiphoniidae, Hyalellidae, Oligochaeta, Ostracoda, Physidae, Psychodidae, and Simuliidae. These 12 Family+ taxa accounted for 91 to 100% of all BMI at these locations. The number of distinct taxa represented in Rio Hondo ranged from two at Station 412LAR015 (Rio

Hondo at the spillway of Peck Rd. Park Lake) in 2005 to 27 at Station SMC01772, in upper Alhambra Wash, sampled in 2012. The average number of distinct taxa represented for the tributary was 14. Except for Station 412RHWNRD there is no WRP flow at any other station. CSCI scores ranged from 0.25 at Station SMC00748 (Rubio Wash, Rosemead) in 2011 to 0.67 at Station 412M08646 (Eaton Wash) in 2019 and averaged 0.39 overall for 23 reported scores. Substrate in Rio Hondo includes both concrete bottom with an open trapezoidal channel upstream of the confluence with the LA River and upstream of the Whittier Narrows Recreation Area, but unlined with some shading and unimproved channel in the Recreation Area upstream of the Whittier Narrows Dam.

Arroyo Seco discharges into the LA River at the top of LAR2 (**Figure 52**). BMI data for Arroyo Seco (from the confluence with LA River to foothills to the mountains) exists for eight stations. Station LALT501 includes BMI data collected in 2012 and 2016 through 2020. The nine most prevalent Family+ taxa throughout the tributary included: Baetidae, Ceratopogonidae, Chironomidae, Hydroptilidae, Oligochaeta, Ostracoda, Psychodidae, Simuliidae, and Stratiomyidae; slightly different than for the Rio Hondo and its tributaries with seven taxa in common. These nine Family+ taxa in Arroyo Seco accounted for 89 to 100% of all BMI at these locations. The number of distinct taxa represented ranged from seven at Station 412LARSCO (at the confluence with the LA River) in 2005 to 33 at Station LALT501 sampled in 2018 (also at the confluence with the LA River near 412LARSCO) and SMC01692 (at the base of the foothills in El Prieto Canyon, with natural substrate and in a sparsely developed area) in 2011. The average number of distinct taxa represented for the tributary was 23. CSCI scores ranged from 0.49 at Station SMC01004 in 2019 to 0.83 at Station SMC01692 in 2011 and averaged 0.66 overall for 19 reported scores. Substrate in Arroyo Seco is concrete with an open trapezoidal channel downstream of the Devils Gate Dam.

Verdugo Wash discharges into the LA River near the top of LAR3 at the bend in the LA River (**Figure 52**). BMI data for Verdugo Wash is limited to a single station – 412LARVGO sampled in 2005. The 412LARVGO station is located near the confluence with the LA River. The five most prevalent taxa at the 412LARVGO station included Baetidae, Chironomidae, Oligochaeta, Ostracoda, Physidae, and Turbellaria. These five Family+ taxa accounted for 100% of all BMI at the location. The number of BMI taxa represented at Station 412LARVGO was six. There are no CSCI scores available for this station. Substrate in lower Verdugo Wash is concrete with an open box channel.

Tujunga Wash (including its tributary Big Tujunga Canyon Creek) discharges into the LA River near the middle of LAR4 (**Figure 52**). BMI data exists for four stations. Station 412LARTJA (near the confluence with the LA River) includes BMI data combined from three stations due to overlapping proximity (412LARTJA, SMC00756/LALT503; mapped as 412LARTJA). The BMI data collected at the combined station encompasses 2005, 2009, 2012 and 2016 through 2018. The two uppermost stations (412M08683 and SMC02484) are in an urban wildlife preserve with a vegetated corridor at the base of the foothills (412M08683) and in an urban residential area that is partially vegetated (SMC02484). The 11 most prevalent Family+ taxa throughout the tributary included: Baetidae, Ceratopogonidae, Chironomidae, Culicidae, Hyalellidae, Hydrobiidae, Hydroptilidae, Oligochaeta, Ostracoda, Simuliidae, and Turbellaria; similar to LAR4 (see above). These 11 Family+ taxa accounted for 93 to 100% of all BMI at these locations. The number of distinct taxa represented ranged from three at Station 412LARTJA in 2005 to 48 at Station 412M08683 (with a vegetated corridor at the base of the foothills) sampled in 2022. The average number of distinct taxa represented for the tributary was 21. CSCI scores ranged from 0.33 at Station 412LARTJA in 2014 and 2015 to 0.76 at the same station just a year later in 2016 and averaged 0.53 overall for 15 reported scores. This CSCI score for 412LARTJA in 2016 near the confluence with the LA River was higher than the CSCI of 0.66 at 412M08683 in 2022, which was characterized by a vegetated corridor at the base of the foothills. Except for this latter station (412M08683), substrate in Tujunga Wash is concrete with an open box channel downstream of Hansen Dam.

Bull Creek discharges into the LA River near the top of LAR5 (**Figure 52**). BMI data for Bull Creek (from the confluence with LA River to last subdivision below foothills to the Michael D. Antonovich Open Space) exists for seven stations. Station 412PS0040 (combined with 412LAR004 in close proximity) is located in urban residential area near State Hwy 118 and includes BMI data collected beginning in 2005 and again in 2008, 2016, and 2022. The nine most prevalent Family+ taxa throughout Bull Creek included: Baetidae, Ceratopogonidae, Chironomidae, Hydroptilidae, Oligochaeta, Ostracoda, Psychodidae, Simuliidae, and Stratiomyidae; roughly similar to Tujunga Wash. These nine Family+ taxa accounted for 92 to 100% of all BMI at these locations. The number of distinct taxa represented ranged from only four at Station 412PS0040 in 2005 to 28 at station 412M08645 in 2019. The average number of distinct taxa represented for the tributary was 19. CSCI scores ranged from 0.42 at Station SMC01972 in 2010 to 0.68 at Station 412PS0040 in 2022 and averaged 0.53 overall for seven reported scores. Bull Creek substrate is mixed with some shading and unimproved channel where it runs through the Sepulveda Basin and joins LAR5, but is an open concrete trapezoidal channel upstream of the Sepulveda Basin.

Several tributaries (e.g., Aliso Canyon Wash, Limekiln Canyon Wash, Santa Susana Creek and Santa Susana Pass Wash, Bell Creek, Arroyo Calabasas, Wilbur Wash, and Cabellero Creek) with higher order tributaries discharge into LAR6 upstream of Bull Creek (**Figure 52**). BMI data for these tributaries exist for 16 stations representing years spanning from 2005 through 2018. Two stations (SMC00440 and 412M08632) included repeat sampling beginning in 2009 or 2012 and repeated in 2018 or 2017, respectively. The tributaries in this area are well characterized in terms of both spatial and temporal sampling, and the diversity of site characteristics represented by the stations. The 11 most prevalent Family+ taxa throughout all tributaries included: Baetidae, Ceratopogonidae, Chironomidae, Culicidae, Ephydridae, Nemouridae, Oligochaeta, Ostracoda, Psychodidae, Simuliidae, and Turbellaria. These 11 Family+ taxa accounted for 94 to 100% of all BMI at these locations. The number of distinct taxa represented ranged from two at Stations SMC02488 and 412LAR024 (in Wilbur Wash, which represent urban residential stations with a developed corridor) to 37 at Station SMC00440 (upper Aliso Canyon Wash, also in an urban residential setting but closer to the base of the foothills with a vegetated corridor) sampled in 2009 and 2018. The average number of distinct taxa represented for the set of LAR6 tributaries was 16. CSCI scores ranged from 0.21 at Station SMC02488 (Wilbur Wash) in 2013 to 0.80 at Station SMC00440 in 2009 and averaged 0.49 overall for 11 reported scores. Substrate for these tributaries is generally concrete with a mix of box and trapezoidal channels with shading in some areas.

5.3.2.3 Summary

In summary, LA River Reaches 1 and 2, characterized by wide and open trapezoidal concrete channels, are dominated by Chironomidae, Ostracoda, and Oligochaeta, with the number of taxa increasing with distance upstream to Glendale Narrows in LAR3 where the substrate is mixed. Here, BMI taxa diversity increases and Baetidae, Hyalellidae, Leptohyphidae, and Turbellaria dominate the abundance immediately below LAGWRP on the mixed substrate, while Chironomidae, Oligochaeta, and Ostracoda again dominate on the concrete substrate immediately above LAGWRP. BMI diversity generally remains elevated further upstream through

LAR4 (concrete-lined). Diversity is highest in the LA River at LAR5 Balboa (unlined), before declining in LAR6 (concrete-lined) to numbers of taxa similar to those found in LAR1 and LAR2. CSCI scores reflect the same pattern, increasing from an average of 0.41 in LAR1, to 0.56 in LAR2, and 0.70 and 0.68 in LAR3 and LAR4, respectively, before reaching a high (0.81) in LAR5 (Balboa), and declining to an average of 0.45 in LAR6.

The BWC is characterized by open square or rectangular concrete channels. BMI taxa are similar above and below BWRP and include: Baetidae, Chironomidae, Hydroptilidae, and Oligochaeta, with CSCI scores in BWC ranging from 0.56 to 0.66.

Noteworthy here is that no matter the reach, repeat sampling events at the same station over time reveals substantial variation among years, with a two- to three-fold difference in number of BMI taxa present at the same station (e.g., Station LAR3 Greenway in lower LAR3, Station LAR4 Kester in upper LAR4), and corresponding variation in CSCI scores. It is difficult to account for these differences in community response given the standardized methodologies consistently employed over the years. However, it is clear natural variation on an annual basis is substantial throughout LA River mainstem, and there is no obvious influence of downstream proximity to WRP outfalls to indicate substantive impact of effluent temperature compared to prevailing background conditions.

Within the context of this study's purpose and the stated study objectives, it is important to also understand and consider the biological community (in this case, BMI) in the LA River mainstem and BWC relative to the several tributaries in the greater LA River Basin that reflect the same highly urbanized and industrial area and degraded habitat conditions, but do not receive WRP flow. As described above, it is clear that the BMI communities in LA River tributaries, without flow from WRPs, are similar in composition, diversity, and functionality, and are also highly variable. For example, the number of distinct taxa represented in Arroyo Seco ranged from seven at Station 412LARSCO (at the confluence with the LA River) in 2005 to 33 at Station LALT501 sampled in 2018 (also at the confluence with the LA River near 412LARSCO). Likewise, CSCI scores ranged from 0.33 at Station 412LARTJA in Tujunga Wash in 2014 to 0.76 at the same station just two years later in 2016. As expected, the number of distinct BMI taxa for stations in tributaries just in or below the foothills were generally, but not always, higher than other downstream stations, but the highest number of taxa just in or below the foothills did not always translate to the highest CSCI score in the tributary. The reader is referred to **Section 5.3.4** for important additional analysis of the similarities in BMI taxa between sets of stations on the LA River mainstem, BWC, and the several tributaries to the mainstem of the LA River.

5.3.3 Benthic Algae (Diatoms and Soft-bodied Algae)

As part of California's current bioassessment program (SWAMP), benthic algae samples have been monitored in conjunction with BMI samples since 2009. At each transect, algae are sampled a quarter meter upstream of the BMI sample in accordance with the protocol originating from Fetscher et al. (2009). The algae samples are split for different indicators (e.g., biomass and community composition). Diatoms and soft-bodied algae (including cyanobacteria) are identified to the lowest taxonomic resolution possible, which is typically species. At each point where substrate size is determined along a transect, the presence or absence of microalgae, macroalgae, and aquatic macrophytes is also recorded. If microalgae are present, the site is given a thickness score. These data are used to determine the percentage of algal cover within a stream reach. The review considers Algal Stream Condition Index (ASCI) scores, which is used to measure the health of streams by analyzing the types of algae present with higher scores indicating a site is closer to a healthy, natural, or "reference-like" condition.

The benthic algae (diatom and soft-bodied algae) data was aggregated from publicly searchable databases and results from the supplementary biological sampling implemented during this study, as described in the Workplan (LWA 2024). The combined data represent multiple years of sampling at several recurring stations in the LA River Mainstem (in Reaches 1, 2, 3, 4, and 6) and several tributaries (i.e., Arroyo Seco, Bull Creek, Compton Creek, Rio Hondo, Tujunga Wash, and several smaller tributaries to LAR6), as well as numerous one- or two-time sampling events at different stations scattered throughout the greater urbanized Study area. Sample years date back to 2009 when, prior to method standardization and implementation in California in 2016 (Ode et al. 2016), diatom taxa count and soft-bodied algae biovolume were compiled for qualitative (only) comparative analysis. There were a total of 56 surveys from 32 unique stations with applicable benthic algae data for evaluation and analysis for LA River mainstem Reaches 1, 2, 3, 4, and 6, and a total of 35 surveys (36 soft algae) from 30 unique stations from 23+ different tributaries of different stream orders (see **Appendix 4** for a list of stations and site characteristics). The locations of benthic algae stations in the LA River mainstem and tributaries are the same as shown for BMI in **Figure 51** and **Figure 52**.

All benthic algae data were collected using data collection and laboratory analysis methodologies based on SWAMP or SWAMP precursor procedures to estimate the biological condition in California inland waters (e.g., Fetscher et al. 2009), although the sampling procedures standardized since 2016 follow the procedures for the Collection of Field Data for Bioassessments of California Wadeable Streams: Benthic Macroinvertebrates, Algae, and Physical Habitat (Ode et al. 2016). The benthic algae collected are identified to the species level when possible.

Data was sufficient to determine the benthic algae present now and over the last 16 years in most of the Study Area and to generally characterize the relationship between likelihood of benthic algae occurrence and waterbody temperature based on a taxon's location in the LA River. Within the context of this study and the stated objectives, the same critical question applies: Is the benthic algal community different upstream and downstream of the WRPs in the relevant, WRP-associated reaches of the LA River? If biology is different, is it because of WRP effluent temperature?

This section summarizes the available benthic algae data from the Study Area (2009 through 2024) to support assessment of benthic algae in the context needed for addressing Study objectives. **Appendix 5** provides descriptive summary tables of benthic algae in the LA River reaches and tributaries critical for addressing the objectives of the Study. The benthic algae data summarized in the appendix is normalized to the species level, as described above. A full list of benthic algae taxa found present at all LA River stations and the years they were sampled is provided in **Appendix 2**, along with indication of expected temperature and general pollution tolerance based on the literature. Below is a descriptive (Qualitative) overview of benthic algae taxa found in LA River mainstem reaches followed by tributaries to the mainstem. Results of quantitative analysis of the benthic algae data are found in **Section 5.3.4**.

5.3.3.1 LA River Mainstem Reaches 1, 2, 3, 4, and 6 and BWC

Benthic algae data for LAR1 exists for two stations. Station 412M08643 includes data collected in 2018, while Station SMC00318 includes data collected in 2010, 2019, and 2021 through 2023 (**Figure 51**). The most frequently reported diatom taxa at both stations and all years sampled included: *Halamphora veneta*, *Staurosira construens var venter*, *Achnanthidium minutissimum*, *Nitzschia amphibioides* and *Nitzschia inconspicua*, and *Cyclotella meneghiniana*. The top five diatom taxa accounted for 55 to 90% of all diatom taxa at these locations. The number of distinct diatom taxa represented in LAR1 ranged from 21 at Station SMC00318 in 2010 to 39 at the same station sampled in 2022 (nearly a two-fold difference). The average number of distinct taxa represented for the reach is 31.5. At station 412M08643 in 2018 and SMC00318 in 2021 and 2023, over 98% of the total soft-bodied algae biovolume was due to *Cladophora glomerata*. In the other years at SMC00318, soft-bodied algae biovolume was dominated by either the combination of *Gongrosira schmidlei* and *Pediastrum inegrum* (42 and 21%, respectively; 2010), or *Calothrix* sp. (89%; 2019), or the combination of *Oedogonium* sp. 1 and *Cladophora glomerata* (65 and 34%, respectively; 2022). Diatom ASCI scores ranged from 0.45 at Station 412M08643 in 2018 to 0.57 at Station SMC00318 in 2023 and averaged 0.52 overall for the six scores available for the reach. Soft (soft-bodied algae) ASCI scores ranged from 0.48 at SMC00318 in 2023 to 0.85 at the same station in 2019 and averaged 0.68. The substrate in LAR1 is concrete with an open trapezoidal channel.

Benthic algae data for LAR2 exists for eight stations representing years spanning 2009 through 2024 (**Figure 51**). No one station was sampled repeatedly over that period, however data for two stations (412CE0104 and SMC02228) were combined due to proximity. The most frequently reported diatom taxa occurring at all stations and years combined included: *Staurosira construens var venter* and *Nitzschia inconspicua* followed by *Cyclotella meneghiniana, Halamphora veneta,* and *Nitzschia palea*. The top five diatom taxa accounted for 64 to 83% of all diatom taxa at these locations. The number of distinct diatom taxa represented in LAR2 ranged from 20 at Station 412M08627 in 2017 to 43 at Station LAR2 Washington (SMC03902) in 2024. The average number of distinct taxa represented for the reach is 27.8. Typically 85 to 95% of the total soft-bodied algae biovolume was due to *Cladophora glomerata* alone or in combination with other diatom species such as *Schizothrix fragilis*, *Oedogonium* sp. 1, or *Leptolyngbya foveolarum,* with the exception of stations SMC05694 in 2014, 412M08602 in 2015, and LAR2 Washington in 2024 when the soft-bodied algae biovolume was dominated by either *Leptolyngbya foveolarum* (SMC05694), the combination of *Stigeoclonium subsecundum* and *Symploca elegans* (412M08602), or *Pleurosira laevis* (LAR2 Washington). Diatom ASCI scores ranged from 0.25 at Station 412M08627 in 2017 to 0.55 at Station 412M08642 in 2018 and averaged 0.43 overall for the eight scores available the reach. Soft ASCI scores ranged from 0.64 at 412M08659 in 2020 to 0.86 at Station 412M08627 in 2017 and averaged 0.73. The substrate in LAR2 is concrete with an open trapezoidal channel.

Benthic algae data for LAR3 exists for seven stations representing years spanning 2009 through 2024 (**Figure 51**). Station LAR3 Griffith (LAR04532) lies at the top of the reach above the confluence with Verdugo Wash and below the confluence with the BWC. Stations LAR00436 and LAR3 Electronics lie above LAGWRP and Station LAR3 N. Atwater (LAR10210) is located immediately below it. Stations LAR08663, LAR3 Greenway (LAR08599), and LAR3 Riverside are all downstream of Station LAR3 N. Atwater over the remaining portion of Glendale Narrows. The most frequently reported diatom taxa throughout the reach included: *Nitzschia inconspicua*, *Cocconeis placentula* var *euglypta*, *Cocconeis pediculus*, *Halamphora veneta*, and *Amphora pediculus*, with *Cocconeis placentula* var *euglypta* and *Amphora pediculus* present only below LAGWRP. The number of distinct taxa represented in LAR3 ranged from 28 at Station LAR00436 above the LAGWRP in 2009 to 54 at Station LAR3 Griffith (also above LAGWRP and just below the confluence with BWC) sampled in 2024 (compared to only 31 diatom taxa in 2012). The average number of distinct taxa represented throughout the reach is 35.2, with averages of 37 and 34 upstream and downstream of LAGWRP, respectively. Either *Cladophora glomerata* or *Pleurosira laevis* generally dominates the total soft-bodied algae biovolume in LAR3 irrespective of orientation with respect to the LAGWRP outfall, although *Pediastrum duplex* and *Heteroleibleinia* sp 1 can occasionally be significant downstream of LAGWRP while *Gongrosira* sp 1, *Gongrosira incrustans*, *Chlorophyta* 17, and *Pediastrum integrum* can occasionally be significant upstream. Diatom ASCI scores ranged from 0.28 at Stations LAR00436 (upstream of LAGWRP) in 2023 and LAR08663 (downstream of LAGWRP) in 2021 to 0.68 at Station LAR3 Greenway (downstream of LAGWRP) in 2018. Diatom ASCI averaged 0.41 overall for the 17 reported scores available for the reach, with averages of 0.39 and 0.42 up- and downstream of LAGWRP, respectively. Soft ASCI scores ranged from 0.45 at LAR3 N. Atwater in 2021 to 1.06 at LAR08663 in 2021 and averaged 0.63, with nearly identical averages up- and downstream of the LAGWRP. The substrate in LAR3 is mixed with an open, trapezoidal improved channel.

The BWC discharges to the LA River at the boundary between LAR3 and LAR4. Benthic algae data for the BWC is limited in comparison to the LA River mainstem. Only 2024 data collected during the current study exists for three stations (**Figure 51**). BWC Riverside lies a short distance above the confluence with the LA River mainstem at the bottom of the BWC. BWC (Down) is located immediately below the BWRP outfall and BWC (Up) lies immediately above it. The most frequently reported diatom taxa appearing at both upstream and downstream BWRP stations included: *Achnanthidium minutissimum, Halamphora veneta,* and *Planothidium frequentissimum*. Total count of *Nitzschia* sp. (*N. amphibia*, *N. inconspicua*, *N. palea var debilis*) and *Sellaphora saugerresii* was also highest downstream of the BWRP, while *Cocconeis pediculus* count was highest at Station BWC (Up). The top five diatom taxa accounted for over 99% of all diatom taxa at these locations. The number of distinct diatom taxa represented in the BWC (in 2024) ranged from only seven at BWC (Down) to 23 at BWC (Up). Despite the disparity in total diatom taxa between the two stations, the diatom ASCI score at BWC (Down) was much higher (0.80) compared to BWC (Up) with a score of only 0.38. Conversely, over 98% of the total soft-bodied algae biovolume was due to *Cladophora glomerata* at both BWC (Up) and BWC (Down), while 53% of the biovolume was *Homeothrix* sp. and 32% was *Chaetophorales* 2 at BWC Riverside. Soft ASCI scores ranged from 0.30 at BWC Riverside to 0.52 at BWC (Down) and 0.66 at BWC (Up). The substrate in the BWC is concrete with an open box channel.

Benthic algae data for LAR4 exists for six stations representing years spanning 2011 through 2024 (**Figure 51**). Two stations (412M08659 and LAR4 Kester [LAR0232]) include repeat sampling. Station LAR4 Zoo (412M08659) includes consecutive sampling in 2023 and 2024, while Station LAR4 Kester includes repeat sampling consecutively from 2015 to 2021 and 2024. Station LAR08661 lies at the top of the reach below the discharge of DCTWRP outfall Eff 008, and is followed by five stations: LAR4 Kester, 412M08597, LAR02804, and LAR08656 sequentially downstream to near the confluence with Tujunga Wash. These are followed by LAR4 Zoo just above the confluence with the BWC. The most frequently reported diatom taxa throughout the reach included: *Planothidium frequentissimum*, *Nitzschia inconspicua* and *Nitzschia amphibia*, *Cyclotella meneghiniana*, and *Cocconeis placentula*. The top five diatom taxa at each station accounted for 49 to 94% of all diatoms at these locations. The number of distinct diatom taxa represented in LAR4 ranges from 22 at Station LAR4 Zoo at the bottom of LAR4 in 2023 (compared to 39 at the same station in 2024) to 52 at Station LAR4 Kester, near the top of LAR4 and just a short distance downstream of DCTWRP outfall Eff 008, sampled in 2024. The average number of distinct taxa represented for the reach is 37.6. The number of distinct taxa represented at Station LAR4 Kester, which lies a short distance below DCTWRP outfall 008, also averages 40 but has varied historically from a low of 26 in 2015 to 52 in 2024, again indicating substantial variability in number of distinct taxa present at a single station among sample years. Within a station over different years (e.g., at LAR4 Kester) and between different stations and station and year combinations, *Cladophora glomerata*, *Hydrosera whampoensis*, or *Pleurosira laevis* can account for >99% of soft-bodied algae biovolume, otherwise *Oocystis borgei*, *Chlorophyta* 3, *Chlorophyta* 12, *Schizothrix fragilis*, or *Phormidium autumnale* was present in greatest biovolume. Diatom ASCI scores ranged from 0.28 at Station LAR4 Zoo in 2024 to 0.48 at Stations LAR4 Kester and 412M08597 in 2015. Average diatom ASCI for LAR4 is 0.39 overall based on the 14 scores available for the reach. Soft ASCI scores range from 0.36 at Station LAR4 Kester in 2024 to 0.84 at the same station in 2016, which reflects a greater than two-fold difference at the same station in different years. Average soft ASCI for LAR4 is 0.68 overall in the reach. The substrate in LAR4 is concrete with an open (or minimally shaded) box channel.

Until 2024, no benthic algae data was available using current methodology (i.e., since 2016) for LAR5. Only one of two target stations was sampled in 2024 as part of this Study (LAR5 Balboa) because the LAR5 Hayvenhurst station could not be sampled due to water depth (i.e., this portion of the reach is relatively deep and generally non-wadeable). The LAR5 Balboa station lies above the Lake Balboa Spillway and is not influenced by effluent discharged from DCTWRP. The most frequently reported diatom taxa at LAR5 Balboa were *Nitzschia inconspicua* (20% of total count), followed by *Amphora pediculus* (13%), *Craticula subminuscula* (11%), *Halamphora veneta* (7.1%), and *Cocconeis placentula* (7.0%). These taxa account for 58% of all diatom taxa at LAR5 Balboa. The number of distinct diatom taxa at LAR5 Balboa was 34. *Cladophora glomerata* accounted for 59.5% of the total soft-bodied algae biovolume, while *Pleurosira laevis* accounted for 38%. The diatom ASCI score for Station LAR5 Balboa was 0.27, which is similar to the diatom score for LAR4 Kester in 2024 (0.28) that lies just a short distance below DCTWRP outfall 008. The soft ASCI was 0.58. The substrate in LAR5 is mixed with some shading and an unimproved channel.

Benthic algae data for LAR6 exists for five stations representing years spanning from 2010 through 2023 (**Figure 51**). The five stations are spread out several miles upstream of LAR5, where there is no WRP flow. Flow is from the headwaters and dry weather urban runoff. The most frequently reported diatom taxa throughout the reach included*: Achnanthidium minutissimum, Nitzschia amphibioides, Staurosira construens var venter, Halamphora veneta*, *Nitzschia inconspicua*, and *Gomphonema parvulum*. The top five taxa account for 68 to 96% of all diatoms at the locations. The number of distinct taxa represented in LAR6 ranges from 14 at Station 412PS0052 in 2022 to 28 at Station LAR01208 in 2020 and 2023. The average number of distinct taxa represented for the reach is only 20 (lowest of all reaches on the LA River mainstem and same as BWC). *Cladophora glomerata* or *Rivularia biasolettiana* accounted for >98% of soft-bodied algae biovolume in the reach, otherwise *Calothrix* sp.*, Schizothrix lacustris, or Rhizoclonium hieroglyphicum* dominated biovolume. Diatom ASCI scores ranged from 0.50 at Station LAR01208 in 2010 to 0.92 at Station 412M08672 in 2021 and average 0.71 overall based on the seven reported scores available for the reach. Soft ASCI scores ranged from 0.40 at Station 412M08672 in 2021 to 0.99 at Station 412PS0052 in 2022 and average 0.68. The substrate in LAR6 is concrete with an open trapezoidal channel.

5.3.3.2 LA River Tributaries

Compton Creek discharges into the LA River at the bottom of LAR2 (**Figure 52**). Benthic algae data for Compton Creek exists for a single station: Station SMC01358 sampled in 2011. The most frequently reported diatom taxa at the station and time included: *Nitzschia amphibia* (37.7%), *Sellaphora pupula* (16.8%), *Nitzschia supralitorea* (13.8%), *Denticula kuetzingii* (7.3%), and *Nitzschia palea* (4.2%). These taxa account for

80% of all diatom taxa at the location. The number of distinct diatom taxa represented was 26. Soft-bodied algae biovolume was dominated by *Tribonema viride* (33.6%), *Oocystis parva* (29.5%), *Oocystis solitaria* (21.3%), *Oocystis borgei* (8.2%), and *Calothrix parietina* (4.0%). The diatom ASCI score was 0.56 and soft ASCI was 0.97. No WRP flow is present at this station. Substrate in Compton Creek includes both unlined (in the lower part of creek) and concrete bottom with an open trapezoidal channel.

Rio Hondo discharges into the LA River near the middle of LAR2 (**Figure 52**). Benthic algae data for Rio Hondo and its tributaries (e.g., Alhambra Wash, Eaton Wash, Rubio Wash) exists for nine stations representing years spanning from 2010 through 2023. Station 412PS0020 includes repeat sampling beginning in 2016 with consecutive annual sampling in 2022 and 2023. The most frequently reported diatom taxa throughout the tributary included: *Halamphora veneta*, *Nitzschia amphibia*, *Achnanthidium minutissimum*, *Craticula subminuscula*, and *Nitzschia palea*. The top five diatom taxa accounted for 64 to 93% of all diatom taxa at the sample locations. The number of distinct taxa represented in Rio Hondo ranged from nine at Station 412M08662 in 2021 to 37 at Station 412M08646 (in Eaton Wash) in 2019. The average number of distinct taxa represented for the tributary is 24. The soft-bodied algae: *Spirogyra*, *Symploca* cf *elegans*, *Cladophora glomerata*, *Homoeothrix stagnalis*, *Leptolyngbya foveolarum*, and *Rhizoclonium hieroglyphicum*, accounted for over 90% of the biovolume at a given site, while *Symplocastrum* sp 1, *Chaetophorales* 2, *Leptolyngbya foveolarum*, and *Calothrix parietina* also contributed notably to the biovolume. Diatom ASCI scores ranged from 0.46 at Station SMC01452 (Eaton Wash) in 2010 to 0.77 at Station 412M08630 (Alhambra Wash) in 2017 and averaged 0.61 overall for 10 reported scores. Soft ASCI scores ranged from 0.59 at Station 412M08646 in 2019 to 1.02 at Station SMC00684 in 2011 and averaged 0.80 overall. Substrate in Rio Hondo includes both concrete bottom with an open trapezoidal channel upstream of the confluence with the LA River and upstream of the Whittier Narrows Recreation Area, but unlined with some shading and unimproved channel in the recreation area upstream of the Whittier Narrows Dam.

Arroyo Seco discharges into the LA River at the top of LAR2 (**Figure 52**). Benthic algae data for Arroyo Seco exists for five stations. No repeat data exist for this tributary. The most frequently reported diatom taxa throughout the tributary included: *Nitzschia* sp (*palea* var debilis, *amphibia*, *amphibioides*, and *inconspicua*), *Achnanthidium minutissimum*, and *Planothidium frequentissimum*. The top five diatom taxa in Arroyo Seco accounted for 69 to 91% of all diatom taxa in the reach. The number of distinct taxa represented ranged from 17 at Station 412M08658 in 2020 to 28 at Station SMC02028 in 2012. The average number of distinct taxa represented for the tributary is 22.8 Depending on station and year, *Cladophora glomerata* accounted for up to 100%, *Phormidium subfuscum*, 82%, and *Homoeothrix stagnalis* as much as 71% of total soft-bodied algae biovolume. Diatom ASCI scores ranged from 0.34 at Station 412M08686 in 2022 to 0.79 at Station SMC01004 in 2019 and averaged 0.51 overall for four reported scores. Soft ASCI scores ranged from 0.59 at Station 412M08658 in 2020 to 1.02 at Station SMC01004 in 2009 and averaged 0.81 overall. Substrate in Arroyo Seco is concrete with an open trapezoidal channel downstream of the Devils Gate Dam.

No benthic algae bioassessment data is available for Verdugo Wash. Substrate in lower Verdugo Wash is concrete with an open box channel.

Tujunga Wash (including its tributary Big Tujunga Canyon Creek) discharges into the LA River near the middle of LAR4 (). Benthic algae data exists for three stations: one nearest the confluence with the LA River is in a residential area with a partially vegetated corridor (SMC02484), one farther upstream is in a mixed residential and commercial area with no shading (SMC02996), and the third (412M08683) lies at the base of the foothills outside of the urban zone. The most frequently reported diatom taxa throughout the tributary included: *Achnanthidium minutissimum, Nitzschia* sp. (*communis* and *palea*), and *Halamphora veneta*. The top five diatom taxa in Tujunga Wash accounted for 61 to 95% of all diatom taxa in the tributary. The number of distinct taxa represented ranged from 12 at Station SMC02484 (nearest the confluence with the LA River) in 2013 to 66 at Station 412M08683 (in the foothills) in 2022. Only three micro- and macroalgae taxa were found at Station 412M08683, where *Cladophora glomerata* accounted for nearly 100% of total soft-bodied algae biovolume. *Cladophora glomerata* also accounted for 95% of total soft-bodied algae biovolume at Station SMC02484 near the confluence with the LA River, but only 67% of total biovolume farther upstream, where *Chroococcus turgidusa* accounted for another 23%. Diatom ASCI scores ranged from 0.60 at Station SMC02996 in 2014 to 0.97 at Station SMC02484 in 2013 and averaged 0.76 overall for the three reported scores. Soft ASCI scores ranged from 0.33 at Station 412M08683 (foothills) in 2022 to 0.91 at Station SMC02484 in 2013 and averaged 0.65 overall. Substrate in Tujunga Wash is concrete with an open box channel downstream of Hansen Dam.

Bull Creek discharges into the LA River near the top of LAR5 (**Figure 52**). Benthic algae data for Bull Creek exists for five stations. Station 412PS0040 (combined with 412LAR004 due to close proximity) is located in urban residential area near State Hwy 118 and includes benthic algae data collected in 2016 and again in 2022. Stations SMC01716 and SMC01972 include data collected in 2010, while stations 412M08645 and 412M08693 include data collected in 2019 and 2022, respectively. The most frequently reported diatom taxa in Bull Creek included: *Halamphora veneta*, *Nitzschia inconspicua*, *Cyclotella meneghiniana*, and *Staurosira venter*. The top five diatom taxa accounted for 44 to 86% of all diatom taxa in the tributary. The number of distinct taxa represented ranged from 28 at Station SMC01716 in 2010 to 40 at Station 412M08645 sampled in 2019. The average number of distinct taxa represented for the tributary was 31.5. The soft-bodied algae: *Cladophora glomerata*, *Rivularia biasolettiana*, and *Heteroleibleinia* sp 1 accounted for over 85 to near 100% of the biovolume at a given site, while *Gongrosira schmidlei* and *Calothrix linearis* also contributed notably to biovolume on occasion. Diatom ASCI scores ranged from 0.34 at Staton 412PS0040 in 2022 to 0.97 at Station 412M08645 in 2019 and averaged 0.60 overall for six reported scores. The lowest and highest soft ASCI scores occurred at the same station (412PS0040) and ranged from 0.58 in 2022 to 0.92 in 2016 and averaged 0.81 overall in Bull Creek. Bull Creek substrate is mixed with some shading and unimproved channel where it runs through the Sepulveda Basin and joins LAR5, but is an open concrete trapezoidal channel upstream of the Sepulveda Basin.

Several tributaries (e.g., Aliso Canyon Wash, Limekiln Canyon Wash, Santa Susana Creek, Bell Creek, and Cabellero Creek) discharge into LAR6 upstream of Bull Creek (**Figure 52**). Benthic algae data for these tributaries exist for seven stations representing years spanning from 2009 through 2023. Two stations (SMC00440 and SMC01972) included repeat sampling beginning in 2009 or 2012 and repeated in 2018 or 2017, respectively. The most frequently reported diatom taxa collectively in the tributaries included: *Halamphora veneta, Achnanthidium minutissimum, Nitzschia sp. (inconspicua, microcephala, palea),* and *Cyclotella meneghiniana*. The top five diatom taxa accounted for 55 to 99% of all diatom taxa in the tributaries. The number of distinct taxa represented ranged from only nine at Station SMC02232 in 2013 to 41 at Station SMC00440 sampled in 2018. The average number of distinct taxa represented for the tributaries was 23.6. The soft-bodied algae: *Vaucheria geminate*, *Cladophora glomerata*, *Symploca elegans*, *Symploca* sp 1, and *Heteroleibleinia kossinskajaeall* accounted for over 73 to near 100% of the total soft-bodied algae biovolume at a given site, while *Gongrosira* cf *debaryana*, *Schizothrix fragilis*, and *Phormidium* sp 4 also contributed notably to biovolume at specific stations and years. Diatom ASCI scores ranged from 0.40 at Staton 412M08632 in 2017 to 0.74 at Station SMC02232 in 2013 and averaged 0.59 overall for nine reported scores. Soft ASCI scores ranged from 0.31 at Station SMC00440 in 2009 to 0.92 at Station SMC01656 in 2012 and averaged 0.76 overall. Substrate for these tributaries is generally concrete with a mix of box and trapezoidal channels with shading in some areas.

5.3.3.3 Summary

In summary, several diatom species: *Halamphora veneta*, *Staurosira construens var venter*, *Achnanthidium minutissimum*, *Nitzschia (amphibioides, inconspicua, palea, palea var debilis)*, *Cyclotella meneghiniana* are observed in high abundances and frequently reported throughout the LA River mainstem, particularly on concrete. A few diatoms, *Cocconeis placentula var euglypta* and *Amphora pediculus*, appear to also occur more frequently with higher abundance on more natural substrate such as below LAGWRP, while other diatoms such as *Cocconeis pediculus, Cocconeis placentula*, and *Gomphonema parvulum* more frequently with greater abundance at stations in the upper reaches (3 – 6) of the LA River. *Cladophora glomerata* was the dominant soft algae species throughout the mainstem, along with other various but less abundant soft algae species including *Gongrosira* sp. (*schmidlei*, sp. 1*, incrustans*), *Heteroleibleinia* sp 1, *Calothrix* sp., *Oedogonium* sp. 1 *Schizothrix fragilis*, *Leptolyngbya foveolarum*, *Symploca elegans*, *Pleurosira laevis*, and *Rivularia biasolettiana* throughout the mainstem.

In terms of index Diatom ASCI and Soft Algae ASCI scores, average Diatom ASCI ranges from 0.39 in LAR4 to 0.71 in LAR6, with a surprisingly low Diatom ASCI score of 0.27 at the Lake Balboa Station in LAR5 above DCTWRP (arguably the station with the most natural substrate and riparian corridor in the entire LA River mainstem, but also a station with greater depth overall). Average Soft Algae ASCI scores range from 0.63 in LAR3 to 0.73 in LAR2. As with CSCI, algae scores can be highly variable both within a single reach and station over multiple years, as well as provide unexpected (incongruous) values. For example, the Diatom ASCI score at BWC (Down) was much higher (0.80) versus at BWC (Up) with a score of only 0.38; the Diatom ASCI at BWC Riverside was 0.64. There is no obvious decrease in any algal index score as a result of being below a WRP, suggesting no impact of WRP discharge on benthic algae of any kind (see also the results of the analyses below under **Section 5.3.4.1**).

Many of the most abundant and frequently reported diatom and soft algae species on the mainstem are similarly abundant and frequently reported in the primary tributaries to the mainstem, although slight differences exist. Average Diatom ASCI and Soft Algae ASCI scores tend to be slightly higher compared to the mainstem, but the range in scores is similar. As with the mainstem, incongruities with regards to expectations exist. For example, Diatom ASCI scores in Tujunga Wash ranged from 0.60 at Station SMC02996 (in the non-urbanized foothills) to 0.97 at Station SMC02484 in mixed commercial and residential area. Likewise, Soft ASCI scores ranged from 0.33 at Station 412M08683 (foothills) to 0.91 at Station SMC02484. **Section 5.3.4** contains important additional analysis of the similarities in benthic algae taxa between LAR1 through LAR6, BWC, and the several tributaries to the mainstem of the LA River.

5.3.4 Analysis of Bioassessment Data and Indices

This section includes the results of two types of analyses used to support Study findings and address Study Objectives.

5.3.4.1 Upstream versus Downstream of WRP Discharge Analysis

As stated above, an important consideration for the Study regarding taxa presence is whether biological communities are meaningfully and functionally different upstream and downstream of WRP outfalls. Ranked-sum tests were conducted using pairings of station groups above and below WRPs to evaluate potential statistical differences in BMI Family+ and diatom taxa counts, soft-bodied algae biovolume, and CSCI and ASCI scores when sufficient data existed; otherwise, visual display was used to compare index (CSCI and ASCI) scores. Comparisons made are presented in order as follows:

- DCTWRP
  - Data collected immediately above the DCTWRP discharge (LAR5) were compared to data below the discharge (LAR4).
  - Data collected in LAR6 was compared to data in LAR5.
- BWRP
  - Data collected immediately above the BWRP discharge in the BWC were compared to data below the discharge in the BWC.
  - Data collected in the LAR upstream (LAR4) of the confluence with the BWC were compared to data collected below the confluence (LAR3 before the LAGWRP discharge).
- LAGWRP
  - Data collected immediately above the LAGWRP discharge (LAR3) were compared to data below the discharge (LAR3).
  - Data collected below the LAGWRP discharge (LAR3) were compared to data in LAR2.

Table 28 provides a summary of the different combinations of station pairings analyzed, station pairing set with respect to WRPs, and years sampled. All results for CSCI and ASCI indices are shown graphically for visual comparison and qualitative interpretation, followed by tabular display of results and written summary of the ranked-sum tests, where available.

When sufficient data existed, Wilcoxon (Mann-Whitney) ranked-sum tests were used to test for differences in count (BMI Family+ and diatom species) and biovolume (benthic soft-bodied algae) data found upstream and downstream of a WRP as well as for CSCI, Diatom _ASCI), Soft Algae ASCI), and Hybrid _ASCI) scores. To conduct the analysis, the data were ranked from high to low, and the sum of the joint ranks was calculated, using average ranks in the case of ties. The sum of ranks between one group and another were subsequently compared. For the test, the probability can be either one or two-sided, depending on the underlying hypothesis. For this analysis, a two-sided test was performed because departures from the null hypothesis (H_0; i.e., no effect) in only one direction are uncertain. For example, within a given BMI family that may contain several genera or species, each individual taxa may have a different response of either greater or lesser above or below a WRP.

Three assumptions were used for the rank-sum test (Conover 1999): 1) data in both groups are random samples from their respective populations; 2) in addition to independence of data within each group, there is mutual independence between the two groups, e.g., data from the same sampling unit (and certainly the exact same observations) should never be present in both groups; and 3) the measurement scale is at least ordinal. Because the rank-sum test is non-parametric, there is no requirement of equal variances or normality of the distribution of data. No assumptions are made about how the data are distributed in either group. They may be normal, lognormal, exponential, or any other distribution. They may also be uni-, bi- or multi-modal. If the only objective is to determine whether one group tends to produce generally higher observations than the other, the two groups do not need to have the same distribution (Helsel et al. 2020).

Prior to conducting the ranked-sum tests, a Mann-Kendall trend test was implemented to justify use of combining years within a given station to increase sample size to strengthen the comparative analysis using the ranked-sum tests described above. From the trend analysis, results of no trend were determined for several stations and taxa, and thus, the conclusion was reached that combining years for stations to be used for determining differences upstream and downstream of WRPs was appropriate and warranted.

Table 28. Bioassessment Data Year and Station Combinations Supporting the Upstream vs Downstream Analysis of BMI Family + and Diatom Taxa Count, Soft-bodied Algae Biovolume, and CSCI and ASCI scores using Wilcoxon-Mann-Whitney Ranked Sum Test

Waterbody	Station ID	Year(s) Sampled[1]	DCTWRP	LAR6 to LAR5	BWRP	BWC LAR Confluence	LAGWRP	LAR3 to LAR2
LAR Reach 6	SMC02680	**2014**		Up				
	SMCLAR0052	2008, 2017, **2022**		Up				
	LAR01208	**2010**, **2020**, **2023**		Up				
	412M08672	**2021**		Up				
	412M08688	**2022**		Up				
LAR Reach 5	LAR5 Balboa	**2024**	Up	Down				
LAR Reach 4	LAR08661	**2021**	Down			Up		
	LAR4 Kester (LAR0232)	2006, **2015-21**, **2024**	Down			Up		
	412M08597	**2015**	Down			Up		
	412CE0616	2007, 2015	Down			Up		
	LAR02804	**2011**	Down			Up		
	LAR08656	**2020**	Down			Up		
	LAR08615	2016	Down			Up		
	SMC01460	2008	Down			Up		
	412CE0732	2007, 2015	Down			Up		
	LAR4 Zoo (412M08695)	**2023**, **2024**	Down			Up		
BWC	BWC (Up)	**2024**			Up			
	BWC (Down)	**2024**			Down			
	SMC01288	2008			Down			
	412LARBBK	2005			Down			
	BWC Riverside	**2024**			Down			
LAR Reach 3	LAR3 Griffith (LAR04532)	**2012**, **2024**				Down	Up	
	LAR00436	**2009**, 2017, **2023**				Down	Up	
	LAR3 Electronics	**2024**				Down	Up	
	LAR3 N. Atwater (LAR10210)	**2021-24**					Down	Up
	LAR08663	**2021**					Down	Up

Waterbody	Station ID	Year(s) Sampled[1]	DCTWRP	LAR6 to LAR5	BWRP	BWC LAR Confluence	LAGWRP	LAR3 to LAR2
	LAR3 Greenway (LAR08599)	**2015**, **2018**, 2019, 2020, **2021-24**					Down	Up
	LAR3 Riverside	**2024**					Down	Up
LAR Reach 2	412CE0104	2005, **2009**						Down
	412M08642	**2018**						Down
	LAR2 Washington (SMC03902)	2008, **2024**						Down
	412LAR007	2005						Down
	SMC03646	2013						Down
	412M08602	**2015**						Down
	412M08659	**2020**						Down
	SMC02622	**2010**						Down
	SMC05694	**2014**						Down
	412M08627	**2017**						Down
	412LAR023	2005						Down

1. Years in **bold** font represent those with both BMI and benthic algae data.

5.3.4.1.1 DCTWRP Analysis

Figure 53 provides a visual comparison of index scores for stations bracketing DCTWRP outfalls, where DCTWRP (Up) in this case reflects data from station LAR5 Balboa sampled in 2024 for the study and DCTWRP (Down) reflects data from the nine stations downstream of all DCTWRP outfalls in LAR4 (refer to **Table 28** for data year and station combinations depicted). Median CSCI is lower downstream of DCTWRP (representing the entirety of LAR4) compared to upstream at LAR5 Balboa, but the range in CSCI scores overlap. In contrast, median Diatom ASCI, Soft Algae ASCI, and Hybrid ASCI scores for downstream stations are above the respective single scores for LAR5 Balboa.

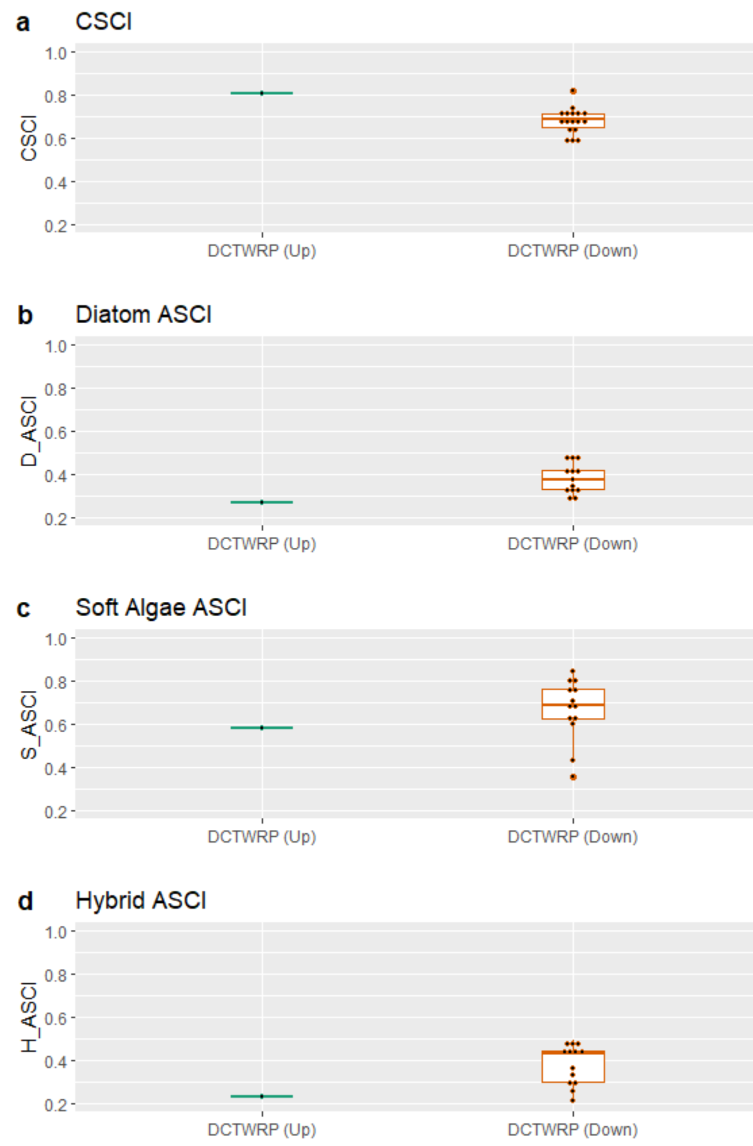


Figure 53. Visual Comparison of Index Scores for Stations Bracketing the DCTWRP in LAR5 and LAR4

Figure 54 provides a visual comparison of index scores for stations in LAR6 and LAR5 Balboa (all of which are not influenced by WRP flow), and where LAR6 to LAR5 (Up) reflects data from five stations in LAR6 where LAR5 (Down) reflects data from station LAR5 Balboa (see **Table 28** for data year and station combinations depicted). Although the data are limited to one event at LAR Balboa, median CSCI is lower for stations in LAR6 compared to LAR5 Balboa prior to receiving any flow from DCTWRP. In contrast, median Diatom ASCI, Soft Algae ASCI, and Hybrid ASCI scores for LAR6 stations are roughly the same (Soft Algae ASCI) or above (Diatom ASCI and Hybrid ASCI) the respective single scores for these indices at LAR5 Balboa.

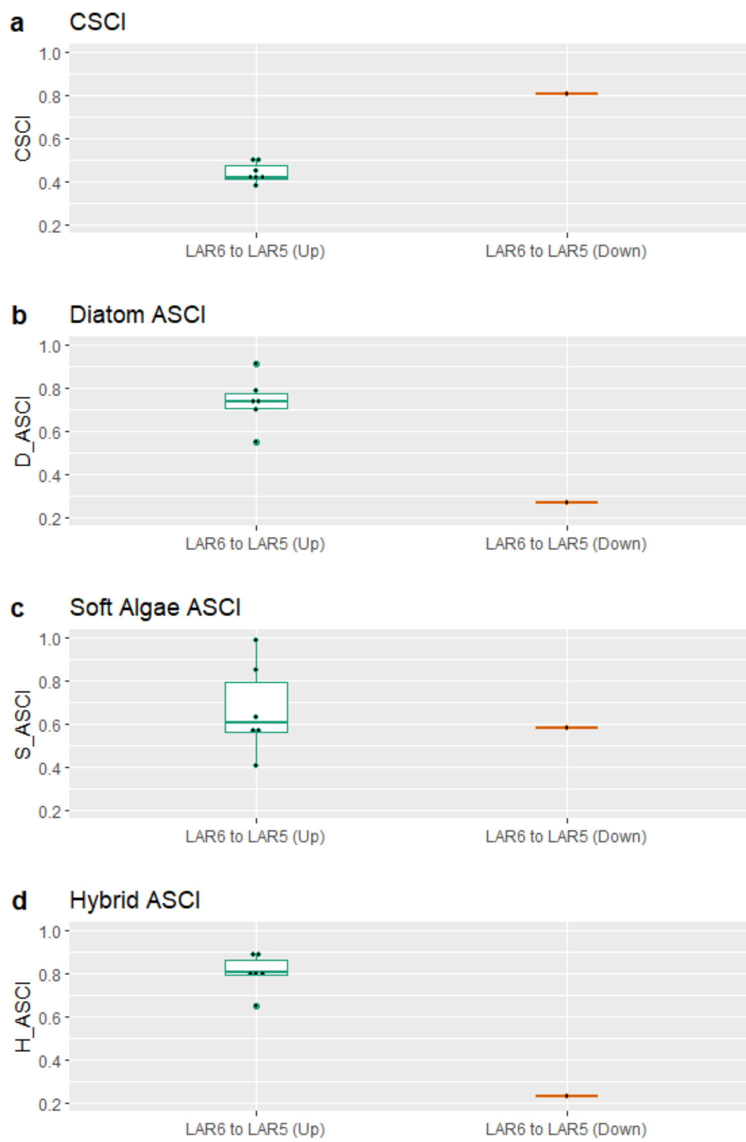


Figure 54. Visual Comparison of Index Scores for Stations in LAR6 and LAR5 above DCTWRP Outfalls

5.3.4.1.2 BWRP Analysis

Figure 55 provides a visual comparison of index scores for stations bracketing the BWRP outfall, where BWRP (Up) in this case reflects data from a single station sampled in 2024 and BWRP (Down) represents two stations downstream of the BWRP also sampled in 2024 (see **Table 28** for data year and station combinations depicted). Median CSCI is lower downstream of BWRP (reflecting the entirety of BWC) compared to upstream. In contrast, Diatom ASCI and Hybrid ASCI scores for downstream stations are substantially higher compared to upstream of the BWRP while Soft Algae ASCI is lower downstream compared to upstream.

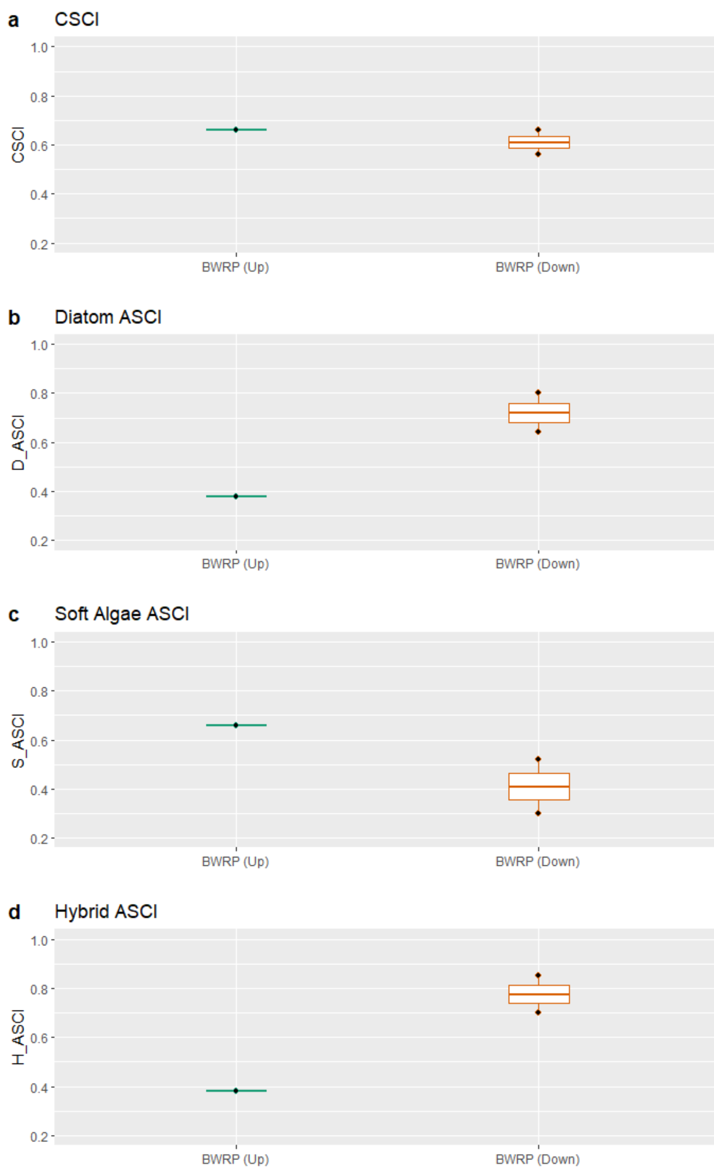


Figure 55. Visual Comparison of Index Scores for Stations for Stations Bracketing the BWRP (2024 data only)

Figure 56 provides a visual comparison of index scores for stations in the LA River mainstem above [BWCLARC (Up)] and below [(BWCLARC(Down)] the confluence of the mainstem with the BWC (see **Table 28** for data year and station combinations depicted). Median CSCI is nearly identical upstream and downstream of the BWC on the LA River mainstem, with approximately the same range in CSCI scores. The same is true for Diatom ASCI, whereas both Soft Algae ASCI and Hybrid ASCI are higher above the confluence compared to below the BWC.

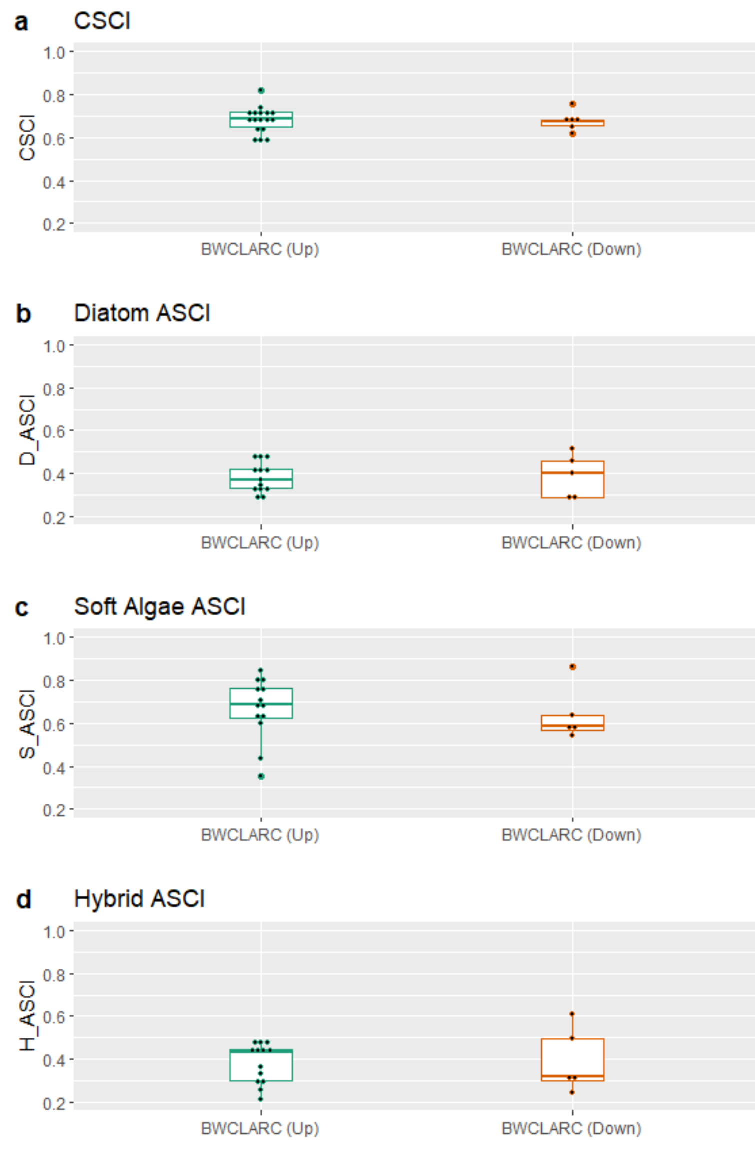


Figure 56. Visual Comparison of Index Scores for Stations in LAR4 above the BWC Confluence and LAR3 Below the Confluence and Above LAGWRP

The results of the ranked-sum test for bioassessment (BMI and benthic algae) stations on the LA River mainstem upstream (Ust) and downstream (Dst) of the confluence with the BWC are shown in **Table 29** (see **Table 28** for data year and station combinations depicted). The BMI results indicate no statistically significant differences for four of the eight prevalent Family+ taxa evaluated. Total count of Oligochaeta and Ostracoda is significantly greater ($p < 0.05$) below the confluence (in upper LAR3; Dst) compared to above the confluence (LAR4; Ust). Conversely, total count of Baetidae and Simuliidae is significantly greater ($p < 0.1$ or $p < 0.05$) above the confluence in LAR4 compared to below it in upper LAR3. Recall that the two-sided test does not technically discriminate in which direction a difference lies between locations, but for explanatory reasons, it is not inappropriate to interpret the sign of the difference to indicate which group is greater or lesser of the two, so we have done so here. CSCI scores were not significantly different from each other between lower LAR4 stations and upper LAR3 stations.

The benthic algae results shown in **Table 30** indicate no statistically significant differences for eight of the nine diatom taxa evaluated, as well as all 11 of the soft-bodied algae taxa evaluated. Total count of the diatom *Halamphora veneta* was significantly greater ($p < 0.1$) below the confluence (in upper LAR3; Dst) compared to above the confluence (LAR4; Ust). ASCI scores were not significantly different from each other between lower LAR4 stations and upper LAR3 stations.

Table 29. Results of Wilcoxon-Mann-Whitney Ranked-Sum Test for BMI Stations on the LA River Above and Below the Confluence with the BWC

Shown are the number of observations (Upstream – Ust and downstream – Dst), the calculated difference in ranks, the upper and lower 95% confidence interval in the calculated difference, W (the test statistic), p-value (value below 0.1 bold font), along with an estimate of likelihood of a difference based on the statistics.

Family+	# Observations (Ust|Dst)	Difference in Ranks (Ust - Dst)	Lower CI	Upper CI	W statistic	p-value	Difference Likely
Baetidae	21 | 6	97.79	-9	261	93.5	**0.080**	yes (Ust greater)
Chironomidae		-125.14	-270	33	34.5	0.102	none
Hyalellidae		18	-12	86	86.5	0.179	none
Oligochaeta		-76.19	-195	-7	19.5	**0.012**	yes (Dst greater)
Ostracoda		-53	-132	-12	16.5	**0.007**	yes (Dst greater)
Physidae		-1	-6	7	47.5	0.372	none
Simuliidae		96	1	139	101	**0.028**	yes (Ust greater)
Turbellaria		-6	-98	1	36.5	0.124	none
CSCI	17 | 6	0.01	-0.06	0.06	55.5	0.779	none

Table 30. Results of Wilcoxon-Mann-Whitney Ranked-Sum Test for Benthic Algae Stations on the LA River Above and Below the Confluence with the BWC

*Shown are the number of observations (Upstream – Ust and downstream – Dst), the calculated difference in ranks, the upper and lower 95% confidence interval in the calculated difference, W (the test statistic), p-value (value below 0.1 **bold** font), along with an estimate of likelihood of a difference based on the statistics. Diatom taxa in **bold**.*

Taxa or Index	# Observations (Ust|Dst)	Difference in Ranks (Ust - Dst)	Lower CI	Upper CI	W statistic	p-value	Difference Likely
Achnanthidium exiguum	14 | 5	5	-19	12	47.5	0.259	none
Achnanthidium minutissimum		-13.45	-25	11	18.5	0.138	none
Cyclotella meneghiniana		-23.81	-83	27	25	0.379	none
Craticula subminuscula		-7	-44	3	25	0.361	none
Gomphonema parvulum		-11.44	-50	5	22	0.246	none
Halamphora veneta		-53.32	-78	1	16	**0.086**	yes (Dst greater)
Nitzschia amphibia		10.5	-6	27	52	0.126	none
Nitzschia amphibioides		0	-8	12	35.5	1	none
Nitzschia inconspicua		-22.37	-52	18	22	0.246	none
Cladophora glomerata	14 | 5	-103174525.1	-1.6973E+11	304645849	28	0.532	none
Heteroleibleinia sp 1		0	-378773	82475	35	1	none
Monoraphidium minutum		0	-1042	28660	36	0.962	none
Pediastrum duplex		0	-107024	92702	32	0.81	none
Pleurosira laevis		0	-4570384	304878048	38.5	0.764	none
Scenedesmus		0	0	1996	45	0.218	none
Scenedesmus abundans		-2369	-40639	321026	33	0.893	none
Scenedesmus armatus		0	-29552	150048	37	0.885	none
Scenedesmus communis		0	-35352	186206	32	0.802	none
Scenedesmus dimorphus		-13678.36	-134980	35936	21	0.207	none
Scenedesmus ellipticus		-2710	-141513	1797625	31	0.745	none
D_ASCI	13 | 5	0	-0.12	0.09	33	1.000	none
S_ASCI		0.06	-0.16	0.19	41	0.443	none
H_ASCI		-0.02	-0.17	0.14	30	0.849	none

5.3.4.1.3 LAGWRP Analysis

Figure 57 provides a visual comparison of index scores for stations bracketing the LAGWRP outfall, where LAGWRP (Up) in this case reflects data from three stations above LAGWRP and LAGWRP (Down) reflects data from four stations downstream of the LAGWRP outfall (see **Table 28** for data year and station combinations depicted). There is nearly complete overlap in index scores for CSCI, Diatom ASCI, and Soft Algae ASCI, while the Hybrid ASCI score is higher downstream of the LAGWRP.

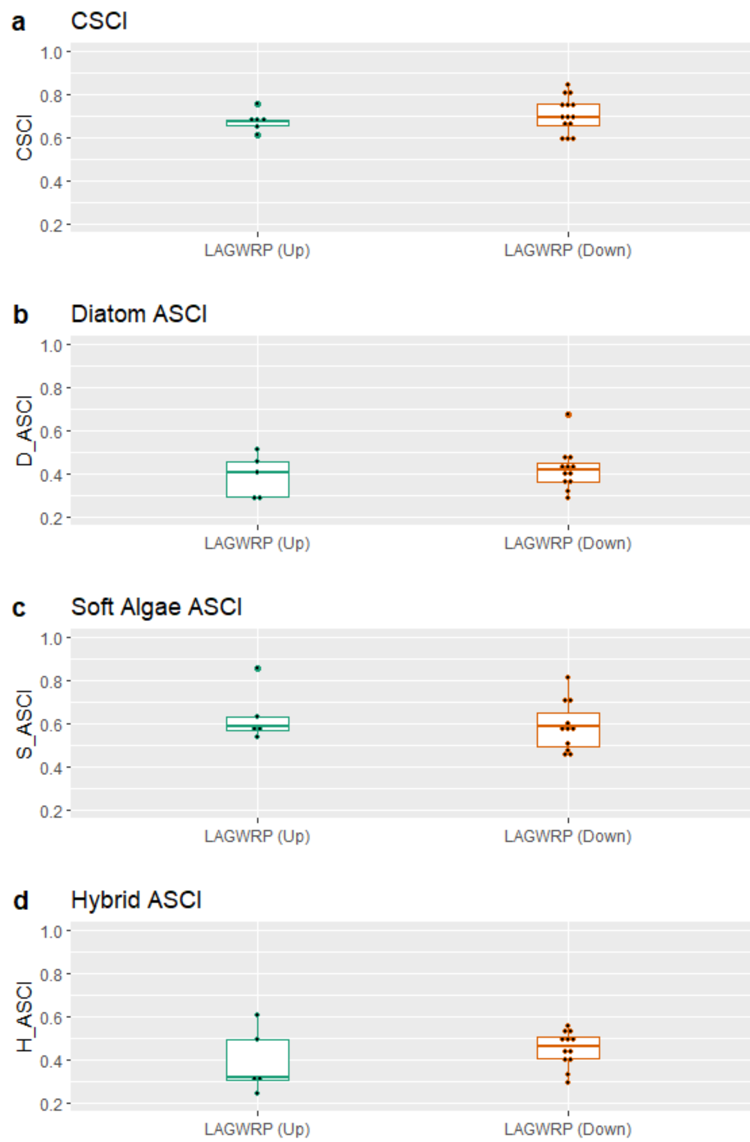


Figure 57. Visual Comparison of Index Scores for Stations Bracketing the LAGWRP

The results of the ranked-sum test for bioassessment stations bracketing the LAGWRP are shown in **Table 31** (see **Table 28** for data year and station combinations depicted). The BMI results indicate no statistically significant differences for four of the eight prevalent Family+ taxa evaluated. Total count of Baetidae is greater at the 0.1 significance level ($p < 0.1$) downstream of the LAGWRP. Conversely, total count of Chironomidae, Oligochaeta, and Ostracoda is greater at the 0.05 level ($p < 0.05$) upstream of the LAGWRP. CSCI scores were not significantly different from each other upstream or downstream of the LAGWRP.

The benthic algae results shown in **Table 32** indicate no statistically significant differences for eight of the nine diatom taxa evaluated, and eight of the 11 soft-bodied algae taxa evaluated. Total count of the diatom *Achnanthidium minutissimum* was significantly greater ($p < 0.05$) upstream of the LAGWRP. Likewise, total biovolume of *Scenedesmus dimorphus* and *Scenedesmus ellipticus* are significantly greater ($p < 0.05$ and $p < 0.1$ and) upstream of the LAGWRP, while *Scenedesmus* is greater ($p < 0.05$) downstream. ASCI scores were not significantly different from each other upstream or downstream of the LAGWRP.

Table 31. Results of Wilcoxon-Mann-Whitney Ranked-Sum Test for BMI Stations Bracketing the LAGWRP

Shown are the number of observations (Upstream – Ust and downstream – Dst), the calculated difference in ranks, the upper and lower 95% confidence interval in the calculated difference, W (the test statistic), p-value (value below 0.1 in bold font along with an estimate of likelihood of a difference based on the statistics.

<table>
<tr><th>Family+</th><th># Observations (Ust|Dst)</th><th>Difference in Ranks (Ust - Dst)</th><th>Lower CI</th><th>Upper CI</th><th>W statistic</th><th>p-value</th><th>Difference Likely</th></tr>
<tr><td>Baetidae</td><td rowspan="8">6 | 14</td><td>-80.33</td><td>-198</td><td>3</td><td>19.5</td><td>0.069</td><td>yes (Dst greater)</td></tr>
<tr><td>Chironomidae</td><td>168.5</td><td>23</td><td>309</td><td>68</td><td>0.033</td><td>yes (Ust greater)</td></tr>
<tr><td>Hyalellidae</td><td>-4</td><td>-50</td><td>36</td><td>36</td><td>0.648</td><td>none</td></tr>
<tr><td>Oligochaeta</td><td>107</td><td>7</td><td>197</td><td>70</td><td>0.023</td><td>yes (Ust greater)</td></tr>
<tr><td>Ostracoda</td><td>57</td><td>41</td><td>136</td><td>82</td><td>0.001</td><td>yes (Ust greater)</td></tr>
<tr><td>Physidae</td><td>1</td><td>-4</td><td>7</td><td>46</td><td>0.772</td><td>none</td></tr>
<tr><td>Simuliidae</td><td>1.79</td><td>-1</td><td>4</td><td>55.5</td><td>0.260</td><td>none</td></tr>
<tr><td>Turbellaria</td><td>1.15</td><td>-12</td><td>95</td><td>45.5</td><td>0.804</td><td>none</td></tr>
<tr><td>CSCI</td><td>6 | 14</td><td>-0.02</td><td>-0.11</td><td>0.06</td><td>31.5</td><td>0.409</td><td>none</td></tr>
</table>

Table 32. Results of Wilcoxon-Mann-Whitney Ranked-Sum Test for Benthic Algae Stations Bracketing the LAGWRP

Shown are the number of observations (Upstream – Ust and downstream – Dst), the calculated difference in ranks, the upper and lower 95% confidence interval in the calculated difference, W (the test statistic), p-value (value below 0.1 in ***bold*** *font along with an estimate of likelihood of a difference based on the statistics. Diatom taxa in* ***bold****.*

Taxa or Index	# Observations (Ust|Dst)	Difference in Ranks (Ust - Dst)	Lower CI	Upper CI	W statistic	p-value	Difference Likely
Achnanthidium exiguum	5 | 12	-4	-16	18	17	0.182	none
Achnanthidium minutissimum		17	3	36	52.5	**0.02**	yes (Ust greater)
Cyclotella meneghiniana		29	-5	101	44.5	0.139	none
Craticula subminuscula		-11	-25	20	20.5	0.342	none
Gomphonema parvulum		14.35	-4	88	41	0.268	none
Halamphora veneta		25.43	-24	71	37.5	0.46	none
Nitzschia amphibia		-11.61	-46	4	14.5	0.113	none
Nitzschia amphibioides		-9.55	-29	7	16.5	0.167	none
Nitzschia inconspicua		21.78	-14	58	44	0.154	none
Cladophora glomerata	5 | 12	193548387	-799530893	1.6973E+11	38	0.392	none
Heteroleibleinia sp 1		0	-67766	787101	32	0.873	none
Monoraphidium minutum		970.63	-18	1042	39	0.344	none
Pediastrum duplex		46536.32	-3599	488895	41	0.243	none
Pleurosira laevis		-119608.53	-548696844	14430536561	22.5	0.451	none
Scenedesmus		-3200.58	-6456	-1632	5	**0.007**	yes (Dst greater)
Scenedesmus abundans		16155.55	-5328	385870	44	0.154	none
Scenedesmus armatus		21038.03	0	61226	41	0.215	none
Scenedesmus communis		1772.02	-1556	35352	39	0.332	none
Scenedesmus dimorphus		52986.52	3273	134980	51	**0.029**	yes (Ust greater)
Scenedesmus ellipticus		30690.93	-2204	141513	48	**0.063**	yes (Ust greater)
D_ASCI	5 | 12	-0.02	-0.15	0.09	26	0.721	none
S_ASCI		0.03	-0.15	0.16	33	0.799	none
H_ASCI		-0.08	-0.2	0.1	22	0.442	none

Figure 58 provides a visual comparison of index scores for stations in LAR3 below the LAGWRP outfall (with a more natural substrate) and LAR2 (with a concrete substrate, see **Table 28** for data year and station combinations depicted). Median CSCI is higher in LAR3 below LAGWRP compared to downstream in LAR2. In contrast, Diatom ASCI and Hybrid ASCI are similar between LAR3 below the LAGWRP and LAR2, but Soft Algae ASCI is slightly higher in LAR2.

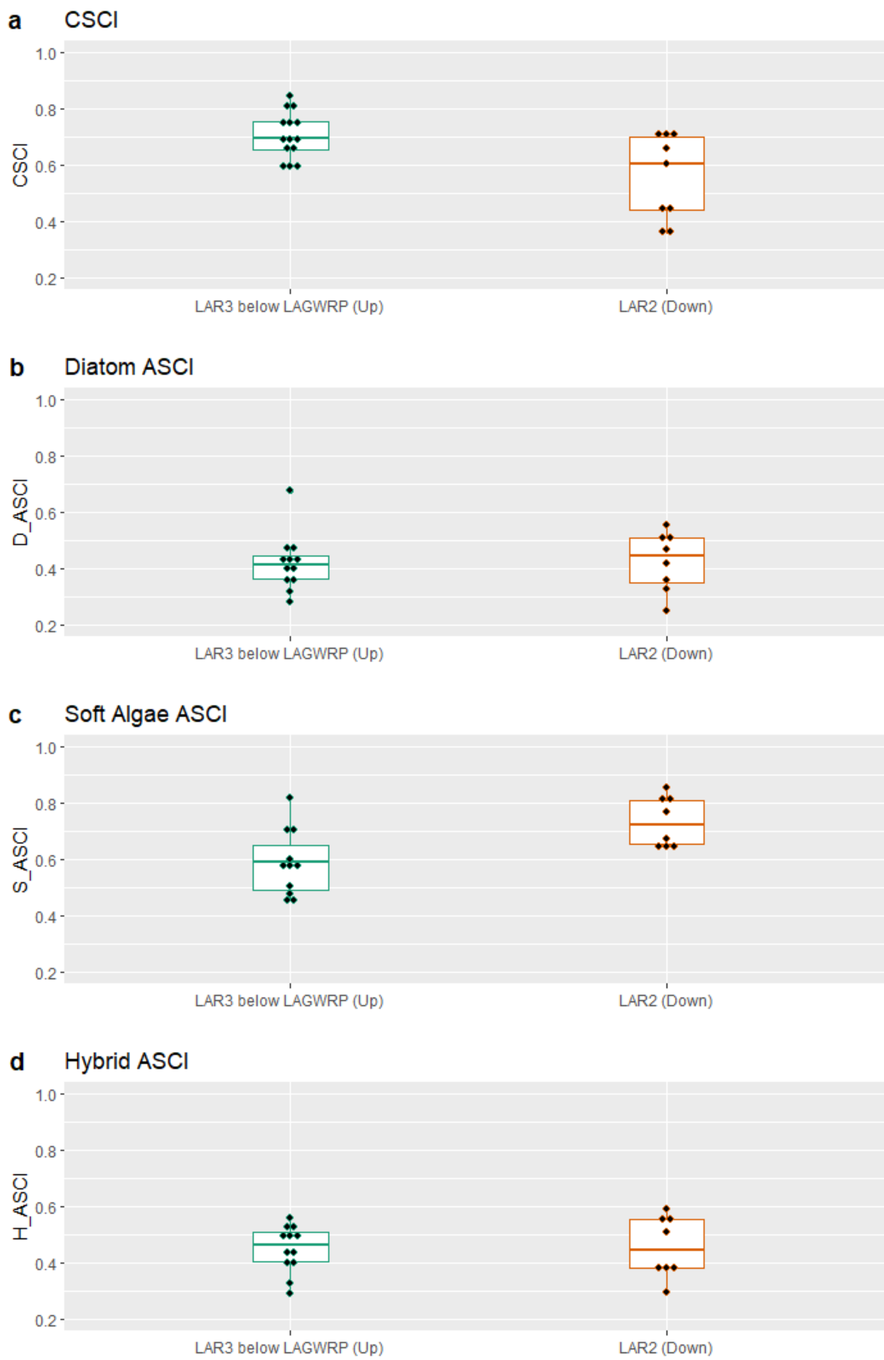


Figure 58. Visual Comparison of Index Scores for Stations in LAR3 below LAGWRP and LAR2

The results of the ranked-sum test for stations below the LAGWRP in LAR3 with stations in LAR2 are shown in **Table 33** (see **Table 28** for data year and station combinations depicted). The results indicate no statistically significant differences for four of the eight prevalent Family+ taxa evaluated. The total count of Baetidae and Turbellaria is significantly greater ($p < 0.05$) at stations with more natural substrate in LAR3 compared to stations with concrete substrate in LAR2. Conversely, the total count of Chironomidae and Ostracoda is significantly greater ($p < 0.05$) in LAR2 stations compared to LAR3 stations. CSCI is also significantly greater ($p < 0.05$) at LAR3, stations with more natural substrate, compared to LAR2 stations with concrete substrate.

The benthic algae results shown in **Table 34** indicate no statistically significant differences for six of the nine diatom taxa evaluated, and seven of the 11 soft-bodied algae taxa evaluated. Total count of the diatom *Achnanthidium exiguum*, *Nitzschia amphibia*, and *Nitzschia amphibioides* were all significantly greater ($p < 0.1$ and $p < 0.05$) above in LAR3 stations with a more natural substrate compared to below LAR2 stations with a concrete substrate. Total biovolume of *Pleurosira laevis* and *Scenedesmus* was significantly greater ($p < 0.05$) at stations with more natural substrate in LAR3 compared to stations with concrete substrate in LAR2. Conversely, total biovolume of *Scenedesmus abundans and Scenedesmus dimorphus* was significantly greater ($p < 0.05$) in LAR2 stations compared to LAR3 stations. Diatom and hybrid ASCI scores were not significantly different from each other above in LAR3 stations compared to below in LAR2 stations. Conversely, Soft ASCI was significantly greater ($p < 0.1$) in LAR2 stations on concrete compared to the stations with more natural substrate in LAR3.

Table 33. Results of Wilcoxon-Mann-Whitney Ranked-Sum Test for BMI Stations Below the LAGWRP Comparing the Transition Area between More Natural Substrate and Concrete

Shown are the number of observations (Upstream – Ust and downstream – Dst), the calculated difference in ranks, the upper and lower 95% confidence interval in the calculated difference, W (the test statistic), p-value (value below 0.05 in bold font), along with an estimate of likelihood of a difference based on the statistics.

Family+	# Observations (Ust|Dst)	Difference in Ranks (Ust - Dst)	Lower CI	Upper CI	W statistic	p-value	Difference Likely
Baetidae	14 | 13	84.87	31	208	147	**0.007**	yes (Ust greater)
Chironomidae		-156	-275	-17	45	**0.025**	yes (Dst greater)
Hyalellidae		7	-1	20	121	0.151	none
Oligochaeta		-53.68	-101	3	61	0.152	none
Ostracoda		-9.91	-116	-3	33.5	**0.005**	yes (Dst greater)
Physidae		1	-2	4	111.5	0.326	none
Simuliidae		0	-1	1	95	0.851	none
Turbellaria		8	3	19	158	**0.001**	yes (Ust greater)
CSCI	14 | 9	0.14	0.01	0.29	96	**0.039**	yes (Ust greater)

Table 34. Results of Wilcoxon-Mann-Whitney Ranked-Sum Test for Benthic Algae Stations Below the LAGWRP Comparing the Transition Area between More Natural Substrate and Concrete

Shown are the number of observations (Upstream – Ust and downstream – Dst), the calculated difference in ranks, the upper and lower 95% confidence interval in the calculated difference, W (the test statistic), p-value (value below 0.05 in bold font), along with an estimate of likelihood of a difference based on the statistics. Diatom taxa in bold.

Taxa or Index	# Observations (Ust|Dst)	Difference in Ranks (Ust - Dst)	Lower CI	Upper CI	W statistic	p-value	Difference Likely
Achnanthidium exiguum	12 | 8	4.54	-1	11	70	**0.095**	yes (Ust greater)
Achnanthidium minutissimum		1.51	-2	8	58	0.458	none
Cyclotella meneghiniana		-12	-122	8	33.5	0.279	none
Craticula subminuscula		10.66	-6	25	64.5	0.216	none
Gomphonema parvulum		1.11	-23	8	53	0.728	none
Halamphora veneta		6.91	-13	30	58.5	0.439	none
Nitzschia amphibia		10	-1	29	70	**0.097**	yes (Ust greater)
Nitzschia amphibioides		14	0	24	77	**0.023**	yes (Ust greater)
Nitzschia inconspicua		7	-22	33	54.5	0.6	none
Cladophora glomerata	12 | 8	-4027953428	-10451612903	799011641	30	0.157	none
Heteroleibleinia sp 1		5374	0	68458	65	0.182	none
Monoraphidium minutum		0	-19230	18	40	0.536	none
Pediastrum duplex		0	-169195	23323	46	0.899	none
Pleurosira laevis		686106	0	519560444	73	**0.048**	yes (Ust greater)
Scenedesmus		3052	1632	5986	85	**0.003**	yes (Ust greater)
Scenedesmus abundans		-287827.04	-1100752	-42838	10	**0.004**	yes (Dst greater)
Scenedesmus armatus		0	0	4241	52	0.739	none
Scenedesmus communis		0	0	1556	53	0.684	none
Scenedesmus dimorphus		-196917	-48469953	-6240	17.5	**0.019**	yes (Dst greater)
Scenedesmus ellipticus		-14544.94	-160712	2253	31	0.197	none
D_ASCI	12 | 8	-0.03	-0.11	0.1	42	0.678	none
S_ASCI		-0.14	-0.23	0	23	**0.057**	yes (Dst greater)
H_ASCI		-0.01	-0.1	0.11	45	0.851	none

5.3.4.1.4 Summary: BMI and Benthic Algae Up vs Downstream Analyses

For this study, we sought to answer a critical question of relevance to the Study objectives: Is the biological community different upstream and downstream of the WRPs? To address this question, BMI Family+ and diatom taxa count, soft-bodied algae biovolume, and CSCI and ASCI scores were evaluated for possible differences above and below WRPs in the LA River Mainstem (Reaches 2 through 5) and the BWC. The following provides summary highlights of the results:

- **DCTWRP**
  - Data collected immediately above the DCTWRP discharge (LAR5) were compared to data below the discharge (LAR4), to evaluate whether any of the discharges from DCTWRP are having a discernable impact on biology.
    - Median CSCI is lower downstream of DCTWRP (0.69 and representing the entirety of LAR4) compared to the one upstream station (0.81; LAR5 Balboa), but the range in CSCI scores overlap. In contrast, median ASCI scores for downstream stations are higher than the upstream station.
    - The LAR5 Balboa station represents a non-wadeable, deepwater habitat location with a mixed, more natural substrate, versus the shallow and wide-open channel characterizing the entirety of LAR4 where the substrate is all concrete.
  - Data collected in LAR6 were compared to data in LAR5 (Balboa), which are both above the DCTWRP discharge.
    - Median CSCI is substantially lower for stations in LAR6 compared to the LAR5 (Balboa) station prior to receiving flow from DCTWRP. In contrast, median ASCI scores for LAR6 stations are roughly the same (Soft ASCI) or substantially higher (Diatom ASCI and Hybrid ASCI) than the LAR5 station.
    - Stations in LAR6 are all on concrete with shallow depth and wide-open canopy. Additionally, neither the LAR6 nor LAR5 Balboa stations receive WRP flow. The median CSCI for LAR6 stations (without WRP flow) is 0.43, whereas the median CSCI for LAR4 stations, below all DCTWRP discharges but also on concrete with shallow depth and wide-open canopy, is 0.69.
- **BWRP**
  - Data collected immediately above the BWRP discharge in the BWC were compared to data below the discharge in the BWC.
    - CSCI is only slightly lower or the same downstream of the BWRP (0.56 at the confluence and 0.66 immediately below the BWRP outfall) compared to upstream (0.66 immediately above the BWRP outfall). In contrast, Diatom ASCI and Hybrid ASCI scores for downstream stations are substantially higher than the upstream station while Soft ASCI is lower downstream compared to upstream.
  - Data collected in the LAR upstream (LAR4) of the confluence with the BWC were compared to data collected below the confluence (LAR3 before the LAGWRP discharge).
    - The results indicate no statistically significant differences for four of the eight prevalent BMI Family+ taxa evaluated, with two Family+ taxa significantly greater below the confluence (in upper LAR3) and two Family+ taxa significantly greater above the confluence (LAR4).
    - The benthic algae results indicate no statistically significant differences for eight

of the nine diatom taxa evaluated, as well as all 11 of the soft-bodied algae taxa evaluated. Only one diatom (*Halamphora veneta*) was significantly greater below the confluence.

- Median CSCI is nearly identical in the LA River upstream and downstream of the confluence with the BWC, with approximately the same range in CSCI scores. The same is true for Diatom ASCI, whereas both Soft ASCI and Hybrid ASCI are slightly higher above the confluence compared to below.
- Neither CSCI nor ASCI scores were statistically different in the LA River above and below the confluence with the BWC.

- **LAGWRP**
  - Data collected immediately above the LAGWRP discharge (LAR3) were compared to data below the discharge (LAR3):
    - The analysis indicates no statistically significant differences for four of the eight prevalent Family+ taxa evaluated, with one Family+ taxa significantly greater below and three significantly greater above the LAGWRP.
    - The benthic algae results indicate no statistically significant differences for eight of the nine diatom taxa evaluated, and eight of the 11 soft-bodied algae taxa evaluated. The total count of the diatom (*Achnanthidium minutissimum*) was significantly greater above compared to below LAGWRP, whereas the total biovolume of two soft algae (both *Scenedesmus* sp.) were greater above compared to below the LAGWRP, while one unspecified *Scenedesmus* was greater below compared to above it.
    - Nearly identical median values were seen along with a nearly complete overlap in index scores for CSCI, Diatom ASCI, and Soft ASCI, while the median Hybrid ASCI score is slightly higher downstream of the LAGWRP.
    - Neither CSCI nor ASCI were statistically different from each other above and below LAGWRP.
  - Data collected below the LAGWRP discharge (LAR3) were compared to data in LAR2.
    - The results indicate no statistically significant differences for four of the eight prevalent Family+ taxa evaluated, with two Family+ taxa significantly greater at stations with more natural substrate in LAR3 and two Family+ taxa significantly greater at stations with concrete substrate in LAR2.
    - The results indicate no statistically significant differences for six of the nine and seven of the 11 diatom and soft-bodied algae taxa evaluated, with three diatom and two soft algae significantly greater at stations with more natural substrate in LAR3 and two soft algae taxa significantly greater at stations with concrete substrate in LAR2.
    - Median CSCI is significantly higher in LAR3 below LAGWRP (on more natural substrate) compared to downstream in LAR2. In contrast, Diatom ASCI and Hybrid ASCI are similar between LAR3 (below LAGWRP) and LAR2, but Soft ASCI is significantly higher in LAR2.

5.3.4.2 Cluster Analysis Using Biological Data from the LA River Mainstem and Its Tributaries

To further support the quantitative upstream and downstream analyses presented in the preceding subsection, an additional analysis was conducted to answer the following question: Are there differences in community composition within organism type (BMI, diatoms, and soft algae) among stations on the mainstem Los Angeles (LA) River and Burbank Western Channel (BWC), which are influenced by discharges from the Water Reclamation Plants (WRPs), and other stations on the LA River and urbanized tributaries, which are not influenced by WRP discharges? The answer to this question was pursued using cluster analysis of the Study-derived and historical BMI and algae bioassessment data. If there were differences in community composition due to WRP temperature addition one would expect to see a unique cluster of stations influenced by WRP discharges and a different cluster (or clusters) of stations that are not influenced by WRP discharges.

The BMI and benthic algae bioassessment data were analyzed for similarities in relative abundance (the numeric contribution of a taxa in proportion to the overall community count) of BMI and diatoms and the relative dominance (the percentage of a taxa's biovolume in proportion to total biovolume) of soft algae. A cluster analysis allows for the comparison of large and complex data sets to detect statistical groupings, in this case, among BMI and algae community composition data at stations with and without the presence of WRP flow (Boesch 1977, Kaufman and Rousseeuw 2009). Clustering was used, because unlike ordination which is better suited for exploring patterns and gradients within a bioassessment dataset, clustering is more useful when one wants to identify distinct groups within the dataset, which better aligns with the purpose of the analysis to answer the question posed.

For the cluster analysis, datasets were first compiled in R for each organism type (BMI, diatom, and soft algae), composed of the relative abundance (BMI and diatom) or dominance (soft algae) for all taxa collected and identified at a bioassessment monitoring station in a given year (station/year combination). A distance matrix of Bray-Curtis similarity values was then calculated for BMI and diatom relative abundance and soft algae relative dominance for all station/year combinations. Notably, because the cluster analysis incorporated all taxa collected and identified at stations, the analysis provides a statistical means to determine if there are differences in community composition due to WRP temperature. Additionally, cluster analysis allowed the incorporation of bioassessment data for sites in relevant tributaries to the LA River mainstem, which do not receive WRP discharge.

The analysis began by determining how many cluster groups reasonably defined the BMI and algae response in the system, using Ward's minimum variance method (Ward and Hook 1963, Szekely and Rizzo 2005). The goal was to form as many statistically different groups as the variance in the observed data allowed, without forming so many groups such that their interpretation became difficult. Four, five, six and eight cluster groupings were initially evaluated, depending on organism group. A four-cluster group membership was found to be sufficient to differentiate BMI and algae response and draw meaningful conclusions. All four groups were found to be statistically different using a pairwise comparison test. All cluster-analysis work was done in R using the package named vegan (Oksanen et al. 2025).

Compositions of station/year groupings are provided for BMI (**Appendix 6** Table 1), diatoms (**Appendix 6** Table 2), and soft algae (**Appendix 6** Table 3). The cluster analysis utilized 155, 91, and 92 total station/year combinations for BMI, diatoms, and soft algae, respectively. **Figure 59**, **Figure 60**, and **Figure 61** map the stations by cluster group membership for BMI, diatoms, and soft algae by color, respectively. If there were differences in community composition due to WRP temperature addition one would expect to see a unique cluster of stations influenced by WRP discharges and a different cluster (or clusters) of stations that are not influenced by WRP discharges. As shown on the maps, stations downstream of WRP discharges appear in multiple cluster groups that also include tributary and/or upstream stations not influenced by WRP discharges. As such, there is no indication that community composition is impacted by WRP temperature addition.

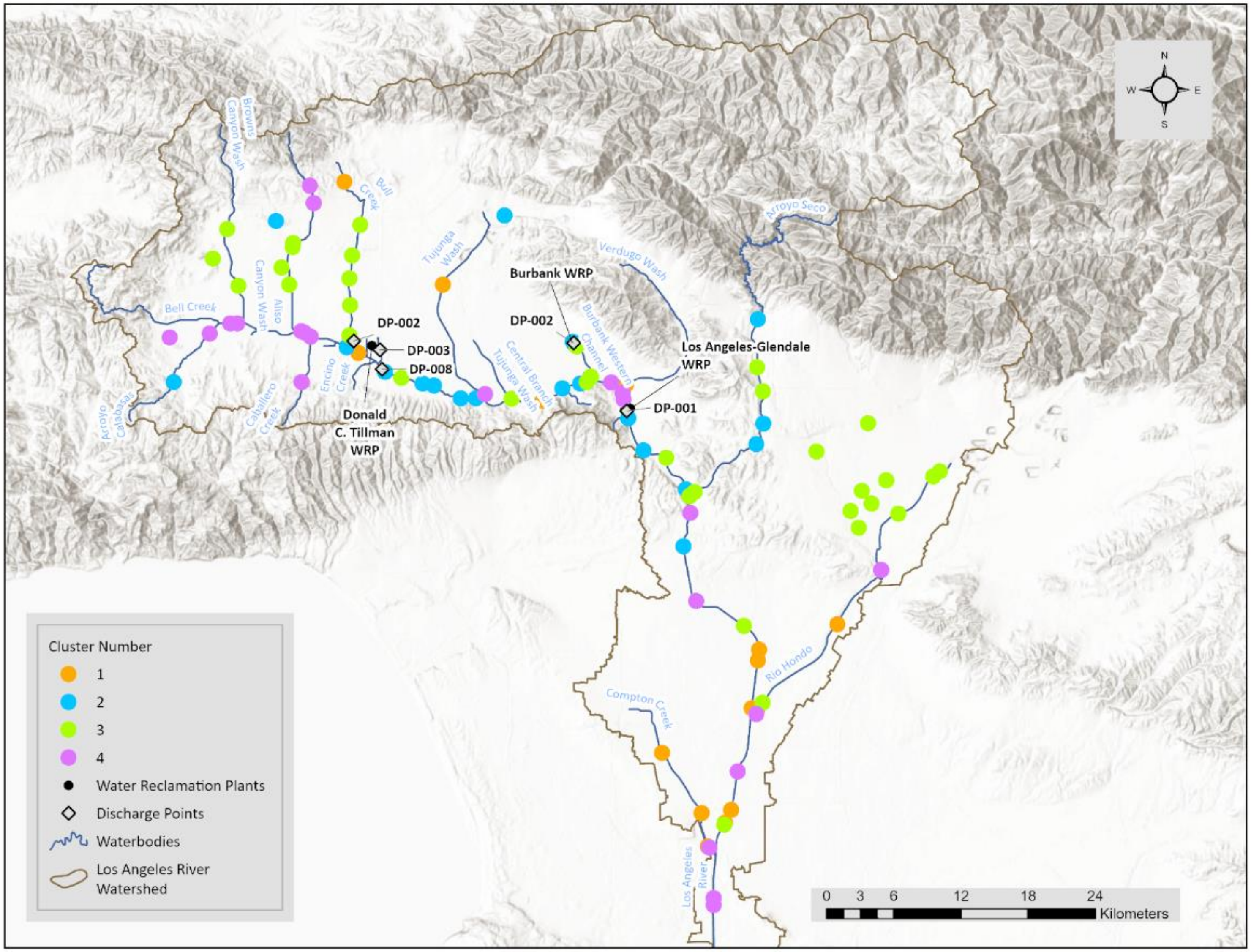


Figure 59. Map Showing Distribution of BMI Sampling Stations by Cluster Group (color)

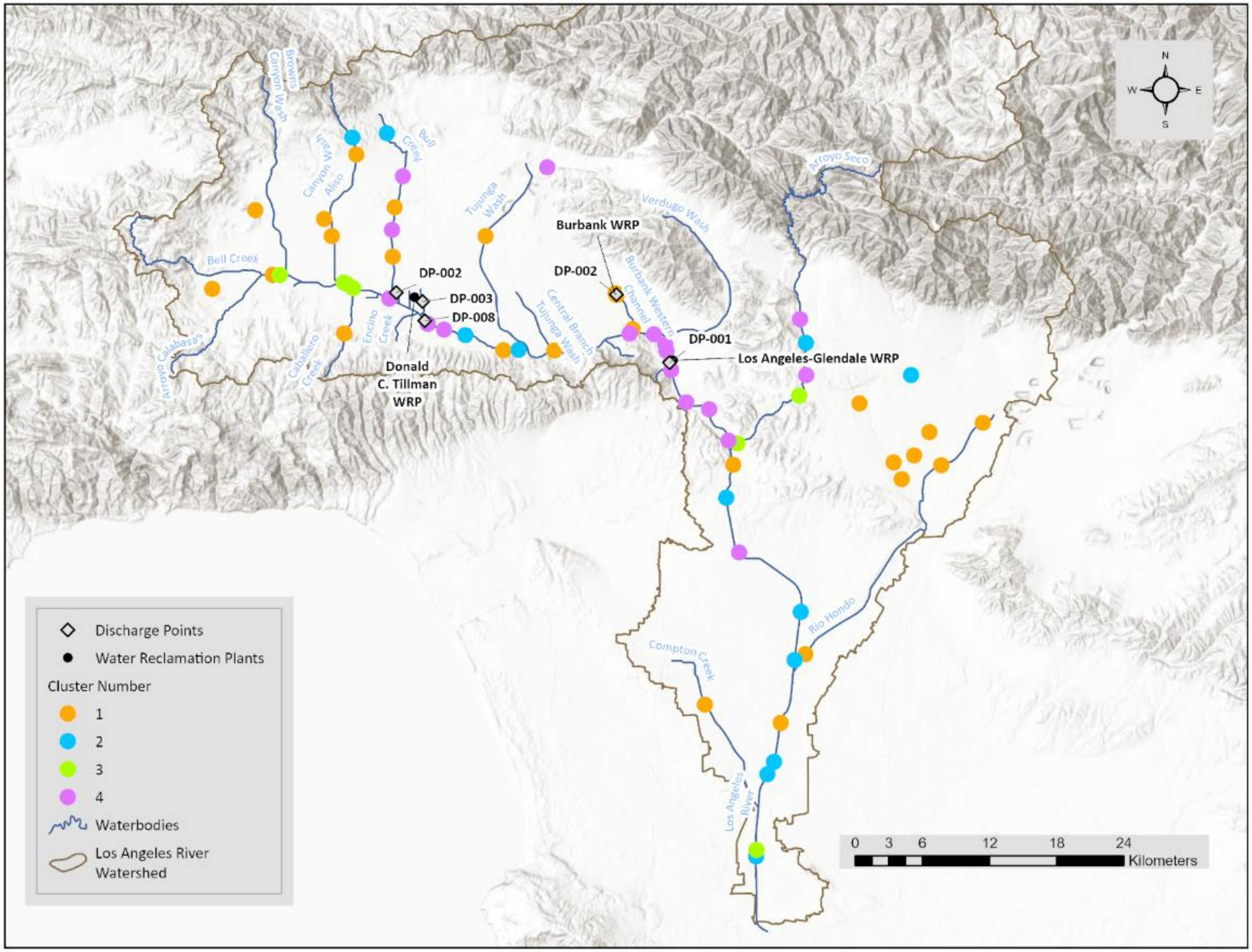


Figure 60. Map Showing Distribution of <u>Diatom</u> Sampling Stations by Cluster Group (color)

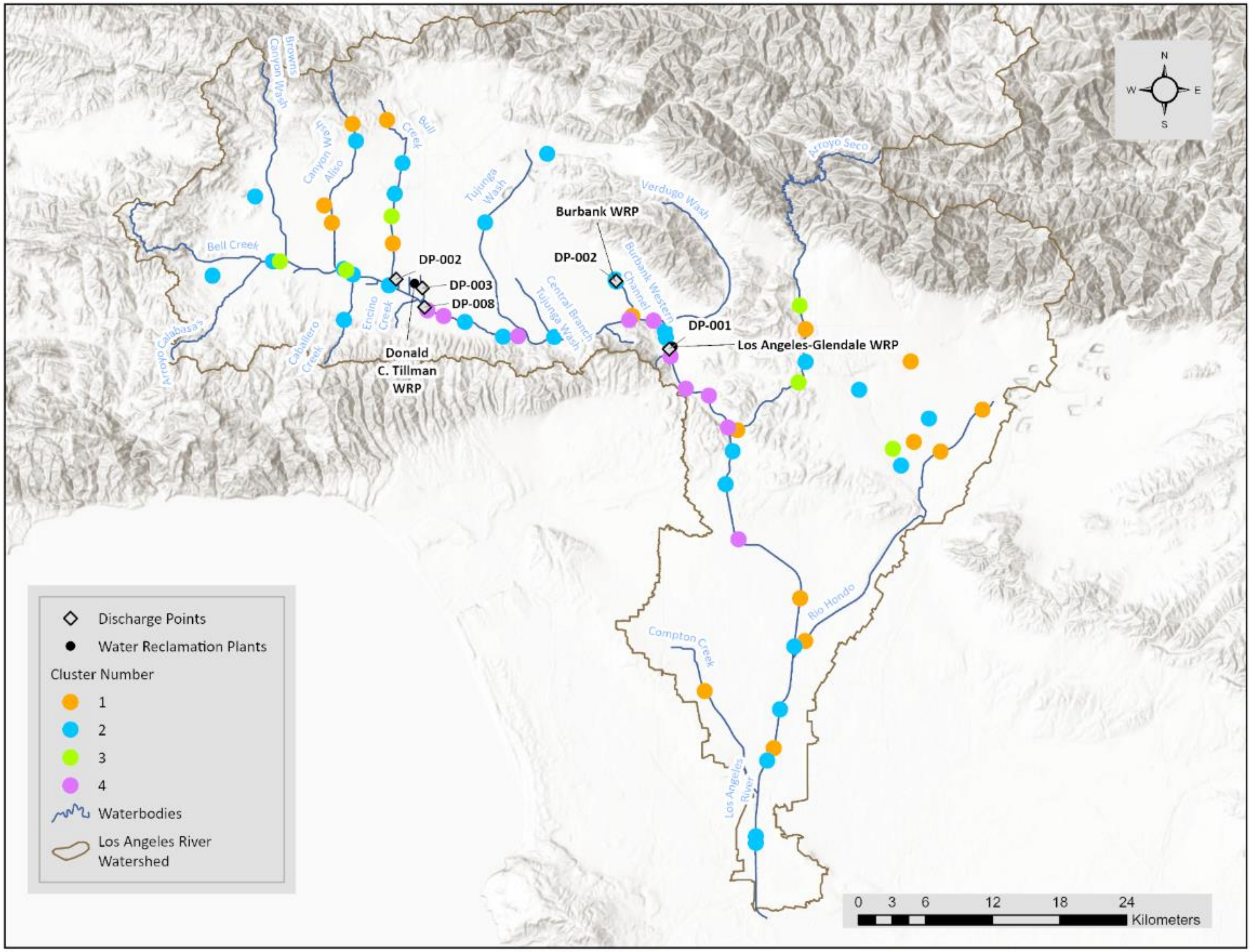


Figure* 61*. Map Showing Distribution of <u>Soft Algae</u> Sampling Stations by Cluster Group (color)

5.3.5 Findings: Biological Data

Based on quantitative upstream versus downstream bioassessment station analysis the data are sufficient to demonstrate no significant or meaningful differences in the BMI or diatom taxa count, soft-bodied algae biovolume, or CSCI or ASCI scores upstream and downstream of the WRP discharges. Cluster analysis indicates the BMI and benthic algal communities downstream of WRP discharges are not unique and can be found throughout the Study area including at locations upstream of WRP discharges or in tributaries, indicating that there is no clear impact of WRP effluent temperatures on the biological community. The supposition that alterations in receiving water temperatures due to WRP effluent adversely affects BMI and benthic algae and their corresponding community health index scores is not supported.

5.4 *Taxa Present or That Could be Present in the Study Area Given Current Habitat Conditions*

This section considers taxa that could be present in the mainstem reaches of the LA River and BWC which comprise the Study area *given current habitat conditions*. For many species this is a clear determination because those species occur there now and appear, either through the observation of juveniles or because of multiyear occurrences of short-lived taxa, to be self-populating locally. For others, particularly for historically reported fish species, current habitat conditions no longer support historical uses.

5.4.1 Fish

Sixteen freshwater fish species, and a genus otherwise represented among the 16 species, are known to occur in the Study area (**Table 35**). All of these are introduced, non-native fish species. The occurrence of non-native fish species is a consequence of introductions, whether purposeful or accidental. While some introduced species that cannot tolerate year-round conditions may persist in an introduced habitat while conditions are optimum, they will not become established. For these reasons the fish species reported in the Study are considered to be representative of any fish species that could become established in the watershed for purposes of evaluating their temperature tolerances. For native fish species to become re-established in the Study area, significant modification and improvement of current habitat to support those species would be needed for them to return to the system. **Table 35** includes the taxa present or that could be present in the Study area given current habitat conditions.

Table 35. Freshwater Fish Species Present in the Study Area

Common Name	Taxa	Study Waterbody					
		R1	R2	R3	R4	R5	BWC
Black Bullhead	*Ameiurus melas*			X		X	
Bluegill	*Lepomis macrochirus*			X			
Brown Bullhead	*Ameiurus nebulosus*			X			
Common Carp	*Cyprinus carpio*			X		X	
Channel Catfish	*Ictalurus punctatus*		X	X			
Fathead Minnow	*Pimephales promelas*	X	X	X		X	
Golden Shiner	*Notemigonus crysoleucas*					X	
Goldfish	*Carassius auratus*			X		X	
Green Sunfish	*Lepomis cyanellus*			X		X	
Largemouth Bass	*Micropterus salmoides*			X		X	
Mississippi Silverside	*Menidia audens*			X			
Pacu	*Colossoma macropomum*			X			
Pond Loach	*Misgurnus anguillicaudatus*			X			
Sailfin Armored Catfish	*Pterygoplichthys*			X		X	
Sunfish	*Lepomis*	X	X	X		X	
Tilapia	*Oreochromis*	X	X	X		X	
Western Mosquitofish	*Gambusia affinis*	X	X	X	X	X	

5.4.2 Aquatic-dependent Amphibians and Reptiles

Similar to the fish, aquatic-dependent amphibian and reptile taxa present or that could be present under current conditions are those species known to occur in the habitat available in the urbanized LA River watershed through observation. As discussed in **Section 5.3.1.2**, this includes two native frog species (Western toad and Baja California tree frog), two introduced frog species (American bullfrog and African clawed frog), a native turtle (western pond turtle), and two introduced turtle taxa (pond sliders and spiny softshell turtle).

5.4.3 Birds (Aquatic-dependent)

Aquatic-dependent birds are frequently migratory and being highly mobile can seek supporting habitat for foraging and nesting over potentially large areas. Although occasional rare visitors are reported, habitat and conditions in the LA River watershed, as discussed in **Section 5.3.1.3**, support a consistent group of reoccurring bird species, which can be expected to continue under current conditions. Note that although birds may be impacted by changes in water temperature due to changes to foraging conditions or prey availability, birds do not have an aquatic development phase subject to impacts as a result of changes in water temperature like other taxa of interest in the study do.

5.4.4 Algae and Benthic Macroinvertebrates

Appendix 2 provides lists of algae and BMI taxa that are and could be present in the Study area. The lists for algae and BMI are based on taxa identified in the Study area since 2005 and are assumed to include all taxa historically in the Study area as well as those currently present, because there is no evidence these taxa have changed anywhere in the Study area over this period. This conservative approach retains all taxa, including infrequently occurring taxa, reported in the long-term data set for the Study area.

6 Answers to Study Objectives

As stated in **Section 2**, the Study is intended to develop a better understanding of the relationship between effluent temperature and potential impacts to the WARM beneficial use in the LA River downstream of the DCTWRP, LAGWRP, and BWRP discharges. Additionally, determining the potential for impacts of the WRPs' effluent temperature supports an evaluation of whether temperature control measures will achieve the intended outcome of addressing those impacts, if present. To support these efforts, the Cities, in consultation with the TAC, identified the following Study Objectives:

1. Determine the wholly or partially aquatic-dependent[21] taxa that are present, were historically present, or could be present given the current habitat conditions in the Los Angeles River.
2. For each taxon identified in Objective 1, describe the relationship between waterbody temperatures and the probability (or likelihood) that different aquatic life stages are supported.
3. Determine how the relationships between waterbody temperature and the support of aquatic life vary based on the taxon's location in the river and seasonality.
4. Determine the critical exposure times, durations, and/or frequencies associated with the temperature relationships described in Objectives 1 through 3.
5. Evaluate how other physical factors (e.g., shading, groundwater discharge, availability of substrate, flow, etc.) and climate change could potentially influence temperature effects on biological communities.
6. Analyze relationships between effluent discharge temperature and in-river temperature, including how river temperature changes as a function of distance from the discharge location and downstream physical characteristics.

For **Study Objective #1**, determine the wholly or partially aquatic-dependent taxa that are present, were historically present, or could be present given the current habitat conditions in the LA River, **Appendix 2** provides lists of algae and BMI taxa that are present and could be present in the Study area based on bioassessment surveys conducted since 2005, including most recently as a part of this Study in 2024. The list includes 276 diatom taxa, 249 soft bodied algae taxa, and 117 BMI taxa. Historically, algae and aquatic macroinvertebrates in the LA River were incompletely characterized in the Study area due, in part, to infrequent monitoring prior to the development and use of standardized bioassessment methods in California beginning with the approval of the California Stream Bioassessment Procedure (CSBP) in 1999. While variability exists in BMI and diatom count data and soft algae biovolume among stations within the Study area, there is as much or more variability on an interannual basis, including for the same stations. Dominant taxa, however, have remained relatively unchanged over all years. All BMI taxa can be classified as eurythermic or temperature generalist species by virtue of their continued presence in the Study area, regardless of exposure to WRP flow or downstream proximity to outfalls.

Section 5.3.1 provides a complete list of freshwater fishes and amphibians with aquatic life stages that could be present in the Study area based on fish and other vertebrate surveys and related studies published over more than 100 years. The collected information is considered comprehensive and reflective of the current fish community in the LA River watershed (**Table 27**). Historically, the LA River watershed was once known to

[21] Aquatic-dependent is defined as a major life stage that resides in the river or relies on the river for food and forage.

host a small and highly endemic native freshwater fish fauna composed of at least seven species, in addition to one salamander, seven frogs, one turtle, and one snake species. Of the native species, only two frog species are still observed in the Study area. In the Study area, LA River Reaches 1-5 and the BWC, 16 freshwater fish and four amphibians are reported as currently present. The amphibians include the two native and two non-native frog species. The number of fish taxa are highest in LAR3 and LAR5, downstream of the discharges of the LAG and DCT WRPs, respectively, due to these reaches having the most suitable habitat for fish in the Study area. All of the fish in the Study area are non-native species, introduced either intentionally or accidentally. While some introduced species that cannot tolerate year-round conditions may persist in an introduced habitat while conditions are optimum, they will not become established. For these reasons the fish species reported in the Study are considered to be representative of any fish species that could become established in the Study area for the purpose of evaluating their temperature tolerances. For native fish species to become re-established in the Study area, significant modification and improvement of current habitat to support those species would be needed for them to return to the system. **Table 35** represents the fish taxa present or that could be present in the Study area given current habitat conditions. Amphibian and reptile taxa present or that could be present in the Study area given current habitat conditions are discussed in **Section 5.4.2**.

For each taxon identified as present or that could be, the relationship between waterbody temperature and the probability (or likelihood) that different aquatic life stages are supported (**Study Objective #2**), how the relationships vary based on the taxon's location in the river and seasonality (**Study Objective #3**), and the critical exposure times, durations, and/or frequencies associated with the relationships (**Study Objective #4**) is described simultaneously below using the combination of reach and location-specific stream temperature data discussed in **Section 5.2.1** and thermal tolerance values for the most temperature-sensitive taxa present or could be given current habitat conditions in the Study area.

Laboratory-derived temperature tolerance information from the literature for the most temperature-sensitive fish species in the Study area are used to represent temperature tolerance for all other less temperature-sensitive vertebrate species based on both short (acute, daily) and longer (chronic, weekly) exposure times and critical life stages (**Appendix 7)**. These values are also used to represent the thermal tolerance of the BMI and benthic algae in the Study area, which are similar to or higher than the corresponding lowest thermal tolerance limits for chronic survival for freshwater fish in the Study area for the Summer dry season. The thermal tolerance limits from the literature for taxa that are present or could be present are provided in **Appendix 7**. The lowest thermal tolerance limits from the literature for the most sensitive species are provided in **Table 36**. It is worth noting here that while conservative laboratory-derived temperature tolerance values are useful for an initial assessment of potential for effects, these values do not reflect the physiological and behavioral relief strategies developed by aquatic organisms in response to local temperature profiles and extremes, particularly the aquatic organisms present in the Study area that regularly experience extreme diel temperature fluctuations during summer. These strategies, along with site-specific generational adaptations in response to years of exposure to local temperature and habitat conditions on a long-term basis and heat-hardening on a short-term basis (i.e., a rapid acclimation response that increases their tolerance to sudden, acute heat stress), explain why literature-based upper thermal tolerance limits generally underestimate taxa-specific critical thermal limits in the real world.

The lowest, highly conservative temperature tolerance values presented in **Table 36** were compared against actual (measured) receiving water temperatures, expressed as different temperature metrics reflecting different exposure magnitudes (average and maximum) and durations (i.e., acute daily for the short term and chronic weekly for the longer term), according to location within the LA River and BWC on a seasonal basis (i.e., late spring and summer). Four stream critical exposure time temperature metrics are included for June through October (Summer dry season) and March through May (Spring spawning season, early life-stages present). The stream temperature metrics utilized consisted of:

- Maximum daily average temperature (MDAT): This value represents the highest average temperature from continuous measurements recorded over a 24-hour (1-day) period.
- Maximum daily maximum temperature (MDMT): This represents the highest maximum temperature recorded over a 24-hour (1-day) period.
- Maximum weekly average temperature (MWAT): This is the maximum average of <u>average daily temperatures</u> over any seven-day period.
- Maximum weekly maximum temperature (MWMT): This is the maximum average of <u>maximum daily temperatures</u> over any seven-day period; also referred to in the literature as 7DADM.

The comparison of the lowest literature-derived thermal tolerance limits for freshwater fish against the four temperature metrics, based on the thermistor Study results from the continuous monitoring data collected at the 16 receiving water temperature monitoring stations, was used to evaluate the likelihood that different life stages are supported during acute (daily) and chronic (weekly) exposure over the Summer dry and Spring spawning seasons. This supports a description of the relationship between waterbody temperatures and different aquatic life stages that could be supported based on literature values. The results also allow description of how that support varies based on seasonality, and the critical exposure times, durations, and/or frequencies associated with the temperature relationships.

MWAT, MWMT, MDAT, and MDMT were selected to compare against lowest literature-based species-specific thermal tolerance limits representing acute and chronic temperature exposure to the different life stages. The following summarizes the findings of the comparisons for all receiving water sites regardless of proximity the WRPs (see for **Appendix 7** additional information), while **Table 36** summarizes the comparison to receiving water sites directly below the WRPs, prior to other factors (e.g., solar radiation) increasing receiving water temperatures:

- Chronic growth of juveniles and adults during summer – compared to MWAT of summer months
  - The Chronic Growth temperature tolerance metric (MWAT of 83.4°F) was lower than temperatures reported occasionally at stations in LAR2 and LAR4; however, temperatures were consistently lower than the Chronic Growth temperature tolerance metric (indicating no risk) at stations in LAR3, LAR5, and BWC throughout the Summer.
- Chronic survival of juveniles and adults during summer – compared to MWMT of summer months:
  - Temperatures were below the Chronic Survival temperature tolerance metric (MWMT of 89.6°F) at stations in LAR5, at the three stations *downstream* of the LAGWRP discharge (the temperatures for the two LAR3 stations *upstream* of the discharge were regularly

above it), and at the two stations bracketing the BWRP discharge (temperatures at the BWC station farthest downstream of the discharge were regularly above this metric).

- Acute daily (24 hour) survival of juveniles and adults during summer – compared to MDAT of summer months:
  - Temperatures were below the Acute Daily Survival temperature tolerance metric (MDAT of 89.6°F) throughout the Summer with only one value higher than the metric in LAR2.
- Acute daytime (8 hour) survival of juveniles and adults during summer – compared to MDMT of summer months):
  - Temperatures were above the Acute Daytime Survival temperature tolerance metric (MDAT of 98.0°F) occasionally in LAR2 and LAR3 upstream of the LAGWRP, and more frequently in LAR4 and at the BWC station farthest downstream of the BWRP discharge. Temperatures were consistently below the comparable fish temperature tolerance metric immediately downstream of all three WRPs.
- Chronic reproduction during Spring spawning – compared to MWAT of spring months:
  - All but one (at the BWC Up station) of the receiving water temperatures were above the comparable temperature tolerance metric value for Chronic Reproduction (MWAT of 70°F) during the Spring spawning season, indicating possible risk to fish reproduction. However, it should be noted that only one month (May) of data were collected during the Spring spawning season for the Study, as such, modeled water temperatures were evaluated. Modeled water temperatures lower than the metric value for Chronic Reproduction are typical throughout Study area in Winter through April, therefore, risk of biology to alteration of water temperatures immediately downstream of WRP discharges is expected to be negligible. The continued presence of the most sensitive species in the Study area supports this supposition and the likelihood of species adaptation to local conditions. Additionally, the comparison made is based on the use of highly conservative, laboratory-derived temperature tolerance values, which, as noted above, are useful for an initial assessment of potential risk but under-estimates taxa-specific critical thermal limits based on real world, local conditions. For these reasons, Chronic Reproduction during the Spring spawning season is fully expected to be supported in the Study area downstream of the WRPs.
- Acute embryo survival during hatch and spring grow out of larvae – compared to MDAT of spring months:
  - Water temperatures were all below the Acute Embryo Survival temperature tolerance metric (MDAT of 81°F). However, it should be noted that only one month (May) of data were collected during the Acute Embryo Survival season for the Study, as such, modeled water temperatures were evaluated. Modeled water temperatures lower than the metric value for Acute Embryo Survival are typical throughout Study area in Winter through April, therefore, risk of biology to alteration of water temperatures immediately downstream of WRP discharges is expected to be negligible. Note that for the BWC, while water temperatures would be supportive of Acute Daily Embryo Survival post-WRP discharge, the concrete channel itself does not support early life stages of fish (RWQCB 2019) so it is not included in the evaluation. Similarly, early life stages of fish are not supported by the concrete channel of LAR4, downstream of the Sepulveda dam (RWQCB 2019).

Table 36 summarizes the findings of this evaluation. Black text in **Table 36** indicates locations downstream of the WRPs where Study-derived receiving water temperatures indicate support for the most sensitive species based on literature-derived thermal limits. Green text in **Table 36** indicates locations where the metric would be supported based on reported observations of taxa presence in the respective Study reaches below WRPs due to the combination of adaptive strategies that allow for reproduction and the continued occurrence of the species in the receiving waters immediately downstream of the WRPs. This approach allows comprehensive description of the relationship between waterbody temperature and the likelihood that different aquatic life stages are supported, how the relationships vary based on the taxon's location in the river and seasonality, and the critical exposure times, durations, and/or frequencies associated with the relationships, simultaneously answering **Study Objectives 2**, **3**, and **4**.

Overall, the results of this analysis indicate that the taxa that are present or could be present in the Study area are not adversely affected by alterations to receiving water temperatures due to WRP effluent temperatures. Any purported need to modify the discharges to reduce thermal effects of the WRP discharges on the biological communities that are present or could be present in the LA River and BWC is not supported.

Table 36. Do Receiving Water Temperatures Immediately Downstream of the WRP Discharges Support the Thermally Most-Sensitive Fish Species Based on Recorded Temperatures in the Study Area?

Findings presented where the temperature tolerance metrics of the most sensitive species are supported based on literature values (black text) or where the most sensitive biota are supported as described in the discussion provided above this table (green text)

Season	Life Stage / Metric	Species Common Name	Thermal Tolerance (°F) From Literature[2]	Could Temperatures in the Post-WRP Discharge Stream Support the Most Sensitive Species for this Metric?		
				LAGWRP	DCTWRP	BWRP
Summer (Dry Season) June - October	Chronic Growth	Goldfish	83.4°F	YES	YES	YES[1]
	Chronic Survival	Pacu	89.6°F	YES	YES	YES[2]
	Acute Daily Survival	Fathead Minnow	89.6°F	YES	YES	YES[1]
	Acute Daytime Survival	Golden Shiner	98.0°F	YES	YES	YES[2]
Spring (Spawning Season) May	Chronic Reproduction	Common Carp & Largemouth Bass	70.0°F	YES	YES	NA[3]
	Acute Daily Embryo Survival	Black Bullhead	81.0°F	YES	YES	NA[3]

1. This metric was met at all three stations in BWC during the 2024 Summer thermistor study.
2. This metric was met at the two stations bracketing the BWRP discharge during the 2024 Summer thermistor study.
3. NA = Not Applicable. Indicative of the situation where biota is supported in the BWC using temperature tolerance metrics, but where the concrete channel does not support early life stages of fish (RWQCB 2019) so findings for the life stage are excluded from the evaluation.

To objectively evaluate how other physical factors (e.g., shading, groundwater discharge, availability of substrate, flow, etc.) and climate change could potentially influence temperature effects on biological communities (**Study Objective #5**), it was first necessary to analyze the relationships between effluent discharge temperature and receiving water temperature, including how temperature changes as a function of distance from the discharge location and downstream physical characteristics (**Study Objective #6** – refer to **Section 5.2.2**). Addressing the two inter-connected objectives was important because up until this Study was conducted, comprehensive knowledge of how receiving water temperature changes as a function of distance from the discharge location on the LA River on a daily and seasonal basis was not well understood.

To address **Study Objectives #5** and **#6**, the continuous monitoring data collected during this Study at locations upstream and downstream of WRP discharges were utilized. Additionally, the temperature model developed as part of this Study was utilized to evaluate conditions where WRP discharge temperatures are set to the same temperature as upstream receiving waters to allow for an estimation of the effect of other factors (e.g., air temperature) on receiving water temperatures. Several key findings of these analyses include:

1) Maximum daily water temperatures above the DCTWRP and LAGWRP (i.e., without WRP influence) consistently exceeded 80°F in the warmer months. Maximum daily water temperatures above the BWRP also exceeded 80°F, but less frequently than DCTWRP and LAGWRP.
2) Except in the area immediately downstream of the WRP discharges, receiving water temperatures in the majority of the LA River and lower portion of the BWC are the result of ambient air temperature and other factors affecting temperature besides WRP effluent temperature.
3) Using the model to evaluate how receiving water temperatures downstream of the WRPs change when WRP effluent temperatures are set equal to the upstream receiving water temperature it was determined that:
    a. The distance downstream in the LA River and BWC of discharge under the influence of thermal input from each WRP is relatively short and depends on both season and location.
    b. The influence of heat from WRP effluent resides for a slightly longer downstream distance in winter (2-5 miles) as compared to late spring through summer (2 miles or less).
    c. The influence of heat from WRP effluent on receiving water temperature downstream in critical summer months is slightly longer (1 to 2 miles) in the BWC below BWRP, shorter below the DCTWRP in LAR5 and LAR4 (0.5 to 1 mile), and much shorter below LAGWRP in LAR3 (less than 0.5 miles).
    d. The influence of other temperature modulating factors (primarily ambient air temperature but with additional contributions from concrete substrate, solar heating) appears to be significant, most notably in the BWC.
    e. Rising groundwater in LA River Reach 3, which is unlined, has the potential to reduce receiving water temperatures upstream and downstream of the LAGWRP discharge; however, receiving water temperatures were regularly greater than 80°F upstream and downstream of the LAGWRP discharge in the summer months.

7 Watershed Modeling

Modeling can provide estimates of how the LA River and BWC will respond to potential control measures to reduce receiving water temperatures as well as evaluate changes under future climate conditions. A model was developed for this study and was used to:

1) Evaluate the effectiveness of potential control measures on reducing receiving water temperatures.
2) Evaluate the effectiveness of scenarios that combine potential control measures on reducing receiving water temperatures.
3) Evaluate the potential effect of climate change on receiving water temperatures.

The following summarizes the modeling efforts completed as part of the Study. Please see the Los Angeles River Temperature Study Modeling Report included as **Attachment A** for a detailed discussion of the modeling efforts.

A Hydrologic Engineering Center's River Analysis System (HEC-RAS) model of the LA River, developed as part of the Los Angeles River Environmental Flows Project (Stein et al 2019b; Environmental Flows Project), was selected to model both river hydraulic parameters and temperature at key assessment points along the LA River and the BWC. The Environmental Flows Project was a collaboration of the State Water Resources Control Board (State Water Board), Regional Board, and the City and County of Los Angeles. The channel geometry of the completed model was validated with LiDAR data, as-builts, and Google Earth to ensure that the low-flow channel was properly represented. Complete model development and calibration is detailed in Stein (2021a). To support the addition of BWC to the model, the as-built drawings from LACFCD were used and the calibrated roughness set to the values of the other concrete channel sections in the model. Additionally, the three WRP river discharges were explicitly added to the model, setting them as flowrate and temperature boundary conditions.

The Environmental Flows Project considered the discharges from the three WRPs, groundwater exfiltration, and urban and industrial non-stormwater flows. In the upper watershed, the WRP flows dominate with a significant component from non-stormwater flows. Through the Glendale Narrows in LAR3, groundwater exfiltration contributes approximately 5% of the total at that point (groundwater exfiltration is set to a constant 0.12 meters per second (cms) or 4.3 cfs, whereas the total flowrate at the end of Glendale Narrows is approximately 85 cfs). Toward the bottom of the watershed, the integrated contribution of the urban area results in non-stormwater flows comprising approximately 50% of the total river flow. The flowrates for the WRP discharges were updated with data from 2020 through 2023 to reflect current operations.

The full energy budget water temperature model[22] integrated within HEC-RAS provides an advanced computational framework designed to simulate the thermal dynamics of riverine environments. The net heat flux defines the full energy budget for a water quality cell and is the sum of the shortwave (solar) radiation, net long wave radiation (atmospheric downwelling and back upwelling), sensible heat, latent heat, and sediment water interface flux. The shortwave radiation is a direct input and can be modified (decreased or increased by a factor) to reflect shading or other processes so that it represents the main calibration "lever".

[22] www.hec.usace.army.mil/software/hec-ras/documentation/HEC-RAS%20Water%20Quality%20User's%20Manual-v6.4.1.pdf

The other fluxes are calculated internally in HEC-RAS from the meteorological data. Meteorological data, including atmospheric pressure, air temperature, humidity, shortwave radiation, cloudiness, and wind speed, were sourced from various agencies, such as National Oceanic and Atmospheric Administration (NOAA)[23], California Irrigation Management Information System (CIMIS)[24], and National Weather Service (NWR)[25]. Long term daily water temperature data at the WRPs were obtained from the California Integrated Water Quality System Project[26] (CIWQS) data management website. Additionally, the historical receiving water temperature (**Section 3.1**) and data collected as part of this study (**Section 5.2.1**) were used to calibrate the model.

7.1 Model Calibration

The calibration of the HEC-RAS water temperature model was conducted over two stages: an initial calibration, and the re-calibration or final calibration. The initial calibration was performed with the CIWQS and historical data. The sparseness of the dataset only allowed a single-point calibration, meaning the same calibration parameters were applied to the whole river. This calibration roughly matched observed temperatures, however the data for the boundary conditions limited the model fit achievable downstream. The continuous water temperature data collected through this Study were used to enhance the calibration of HEC-RAS water temperature model by both providing dense concurrent receiving water temperatures over the region of interest, and by allowing refinement of the upstream boundary conditions. By more accurately setting the upstream temperatures, the model responded more accurately over the simulation period. The concurrent sampling along the river length allowed a multipoint calibration where parameters were adjusted to appropriate levels in separate reaches to reflect local conditions.

The model calibration parameters were systematically modified and model output analyzed with four metrics: root mean square error (RMSE), mean absolute error (MAE), mean absolute percentage error (MAPE), and coefficient of determination (r^2). Goodness of fit parameters for the range of re-calibration trial sets and the final selected model are presented in **Table 37**. The river temperatures values from the final calibrated model are generally within 1.2°C and under 5% of the observed values. This calibration is considered “very good” as described in guidelines for modeling developed by the Regional Board (LARWQCB 2014).

Table 37. Summary of Model Calibration Goodness of Fit

Parameter	Range over Calibration Runs	Selected Model
RMSE (°C)	1.5 – 2.5	1.5
MAE (°C)	1.2 – 2.1	1.2
MAPE (%)	4.9 – 9.0	4.9
r^2	0.8 – 0.9	0.8

[23] https://www.ncei.noaa.gov/cdo-web/
[24] https://cimis.water.ca.gov/WSNReportCriteria.aspx
[25] https://www.weather.gov/lox/observations_historical
[26] https://ciwqs.waterboards.ca.gov/ciwqs/readOnly/CiwqsReportServlet?inCommand=reset&reportName=esmrAnalytical

7.2 Modeling of Potential Control Measures

The following three potential control measures were identified to control the effect of WRP discharge temperature on the temperatures in the LA River and the BWC: effluent temperature reduction, effluent flowrate reduction, and riparian shading. The following subsections present the results of the evaluation of potential control measures.

7.2.1 Effluent Temperature Reduction

The effluent temperature reduction control measure seeks to ensure the WRP discharges are compliant with the temperature limits identified in their NPDES permits (i.e., effluent temperatures are not more than 80°F and receiving waters are not raised by more than 5°F). The required monthly effluent temperature reductions to meet the limits are listed in **Table 38** for the three WRPs and are based on data from 2000 to 2024. The required reductions were determined monthly through a three-step process. First, where the effluent temperatures were greater than 80°F the reduction to reach 80°F was calculated. In the second step, the receiving water upstream and downstream were compared and where the measured difference was greater than 5°F, the reduction necessary to bring the effluent temperature to within 5°F of the upstream temperature was calculated. The last step was to select the greater required reduction. Note that for most months the temperature reduction requirements are driven by the delta 5°F limit.

Table 38. Required Effluent Temperature Reductions Needed to Meet Limits (80°F and Delta 5°F)

Month	Required Temperature Reduction (°F)[1]		
	DCTWRP	LAGWRP	BWRP
January	29	29	33
February	29	30	37
March	23	22	29
April	26	24	29
May	14	19	22
June	13	6	24
July	9	7	20
August	11	8	18
September	14	7	24
October	24	35	25
November	30	34	35
December	32	34	33

1. Shaded cells correspond to reduction necessary to meet the 80°F limit, non-shaded cells required reduction to meet the delta 5°F limit.

To conduct the modeling analysis of this control measure, effluent temperatures in the model were reduced so that the limits were met with all other conditions remaining constant (e.g., flow, air temperature, etc.). The model was then rerun to generate hourly receiving water temperatures for a three-year period (2022 through 2024) and then compared to the current condition baseline. **Figure 62** presents a comparison of the baseline receiving water temperatures to the receiving water temperatures if the WRPs' effluent temperatures were reduced to comply with limits (i.e., effluent temperatures are not more than 80°F and receiving waters are not raised by more than 5°F). The figure represents temperatures on August 6, 2024 as an example date, see **Attachment A** for additional example dates and time series plots. As shown in **Figure 62**, when effluent is cooled to meet the limits:

- Downstream receiving water temperatures are negligibly different (i.e., within ± 1°F) from the baseline conditions less than 1 mile of the DCTWRP, less than 2 miles of the BWRP, and less than 0.5 miles of the LAGWRP.
- Receiving water temperatures will still exceed the 80°F objective downstream of all WRPs, even though the WRPs' effluent is cooled to meet the limits. Note that LA River temperatures upstream of the DCTWRP and LAGWRP discharges already exceed the 80°F objective and that receiving water temperatures in the BWC increase by more than 5°F downstream of the BWRP discharge.

It appears the WRP heat addition (baseline) or subtraction (effluent cooling) is not as significant as the local meteorological conditions (air temperature and solar radiation). In colder months, the receiving water temperature generally returns to baseline further downstream. However, regardless of the time of year, the modeling shows that even when cooling effluent temperatures to meet the permit limits that:

1) receiving water temperatures return to baseline not far downstream of the WRPs,
2) temperatures upstream and downstream of the WRPs can exceed the 80°F objective, and
3) temperatures downstream of the WRPs can still increase more than 5°F due to air temperature and solar radiation.

7.2.2 Reduced Effluent Flowrate

When effluent flowrate is reduced, it reduces the potential impact of WRP effluent temperatures on receiving waters. To evaluate the effect of the reduced flowrate, the model was run using a 5, 10, 25, and 50 percent WRP effluent flowrate reduction. **Figure 63** presents a comparison of the baseline receiving water temperatures to the receiving water temperatures if the WRPs' effluent flow rates were reduced by 50 percent on August 6, 2024 (see **Attachment A** for additional example dates and time series plots). As shown in **Figure 63**, effluent flow rate reductions have little effect on receiving water temperatures. Similar to effluent cooling, in colder months, the instream temperature returns to baseline further downstream. However, regardless of the time of year, the modeling shows that with effluent flow reductions:

1) receiving water temperatures return to baseline downstream of the WRPs, and
2) temperatures upstream and downstream of the WRPs can exceed the 80°F objective.

7.2.3 Riparian Shading

To determine the effect of tree shading on receiving water temperatures, the reduction of solar radiation incident on the water surface was simulated assuming 100% cover along the river outside of the established channel. Temperatures in the respective receiving waters downstream from the three WRPs for the riparian shading control measure for August 6, 2024 are presented in **Figure 64** (see **Attachment A** for additional example dates and time series plots). As shown in **Figure 64**, little difference occurs from the baseline and shading does not reduce receiving water temperatures downstream of the WRPs below the 80°F objective.

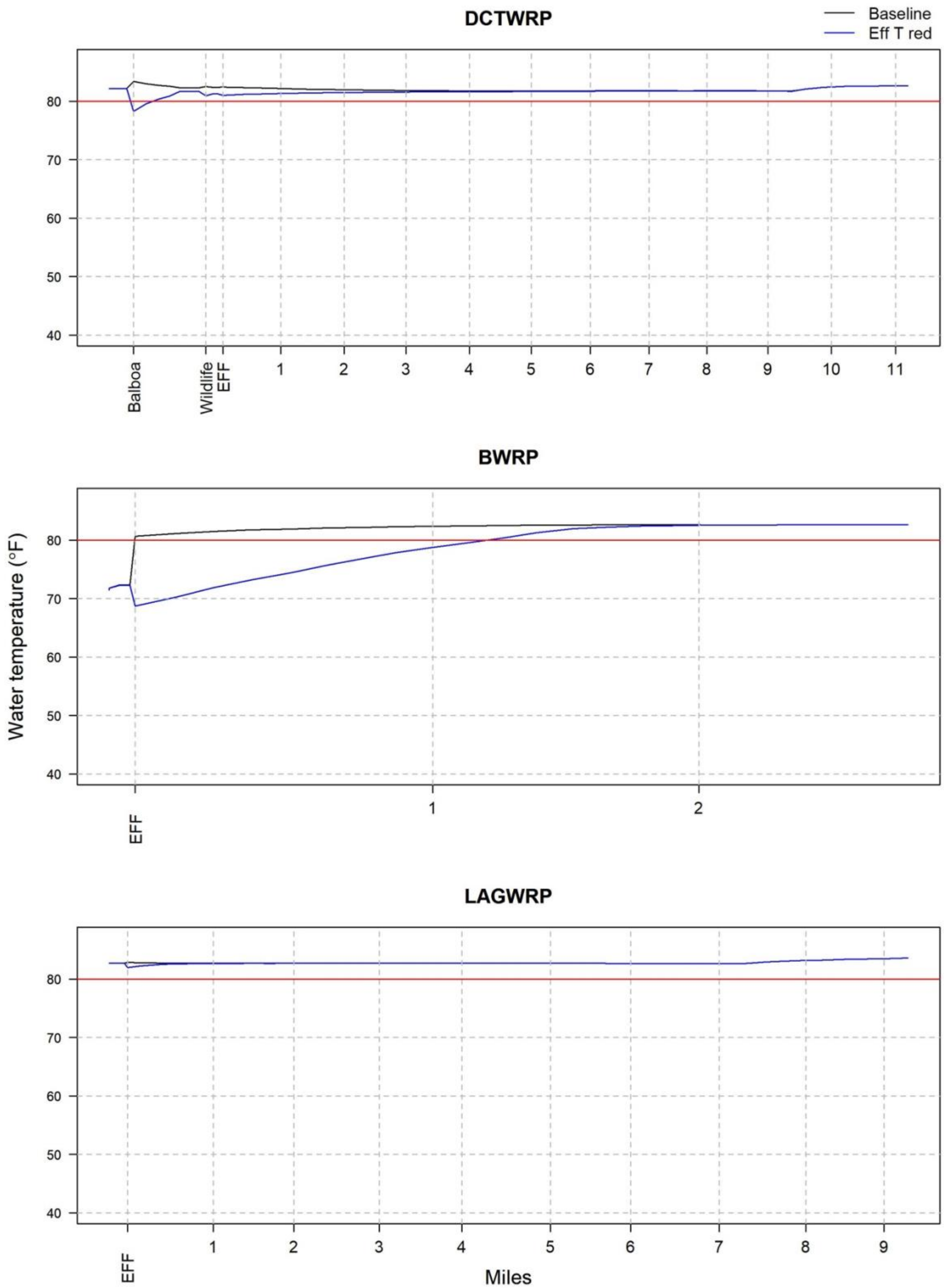


Figure 62. Receiving Water Temperatures at and Downstream from WRPs for Current Condition and with Effluent Cooling on August 6, 2024

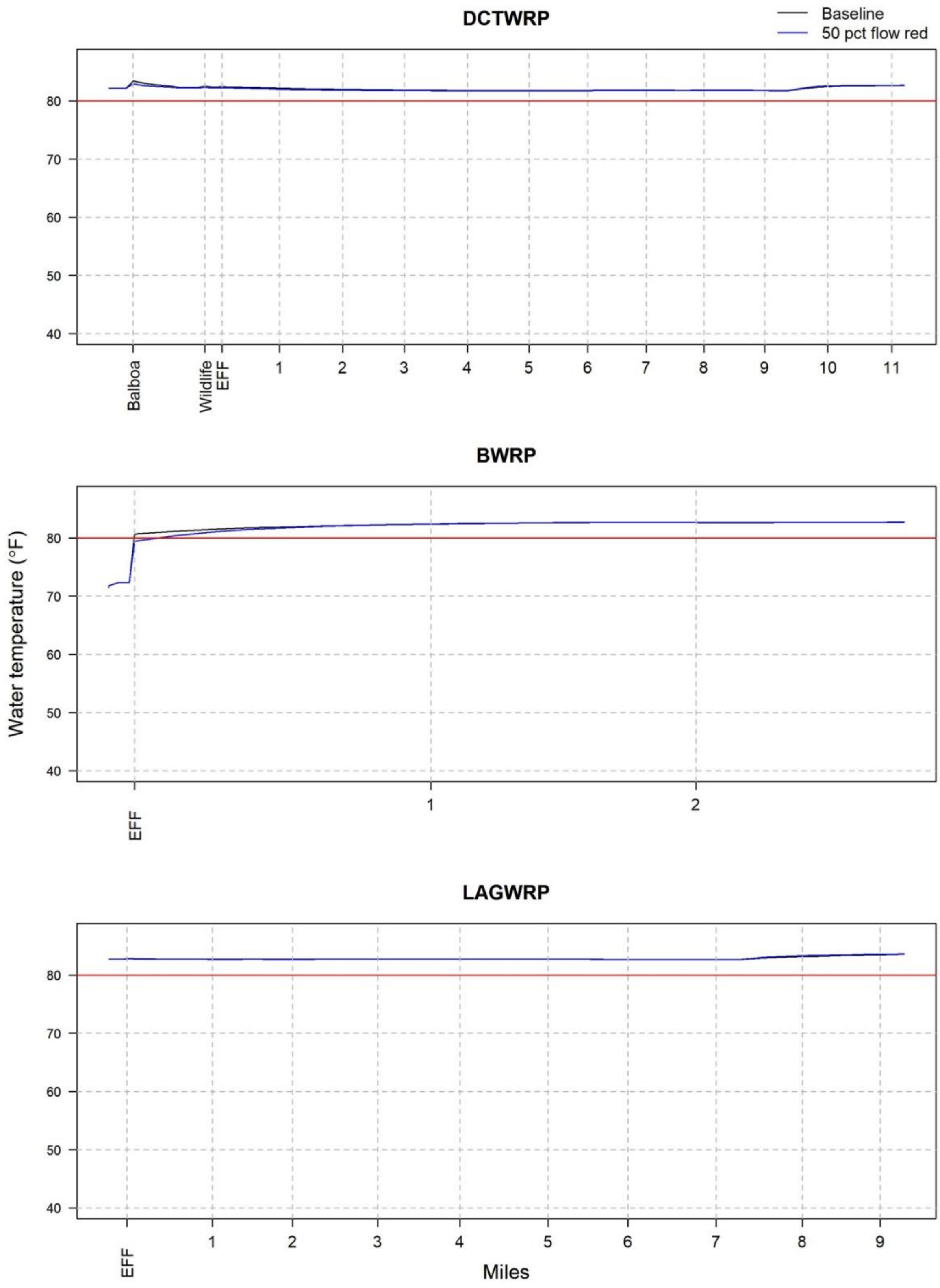


Figure 63. Receiving Water Temperatures at and Downstream from WRPs for Current Condition and in Response to a 50 Percent Reduction in Discharge Flowrate on August 6, 2024

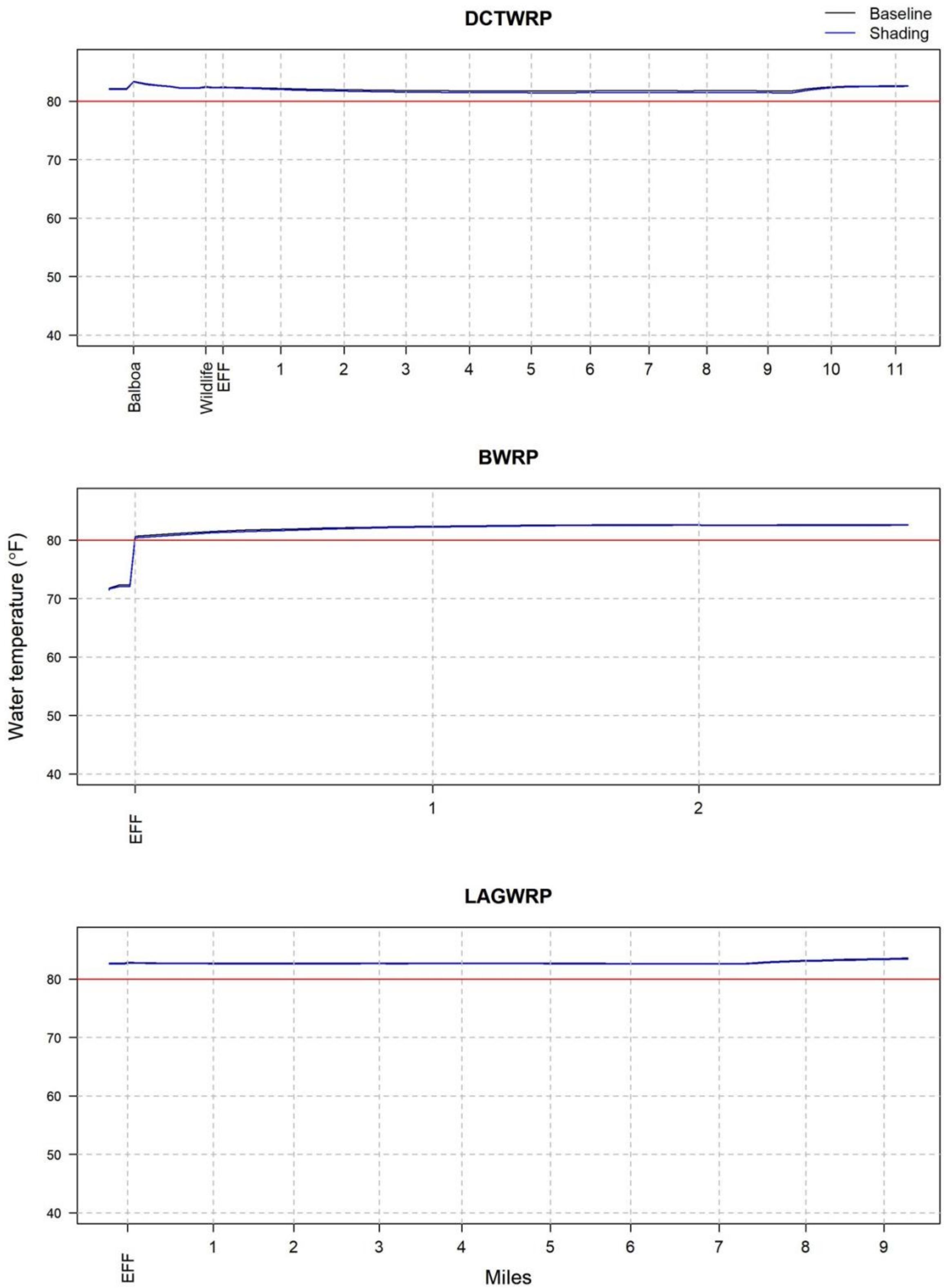


Figure 64. Receiving Water Temperatures Downstream of WRP discharges with 100 Percent Edge of Channel Shading on August 6, 2024

7.3 Modeling of Scenarios

Modeling scenarios seek to combine control measures to investigate potential synergies in combining control measures. Each scenario presented in the following subsections is compared to both the baseline (no action) and to the effluent temperature reduction control measure, which had the greatest effect on receiving water temperatures.

7.3.1 Effluent Temperature Reduction and Flowrate Reduction

Figure 65 compares a scenario that combines the effluent cooling and flowrate reduction control measures against the baseline and effluent cooling on August 6, 2024 (see **Attachment A** for additional example dates). As shown in **Figure 65**, this scenario has less effect on receiving water temperature than just the effluent temperature reduction control measure due to the flowrate of the cooled effluent being reduced and receiving waters downstream of the WRPs exceed the 80°F objective even though the WRPs' effluent is meeting the limits and riparian shading is added.

7.3.2 Effluent Temperature Reduction and Riparian Shading

Figure 66 compares a scenario that combines the effluent cooling and riparian shading control measures against the baseline and effluent cooling on August 6, 2024 (see **Attachment A** for additional example dates). As shown in **Figure 66**, when effluent temperature control is combined with riparian shading, the receiving water temperatures downstream of the WRP discharges revert to the corresponding baseline temperatures slightly further downstream and receiving waters downstream of the WRPs exceed the 80°F objective even though the WRPs' effluent is meeting the limits and riparian shading is added.

7.3.3 Effluent Temperature Reduction, Flowrate Reduction, and Riparian Shading

Figure 67 compares a scenario that combines all three control measures against the baseline and effluent cooling on August 6, 2024 (see **Attachment A** for additional example dates and time series plots). As shown in **Figure 67**, when effluent temperature control is combined with effluent reduction and riparian shading, the receiving water temperatures downstream of the WRP discharges reach the corresponding baseline temperatures, similar to effluent temperature reduction alone and receiving waters downstream of the WRPs exceed the 80°F objective even though the WRPs' effluent is meeting the limits, effluent discharge is reduced, and riparian shading is added.

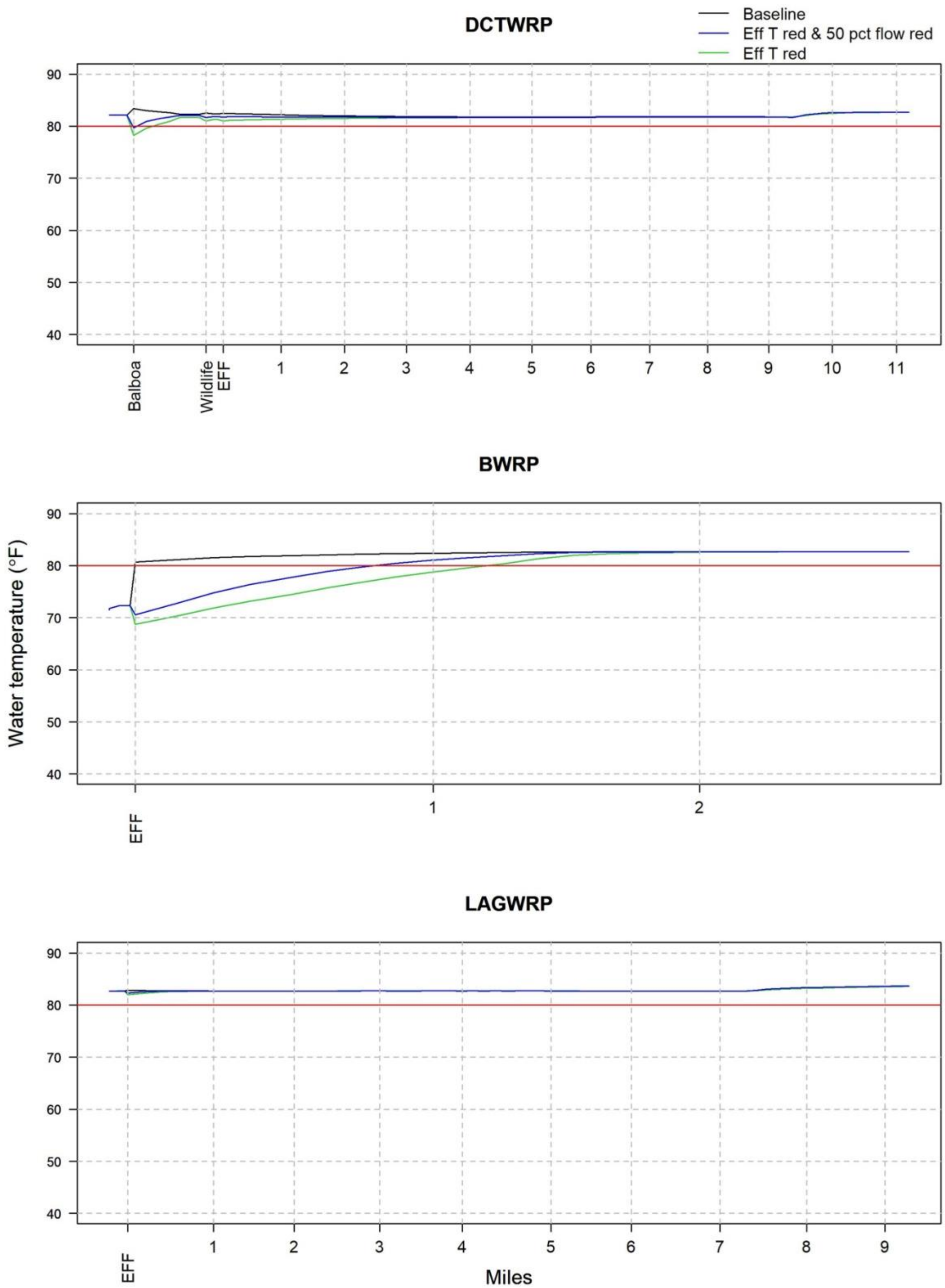


Figure 65. Receiving Water Temperatures Downstream of WRPs for the Effluent Temperature and Flowrate Reduction Scenario on August 6, 2024

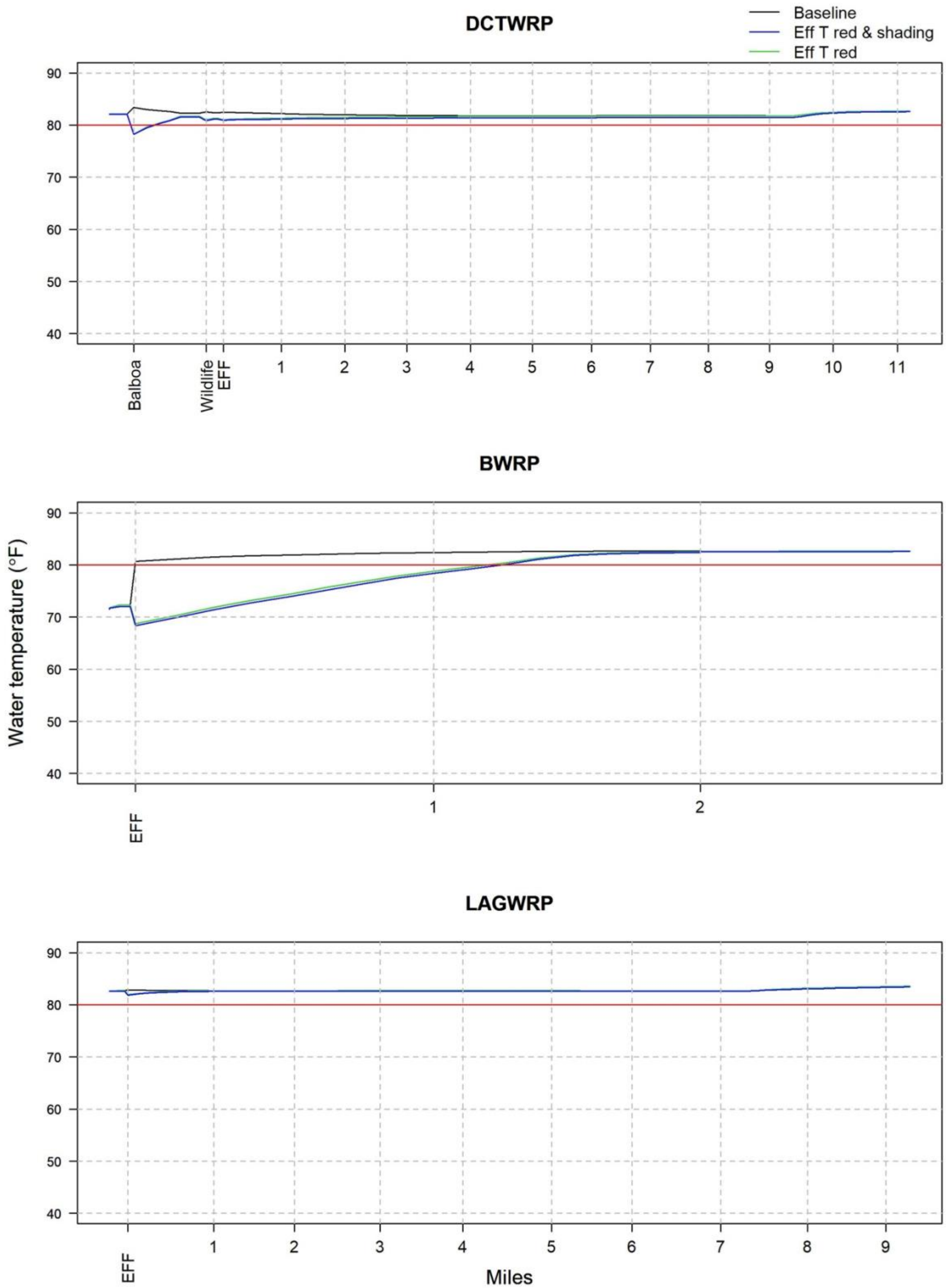


Figure 66. Receiving Water Temperatures Downstream of WRPs for the Effluent Temperature Reduction and Riparian Shading Scenario on August 6, 2024

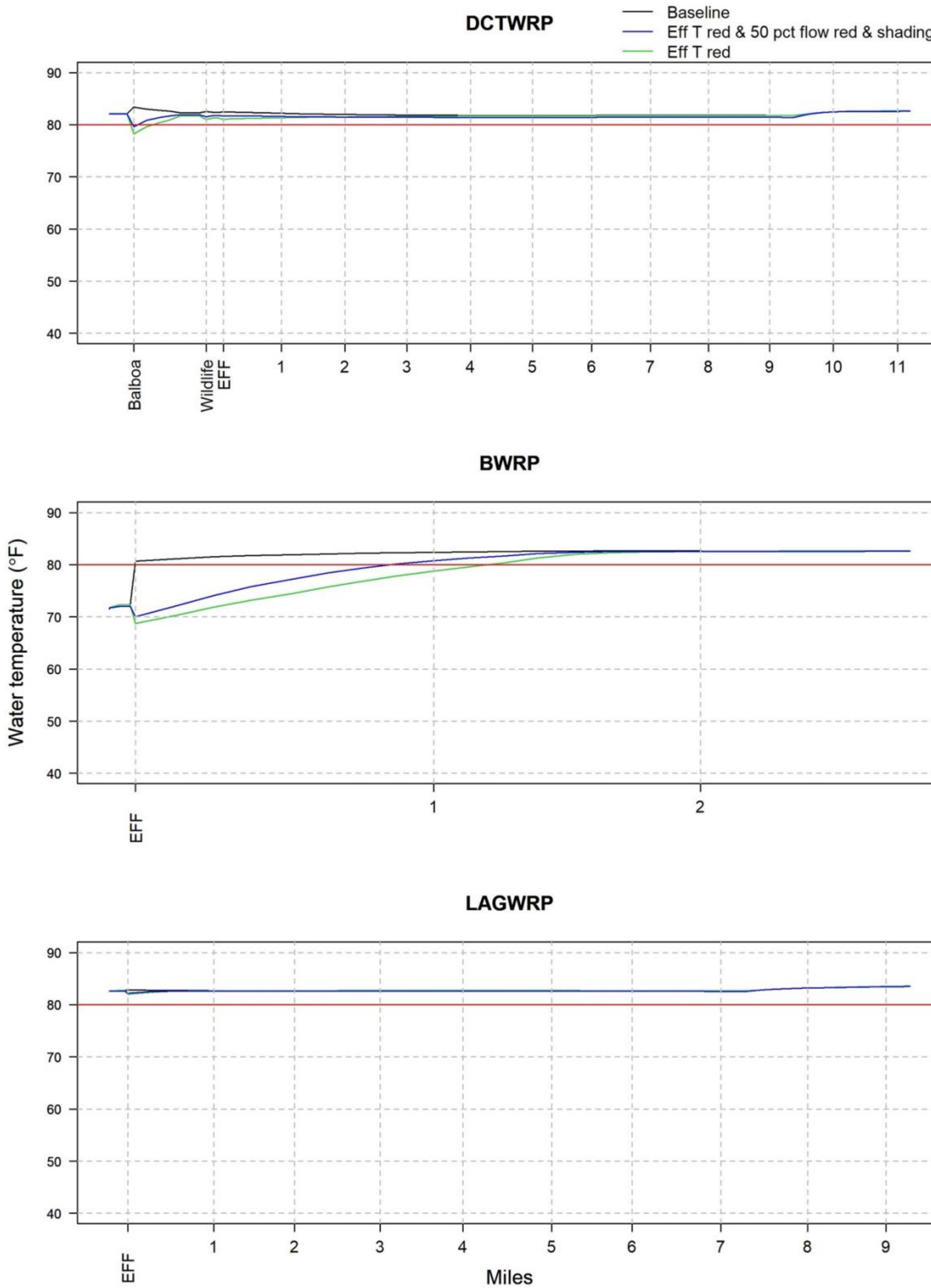


Figure 67. Receiving Water Temperatures Downstream of WRPs for a Scenario with all Three Control Measures Implemented Concurrently on August 6, 2024

7.4 Climate Change

To assess the effect of climate change, the model was run using predicted air temperatures projected 30 years into the future. The future air temperatures in the LA Basin were predicted using the CMIP5 North America model downscaled with the Localized Constructed Analogs (LOCA2-Hybrid) technique, and were downloaded from Cal-Adapt[27]. Predicted mean monthly water temperatures increased by approximately 2°F in August due to increased air temperature in climate change scenarios. The 30-year time frame was selected to align with the life cycle of effluent temperature control machinery.

LA River receiving water temperatures downstream of the DCTWRP, BWRP, and LAGWRP are compared to conditions 30 years in the future in response to climate change and for effluent temperature reduction under climate change and presented in **Figure 68**. On the figure, the black line corresponds to current conditions (baseline), the green line is the baseline after 30 years of climate change (i.e., 30 years in the future), and the blue line is effluent temperature reduction after 30 years of climate change.

7.5 Exploration of Additional Scenarios for River Shading

Given that shading along the banks of the Study area did not result in meaningful changes to receiving water temperatures, the TAC requested an exploration of two additional shading scenarios. The first was an evaluation of planting dense riparian vegetation in the current unlined sections of LAR3 and 5 that might result in blocking 80% of the incident solar radiation. The second was identifying the amount of shading required to maintain the river temperature below 80°F. As exploratory scenarios, they were modeled regardless of whether they would be implementable. In summary, the exploration found the following:

- **80% Shading in Current Unlined Sections:** Under this exploratory scenario, solar radiation was reduced 80% over unlined channels. While receiving water temperatures decreased in the shaded areas, the receiving water temperature quickly increased and returned to the previous equilibrium downstream of the unlined sections.
- **River-wide Shading to Maintain River Temperatures Below 80°F:** Under this exploratory scenario, the potential for consistent attainment of 80°F in receiving waters was evaluated. It was determined that the entire mainstem of the LA River and BWC would have to be shaded to reduce solar radiation by 80%, and in addition, the local air temperatures would simultaneously need to be reduced by 15%.

[27] https://cal-adapt.org/data/download/

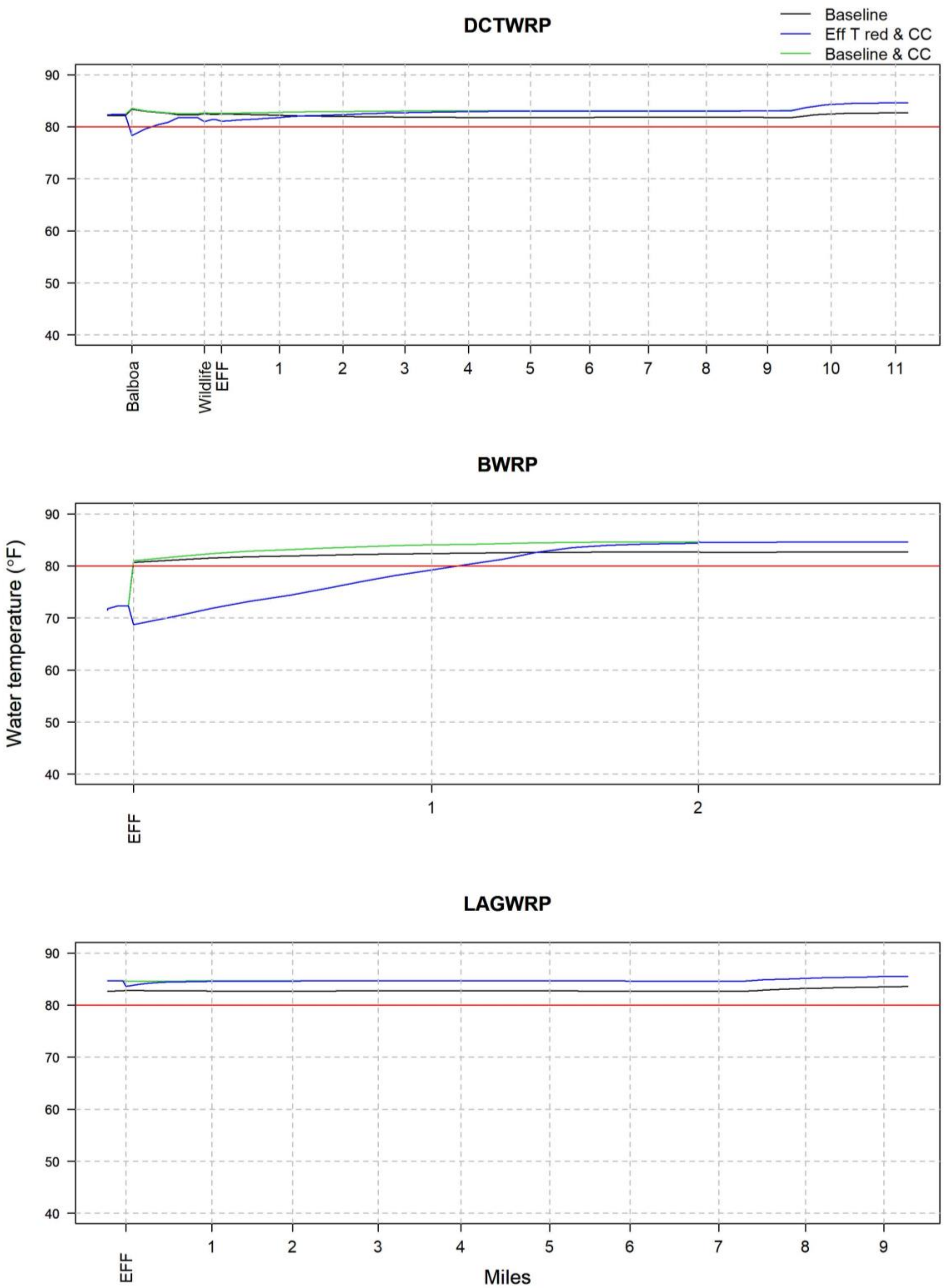


Figure 68. Receiving Water Temperatures Downstream of WRPs for Baseline, Baseline Conditions with Climate Change, and Effluent Temperature Reduction with Climate Change

7.6 Summary of Modeling

A temperature model for the LA River and BWC was created for this Study to evaluate potential control measures, climate change effects, and receiving water temperature changes downstream of discharges. The backbone for the temperature model was the LA River Environmental Flows HEC-RAS hydraulic model, which was updated to include the BWC and the three WRPs as explicit boundary conditions. The model was successfully calibrated and achieved a mean absolute error of 1.2°C and a mean absolute percent error under 5%.

The temperature model was used to evaluate effluent temperature control, effluent flowrate reduction, and riparian shading control measures. Under all three potential control measures either receiving water temperatures are not affected or return to baseline conditions not far downstream (i.e., downstream temperatures are no different than if the control measure had not been implemented). Scenarios comprised of multiple potential control measures were also analyzed, but did not show synergetic gains in downstream temperature reduction. Similar to the results for the individual control measures, either receiving water temperatures are not affected or return to baseline conditions due to factors outside of the control of the WRPs. None of the individual control measures or combinations of control measures result in the consistent attainment of the 80°F objective downstream of the WRPs. Additionally, temperatures downstream of the WRPs can still increase more than 5°F due to air temperature and solar radiation. It should also be noted that the 80°F objective is exceeded upstream of the WRPs, and therefore appears to be naturally unattainable.

Climate change was assessed for 30 years into the future using predicted air temperatures, with the model indicating the receiving water temperatures would increase by a few degrees. On the river reach scale, no meaningful difference was seen in the receiving water temperature after implementation of individual control measures or combinations of control measures, as the receiving water temperature returned to the baseline within the reach.

8 Potential Control Measures

To meet the requirements of the compliance schedule (**Table 1**), potential control measures (including nature-based solutions) that can be implemented to protect beneficial uses were identified and evaluated. The following technical memoranda, summarized in this section, provide detailed descriptions of potential control measures and an evaluation of their potential effectives:

- **Attachment B. Technical Memorandum 1 Alternative Options for Potential Attainment of Effluent and Receiving Water Temperature Limits** – This Technical Memorandum (TM) summarizes a review of alternative temperature reduction options such as nature-based solutions, evaporative cooling, in-plant process changes, and source control to comply with the 80°F and delta 5°F permit limits.
- **Attachment C. Technical Memorandum 2 Traditional Engineering Solutions for Attainment of Effluent and Receiving Water Temperature Limits** – This TM evaluates traditional engineering solutions (i.e., mechanical cooling) to reduce effluent temperatures to comply with the 80°F and delta 5°F permit limits.

8.1 Data Analysis and Preliminary Design Criteria

To support the evaluation of potential control measures, the amount of cooling needed for each of the WRPs' effluent to reach the new temperature limits year-round was needed. To ensure reliable and consistent compliance with the new limits, the maximum effluent flow and maximum temperature reduction were selected as the preliminary design criteria (**Table 39** – see **Attachment C** for additional details). Temperature data was evaluated between 2000 and 2024 while flow data was evaluated between 2019 and 2024 to represent current flow conditions. The required reductions were determined in the same manner as described for the effluent temperature reduction modeling (**Section 7.2.1**). Note that some flow data were excluded from the analysis as they were not representative of typical operating conditions (e.g., during construction at a WRP that led to a temporary diversion of flows).

Table 39. Summary of Design Criteria for Effluent Cooling[1, 2]

Design Criteria	LAGWRP	DCTWRP	BWRP
Maximum Effluent Flow Rate (Million Gallons per Day)	15.9	30.9	5.9
80 °F Limit			
Maximum Temperature Reduction to Meet 80°F Limit	8°F	7°F	9°F
Cooling Capacity, tons	3,100	6,200	1,500
Delta 5 °F Limit			
Maximum Temperature Reduction to Meet delta 5 °F Limit	35°F	32°F	37°F
Cooling Capacity, tons	16,100	29,000	6,300

1. Temperature data was evaluated between 2000 and 2024 for all the WRPs.
2. Flow data was evaluated between 2019 and 2024 for all the WRPs.

8.2 Alternative Control Measure Options

Several non-traditional effluent cooling options were identified to assess their ability to reliably attain the 80°F and delta 5°F permit limits. The options are grouped into the following categories and, where applicable, subcategories (see Attachment B for additional details on each category and **Section 7** for an evaluation of two additional non-traditional options: reducing effluent discharge and shading of the receiving water):

- Natural Heat Flow
    - Cooling with groundwater Using Heat Exchanger
    - Blending With Deep Groundwater Source
    - Geothermal Cooling
    - Infiltration Trenches
    - Aquifer Storage and Recovery
    - Hyporheic Zone Injection
- Evaporative Cooling
    - Passive Cooling Wetlands/Ponds, Seasonal Ponds, Spray Ponds, and Pipe in Cooling Pond
    - Effluent Discharge Structure Modification or Enhanced Mixing of Effluent and Receiving Stream
- Source Control
- In-Plant Process Changes

Cooling alternatives for each WRP were evaluated on a pass/fail basis using the screening criteria summarized in **Table 40**. For many of these options, little information is available about actual operating systems, so the term "unknown" was included in the screening criteria. As few alternative control measures have actually been utilized to reduce effluent temperature elsewhere, reliable cost estimates are not readily available. Therefore, the cost criterion was used to describe what estimated costs would be incurred for implementing the option. Other benefits were identified as Yes/No and a description of the benefit. **Table 41** presents a summary of the results of the screening analysis. In summary, none of the options evaluated reliably meet the limits. For reliable compliance with the temperature limits, a mechanical solution (cooling towers and chillers) or elimination of flow from the discharge would be needed.

Table 40. Screening Criteria for Alternative Control Measures

Screening Criteria	Criteria Description	Metric
Ability to Meet Regulations	Complies with NPDES limits for effluent temperature (not to exceed 80°F) and not altering receiving water by more than 5°F.	Pass/Fail/ Unknown
Technology Implementation (at this size)	Proposed technology/approach has at least one proven installation in the United States for water/wastewater application.	Pass/Fail/ Unknown
Site Constraints	Structures, equipment, etc., fit within the existing WRP boundaries.	Pass/Fail
Cost	Descriptions of infrastructure required to calculate costs.	Not Available
Operations	Facilities can be fully operated by staff (i.e., contract operations are not required). Not overly complicated operationally.	Pass/Fail
Provides Other Benefits	Recreation, treatment, Greenhouse gas reduction, etc.	Yes/No

Table 41. Summary of Screening Results for Alternative Control Measures

Classification	Examples	Summary Screening Results		
		DCTWRP	BWRP	LAGWRP
Natural Heat Flow	Cooling with groundwater using a heat exchanger and geothermal cooling.	**FAIL:** Does not meet the limits. Large space requirement, unknown applications, cost-effectiveness unknown. Groundwater temperatures likely not low enough to meet delta 5°F limit (typically in low 60 °F). Local groundwater contamination makes this infeasible at BWRP.		
	Aquifer storage and recovery.	**FAIL:** Does not meet the limits. Aquifer storage and recovery likely requires higher level of treatment and WDR to meet potable reuse standards. Local groundwater contamination makes this infeasible at BWRP.		
	Hyporheic zone injection or infiltration trenches.	**FAIL:** Does not meet the limits. Land space available for infiltration trenches, but it is in the floodplain. Requires a WDR for land discharge - unknown if RWQCB would permit. Would be sited on USACE land and within floodplain, needing USACE approval for land use and associated permits. Additional investigation (groundwater modeling) required to see if surface flooding occurs. Effect of warm effluent in the hyporheic zone is unknown.	**FAIL:** Does not meet the limits. Local groundwater contamination makes this infeasible. Insufficient space for trenches. Requires a WDR for land discharge - unknown if RWQCB would permit.	**FAIL:** Does not meet the limits. Insufficient space for trenches. Requires a WDR for land discharge, unknown if RWQCB would permit. May be required to meet potable reuse standards. Need groundwater modeling to evaluate travel path and time to nearest potable wells.
	Blending with deep groundwater water source.	**FAIL:** Does not meet the limits. Requires groundwater extraction permits, flow availability, temperature of groundwater unknown, cost-effectiveness unknown. Blending with deep groundwater may affect effluent water quality. Volume of water required to blend make this unfeasible and may cause overdraft and subsidence. Groundwater temperatures likely not low enough to meet the delta 5°F limit (typically in low 60 °F). Local groundwater contamination makes this infeasible at BWRP.		
Evaporative Cooling	Passive cooling wetlands/pond, seasonal pond storage, spray pond cooling system, pipe in pond cooling.	**FAIL:** Does not meet the limits. Large space required outside of plant; cost-effectiveness unknown.		
	Effluent discharge structure modifications.	**FAIL:** Does not meet the limits. Unknown temperature reduction, requires additional space near the outfall.		

Classification	Examples	Summary Screening Results		
		DCTWRP	BWRP	LAGWRP
Source Control	Limiting the use of hot water for non-essential purposes.	**FAIL:** Does not meet the limits. Unknown applications, unknown ability for temperature control.		
	Recovering heat in buildings or in large sewer trunks and interceptors in the service area.	**FAIL:** Does not meet the limits. This concept harvests heat from the sewer in cold environments, but is not suitable for warm climates.		
	Public outreach and residential rebate programs.	**FAIL:** Does not meet the limits. Unknown applications, cost-effectiveness unknown. Difficult to implement.		
	Industrial source control through local limit or site specific limit.	**FAIL:** Does not meet the limits. May provide some reduction, but will not meet limit. May adversely impact industries.		
In-Plant Process Changes	Identifying processes that increase wastewater temperature, Using alternatives processes/technology for wastewater treatment, Using energy-efficient mechanical equipment to minimize losses due to friction.	**FAIL:** Does not meet the limits. The ability to control temperature increases from biological treatment is unlikely. Equipment temperature rises may not be controllable.		

8.3 Traditional Engineering Control Measure Options

Cooling towers and chillers were evaluated to assess their ability to consistently and reliably attain the 80°F and delta 5°F permit limits. **Attachment C** provides additional details on each of the technologies, which are briefly summarized in the following subsections.

8.3.1 Cooling Towers

Cooling towers utilize evaporative cooling to remove heat from water that is passed through the tower. This means that a portion of the water is evaporated as the liquid stream passes through the cooling tower, causing the temperature of the liquid stream to be reduced. However, the performance of a cooling tower is highly dependent on the temperature and humidity of the ambient air. The wet bulb temperature of the ambient air represents the theoretical minimum temperature to which the water can be cooled by evaporation only. Practical limitations prevent cooling towers from reducing the water temperature to exactly the wet bulb temperature. In practice, cooling towers can only cool water to a few degrees above the wet bulb temperature of the air entering the cooling tower. Wet bulb temperatures are directly related to humidity. At 100 percent humidity the wet bulb temperature equals air temperature (dry-bulb temperature).

The Cooling Technology Institute (CTI) is a third-party association that certifies the performance of evaporative heat rejection equipment such as cooling towers. CTI does not certify the performance of a cooling tower if the approach (difference between the leaving water temperature and ambient wet bulb temperature) is less than 5°F. As such, for the purposes of evaluating the effectiveness of cooling towers, it is assumed that cooling towers can only reliably reduce the temperature of effluent to 5°F above the ambient wet bulb temperature (e.g., the wet bulb temperature would have to be 75°F or less to produce effluent temperatures 80°F or less).

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) tabulates weather data from a multitude of weather stations across the globe. The nearest weather station to the LAGWRP and BWRP is located in Burbank. The weather station nearest to DCTWRP is located in Van Nuys. The weather data presented by ASHRAE includes the 0.4 percent monthly design wet bulb temperature. For a given month, the ambient wet bulb temperature is equal to or less than the 0.4 percent wet bulb temperature 99.6 percent of the time. The 0.4 percent monthly design wet bulb temperature was used to determine the potential performance of cooling towers. Based on a review of the weather station data, the ambient wet bulb temperature is expected to be above 75°F approximately 0.4 percent of the time in July, less than 0.4 percent of the time in August, and in rare instances throughout the year. As such, cooling towers may be able to meet the 80°F limit for the majority of the year, but cannot cool water below the ambient wet bulb temperature. Further, since the delta 5°F limit requires effluent temperatures below the wet bulb temperature, cooling towers cannot meet the delta 5°F limit. As such, cooling towers were determined not to be a viable technology for meeting limits and are not discussed further in this report.

8.3.2 Chillers

Rather than using evaporative cooling, chillers utilize mechanical cooling. Refrigerant is used to extract heat from effluent and reject that heat to a separate fluid. Some chillers reject heat to ambient air (air-cooled chillers) and other chillers reject heat to a separate water stream (water-cooled chillers). The maximum cooling capacity of air-cooled chillers is generally lower than water-cooled chillers. Air-cooled chillers offer a less complex cooling system than water-cooled chillers because they do not require a secondary system to supply and dispose of heated water. This makes air-cooled chillers best suited for projects that require relatively small amounts of cooling. The maximum capacity of a single air-cooled chiller offered by major chiller manufacturers in southern California is approximately 500 tons. Due to the cooling capacity required to meet the limits (over 6,000 tons for the smallest WRP), air-cooled chillers are not recommended.

Figure 69 shows a schematic of a water-cooled chiller, which take heat from the liquid stream to be cooled and rejects that heat to a secondary stream. The heat exchanger shown in **Figure 69** allows heat to be removed from the effluent without sending the effluent directly to the chiller. Utilizing a heat exchanger between the WRP effluent and chillers allows the chilled water loop to use a fluid of higher quality than the WRP effluent. The heated secondary stream is often subsequently sent through a cooling tower to ultimately reject the heat to the environment. The water sent to the cooling tower via a chiller would be at an elevated temperature compared to sending the initial effluent stream directly to the cooling tower. The water sent back to the chillers from the cooling towers would be warmer than the final effluent temperature. This allows cooling towers to be used even when the final effluent temperature needs to be below the ambient wet bulb temperature. Because chillers use a refrigerant, they would be expected to reduce effluent temperatures to consistently meet the limits. As such, chillers were further evaluated and conceptual designs and layouts, as well as estimates of costs, energy use, and GHG emissions were developed and are presented in the following subsections. Figures on later pages depict how chillers might be laid out for each WRP. The layouts depict footprints for the effluent pump station, chilled water loop pump station, condenser loop pump station, electrical building, chiller building, and associated cooling towers.

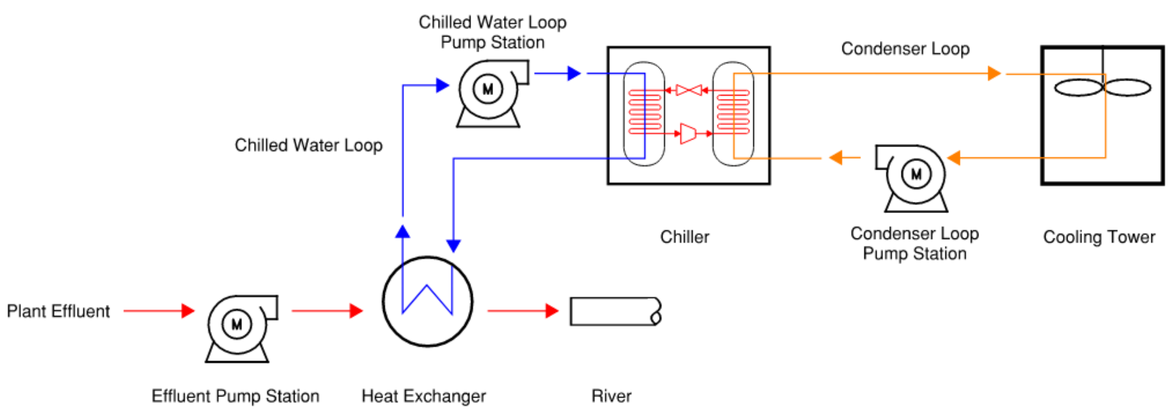


Figure 69. Example of Water-Cooled Chiller

8.3.2.1 Chiller Conceptual Design: DCTWRP

Currently, many future planned projects already exist within the DCTWRP boundaries as well as in the construction laydown area north of the cricket fields. Some of the planned projects within the DCTWRP boundary include the addition of 9.2 million gallon equalization (EQ) tanks and a 25 million gallon per day (mgd) Advanced Water Purification Facility (AWPF) with potential for future capacity expansion to 45 mgd. A power station project, currently in design phase, will be located in the northeast corner of the construction laydown area. Other projects planned in this area include future EQ expansion, a new headworks/screening facility, and future employee parking. The DCTWRP and land south of the WRP, where the cricket fields are currently located, is owned by the USACE and is in a floodplain. The DCTWRP is protected by a berm around the site. The City of Los Angeles leases the DCTWRP site from the USACE, with another 25 years on the lease. Conditions in the lease require coordination with USACE for major capital efforts at the DCTWRP. With all space in the DCTWRP boundaries currently planned for other uses, siting new temperature treatment facilities offsite is the logical option. However, the ownership, floodplain, and amenities such as a public park and recreation spaces supporting the community complicate implementation. Discussions with the USACE, an extensive permitting process, an Environmental Impact Report, community outreach and engagement, and other studies will be required to confirm the feasibility of this location. Additionally, the power feed to the DCTWRP would have to be increased by nearly two-fold to accommodate temperature reduction facilities; therefore, additional power facilities and coordination with the Los Angeles Department of Water and Power (LADWP) will be required.

Figure 70 shows a conceptual layout of the eight chillers and nine associated cooling towers (all duty units) that would be necessary for the DCTWRP to consistently and reliably comply with the limits. As land availability is limited within the DCTWRP boundaries, the cooling towers are shown located in the northwest corner of the cricket field. Additional detailed evaluations, typically conducted as part of a preliminary design effort (e.g., site surveys, location of existing utilities, and integration with other planned projects), will be needed to confirm this location is feasible. Furthermore, consultation with and ultimately approval from the USACE along with securing an adequate power supply would be required.

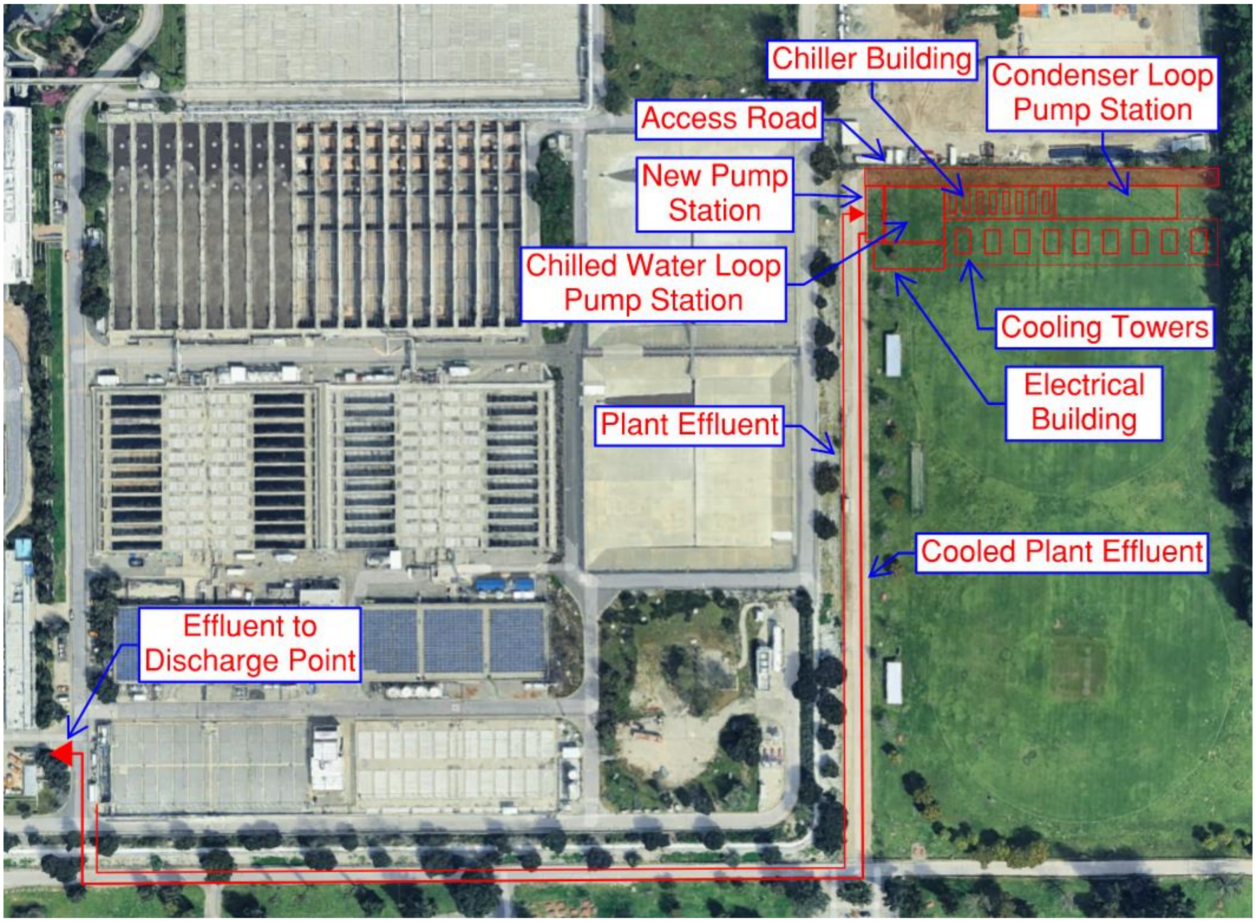


Figure 70. Potential Layout of Water-Cooled Chillers and Associated Cooling Towers at DCTWRP

8.3.2.2 Chiller Conceptual Design: BWRP

There are numerous projects being planned at the BWRP for treatment improvement and capacity expansion that are needed to both support growth driven by the statewide housing mandate and to address increased pollutant concentrations due to water conservation. These projects include the expansion of existing headworks, primary clarifiers, equalization basins, aeration basins, secondary clarifiers, electrical facilities, and a warehouse. There are several existing facilities, including underground and aboveground utilities that require access for maintenance, so the overall land availability onsite is very limited and already planned for future projects. Burbank is also planning to increase recycled water use with the potential of adding advanced treatment facilities for potable reuse. The BWRP is surrounded by train tracks and the BWC and there is essentially little to no adjacent land available. Also, several support facilities are required for chillers, therefore, it will take nearly all the open space at the BWRP and may impede the ability to do the other planned projects. Additionally, the power feed to the BWRP would have to be increased substantially to operate chillers; therefore, additional power facilities and coordination with Burbank Water and Power will be required.

Figure 71 shows a conceptual layout of the two chillers and two associated cooling towers (all duty units) that would be necessary for the BWRP to consistently and reliably comply with the limits. As land availability is limited, an additional evaluation, typical of a preliminary design effort (e.g., site surveys, location of existing utilities, and integration with other planned projects) would be needed to determine the feasibility of these locations for chillers and associated facilities.

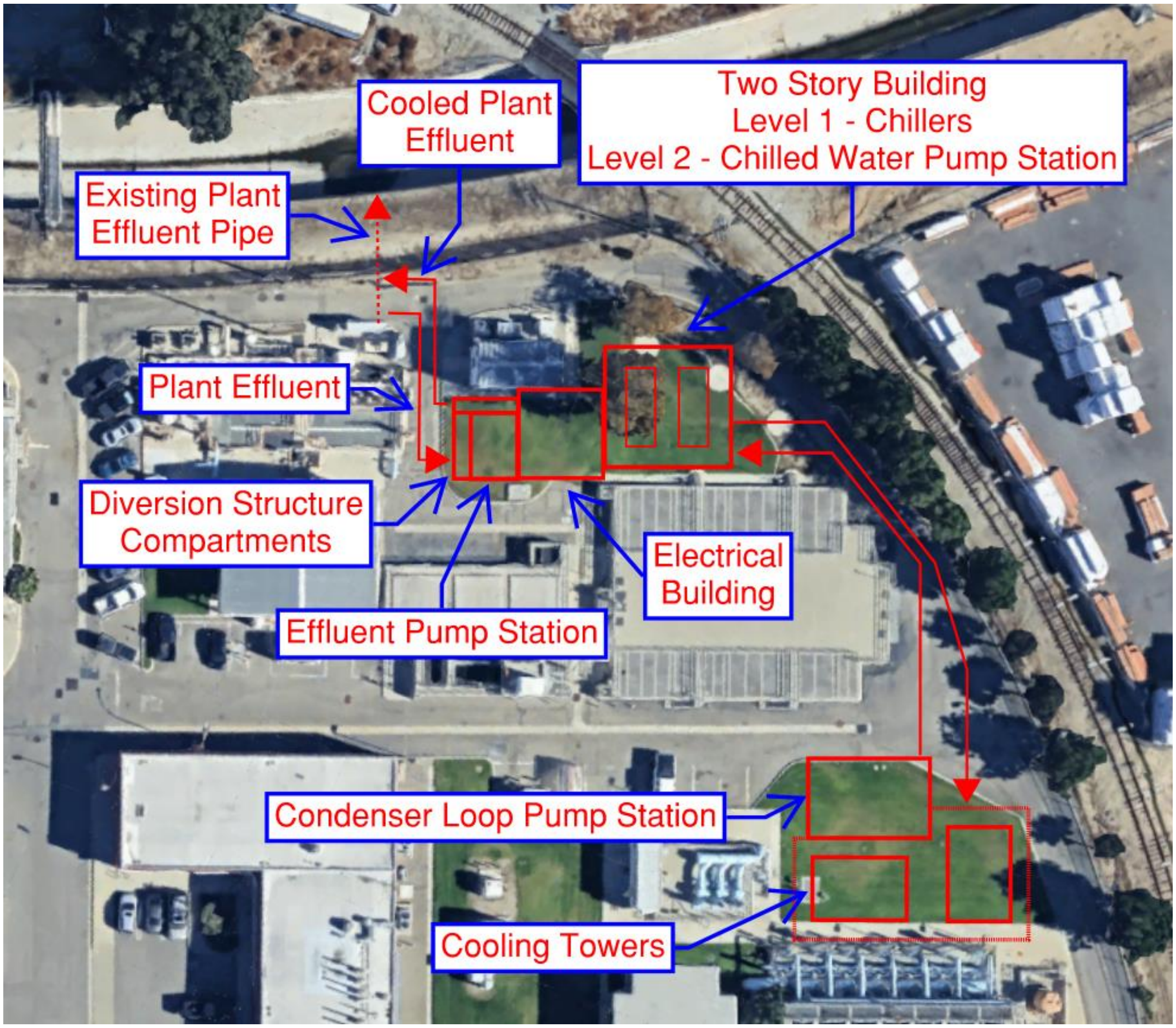


Figure 71. Potential Layout of Water-Cooled Chillers and Associated Cooling Towers at BWRP

8.3.2.3 Chiller Conceptual Design: LAGWRP

Several future projects are planned within the LAGWRP boundaries, including the Campus Plan, primary effluent equalization storage project, a personnel building, and blower air cleanup system project. These projects are at 90% design, and construction will begin in 2026-2027. The LAGWRP is surrounded by developed land and the LA River, therefore, no offsite location would clearly work for siting chillers. Due to the tight site and extensive ongoing improvements, it was difficult to find suitable space. Additionally, the power feed to the LAGWRP would have to be substantially increased and potentially doubled; therefore, additional power facilities and coordination with the LADWP will be required.

Figure 72 shows a conceptual layout of the five chillers and six associated cooling towers (all duty units) that would be necessary for the LAGWRP to consistently and reliably comply with the limits. As land availability is limited, implementing this project would eliminate all laydown space at LAGWRP as well as require a relocation of the future electrical facilities. Additional detailed evaluations, typically conducted as part of a preliminary design effort (e.g., site surveys, location of existing utilities, and integration with other planned projects), would be needed to determine the feasibility of these locations for chillers and associated facilities.

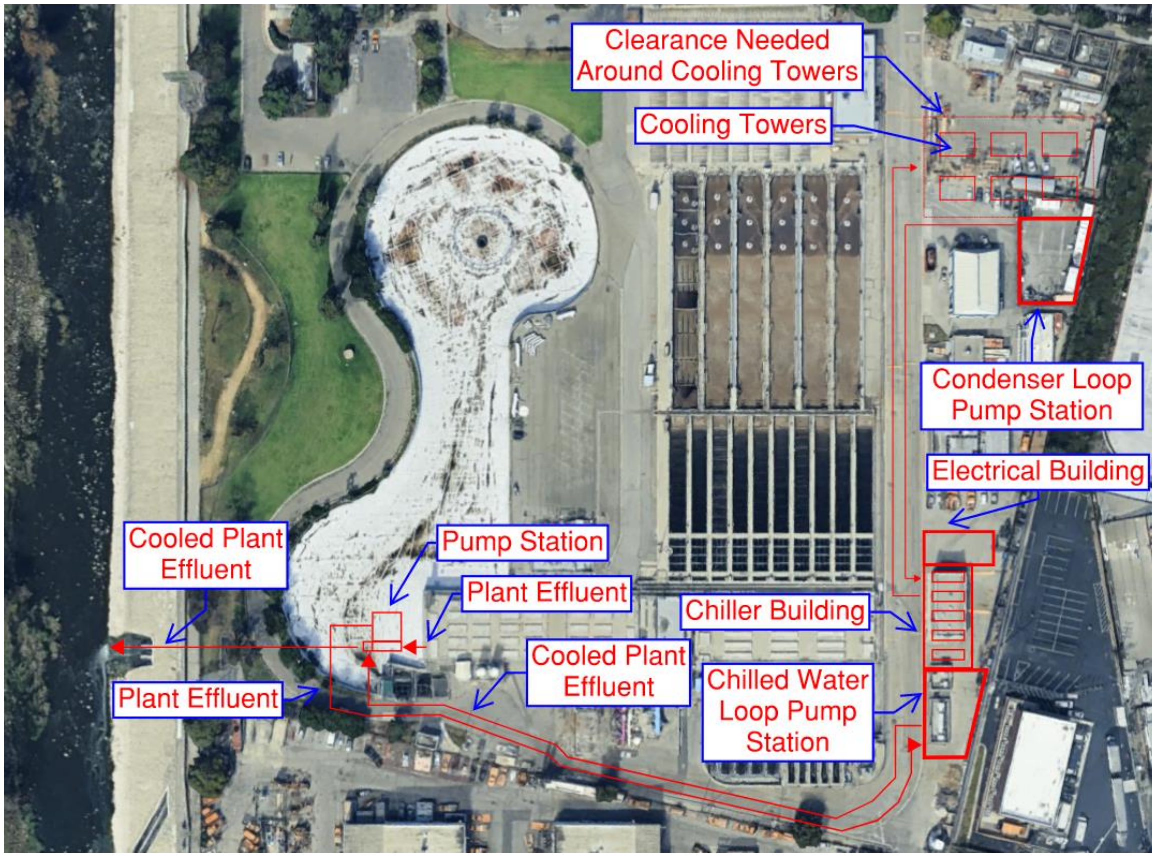


Figure 72. Potential Layout of Water-Cooled Chillers and Associated Cooling Towers at LAGWRP

8.3.2.4 Chiller System Cost Estimates

A Class 5 cost estimate was prepared for each WRP (**Table 42**). A Class 5 cost estimate has an expected accuracy range of -20 to -50 percent and +30 to +100 percent for the low and high ranges, respectively. The costs presented in **Table 42** were developed using Carollo Engineers' Cost Estimation database and information from past similar projects. The following assumptions were made to estimate the project cost and are calculated in 2025 dollars:

- Subtotal Construction Cost is calculated as the sum of the following:
    - Total Direct Cost, accounting for a 35 percent estimating contingency.
    - General Conditions, Bonds, Insurance = 15 percent of Total Direct Cost.
    - Sales Tax = 7.8 percent based on 50 percent of Total Direct Cost.
    - Contractor Overhead, Profit and Risk = 15 percent of Total Direct Cost.
- Total Construction Cost is calculated as the sum of the following:
    - Subtotal of Construction Cost.
    - Change Order Allowance = 10 percent of Subtotal of Construction Cost.
- Total Project Cost is calculated as the sum of the following:
    - Total Construction Cost.
    - Engineering = 15 percent of Total Construction Cost.
    - Legal and Administrative Fees = 5 percent of Total Construction Cost.
    - Environmental Permitting = 2 percent of Total Construction Cost.
    - Construction Management = 7 percent of Total Construction Cost.
    - Warranty = 1 percent of Total Construction Cost.

Table 42. Capital Cost Estimates for Water-Cooled Chiller System

Cost Item/Process Area	Description	LAGWRP Cost ($ million)	DCTWRP Cost ($ million)	BWRP Cost ($ million)
Direct Costs				
Cooling System	Equipment + Installation(1)	14.6	22.2	5.3
Effluent Pump Station	Vertical Turbine Type Pumps(2)	7.4	12.3	3.7
Condenser Loop Pump Station		3.5(3)	6.5(3)	7.4(2)
Chillers Loop Pump Station	Horizontal Centrifugal Pumps	3.0(3)	5.1(3)	1.4(4)
Diversion Structure/Wet Well(5)		1.5	0.4	0.6
Pipelines to/from Pump Station to Chillers		4.1(6)	5.3(7)	0.8(8)
Support Facilities(9)	Electrical and Chiller Buildings	5.5	8.5	5.0(10)
Deep excavation, complex shoring, and existing utility conflicts for new pipeline	20% of Pipeline Cost	0.83	0.04	0.2
New Power Feed(11)		5.2	8.6	5.2(12)
New Access Road(13)		-	0.3	-
Traffic Control (14)		-	0.6	-
Electrical and Instrumentation	30% of Equipment Cost	9.5	15.6	6.7
	Subtotal Direct Cost	**55.1**	**85.4**	**36.3**
Estimating Contingency	35%	19.3	29.9	12.7
	Total Direct Cost (Subtotal + Contingency)	**74.5**	**115.3**	**49.0**
Construction Costs				
General Conditions, Bonds, and Insurance	15% of Total Direct Cost	11.2	17.3	7.3
Contractor Overhead and Profit	15% of Total Direct Cost	11.2	17.3	7.3
Sales Tax	10.5% of 50% of Total Direct Cost	2.8	4.3	1.9
	Subtotal Construction Cost (Direct + Construction %)	**99.6**	**154.2**	**65.5**
Change Order Allowance	10%	9.9	15.4	6.6
Total Construction Costs	**Subtotal + Allowance**	**109.5**	**169.6**	**72.1**
Project Costs				
Total Project Cost (Total Construction Cost + 15% for Engineering, 5% for Legal and Administrative, 2% for Environmental Permitting, 7% for Construction Management, and 1% for Warranty)		**142.4**	**220.5**	**93.7**

1. Combined costs for chillers and associated cooling towers. Includes installation factors of 40 percent and 50 percent applied to direct equipment costs for chillers and cooling towers, respectively.
2. Based on vertical turbine pump station and assumed fixed cost of $308,000/mgd.
3. Based on horizontal split case pumps and assumed fixed costs of $1,660/hp.
4. Based on horizontal split case pumps and assumed fixed costs of $2,210/hp.
5. Assumed fixed cost of $3,750/$ft^2$.
6. Cost of 1500 ft of 24 in DIP at $1,010/LF, Cost of 1000 ft of 48 in in DIP at $2,100/LF, Cost of 300 ft of 42 in in DIP at $1810/LF.
7. Cost of 4,200 ft of 30 in DIP at $1,260/LF.
8. Costs of 200 ft of 24 in DIP at $975/LF, 200 ft of 14 in DIP at $620/LF, and 400 ft of 30 in DIP at $1,260/LF.
9. Assumed fixed cost of $1,000/$ft^2$.
10. Cost for 2-story chiller building.
11. Cost from DCTWRP AWPF Power Facilities- $350,000/MVA.
12. The cost of the new power feed for BWRP is provided by Burbank Water and Power in 2025 dollars. Inflation for electrical construction will cause this number to rise in the future.
13. 20 feet wide asphalt road, $500/LF.
14. $5000/day/80 LF in urban areas; $5000/day/120 LF in non-urban areas; additional $5000/day for 60 days.

The total operation and maintenance (O&M) costs are presented in **Table 43**, inclusive of labor costs. The chillers will be run year round, but only to the level for which cooling is needed (i.e., the chillers would vary operation based on the amount of cooling needed). Historical WRP effluent and river temperature data were used to determine the percentage of the time that cooling was needed and the number of hours per year that cooling was needed was estimated. The average power requirement, hours of operation and electrical cost were then used to estimate the cost to power the chillers at each WRP. These estimates may increase if climate change modifies the temperature variations. It should be noted that to meet the temperature limits, electrical power consumption at each WRP would increase by approximately 60% to 100% (above 2025 usage), essentially doubling current power costs. Additionally, there is the likelihood that by the time construction would be completed on of these projects, the cost of electricity per kWh would be significantly higher than today's rates, further increasing O&M costs.

Table 43. O&M Costs for Water-Cooled Chillers System

Cost	Units	LAGWRP	DCTWRP	BWRP
Average Power Usage (1)	kW	1,900	3,500	330
Time Spent Cooling Per Year	hour/year	7,100	8,000	7,700
Power Cost(2)	$/kWh	$0.26	$0.26	$0.203
Total Annual Power Cost	$/year	3,500,000	7,300,000	516,000
Additional Annual Labor Cost(3,4)	$/year	1,200,000	2,000,000	400,000
Total Annual O&M Cost	**$/year**	**4,700,000**	**9,300,000**	**916,000**

Note: kWh - kilowatt-hour

1. Average annual power usage derived from average flows and temperature reduction required.
2. LAGWRP and DCTWRP power costs are reflective of 2025 rates and BWRP power costs are reflective of January 2026 rates. Electrical rates are currently escalating annually; therefore, power costs will increase in the future.
3. Fully burdened salaries for an additional 4 operators and 2 maintenance Full-Time Equivalents at LAGWRP, an additional 6 operators and 4 maintenance Full-Time Equivalents at DCTWRP, and a minimum of 3 new full-time operations and maintenance staff at BWRP. Salaries are based on current rates, which are expected increase in the future.

8.3.2.5 Chiller System GHG Emissions

To calculate annual GHG emissions the following assumptions were utilized: an initial calculation year of 2025, a growth rate of 0%, and GHG Emissions Intensity of 0.17 metric tons of carbon dioxide emissions per megawatt-hour of electricity generated (MT CO_2/MWh) based on Edison International's 2023 Sustainability Report. GHG emissions are based on the electricity demand (**Table 43**) and the emissions per electricity use. The electrical demand was multiplied by the operating hours each year at each WRP to produce the annual power demand. The chillers would need to operate year-round to meet the limits; however, not necessarily every hour of every day. Hours of operations were estimated based on historical temperature data. The power demand was multiplied by Edison International's calculated emissions of 0.17 MT CO_2e/MWh to calculate the total emissions in a year. **Table 44** shows the annual and 20-year GHG emissions for each WRP.

Based on estimates developed for the City of LA's 2023 Municipal GHG Inventory Report, GHG emissions from operation of LAGWRP and the DCTWRP totaled 3,914 and 10,729 MT CO_2e, respectively. Operation of chillers will increase GHG emissions by approximately 59 percent and 44 percent at LAGWRP and DCTWRP, respectively. According to the City of Burbank's 2022 GHG Reduction Plan Update, operation of the BWRP accounted for 2,360 MT CO_2e of emissions in 2019. Compared to 2019 emissions, operation of chillers will increase GHG emissions by approximately 18 percent at the BWRP.

Table 44. Annual and 20-Year GHG Emissions Estimates

WRP	Annual GHG Emissions ($MT\ CO_2e$)	Total for 20 years (2025-2045) ($MT\ CO_2e$)
DCTWRP	4,760	95,200
BWRP	430	8,600
LAGWRP	2,290	45,800
Total	**7,480**	**149,600**

8.3.2.6 Chiller System Potable Water Usage

There are three separate streams of water associated with chiller operation:

1. WRP effluent: Effluent from the WRP would be sent to a heat exchanger. The effluent would be cooled as it passes through the heat exchanger. After the effluent cooled, the effluent would be directed to the WRP's discharge location. The WRP effluent would not touch the chiller directly.
2. Chilled water loop: Water is circulated between the chillers and heat exchangers, using a potable water and glycol mixture. As potable water has fewer impurities than recycled water, it would reduce scaling, fouling, corrosion, and required maintenance activities and therefore extend the life of the cooling equipment. Ideally, there would be no loss of the water and glycol mixture as this will be a closed system. The chilled water loop would be kept at a lower temperature than the WRP effluent. As the chilled water passes through the heat exchanger, the chilled water will naturally pick up heat from the plant effluent, but the two streams would not mix. After passing through the heat exchanger, the chilled water would be directed back to the chiller to be cooled again.
3. Condenser loop: The chillers extract heat from the chilled water loop and place that heat in the condenser loop. This means that the chillers continuously heat the condenser loop. The warm water in the condenser loop would exit the chillers and be sent to the associated cooling towers. The cooling towers would cool the water with ambient air so that the cooled water could be returned to the chillers. The condenser loop would circulate water between chillers and cooling towers. Some water in the condenser loop would be lost through evaporation and blowdown. Evaporation losses occur as the water passes through the cooling towers. It is assumed this loss would be approximately 1% of the total flow sent to the cooling towers. As water evaporates, the concentration of impurities in the water continuously increase. These impurities can cause corrosion and scaling in the cooling system. To limit the maximum concentration of these impurities, water would be removed from the system and sent to a waste drain which is called blowdown. It is assumed that the blowdown rate would be approximately equal to the evaporation rate (1% of the condenser loop flow).

Therefore, an estimated 2% of the condenser loop flow rate (1% from cooling tower evaporation+ 1% from blowdown) would be lost and additional potable water would be needed. **Table 45** shows the potable water losses under maximum and average load conditions for each WRP. The time spent cooling per year for chillers presented in **Table 43** was used to estimate yearly water consumption and associated losses. Under average conditions, approximately 350 million gallons of potable water would be needed on an annual basis to operate the chillers across all three WRPs.

Table 45. Approximate Potable Water Losses Under Maximum Load Conditions

WRP	Maximum Cooling		Average Cooling		Yearly Water Consumption (mg)
	Condenser Loop Pump Station Capacity (mgd)	Potable Water Loss (mgd)	Condenser Loop Pump Station Capacity (mgd)	Potable Water Loss (mgd)	
DCTWRP	113	2.3	28	0.6	190
BWRP	24	0.5	12	0.24	77
LAGWRP	71	1.4	14.1	0.3	83

mgd = million gallons per day mg = million gallons

8.4 Summary of Potential Control Measures

Several non-traditional effluent cooling options were identified and analyzed to assess their ability to consistently and reliably attain the 80°F and delta 5°F limits. The non-traditional control measures considered in this section included processes that utilize natural heat flow or evaporative cooling as well as source control and in-plant process changes. The results of the screening analysis indicated that none of the alternative measures can meet the temperature limits. Additional non-traditional options (i.e., reducing effluent discharge and shading of the receiving water) were considered as part of the modeling efforts presented in **Section 7**.

Cooling tower performance is dependent on ambient wet bulb temperatures and it was determined that, given the historical estimates of wet bulb temperatures in the Study area, cooling towers may be able to meet the 80°F limit for the majority of the year. However, because the delta 5°F limit requires effluent temperatures below the wet bulb temperature, cooling towers were not considered a viable technology.

Chillers use mechanical cooling to provide more consistent performance and are expected to be able to reliably attain both the 80°F and delta 5°F limits. However, siting chillers at any of these WRPs is problematic as all facilities have plans for improvements that take up the available open areas on-site and will require the Cities to make tough decisions about the potential need to forgo other important improvements. Initial concepts for chiller placement were developed as part of this effort; however, given the significant space constraints at all three WRPs additional detailed evaluations, typically conducted as part of the initial efforts for a full design, will be needed. Additional structures will also need to be constructed to support the chillers. New electrical buildings are likely required to power and control the cooling equipment and, as standard chillers are not suitable for exposure to the elements, new buildings will be needed to house the chillers. Pump stations will be needed to convey plant effluent to the cooling equipment. Additionally, the power feed to the WRPs will have to be substantially increased. The total capital costs for all three WRPs is $457 million with annual O&M costs of approximately $15 million. Due to the energy intensive nature of chillers, GHG emissions associated with the Cities' WRPs will go up by approximately 44% at the DCTWRP, 18% at the BWRP, and 59% at the LAGWRP. Additionally, under average conditions, approximately 350 million gallons of potable water would be needed on an annual basis to operate the chillers across all three WRPs.

9 Study Conclusions

The following briefly summarizes the findings and key conclusions of the Study. For **Study Objective #1**, taxa presence is based on historical, recent, and new biological surveys (BMI and benthic algae) and other data collected not only upstream and downstream of WRP outfalls, but also in urbanized tributaries to the LA River with similar physical characteristics but without WRP flow. Additionally, four thermal metrics were calculated to directly address **Study Objectives #2-4**. Comprehensive modeling of water temperature was also conducted to understand the influence of physical factors and climate change on temperature effects on biological communities (**Study Objective #5**) and the relationships between effluent discharge temperature and receiving water temperature and estimated distance downstream potentially influenced by heat addition from the WRPs (**Study Objective #6**). The key Study conclusion is that alterations to receiving water temperatures due to WRP effluent temperatures does not adversely affect the WARM beneficial use. The Study conclusions are briefly summarized below, with additional conclusions presented in **Table 46**:

- Temperatures in the LA River and BWC routinely exceed 80°F irrespective of WRP flow or location upstream or downstream of a WRP discharge.
- Temperatures in the LA River and BWC routinely increase by more than 5°F over the course of a day from May through October, irrespective of WRP flow.
- There is no significant or meaningful difference in BMI and benthic algae composition upstream and downstream of the WRPs.
- The BMI and benthic algal communities downstream of WRP discharges are not unique and can be found throughout the Study area including at locations upstream of WRP discharges or in tributaries, indicating that there is no clear impact of WRP effluent temperatures on the biological community.
- The number of fish taxa are highest in LAR3 and LAR5, downstream of the discharges of the LAG and DCT WRPs due to these reaches having the most suitable habitat for fish in the Study area.
- Study-derived continuous temperature results indicate that locations downstream of the WRPs are able to support the most temperature sensitive species that are present or could be present in the Study area based on literature-derived thermal tolerances.
- Modeling demonstrated that chilling effluent, reducing effluent flows, providing shading, or combinations of the three will not result in the LA River or BWC consistently meeting 80°F or keeping receiving water temperatures from increasing by more than 5°F due to factors outside of the WRPs control (e.g., solar radiation, air temperature, concrete lining of channels).
- Chillers are the only technology that could consistently and reliably attain the new NPDES permit limits with total capital costs for all three WRPs of at least $457 million, O&M costs of approximately $15 million annually, and increases in greenhouse gas (GHG) emissions by approximately 44% at the DCTWRP, 18% at the BWRP, and 59% at the LAGWRP.
- Due to space constraints at all three WRPs, installation of chillers will impair the ability to complete other capital improvements to address additional treatment capacity required for state-mandated housing units and for additional recycled water and advanced treatment.

In summary, alterations to receiving water temperatures due to WRP effluent temperatures do not adversely affect the WARM beneficial use. Even if the WRPs implemented measures to chill their effluent to meet the new temperature limits, at a significant expense in terms of cost, energy, and GHG impacts and negative impact to the environment, temperatures in the LA River and BWC downstream of the WRPs would quickly return to baseline/ambient temperatures as if the effluent had never been chilled before being discharged.

Table 46. Summary of Study Conclusions

Habitat	• The habitat in the Study area (LAR Reaches 1-5 and BWC) has been highly modified and concrete lined in most areas for almost a century to support flood control purposes. • Bottom substrate type, channel width and depth, riparian vegetation, stream flow, and groundwater influx, are all significant factors affecting surface water temperature, which varies depending on location.
Water Temperature	• Daily and weekly average and maximum water temperatures in the Study area exceed 80°F in spring/summer months (May through October) regardless of location (upstream or downstream) in relation to a WRP discharge, or local habitat (i.e., concrete lined vs. unlined bottom, or open channels vs. riparian habitat). • Exceedances of 80°F in receiving waters increase in magnitude, duration, and severity in areas where water flows over concrete lined channel bottoms and where channels are wide and open (no canopy cover) versus unlined channels with some canopy cover. • Diel water temperature fluctuations greater than 5°F are common May through September regardless of location and WRP flow. • The influence of heat from WRP effluent on receiving river temperature is seasonally dependent, with indications of WRP-specific thermal inputs residing for a slightly longer downstream distance in winter, and much shorter downstream distances beginning late spring through summer. • The influence of other temperature modulating factors (primarily ambient air temperature but with additional contributions from concrete substrate, and solar heating) appears to be significant, most notably in the BWC. • The estimated distance downstream in the LA River and BWC of discharge under the influence of thermal input from each WRP is expected to be less than 0.5 to 2 miles in summer and between 2 and 5 miles in the winter; receiving water temperature in other portions of the LA River is the result of ambient air temperature and other factors affecting receiving water temperature besides WRP effluent temperature.
Biology	• The wholly or partially aquatic-dependent taxa that are present, were historically present, or could be present in the Study area given the current habitat conditions includes 276 diatom taxa, 249 soft bodied algae taxa, 117 BMI taxa, 16 non-native freshwater fish, and two native and two non-native frog species. • All fish present in the Study area are non-native warmwater taxa tolerant of temperatures common in the Study area. • The number of fish taxa are highest in LAR3 and LAR5, downstream of the discharges of the LAG and DCT WRPs, respectively, due to these reaches having the most suitable habitat for fish in the Study area. • BMI and benthic algae taxa currently present or could be present are adaptable eurythermal or temperature-generalist taxa, based on literature or by virtue of being found present both above and below WRP discharge. • No significant or meaningful differences were seen in the BMI or diatom taxa and taxa count, soft-bodied algae taxa and biovolume, or CSCI or ASCI scores upstream and downstream of the WRP discharges based on quantitative analysis. Similarly, cluster analysis indicates no unique BMI or benthic algal communities exist below WRP discharges that are not found elsewhere in the Study area and in other tributaries without WRP flow, indicating that there is no clear impact of WRP effluent temperatures on the biological community.

	• The most sensitive thermal tolerance values for freshwater fish and life stages present or that could be present in the Study area appear to represent the lowest thermal tolerance approximations for other taxa including BMI and algae. • For the fish community, the Study-derived continuous temperature results indicate that locations downstream of the WRPs support the most sensitive species based on literature-derived thermal limits. • Current habitat conditions indicate taxa present have capacity for temperature acclimation, use of refugia, and adaptation to local habitat and climatic conditions.
Modeling	• Modeling of all three potential control measures individually (effluent temperature control, effluent flowrate reduction, and riparian shading) demonstrated that either receiving water temperatures are not affected or they are minimally affected and quickly return to baseline conditions (i.e., downstream temperatures are no different than if the control measure had not been implemented). • Scenarios comprised of multiple potential control measures were also analyzed, but did not show synergetic gains in temperature reduction, with results similar to those for the individual control measures. • None of the individual control measures or combinations of control measures result in the consistent attainment of the 80°F objective downstream of the WRPs. • Climate change was assessed for 30-years in the future, where the model indicated the receiving water temperatures would increase by a few degrees.
Treatment Controls	• Non-traditional cooling options (i.e., natural heat flow, evaporative cooling, source control, in-plant process changes, shading, and effluent flow reduction) cannot meet the new temperature limits. • Cooling towers may be able to meet the 80°F limit for the majority of the year, but cannot meet the delta 5°F limit. • Chillers could reliably attain both the 80°F and delta 5°F limits; however, siting chillers at any of the WRPs is problematic as all facilities have plans for improvements that take up the available open areas on-site and will require the Cities to make tough decisions about the potential need to forgo other improvements. • The total capital costs for all three WRPs is estimated to be at least $457 million with annual O&M costs of approximately $5 million. • Due to the energy intensive nature of chillers, GHG emissions from the WRPs will go up by approximately 44% at the DCTWRP, 18% at the BWRP, and 59% at the LAGWRP.
Summary of Findings	• Diel variation in receiving water temperatures often fluctuates more than 5°F as a result of ambient air temperature and solar radiation. • Based on conservative literature-based thermal tolerances for sensitive species and life stages and receiving water temperature measurements, biota that reside in the LA River and BWC in the vicinity of the discharges are not adversely affected by the thermal component of the WRP discharges. • Alterations to receiving water temperatures due to WRP effluent temperatures do not adversely affect the WARM beneficial use. • Chillers would be needed at all three WRPs to meet the limits at a significant expense in terms of cost, energy, and GHG impacts and negative impact to the environment, temperatures in the LA River and BWC downstream of the WRPs would quickly return to baseline/ambient temperatures as if the effluent had never been chilled before being discharged.

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US Census Bureau, 2020 Census Urban Areas Facts: https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural/2020-ua-facts.html

US Climate Data: https://www.usclimatedata.com/climate/los-angeles/california/united-states/usca1339

USFWS IPAC: https://ipac.ecosphere.fws.gov/

VertNet: http://vertnet.org/

Appendix 1. Summary of Available Habitat Information

While much of the urbanized LA River is channelized and concrete lined, riparian and more natural in-stream habitats do occur along the LA River. These areas have been the subject of several large-scale studies, generally associated with assessment of environmental conditions for specific projects or to support long-term planning. These reports are comprehensive and representative of the habitats in the areas of concern for this Study and are summarized in this appendix.

A1.1 Riparian and In-stream Habitat

The following presents a summary of riparian and in-stream habitat data developed for a number of studies completed in the LA River watershed. Data sources are presented in **Section 4.3** of the Study Report.

A.1.1 USACE, 2015. LA River Ecosystem Restoration Integrated Feasibility Report

The appendix in this 2015 feasibility report provides a habitat assessment analysis of alternatives proposed for the LA River Ecosystem Restoration (ER) Feasibility Study. It reflects the USACE's examination of the restoration opportunities within the 11-mile segment of the LA River which encompasses the soft bottom Glendale Narrows as well as portions of the concrete channel from Griffith Park to northern downtown LA ending at First Street. The habitat assessment approach used was the Combined Habitat Assessment Protocols (CHAP) method, which incorporates the HAB (Habitat Accounting and Appraisal) methodology and generates habitat units (HUs) based on an assessment of multiple species, habitat features, and functions by habitat type. In the HAB approach, fish and wildlife with the potential to occur at a given site are identified. Potential species are determined using range maps in conjunction with information on vegetation types and habitat types, structural conditions, and habitat elements, also known as Key Environmental Correlates (KECs). KECs represent habitat elements (physical and biological) that are known to most influence a species distribution, abundance, fitness, and viability. KECs include habitat elements such as down wood, snags, litter layer, shrub layer, flowers, burrows, boulders, or riffles and pools. Structural conditions of the habitat were also considered. Function refers to the principal way organisms influence the environment, also known as Key Ecological Functions (KEF) (NHI 2007). The CHAP evaluation utilized the ecosystem-based approach to quantitatively characterize the ecological value of wildlife habitat associated with the restoration alternatives proposed for the LA River ER Study. Habitats for fish, amphibians, reptiles, resident and migratory birds, including raptors, and mammals were evaluated as part of the CHAP analysis. GIS maps generated from the analysis depict HUs of each of 172 polygons.

A.1.2 Environmental Science Associates (ESA), 2017. Burbank Wastewater Change Petition and Recycled Water Distribution Project Biological Resources Assessment

Appendices D and E of this 2017 report memorandum summarize the results of a site survey and literature search of the aquatic and riparian habitat within the Los Angeles River between the Burbank Western Channel and the Pacific Ocean. The survey was conducted by ESA on December 15 and 21, 2016 to evaluate potential effects of the City of Burbank's Recycled Water Project that would divert a portion of the treated effluent currently discharged into the BWC by the BWRP. For the 2016 assessment, the study area was divided into seven segments, five of which (segments 1-5) were assessed in a habitat assessment of the river as described in USACE LA River ER Study (USACE 2015; see above). In the study area Segments

1, 3, 4, and 5 were soft bottom with trapezoidal concrete slopes, Segment 7 was soft bottom with boulder rip-rap reinforced slopes, and Segments 2 and 6 were concrete lined box or trapezoidal channels.

The field survey included Segments 1-5, and largely focused on the soft-bottom portions of the LA River where vegetation occurs. No field survey was conducted in Segment 6 because these areas are almost entirely concrete lined and devoid of vegetation, and the generally uniform condition of the segment made the assessment of habitat conducive to a desktop analysis. During the survey, the biologists walked along the bike path on the western edge of the LA River to characterize and map vegetation and habitats, and to survey for wildlife and assess the quality of riparian and aquatic habitats within Segments 1-5 of the Study Area. Vegetation communities were characterized in the field using *A Manual of California Vegetation*, 2 Ed. (Sawyer et al. 2009). The limited vegetation within Segment 6 was mapped digitally by delineating the boundaries on aerial imagery using GIS software. The quality of habitat for native wildlife was determined based on the abundance, health, and vigor of native plant communities; abundance and diversity of invasive plant species; level of disturbance from homeless encampments, trash, and debris; and important habitat features, such as the presence of sand bars unobstructed flowing water, native riparian vegetation, evidence of bird nesting (i.e., predated nests), suitable perch sites for birds of prey, etc.

The report determined that habitats were generally of low quality and degraded by development, invasive species, homeless camps, and trash. Native riparian and aquatic/semi-aquatic habitats in pristine form almost no longer exist in the segments evaluated. However, wildlife is attracted to the segments evaluated because it is one of the only sources of perennial water and riparian habitat in the vicinity, and the rarity of a perennial river and riparian habitat alone makes it a valuable resource despite the degradation that has occurred to the natural habitat.

A.1.3 ESA, 2018. Glendale Water and Power Wastewater Change Petition and Recycled Water Distribution Project Biological Resources Assessment

Appendix B of this 2018 report provides a memorandum that summarizes the results of a site survey and literature search of the sensitive biological resources that may occur within the City of Glendale, CA and the aquatic and riparian habitat within the LA River between the Glendale WRP and LAR estuary. The survey was conducted by ESA on December 15 and 16, 2017 to evaluate the potential effects of the Glendale Water and Power (GWP) Wastewater Change Petition and Recycled Water Distribution Project. For the 2017 assessment, the study area was divided into seven segments, five of which (segments 1-5) were assessed in a habitat assessment of the river as described in USACE LA River ER Study (USACE 2015; see above), however, the study area within the LAR in this particular analysis included only Segments 3-7. Segments 3, 4, and 5 (in LAR Reach 3) are soft bottom with trapezoidal concrete slopes, and Segment 7 (in LAR Reach 1) is soft bottom with boulder rip-rap reinforced slopes. Segment 6, the longest segment (in LAR Reach 2), is concrete lined and varies in shape between box and trapezoidal.

Segments 3-5 were surveyed on December 16, 2017. Field surveys in Segments 6 and 7 were conducted February 2018 although these areas were almost entirely concrete-lined and devoid of vegetation. The generally uniform condition of Segment 6 made habitat assessment by desktop analysis possible to supplement the field survey. During the survey, the biologists characterized and mapped vegetation and habitats, surveyed for wildlife and plants, and assessed the quality of habitats within the segments. Areas of natural vegetation were the focus of the vegetation and habitat mapping. Vegetation communities were characterized in the field following *A Manual of California Vegetation* (MCV), 2nd Ed. (Sawyer et al. 2009). The limited vegetation within Segments 6 and 7 of the LAR was mapped digitally by delineating the boundaries on aerial imagery using GIS software. The quality of habitat for native wildlife was determined based on the abundance, health, and vigor of native plant communities; abundance and diversity of invasive plant species; level of disturbance from urbanization, homeless encampments, trash, and debris; and important habitat features, such as the presence of sand bars, unobstructed flowing water, native vegetation, evidence of bird nesting (i.e., predated nests), suitable perch sites for birds of prey, etc. Based on a visual inspection during the December 16 survey, the composition of substrate in the soft bottom segments (in the Glendale Narrows study segments 3, 4 and 5) was estimated to be about 80 percent boulders, large rocks, and cobble; and 20 percent gravel and sand.

A.1.4 LASAN, 2021. D.C. Tillman Water Reclamation Plant: Japanese Garden Discharge Reuse Initial Study/Negative Declaration

This 2021 report appears to rely, in part, on data developed in support of the USACE LA River ER Study (USACE 2015) to evaluate alternatives for restoring 11 miles of the LAR from approximately Griffith Park (at the beginning of the Glendale Narrows) to downtown Los Angeles (a few miles downstream of the end of the Glendale Narrows natural bottom area). Descriptions are provided of the biological resources in the upper LA River, Glendale Narrows, lower LA River, and LA River estuary, including riparian habitat. Additionally, the report utilizes information used to assess the health of the LA River system from 2009 through 2019, as reported in the Los Angeles River Watershed Monitoring Program – 2019 Annual Report (CWH/ABC 2019).

A.1.5 Stein et al. 2021a. Assessment of Aquatic Life Use Needs for the Los Angeles River: Los Angeles River Environmental Flows Project

The overarching goal of the *Los Angeles River Environmental Flows Project* (Flows Study) was to consider potential effects of reduced WRP discharge and increased stormwater capture on existing and potential future beneficial uses. The supporting analysis included characterizing species and habitats that currently occur and those that could reasonably occur in the future (based on a comparison to similar southern California watersheds). For the purposes of the study, aquatic life beneficial uses in the LA River were defined based on the ability of the river and its tributaries to support characteristic aquatic plant and animal communities.

For the analysis, all readily available species and habitat data from a variety of sources, including surveys and species/habitat databases, were used to broadly characterize the ecology of the LA River. The habitat locations and species observations were mapped. These maps were used to compile data on species that occur in each habitat, which were in turn used to identify a handful of "*endmember species*" that represent species that occur within the range of flow or temperature tolerances for each habitat. Data was restricted to the relatively small number of pre-determined endmember species based on coordination with and review and approval by the project's Technical Advisory Committee (TAC) and Stakeholder Work Group (SWG). Significant data sources for habitat information included the: National Wetlands Inventory (NWI), California Native Plant Society, and CalVeg. Additionally, a detailed cross-sectional analysis of soft-bottom channel geometry was conducted to characterize the representative stream habitat features (i.e., pools, split channels, depositional islands, side channels, floodplains) in each of the soft-bottom reaches of the mainstem (i.e., Long Beach Estuary, Glendale Narrows, and Sepulveda Basin). The goal of the latter analysis was to qualitatively and semi-quantitively describe the microhabitats observed in the soft bottom reaches to ensure that the selected model output nodes were representative of conditions in each reach. Channel hydraulics (i.e., maximum channel depth, velocity, and shear stress) were noted as being vastly different across different sections of the channel at a single site.

A.1.6 Cooper et al. 2022. Biological Resources Survey and Report for Baseline Dry Season In-Channel Vegetation Mapping and Appendices

A final major source of in-stream and riparian habitat information is from the recent report by Cooper et al. (2022). In late 2021 and early 2022, the investigators surveyed and mapped the entire length of the LA River channel, from the mid-San Fernando Valley (Canoga Park) to the mouth at Long Beach harbor. Four coarse-scale habitat types were added to the four initially identified by (Stein et al. 2021a, 2021b; i.e., Flows Study, as identified above), for a total of eight types:

1. Wading shorebird habitat
2. Freshwater marsh habitat
3. Riparian habitat;
4. Warm water habitat;
5. Non-native Trees and Shrubs (Cooper study);
6. Transitional Herbaceous (Cooper study);
7. Bare Channel – Natural (Cooper study); and
8. Bare Channel – Concrete (Cooper study)

Within these categories, fine-scale maps were produced for portions of four natural-floor stretches (i.e., where concrete was not poured onto the bed of the river, allowing natural vegetation to develop). Several areas were not able to be accessed due to safety concerns (illegal encampments) or because they were too time-consuming to safely access. The fine-scale mapping resulted in 133 discrete vegetation communities, based on MCV criteria (Sawyer et al. 2009), adapted for use in urban areas where non-native herbs and shrubs frequently dominate.

The field visits in the study were also used to record birds and other wildlife, which helped differentiate these communities, similar to the approach used by (Jones et al. 2016) to categorize wetland habitat types at the Salton Sea, another warm-water, anthropomorphically-altered southern California wetland system with no clear historical natural analogue.

From these field data, a hierarchical habitat categorization (i.e., broadest to most specific), as well as a “crosswalk” of corresponding categories was established, ultimately settling on eight coarse-scale habitat categories based on Stein et al. (2021a) and 132 finer-scale vegetation and substrate categories based on Sawyer et al. (2009) where possible. An Arc-based mapping framework was then employed, and the habitats and, where data were obtained, the vegetation communities present, were mapped.

A total of 243 plant species were recorded in the channel, of which at least 98 (40%) were considered native and naturally occurring in the region. Through herbarium research, the investigators found that as many as 43 native plant species have apparently been extirpated along the river channel. By species frequency, Glendale Narrows had the most native-dominated vegetation, while one of the reference sites, Rio Hondo, had the least, presumably owing to the abundance of weedy forbs on the sandy bed and sides of the Rio Hondo. By proportion as well as numerically, Elysian Valley was found to support the highest number of native species, but it also had the highest number of non-native species (and it was the largest natural-floor area surveyed). Structurally, the vegetation in Sepulveda Basin was the most woodland-like (75% of vegetation points >5 meters tall), while Willow St. had almost no vegetation higher than 5 meters tall, illustrating the broad variation between sites. Noteworthy is that even the highly comprehensive MCV categories fail to account for the diversity and abundance of the vegetation present in the channel much of the year, particularly the non-native trees and shrubs, whose distribution has profound implications for local wildlife.

A.1.7 Other Habitat Information

As mentioned above, riparian condition has also been assessed in the LA River system from 2009 through 2021, as reported in the Los Angeles River Watershed Monitoring Program – 2021 Annual Report (CWH 2021), using the California Rapid Assessment Method (CRAM; Collins et al. 2007). The CRAM method assesses four attributes of wetland condition: buffer and landscape, hydrologic connectivity, physical structure, and biotic structure. CRAM is unique in that it is frequently used as both a biotic index and a surrogate for abiotic stress in the riparian zone.

Physical habitat (PHAB) has also been surveyed in the LA River using the protocol from Ode et al. (2016), which was adapted from the USEPA's Environmental Monitoring and Assessment Program (Peck et al. 2006). Using this protocol, at each transect within a reach, physical habitat quality is determined by observing substrate complexity, consolidation, embeddedness, the presence of coarse particulate organic material (CPOM), human influence, in-stream habitat complexity, bank stability, surrounding vegetative protection, canopy cover, habitat flow type, stream gradient, sinuosity, channel engineering, hydromodification, bank-full, and wetted widths. Each sampling reach is scored using a subjective, reach-wide approach using epifaunal substrate, sediment deposition, and channel alteration (Qualitative Physical Habitat Score). In addition to the Qualitative Physical Habitat Score, Stream Habitat Characterization Form data are used to generate first order metrics to characterize riparian disturbance and instream natural habitat complexity. At each point where substrate size is determined along a transect, the presence or absence of microalgae, macroalgae, and aquatic macrophytes were recorded. If microalgae are present, it is given a thickness score. These data are used to determine the percent of algal cover within a stream reach.

A1.2 References

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Appendix 2. BMI and Algae and Taxa Occurrence List in Study Waterbodies

Appendix 2. Table 1. BMI Taxa Occurrence List in LA River Reach 1. X = present

Family	Taxa	Site Name and Sampling Date					
		412M08643	SMC00318	SMC00318	SMC00318	SMC00318	SMC00318
		5/23/2018	6/15/2010	8/7/2019	6/9/2021	6/21/2022	8/4/2023
Baetidae	Baetis			x			
Baetidae	Fallceon			x		x	x
Ceratopogonidae	Ceratopogonidae						x
Ceratopogonidae	Dasyhelea					x	x
Chironomidae	Ablabesmyia		x				x
Chironomidae	Apedilum	x	x	x			x
Chironomidae	Chironomus	x	x	x	x	x	x
Chironomidae	Cricotopus	x	x	x	x	x	x
Chironomidae	Cricotopus bicinctus group			x			
Chironomidae	Cryptochironomus		x				
Chironomidae	Dicrotendipes	x	x	x	x	x	x
Chironomidae	Micropsectra						x
Chironomidae	Pentaneura	x					
Chironomidae	Polypedilum				x	x	
Chironomidae	Procladius		x		x		
Chironomidae	Pseudochironomus			x		x	x
Chironomidae	Tanypodinae						x
Chironomidae	Tanytarsus	x	x				x
Chironomidae	Thienemannimyia group					x	x
Corixidae	Corixidae			x			
Dolichopodidae	Dolichopodidae						x
Ephydridae	Ephydridae		x				
Hyalellidae	Hyalella			x		x	x
Hydroptilidae	Hydroptila			x		x	x
Hydroptilidae	Hydroptilidae						x
Oligochaeta	Oligochaeta	x	x	x	x	x	x
Ostracoda	Ostracoda	x	x	x	x	x	x
Physidae	Physa					x	x
Psychodidae	Psychodidae			x	x		
Pyralidae	Petrophila			x			
Simuliidae	Simulium vittatum					x	
Sperchonidae	Sperchon					x	
Turbellaria	Turbellaria			x		x	

Appendix 2. Table 2a. BMI Taxa Occurrence List in LA River Reach 2. X = present

Family	Taxa	Site Name and Sampling Date							
		412LAR023	412M08627	SMC05694	SMC02622	412M08659	412M08602	SMC03646	412LAR007
		5/24/2005	5/17/2017	6/26/2014	6/15/2010	7/20/2020	9/30/2015	6/5/2013	6/29/2005
Baetidae	Baetis					x		x	
Baetidae	Baetis adonis					x			
Baetidae	Fallceon			x			x	x	
Ceratopogonidae	Dasyhelea				x		x		
Chironomidae	Ablabesmyia		x						
Chironomidae	Apedilum					x	x		
Chironomidae	Chironomidae	x					x		x
Chironomidae	Chironomus		x	x	x	x	x	x	
Chironomidae	Cladopelma								
Chironomidae	Cricotopus		x	x	x	x	x	x	
Chironomidae	Cricotopus bicinctus group				x	x			
Chironomidae	Cricotopus trifascia group					x			
Chironomidae	Cryptochironomus			x				x	
Chironomidae	Dicrotendipes		x	x	x	x	x	x	
Chironomidae	Pentaneura					x		x	
Chironomidae	Polypedilum			x		x	x		
Chironomidae	Procladius		x		x				
Chironomidae	Pseudochironomus		x	x	x	x	x	x	
Chironomidae	Tanypodinae					x			
Chironomidae	Tanytarsus				x				
Chironomidae	Thienemanniella						x		
Chironomidae	Thienemannimyia group					x		x	
Corixidae	Corixidae				x				x
Dytiscidae	Sanfilippodytes					x			
Empididae	Empididae							x	
Empididae	Hemerodromia							x	
Ephydridae	Ephydridae			x	x		x		
Hyalellidae	Hyalella			x	x	x	x	x	x
Hydroptilidae	Hydroptila			x	x	x		x	
Hydroptilidae	Hydroptilidae			x	x	x			
Leptohyphidae	Tricorythodes explicatus							x	
Muscidae	Muscidae		x						
Oligochaeta	Oligochaeta	x	x	x	x	x	x	x	x
Ostracoda	Ostracoda		x	x	x	x	x	x	x
Physidae	Physa			x		x		x	x
Psychodidae	Psychodidae						x		
Pyralidae	Petrophila						x	x	
Simuliidae	Simulium vittatum					x			
Sperchontidae	Sperchon			x			x	x	
Stratiomyidae	Caloparyphus/ Euparyphus					x	x		
Thiaridae	Melanoides tuberculata						x		
Turbellaria	Turbellaria				x	x		x	

Appendix 2. Table 2b. BMI Taxa Occurrence List in LA River Reach 2. X = present

Family	Taxa	Site Name and Sampling Date				
		LAR2 Washington 6/26/2008	LAR2 Washington 6/12/2024	412M08642 6/20/2018	412CE0104 7/19/2005	412CE0104 6/23/2009
Baetidae	Baetis	x	x	x		x
Baetidae	Baetis adonis		x	x	x	
Baetidae	Fallceon		x			
Baetidae	Fallceon quilleri	x			x	x
Ceratopogonidae	Ceratopogonidae				x	
Ceratopogonidae	Dasyhelea	x				x
Chironomidae	Chironomidae	x				
Chironomidae	Chironomus	x	x	x	x	
Chironomidae	Cladopelma		x			
Chironomidae	Cricotopus	x	x	x	x	x
Chironomidae	Cricotopus bicinctus group	x	x	x	x	x
Chironomidae	Cricotopus trifascia group			x		
Chironomidae	Dicrotendipes	x	x		x	x
Chironomidae	Microtendipes pedellus group				x	
Chironomidae	Orthocladius complex		x	x		
Chironomidae	Parachironomus				x	
Chironomidae	Pentaneura		x		x	x
Chironomidae	Polypedilum		x	x		
Chironomidae	Psectrocladius				x	
Chironomidae	Pseudochironomus	x	x	x	x	x
Chironomidae	Rheocricotopus				x	
Chironomidae	Tanypodinae			x		
Chironomidae	Thienemanniella			x		
Chironomidae	Thienemannimyia group		x		x	
Corixidae	Corisella				x	
Corixidae	Corixidae				x	
Empididae	Empididae		x			
Empididae	Hemerodromia	x	x			x
Ephydridae	Ephydridae					
Hyalellidae	Hyalella	x	x	x	x	x
Hydridae	Hydra				x	
Hydropsychidae	Hydropsyche		x			
Hydroptilidae	Hydroptila	x	x	x	x	x
Hydroptilidae	Hydroptilidae	x	x	x		
Leptohyphidae	Tricorythodes explicatus		x	x		
Oligochaeta	Oligochaeta			x	x	x
Ostracoda	Ostracoda	x	x	x	x	x
Physidae	Physa	x	x	x	x	
Planorbidae	Ferrissia				x	
Psychodidae	Psychodidae			x		
Simuliidae	Simulium		x		x	x
Simuliidae	Simulium vittatum			x		

Family	Taxa	Site Name and Sampling Date				
		LAR2 Washington	LAR2 Washington	412M08642	412CE0104	412CE0104
		6/26/2008	6/12/2024	6/20/2018	7/19/2005	6/23/2009
Sperchontidae	Sperchon			x		x
Stratiomyidae	Caloparyphus/Euparyphus		x		x	
Stratiomyidae	Euparyphus		x			
Turbellaria	Turbellaria			x	x	x

Appendix 2. Table 3a. BMI Taxa Occurrence List in LA River Reach 3 - Greenway. X = present

Family	Taxa	Site Name and Sampling Date							
		LAR3 Greenway 9/30/2015	LAR3 Greenway 6/20/2018	LAR3 Greenway 7/11/2019	LAR3 Greenway 7/1/2020	LAR3 Greenway 6/15/2021	LAR3 Greenway 7/21/2022	LAR3 Greenway 7/11/2023	LAR3 Greenway 6/24/2024
Aeshnidae	Aeshnidae			x					
Arachnida	Acari				x				
Baetidae	Baetis	x	x	x	x		x	x	x
Baetidae	Baetis adonis	x		x	x	x	x		x
Baetidae	Fallceon	x		x	x	x	x	x	x
Ceratopogonidae	Bezzia/ Palpomyia	x							
Chironomidae	Apedilum	x							
Chironomidae	Chironomidae		x						
Chironomidae	Chironomini				x		x	x	
Chironomidae	Chironomus	x			x				
Chironomidae	Cladotanytarsus				x				
Chironomidae	Cricotopus			x	x	x			x
Chironomidae	Cricotopus bicinctus group			x	x	x			
Chironomidae	Cricotopus trifascia group				x				
Chironomidae	Cricotopus/ Orthocladius			x		x			
Chironomidae	Dicrotendipes	x		x	x	x	x	x	
Chironomidae	Eukiefferiella brehmi group				x				x
Chironomidae	Eukiiefferiella gracei group							x	
Chironomidae	Nilothauma							x	
Chironomidae	Orthocladiinae			x					
Chironomidae	Orthocladius				x				
Chironomidae	Pentaneura	x				x	x		x
Chironomidae	Phaenopsectra						x		
Chironomidae	Polypedilum			x	x	x	x	x	x
Chironomidae	Pseudochironomus	x		x	x	x	x	x	x
Chironomidae	Rheotanytarsus	x		x					
Chironomidae	Saetheria				x				
Chironomidae	Thienemanniella	x			x	x			
Chironomidae	Thienemannimyia group	x		x	x	x	x	x	x
Coenagrionidae	Coenagrionidae			x					
Corbiculidae	Corbicula	x	x			x	x		
Corixidae	Corixidae				x				
Empididae	Empididae				x	x			
Empididae	Hemerodromia				x	x		x	x
Erpobdellidae	Dina	x	x						

Family	Taxa	Site Name and Sampling Date							
		LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway
		9/30/2015	6/20/2018	7/11/2019	7/1/2020	6/15/2021	7/21/2022	7/11/2023	6/24/2024
Erpobdellidae	Erpobdella			x	x	x	x	x	
Glossiphoniidae	Helobdella			x	x	x	x		
Glossiphoniidae	Helobdella stagnalis							x	
Hyalellidae	Hyalella	x		x	x	x	x	x	
Hydropsychidae	Hydropsyche		x	x	x	x	x	x	x
Hydropsychidae	Hydropsychidae		x	x	x	x	x	x	x
Hydroptilidae	Hydroptila		x	x	x	x		x	x
Hydroptilidae	Hydroptilidae		x		x			x	x
Lepidoptera	Lepidoptera			x	x	x			
Leptohyphidae	Leptohyphidae							x	
Leptohyphidae	Tricorythodes			x	x	x	x	x	x
Leptohyphidae	Tricorythodes explicatus	x	x						
Oligochaeta	Oligochaeta	x	x	x	x	x	x	x	x
Ostracoda	Ostracoda	x		x		x	x		
Pelecorhynichidae	Glutops								x
Physidae	Physa			x	x	x	x	x	x
Planorbidae	Ferrissia			x	x	x	x		
Planorbidae	Gyraulus						x		
Planorbidae	Helisoma					x			
Pyralidae	Petrophila	x	x	x	x	x	x	x	x
Simuliidae	Simulium				x			x	
Simuliidae	Simulium vittatum	x							
Sperchonidae	Sperchon	x	x		x	x		x	x
Stratiomyidae	Caloparyphus/ Euparyphus				x		x	x	x
Stratiomyidae	Euparyphus				x				
Tetrastemmatidae	Prostoma				x	x			
Turbellaria	Turbellaria	x		x	x	x	x	x	x

Appendix 2. Table 3b. BMI Taxa Occurrence List in LA River Reach 3 – Remaining Downstream. X = present

Family	Taxa	Site Name and Sampling Date					
		LAR3 Riverside	LAR08663	LAR3 N. Atwater	LAR3 N. Atwater	LAR3 N. Atwater	LAR3 N. Atwater
		6/11/2024	5/26/2021	6/15/2021	7/21/2022	7/12/2023	6/24/2024
Baetidae	Baetis	x	x	x	x	x	x
Baetidae	Baetis adonis	x	x	x	x		x
Baetidae	Fallceon	x	x	x	x	x	x
Ceratopogonidae	Dasyhelea	x					
Chironomidae	Apedilum		x				
Chironomidae	Chironomus					x	
Chironomidae	Conchapelopia				x		
Chironomidae	Cricotopus	x	x	x			
Chironomidae	Cricotopus bicinctus group		x	x			
Chironomidae	Dicrotendipes	x	x				
Chironomidae	Eukiefferiella	x	x				
Chironomidae	Pentaneura	x				x	
Chironomidae	Polypedilum	x	x	x	x	x	
Chironomidae	Pseudochironomus	x	x				x
Chironomidae	Rheotanytarsus		x				
Chironomidae	Tanytarsus	x					
Chironomidae	Thienemanniella		x				
Chironomidae	Thienemannimyia group	x	x			x	
Corbiculidae	Corbicula		x				
Empididae	Hemerodromia	x					
Erpobdellidae	Erpobdella			x	x	x	x
Glossiphoniidae	Helobdella			x	x		x
Glossiphoniidae	Helobdella stagnalis					x	
Hyalellidae	Hyalella	x	x	x		x	x
Hydridae	Hydra						x
Hydropsychidae	Hydropsyche	x	x	x	x		
Hydropsychidae	Hydropsychidae	x					
Hydroptilidae	Hydroptila	x	x	x	x	x	x
Hydroptilidae	Hydroptilidae	x		x		x	x
Leptohyphidae	Leptohyphidae					x	
Leptohyphidae	Tricorythodes			x	x	x	x
Leptohyphidae	Tricorythodes explicatus	x	x				
Oligochaeta	Oligochaeta	x	x	x	x	x	x
Ostracoda	Ostracoda	x			x	x	x
Physidae	Physa	x	x	x	x	x	x
Planorbidae	Ferrissia	x	x	x	x	x	x
Planorbidae	Helisoma			x			
Planorbidae	Menetus opercularis					x	
Pyralidae	Petrophila	x	x	x			

Family	Taxa	Site Name and Sampling Date					
		LAR3 Riverside	LAR08663	LAR3 N. Atwater	LAR3 N. Atwater	LAR3 N. Atwater	LAR3 N. Atwater
		6/11/2024	5/26/2021	6/15/2021	7/21/2022	7/12/2023	6/24/2024
Simuliidae	Simulium			x		x	x
Simuliidae	Simulium vittatum		x				
Sperchonidae	Sperchon	x	x		x	x	x
Stratiomyidae	Caloparyphus/ Euparyphus		x		x		
Stratiomyidae	Euparyphus				x		
Stratiomyidae	Stratiomyidae				x		
Turbellaria	Turbellaria	x	x	x	x	x	x

Appendix 2. Table 3c. BMI Taxa Occurrence List in LA River Reach 3 – Upstream LAG. X = present

Family	Taxa	Site Name and Sampling Date					
		LAR00436	LAR00436	LAR00436	LAR3 Electronics	LAR3 Griffith	LAR3 Griffith
		5/26/2009	5/31/2017	6/12/2023	6/11/2024	7/11/2012	6/17/2024
Baetidae	Baetis	x	x	x	x	x	x
Baetidae	Baetis adonis			x		x	x
Baetidae	Fallceon		x	x	x	x	x
Baetidae	Fallceon quilleri	x					
Ceratopogonidae	Ceratopogonidae					x	
Ceratopogonidae	Dasyhelea	x				x	
Chaoboridae	Ephydridae	x		x		x	
Chironomidae	Apedilum			x		x	
Chironomidae	Chironomidae	x					
Chironomidae	Chironomus	x	x	x		x	x
Chironomidae	Cladotanytarsus	x					
Chironomidae	Cricotopus	x	x	x	x	x	x
Chironomidae	Cricotopus bicinctus group	x				x	x
Chironomidae	Cryptochironomus	x				x	x
Chironomidae	Dicrotendipes	x	x	x		x	x
Chironomidae	Nanocladius				x		x
Chironomidae	Orthocladius complex		x				
Chironomidae	Paracladopelma				x		
Chironomidae	Pentaneura	x			x	x	x
Chironomidae	Polypedilum	x		x	x		x
Chironomidae	Procladius			x			
Chironomidae	Pseudochironomus		x	x	x	x	x
Chironomidae	Rheotanytarsus						x
Chironomidae	Tanytarsus		x	x			x
Chironomidae	Thienemannimyia group		x		x	x	x
Corixidae	Corixidae		x				
Empididae	Empididae					x	
Empididae	Hemerodromia	x			x	x	
Ephydridae	Endochironomus						x
Erpobdellidae	Dina				x		x
Hyalellidae	Hyalella	x	x	x	x	x	x
Hydroptilidae	Hydroptila	x	x		x	x	x
Hydroptilidae	Hydroptilidae		x		x		x
Leptohyphidae	Tricorythodes explicatus		x		x		x
Nematoda	Nematoda	x					
Oligochaeta	Oligochaeta	x	x	x	x	x	x
Ostracoda	Ostracoda	x	x	x	x	x	x
Physidae	Physa	x	x	x	x	x	x

Family	Taxa	Site Name and Sampling Date					
		LAR00436	LAR00436	LAR00436	LAR3 Electronics	LAR3 Griffith	LAR3 Griffith
		5/26/2009	5/31/2017	6/12/2023	6/11/2024	7/11/2012	6/17/2024
Psychodidae	Psychodidae					x	
Pyralidae	Petrophila					x	
Simuliidae	Simulium						x
Simuliidae	Simulium argus		x				
Simuliidae	Simulium vittatum			x		x	
Sperchonidae	Sperchon	x	x	x	x	x	x
Stratiomyidae	Caloparyphus/ Euparyphus				x		
Tetrastemmatidae	Prostoma				x		
Turbellaria	Turbellaria	x		x	x	x	x

Appendix 2. Table 4a. BMI Taxa Occurrence List in LA River Reach 4. X = present

Family	Taxa	Site Name and Sampling Date											
		LAR4 Zoo	LAR4 Zoo	412CE0732	412CE0732	SMC01460	LAR08615	LAR08656	LAR02804	412CE0616	412CE0616	412M08597	LAR08661
		6/12/2023	6/17/2024	7/25/2007	9/2/2015	6/12/2008	7/7/2016	7/14/2020	6/20/2011	7/24/2007	7/16/2015	7/16/2015	6/7/2021
Baetidae	Baetis	x	x			x	x	x	x		x	x	x
Baetidae	Baetis adonis		x				x		x		x	x	x
Baetidae	Fallceon	x	x		x		x	x			x	x	x
Baetidae	Fallceon quilleri								x				
Ceratopogonidae	Ceratopogonidae				x								
Ceratopogonidae	Dasyhelea			x		x						x	x
Chironomidae	Alotanypus	x											
Chironomidae	Apedilum			x	x								
Chironomidae	Chironomidae											x	
Chironomidae	Chironomini												
Chironomidae	Chironomus	x	x	x	x			x	x	x		x	
Chironomidae	Corynoneura						x						
Chironomidae	Cricotopus	x		x	x	x	x	x	x	x	x	x	x
Chironomidae	Cricotopus bicinctus group	x		x	x	x	x	x	x	x	x	x	x
Chironomidae	Cricotopus trifascia group	x											x
Chironomidae	Dicrotendipes	x		x	x	x		x	x			x	x
Chironomidae	Endochironomus		x										
Chironomidae	Eukiefferiella	x											
Chironomidae	Goeldichironomus									x			
Chironomidae	Micropsectra								x				
Chironomidae	Orthocladiinae									x			
Chironomidae	Orthocladius complex						x						
Chironomidae	Parachironomus								x			x	
Chironomidae	Paracladopelma				x								
Chironomidae	Pentaneura		x		x			x			x	x	x
Chironomidae	Polypedilum	x	x		x			x	x	x		x	x
Chironomidae	Procladius	x											
Chironomidae	Pseudochironomus		x		x		x	x	x		x	x	x
Chironomidae	Rheocricotopus									x			
Chironomidae	Rheotanytarsus				x			x	x			x	x
Chironomidae	Tanypodinae						x						
Chironomidae	Tanytarsus	x							x			x	
Chironomidae	Thienemanniella				x		x				x		
Chironomidae	Thienemannimyia group		x		x		x	x	x		x	x	x
Coenagrionidae	Coenagrionidae											x	
Corbiculidae	Corbicula				x						x	x	
Corixidae	Corisella decolor			x									
Corixidae	Corixidae			x		x				x			
Dolichopodidae	Dolichopodidae											x	
Empididae	Empididae		x										
Empididae	Hemerodromia					x			x				x
Ephydridae	Ephydridae					x	x						
Erpobdellidae	Mooreobdella						x						
Hyalellidae	Hyalella			x	x	x	x	x	x	x	x	x	x
Hydroptilidae	Hydroptila		x			x	x	x	x		x	x	x

Family	Taxa	Site Name and Sampling Date											
		LAR4 Zoo	LAR4 Zoo	412CE0732	412CE0732	SMC01460	LAR08615	LAR08656	LAR02804	412CE0616	412CE0616	412M08597	LAR08661
		6/12/2023	6/17/2024	7/25/2007	9/2/2015	6/12/2008	7/7/2016	7/14/2020	6/20/2011	7/24/2007	7/16/2015	7/16/2015	6/7/2021
Hydroptilidae	Hydroptilidae		x			x			x				
Leptohyphidae	Tricorythodes explicatus		x										
Oligochaeta	Oligochaeta	x	x	x	x	x	x	x	x	x	x	x	x
Ostracoda	Ostracoda		x	x	x	x	x	x	x	x	x	x	x
Pediciidae	Dicranota								x				
Physidae	Physa		x	x	x		x				x	x	x
Planorbidae	Ferrissia											x	x
Psychodidae	Pericoma/ Telmatoscopus				x								
Psychodidae	Psychodidae					x	x					x	
Pyralidae	Petrophila				x		x	x			x	x	
Simuliidae	Simulium		x					x	x			x	
Simuliidae	Simulium argus							x	x				
Simuliidae	Simulium vittatum	x			x		x	x			x	x	x
Sperchontidae	Sperchon		x		x			x	x			x	
Turbellaria	Turbellaria				x		x	x	x		x	x	x

Appendix 2. Table 4b. BMI Taxa Occurrence List in LA River Reach 4 - Kester. X = present

Family	Taxa	Site Name and Sampling Date								
		LAR4 Kester 6/1/2006	LAR4 Kester 7/16/2015	LAR4 Kester 6/21/2016	LAR4 Kester 5/31/2017	LAR4 Kester 5/30/2018	LAR4 Kester 7/15/2019	LAR4 Kester 7/14/2020	LAR4 Kester 6/15/2021	LAR4 Kester 6/26/2024
Baetidae	Baetis		x	x	x	x	x	x	x	x
Baetidae	Baetis adonis	x	x	x	x	x	x	x	x	x
Baetidae	Fallceon		x		x	x	x	x	x	x
Baetidae	Fallceon quilleri	x								
Caenidae	Caenis	x								
Chironomidae	Apedilum	x								
Chironomidae	Chironomidae	x	x	x						
Chironomidae	Chironomini	x								
Chironomidae	Chironomus	x			x	x				
Chironomidae	Cricotopus	x	x	x	x	x	x		x	x
Chironomidae	Cricotopus bicintus group	x	x		x	x	x		x	x
Chironomidae	Cricotopus trifascia group				x					
Chironomidae	Cryptochironomus									x
Chironomidae	Dicrotendipes	x	x		x	x	x			x
Chironomidae	Endochironomus									
Chironomidae	Eukiefferiella					x				x
Chironomidae	Nanocladius									x
Chironomidae	Orthocladiinae	x								
Chironomidae	Orthocladius complex	x				x				
Chironomidae	Parachironomus		x							
Chironomidae	Pentaneura	x					x			x
Chironomidae	Polypedilum	x			x	x	x	x	x	x
Chironomidae	Procladius									
Chironomidae	Pseudochironomus		x	x	x	x	x	x	x	x
Chironomidae	Rheocricotopus	x								
Chironomidae	Rheotanytarsus				x		x		x	
Chironomidae	Tanytarsus				x				x	
Chironomidae	Thienemanniella			x						
Chironomidae	Thienemannimyia group		x		x	x	x	x		x
Coenagrionidae	Coenagrion					x				
Corbiculidae	Corbicula							x		x
Corixidae	Corixidae									x
Dolichopodidae	Dolichopodidae									x
Empididae	Empididae				x					x
Empididae	Hemerodromia			x						x
Glossiphoniidae	Helobdella stagnalis	x								
Hyalellidae	Hyalella	x	x	x	x	x	x	x	x	x

Family	Taxa	Site Name and Sampling Date								
		LAR4 Kester 6/1/2006	LAR4 Kester 7/16/2015	LAR4 Kester 6/21/2016	LAR4 Kester 5/31/2017	LAR4 Kester 5/30/2018	LAR4 Kester 7/15/2019	LAR4 Kester 7/14/2020	LAR4 Kester 6/15/2021	LAR4 Kester 6/26/2024
Hydropsychidae	Hydropsyche								x	x
Hydropsychidae	Hydropsychidae									x
Hydroptilidae	Hydroptila			x	x	x	x	x	x	x
Hydroptilidae	Hydroptilidae				x	x		x		x
Oligochaeta	Oligochaeta	x	x	x	x	x	x			x
Ostracoda	Ostracoda	x	x	x	x	x	x	x	x	x
Pediciidae	Dicranota									x
Physidae	Physa		x	x		x	x			x
Psychodidae	Psychodidae		x							
Pyralidae	Petrophila		x	x			x	x		
Simuliidae	Simulium	x	x		x			x		x
Simuliidae	Simulium vittatum		x	x	x	x	x	x	x	
Sperchontidae	Sperchon	x	x	x	x		x	x	x	x
Sphaeriidae	Pisidium						x			
Stratiomyidae	Caloparyphus/ Euparyphus	x								
Turbellaria	Turbellaria		x	x	x		x	x	x	x

Appendix 2. Table 5. BMI Taxa Occurrence List in LA River Reach 5. X = present

Family	Taxa	Site Name and Sampling Date	
		LAR5 Hayvenhurst	LAR5 Balboa
		6/24/2024	6/24/2024
Baetidae	Baetis		x
Baetidae	Baetis adonis		x
Baetidae	Fallceon		x
Ceratopogonidae	Atrichopogon		x
Ceratopogonidae	Bezzia/ Palpomyia	x	
Ceratopogonidae	Dasyhelea		x
Chaoboridae	Endochironomus	x	
Chironomidae	Ablabesmyia	x	
Chironomidae	Chironomus	x	
Chironomidae	Cladotanytarsus	x	
Chironomidae	Cricotopus	x	x
Chironomidae	Cricotopus bicinctus group		x
Chironomidae	Dicrotendipes	x	x
Chironomidae	Endotribelos	x	
Chironomidae	Eukiefferiella		x
Chironomidae	Nanocladius		x
Chironomidae	Nilotanypus	x	
Chironomidae	Orthocladius complex		x
Chironomidae	Parachironomus	x	
Chironomidae	Paracladopelma		x
Chironomidae	Paratanytarsus		x
Chironomidae	Pentaneura		x
Chironomidae	Polypedilum	x	x
Chironomidae	Procladius		x
Chironomidae	Pseudochironomus		x
Chironomidae	Rheotanytarsus		x
Chironomidae	Tanytarsus	x	
Chironomidae	Thienemannimyia group		x
Coenagrionidae	Coenagrionidae		x
Dolichopodidae	Dolichopodidae	x	
Empididae	Empididae		x
Empididae	Hemerodromia		x
Erpobdellidae	Dina	x	x
Hyalellidae	Hyalella	x	x
Hydrobiidae	Potamopyrgus antipodarum		x
Hydropsychidae	Hydropsyche		x
Hydropsychidae	Hydropsychidae		x
Hydroptilidae	Hydroptila		x
Hydroptilidae	Hydroptilidae		x
Mideopsidae	Mideopsis	x	
Muscidae	Muscidae		x
Oligochaeta	Oligochaeta	x	x

Family	Taxa	Site Name and Sampling Date	
		LAR5 Hayvenhurst	LAR5 Balboa
		6/24/2024	6/24/2024
Ostracoda	Ostracoda	x	x
Physidae	Physa		x
Simuliidae	Simulium		x
Sperchonidae	Sperchon		x
Stratiomyidae	Caloparyphus/Euparyphus		x
Stratiomyidae	Euparyphus		x
Turbellaria	Turbellaria		x

Appendix 2. Table 6. BMI Taxa Occurrence List in LA River Reach 6. X = present

Family	Taxa	Site Name and Sampling Date								
		412M08672	412M08688	LAR01208	LAR01208	LAR01208	412PS0052	412PS0052	412PS0052	SMC02680
		6/7/2021	7/19/2022	6/8/2010	7/14/2020	8/14/2023	5/20/2008	4/25/2017	7/19/2022	6/3/2014
Baetidae	Callibaetis					x				
Baetidae	Fallceon	x			x	x				
Ceratopogonidae	Bezzia/Palpomyia				x					
Ceratopogonidae	Ceratopogonidae					x	x	x		
Ceratopogonidae	Dasyhelea	x			x	x	x	x		x
Chironomidae	Ablabesmyia					x				
Chironomidae	Apedilum	x	x		x	x			x	x
Chironomidae	Chironomidae						x			
Chironomidae	Chironomini						x			
Chironomidae	Chironomus	x	x	x	x	x	x	x		
Chironomidae	Cricotopus	x	x	x	x	x	x	x	x	x
Chironomidae	Cricotopus bicinctus group						x			
Chironomidae	Cryptochironomus			x						
Chironomidae	Dicrotendipes	x	x	x	x	x	x	x		x
Chironomidae	Eukiefferiella					x				x
Chironomidae	Micropsectra						x			
Chironomidae	Orthocladius complex						x	x		
Chironomidae	Pentaneura	x				x				
Chironomidae	Polypedilum	x		x	x			x		x
Chironomidae	Pseudochironomus	x		x		x		x		x
Chironomidae	Rheotanytarsus	x								
Chironomidae	Tanytarsini						x			
Chironomidae	Tanytarsus								x	
Chironomidae	Thienemannimyia group		x			x			x	x
Corixidae	Corisella decolor		x							
Corixidae	Corixidae		x			x			x	
Culicidae	Aedes							x		
Culicidae	Culex					x				
Dolichopodidae	Dolichopodidae					x				
Ephydridae	Ephydridae		x			x	x	x		
Hyalellidae	Hyalella	x	x	x		x	x		x	x
Hydroptilidae	Hydroptila			x	x	x				
Hydroptilidae	Hydroptilidae			x						
Lymnaeidae	Lymnidae			x						
Oligochaeta	Oligochaeta	x	x	x	x	x	x	x		x
Ostracoda	Ostracoda	x	x	x	x	x	x	x	x	x
Physidae	Physa				x	x	x		x	
Psychodidae	Pericoma/ Telmatoscopus							x		

Family	Taxa	Site Name and Sampling Date								
		412M08672	412M08688	LAR01208	LAR01208	LAR01208	412PS0052	412PS0052	412PS0052	SMC02680
		6/7/2021	7/19/2022	6/8/2010	7/14/2020	8/14/2023	5/20/2008	4/25/2017	7/19/2022	6/3/2014
Psychodidae	Psychodidae							x		
Simuliidae	Simulium			x			x	x		
Stratiomyidae	Caloparyphus/ Euparyphus	x	x	x	x	x		x	x	
Stratiomyidae	Euparyphus		x		x	x			x	
Turbellaria	Turbellaria	x		x						x

Appendix 2. Table 7. BMI Taxa Occurrence List in LA River Reach Burbank Western Channel. X = present

Family	Taxa	Site Name and Sampling Date				
		412LARBBK	BWC Riverside	SMC01288	BWC (Down)	BWC (Up)
		6/13/2005	6/27/2024	6/12/2008	6/27/2024	6/27/2024
Baetidae	Baetis		x	x		x
Baetidae	Baetis adonis		x			
Baetidae	Fallceon		x		x	x
Baetidae	Fallceon quilleri			x		
Ceratopogonidae	Ceratopogonidae					x
Ceratopogonidae	Dasyhelea			x		
Chironomidae	Ablabesmyia					x
Chironomidae	Alotanypus				x	x
Chironomidae	Chironomidae	x		x		
Chironomidae	Chironomus					x
Chironomidae	Cricotopus		x		x	x
Chironomidae	Cricotopus bicinctus group					x
Chironomidae	Dicrotendipes		x			x
Chironomidae	Eukiefferiella					x
Chironomidae	Micropsectra		x			x
Chironomidae	Paratanytarsus					x
Chironomidae	Pentaneura					x
Chironomidae	Polypedilum		x		x	x
Chironomidae	Pseudochironomus		x		x	x
Chironomidae	Thienemannimyia group				x	x
Corixidae	Corixidae		x			
Dytiscidae	Sanfilippodytes		x			
Empididae	Empididae		x			
Hydroptilidae	Hydroptila		x	x		x
Hydroptilidae	Hydroptilidae		x	x		x
Leptohyphidae	Tricorythodes explicatus				x	x
Oligochaeta	Oligochaeta	x	x	x	x	x
Physidae	Physa			x		
Psychodidae	Pericoma/ Telmatoscopus			x		
Psychodidae	Psychodidae			x		
Simuliidae	Simulium		x		x	
Stratiomyidae	Caloparyphus/ Euparyphus		x			x

Appendix 2. Table 8. Diatom (Phylum Heterokontophyta) Taxa Occurrence List in LA River Reach 1. X = present

ID Level	Taxa	Site Name and Sampling Date					
		412M08643	SMC00318	SMC00318	SMC00318	SMC00318	SMC00318
		5/23/2018	6/15/2010	8/7/2019	7/9/2021	6/21/2022	8/14/2023
Species	Achnanthidium eutrophilum					x	
Species	Achnanthidium exiguum		x	x		x	x
Species	Achnanthidium gracillimum			x			
Species	Achnanthidium minutissimum			x	x	x	x
Species	Achnanthidium rivulare					x	
Species	Adlafia minuscula	x		x			
Genus	Amphora			x			
Species	Amphora copulata				x		
Species	Amphora pediculus				x	x	x
Class	Bacillariophyceae			x			
Order	Chaetophorales		x			x	
Species	Cocconeis lineata					x	
Species	Cocconeis pediculus	x	x	x	x	x	x
Species	Cocconeis placentula	x		x			x
Species	Cocconeis placentula var euglypta		x		x	x	
Species	Craticula minusculoides		x				
Species	Craticula subminuscula			x	x	x	x
Genus	Cyclotella	x					
Species	Cyclotella atomus			x		x	
Species	Cyclotella meneghiniana	x	x	x	x	x	x
Species	Diadesmis confervacea	x					
Species	Diatoma moniliformis			x			
Species	Ellerbeckia arenaria			x			
Species	Encyonopsis microcephala					x	x
Species	Eolimna subminuscula	x					
Genus	Eunotia	x					
Species	Fistulifera saprophila	x					
Genus	Fragilaria						x
Species	Fragilaria radians						x
Species	Fragilaria rumpens						x
Species	Fragilaria vaucheriae		x				
Genus	Gomphonema		x		x	x	
Species	Gomphonema lagenula						x
Species	Gomphonema parvulum	x		x	x	x	
Species	Gongrosira schmidlei		x				
Species	Halamphora veneta	x	x	x	x	x	x
Species	Hantzschia amphioxys		x				
Species	Heteroleibleinia kossinskaja		x				
Species	Heteroleibleinia sp 1	x			x	x	x
Species	Hippodonta capitata				x		
Species	Hippodonta hungarica					x	
Species	Leptolyngbya foveolara		x				

ID Level	Taxa	Site Name and Sampling Date					
		412M08643	SMC00318	SMC00318	SMC00318	SMC00318	SMC00318
		5/23/2018	6/15/2010	8/7/2019	7/9/2021	6/21/2022	8/14/2023
Species	Leptolyngbya foveolarum				x	x	
Species	Leptolyngbya tenuis	x					
Species	Luticola mutica	x					
Species	Mayamaea atomus		x				
Species	Mayamaea permitis					x	x
Species	Melosira varians				x		
Species	Microccrocis irregularis		x				
Species	Nanofrustulum trainorii				x	x	
Genus	Navicula					x	
Species	Navicula capitatoradiata			x			
Species	Navicula caterva						x
Species	Navicula cryptotenelloides					x	
Species	Navicula germainii				x		
Species	Navicula gregaria						x
Species	Navicula recens					x	
Species	Navicula rostellata			x		x	
Species	Navicula veneta		x			x	x
Order	Naviculales		x				
Genus	Nitzschia	x	x	x		x	
Species	Nitzschia acidoclinata			x			
Species	Nitzschia amphibia	x		x	x	x	x
Species	Nitzschia amphibioides	x		x	x	x	x
Species	Nitzschia bulnheimiana		x				
Species	Nitzschia capitellata	x					
Species	Nitzschia communis	x			x		x
Species	Nitzschia desertorum		x				
Species	Nitzschia dissipata	x		x			
Species	Nitzschia dissipata var media						x
Species	Nitzschia fonticola	x		x			
Species	Nitzschia frustulum	x			x	x	
Species	Nitzschia incognita				x		
Species	Nitzschia inconspicua	x	x	x	x	x	x
Species	Nitzschia liebethruthii				x	x	x
Species	Nitzschia microcephala	x		x			
Species	Nitzschia minuta			x		x	
Species	Nitzschia palea	x	x		x	x	x
Species	Nitzschia palea var debilis			x	x	x	x
Species	Nitzschia paleacea				x		
Species	Nitzschia perminuta			x			
Species	Nitzschia sociabilis	x		x			
Species	Nitzschia soratensis			x		x	
Species	Nitzschia supralitorea	x				x	
Species	Nitzschia umbonata					x	

ID Level	Taxa	Site Name and Sampling Date					
		412M08643	SMC00318	SMC00318	SMC00318	SMC00318	SMC00318
		5/23/2018	6/15/2010	8/7/2019	7/9/2021	6/21/2022	8/14/2023
Species	Nupela lapidosa			x			
Species	Orthoseira roeseana		x				
Genus	Planothidium		x				
Species	Planothidium delicatulum			x	x	x	x
Species	Planothidium frequentissimum			x			
Species	Planothidium lanceolatum			x	x		
Species	Planothidium robustum				x	x	
Species	Pleurosira laevis			x	x		x
Species	Pseudostaurosira brevistriata	x				x	
Species	Pseudostaurosira elliptica		x				
Genus	Rhoicosphenia				x		
Species	Rhoicosphenia abbreviata	x					
Species	Rhoicosphenia californica				x		x
Genus	Sellaphora						x
Species	Sellaphora nigri						x
Species	Sellaphora pupula				x		
Species	Staurosira construens var venter	x		x			
Species	Staurosira venter				x	x	x
Species	Stephanodiscus hantzschii		x				
Species	Tabularia fasciculata				x		
Species	Ulnaria ulna			x			

Appendix 2. Table 9. Diatom (Phylum Heterokontophyta) Taxa Occurrence List in LA River Reach 2. X = present.

ID Level	Taxa	Site Name and Sampling Date							
		412M08627	SMC05694	SMC02622	412M08659	412M08602	LAR2 Washington	412M08642	412CE0104
		5/17/2017	6/26/2014	6/15/2010	7/20/2020	9/30/2015	6/12/2024	6/20/2018	6/23/2009
Species	Achnanthidium exiguum	x	x	x	x		x	x	
Species	Achnanthidium exiguum var heterovalvum								x
Species	Achnanthidium minutissimum		x	x	x		x	x	x
Species	Achnanthidium rivulare						x		
Species	Adlafia minuscula		x						
Species	Amphora ovalis								x
Species	Amphora pediculus		x		x		x	x	
Species	Amphora perpusilla								x
Species	Amphora sp 5 SWAMP JPK								x
Genus	Aulacoseira								x
Genus	Chaetophorales 2	x							
Species	Chamaesiphon minutus	x							
Species	Chroococcopsis epiphytica				x				
Species	Chroococcopsis fluviatilis							x	
Species	Cocconeis pediculus	x	x	x	x		x	x	x
Species	Cocconeis placentula	x	x		x	x	x	x	x
Species	Cocconeis placentula var euglypta	x		x		x	x		
Species	Cocconeis placentula var lineata		x						
Genus	Craticula						x		
Species	Craticula subminuscula	x		x	x		x	x	
Species	Cyclotella atomus	x				x			
Species	Cyclotella meneghiniana	x	x	x	x	x	x	x	x
Genus	Denticula			x				x	
Species	Diadesmis confervacea		x		x	x			
Species	Discotella pseudostelligera			x					
Species	Ellerbeckia arenaria							x	
Species	Encyonopsis microcephala						x		
Species	Eolimna subminuscula		x			x			
Species	Fistulifera saprophila						x		
Genus	Fragilaria							x	
Genus	Fragilaria vaucheriae		x	x					
Family	Fragilariaceae			x					
Species	Gloeocapsopsis pleurocapsoides		x						
Genus	Gomphonema			x			x		
Species	Gomphonema kobayasii						x		
Species	Gomphonema mexicanum				x				
Species	Gomphonema minutum						x		
Species	Gomphonema parvulum	x		x	x		x	x	x

ID Level	Taxa	Site Name and Sampling Date							
		412M08627	SMC05694	SMC02622	412M08659	412M08602	LAR2 Washington	412M08642	412CE0104
		5/17/2017	6/26/2014	6/15/2010	7/20/2020	9/30/2015	6/12/2024	6/20/2018	6/23/2009
Species	Gomphonema stoermeri						x		
Species	Gomphonema truncatum var turgidum				x				
Species	Gongrosira debaryana	x							
Species	Gongrosira schmidlei	x							
Species	Halamphora veneta	x	x	x	x		x	x	
Species	Heteroleibleinia kossinskajae			x		x			x
Species	Heteroleibleinia sp 1	x			x		x	x	
Species	Hippodonta capitata								x
Species	Leptolyngbya foveolarum	x		x	x	x			
Species	Leptolyngbya tenuis							x	
Species	Luticola goeppertiana								x
Species	Mayamaea permitis						x		
Species	Melosira varians			x					
Genus	Navicula						x		
Species	Navicula amphiceropsis					x			
Species	Navicula antonii						x		
Species	Navicula capitatoradiata				x				
Species	Navicula cryptotenella			x			x		
Species	Navicula cryptotenelloides		x				x		
Species	Navicula erifuga					x	x		
Species	Navicula germainii						x		
Species	Navicula gregaria						x		x
Species	Navicula recens	x	x		x	x			
Species	Navicula schroeteri								x
Species	Navicula sp 3 SWAMP JPK								x
Species	Navicula submuralis			x					
Species	Navicula tripunctata							x	
Species	Navicula veneta					x	x		x
Order	Naviculales			x					
Genus	Nitzschia		x	x				x	x
Species	Nitzschia amphibia	x	x	x	x	x	x	x	
Species	Nitzschia amphibioides				x		x		
Species	Nitzschia archibaldii		x						
Species	Nitzschia aurariae			x			x		
Species	Nitzschia bulnheimiana			x					
Species	Nitzschia capitellata					x			
Species	Nitzschia cf bacillum	x							
Species	Nitzschia cf hantzschiana					x			
Species	Nitzschia communis	x						x	x
Species	Nitzschia desertorum		x						
Species	Nitzschia fonticola			x				x	x
Species	Nitzschia frustulum	x	x			x	x	x	x

ID Level	Taxa	Site Name and Sampling Date							
		412M08627	SMC05694	SMC02622	412M08659	412M08602	LAR2 Washington	412M08642	412CE0104
		5/17/2017	6/26/2014	6/15/2010	7/20/2020	9/30/2015	6/12/2024	6/20/2018	6/23/2009
Species	Nitzschia inconspicua	x	x	x	x	x	x		x
Species	Nitzschia intermedia					x			
Species	Nitzschia lacuum							x	
Species	Nitzschia liebethruthii				x		x	x	
Species	Nitzschia microcephala						x	x	x
Species	Nitzschia minuta							x	
Species	Nitzschia palea	x	x			x		x	x
Species	Nitzschia palea var debilis				x		x		
Species	Nitzschia paleacea	x	x						
Species	Nitzschia perminuta						x		
Species	Nitzschia sociabilis		x						
Species	Nitzschia soratensis							x	
Species	Nitzschia valdecostata								x
Species	Planothidium delicatulum		x		x			x	
Species	Planothidium dubium				x				
Species	Planothidium frequentissimum		x				x	x	
Species	Planothidium lanceolatum								x
Species	Planothidium robustum						x		
Species	Pleurosira laevis	x	x		x	x	x		x
Species	Protoderma viride		x						
Species	Pseudocharaciopsis minuta			x					
Species	Pseudostaurosira brevistriata		x						
Species	Pseudostaurosira elliptica			x					x
Species	Pseudostaurosira subsalina			x					
Species	Pseudostaurosira trainorii	x							
Species	Rhoicosphenia abbreviata						x		
Species	Sellaphora atomoides				x		x		
Species	Sellaphora saugerresii						x		
Species	Staurosira construens		x					x	
Species	Staurosira construens var pumila							x	
Species	Staurosira construens var venter		x			x		x	
Species	Staurosira venter	x			x		x		
Species	Staurosirella pinnata					x			
Species	Synedra goulardi					x			
Species	Tabularia fasciculata								x
Genus	Thalassiosira								x
Genus	Ulnaria				x				
Species	Ulnaria contracta							x	
Species	Xenococcus gracilis	x						x	

Appendix 2. Table 10a. Diatom (Phylum Heterokontophyta) Taxa Occurrence List in LA River Reach 3 - Greenway. X = present

ID Level	Taxa	Site Name and Sampling Date					
		LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway
		9/30/2015	6/20/2018	6/15/2021	6/21/2022	7/11/2023	6/24/2024
Species	Achnanthidium affine						
Species	Achnanthidium exiguum	x	x	x	x		x
Species	Achnanthidium minutissimum		x		x	x	x
Species	Achnanthidium rivulare			x			x
Species	Amphora copulata			x			
Species	Amphora inariensis	x					
Species	Amphora pediculus		x	x	x	x	x
Species	Bacillaria paxillifera	x					x
Genus	Caloneis			x			
Species	Chroococcopsis epiphytica	x					
Species	Chroococcopsis fluviatilis		x				
Species	Cocconeis lineata				x		
Species	Cocconeis pediculus			x	x	x	x
Species	Cocconeis placentula	x	x		x	x	x
Species	Cocconeis placentula var euglypta	x		x	x		x
Species	Craticula subminuscula	x	x	x	x	x	x
Species	Cyclotella atomus	x			x		
Species	Cyclotella meneghiniana	x	x	x	x	x	x
Genus	Denticula		x				
Species	Diadesmis confervacea	x		x	x		
Species	Diatomella balfouriana		x				
Genus	Diploneis						x
Species	Ellerbeckia arenaria				x		
Species	Encyonopsis microcephala						x
Species	Eucocconeis laevis		x				
Species	Fragilaria vaucheriae					x	
Genus	Gomphonema			x			
Species	Gomphonema exilissimum				x		
Species	Gomphonema gracile		x				
Species	Gomphonema kobayasii					x	x
Species	Gomphonema lagenula					x	
Species	Gomphonema micropus		x				
Species	Gomphonema parvulum	x	x	x	x	x	x
Species	Gomphonema truncatum var turgidum					x	
Species	Halamphora coffeaeformis		x				
Species	Halamphora tumida			x			
Species	Halamphora veneta	x		x	x	x	x
Species	Heteroleibleinia kossinskajae	x					
Species	Heteroleibleinia sp 1		x		x	x	x
Species	Hippodonta capitata			x			

ID Level	Taxa	Site Name and Sampling Date					
		LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway
		9/30/2015	6/20/2018	6/15/2021	6/21/2022	7/11/2023	6/24/2024
Species	Kolbesia gessneri				x		
Species	Leptolyngbya foveolarum	x	x				
Species	Leptolyngbya sp 1	x					
Species	Leptolyngbya tenuis		x				
Species	Luticola mutica	x					
Species	Mayamaea permitis				x	x	
Species	Melosira varians					x	x
Species	Nanofrustulum trainorii			x	x		
Genus	Navicula					x	
Species	Navicula amphiceropsis	x					
Species	Navicula cryptotenelloides		x			x	x
Species	Navicula erifuga	x			x	x	x
Species	Navicula germainii					x	
Species	Navicula gregaria	x	x			x	
Species	Navicula lundii	x					
Species	Navicula microcari					x	x
Species	Navicula recens	x		x	x	x	x
Species	Navicula rostellata				x		x
Species	Navicula tripunctata						x
Species	Navicula veneta		x	x	x	x	x
Genus	Nitzschia		x	x	x	x	
Species	Nitzschia amphibia	x	x	x	x	x	x
Species	Nitzschia amphibioides			x	x	x	x
Species	Nitzschia desertorum				x		
Species	Nitzschia fonticola		x	x			
Species	Nitzschia frustulum	x	x			x	
Species	Nitzschia inconspicua	x		x	x	x	x
Species	Nitzschia intermedia	x					
Species	Nitzschia lacuum		x				
Species	Nitzschia liebethruthii		x	x	x	x	
Species	Nitzschia microcephala		x				
Species	Nitzschia oregona					x	
Species	Nitzschia palea	x	x	x	x	x	
Species	Nitzschia palea var debilis				x		
Species	Nitzschia perminuta		x				
Species	Nitzschia soratensis		x				
Species	Nitzschia supralitorea					x	
Species	Nitzschia valdestriata					x	
Species	Oedogonium sp 3		x				
Genus	Planothidium				x		
Species	Planothidium delicatulum	x	x	x	x		
Species	Planothidium dubium		x				

ID Level	Taxa	Site Name and Sampling Date					
		LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway
		9/30/2015	6/20/2018	6/15/2021	6/21/2022	7/11/2023	6/24/2024
Species	Planothidium frequentissimum			x	x	x	x
Species	Planothidium lanceolatum		x				x
Species	Planothidium robustum				x	x	x
Species	Pleurosira laevis	x		x	x	x	x
Species	Pseudostaurosira brevistriata	x					x
Species	Pseudostaurosira trainorii	x					
Species	Rhoicosphenia abbreviata					x	
Genus	Sellaphora					x	
Species	Sellaphora atomoides			x		x	x
Species	Sellaphora pupula					x	
Species	Sellaphora saugerresii					x	
Species	Staurosira construens				x		x
Species	Staurosira venter	x	x	x	x	x	
Species	Staurosirella pinnata	x					
Species	Synedra goulardi	x					
Species	Tryblionella constricta	x					
Genus	Ulnaria			x			
Species	Ulnaria contracta		x				x
Species	Xenococcus minimus	x					

Appendix 2. Table 10b. Diatom (Phylum Heterokontophyta) Taxa Occurrence List in LA River Reach 3 – Remaining Downstream Sites. X = present

ID Level	Taxa	Site Name and Sampling Date					
		LAR3 Riverside	LAR08663	LAR3 N. Atwater	LAR3 N. Atwater	LAR3 N. Atwater	LAR3 N. Atwater
		6/11/2024	5/22/2021	6/15/2021	6/21/2022	7/11/2023	6/25/2024
Species	Achnanthidium exiguum	x	x	x	x	x	
Species	Achnanthidium exiguum var heterovalvum						
Species	Achnanthidium minutissimum	x		x	x	x	x
Species	Achnanthidium rivulare	x		x			
Species	Adlafia minuscula					x	
Species	Amphora copulata	x	x	x			x
Species	Amphora inariensis	x					
Species	Amphora ovalis	x					
Species	Amphora pediculus	x	x	x	x	x	x
Genus	Aulacoseira		x				
Species	Aulacoseira ambigua			x			
Species	Aulacoseira distans	x					
Species	Bacillaria paxillifera	x					
Species	Cocconeis lineata					x	
Species	Cocconeis pediculus	x	x	x		x	x
Species	Cocconeis placentula	x	x		x	x	
Species	Cocconeis placentula var euglypta	x	x	x	x		x
Genus	Craticula					x	
Species	Craticula subminuscula	x	x	x	x	x	x
Species	Cyclotella atomus				x		
Species	Cyclotella meneghiniana	x	x	x		x	x
Species	Diadesmis confervacea	x	x	x	x	x	x
Species	Ellerbeckia arenaria				x		
Species	Encyonopsis microcephala	x					
Species	Fallacia monoculata					x	
Species	Fallacia tenera	x					
Genus	Fragilaria		x				
Species	Fragilaria vaucheriae					x	
Genus	Gomphonema			x			x
Species	Gomphonema angustatum						x
Species	Gomphonema exilissimum						
Species	Gomphonema gracile						
Species	Gomphonema kobayasii	x				x	x
Species	Gomphonema lagenula				x		
Species	Gomphonema parvulum	x	x	x	x	x	x
Species	Halamphora tumida			x			
Species	Halamphora veneta	x	x	x	x	x	x
Species	Heteroleibleinia sp 1	x				x	x
Species	Hydrosera whampoensis					x	
Species	Leptolyngbya foveolarum					x	
Species	Mayamaea permitis					x	

ID Level	Taxa	Site Name and Sampling Date					
		LAR3 Riverside	LAR08663	LAR3 N. Atwater	LAR3 N. Atwater	LAR3 N. Atwater	LAR3 N. Atwater
		6/11/2024	5/22/2021	6/15/2021	6/21/2022	7/11/2023	6/25/2024
Species	Nanofrustulum trainorii		x	x	x		x
Genus	Navicula			x	x		
Species	Navicula antonii						x
Species	Navicula cryptocephala	x					
Species	Navicula cryptotenella	x					
Species	Navicula cryptotenelloides	x				x	
Species	Navicula erifuga	x			x		
Species	Navicula gregaria					x	
Species	Navicula recens	x	x	x	x		x
Species	Navicula reichardtiana					x	
Species	Navicula rostellata						x
Species	Navicula tripunctata	x					
Species	Navicula veneta	x	x	x	x	x	x
Genus	Nitzschia		x	x		x	
Species	Nitzschia amphibia	x	x	x	x	x	x
Species	Nitzschia amphibioides	x	x	x	x	x	x
Species	Nitzschia archibaldii				x	x	
Species	Nitzschia capitellata					x	
Species	Nitzschia communis				x	x	
Species	Nitzschia fonticola			x		x	
Species	Nitzschia frustulum	x		x		x	x
Species	Nitzschia inconspicua	x	x	x	x	x	x
Species	Nitzschia lacuum				x		
Species	Nitzschia liebethruthii	x	x	x	x		
Species	Nitzschia palea			x	x		
Species	Nitzschia palea var debilis		x		x		
Species	Nitzschia rosenstockii		x				
Species	Nitzschia supralitorea		x			x	
Genus	Planothidium	x			x		
Species	Planothidium delicatulum		x	x	x		
Species	Planothidium frequentissimum	x	x	x	x	x	x
Species	Planothidium robustum	x	x	x	x	x	x
Species	Pleurosira laevis	x	x				x
Species	Pseudostaurosira brevistriata			x			x
Species	Reimeria uniseriata	x					
Genus	Rhoicosphenia			x			
Species	Rhoicosphenia abbreviata					x	
Species	Rhoicosphenia californica	x	x				x
Genus	Sellaphora			x			
Species	Sellaphora atomoides			x	x		x
Species	Sellaphora nigri			x	x		
Species	Sellaphora pupula			x			
Species	Sellaphora saugerresii	x				x	

ID Level	Taxa	Site Name and Sampling Date					
		LAR3 Riverside	LAR08663	LAR3 N. Atwater	LAR3 N. Atwater	LAR3 N. Atwater	LAR3 N. Atwater
		6/11/2024	5/22/2021	6/15/2021	6/21/2022	7/11/2023	6/25/2024
Species	Staurosira construens						x
Species	Staurosira venter	x	x	x	x	x	x
Species	Stipitococcus sp 1					x	
Species	Surirella ovalis	x					
Species	Tryblionella apiculata					x	

Appendix 2. Table 10c. Diatom (Phylum Heterokontophyta) Taxa Occurrence List in LA River Reach 3 – Upstream LAG. X = present

ID Level	Taxa	Site Name and Sampling Date				
		LAR00436	LAR00436	LAR3 Electronics	LAR3 Griffith	LAR3 Griffith
		5/26/2009	6/12/2023	6/11/2024	7/11/2012	6/17/2024
Species	Achnanthidium affine					x
Species	Achnanthidium exiguum				x	x
Species	Achnanthidium exiguum var heterovalvum	x				
Species	Achnanthidium minutissimum	x	x	x	x	x
Species	Achnanthidium rivulare			x		x
Species	Adlafia minuscula		x			
Species	Amphora copulata		x		x	
Species	Amphora ovalis	x				
Species	Amphora pediculus			x		x
Species	Amphora sp 5 SWAMP JPK	x				
Species	Amphora stoermerii	x				
Genus	Aulacoseira					x
Species	Aulacoseira ambigua					x
Species	Aulacoseira granulata var angustissima			x		
Species	Bacillaria paxillifera					x
Species	Cocconeis pediculus	x	x	x		x
Species	Cocconeis placentula	x	x	x	x	x
Species	Cocconeis placentula var euglypta			x		x
Species	Craticula molestiformis					x
Species	Craticula subminuscula		x	x		x
Species	Cyclostephanos invisitatus				x	
Species	Cyclotella atomus		x	x		x
Species	Cyclotella meneghiniana	x	x	x	x	x
Genus	Denticula					
Species	Denticula kuetzingii	x			x	
Species	Diadesmis confervacea			x		
Species	Discostella pseudostelligera		x			x
Species	Encyonopsis microcephala			x		x
Species	Eolimna subminuscula				x	
Species	Fallacia californica		x			x
Species	Fistulifera saprophila			x		x
Genus	Fragilaria		x			
Species	Fragilaria mesolepta		x			
Species	Fragilaria pectinalis		x			
Species	Fragilaria vaucheriae		x			
Species	Gomphonema exilissimum				x	
Species	Gomphonema kobayasii	x	x	x		x
Species	Gomphonema minutum			x		
Species	Gomphonema parvulum	x	x	x	x	x
Species	Halamphora tumida				x	
Species	Halamphora veneta		x	x	x	x
Species	Heteroleibleinia sp 1		x	x		x

ID Level	Taxa	Site Name and Sampling Date				
		LAR00436	LAR00436	LAR3 Electronics	LAR3 Griffith	LAR3 Griffith
		5/26/2009	6/12/2023	6/11/2024	7/11/2012	6/17/2024
Species	Leptolyngbya foveolarum		x	x		
Species	Mayamaea permitis		x	x		
Species	Nanofrustulum trainorii		x			
Genus	Navicula	x	x	x		x
Species	Navicula antonii			x		x
Species	Navicula cryptotenella		x	x		x
Species	Navicula erifuga					x
Species	Navicula germainii				x	x
Species	Navicula gregaria	x	x	x	x	x
Species	Navicula recens					x
Species	Navicula reichardtiana			x		x
Species	Navicula rostellata					x
Species	Navicula schroeteri	x				
Species	Navicula sp 3 SWAMP JPK	x				
Species	Navicula veneta		x			
Species	Navicula viridula	x				
Genus	Nitzschia			x		x
Species	Nitzschia amphibia		x	x	x	x
Species	Nitzschia amphibioides		x	x		x
Species	Nitzschia archibaldii		x			
Species	Nitzschia aurariae		x			x
Species	Nitzschia cf frustulum SWAMP JPK	x				
Species	Nitzschia cf umbonata SWAMP JPK	x				
Species	Nitzschia communis			x	x	
Species	Nitzschia costei		x			
Species	Nitzschia fonticola		x		x	x
Species	Nitzschia frustulum	x	x	x		x
Species	Nitzschia inconspicua	x	x	x	x	x
Species	Nitzschia liebethruthii					x
Species	Nitzschia microcephala	x			x	x
Species	Nitzschia palea	x			x	
Species	Nitzschia palea var debilis		x			x
Species	Nitzschia paleacea			x	x	
Species	Nitzschia perminuta			x		x
Species	Nitzschia siliqua				x	
Species	Nitzschia valdecostata			x		
Genus	Orthoseira					x
Species	Planothidium delicatulum	x			x	
Species	Planothidium frequentissimum			x	x	x
Species	Planothidium lanceolatum	x				
Species	Planothidium robustum			x		
Species	Pleurosira laevis	x		x	x	x
Species	Protoderma viride			x		

ID Level	Taxa	Site Name and Sampling Date				
		LAR00436	LAR00436	LAR3 Electronics	LAR3 Griffith	LAR3 Griffith
		5/26/2009	6/12/2023	6/11/2024	7/11/2012	6/17/2024
Genus	Psammothidium					x
Species	Pseudostaurosira brevistriata					x
Species	Pseudostaurosira elliptica	x			x	
Species	Pseudostaurosira parasitica				x	
Species	Pseudostaurosira trainorii				x	
Species	Rhoicosphenia abbreviata	x	x			x
Species	Rhoicosphenia californica			x		
Species	Sellaphora atomoides					x
Species	Sellaphora pupula			x	x	x
Species	Sellaphora saugerresii					x
Species	Staurosira construens					x
Species	Staurosira venter			x		x
Species	Stephanodiscus hantzschii					x
Species	Synedra ulna	x			x	
Species	Tabularia fasciculata				x	
Species	Thalassiosira weissflogii		x			

Appendix 2. Table 11a. Diatom (Phylum Heterokontophyta) Taxa Occurrence List in LA River Reach 4. X = present

ID Level	Taxa	Site Name and Sampling Date					
		LAR4 Zoo	LAR4 Zoo	LAR08656	LAR02804	412M08597	LAR08661
		6/12/2023	6/17/2024	7/14/2020	6/20/2011	7/16/2015	7/6/2021
Species	Achnanthidium deflexum		x				
Species	Achnanthidium eutrophilum						x
Species	Achnanthidium exiguum			x	x	x	x
Species	Achnanthidium minutissimum	x	x	x	x	x	x
Species	Actinocyclus normanii				x		
Species	Amphora pediculus		x	x	x		x
Genus	Aulacoseira		x				
Species	Aulacoseira ambigua						x
Species	Aulacoseira granulata var angustissima			x			
Species	Aulacoseira subarctica				x		
Species	Bacillaria paradoxa					x	
Species	Bacularia vermicularis					x	
Species	Chamaesiphon minutus						x
Species	Chroococcopsis epiphytica	x				x	
Species	Chroococcopsis fluviatilis						x
Species	Cocconeis pediculus	x	x	x	x		x
Species	Cocconeis placentula		x	x	x	x	
Species	Cocconeis placentula var euglypta	x	x				x
Species	Craticula subminuscula		x	x	x		x
Species	Cyclostephanos invisitatus	x					x
Genus	Cyclotella				x		
Species	Cyclotella atomus			x	x	x	
Species	Cyclotella comensis						
Species	Cyclotella meneghiniana	x	x	x	x	x	x
Species	Denticula kuetzingii				x	x	
Species	Diadesmis confervacea			x		x	x
Species	Diploneis separanda						x
Species	Discostella pseudostelligera	x	x	x	x		
Species	Encyonopsis microcephala	x					x
Species	Eolimna minima				x		
Species	Fallacia tenera					x	
Species	Fistulifera saprophila		x				
Species	Fragilaria pectinalis	x					
Species	Fragilaria vaucheriae	x					
Genus	Gomphoneis						x
Species	Gomphonema exilissimum						x
Species	Gomphonema kobayasii	x	x				
Species	Gomphonema lagenula				x		
Species	Gomphonema mexicanum						
Species	Gomphonema parvulum	x	x	x	x	x	x
Species	Halamphora veneta	x	x	x	x	x	x
Species	Heteroleibleinia kossinskajae					x	

ID Level	Taxa	Site Name and Sampling Date					
		LAR4 Zoo	LAR4 Zoo	LAR08656	LAR02804	412M08597	LAR08661
		6/12/2023	6/17/2024	7/14/2020	6/20/2011	7/16/2015	7/6/2021
Species	Heteroleibleinia sp 1	x	x	x			x
Species	Hippodonta capitata		x				
Species	Karayevia clevei						x
Species	Leibleinia epiphytica					x	
Species	Leptolyngbya foveolarum	x	x			x	x
Species	Leptolyngbya sp 1					x	
Species	Mayamaea atomus			x			x
Species	Mayamaea ingenua		x				
Species	Mayamaea permitis		x			x	
Species	Melosira varians						x
Species	Nanofrustulum trainorii						x
Genus	Navicula		x	x	x		x
Species	Navicula antonii		x				
Species	Navicula cryptocephala						x
Species	Navicula cryptotenella		x		x		
Species	Navicula erifuga		x				x
Species	Navicula germainii						x
Species	Navicula gregaria	x	x				
Species	Navicula oppugnata				x		
Species	Navicula reichardtiana	x	x				
Species	Navicula rostellata		x	x	x	x	
Species	Navicula veneta				x	x	
Genus	Nitzschia		x	x	x		x
Species	Nitzschia amphibia	x	x	x	x	x	x
Species	Nitzschia amphibioides		x	x			x
Species	Nitzschia aurariae	x					
Species	Nitzschia capitellata				x		
Species	Nitzschia cf hantzschiana					x	
Species	Nitzschia communis		x		x		
Species	Nitzschia desertorum			x	x		
Species	Nitzschia dissipata	x					
Species	Nitzschia fonticola	x		x			x
Species	Nitzschia frustulum				x	x	x
Species	Nitzschia inconspicua	x	x	x			x
Species	Nitzschia lacuum			x			
Species	Nitzschia liebethruthii		x		x		x
Species	Nitzschia microcephala				x		x
Species	Nitzschia minuta				x		
Species	Nitzschia palea			x	x		
Species	Nitzschia palea var debilis	x		x			x
Species	Nitzschia paleacea						x
Species	Nitzschia pusilla			x			
Species	Nitzschia solita					x	

ID Level	Taxa	Site Name and Sampling Date					
		LAR4 Zoo	LAR4 Zoo	LAR08656	LAR02804	412M08597	LAR08661
		6/12/2023	6/17/2024	7/14/2020	6/20/2011	7/16/2015	7/6/2021
Species	Nitzschia sp 2 SWAMP CG				x		
Species	Nitzschia supralitorea			x			x
Species	Planothidium delicatulum			x	x	x	x
Species	Planothidium frequentissimum		x	x	x	x	x
Species	Planothidium granum					x	
Species	Planothidium lanceolatum	x	x				x
Species	Planothidium robustum		x				x
Species	Pleurosira laevis		x	x	x		x
Species	Protoderma viride					x	
Species	Pseudostaurosira brevistriata					x	x
Species	Pseudostaurosira elliptica				x		
Species	Pseudostaurosira sp 1					x	
Species	Pseudostaurosira subsalina				x		
Species	Reimeria sinuata				x		
Species	Rhoicosphenia abbreviata	x	x				
Species	Sellaphora atomoides		x				x
Species	Sellaphora pupula					x	
Species	Sellaphora saugerresii		x				
Species	Staurosira construens			x			x
Species	Staurosira construens var venter					x	
Species	Staurosira venter		x	x			x
Species	Staurosirella leptostauron					x	
Species	Staurosirella pinnata						x
Species	Stephanodiscus hantzschii		x				
Species	Surirella ovalis				x		
Species	Thalassiosira pseudonana				x		
Species	Thalassiosira weissflogii				x		
Species	Tryblionella acuminata				x		
Species	Tryblionella constricta				x		
Species	Xenococcus gracilis	x					

Appendix 2. Table 11b. Diatom (Phylum Heterokontophyta) Taxa Occurrence List in LA River Reach 4 - Kester. X = present

ID Level	Taxa	Site Name and Sampling Date							
		LAR4 Kester 7/16/2015	LAR4 Kester 6/21/2016	LAR4 Kester 5/31/2017	LAR4 Kester 5/30/2018	LAR4 Kester 7/15/2019	LAR4 Kester 7/14/2020	LAR4 Kester 6/15/2021	LAR4 Kester 6/26/2024
Species	Achnanthidium affine				x	x			
Species	Achnanthidium eutrophilum							x	
Species	Achnanthidium exiguum	x	x		x	x	x	x	x
Species	Achnanthidium minutissimum	x		x	x	x		x	x
Species	Achnanthidium pyrenaicum				x				
Species	Adlafia minuscula				x	x			
Species	Amphora copulata				x				x
Species	Amphora indistincta			x				x	
Species	Amphora pediculus			x	x			x	x
Species	Aulacoseira ambigua							x	x
Species	Aulacoseira crenulata					x			
Species	Aulacoseira subarctica				x				
Species	Bacillaria paxillifera			x					
Class	Bacillariophyceae					x			
Species	Bacularia vermicularis		x						
Species	Caloneis fontinalis							x	
Species	Caloneis lewisii				x				
Species	Chamaesiphon minimus			x					
Species	Chamaesiphon minutus		x						
Species	Chroococcopsis epiphytica			x					
Species	Cocconeis pediculus			x	x			x	x
Species	Cocconeis placentula			x	x	x	x	x	
Species	Cocconeis placentula var euglypta			x				x	x
Species	Craticula subminuscula		x				x	x	x
Species	Cyclostephanos invisitatus					x			x
Species	Cyclostephanos tholiformis								x
Genus	Cyclotella					x			
Species	Cyclotella atomus	x	x		x	x	x		x
Species	Cyclotella comensis				x				

ID Level	Taxa	Site Name and Sampling Date							
		LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester
		7/16/2015	6/21/2016	5/31/2017	5/30/2018	7/15/2019	7/14/2020	6/15/2021	6/26/2024
Species	Cyclotella meneghiniana	x	x	x	x	x	x	x	x
Species	Cymatopleura solea		x					x	
Genus	Denticula					x	x		
Species	Denticula kuetzingii	x							
Species	Diadesmis confervacea	x	x			x		x	
Species	Diploneis hinziae								x
Species	Discostella pseudostelligera							x	x
Genus	Encyonema						x		
Species	Encyonema silesiacum							x	
Species	Encyonopsis microcephala							x	
Species	Eolimna minima			x					
Species	Eolimna subminuscula				x	x			
Species	Fallacia tenera	x							
Species	Geissleria decussis			x					
Genus	Gomphonema			x	x			x	x
Species	Gomphonema exilissimum			x					
Species	Gomphonema kobayasii				x				
Species	Gomphonema lagenula		x	x					
Species	Gomphonema mexicanum								x
Species	Gomphonema parvulum	x	x	x	x	x	x	x	x
Species	Gomphonema truncatum							x	
Species	Halamphora montana					x			
Species	Halamphora tumida								x
Species	Halamphora veneta	x	x	x	x	x	x	x	x
Species	Heteroleibleinia kossinskajae	x							
Species	Heteroleibleinia sp 1		x	x	x		x		x
Species	Hippodonta capitata								x
Species	Hydrosera whampoensis		x			x	x		
Species	Karayevia clevei						x		

ID Level	Taxa	Site Name and Sampling Date							
		LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester
		7/16/2015	6/21/2016	5/31/2017	5/30/2018	7/15/2019	7/14/2020	6/15/2021	6/26/2024
Species	Lemnicola hungarica							x	
Species	Leptolyngbya foveolarum	x	x						
Species	Leptolyngbya sp 1	x							
Species	Leptolyngbya tenuis			x	x				
Species	Lindavia ocellata						x		
Species	Mayamaea atomus							x	
Species	Mayamaea permitis	x							x
Species	Melosira varians			x					
Species	Nanofrustulum trainorii							x	x
Genus	Navicula							x	
Species	Navicula aitchelbee					x			
Species	Navicula amphiceropsis						x		
Species	Navicula antonii			x					
Species	Navicula capitatoradiata				x				
Species	Navicula caterva								x
Species	Navicula cryptocephala				x				
Species	Navicula cryptotenella					x			x
Species	Navicula cryptotenelloides								x
Species	Navicula erifuga	x				x			x
Species	Navicula exilis	x							
Species	Navicula germainii					x	x		x
Species	Navicula gregaria			x	x				x
Species	Navicula oppugnata								
Species	Navicula recens	x	x			x			
Species	Navicula rostellata	x	x		x	x	x	x	x
Species	Navicula symmetrica	x			x		x		
Species	Navicula tripunctata							x	
Species	Navicula veneta	x		x		x			
Genus	Nitzschia		x		x	x		x	x
Species	Nitzschia acidoclinata							x	
Species	Nitzschia amphibia	x		x	x	x	x	x	x
Species	Nitzschia amphibioides		x		x	x	x	x	x
Species	Nitzschia archibaldii					x			
Species	Nitzschia aurariae								x
Species	Nitzschia bryophila					x			

ID Level	Taxa	Site Name and Sampling Date							
		LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester
		7/16/2015	6/21/2016	5/31/2017	5/30/2018	7/15/2019	7/14/2020	6/15/2021	6/26/2024
Species	Nitzschia cf supralitorea	x	x						
Species	Nitzschia communis		x						
Species	Nitzschia desertorum				x		x		x
Species	Nitzschia dissipata			x				x	
Species	Nitzschia fonticola				x		x		
Species	Nitzschia fossilis						x		
Species	Nitzschia frustulum	x	x	x				x	x
Species	Nitzschia inconspicua		x	x	x	x	x	x	x
Species	Nitzschia lacuum					x	x	x	x
Species	Nitzschia liebethruthii				x			x	x
Species	Nitzschia microcephala				x	x			
Species	Nitzschia minuta					x			
Species	Nitzschia palea	x	x		x		x		x
Species	Nitzschia palea var debilis					x	x	x	x
Species	Nitzschia palea var tenuirostris					x			
Species	Nitzschia paleacea				x	x			
Species	Nitzschia radicula						x		
Species	Nitzschia solita	x							
Species	Nitzschia soratensis				x	x	x		
Species	Nitzschia subacicularis					x			
Species	Nitzschia supralitorea				x	x	x		
Species	Nitzschia tubicola	x							
Species	Planothidium delicatulum		x	x	x	x	x	x	
Species	Planothidium dubium					x	x		
Species	Planothidium frequentissimum		x	x	x	x	x	x	x
Species	Planothidium granum								
Species	Planothidium lanceolatum			x			x	x	
Species	Planothidium robustum							x	x
Species	Planothidium rostratoholarcticum								x
Species	Pleurosira laevis		x		x	x	x	x	x
Genus	Psammothidium					x			
Species	Pseudostaurosira brevistriata	x	x		x	x			x

ID Level	Taxa	Site Name and Sampling Date							
		LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester
		7/16/2015	6/21/2016	5/31/2017	5/30/2018	7/15/2019	7/14/2020	6/15/2021	6/26/2024
Species	Pseudostaurosira parasitica							x	
Species	Pseudostaurosira sp 1	x							
Species	Rhoicosphenia abbreviata			x					x
Genus	Sellaphora								x
Species	Sellaphora atomoides							x	
Species	Sellaphora nigri				x				
Species	Sellaphora pupula		x			x	x	x	x
Species	Sellaphora seminulum		x						
Species	Staurosira construens				x	x		x	x
Species	Staurosira construens var venter	x			x	x			
Species	Staurosira venter		x				x	x	
Species	Staurosirella leptostauron	x							
Species	Staurosirella pinnata		x						
Genus	Stephanodiscus		x						
Species	Stephanodiscus hantzschii		x						
Species	Stephanodiscus hantzschii f tenuis								x
Species	Surirella angusta				x				
Species	Tabularia fasciculata			x				x	
Species	Terpsinoe musica				x				
Species	Thalassiosira weissflogii		x				x		x
Species	Tryblionella apiculata								x
Species	Tryblionella hungarica		x					x	
Species	Ulnaria ulna			x					
Species	Xenococcus gracilis			x					
Species	Xenococcus minimus			x					

Appendix 2. Table 12. Diatom (Phylum Heterokontophyta) Taxa Occurrence List in LA River Reach 5. X = present

ID Level	Taxa	Site Name and Sampling Date
		LAR5 Balboa
		6/24/2024
Species	Achnanthidium minutissimum	x
Species	Amphora pediculus	x
Species	Aulacoseira granulata var angustissima	x
Species	Cocconeis pediculus	x
Species	Cocconeis placentula	x
Species	Cocconeis placentula var euglypta	x
Species	Craticula buderi	x
Species	Craticula subminuscula	x
Species	Cyclotella meneghiniana	x
Species	Encyonopsis microcephala	x
Species	Gomphonema parvulum	x
Species	Halamphora veneta	x
Species	Heteroleibleinia sp 1	x
Species	Melosira varians	x
Species	Nanofrustulum trainorii	x
Species	Navicula erifuga	x
Species	Navicula gregaria	x
Species	Navicula recens	x
Species	Navicula tripunctata	x
Species	Navicula veneta	x
Species	Nitzschia amphibia	x
Species	Nitzschia amphibioides	x
Species	Nitzschia aurariae	x
Species	Nitzschia frustulum	x
Species	Nitzschia inconspicua	x
Species	Nitzschia microcephala	x
Species	Nitzschia palea	x
Species	Nitzschia palea var debilis	x
Species	Nitzschia supralitorea	x
Species	Planothidium frequentissimum	x
Species	Pleurosira laevis	x
Species	Pseudostaurosira brevistriata	x
Species	Rhoicosphenia abbreviata	x
Species	Surirella brebissonii var kuetzingii	x
Species	Surirella ovalis	x

Appendix 2. Table 13. Diatom (Phylum Heterokontophyta) Taxa Occurrence List in LA River Reach 6. X = present

ID Level	Taxa	Site Name and Sampling Date						
		412M0672	412M08688	LAR01208	LAR01208	LAR01208	412PS0052	SMC02680
		7/6/2021	7/19/2022	6/8/2010	7/14/2020	8/14/2023	7/19/2022	6/3/2014
Genus	Achnanthidium					x		
Species	Achnanthidium exiguum		x		x	x	x	
Species	Achnanthidium minutissimum	x	x	x	x	x	x	x
Species	Achnanthidium minutissimum var affinis							x
Species	Achnanthidium rivulare							x
Species	Amphora pediculus		x	x		x		
Genus	Chamaesiphon							x
Species	Chlamydomonadopsis sp.1			x				
Species	Chroococcopsis epiphytica			x				
Species	Cocconeis pediculus			x		x		
Species	Cocconeis placentula					x		
Species	Craticula buderi					x		
Species	Craticula subminuscula	x			x	x	x	
Species	Cyanobium diatomicola							x
Species	Cyclotella meneghiniana			x	x	x		x
Species	Denticula kuetzingii			x				x
Species	Diadesmis confervacea		x			x	x	
Genus	Encyonema					x		
Genus	Encyonopsis			x				
Species	Encyonopsis microcephala	x						
Species	Eolimna subminuscula			x				
Genus	Gomphonema			x		x		x
Species	Gomphonema exilissimum							x
Species	Gomphonema lagenula				x	x		
Species	Gomphonema parvulum	x	x	x	x		x	x
Species	Gongrosira schmidlei			x				
Species	Halamphora veneta	x	x	x	x	x	x	x
Species	Heteroleibleinia kossinskajae			x				x
Species	Heteroleibleinia sp 1	x	x					
Species	Karayevia clevei				x			
Species	Leptolyngbya foveolarum	x	x	x	x			x
Species	Mayamaea atomus			x				
Species	Mayamaea permitis	x						
Species	Melosira varians				x	x		
Species	Nanofrustulum trainorii	x			x	x		
Genus	Navicula	x			x			
Species	Navicula erifuga		x					
Species	Navicula gregaria		x	x		x		
Species	Navicula menisculus			x				
Species	Navicula rostellata			x				
Species	Navicula symmetrica					x		
Species	Navicula veneta		x					

ID Level	Taxa	Site Name and Sampling Date						
		412M0672	412M08688	LAR01208	LAR01208	LAR01208	412PS0052	SMC02680
		7/6/2021	7/19/2022	6/8/2010	7/14/2020	8/14/2023	7/19/2022	6/3/2014
Order	Naviculales			x				
Species	Navicymbula pusilla		x					
Genus	Nitzschia	x			x	x	x	
Species	Nitzschia amphibia		x		x	x	x	x
Species	Nitzschia amphibioides	x	x		x	x	x	
Species	Nitzschia communis			x				
Species	Nitzschia desertorum			x	x			
Species	Nitzschia fonticola			x	x			
Species	Nitzschia frustulum	x				x	x	
Species	Nitzschia hantzschiana	x						
Species	Nitzschia inconspicua	x		x	x	x	x	x
Species	Nitzschia lacuum		x					
Species	Nitzschia liebethruthii	x				x		
Species	Nitzschia linearis				x			
Species	Nitzschia minuta	x			x			
Species	Nitzschia palea			x	x			x
Species	Nitzschia palea var debilis		x		x	x	x	
Species	Nitzschia rosenstockii				x			
Species	Nitzschia siliqua				x			
Species	Nitzschia sociabilis				x			
Species	Nitzschia soratensis				x			
Species	Nitzschia supralitorea	x				x		
Species	Planothidium frequentissimum			x	x			
Species	Planothidium robustum						x	
Species	Pseudostaurosira brevistriata							x
Species	Reimeria sinuata					x		
Species	Sellaphora atomoides				x			
Species	Sellaphora saugerresii	x						
Species	Staurosira construens							x
Species	Staurosira construens var venter							x
Species	Staurosira punctiformis			x				
Species	Staurosira venter	x	x		x	x	x	
Species	Xenococcus gracilis							x

Appendix 2. Table 14. Diatom (Phylum Heterokontophyta) Taxa Occurrence List in LA River Reach Burbank Western Channel. X = present

ID Level	Taxa	Site Name and Sampling Date		
		BWC Riverside	BWC (Down)	BWC (Up)
		6/27/2024	6/27/2024	6/27/2024
Species	Achnanthidium exiguum	x		
Species	Achnanthidium minutissimum	x	x	x
Species	Amphora pediculus	x		x
Genus	Aulacoseira	x		
Species	Chroococcopsis epiphytica			x
Species	Cocconeis pediculus		x	x
Species	Cocconeis placentula	x		
Species	Cocconeis placentula var euglypta			x
Species	Craticula subminuscula	x		x
Species	Cyclotella meneghiniana			x
Genus	Encyonopsis			x
Species	Encyonopsis microcephala	x		
Genus	Gomphonema	x		
Species	Gomphonema kobayasii	x		
Species	Gomphonema parvulum			x
Species	Halamphora veneta	x	x	x
Species	Heteroleibleinia sp 1			x
Species	Leibleinia epiphytica			x
Species	Mayamaea permitis			x
Species	Navicula erifuga	x		
Species	Navicula gregaria			x
Species	Navicula veneta	x		x
Species	Nitzschia amphibia	x	x	x
Species	Nitzschia amphibioides	x		x
Species	Nitzschia aurariae			x
Species	Nitzschia capitellata	x		
Species	Nitzschia communis	x	x	x
Species	Nitzschia frustulum			x
Species	Nitzschia inconspicua	x	x	x
Species	Nitzschia liebethruthii	x		
Species	Nitzschia palea			x
Species	Nitzschia palea var debilis	x		x
Species	Planothidium frequentissimum	x		x
Species	Planothidium lanceolatum			x
Species	Protoderma viride			x
Species	Sellaphora saugerresii		x	
Species	Staurosira venter			x

Appendix 2. Table 15. Soft Algae Taxa Occurrence List in LA River Reach 1. X = present

Group	ID Level	Taxa	Site Name and Sampling Date					
			412M08643	SMC00318	SMC00318	SMC00318	SMC00318	SMC00318
			5/23/2018	6/15/2010	8/7/2019	7/9/2021	6/21/2022	8/14/2023
Blue-Green Algae (Cyanobacteria)	Species	Aphanocapsa delicatissima		x			x	
Blue-Green Algae (Cyanobacteria)	Species	Aphanothece clathrata		x				
Blue-Green Algae (Cyanobacteria)	Species	Aphanothece minutissima						x
Blue-Green Algae (Cyanobacteria)	Genus	Calothrix	x		x	x	x	
Blue-Green Algae (Cyanobacteria)	Species	Calothrix fusca				x		
Blue-Green Algae (Cyanobacteria)	Species	Chamaesiphon minutus	x					
Blue-Green Algae (Cyanobacteria)	Genus	Chroococcopsis	x					
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus minimus		x				x
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus minor		x			x	
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus minutus	x		x	x		
Blue-Green Algae (Cyanobacteria)	Class	Cyanophyceae						x
Blue-Green Algae (Cyanobacteria)	Species	Heteroleibleinia kossinskajae		x				
Blue-Green Algae (Cyanobacteria)	Species	Heteroleibleinia sp 1	x			x	x	
Blue-Green Algae (Cyanobacteria)	Species	Homoeothrix janthina		x			x	
Blue-Green Algae (Cyanobacteria)	Species	Homoeothrix stagnalis	x					x
Blue-Green Algae (Cyanobacteria)	Species	Homoeothrix varians			x			
Blue-Green Algae (Cyanobacteria)	Species	Leptolyngbya foveolarum		x				
Blue-Green Algae (Cyanobacteria)	Species	Leptolyngbya subtilis				x		
Blue-Green Algae (Cyanobacteria)	Species	Merismopedia punctata	x	x			x	
Blue-Green Algae (Cyanobacteria)	Genus	Phormidium				x	x	
Blue-Green Algae (Cyanobacteria)	Species	Phormidium subfuscum		x				
Blue-Green Algae (Cyanobacteria)	Species	Pleurocapsa minor		x				
Blue-Green Algae (Cyanobacteria)	Species	Pseudanabaena catenata	x					
Blue-Green Algae (Cyanobacteria)	Species	Pseudanabaena mucicola	x					
Blue-Green Algae (Cyanobacteria)	Species	Schizothrix fragilis		x				
Blue-Green Algae (Cyanobacteria)	Species	Spirulina subtilissima				x		
Blue-Green Algae (Cyanobacteria)	Species	Symploca sp 1				x		x
Green Algae (Chlorophyta)	Order	Chaetophorales				x	x	x
Green Algae (Chlorophyta)	Species	Chlamydomonadopsis sp 1		x				
Green Algae (Chlorophyta)	Species	Chlamydomonas bicocca		x				
Green Algae (Chlorophyta)	Species	Chlorella vulgaris	x	x		x		
Green Algae (Chlorophyta)	Genus	Chlorophyta				x	x	
Green Algae (Chlorophyta)	Species	Chlorophyta 9				x		
Green Algae (Chlorophyta)	Species	Cladophora glomerata	x	x		x	x	x
Green Algae (Chlorophyta)	Species	Coelastrum astroideum						x
Green Algae (Chlorophyta)	Species	Cosmarium angulosum					x	
Green Algae (Chlorophyta)	Species	Gongrosira schmidlei		x				
Green Algae (Chlorophyta)	Species	Monoraphidium arcuatum		x		x		
Green Algae (Chlorophyta)	Species	Monoraphidium contortum		x			x	
Green Algae (Chlorophyta)	Species	Monoraphidium minutum	x	x		x		
Green Algae (Chlorophyta)	Species	Oedogonium sp 1					x	x
Green Algae (Chlorophyta)	Genus	Oocystis	x			x		x

Group	ID Level	Taxa	Site Name and Sampling Date					
			412M08643	SMC00318	SMC00318	SMC00318	SMC00318	SMC00318
			5/23/2018	6/15/2010	8/7/2019	7/9/2021	6/21/2022	8/14/2023
Green Algae (Chlorophyta)	Species	Oocystis borgei		x				
Green Algae (Chlorophyta)	Species	Oocystis parva		x				
Green Algae (Chlorophyta)	Species	Oocystis pusilla					x	
Green Algae (Chlorophyta)	Species	Pediastrum boryanum		x		x	x	
Green Algae (Chlorophyta)	Species	Pediastrum duplex	x		x	x	x	
Green Algae (Chlorophyta)	Species	Pediastrum integrum	x	x		x	x	x
Green Algae (Chlorophyta)	Species	Rhizoclonium hieroglyphicum				x		
Green Algae (Chlorophyta)	Genus	Scenedesmus				x		
Green Algae (Chlorophyta)	Species	Scenedesmus abundans	x	x	x	x	x	x
Green Algae (Chlorophyta)	Species	Scenedesmus armatus	x			x		
Green Algae (Chlorophyta)	Species	Scenedesmus communis		x			x	
Green Algae (Chlorophyta)	Species	Scenedesmus dimorphus	x			x	x	x
Green Algae (Chlorophyta)	Species	Scenedesmus ellipticus	x			x	x	x
Green Algae (Chlorophyta)	Species	Scenedesmus obliquus	x	x		x		
Green Algae (Chlorophyta)	Species	Scenedesmus opoliensis				x		x
Green Algae (Chlorophyta)	Species	Scenedesmus opoliensis var. mononensis		x				
Green Algae (Chlorophyta)	Species	Stauridium tetras	x	x				
Green Algae (Chlorophyta)	Species	Stigeoclonium nanum		x				
Green Algae (Chlorophyta)	Species	Tetraedron caudatum	x			x		
Green Algae (Chlorophyta)	Species	Tetraedron minimum	x					
Yellow-Green Algae (Heterookontophyta/Ochrophyta)	Species	Pleurosira laevis					x	

Appendix 2. Table 16. Soft Algae Taxa Occurrence List in LA River Reach 2. X = present

Group	ID Level	Taxa	Site Name and Sampling Date							
			412M08627	SMC05694	SMC02622	412M08659	412M08602	LAR2 Washington	412M08642	412CE0104
			5/17/2017	6/26/2014	6/15/2010	7/20/2020	9/30/2015	6/12/2024	6/20/2018	6/23/2009
Blue-Green Algae (Cyanobacteria)	Species	Aphanocapsa delicatissima	x		x		x			
Blue-Green	Species	Aphanocapsa incerta		x						
Algae (Cyanobacteria)	Species	Aphanocapsa sp 1	x				x			
Blue-Green	Species	Aphanothece minutissima	x							
Algae (Cyanobacteria)	Species	Aphanothece nebulosa	x							
Blue-Green	Species	Aphanothece saxicola		x						
Algae (Cyanobacteria)	Species	Calothrix fusca	x							
Blue-Green	Species	Chamaesiphon minutus							x	
Algae (Cyanobacteria)	Species	Chroococcopsis fluviatilis							x	
Blue-Green	Genus	Chroococcus		x						
Algae (Cyanobacteria)	Species	Chroococcus minimus	x		x		x	x		x
Blue-Green	Species	Chroococcus minor	x		x	x	x			
Algae (Cyanobacteria)	Species	Chroococcus minutus	x				x			x
Blue-Green	Species	Chroococcus vacuolatus	x							
Algae (Cyanobacteria)	Class	Cyanophyceae				x				
Blue-Green	Species	Cyanophyceae 12	x							
Algae (Cyanobacteria)	Species	Cyanophyceae 7					x			
Blue-Green	Species	Geitlerinema amphibium					x			
Algae (Cyanobacteria)	Species	Geitlerinema ionicum					x			
Blue-Green	Species	Gloeocapsopsis cyanea		x						
Algae (Cyanobacteria)	Species	Gloeocapsopsis pleurocapsoides		x						
Blue-Green	Species	Heteroleibleinia kossinskajae			x		x			x
Algae (Cyanobacteria)	Species	Heteroleibleinia sp 1	x						x	
Blue-Green	Species	Homoeothrix janthina			x					
Algae (Cyanobacteria)	Genus	Homoeothrix						x		
Blue-Green	Species	Homoeothrix stagnalis							x	
Algae (Cyanobacteria)	Species	Homoeothrix varians		x						
Blue-Green	Species	Leptolyngbya foveolarum	x	x	x	x				x
Algae (Cyanobacteria)	Species	Leptolyngbya granulifera	x							
Blue-Green	Species	Leptolyngbya sp 1					x			
Algae (Cyanobacteria)	Species	Leptolyngbya tenuis						x	x	
Blue-Green	Species	Lyngbya martensiana	x							
Algae (Cyanobacteria)	Species	Merismopedia glauca	x				x		x	

Group	ID Level	Taxa	Site Name and Sampling Date							
			412M08627	SMC05694	SMC02622	412M08659	412M08602	LAR2 Washington	412M08642	412CE0104
			5/17/2017	6/26/2014	6/15/2010	7/20/2020	9/30/2015	6/12/2024	6/20/2018	6/23/2009
Blue-Green	Species	Merismopedia punctata			x			x		
Algae (Cyanobacteria)	Species	Merismopedia tenuissima				x				
Blue-Green	Species	Microcoleus autumnalis	x							
Algae (Cyanobacteria)	Species	Nostoc verrucosum								x
Blue-Green	Genus	Phormidium							x	
Algae (Cyanobacteria)	Species	Phormidium autumnale	x				x			
Blue-Green	Species	Phormidium sp 3								x
Algae (Cyanobacteria)	Species	Phormidium subfuscum								x
Blue-Green	Species	Pleurocapsa minor	x		x					x
Algae (Cyanobacteria)	Family	Rivulariaceae			x					
Blue-Green	Species	Schizothrix fragilis	x							
Algae (Cyanobacteria)	Species	Spirulina corakiana					x			
Blue-Green	Genus	Symploca		x						
Algae (Cyanobacteria)	Species	Symploca elegans					x			
Blue-Green	Species	Tychonema sp 1				x				
Algae (Cyanobacteria)	Species	Xenococcus gracilis							x	
Cryptophytes (Cryptophyta)	Species	Cryptomonas anomala			x					
Green Algae (Chlorophyta)	Species	Actinastrum hantzschii					x			
Green Algae (Chlorophyta)	Species	Botryosphaerella sudetica					x			
Green Algae (Chlorophyta)	Species	Chaetophorales 2	x							
Green Algae (Chlorophyta)	Species	Chlamydomonadopsis sp 1			x					
Green Algae (Chlorophyta)	Species	Chlamydomonas debaryana	x							
Green Algae (Chlorophyta)	Species	Chlamydomonas globosa			x					
Green Algae (Chlorophyta)	Species	Chlorella cf minutissima			x					
Green Algae (Chlorophyta)	Species	Chlorella sp 1								x
Green Algae (Chlorophyta)	Species	Chlorella vulgaris			x					
Green Algae (Chlorophyta)	Division	Chlorophyta							x	
Green Algae (Chlorophyta)	Species	Chlorophyta 1	x							x
Green Algae (Chlorophyta)	Species	Chlorophyta 20					x			
Green Algae (Chlorophyta)	Species	Chlorophyta 3						x		
Green Algae (Chlorophyta)	Species	Chlorophyta 8	x							
Green Algae (Chlorophyta)	Genus	Cladophora		x						
Green Algae (Chlorophyta)	Species	Cladophora glomerata	x		x	x		x	x	x

Group	ID Level	Taxa	Site Name and Sampling Date							
			412M08627	SMC05694	SMC02622	412M08659	412M08602	LAR2 Washington	412M08642	412CE0104
			5/17/2017	6/26/2014	6/15/2010	7/20/2020	9/30/2015	6/12/2024	6/20/2018	6/23/2009
Green Algae (Chlorophyta)	Species	Coelastrum astroideum						x		
Green Algae (Chlorophyta)	Species	Coelastrum microporum	x							
Green Algae (Chlorophyta)	Species	Comasiella arcuata var platydisca					x			
Green Algae (Chlorophyta)	Species	Crucigeniella apiculata						x		
Green Algae (Chlorophyta)	Genus	Gongrosira						x		
Green Algae (Chlorophyta)	Species	Gongrosira debaryana	x				x			
Green Algae (Chlorophyta)	Species	Gongrosira schmidlei			x					
Green Algae (Chlorophyta)		Green flagellate colonial			x					
Green Algae (Chlorophyta)	Genus	Kirchneriella		x						
Green Algae (Chlorophyta)	Species	Monoraphidium arcuatum					x	x	x	x
Green Algae (Chlorophyta)	Species	Monoraphidium contortum			x	x	x	x		
Green Algae (Chlorophyta)	Species	Monoraphidium minutum	x			x	x	x		
Green Algae (Chlorophyta)	Species	Oedogonium sp 1				x				
Green Algae (Chlorophyta)	Species	Oocystis borgei	x							
Green Algae (Chlorophyta)	Species	Oocystis parva	x	x			x	x		
Green Algae (Chlorophyta)	Species	Oocystis pusilla	x			x	x		x	x
Green Algae (Chlorophyta)	Species	Oocystis solitaria	x	x			x			
Green Algae (Chlorophyta)	Species	Pediastrum boryanum	x	x	x	x	x	x	x	x
Green Algae (Chlorophyta)	Species	Pediastrum boryanum var cornutum						x		
Green Algae (Chlorophyta)	Species	Pediastrum boryanum var longicorne			x					
Green Algae (Chlorophyta)	Species	Pediastrum duplex				x		x	x	
Green Algae (Chlorophyta)	Species	Pediastrum integrum		x	x	x	x	x		
Green Algae (Chlorophyta)	Species	Pediastrum obtusum	x							
Green Algae (Chlorophyta)	Species	Protoderma viride		x					x	
Green Algae (Chlorophyta)	Species	Rhizoclonium hieroglyphicum			x	x				
Green Algae (Chlorophyta)	Genus	Scenedesmus						x		
Green Algae (Chlorophyta)	Species	Scenedesmus abundans	x	x	x	x	x	x	x	x
Green Algae (Chlorophyta)	Species	Scenedesmus acuminatus					x			x
Green Algae (Chlorophyta)	Species	Scenedesmus armatus						x	x	
Green Algae (Chlorophyta)	Species	Scenedesmus bicaudatus				x			x	

Group	ID Level	Taxa	Site Name and Sampling Date							
			412M08627	SMC05694	SMC02622	412M08659	412M08602	LAR2 Washington	412M08642	412CE0104
			5/17/2017	6/26/2014	6/15/2010	7/20/2020	9/30/2015	6/12/2024	6/20/2018	6/23/2009
Green Algae (Chlorophyta)	Species	Scenedesmus communis				x	x			
Green Algae (Chlorophyta)	Species	Scenedesmus denticulatus								x
Green Algae (Chlorophyta)	Species	Scenedesmus dimorphus	x	x		x	x	x	x	x
Green Algae (Chlorophyta)	Species	Scenedesmus dispar		x						
Green Algae (Chlorophyta)	Species	Scenedesmus ellipticus	x			x	x	x	x	x
Green Algae (Chlorophyta)	Species	Scenedesmus intermedius var balatonicus								x
Green Algae (Chlorophyta)	Species	Scenedesmus magnus						x		
Green Algae (Chlorophyta)	Species	Scenedesmus microspina	x					x		
Green Algae (Chlorophyta)	Species	Scenedesmus obliquus		x	x	x	x	x	x	
Green Algae (Chlorophyta)	Species	Scenedesmus opoliensis		x		x		x		
Green Algae (Chlorophyta)	Species	Scenedesmus opoliensis var mononensis			x					
Green Algae (Chlorophyta)	Species	Scenedesmus raciborskii	x			x	x	x		x
Green Algae (Chlorophyta)	Species	Scenedesmus semipulcher						x		
Green Algae (Chlorophyta)	Species	Stauridium tetras		x	x	x				
Green Algae (Chlorophyta)	Species	Stigeoclonium cf lubricum	x							
Green Algae (Chlorophyta)	Species	Stigeoclonium nanum			x					
Green Algae (Chlorophyta)	Species	Stigeoclonium subsecundum				x	x			
Green Algae (Chlorophyta)	Species	Tetraedron caudatum	x							
Green Algae (Chlorophyta)	Species	Tetraedron minimum					x			
Green Algae (Chlorophyta)	Species	Tetrasporidium javanicum				x				
Green Algae (Chlorophyta)	Species	Tetrastrum komarekii						x		
Yellow-Green Algae (Heterookontophyta/Ochrophyta)	Species	Gloeobotrys limneticus					x			
Yellow-Green Algae (Heterookontophyta/Ochrophyta)	Species	Pleurosira laevis						x	x	

Appendix 2. Table 17a. Soft Algae Taxa Occurrence List in LA River Reach 3 - Greenway. X = present

Group	ID Level	Taxa	Site Name and Sampling Date					
			LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway
			9/30/2015	6/20/2018	6/15/2021	6/21/2022	7/11/2023	6/24/2024
Blue-Green Algae (Cyanobacteria)	Species	Aphanocapsa delicatissima	x					
Blue-Green Algae (Cyanobacteria)	Species	Aphanocapsa sp 1	x					
Blue-Green Algae (Cyanobacteria)	Species	Aphanothece cf elabens	x					
Blue-Green Algae (Cyanobacteria)	Species	Aphanothece minutissima	x					
Blue-Green Algae (Cyanobacteria)	Species	Aphanothece saxicola		x				
Blue-Green Algae (Cyanobacteria)	Species	Aphanothece sp 1	x					
Blue-Green Algae (Cyanobacteria)	Species	Chamaesiphon minutus	x					
Blue-Green Algae (Cyanobacteria)	Species	Chroococcopsis fluviatilis		x				
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus minimus	x					
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus minor	x			x	x	
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus minutus	x	x				
Blue-Green Algae (Cyanobacteria)	Class	Cyanophyceae		x	x	x		
Blue-Green Algae (Cyanobacteria)	Species	Cyanophyceae 7	x					
Blue-Green Algae (Cyanobacteria)	Species	Geitlerinema ionicum	x					
Blue-Green Algae (Cyanobacteria)	Species	Heteroleibleinia kossinskajae	x					
Blue-Green Algae (Cyanobacteria)	Species	Heteroleibleinia sp 1		x	x	x	x	x
Blue-Green Algae (Cyanobacteria)	Species	Homoeothrix stagnalis		x				
Blue-Green Algae (Cyanobacteria)	Genus	Leptolyngbya					x	
Blue-Green Algae (Cyanobacteria)	Species	Leptolyngbya foveolarum	x	x		x		x
Blue-Green Algae (Cyanobacteria)	Species	Leptolyngbya sp 1	x					
Blue-Green Algae (Cyanobacteria)	Species	Leptolyngbya tenuis		x				
Blue-Green	Species	Merismopedia punctata						x

Group	ID Level	Taxa	Site Name and Sampling Date					
			LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway
			9/30/2015	6/20/2018	6/15/2021	6/21/2022	7/11/2023	6/24/2024
Algae (Cyanobacteria)								
Blue-Green Algae (Cyanobacteria)	Genus	Phormidium		x				
Blue-Green Algae (Cyanobacteria)	Species	Pleurocapsa minor	x					
Blue-Green Algae (Cyanobacteria)	Species	Pseudanabaena mucicola	x					
Blue-Green Algae (Cyanobacteria)	Species	Symploca elegans	x				x	
Chyrsophyte	Species	Hibberdiales 2	x					
Green Algae (Chlorophyta)	Species	Actinastrum hantzschii	x					
Green Algae (Chlorophyta)	Species	Asterococcus limneticus	x					
Green Algae (Chlorophyta)	Species	Botryosphaerella sudetica	x					
Green Algae (Chlorophyta)	Order	Chaetophorales				x	x	
Green Algae (Chlorophyta)	Species	Chlamydomonadales 1					x	
Green Algae (Chlorophyta)	Species	Chlorella vulgaris		x	x		x	
Green Algae (Chlorophyta)	Genus	Chlorophyta		x				
Green Algae (Chlorophyta)	Species	Chlorophyta 1					x	x
Green Algae (Chlorophyta)	Species	Chlorophyta 20	x					
Green Algae (Chlorophyta)	Species	Cladophora glomerata	x	x				x
Green Algae (Chlorophyta)	Species	Closterium moniliferum						x
Green Algae (Chlorophyta)	Species	Gloeocystis vesiculosa		x				
Green Algae (Chlorophyta)	Species	Kirchneriella obesa						x
Green Algae (Chlorophyta)	Species	Monoraphidium arcuatum	x	x	x			
Green Algae (Chlorophyta)	Species	Monoraphidium contortum	x			x		
Green Algae (Chlorophyta)	Species	Monoraphidium minutum	x	x		x	x	x
Green Algae (Chlorophyta)	Species	Oedogonium sp 3	x					
Green Algae (Chlorophyta)	Genus	Oocystis		x			x	
Green Algae (Chlorophyta)	Species	Oocystis borgei	x		x			
Green Algae (Chlorophyta)	Species	Oocystis parva	x					
Green Algae (Chlorophyta)	Species	Oocystis pusilla	x		x	x		
Green Algae (Chlorophyta)	Species	Oocystis solitaria	x					
Green Algae (Chlorophyta)	Species	Pediastrum boryanum	x	x				
Green Algae (Chlorophyta)	Species	Pediastrum duplex		x	x			x
Green Algae (Chlorophyta)	Species	Pediastrum integrum		x		x		
Green Algae (Chlorophyta)	Genus	Scenedesmus			x	x	x	x
Green Algae (Chlorophyta)	Species	Scenedesmus abundans	x	x	x	x		
Green Algae (Chlorophyta)	Species	Scenedesmus acuminatus	x					
Green Algae (Chlorophyta)	Species	Scenedesmus armatus		x	x			

Group	ID Level	Taxa	Site Name and Sampling Date					
			LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway	LAR3 Greenway
			9/30/2015	6/20/2018	6/15/2021	6/21/2022	7/11/2023	6/24/2024
Green Algae (Chlorophyta)	Species	Scenedesmus bicaudatus				x		x
Green Algae (Chlorophyta)	Species	Scenedesmus communis	x		x	x		x
Green Algae (Chlorophyta)	Species	Scenedesmus dimorphus	x	x	x		x	x
Green Algae (Chlorophyta)	Species	Scenedesmus dispar						
Green Algae (Chlorophyta)	Species	Scenedesmus ellipticus	x	x	x	x	x	
Green Algae (Chlorophyta)	Species	Scenedesmus komarekii	x	x				
Green Algae (Chlorophyta)	Species	Scenedesmus obliquus	x	x	x			
Green Algae (Chlorophyta)	Species	Scenedesmus opoliensis						
Green Algae (Chlorophyta)	Species	Scenedesmus raciborskii	x		x			x
Green Algae (Chlorophyta)	Species	Scenedesmus sp 2		x				
Green Algae (Chlorophyta)	Species	Tetraedron caudatum						
Green Algae (Chlorophyta)	Species	Tetraedron minimum	x	x				
Green Algae (Chlorophyta)	Species	Tetrastrum komarekii	x					
Yellow-Green Algae (Heterookontophyta/Ochrophyta)	Species	Pleurosira laevis		x		x	x	x

Appendix 2. Table 17b. Soft Algae Taxa Occurrence List in LA River Reach 3 – Remaining Downstream Sites. X = present

Group	ID Level	Taxa	Site Name and Sampling Dates					
			LAR3 Riverside 6/11/2024	LAR08663 5/22/2021	LAR3 N. Atwater 6/15/2021	LAR3 N. Atwater 6/21/2022	LAR3 N. Atwater 7/11/2023	LAR3 N. Atwater 6/25/2024
Blue-Green Algae (Cyanobacteria)	Genus	Aphanocapsa					x	
Blue-Green Algae (Cyanobacteria)	Species	Aphanocapsa incerta	x					
Blue-Green Algae (Cyanobacteria)	Genus	Chlorogloea						x
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus minutus				x		
Blue-Green Algae (Cyanobacteria)	Class	Cyanophyceae			x	x		
Blue-Green Algae (Cyanobacteria)	Species	Gloeocapsopsis cyanea	x		x	x		
Blue-Green Algae (Cyanobacteria)	Species	Heteroleibleinia sp 1	x		x		x	x
Blue-Green Algae (Cyanobacteria)	Species	Homoeothrix stagnalis				x		
Blue-Green Algae (Cyanobacteria)	Species	Leptolyngbya notata						x
Blue-Green Algae (Cyanobacteria)	Species	Leptolyngbya sp 1	x					
Blue-Green Algae (Cyanobacteria)	Species	Leptolyngbya tenuis	x		x		x	
Blue-Green Algae (Cyanobacteria)	Genus	Phormidium				x		
Blue-Green Algae (Cyanobacteria)	Species	Tychonema sp 1			x			
Green Algae (Chlorophyta)	Order	Chaetophorales				x	x	x
Green Algae (Chlorophyta)	Genus	Chlamydomonas			x			
Green Algae (Chlorophyta)	Species	Chlorella vulgaris			x		x	
Green Algae (Chlorophyta)	Genus	Chlorophyta		x		x		
Green Algae (Chlorophyta)	Species	Chlorophyta 1					x	x
Green Algae (Chlorophyta)	Species	Chlorophyta 3	x					
Green Algae (Chlorophyta)	Species	Chlorophyta 9	x					x
Green Algae (Chlorophyta)	Genus	Cladophora	x					
Green Algae (Chlorophyta)	Species	Cladophora glomerata					x	x
Green Algae (Chlorophyta)	Species	Closterium moniliferum	x					
Green Algae (Chlorophyta)	Genus	Coelastrum						x
Green Algae (Chlorophyta)	Species	Coelastrum microporum	x					
Green Algae (Chlorophyta)	Genus	Comasiella			x			
Green Algae (Chlorophyta)	Species	Crucigenia tetrapedia	x					
Green Algae (Chlorophyta)	Genus	Gongrosira	x			x		
Green Algae (Chlorophyta)	Species	Monoraphidium contortum			x			
Green Algae (Chlorophyta)	Species	Monoraphidium minutum					x	
Green Algae (Chlorophyta)	Species	Monoraphidium tortile						x
Green Algae (Chlorophyta)	Species	Oedogonium sp 1					x	
Green Algae (Chlorophyta)	Genus	Oocystis	x				x	
Green Algae (Chlorophyta)	Species	Oocystis pusilla				x		
Green Algae (Chlorophyta)	Genus	Pediastrum				x		
Green Algae (Chlorophyta)	Species	Pediastrum boryanum	x				x	
Green Algae (Chlorophyta)	Species	Pediastrum duplex	x		x			x
Green Algae (Chlorophyta)	Species	Rhizoclonium hieroglyphicum						x
Green Algae (Chlorophyta)	Genus	Scenedesmus	x	x	x	x	x	x
Green Algae (Chlorophyta)	Species	Scenedesmus abundans	x		x	x	x	x

Group	ID Level	Taxa	Site Name and Sampling Dates					
			LAR3 Riverside	LAR08663	LAR3 N. Atwater	LAR3 N. Atwater	LAR3 N. Atwater	LAR3 N. Atwater
			6/11/2024	5/22/2021	6/15/2021	6/21/2022	7/11/2023	6/25/2024
Green Algae (Chlorophyta)	Species	Scenedesmus acuminatus						
Green Algae (Chlorophyta)	Species	Scenedesmus armatus	x					x
Green Algae (Chlorophyta)	Species	Scenedesmus communis			x			
Green Algae (Chlorophyta)	Species	Scenedesmus dimorphus	x				x	
Green Algae (Chlorophyta)	Species	Scenedesmus dispar			x			
Green Algae (Chlorophyta)	Species	Scenedesmus ellipticus	x		x	x		
Green Algae (Chlorophyta)	Species	Scenedesmus intermedius	x					
Green Algae (Chlorophyta)	Species	Scenedesmus magnus	x					
Green Algae (Chlorophyta)	Species	Scenedesmus obliquus	x					
Green Algae (Chlorophyta)	Species	Scenedesmus opoliensis	x					
Green Algae (Chlorophyta)	Species	Scenedesmus subspicatus	x					
Green Algae (Chlorophyta)	Species	Tetraedron minimum					x	
Yellow-Green Algae (Heterookontophyta/Ochrophyta)	Species	Hydrosera whampoensis					x	
Yellow-Green Algae (Heterookontophyta/Ochrophyta)	Species	Pleurosira laevis	x	x		x	x	x

Appendix 2. Table 17c. Soft Algae Taxa Occurrence List in LA River Reach 3 – Upstream LAG. X = present

Group	ID Level	Taxa	Site Name and Sampling Date				
			LAR00436	LAR00436	LAR3 Electronics	LAR3 Griffith	LAR3 Griffith
			5/26/2009	6/12/2023	6/11/2024	7/11/2012	6/17/2024
Blue-Green Algae (Cyanobacteria)	Species	Aphanocapsa delicatissima				x	
Blue-Green Algae (Cyanobacteria)	Species	Aphanocapsa planctonica				x	
Blue-Green Algae (Cyanobacteria)	Species	Aphanothece clathrata				x	
Blue-Green Algae (Cyanobacteria)	Species	Calothrix cf fusca				x	
Blue-Green Algae (Cyanobacteria)	Species	Calothrix cf marchica				x	
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus minimus				x	
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus minor			x	x	
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus minutus	x			x	
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus turgidus				x	
Blue-Green Algae (Cyanobacteria)	Class	Cyanophyceae					x
Blue-Green Algae (Cyanobacteria)	Species	Geitlerinema cf amphibium				x	
Blue-Green Algae (Cyanobacteria)	Species	Heteroleibleinia kossinskajae				x	
Blue-Green Algae (Cyanobacteria)	Species	Heteroleibleinia sp 1		x	x		x
Blue-Green Algae (Cyanobacteria)	Species	Homoeothrix cf varians				x	
Blue-Green Algae (Cyanobacteria)	Genus	Komvophoron					x
Blue-Green Algae (Cyanobacteria)	Species	Leptolyngbya foveolarum	x	x	x		
Blue-Green Algae (Cyanobacteria)	Species	Leptolyngbya tenuis			x		x
Blue-Green Algae (Cyanobacteria)	Species	Merismopedia punctata	x		x		
Blue-Green Algae (Cyanobacteria)	Genus	Phormidium		x			
Blue-Green Algae (Cyanobacteria)	Species	Phormidium autumnale				x	
Blue-Green Algae (Cyanobacteria)	Species	Phormidium sp 1	x				
Blue-Green Algae (Cyanobacteria)	Species	Pleurocapsa minor	x			x	
Blue-Green Algae (Cyanobacteria)	Species	Pseudanabaena sp 1		x			
Blue-Green Algae (Cyanobacteria)	Species	Spirulina sp 1				x	
Blue-Green Algae (Cyanobacteria)	Species	Spirulina tenerrima					x
Blue-Green Algae (Cyanobacteria)	Species	Symploca cf elegans				x	
Green Algae (Chlorophyta)	Species	Chlamydomonadopsis sp 1				x	
Green Algae (Chlorophyta)	Species	Chlamydomonas sp 2				x	
Green Algae (Chlorophyta)	Species	Chlorella cf vulgaris				x	
Green Algae (Chlorophyta)	Species	Chlorella sp 1	x				
Green Algae (Chlorophyta)	Genus	Chlorophyta		x			
Green Algae (Chlorophyta)	Species	Chlorophyta 1				x	
Green Algae (Chlorophyta)	Species	Chlorophyta 17	x				
Green Algae (Chlorophyta)	Species	Chlorophyta 3			x		x
Green Algae (Chlorophyta)	Species	Chlorophyta 9			x		
Green Algae (Chlorophyta)	Species	Cladophora glomerata		x	x		x
Green Algae (Chlorophyta)	Species	Coelastrum astroideum				x	
Green Algae (Chlorophyta)	Species	Coelastrum microporum			x		x
Green Algae (Chlorophyta)	Species	Cosmarium subtumidum var minutum				x	
Green Algae (Chlorophyta)	Species	Crucigenia tetrapedia			x		
Green Algae (Chlorophyta)	Species	Crucigeniella apiculata					x
Green Algae (Chlorophyta)	Species	Gloeocystis vesiculosa		x		x	

Group	ID Level	Taxa	Site Name and Sampling Date				
			LAR00436	LAR00436	LAR3 Electronics	LAR3 Griffith	LAR3 Griffith
			5/26/2009	6/12/2023	6/11/2024	7/11/2012	6/17/2024
Green Algae (Chlorophyta)	Species	Golenkinia radiata			x		x
Green Algae (Chlorophyta)	Species	Gongrosira incrustans				x	
Green Algae (Chlorophyta)	Species	Gongrosira sp 1				x	
Green Algae (Chlorophyta)	Species	Hariotina reticulata					x
Green Algae (Chlorophyta)	Species	Kirchneriella obesa					
Green Algae (Chlorophyta)	Species	Monoraphidium arcuatum	x		x	x	x
Green Algae (Chlorophyta)	Species	Monoraphidium contortum	x	x	x		x
Green Algae (Chlorophyta)	Species	Monoraphidium minutum	x			x	x
Green Algae (Chlorophyta)	Species	Monoraphidium tortile			x		x
Green Algae (Chlorophyta)	Species	Oedogonium sp 1		x			
Green Algae (Chlorophyta)	Species	Oocystis parva				x	
Green Algae (Chlorophyta)	Species	Oocystis solitaria				x	
Green Algae (Chlorophyta)	Species	Oocystis sp 1	x				
Green Algae (Chlorophyta)	Species	Pediastrum boryanum		x		x	
Green Algae (Chlorophyta)	Species	Pediastrum duplex		x	x		x
Green Algae (Chlorophyta)	Species	Pediastrum duplex var rugulosum				x	
Green Algae (Chlorophyta)	Species	Pediastrum integrum	x	x		x	
Green Algae (Chlorophyta)	Species	Pediastrum simplex				x	
Green Algae (Chlorophyta)	Species	Pediastrum sp 1				x	
Green Algae (Chlorophyta)	Species	Protoderma viride		x	x		
Green Algae (Chlorophyta)	Species	Scenedesmus abundans	x	x	x	x	x
Green Algae (Chlorophyta)	Species	Scenedesmus armatus			x	x	x
Green Algae (Chlorophyta)	Species	Scenedesmus bicaudatus			x		x
Green Algae (Chlorophyta)	Species	Scenedesmus brasiliensis			x		
Green Algae (Chlorophyta)	Species	Scenedesmus circumfusus		x			
Green Algae (Chlorophyta)	Species	Scenedesmus communis	x	x		x	
Green Algae (Chlorophyta)	Species	Scenedesmus dimorphus	x	x	x	x	x
Green Algae (Chlorophyta)	Species	Scenedesmus dispar					
Green Algae (Chlorophyta)	Species	Scenedesmus ellipticus	x	x	x	x	x
Green Algae (Chlorophyta)	Species	Scenedesmus intermedius			x	x	
Green Algae (Chlorophyta)	Species	Scenedesmus komarekii				x	
Green Algae (Chlorophyta)	Species	Scenedesmus microspina				x	
Green Algae (Chlorophyta)	Species	Scenedesmus obliquus		x		x	x
Green Algae (Chlorophyta)	Species	Scenedesmus opoliensis	x		x	x	x
Green Algae (Chlorophyta)	Species	Scenedesmus raciborskii	x	x	x		
Green Algae (Chlorophyta)	Species	Selenastrum bibraianum					x
Green Algae (Chlorophyta)	Species	Tetraedron caudatum				x	
Green Algae (Chlorophyta)	Species	Tetraedron minimum				x	
Green Algae (Chlorophyta)	Species	Tetrastrum komarekii					x
Yellow-Green Algae (Heterookontophyta/Ochrophyta)	Species	Pleurosira laevis			x		x

Appendix 2. Table 18a. Soft Algae Taxa Occurrence List in LA River Reach 4. X = present

Group	ID Level	Taxa	Site Name and Sampling Date					
			LAR4 Zoo 6/12/2023	LAR4 Zoo 6/17/2024	LAR08656 7/14/2020	LAR02804 6/20/2011	412M08597 7/16/2015	LAR08661 7/6/2021
Blue-Green Algae (Cyanobacteria)	Species	Aphanocapsa delicatissima					x	
Blue-Green Algae (Cyanobacteria)	Species	Aphanocapsa holsatica						
Blue-Green Algae (Cyanobacteria)	Species	Aphanocapsa sp 1	x					x
Blue-Green Algae (Cyanobacteria)	Species	Aphanothece cf elabens					x	
Blue-Green Algae (Cyanobacteria)	Species	Aphanothece clathrata					x	
Blue-Green Algae (Cyanobacteria)	Species	Aphanothece minutissima					x	
Blue-Green Algae (Cyanobacteria)	Species	Aphanothece sp 1					x	
Blue-Green Algae (Cyanobacteria)	Species	Chamaesiphon minutus	x		x			
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus dispersus				x		
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus minimus					x	
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus minor					x	
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus minutus					x	
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus vacuolatus					x	
Blue-Green Algae (Cyanobacteria)	Species	Geitlerinema acuiforme					x	
Blue-Green Algae (Cyanobacteria)	Species	Heteroleibleinia kossinskajae				x	x	
Blue-Green Algae (Cyanobacteria)	Species	Heteroleibleinia sp 1	x		x			x
Blue-Green Algae (Cyanobacteria)	Species	Homoeothrix stagnalis			x			
Blue-Green Algae (Cyanobacteria)	Species	Homoeothrix varians				x		
Blue-Green Algae (Cyanobacteria)	Species	Leptolyngbya foveolarum	x	x		x	x	x
Blue-Green Algae (Cyanobacteria)	Species	Leptolyngbya sp 1					x	
Blue-Green Algae (Cyanobacteria)	Species	Leptolyngbya tenuis		x				x
Blue-Green Algae (Cyanobacteria)	Species	Merismopedia punctata	x		x			x
Blue-Green Algae (Cyanobacteria)	Species	Merismopedia tenuissima					x	
Blue-Green Algae (Cyanobacteria)	Genus	Phormidium	x	x				x
Blue-Green Algae (Cyanobacteria)	Species	Phormidium autumnale					x	
Blue-Green Algae (Cyanobacteria)	Species	Planktolyngbya limnetica					x	
Blue-Green Algae (Cyanobacteria)	Species	Pleurocapsa minor				x	x	x
Blue-Green Algae (Cyanobacteria)	Species	Schizothrix fragilis					x	
Blue-Green Algae (Cyanobacteria)	Species	Spirulina tenerrima		x				
Blue-Green Algae (Cyanobacteria)	Species	Symploca elegans						x
Blue-Green Algae (Cyanobacteria)	Species	Xenococcus gracilis	x					
Cryptophytes (Cryptophyta)	Genus	Cryptomonas		x	x			
Cryptophytes (Cryptophyta)	Species	Cryptomonas cf ovata				x		
Euglenoids (Euglenophyta)	Genus	Phacus	x					
Green Algae (Chlorophyta)	Species	Actinastrum hantzschii				x	x	
Green Algae (Chlorophyta)	Species	Carteria sp 1					x	
Green Algae (Chlorophyta)	Order	Chaetophorales		x				x
Green Algae (Chlorophyta)	Genus	Chlamydomonas						x
Green Algae (Chlorophyta)	Species	Chlamydomonas globosa				x		
Green Algae (Chlorophyta)	Species	Chlorella sp 1				x		
Green Algae (Chlorophyta)	Genus	Chlorophyta	x		x			x
Green Algae (Chlorophyta)	Species	Chlorophyta 1						

Group	ID Level	Taxa	Site Name and Sampling Date					
			LAR4 Zoo	LAR4 Zoo	LAR08656	LAR02804	412M08597	LAR08661
			6/12/2023	6/17/2024	7/14/2020	6/20/2011	7/16/2015	7/6/2021
Green Algae (Chlorophyta)	Species	Chlorophyta 3		x				
Green Algae (Chlorophyta)	Species	Cladophora glomerata	x	x		x	x	x
Green Algae (Chlorophyta)	Genus	Coelastrum	x					
Green Algae (Chlorophyta)	Species	Coelastrum astroideum				x	x	
Green Algae (Chlorophyta)	Species	Coelastrum microporum		x		x		
Green Algae (Chlorophyta)	Genus	Crucigenia			x			x
Green Algae (Chlorophyta)	Species	Crucigenia tetrapedia			x			
Green Algae (Chlorophyta)	Species	Crucigeniella apiculata		x				
Green Algae (Chlorophyta)	Species	Golenkinia radiata		x	x			
Green Algae (Chlorophyta)	Species	Lobomonas sp 2				x		
Green Algae (Chlorophyta)	Species	Monoraphidium arcuatum		x		x	x	
Green Algae (Chlorophyta)	Species	Monoraphidium contortum	x	x	x			
Green Algae (Chlorophyta)	Species	Monoraphidium minutum	x	x	x	x	x	
Green Algae (Chlorophyta)	Species	Monoraphidium tortile		x				
Green Algae (Chlorophyta)	Genus	Oedogonium	x					
Green Algae (Chlorophyta)	Species	Oedogonium sp 1	x					x
Green Algae (Chlorophyta)	Species	Oedogonium sp 2					x	
Green Algae (Chlorophyta)	Genus	Oocystis						x
Green Algae (Chlorophyta)	Species	Oocystis parva		x	x			
Green Algae (Chlorophyta)	Species	Oocystis pusilla					x	
Green Algae (Chlorophyta)	Species	Oocystis solitaria						x
Green Algae (Chlorophyta)	Species	Pediastrum boryanum	x			x	x	
Green Algae (Chlorophyta)	Species	Pediastrum boryanum var longicorne				x		
Green Algae (Chlorophyta)	Species	Pediastrum duplex	x	x	x		x	
Green Algae (Chlorophyta)	Species	Pediastrum duplex var rugulosum				x	`	
Green Algae (Chlorophyta)	Species	Pediastrum integrum	x	x		x		
Green Algae (Chlorophyta)	Species	Rhizoclonium hieroglyphicum						x
Green Algae (Chlorophyta)	Genus	Scenedesmus						x
Green Algae (Chlorophyta)	Species	Scenedesmus abundans	x	x	x	x	x	x
Green Algae (Chlorophyta)	Species	Scenedesmus acuminatus		x				
Green Algae (Chlorophyta)	Species	Scenedesmus armatus		x	x			
Green Algae (Chlorophyta)	Species	Scenedesmus bicaudatus		x	x		x	x
Green Algae (Chlorophyta)	Species	Scenedesmus cf denticulatus					x	
Green Algae (Chlorophyta)	Species	Scenedesmus circumfusus					x	x
Green Algae (Chlorophyta)	Species	Scenedesmus communis	x			x	x	
Green Algae (Chlorophyta)	Species	Scenedesmus denticulatus			x	x		
Green Algae (Chlorophyta)	Species	Scenedesmus dimorphus	x	x	x	x	x	
Green Algae (Chlorophyta)	Species	Scenedesmus ellipticus	x	x	x		x	x
Green Algae (Chlorophyta)	Species	Scenedesmus intermedius		x				
Green Algae (Chlorophyta)	Species	Scenedesmus komarekii					x	x
Green Algae (Chlorophyta)	Species	Scenedesmus obliquus	x	x		x	x	
Green Algae (Chlorophyta)	Species	Scenedesmus opoliensis	x	x	x	x		x

Group	ID Level	Taxa	Site Name and Sampling Date					
			LAR4 Zoo	LAR4 Zoo	LAR08656	LAR02804	412M08597	LAR08661
			6/12/2023	6/17/2024	7/14/2020	6/20/2011	7/16/2015	7/6/2021
Green Algae (Chlorophyta)	Species	Scenedesmus opoliensis var carinatus				x		
Green Algae (Chlorophyta)	Species	Scenedesmus pannonicus				x		
Green Algae (Chlorophyta)	Species	Scenedesmus raciborskii	x					
Green Algae (Chlorophyta)	Species	Scenedesmus semipulcher	x					
Green Algae (Chlorophyta)	Species	Sphaerocystis planctonica				x		
Green Algae (Chlorophyta)	Species	Spirogyra sp 4					x	
Green Algae (Chlorophyta)	Species	Tetrastrum komarekii		x				
Green Algae (Chlorophyta)	Species	Trebouxia sp 1				x		
Pyrrophycophyta	Family	Dinophyceae			x			
Yellow-Green Algae (Heterookontophyta/Ochrophyta)	Species	Hydrosera whampoensis		x	x			x
Yellow-Green Algae (Heterookontophyta/Ochrophyta)	Species	Pleurosira laevis	x	x	x			x

Appendix 2. Table 18b. Soft Algae Taxa Occurrence List in LA River Reach 4 - Kester. X = present

Group	ID Level	Taxa	Site Name and Sampling Date							
			LAR4 Kester 7/16/2015	LAR4 Kester 6/21/2016	LAR4 Kester 5/31/2017	LAR4 Kester 5/30/2018	LAR4 Kester 7/15/2019	LAR4 Kester 7/14/2020	LAR4 Kester 6/15/2021	LAR4 Kester 6/26/2024
Blue-Green Algae (Cyanobacteria)	Species	Aphanocapsa delicatissima	x	x						
Blue-Green Algae (Cyanobacteria)	Species	Aphanocapsa holsatica		x						
Blue-Green Algae (Cyanobacteria)	Species	Aphanocapsa sp 1	x	x		x				
Blue-Green Algae (Cyanobacteria)	Species	Aphanothece minutissima	x	x						
Blue-Green Algae (Cyanobacteria)	Species	Bacularia vermicularis			x					
Blue-Green Algae (Cyanobacteria)	Species	Chamaesiphon incrustans			x					
Blue-Green Algae (Cyanobacteria)	Species	Chamaesiphon minimus					x			
Blue-Green Algae (Cyanobacteria)	Species	Chamaesiphon minutus		x	x					
Blue-Green Algae (Cyanobacteria)	Species	Chroococcopsis epiphytica			x					
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus minimus	x	x	x	x				
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus minor	x	x		x				
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus minutus	x	x						
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus sp 1			x					
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus sp 2			x					
Blue-Green Algae (Cyanobacteria)	Species	Geitlerinema acuiforme		x						
Blue-Green Algae (Cyanobacteria)	Species	Geitlerinema acutissimum		x						
Blue-Green Algae (Cyanobacteria)	Species	Geitlerinema amphibium	x							
Blue-Green Algae (Cyanobacteria)	Species	Geitlerinema ionicum	x							
Blue-Green Algae (Cyanobacteria)	Species	Geitlerinema sp 2			x					
Blue-Green Algae (Cyanobacteria)	Genus	Gloeocapsa						x		
Blue-Green Algae (Cyanobacteria)	Species	Gloeocapsopsis cyanea						x	x	
Blue-Green Algae (Cyanobacteria)	Species	Heteroleibleinia kossinskajae	x							

Group	ID Level	Taxa	Site Name and Sampling Date							
			LAR4 Kester 7/16/2015	LAR4 Kester 6/21/2016	LAR4 Kester 5/31/2017	LAR4 Kester 5/30/2018	LAR4 Kester 7/15/2019	LAR4 Kester 7/14/2020	LAR4 Kester 6/15/2021	LAR4 Kester 6/26/2024
Blue-Green Algae (Cyanobacteria)	Species	Heteroleibleinia sp 1		x	x	x	x	x	x	x
Blue-Green Algae (Cyanobacteria)	Genus	Homoeothrix				x				
Blue-Green Algae (Cyanobacteria)	Species	Homoeothrix janthina			x					
Blue-Green Algae (Cyanobacteria)	Species	Homoeothrix stagnalis						x		
Blue-Green Algae (Cyanobacteria)	Species	Leibleinia epiphytica			x					
Blue-Green Algae (Cyanobacteria)	Species	Leptolyngbya foveolarum	x	x						x
Blue-Green Algae (Cyanobacteria)	Species	Leptolyngbya tenuis				x				
Blue-Green Algae (Cyanobacteria)	Species	Merismopedia glauca	x	x						
Blue-Green Algae (Cyanobacteria)	Species	Merismopedia punctata				x		x		
Blue-Green Algae (Cyanobacteria)	Species	Merismopedia tenuissima	x		x	x				
Blue-Green Algae (Cyanobacteria)	Species	Microcoleus autumnalis		x						
Blue-Green Algae (Cyanobacteria)	Genus	Phormidium						x	x	
Blue-Green Algae (Cyanobacteria)	Species	Phormidium autumnale	x							
Blue-Green Algae (Cyanobacteria)	Species	Phormidium chalybeum		x						
Blue-Green Algae (Cyanobacteria)	Species	Phormidium sp 5			x					
Blue-Green Algae (Cyanobacteria)	Species	Pleurocapsa minor	x	x						
Blue-Green Algae (Cyanobacteria)	Species	Schizothrix fragilis	x	x						
Blue-Green Algae (Cyanobacteria)	Species	Spirulina corakiana		x						
Blue-Green Algae (Cyanobacteria)	Species	Spirulina sp 1						x		
Blue-Green Algae (Cyanobacteria)	Species	Spirulina subtilissima	x							
Blue-Green Algae (Cyanobacteria)	Species	Symploca sp 1				x				
Cryptophycophyta	Genus	Chroomonas						x		
Cryptophycophyta	Species	Chroomonas sp 5			x				x	
Cryptophytes (Cryptophyta)	Species	Cryptomonas anomala					x			
Cryptophytes (Cryptophyta)	Species	Cryptomonas erosa		x					x	

Group	ID Level	Taxa	Site Name and Sampling Date							
			LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester
			7/16/2015	6/21/2016	5/31/2017	5/30/2018	7/15/2019	7/14/2020	6/15/2021	6/26/2024
Euglenoids (Euglenophyta)	Species	Discoplastis spathirhyncha			x					
Euglenoids (Euglenophyta)	Genus	Euglena							x	
Euglenoids (Euglenophyta)	Genus	Trachelomonas							x	
Golden-Brown Algae (Chrysophycophytes)	Species	Epipyxis sp 1								x
Green Algae (Chlorophyta)	Species	Ankistrodesmus fusiformis			x					
Green Algae (Chlorophyta)	Species	Botryosphaerella sudetica		x						
Green Algae (Chlorophyta)	Genus	Carteria							x	
Green Algae (Chlorophyta)	Species	Carteria sp 1			x					
Green Algae (Chlorophyta)	Order	Chaetophorales							x	
Green Algae (Chlorophyta)	Genus	Chlamydomonas				x			x	
Green Algae (Chlorophyta)	Species	Chlamydomonas debaryana					x			
Green Algae (Chlorophyta)	Species	Chlamydomonas ehrenbergii		x	x					
Green Algae (Chlorophyta)	Species	Chlamydomonas globosa			x					
Green Algae (Chlorophyta)	Species	Chlamydomonas pila		x						
Green Algae (Chlorophyta)	Species	Chlamydomonas snowiae			x					
Green Algae (Chlorophyta)	Species	Chlamydomonas sp 1							x	
Green Algae (Chlorophyta)	Species	Chlorella vulgaris						x		
Green Algae (Chlorophyta)	Genus	Chlorophyta				x	x	x	x	
Green Algae (Chlorophyta)	Species	Chlorophyta 1	x	x						
Green Algae (Chlorophyta)	Species	Chlorophyta 12		x						
Green Algae (Chlorophyta)	Species	Chlorophyta 3							x	
Green Algae (Chlorophyta)	Species	Chlorophyta 8		x						
Green Algae (Chlorophyta)	Species	Cladophora glomerata			x			x		x
Green Algae (Chlorophyta)	Species	Coelastrum astroideum	x					x		
Green Algae (Chlorophyta)	Species	Coelastrum microporum			x	x			x	
Green Algae (Chlorophyta)	Species	Comasiella arcuata var platydisca			x	x				
Green Algae (Chlorophyta)	Species	Cosmarium subcrenatum	x							

Group	ID Level	Taxa	Site Name and Sampling Date							
			LAR4 Kester 7/16/2015	LAR4 Kester 6/21/2016	LAR4 Kester 5/31/2017	LAR4 Kester 5/30/2018	LAR4 Kester 7/15/2019	LAR4 Kester 7/14/2020	LAR4 Kester 6/15/2021	LAR4 Kester 6/26/2024
Green Algae (Chlorophyta)	Genus	Crucigenia						x		
Green Algae (Chlorophyta)	Species	Crucigenia tetrapedia						x		
Green Algae (Chlorophyta)	Species	Crucigeniella apiculata			x					
Green Algae (Chlorophyta)	Species	Dictyosphaerium ehrenbergianum		x						
Green Algae (Chlorophyta)	Species	Dictyosphaerium pulchellum						x		
Green Algae (Chlorophyta)	Species	Gloeocystis vesiculosa		x						
Green Algae (Chlorophyta)	Species	Golenkinia radiata			x	x	x	x		
Green Algae (Chlorophyta)	Species	Kirchneriella obesa			x					
Green Algae (Chlorophyta)	Species	Monoraphidium arcuatum	x	x				x		
Green Algae (Chlorophyta)	Species	Monoraphidium contortum	x	x	x					x
Green Algae (Chlorophyta)	Species	Monoraphidium minutum	x	x				x		
Green Algae (Chlorophyta)	Species	Monoraphidium tortile				x				x
Green Algae (Chlorophyta)	Genus	Oocystis							x	x
Green Algae (Chlorophyta)	Species	Oocystis borgei				x			x	
Green Algae (Chlorophyta)	Species	Oocystis parva	x					x		
Green Algae (Chlorophyta)	Species	Oocystis pusilla	x							
Green Algae (Chlorophyta)	Species	Oocystis solitaria	x							
Green Algae (Chlorophyta)	Species	Pediastrum boryanum	x	x						
Green Algae (Chlorophyta)	Species	Pediastrum duplex				x		x	x	x
Green Algae (Chlorophyta)	Species	Protoderma viride			x					
Green Algae (Chlorophyta)	Species	Rhizoclonium hieroglyphicum		x						
Green Algae (Chlorophyta)	Genus	Scenedesmus				x			x	x
Green Algae (Chlorophyta)	Species	Scenedesmus abundans	x	x	x	x	x	x	x	
Green Algae (Chlorophyta)	Species	Scenedesmus aculeolatus			x					
Green Algae (Chlorophyta)	Species	Scenedesmus acuminatus	x	x	x	x				

Group	ID Level	Taxa	Site Name and Sampling Date							
			LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester	LAR4 Kester
			7/16/2015	6/21/2016	5/31/2017	5/30/2018	7/15/2019	7/14/2020	6/15/2021	6/26/2024
Green Algae (Chlorophyta)	Species	Scenedesmus armatus	x		x	x		x	x	x
Green Algae (Chlorophyta)	Species	Scenedesmus bicaudatus		x	x	x		x	x	
Green Algae (Chlorophyta)	Species	Scenedesmus communis	x	x			x			
Green Algae (Chlorophyta)	Species	Scenedesmus denticulatus						x	x	
Green Algae (Chlorophyta)	Species	Scenedesmus dimorphus	x			x	x	x		
Green Algae (Chlorophyta)	Species	Scenedesmus ellipticus	x	x	x	x		x		x
Green Algae (Chlorophyta)	Species	Scenedesmus flavescens				x				
Green Algae (Chlorophyta)	Species	Scenedesmus komarekii	x	x						
Green Algae (Chlorophyta)	Species	Scenedesmus microspina			x					
Green Algae (Chlorophyta)	Species	Scenedesmus obliquus	x			x			x	
Green Algae (Chlorophyta)	Species	Scenedesmus opoliensis		x	x	x		x	x	
Green Algae (Chlorophyta)	Species	Scenedesmus sp 2			x					
Green Algae (Chlorophyta)	Genus	Sorastrum							x	
Green Algae (Chlorophyta)	Species	Sphaerocystis planctonica		x						
Green Algae (Chlorophyta)	Species	Tetrastrum komarekii	x							
Miozoa (Dinophyceae)	Family	Peridiniaceae		x					x	
Miozoa (Dinophyceae)	Species	Peridiniaceae 1		x						
Yellow-Green Algae (Heterookontophyta/Ochrophyta)	Species	Hydrosera whampoensis				x		x		x
Yellow-Green Algae (Heterookontophyta/Ochrophyta)	Species	Mallomonas sp 3		x						
Yellow-Green Algae (Heterookontophyta/Ochrophyta)	Species	Pleurosira laevis					x	x		x

Appendix 2. Table 19. Soft Algae Taxa Occurrence List in LA River Reach 5. X = present

Group	ID Level	Taxa	Site Name and Sampling Date
			LAR5 Balboa
			6/24/2024
Blue-Green Algae (Cyanobacteria)	Species	Gloeocapsopsis pleurocapsoides	x
Blue-Green Algae (Cyanobacteria)	Species	Heteroleibleinia sp 1	x
Blue-Green Algae (Cyanobacteria)	Species	Homoeothrix sp 1	x
Blue-Green Algae (Cyanobacteria)	Species	Merismopedia punctata	x
Cryptophytes (Cryptophyta)	Species	Cryptomonas anomala	x
Green Algae (Chlorophyta)	Order	Chaetophorales	x
Green Algae (Chlorophyta)	Species	Cladophora glomerata	x
Green Algae (Chlorophyta)	Species	Monoraphidium arcuatum	x
Green Algae (Chlorophyta)	Species	Monoraphidium contortum	x
Green Algae (Chlorophyta)	Species	Pediastrum integrum	x
Green Algae (Chlorophyta)	Species	Scenedesmus abundans	x
Green Algae (Chlorophyta)	Species	Scenedesmus armatus	x
Green Algae (Chlorophyta)	Species	Scenedesmus raciborskii	x
Yellow-Green Algae (Heterookontophyta/Ochrophyta)	Species	Hydrosera whampoensis	x
Yellow-Green Algae (Heterookontophyta/Ochrophyta)	Species	Pleurosira laevis	x

Appendix 2. Table 20. Soft Algae Taxa Occurrence List in LA River Reach 6. X = present

Group	ID Level	Taxa	Site Name and Sampling Date						
			412M0672	412M08688	LAR01208	LAR01208	LAR01208	412PS0052	SMC02680
			7/6/2021	7/19/2022	6/8/2010	7/14/2020	8/14/2023	7/19/2022	6/3/2014
Blue-Green Algae (Cyanobacteria)	Species	Aphanocapsa incerta							x
Blue-Green Algae (Cyanobacteria)	Species	Aphanothece stagnina		x					
Blue-Green Algae (Cyanobacteria)	Genus	Calothrix				x	x		
Blue-Green Algae (Cyanobacteria)	Species	Calothrix fusca			x				
Blue-Green Algae (Cyanobacteria)	Species	Calothrix parietina							x
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus minor		x		x		x	
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus minutus		x			x		
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus turgidus							x
Blue-Green Algae (Cyanobacteria)	Class	Cyanophyceae	x	x			x	x	
Blue-Green Algae (Cyanobacteria)	Species	Geitlerinema amphibium							x
Blue-Green Algae (Cyanobacteria)	Species	Gloeocapsopsis cyanea		x				x	x
Blue-Green Algae (Cyanobacteria)	Species	Heteroleibleinia kossinskajae			x				
Blue-Green Algae (Cyanobacteria)	Species	Heteroleibleinia sp 1	x			x			
Blue-Green Algae (Cyanobacteria)	Genus	Homoeothrix							x
Blue-Green Algae (Cyanobacteria)	Species	Homoeothrix stagnalis	x			x		x	
Blue-Green Algae (Cyanobacteria)	Species	Leptolyngbya foveolarum			x	x			
Blue-Green Algae (Cyanobacteria)	Species	Leptolyngbya granulifera							x
Blue-Green Algae (Cyanobacteria)	Species	Leptolyngbya tenuis							x
Blue-Green Algae (Cyanobacteria)	Species	Merismopedia glauca		x				x	
Blue-Green Algae (Cyanobacteria)	Species	Merismopedia punctata	x		x	x	x		x
Blue-Green Algae (Cyanobacteria)	Species	Merismopedia tenuissima		x	x			x	

Group	ID Level	Taxa	Site Name and Sampling Date						
			412M0672	412M08688	LAR01208	LAR01208	LAR01208	412PS0052	SMC02680
			7/6/2021	7/19/2022	6/8/2010	7/14/2020	8/14/2023	7/19/2022	6/3/2014
Blue-Green Algae (Cyanobacteria)	Genus	Phormidium				x			
Blue-Green Algae (Cyanobacteria)	Species	Planktolyngbya limnetica							x
Blue-Green Algae (Cyanobacteria)	Species	Pseudanabaena mucicola							x
Blue-Green Algae (Cyanobacteria)	Species	Rivularia biasolettiana		x				x	
Blue-Green Algae (Cyanobacteria)	Species	Rivularia cf biasolettiana		x				x	
Blue-Green Algae (Cyanobacteria)	Species	Schizothrix lacustris					x		
Green Algae (Chlorophyta)	Species	Chlamydomonadopsis sp 1			x				
Green Algae (Chlorophyta)	Species	Chlorella vulgaris	x						
Green Algae (Chlorophyta)	Genus	Chlorophyta				x		x	
Green Algae (Chlorophyta)	Species	Cladophora glomerata	x	x	x	x			x
Green Algae (Chlorophyta)	Genus	Coelastrum							x
Green Algae (Chlorophyta)	Species	Cosmarium granatum							x
Green Algae (Chlorophyta)	Species	Cosmarium laeve	x	x		x	x	x	
Green Algae (Chlorophyta)	Species	Cosmarium sportella var subnudum							x
Green Algae (Chlorophyta)	Species	Cosmarium subcrenatum					x		
Green Algae (Chlorophyta)	Species	Gongrosira schmidlei			x				
Green Algae (Chlorophyta)	Genus	Kirchneriella							x
Green Algae (Chlorophyta)	Species	Monoraphidium minutum	x	x	x	x	x	x	
Green Algae (Chlorophyta)	Species	Oedogonium sp 1	x						
Green Algae (Chlorophyta)	Species	Oedogonium sp 3							x
Green Algae (Chlorophyta)	Genus	Oocystis					x		
Green Algae (Chlorophyta)	Species	Oocystis parva	x			x			x

Group	ID Level	Taxa	Site Name and Sampling Date						
			412M0672	412M08688	LAR01208	LAR01208	LAR01208	412PS0052	SMC02680
			7/6/2021	7/19/2022	6/8/2010	7/14/2020	8/14/2023	7/19/2022	6/3/2014
Green Algae (Chlorophyta)	Species	Oocystis pusilla		x				x	
Green Algae (Chlorophyta)	Species	Palmellopsis gelatinosa							x
Green Algae (Chlorophyta)	Species	Pediastrum boryanum			x		x		
Green Algae (Chlorophyta)	Species	Pediastrum boryanum var cornutum	x						
Green Algae (Chlorophyta)	Species	Pediastrum boryanum var longicorne							x
Green Algae (Chlorophyta)	Species	Pediastrum integrum			x				x
Green Algae (Chlorophyta)	Species	Rhizoclonium hieroglyphicum							x
Green Algae (Chlorophyta)	Genus	Scenedesmus						x	
Green Algae (Chlorophyta)	Species	Scenedesmus abundans	x	x	x	x	x		x
Green Algae (Chlorophyta)	Species	Scenedesmus aculeolatus							x
Green Algae (Chlorophyta)	Species	Scenedesmus armatus	x						
Green Algae (Chlorophyta)	Species	Scenedesmus dimorphus	x			x	x		x
Green Algae (Chlorophyta)	Species	Scenedesmus dispar				x			x
Green Algae (Chlorophyta)	Species	Scenedesmus ellipticus	x			x	x		
Green Algae (Chlorophyta)	Species	Scenedesmus komarekii							x
Green Algae (Chlorophyta)	Species	Scenedesmus microspina							x
Green Algae (Chlorophyta)	Species	Scenedesmus obliquus	x		x	x			x
Green Algae (Chlorophyta)	Species	Scenedesmus opoliensis	x				x		
Green Algae (Chlorophyta)	Species	Scenedesmus raciborskii							x
Green Algae (Chlorophyta)	Species	Scenedesmus sp 2	x						
Green Algae (Chlorophyta)	Species	Tetraedron minimum							x

Appendix 2. Table 21. Soft Algae Taxa Occurrence List in LA River Reach Burbank Western Channel. X = present

Group	ID Level	Taxa	Site Name and Sampling Date		
			BWC Riverside	BWC (Down)	BWC (Up)
			6/27/2024	6/27/2024	6/27/2024
Blue-Green Algae (Cyanobacteria)	Species	Chamaesiphon minutus		x	
Blue-Green Algae (Cyanobacteria)	Species	Chlorogloea rivularis		x	
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus minutus		x	
Blue-Green Algae (Cyanobacteria)	Species	Chroococcus sp 1		x	x
Blue-Green Algae (Cyanobacteria)	Species	Heteroleibleinia sp 1	x	x	x
Blue-Green Algae (Cyanobacteria)	Genus	Homoeothrix	x		
Blue-Green Algae (Cyanobacteria)	Species	Leibleinia epiphytica			x
Blue-Green Algae (Cyanobacteria)	Species	Leptolyngbya foveolarum	x	x	x
Blue-Green Algae (Cyanobacteria)	Species	Merismopedia punctata		x	x
Blue-Green Algae (Cyanobacteria)	Species	Pseudanabaena sp 1			x
Blue-Green Algae (Cyanobacteria)	Species	Spirulina sp 1			x
Blue-Green Algae (Cyanobacteria)	Species	Symploca sp 1		x	
Green Algae (Chlorophyta)	Species	Chaetophorales 2	x	x	x
Green Algae (Chlorophyta)	Species	Cladophora glomerata		x	x
Green Algae (Chlorophyta)	Species	Coelastrum microporum		x	x
Green Algae (Chlorophyta)	Species	Monoraphidium arcuatum			x
Green Algae (Chlorophyta)	Species	Monoraphidium griffithii			x
Green Algae (Chlorophyta)	Species	Monoraphidium minutum	x	x	x
Green Algae (Chlorophyta)	Species	Oocystis parva		x	x
Green Algae (Chlorophyta)	Species	Pediastrum integrum			x
Green Algae (Chlorophyta)	Species	Scenedesmus abundans	x		x
Green Algae (Chlorophyta)	Species	Scenedesmus arthrodesmiformis			x
Green Algae (Chlorophyta)	Species	Scenedesmus dimorphus	x	x	x
Green Algae (Chlorophyta)	Species	Scenedesmus ellipticus		x	x
Green Algae (Chlorophyta)	Species	Scenedesmus raciborskii			x
Green Algae (Chlorophyta)	Species	Sphaerocystis planctonica			x
Green Algae (Chlorophyta)	Species	Tetraedron minimum		x	x
Ochrophyta	Species	Chytridiochloris acus		x	

Appendix 3. Monitoring Station Photographs

Donald C. Tillman Water Reclamation Plant Stations

Los Angeles River (LAR) Reach 5

Monitoring Station:
LAR5 Balboa
View: Upstream
Location:
34.1795, -118.5003
Site Description:
LAR Reach 5 at Balboa Blvd. Bioassessment site.

Lake Balboa

Monitoring Station:
Lake Balboa Spillway
View: Downstream
Location:
34.1774, -118.4928
Site Description:
Lake Balboa Spillway.

LAR Reach 5

Monitoring Station:
LAR5 Hayvenhurst
View: Downstream
Location:
34.1757, -118.4908
Site Description:
LAR Reach 5 downstream of Hayvenhurst Channel. Bioassessment site.

LAR Reach 5

Monitoring Station:
LAR5 Burbank
View: Across
Location:
34.1709, -118.4778
Site Description:
LAR Reach 5 at Burbank Blvd.

Wildlife Lake

Monitoring Station:
Wildlife Lake Spillway
View: Downstream
Location:
34.1725, -118.4722
Site Description:
Wildlife Lake Spillway

LAR Reach 5

Monitoring Station:
LAR5 Haskell
View: Upstream
Location:
34.1673, -118.4740
Site Description:
LAR Reach 5 downstream of Haskell Flood Control Channel.

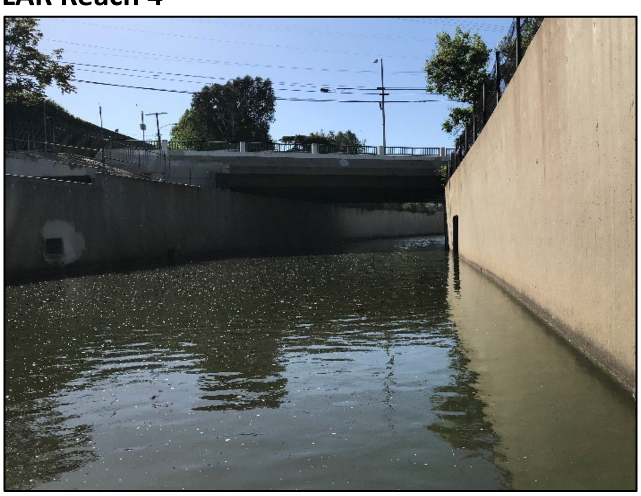
DCTWRP

Monitoring Station:
DCT Eff 001
View: Upstream
Location:
34.1803, -118.4803
Site Description:
DCTWRP Effluent (001A).

DCTWRP

Monitoring Station:
DCT Eff 008
View: Downstream
Location:
34.1648, -118.4718
Site Description:
DCTWRP Effluent (008).

LAR Reach 4



Monitoring Station:
LAR4 Kester
View: Upstream
Location:
34.1591, -118.4562
Site Description:
Downstream of LAR Reach 4 at Kester (LARWMP LAR0232).
Bioassessment site.

LAR Reach 4

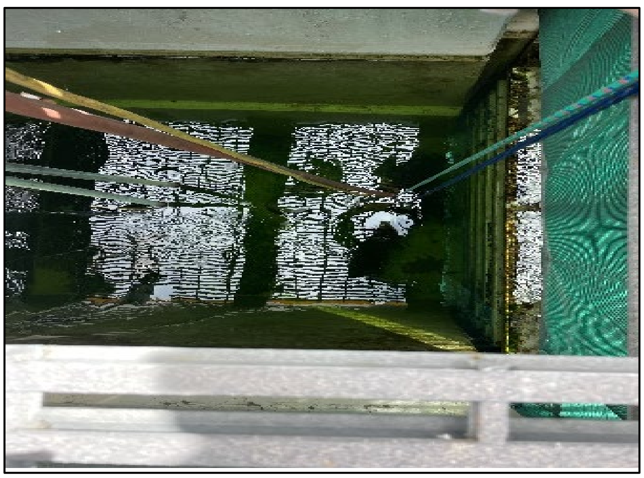
Monitoring Station:
LAR4 Van Nuys
View: Downstream
Location:
34.1578, -118.4489
Site Description:
LAR Reach 4 at Van Nuys Blvd.

Burbank Water Reclamation Plant Stations

Burbank Western Channel (BWC)

Monitoring Station:
BWC Up
View: Across
Location:
34.1832, -118.3184
Site Description:
BWC Upstream.
Bioassessment site.

BWRP



Monitoring Station:
BWRP Eff 001
View: Down
Location:
34.1825, -118.3183
Site Description:
BWRP Effluent.

BWC

Monitoring Station:
BWC Down
View: Downstream
Location:
34.1819, -118.3176
Site Description:
Downstream of BWC Near
Downstream.
Bioassessment site.

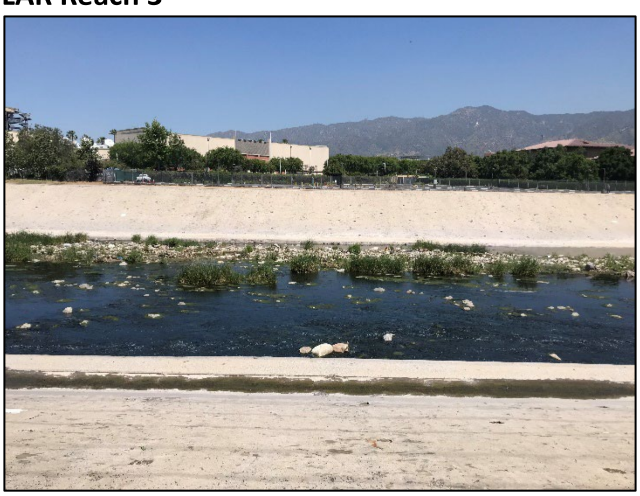
BWC

Monitoring Station:
BWC Riverside
View: Downstream
Location:
34.1591, -118.3049
Site Description:
BWC at Riverside Dr upstream of LAR Confluence.
Bioassessment site.

LAR Reach 4

Monitoring Station:
LAR4 Zoo
View: Across
Location:
34.1563, -118.3074
Site Description:
LAR Reach 4 at LA Zoo, upstream of BWC Confluence
(LARWMP LAR08695).
Bioassessment site.

LAR Reach 3



Monitoring Station:
LAR3 Griffith
View: Across
Location:
34.1560, -118.2877
Site Description:
LAR Reach 3 at Griffith downstream of BWC Confluence
(LARWMP LAR0453).
Bioassessment site.

Los Angeles/Glendale Water Reclamation Plant Stations

LAR Reach 3

Monitoring Station:
LAR3 Electronics
View: Across
Location:
34.1447, -118.2777
Site Description:
LAR Reach 3 at Electronics Place.
Bioassessment site.

LAGWRP

Monitoring Station:
LAG Eff 001
View: Downstream
Location:
34.1372, -118.2742
Site Description:
LAGWRP Effluent.

LAR Reach 3

Monitoring Station:
LAR3 N. Atwater
View: Across
Location:
34.1322, -118.2741
Site Description:
LAR Reach 3 at North Atwater
(LARWMP LAR10210).
Bioassessment site.

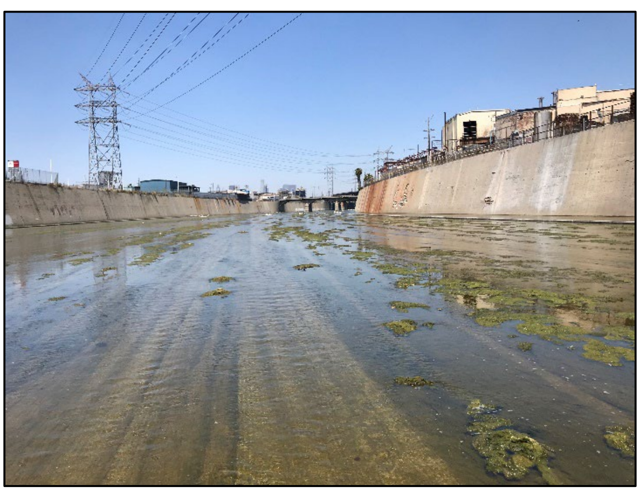
LAR Reach 3

Monitoring Station:
LAR3 Greenway
View: Across
Location:
34.1060, -118.2434
Site Description:
LAR Reach 3 at Greenway (LARWMP LAR08599). Bioassessment site.

LAR Reach 3

Monitoring Station:
LAR3 Riverside
View: Downstream
Location:
34.0851, -118.2279
Site Description:
LAR Reach 3 at Riverside Dr at the end of natural bottom. Bioassessment site.

LAR Reach 2



Monitoring Station:
LAR2 Washington
View: Upstream
Location:
34.0108, -118.2196
Site Description:
LAR Reach 2 downstream of Washington Blvd (LARWMP LAR03902). Bioassessment site.

Appendix 4. Bioassessment Stations Site Characteristics

Table 4.1. Bioassessment and Environmental Descriptors for LA River Reaches and Burbank Western Channel (BWC)

Waterbody	Station ID (Co-located 2024 Study Stations)	Lat	Long	Year(s)	WRP Flow	Canopy Cover	Channel Width[1]	Substrate Type
LAR Reach 1	412M08643	33.8084099	-118.20559	2018	Yes	Open	Very Large	Concrete
LAR Reach 1	SMC00318	33.81288	-118.20559	2010, 2019, 2021-2023	Yes	Open	Very Large	Concrete
LAR Reach 2	412LAR023	33.86185	-118.197	2005	Yes	Open	Very Large	Concrete
LAR Reach 2	412M08627	33.8632613	-118.19656	2017	Yes	Open	Very Large	Concrete
LAR Reach 2	SMC05694	33.87164	-118.19136	2014	Yes	Open	Very Large	Concrete
LAR Reach 2	SMC02622	33.89739	-118.18616	2010	Yes	Open	Very Large	Concrete
LAR Reach 2	412M08659	33.93942	-118.1748	2020	Yes	Open	Very Large	Concrete
LAR Reach 2	412M08602	33.9713196	-118.16997	2015	Yes	Open	Very Large	Concrete
LAR Reach 2	SMC03646	33.9784	-118.16911	2013	Yes	Open	Very Large	Concrete
LAR Reach 2	412LAR007	33.9943	-118.181	2005	Yes	Open	Very Large	Concrete
LAR Reach 2	SMC03902 (LAR2 Washington)	34.010762	-118.21959	2008, 2024	Yes	Open	Very Large	Concrete
LAR Reach 2	412M08642	34.0472006	-118.22979	2018	Yes	Open	Large	Concrete
LAR Reach 2	SMC02228/412CE0104	34.069337	-118.22428	2005, 2009	Yes	Open	Large	Concrete
LAR Reach 3	LAR08599 (LAR3 Greenway)	34.1060295	-118.24339	2015, 2018-2024	Yes	Open	Very Large	Unlined
LAR Reach 3	LAR3 Riverside	34.0851	-118.2279	2024	Yes	Open	Very Large	Unlined
LAR Reach 3	LAR08663	34.11082	-118.26183	2021	Yes	Open	Large	Unlined
LAR Reach 3	LAR10210 (LAR3 N. Atwater)	34.13224	-118.27407	2021-2024	Yes	Open	Large	Unlined
LAR Reach 3	LAR00436	34.149	-118.27864	2009, 2017, 2023	Yes	Open	Very Large	Unlined
LAR Reach 3	LAR04532 (LAR3 Griffith)	34.155954	-118.28771	2012, 2024	Yes	Open	Large	Unlined
LAR Reach 3	LAR3 Electronics	34.1447	-118.2777	2024	Yes	Open	Large	Unlined
Burbank Western Channel	412LARBBK	34.1599	-118.304	2005	Yes	Open	Medium	Concrete
Burbank Western Channel	SMC01288	34.180052	-118.31532	2008	Yes	Open	Small	Concrete
Burbank Western Channel	BWC (Up)	34.1832	-118.3184	2024	No	Open	Small	Concrete
Burbank Western Channel	BWC (Down)	34.1819	-118.3176	2024	Yes	Open	Small	Concrete

Waterbody	Station ID (Co-located 2024 Study Stations)	Lat	Long	Year(s)	WRP Flow	Canopy Cover	Channel Width[1]	Substrate Type
Burbank Western Channel	BWC Riverside	34.1591	-118.3049	2024	Yes	Open	Medium	Concrete
LAR Reach 4	412M08695 (LAR4 Zoo)	34.15638	-118.30746	2023, 2024	Yes	Open	Medium	Concrete
LAR Reach 4	SMCLAR0732/CEDEN 412CE0732	34.155134	-118.31261	2007, 2015	Yes	Open	Medium	Concrete
LAR Reach 4	SMC01460	34.152252	-118.32694	2008	Yes	Open	Medium	Concrete
LAR Reach 4	LAR08615	34.1439265	-118.34294	2016	Yes	Minimal	Large	Concrete
LAR Reach 4	LAR08656	34.14554	-118.39652	2020	Yes	Minimal	Medium	Concrete
LAR Reach 4	LAR02804	34.145341	-118.40866	2011	Yes	Minimal	Medium	Concrete
LAR Reach 4	412CE0616/LAR0616	34.15397	-118.42995	2007, 2015	Yes	Minimal	Medium	Concrete
LAR Reach 4	412M08597/LAR08597	34.1552434	-118.43907	2015	Yes	Minimal	Medium	Concrete
LAR Reach 4	SMCLAR0232/ CEDEN412CE0232 (LAR4 Kester)	34.159077	-118.45624	2006, 2015-2021, 2024	Yes	Open	Small	Concrete
LAR Reach 4	LAR08661	34.16288	-118.46936	2021	Yes	Minimal	Medium	Concrete
LAR Reach 5	LAR5 Balboa	34.1795	-118.5003	2024	No	Partial	Medium	Unlined
LAR Reach 5	LAR5 Hayvenhurst	34.1757	-118.4908	2024	Yes	Partial	Medium	Unlined
LAR Reach 6	412M08672/LAR08672	34.18654	-118.52912	2021	No	Open	Large	Concrete
LAR Reach 6	412M08688	34.1893402	-118.53445	2022	No	Open	Large	Concrete
LAR Reach 6	LAR01208	34.19016	-118.53651	2020, 2023	No	Open	Large	Concrete
LAR Reach 6	SMCLAR0052/CEDEN412PS0052	34.195308	-118.58797	2008, 2017, 2022	No	Open	Small	Concrete
LAR Reach 6	SMC02680/LAR02680	34.19532	-118.59357	2014	No	Open	Small	Concrete

1. Based on width at the bottom of the channel. Small <50 feet; Medium 50-100 feet; Large 100-200 feet; Very Large >200 feet

Table 4.2. Bioassessment and Environmental Descriptors for Tributaries to the LA River in the Study Area

Waterbody	Station ID (Co-located 2024 Study Stations)	Lat	Long	Year(s)	WRP Flow	Canopy Cover	Channel Width[1]	Substrate Type
Compton Creek	LALT502	33.84655	-118.20894	2012, 2016-2019	No	Open	Medium	Unlined
Compton Creek	412LARCMP	33.8473	-118.21	2005	No	Open	Medium	Unlined
Compton Creek	Compton_R1	33.86953	-118.215	2023	No	Open	Small	Unlined
Compton Creek	SMC01358	33.909652	-118.24673	2011	No	Open	Small	Concrete
Bull Creek	412M08608	34.1854317	-118.49769	2016	No	Partial	Small	Unlined
Bull Creek	412LARBLL	34.1872	-118.498	2005	No	Open	Small	Concrete
Bull Creek	SMC01716	34.20731	-118.49728	2010	No	Open	Small	Concrete
Bull Creek	412M08693	34.2251309	-118.49802	2022	No	Open	Small	Concrete
Bull Creek	SMC01972	34.24018	-118.49564	2010	No	Open	Small	Concrete
Bull Creek	SMC412PS0040/CEDEN412LAR004	34.260652	-118.48936	2005, 2008, 2016, 2022	No	Open	Small	Concrete
Bull Creek	412M08645	34.2892231	-118.50196	2019	No	Partial	Small	Concrete
Rio Hondo Reach 1	LALT500	33.93557	-118.17126	2012, 2016-2019	No	Open	Medium	Concrete
Rio Hondo Reach 1	412LARRHO	33.9377	-118.171	2005	No	Open	Large	Concrete
Rio Hondo Reach 1	SMC00830	33.943059	-118.16606	2011	No	Open	Large	Concrete
Rio Hondo Reach 2	412LAR031	33.99525	-118.106	2005	No	Open	Large	Concrete
Rio Hondo Reach 3	412RHWNRD-12864	34.03147	-118.071	2005	Yes	Partial	Medium	Unlined
Rio Hondo Reach 3	412RHWNRD-12865	34.03147	-118.071	2005	Yes	Partial	Medium	Unlined
Rio Hondo Reach 3	412RHWNRD-12866	34.03147	-118.071	2005	Yes	Partial	Medium	Unlined
Rio Hondo Reach 3	412RHWNRD-13018	34.03147	-118.071	2005	Yes	Partial	Medium	Unlined
Rio Hondo Reach 3	412RHWNRD-13019	34.03147	-118.071	2005	Yes	Partial	Medium	Unlined
Rio Hondo Reach 3	412RHWNRD-13020	34.03147	-118.071	2005	Yes	Partial	Medium	Unlined
Rio Hondo Reach 3	412RHWNRD-13021	34.03147	-118.071	2005	Yes	Partial	Medium	Unlined
Rio Hondo Reach 3	412RHWNRD-13022	34.03147	-118.071	2005	Yes	Partial	Medium	Unlined
Rio Hondo Reach 3	412RHWNRD-13023	34.03147	-118.071	2005	Yes	Partial	Medium	Unlined

Waterbody	Station ID (Co-located 2024 Study Stations)	Lat	Long	Year(s)	WRP Flow	Canopy Cover	Channel Width[1]	Substrate Type
Rio Hondo Reach 3	412M08662	34.06892	-118.05718	2021	No	Open	Large	Concrete
Rio Hondo Reach 3	412LAR015	34.09369	-118.029	2005	No	Open	Medium	Concrete
Rio Hondo Reach 3	SMC00684	34.096982	-118.02374	2011	No	Open	Very Large	Concrete
Alhambra Wash	412M08630	34.0596169	-118.08903	2017	No	Open	Small	Concrete
Alhambra Wash	412PS0020	34.070771	-118.09546	2016, 2022, 2023	No	Open	Small	Concrete
Alhambra Wash	SMC01772	34.110013	-118.12281	2012	No	Full	Small	Concrete
Rubio Wash	SMC00748	34.075488	-118.07881	2011	No	Partial	Small	Concrete
Rubio Wash	SMC02796	34.083977	-118.08632	2013	No	Partial	Small	Concrete
Eaton Wash	SMC01452	34.09095	-118.06675	2010	No	Open	Small	Concrete
Eaton Wash	412M08646	34.1289095	-118.08133	2019	No	Partial	Small	Concrete
Arroyo Seco Reach 1	LALT501	34.08046	-118.22491	2012, 2016-2020	No	Open	Medium	Concrete
Arroyo Seco Reach 1	LALT501- 2016 D(Up)	34.08046	-118.22491	2012, 2016-2020	No	Open	Medium	Concrete
Arroyo Seco Reach 1	412LARSCO	34.0827	-118.222	2005	No	Open	Small	Concrete
Arroyo Seco Reach 1	412M08658	34.0833	-118.22061	2020	No	Open	Small	Concrete
Arroyo Seco Reach 1	412M08694	34.11501	-118.17122	2023	No	Open	Medium	Concrete
Arroyo Seco Reach 1	SMC02028	34.128683	-118.16554	2012	No	Partial	Medium	Concrete
Arroyo Seco Reach 2	SMC01004	34.150162	-118.16579	2009, 2019	No	Open	Medium	Concrete
Arroyo Seco Reach 2	412M08686	34.1660498	-118.17048	2022	No	Open	Small	Concrete
Arroyo Seco Reach 3	SMC01692	34.198	-118.17	2011	No	Open	Very Large	Unlined
Verdugo Wash Reach 1	412LARVGO	34.1546	-118.276	2005	No	Partial	Medium	Concrete
Tujunga Wash	412LARTJA/SMC00756/LALT503	34.14832	-118.38907	2005, 2009, 2012, 2016-2018	No	Open	Medium	Concrete
Tujunga Wash	SMC02996	34.22108	-118.42296	2014	No	Open	Medium	Concrete
Big Tujunga Canyon Creek	412M08683	34.2667588	-118.37323	2022	No	Open	Very Large	Unlined
Tujunga Wash	SMC02484	34.145104	-118.36765	2013	No	Partial	Small	Concrete
Aliso Canyon Wash	412M08640/LAR08640	34.2209551	-118.54618	2018	No	Open	Medium	Concrete

Waterbody	Station ID (Co-located 2024 Study Stations)	Lat	Long	Year(s)	WRP Flow	Canopy Cover	Channel Width[1]	Substrate Type
Aliso Canyon Wash	SMC01464/LAR01464	34.275165	-118.52666	2012	No	Open	Large	Concrete
Aliso Canyon Wash	SMC00440/LAR00440	34.286587	-118.52966	2009, 2018	No	Partial	Small	Unlined
Limekiln Canyon Wash	SMC02232/LAR02232	34.232415	-118.5524	2013	No	Open	Small	Concrete
Wilbur Wash	SMC02488/LAR02488	34.24585	-118.54344	2013	No	Open	Medium	Concrete
Wilbur Wash	412LAR024	34.2486	-118.543	2005	No	Open	Medium	Concrete
Limekiln Canyon Wash	412LAR008	34.2632	-118.557	2005	No	Open	Very Large	Unlined
Browns Canyon Wash	SMC00184	34.220319	-118.58713	2008	No	Open	Medium	Concrete
Browns Canyon Wash	412LAR020	34.2577	-118.596	2005	No	Open	Medium	Concrete
Browns Canyon Wash	412LAR018	34.220319	-118.58713	2005	No	Open	Medium	Concrete
Santa Susana Pass Wash	SMC01912/LAR01912/ LAR08632/412M08632	34.2383447	-118.6077	2012, 2017	No	Open	Small	Concrete
Bell Creek (South Fork)	SMC02936/LAR02936	34.185903	-118.64211	2013	No	Open	Small	Concrete
Arroyo Calabasas	412M08616 / LAR08616	34.1885531	-118.61028	2016	No	Open	Small	Concrete
McCoy Canyon Creek	412LAR016	34.1563	-118.639	2005	No	Full	Small	Concrete
Cabellero Creek	SMC01656	34.156332	-118.53627	2012	No	Open	Small	Concrete

1. Based on width at the bottom of the channel. Small <50 feet; Medium 50-100 feet; Large 100-200 feet; Very Large >200 feet.

Appendix 5. Bioassessment Dominant Taxa Summary

Table 5.1. Dominant BMI Taxa Summary for LA River Reaches and Burbank Western Channel (BWC)

See Appendix 2 for a list of all BMI taxa found at all stations and years for a reach. This table has been truncated to show only the top three taxa based on percentage total count for each historical station/year record.

Reach	Station ID	Year	# Taxa	% Top Taxa	Taxa 1	T1%	Taxa 2	T2%	Taxa 3	T3%
Reach 1	412M08643	2018	9	100%	Ostracoda	60%	Oligochaeta	32%	Chironomidae	9%
	SMC00318	2010	13	100%	Chironomidae	84%	Ostracoda	8%	Oligochaeta	7%
		2019	19	98%	Chironomidae	57%	Oligochaeta	27%	Ostracoda	14%
		2021	16	100%	Oligochaeta	84%	Chironomidae	15%	Ostracoda	1%
		2022	18	97%	Oligochaeta	75%	Ostracoda	15%	Chironomidae	7%
		2023	22	97%	Ostracoda	84%	Chironomidae	10%	Oligochaeta	4%
Reach 2	412LAR023	2005	2	100%	Chironomidae	98%	Oligochaeta	2%		
	412M08627	2017	14	100%	Chironomidae	56%	Oligochaeta	43%	Ostracoda	1%
	SMC05694	2014	17	98%	Chironomidae	52%	Ostracoda	20%	Oligochaeta	15%
	SMC02622	2010	19	99%	Chironomidae	41%	Oligochaeta	30%	Ostracoda	27%
	412M08659	2020	26	99%	Oligochaeta	56%	Chironomidae	37%	Ostracoda	3%
	412M08602	2015	23	97%	Chironomidae	64%	Oligochaeta	20%	Ostracoda	12%
	SMC03646	2013	23	97%	Chironomidae	58%	Hyalellidae	20%	Oligochaeta	15%
	412LAR007	2005	6	99%	Chironomidae	81%	Oligochaeta	17%	Ostracoda	1%
	LAR2 Washington	2008	17	99%	Chironomidae	53%	Ostracoda	39%	Hydroptilidae	3%
		2024	31	93%	Simuliidae	29%	Baetidae	28%	Chironomidae	22%
	412M08642	2018	27	93%	Baetidae	46%	Chironomidae	19%	Hydroptilidae	10%
	412CE0104	2005	23	96%	Ostracoda	64%	Chironomidae	19%	Baetidae	7%
	412CE0104	2009	18	98%	Baetidae	84%	Hydroptilidae	6%	Chironomidae	3%
Reach 3	LAR3 Greenway	2015	25	96%	Chironomidae	59%	Baetidae	12%	Leptohyphidae	8%
		2018	14	95%	Chironomidae	71%	Oligochaeta	14%	Hydropsychidae	5%
		2019	33	96%	Hydropsychidae	34%	Chironomidae	21%	Pyralidae	18%
		2020	45	86%	Hydropsychidae	27%	Chironomidae	22%	Leptohyphidae	14%
		2021	34	84%	Leptohyphidae	24%	Hyalellidae	20%	Baetidae	14%
		2022	26	93%	Baetidae	39%	Hyalellidae	19%	Leptohyphidae	18%
		2023	28	96%	Chironomidae	39%	Hydropsychidae	24%	Baetidae	11%
		2024	24	96%	Baetidae	33%	Hydropsychidae	30%	Leptohyphidae	23%
	LAR3 Riverside	2024	30	95%	Leptohyphidae	36%	Chironomidae	22%	Baetidae	22%
	LAR08663	2021	28	95%	Baetidae	45%	Chironomidae	27%	Leptohyphidae	13%

Reach	Station ID	Year	# Taxa	% Top Taxa	Taxa 1	T1%	Taxa 2	T2%	Taxa 3	T3%
	LAR3 N. Atwater	2021	20	94%	Baetidae	34%	Hyalellidae	31%	Leptohyphidae	15%
		2022	19	95%	Baetidae	60%	Leptohyphidae	28%	Turbellaria	3%
		2023	21	96%	Physidae	34%	Baetidae	30%	Leptohyphidae	21%
		2024	18	95%	Baetidae	67%	Leptohyphidae	15%	Turbellaria	5%
	LAR00436	2009	26	94%	Chironomidae	37%	Oligochaeta	35%	Ostracoda	9%
		2017	30	94%	Chironomidae	38%	Ostracoda	30%	Oligochaeta	24%
		2023	21	97%	Chironomidae	50%	Ostracoda	22%	Oligochaeta	13%
	LAR3 Electronics	2024	23	91%	Oligochaeta	27%	Turbellaria	18%	Chironomidae	17%
	LAR3 Griffith	2012	28	95%	Chironomidae	57%	Baetidae	23%	Hyalellidae	11%
		2024	28	87%	Chironomidae	30%	Turbellaria	17%	Baetidae	10%
BWC	412LARBBK	2005	2	100%	Chironomidae	94%	Oligochaeta	6%		
	BWC Riverside	2024	11	99%	Baetidae	94%	Chironomidae	5%	Simuliidae	1%
	SMC01288	2008	10	97%	Chironomidae	67%	Oligochaeta	16%	Hydroptilidae	9%
	BWC (Down)	2024	18	99%	Baetidae	87%	Chironomidae	8%	Hydroptilidae	2%
	BWC (Up)	2024	23	98%	Chironomidae	67%	Oligochaeta	17%	Hydroptilidae	9%
Reach 4	LAR Zoo	2023	18	100%	Chironomidae	81%	Oligochaeta	18%	Baetidae	1%
		2024	21	87%	Chironomidae	36%	Ostracoda	25%	Baetidae	13%
	412CE0732	2007	15	99%	Hyalellidae	53%	Chironomidae	42%	Corixidae	3%
		2015	29	95%	Chironomidae	34%	Baetidae	24%	Ostracoda	20%
	SMC01460	2008	16	98%	Baetidae	65%	Chironomidae	30%	Psychodidae	2%
	LAR08615	2016	26	96%	Chironomidae	63%	Baetidae	13%	Pyralidae	10%
	LAR08656	2020	26	99%	Baetidae	60%	Simuliidae	18%	Chironomidae	8%
	LAR02804	2011	28	85%	Baetidae	51%	Hyalellidae	14%	Chironomidae	11%
	412CE0616	2007	17	100%	Hyalellidae	85%	Chironomidae	15%	Ostracoda	0%
		2015	21	95%	Baetidae	40%	Simuliidae	24%	Hyalellidae	21%
	412M08597	2015	63	89%	Chironomidae	28%	Baetidae	20%	Hyalellidae	14%
	LAR4 Kester	2006	38	100%	Chironomidae	78%	Oligochaeta	15%	Simuliidae	3%
		2015	24	98%	Baetidae	55%	Simuliidae	31%	Chironomidae	5%
		2016	19	97%	Chironomidae	60%	Simuliidae	17%	Hyalellidae	11%
		2017	28	96%	Baetidae	42%	Simuliidae	26%	Chironomidae	21%
		2018	23	98%	Simuliidae	37%	Oligochaeta	30%	Baetidae	16%
		2019	25	96%	Baetidae	59%	Simuliidae	22%	Hyalellidae	5%

Reach	Station ID	Year	# Taxa	% Top Taxa	Taxa 1	T1%	Taxa 2	T2%	Taxa 3	T3%
		2020	17	99%	Simuliidae	72%	Baetidae	25%	Chironomidae	1%
		2021	19	95%	Baetidae	66%	Simuliidae	17%	Chironomidae	6%
		2024	35	87%	Chironomidae	28%	Hyalellidae	27%	Baetidae	18%
	LAR08661	2021	26	90%	Chironomidae	25%	Simuliidae	24%	Oligochaeta	17%
Reach 5	LAR5 Hayvenhurst	2024	21	88%	Hyalellidae	45%	Oligochaeta	28%	Chironomidae	15%
	LAR5 Balboa	2024	43	68%	Chironomidae	33%	Simuliidae	24%	Baetidae	11%
Reach 6	412M08672	2021	18	98%	Ostracoda	63%	Chironomidae	19%	Oligochaeta	16%
	412M08688	2022	17	97%	Ostracoda	77%	Chironomidae	16%	Stratiomyidae	4%
	LAR01208	2010	17	95%	Ostracoda	48%	Chironomidae	34%	Oligochaeta	13%
		2020	17	98%	Ostracoda	77%	Chironomidae	19%	Stratiomyidae	1%
		2023	28	96%	Chironomidae	48%	Ostracoda	46%	Stratiomyidae	2%
	412PS0052	2008	30	98%	Ostracoda	50%	Chironomidae	42%	Oligochaeta	5%
		2017	19	98%	Chironomidae	56%	Oligochaeta	37%	Ostracoda	5%
		2022	12	98%	Ostracoda	65%	Chironomidae	22%	Stratiomyidae	10%
	SMC02680	2014	15	99%	Ostracoda	74%	Chironomidae	24%	Hyalellidae	1%

Table 5.2. Dominant BMI Taxa Summary for Tributaries to the LA River in the Study Area

This table has been truncated to show only the top three taxa based on percentage total count for each historical station/year record.

Tributary	Station ID	Year	# Taxa	% Top Taxa	Taxa 1	T1%	Taxa 2	T2%	Taxa 3	T3%
Compton Creek	LALT502	2012	25	87%	Hyalellidae	63%	Chironomidae	13%	Oligochaeta	9%
		2016	21	93%	Ostracoda	30%	Hyalellidae	18%	Chironomidae	16%
		2017	26	92%	Ostracoda	59%	Chironomidae	27%	Coenagrionidae	6%
		2018	16	98%	Ostracoda	39%	Oligochaeta	39%	Hyalellidae	10%
		2019	15	92%	Hyalellidae	47%	Oligochaeta	36%	Coenagrionidae	5%
	412LARCMP	2005	4	100%	Chironomidae	69%	Oligochaeta	30%	Coenagrionidae	0%
	Compton_R1	2023	12	95%	Oligochaeta	67%	Chironomidae	22%	Hyalellidae	6%
	SMC01358	2011	12	100%	Chironomidae	67%	Oligochaeta	32%	Hyalellidae	0%
Rio Hondo Reach 1	LALT500	2012	12	85%	Chironomidae	51%	Hyalellidae	24%	Oligochaeta	9%
		2016	22	90%	Chironomidae	57%	Ostracoda	25%	Oligochaeta	8%
		2017	19	81%	Chironomidae	29%	Hyalellidae	26%	Ostracoda	26%
		2018	15	94%	Ostracoda	45%	Hyalellidae	29%	Chironomidae	20%
		2019	18	77%	Chironomidae	38%	Ostracoda	27%	Oligochaeta	13%
	412LARRHO	2005	4	99%	Chironomidae	73%	Oligochaeta	23%	Physidae	3%
	SMC00830	2011	14	96%	Chironomidae	91%	Baetidae	3%	Oligochaeta	2%
Rio Hondo Reach 2	412LAR031	2005	4	100%	Chironomidae	78%	Oligochaeta	22%	Corixidae	0%
Rio Hondo Reach 3	412RHWNRD-9 subsamples	2005	17	86%	Chironomidae	42%	Oligochaeta	35%	Ceratopogonidae	9%
		2005	15	84%	Chironomidae	53%	Oligochaeta	18%	Ostracoda	13%
		2005	22	75%	Chironomidae	37%	Ostracoda	32%	Physidae	7%
		2005	14	92%	Chironomidae	68%	Oligochaeta	20%	Ostracoda	4%
		2005	15	86%	Chironomidae	45%	Oligochaeta	35%	Ceratopogonidae	6%
		2005	18	78%	Chironomidae	39%	Ceratopogonidae	22%	Ostracoda	17%
		2005	20	85%	Chironomidae	60%	Oligochaeta	17%	Ceratopogonidae	8%
		2005	17	86%	Chironomidae	47%	Oligochaeta	34%	Ceratopogonidae	5%
		2005	16	81%	Chironomidae	45%	Oligochaeta	29%	Glossiphoniidae	7%
	412M08662	2021	12	99%	Chironomidae	80%	Oligochaeta	16%	Ostracoda	2%
	412LAR015	2005	2	100%	Chironomidae	86%	Simuliidae	14%		
	SMC00684	2011	15	100%	Chironomidae	84%	Simuliidae	13%	Ceratopogonidae	2%
Alhambra Wash	412M08630	2017	10	100%	Chironomidae	99%	Hyalellidae	0%	Culicidae	0%
	412PS0020	2016	8	100%	Chironomidae	94%	Oligochaeta	5%	Psychodidae	1%

Tributary	Station ID	Year	# Taxa	% Top Taxa	Taxa 1	T1%	Taxa 2	T2%	Taxa 3	T3%
	SMC01772	2012	27	96%	Chironomidae	79%	Baetidae	11%	Oligochaeta	6%
Rubio Wash	SMC00748	2011	9	100%	Chironomidae	100%	Ceratopogonidae	0%		
	SMC02796	2013	6	100%	Chironomidae	100%	Oligochaeta	0%		
Eaton Wash	SMC01452	2010	14	94%	Chironomidae	69%	Ostracoda	17%	Oligochaeta	7%
	412M08646	2019	26	93%	Chironomidae	74%	Oligochaeta	14%	Simuliidae	5%
Arroyo Seco Reach 1	LALT501	2012	12	94%	Baetidae	58%	Ostracoda	19%	Simuliidae	18%
		2016	28	91%	Baetidae	76%	Chironomidae	9%	Oligochaeta	6%
		2016	18	93%	Baetidae	69%	Chironomidae	13%	Oligochaeta	11%
		2017	25	85%	Chironomidae	37%	Baetidae	29%	Simuliidae	18%
		2018	33	86%	Ostracoda	33%	Baetidae	32%	Chironomidae	20%
		2019	21	97%	Chironomidae	83%	Oligochaeta	13%	Simuliidae	2%
		2020	25	96%	Hydroptilidae	58%	Chironomidae	33%	Baetidae	5%
	412LARSCO	2005	7	95%	Chironomidae	49%	Baetidae	23%	Simuliidae	22%
	412M08658	2020	24	98%	Chironomidae	79%	Baetidae	18%	Stratiomyidae	1%
	412M08694	2023	27	94%	Chironomidae	51%	Baetidae	40%	Stratiomyidae	3%
	SMC02028	2012	27	85%	Baetidae	55%	Stratiomyidae	22%	Hydroptilidae	7%
Arroyo Seco Reach 2	SMC01004	2009	26	81%	Baetidae	46%	Chironomidae	19%	Hydroptilidae	16%
		2019	21	98%	Chironomidae	94%	Psychodidae	3%	Ceratopogonidae	1%
	412M08686	2022	11	100%	Chironomidae	69%	Simuliidae	30%	Hydroptilidae	1%
Arroyo Seco Reach 3	SMC01692	2011	33	87%	Baetidae	47%	Simuliidae	22%	Hydroptilidae	18%
Tujunga Wash	412LARTJA	2005	3	100%	Chironomidae	50%	Oligochaeta	50%	Ostracoda	0%
		2009	19	96%	Chironomidae	88%	Baetidae	6%	Simuliidae	2%
		2012	10	88%	Ostracoda	66%	Oligochaeta	15%	Baetidae	7%
		2016	19	98%	Chironomidae	93%	Oligochaeta	3%	Ostracoda	3%
		2017	14	98%	Chironomidae	83%	Ostracoda	14%	Culicidae	1%
		2018	20	92%	Chironomidae	83%	Simuliidae	6%	Baetidae	4%
	SMC02996	2014	20	96%	Chironomidae	73%	Oligochaeta	21%	Ceratopogonidae	2%
	SMC02484	2013	37	97%	Chironomidae	91%	Hydroptilidae	5%	Simuliidae	1%
Big Tujunga Canyon Creek	412M08683	2022	48	82%	Hydrobiidae	60%	Turbellaria	12%	Hyalellidae	10%
Verdugo Wash Reach 1	412LARVGO	2005	6	95%	Chironomidae	54%	Oligochaeta	22%	Physidae	19%
Bull Creek	412M08608	2016	25	94%	Chironomidae	69%	Oligochaeta	21%	Ostracoda	4%
	412LARBLL	2005	10	95%	Chironomidae	86%	Oligochaeta	5%	Simuliidae	3%

Tributary	Station ID	Year	# Taxa	% Top Taxa	Taxa 1	T1%	Taxa 2	T2%	Taxa 3	T3%
	SMC01716	2010	11	100%	Chironomidae	99%	Psychodidae	1%	Simuliidae	0%
	412M08693	2022	24	98%	Chironomidae	87%	Ostracoda	10%	Stratiomyidae	2%
	SMC01972	2010	12	99%	Chironomidae	86%	Oligochaeta	13%	Ceratopogonidae	0%
	SMC412PS0040	2005	4	100%	Chironomidae	97%	Oligochaeta	3%	Baetidae	0%
		2008	27	94%	Chironomidae	75%	Oligochaeta	12%	Simuliidae	7%
		2016	22	99%	Chironomidae	93%	Ostracoda	5%	Hydroptilidae	1%
		2022	25	83%	Chironomidae	39%	Baetidae	28%	Simuliidae	16%
	412M08645	2019	28	86%	Chironomidae	47%	Oligochaeta	22%	Ceratopogonidae	17%
Aliso Canyon Wash	412M08640	2018	11	100%	Chironomidae	98%	Psychodidae	1%	Ceratopogonidae	0%
	SMC01464	2012	23	96%	Oligochaeta	47%	Chironomidae	28%	Ostracoda	21%
	SMC00440	2009	36	81%	Chironomidae	47%	Simuliidae	20%	Oligochaeta	14%
		2018	36	90%	Chironomidae	42%	Culicidae	32%	Ostracoda	16%
Limekiln Canyon Wash	SMC02232	2013	4	100%	Chironomidae	100%	Psychodidae	0%		
Wilbur Wash	SMC02488	2013	2	100%	Chironomidae	100%				
	412LAR024	2005	2	100%	Chironomidae	100%	Oligochaeta	0%		
Limekiln Canyon Wash	412LAR008	2005	13	89%	Chironomidae	45%	Baetidae	28%	Ostracoda	15%
Browns Canyon Wash	SMC00184	2008	10	100%	Chironomidae	82%	Ostracoda	17%	Oligochaeta	1%
	412LAR020	2005	4	100%	Chironomidae	99%	Ephydridae	0%	Psychodidae	0%
	412LAR018	2005	15	92%	Chironomidae	45%	Baetidae	41%	Nemouridae	6%
Santa Susana Pass Wash	412M08632	2012	16	100%	Chironomidae	88%	Oligochaeta	6%	Ostracoda	6%
		2017	10	99%	Chironomidae	96%	Ostracoda	2%	Ceratopogonidae	1%
Bell Creek (South Fork)	SMC02936	2013	20	91%	Oligochaeta	34%	Ostracoda	29%	Chironomidae	28%
Arroyo Calabasas	412M08616	2016	20	98%	Ostracoda	57%	Chironomidae	38%	Oligochaeta	3%
McCoy Canyon Creek	412LAR016	2005	11	91%	Simuliiudae	63%	Turbellaria	15%	Baetidae	14%
Cabellero Creek	SMC01656	2012	33	89%	Chironomidae	47%	Ostracoda	34%	Oligochaeta	9%

Table 5.3. Dominant Diatom Taxa Summary for LA River Reaches and Burbank Western Channel (BWC)

See Appendix 2 for a list of all BMI taxa found at all stations and years for a reach. This table has been truncated to show only the top three taxa based on percentage total count for each historical station/year record.

Reach	Station ID	Year	# Taxa	% Top Taxa	Taxa 1	T1%	Taxa 2	T2%	Taxa 3	T3%
LAR Reach 1	412M08643	2018	28	85%	Nitzschia fonticola	75%	Staurosira construens var venter	7%	Nitzschia inconspicua	3%
	SMC00318	2010	21	85%	Nitzschia bulnheimiana	78%	Craticula minusculoides	4%	Halamphora veneta	3%
		2019	37	44%	Cyclotella meneghiniana	20%	Achnanthidium minutissimum	17%	Ellerbeckia arenaria	7%
		2021	33	84%	Nitzschia liebethruthii	60%	Nanofrustulum trainorii	20%	Cyclotella meneghiniana	3%
		2022	39	59%	Achnanthidium minutissimum	36%	Staurosira venter	13%	Nitzschia amphibioides	10%
		2023	31	79%	Achnanthidium minutissimum	63%	Nitzschia amphibioides	13%	Staurosira venter	2%
LAR Reach 2	412M08627	2017	20	67%	Nitzschia cf bacillum	42%	Staurosira venter	13%	Cyclotella meneghiniana	12%
	SMC05694	2014	29	71%	Staurosira construens	34%	Nitzschia inconspicua	24%	Nitzschia palea	12%
	SMC02622	2010	25	61%	Cyclotella meneghiniana	27%	Gomphonema parvulum	19%	Pseudostaurosira elliptica	15%
	412M08659	2020	25	59%	Nitzschia palea var debilis	35%	Staurosira venter	14%	Cyclotella meneghiniana	9%
	412M08602	2015	21	62%	Nitzschia palea	39%	Nitzschia cf hantzschiana	12%	Eolimna subminuscula	11%
	LAR2 Washington	2024	43	47%	Cocconeis pediculus	26%	Achnanthidium minutissimum	11%	Gomphonema kobayasii	10%
	412M08642	2018	30	55%	Nitzschia palea	21%	Staurosira construens var venter	18%	Cocconeis pediculus	16%
	412CE0104	2009	29	72%	Cyclotella meneghiniana	32%	Nitzschia palea	28%	Pseudostaurosira elliptica	12%
LAR Reach 3	LAR3 Greenway	2015	30	49%	Nitzschia palea	28%	Planothidium delicatulum	13%	Cocconeis placentula var euglypta	9%
		2018	31	60%	Staurosira venter	33%	Nitzschia palea	14%	Nitzschia soratensis	13%
		2021	31	49%	Staurosira venter	28%	Planothidium delicatulum	11%	Cocconeis placentula var euglypta	10%
		2022	37	34%	Planothidium robustum	14%	Staurosira venter	11%	Planothidium delicatulum	9%
		2023	41	46%	Nitzschia inconspicua	24%	Craticula subminuscula	11%	Halamphora veneta	11%
		2024	34	60%	Navicula recens	25%	Cocconeis placentula var euglypta	25%	Amphora pediculus	9%
	LAR3 Riverside	2024	41	41%	Cocconeis pediculus	18%	Amphora pediculus	13%	Cocconeis placentula	10%
	LAR08663	2021	30	53%	Cocconeis placentula	31%	Nanofrustulum trainorii	13%	Cocconeis pediculus	9%
	LAR3 N. Atwater	2021	37	36%	Staurosira venter	13%	Nitzschia	12%	Nitzschia amphibia	11%
		2022	33	50%	Nitzschia amphibia	20%	Halamphora veneta	18%	Nitzschia liebethruthii	12%
		2023	38	57%	Cocconeis placentula	32%	Cocconeis pediculus	13%	Nitzschia inconspicua	11%
		2024	30	44%	Cocconeis placentula var euglypta	25%	Cocconeis pediculus	10%	Nitzschia amphibioides	9%
	LAR00436	2009	28	33%	Amphora sp 5 SWAMP JPK	14%	Nitzschia inconspicua	10%	Pleurosira laevis	9%

Reach	Station ID	Year	# Taxa	% Top Taxa	Taxa 1	T1%	Taxa 2	T2%	Taxa 3	T3%
		2023	34	53%	Cyclotella meneghiniana	24%	Gomphonema parvulum	18%	Nitzschia inconspicua	12%
	LAR3 Electronics	2024	38	37%	Halamphora veneta	13%	Cocconeis pediculus	12%	Nitzschia inconspicua	12%
	LAR3 Griffith	2012	31	44%	Pseudostaurosira trainorii	20%	Halamphora veneta	17%	Nitzschia palea	7%
		2024	54	34%	Cyclotella meneghiniana	15%	Staurosira venter	9%	Cocconeis pediculus	9%
BWC	BWC (Up)	2024	23	60%	Achnanthidium minutissimum	32%	Halamphora veneta	20%	Cocconeis pediculus	8%
	BWC (Down)	2024	7	84%	Nitzschia amphibia	65%	Halamphora veneta	13%	Sellaphora saugerresii	6%
	BWC Riverside	2024	20	69%	Planothidium frequentissimum	26%	Halamphora veneta	23%	Nitzschia amphibia	21%
LAR Reach 4	LAR4 Zoo	2023	22	91%	Achnanthidium minutissimum	87%	Cyclotella meneghiniana	2%	Gomphonema parvulum	2%
		2024	39	50%	Cyclotella meneghiniana	20%	Gomphonema kobayasii	20%	Cocconeis pediculus	9%
	LAR08656	2020	32	65%	Nitzschia fonticola	55%	Nitzschia amphibia	5%	Cocconeis placentula	5%
	LAR02804	2011	44	34%	Cyclotella meneghiniana	13%	Pseudostaurosira elliptica	12%	Gomphonema parvulum	10%
	412M08597	2015	26	72%	Staurosira construens var venter	58%	Pseudostaurosira brevistriata	8%	Nitzschia amphibia	5%
	LAR4 Kester	2015	26	68%	Staurosira construens var venter	54%	Pseudostaurosira brevistriata	8%	Nitzschia amphibia	6%
		2016	31	37%	Nitzschia frustulum	14%	Planothidium delicatulum	13%	Nitzschia inconspicua	11%
		2017	29	40%	Cocconeis placentula	14%	Planothidium frequentissimum	14%	Planothidium lanceolatum	13%
		2018	45	57%	Staurosira construens var venter	29%	Pseudostaurosira brevistriata	21%	Achnanthidium minutissimum	7%
		2019	49	52%	Nitzschia inconspicua	25%	Nitzschia paleacea	16%	Planothidium frequentissimum	11%
		2020	36	70%	Nitzschia fonticola	47%	Nitzschia inconspicua	13%	Cocconeis placentula	10%
		2021	49	35%	Cocconeis placentula var euglypta	13%	Cyclotella meneghiniana	12%	Nitzschia inconspicua	10%
		2024	52	36%	Nanofrustulum trainorii	17%	Nitzschia inconspicua	10%	Planothidium frequentissimum	9%
	LAR08661	2021	46	45%	Nanofrustulum trainorii	17%	Planothidium frequentissimum	16%	Cocconeis placentula var euglypta	13%
LAR Reach 5	LAR5 Balboa	2024	34	44%	Nitzschia inconspicua	20%	Amphora pediculus	13%	Craticula subminuscula	11%
LAR Reach 6	412M08672	2021	18	91%	Nitzschia amphibioides	48%	Achnanthidium minutissimum	36%	Nitzschia liebethruthii	6%
	412M08688	2022	15	92%	Achnanthidium minutissimum	56%	Nitzschia amphibioides	33%	Nitzschia amphibia	3%
	LAR01208	2010	22	63%	Achnanthidium minutissimum	46%	Denticula kuetzingii	10%	Gomphonema parvulum	8%
		2020	28	51%	Nitzschia amphibioides	24%	Achnanthidium minutissimum	15%	Achnanthidium exiguum	12%
		2023	28	80%	Nitzschia amphibioides	50%	Achnanthidium minutissimum	26%	Staurosira venter	5%
	412PS0052	2022	14	93%	Achnanthidium minutissimum	66%	Nitzschia amphibioides	21%	Achnanthidium exiguum	6%
	SMC02680	2014	15	90%	Denticula kuetzingii	59%	Staurosira construens var venter	20%	Achnanthidium minutissimum	11%

Table 5.4. Dominant BMI Taxa Summary for Tributaries to the LA River in the Study Area

This table has been truncated to show only the top three taxa based on percentage total count for each historical station/year record. See text for additional details

Reach	Station ID	Year	# Taxa	% Top Taxa	Taxa 1	T1%	Taxa 2	T2%	Taxa 3	T3%
Compton Creek	SMC01358	2011	26	68%	Nitzschia amphibia	38%	Sellaphora pupula	17%	Nitzschia supralitorea	14%
Rio Hondo Reach 1	SMC00830	2011	21	68%	Nitzschia paleaeformis	37%	Nitzschia perspicua	20%	Nitzschia elegantula	12%
Rio Hondo Reach 3	412M08662	2021	9	58%	Halamphora veneta	21%	Tabellaria	21%	Nitzschia	16%
	SMC00684	2011	41	79%	Achnanthidium minutissimum	75%	Navicula	3%	Grunowia tabellaria	2%
Alhambra Wash	412M08630	2017	11	78%	Fistulifera saprophila	57%	Nitzschia palea	12%	Halamphora veneta	9%
	412PS0020	2016	14	86%	Halamphora veneta	64%	Nitzschia cf bacillum	15%	Nitzschia amphibia	6%
		2022	19	90%	Nitzschia liebethruthii	79%	Halamphora veneta	9%	Achnanthidium minutissimum	2%
		2023	30	61%	Nitzschia amphibia	38%	Nitzschia palea var debilis	14%	Navicula veneta	9%
	SMC01772	2012	26	56%	Nitzschia palea	28%	Navicula veneta	17%	Nitzschia microcephala	12%
Rubio Wash	SMC00748	2011	25	83%	Halamphora veneta	69%	Nitzschia communis	9%	Nitzschia	5%
Eaton Wash	SMC01452	2010	32	50%	Nitzschia palea	25%	Halamphora veneta	15%	Pseudostaurosira elliptica	10%
	412M08646	2019	37	75%	Craticula subminuscula	62%	Halamphora veneta	7%	Achnanthidium minutissimum	6%
Arroyo Seco Reach 1	412M08658	2020	17	76%	Achnanthidium minutissimum	38%	Nitzschia amphibioides	27%	Planothidium frequentissimum	11%
	412M08694	2023	18	80%	Nitzschia amphibioides	30%	Nitzschia palea var debilis	27%	Nitzschia palea	22%
	SMC02028	2012	28	60%	Cocconeis pediculus	48%	Cocconeis placentula	6%	Nitzschia amphibia	6%
Arroyo Seco Reach 2	SMC01004	2019	26	67%	Nitzschia inconspicua	42%	Nitzschia palea var debilis	12%	Nitzschia soratensis	12%
	412M08686	2022	25	70%	Gomphonema parvulum	55%	Nitzschia inconspicua	10%	Nitzschia liebethruthii	5%
Tujunga Wash	SMC02996	2014	32	64%	Nitzschia palea	28%	Nitzschia communis	22%	Halamphora veneta	15%
	SMC02484	2013	12	72%	Nitzschia palea	30%	Achnanthidium minutissimum	26%	Halamphora veneta	16%
Big Tujunga Canyon Creek	412M08683	2022	66	44%	Amphora pediculus	19%	Achnanthidium minutissimum	14%	Cocconeis placentula	11%
Bull Creek	SMC01716	2010	26	81%	Halamphora veneta	62%	Cyclotella meneghiniana	11%	Nitzschia inconspicua	8%
	412M08693	2022	31	63%	Nanofrustulum trainorii	44%	Halamphora veneta	12%	Nitzschia lacuum	7%
	SMC01972	2010	28	77%	Halamphora veneta	54%	Nitzschia inconspicua	16%	Nitzschia fonticola	7%
	SMC412PS0040	2016	36	31%	Nitzschia paleacea	12%	Nitzschia frustulum	9%	Planothidium frequentissimum	9%
		2022	28	65%	Halamphora veneta	34%	Nanofrustulum trainorii	16%	Nitzschia inconspicua	15%
	412M08645	2019	40	41%	Psammothidium	22%	Nitzschia linearis	10%	Staurosira construens	9%
	412M08640	2018	23	83%	Halamphora veneta	77%	Nitzschia communis	3%	Nitzschia palea	3%

Reach	Station ID	Year	# Taxa	% Top Taxa	Taxa 1	T1%	Taxa 2	T2%	Taxa 3	T3%
Aliso Canyon Wash	SMC01464	2012	26	66%	Halamphora veneta	24%	Nitzschia palea	22%	Achnanthidium minutissimum	20%
	SMC00440	2009	24	41%	Navicula	22%	Navicula gregaria	10%	Achnanthidium minutissimum	10%
		2018	41	60%	Planothidium lanceolatum	32%	Nitzschia microcephala	20%	Navicula gregaria	8%
Limekiln Canyon Wash	SMC02232	2013	9	98%	Halamphora veneta	93%	Nitzschia supralitorea	3%	Nitzschia inconspicua	2%
Santa Susana Pass Wash	412M08632	2012	27	63%	Denticula kuetzingii	30%	Achnanthidium minutissimum	25%	Aulacoseira distans	8%
		2017	16	86%	Fistulifera saprophila	67%	Halamphora veneta	13%	Nitzschia inconspicua	6%
Bell Creek (South Fork)	SMC02936	2023	25	60%	Achnanthidium exiguum	37%	Nitzschia palea	13%	Achnanthidium minutissimum	10%
Cabellero Creek	SMC01656	2012	21	75%	Halamphora veneta	59%	Cyclotella meneghiniana	9%	Nitzschia inconspicua	8%

Table 5.5. Dominant Soft Algae Taxa Summary for LA River Reaches and Burbank Western Channel (BWC)

See Appendix 2 for a list of all BMI taxa found at all stations and years for a reach. This table has been truncated to show only the top three taxa based on percentage total count for each historical station/year record. See text for additional details.

Reach	Station ID	Year	# Taxa	% Top Taxa	Taxa 1	T1%	Taxa 2	T2%	Taxa 3	T3%
LAR Reach 1	412M08643	2018	23	100%	Cladophora glomerata	100%	Homoeothrix stagnalis	0%	Scenedesmus ellipticus	0%
	SMC00318	2010	29	73%	Gongrosira schmidlei	42%	Pediastrum integrum	21%	Chlamydomonadopsis sp.1	10%
		2019	5	100%	Calothrix	89%	Homoeothrix varians	10%	Pediastrum duplex	1%
		2021	29	100%	Cladophora glomerata	100%	Symploca sp 1	0%	Pediastrum integrum	0%
		2022	22	100%	Oedogonium sp 1	65%	Cladophora glomerata	34%	Pleurosira laevis	1%
		2023	15	100%	Cladophora glomerata	98%	Symploca sp 1	1%	Pediastrum integrum	0%
LAR Reach 2	412M08627	2017	40	93%	Cladophora glomerata	72%	Schizothrix fragilis	15%	Microcoleus autumnalis	6%
	SMC05694	2014	21	90%	Leptolyngbya foveolarum	77%	Protoderma viride	6%	Cladophora	6%
	SMC02622	2010	27	100%	Cladophora glomerata	74%	Rhizoclonium hieroglyphicum	25%	Gongrosira schmidlei	0%
	412M08659	2020	25	100%	Cladophora glomerata	97%	Oedogonium sp 1	3%	Rhizoclonium hieroglyphicum	0%
	412M08602	2015	37	99%	Stigeoclonium subsecundum	54%	Symploca elegans	44%	Botryosphaerella sudetica	1%
	LAR2 Washington	2024	30	98%	Pleurosira laevis	93%	Leptolyngbya tenuis	3%	Cladophora glomerata	1%
	412M08642	2018	22	100%	Cladophora glomerata	99%	Pleurosira laevis	1%	Homoeothrix stagnalis	0%
	412CE0104	2009	21	99%	Cladophora glomerata	75%	Leptolyngbya foveolarum	21%	Nostoc verrucosum	3%
LAR Reach 3	LAR3 Greenway	2015	42	89%	Cladophora glomerata	75%	Oedogonium sp 3	9%	Pediastrum boryanum	5%
		2018	28	100%	Cladophora glomerata	100%	Leptolyngbya foveolarum	0%	Leptolyngbya tenuis	0%
		2021	15	78%	Pediastrum duplex	48%	Heteroleibleinia sp 1	22%	Scenedesmus	8%
		2022	15	100%	Pleurosira laevis	100%	Heteroleibleinia sp 1	0%	Pediastrum integrum	0%
		2023	14	96%	Pleurosira laevis	85%	Symploca elegans	8%	Heteroleibleinia sp 1	2%
		2024	15	100%	Pleurosira laevis	61%	Cladophora glomerata	39%	Closterium moniliferum	0%
	LAR3 Riverside	2024	26	100%	Pleurosira laevis	99%	Closterium moniliferum	0%	Leptolyngbya tenuis	0%
	LAR08663	2021	3	100%	Pleurosira laevis	100%	Scenedesmus	0%	Chlorophyta	0%
	LAR3 N. Atwater	2021	15	63%	Pediastrum duplex	39%	Chlamydomonas	14%	Chlorella vulgaris	10%
		2022	14	100%	Pleurosira laevis	99%	Phormidium	0%	Gongrosira	0%
		2023	17	100%	Cladophora glomerata	100%	Hydrosera whampoensis	0%	Pleurosira laevis	0%
		2024	15	100%	Cladophora glomerata	100%	Rhizoclonium hieroglyphicum	0%	Chlorogloea	0%
	LAR00436	2009	18	63%	Chlorophyta 17	23%	Pediastrum integrum	23%	Pleurocapsa minor	18%

Reach	Station ID	Year	# Taxa	% Top Taxa	Taxa 1	T1%	Taxa 2	T2%	Taxa 3	T3%
		2023	20	100%	Cladophora glomerata	100%	Oedogonium sp 1	0%	Scenedesmus raciborskii	0%
	LAR3 Griffith	2012	46	81%	Gongrosira sp 1	41%	Gongrosira incrustans	25%	Gloeocystis vesiculosa	15%
		2024	26	100%	Pleurosira laevis	99%	Cladophora glomerata	1%	Heteroleibleinia sp 1	0%
	LAR3 Electronics	2024	26	100%	Cladophora glomerata	100%	Pleurosira laevis	0%	Leptolyngbya tenuis	0%
BWC	BWC (Up)	2024	22	100%	Cladophora glomerata	100%	Leibleinia epiphytica	0%	Heteroleibleinia sp 1	0%
	BWC (Down)	2024	17	100%	Cladophora glomerata	100%	Chaetophorales 2	0%	Leptolyngbya foveolarum	0%
	BWC Riverside	2024	7	97%	Homoeothrix	53%	Chaetophorales 2	32%	Leptolyngbya foveolarum	12%
LAR Reach 4	LAR4 Zoo	2023	27	100%	Cladophora glomerata	100%	Oedogonium sp 1	0%	Pleurosira laevis	0%
		2024	30	100%	Pleurosira laevis	99%	Cladophora glomerata	1%	Hydrosera whampoensis	0%
	LAR08656	2020	23	100%	Hydrosera whampoensis	50%	Pleurosira laevis	50%	Homoeothrix stagnalis	0%
	LAR02804	2011	29	85%	Cladophora glomerata	76%	Scenedesmus obliquus	5%	Pleurocapsa minor	4%
	412M08597	2015	38	90%	Cladophora glomerata	40%	Schizothrix fragilis	38%	Oedogonium sp 2	12%
	LAR4 Kester	2015	35	66%	Schizothrix fragilis	25%	Phormidium autumnale	22%	Pleurocapsa minor	20%
		2016	43	94%	Chlorophyta 12	72%	Rhizoclonium hieroglyphicum	14%	Schizothrix fragilis	8%
		2017	37	100%	Cladophora glomerata	100%	Chroococcopsis epiphytica	0%	Monoraphidium contortum	0%
		2018	28	100%	Hydrosera whampoensis	99%	Chlorophyta	0%	Scenedesmus ellipticus	0%
		2019	10	100%	Pleurosira laevis	99%	Heteroleibleinia sp 1	1%	Chlamydomonas debaryana	0%
		2020	29	100%	Hydrosera whampoensis	50%	Pleurosira laevis	50%	Cladophora glomerata	0%
		2021	26	84%	Oocystis borgei	50%	Chlorophyta 3	32%	Chlamydomonas sp 1	3%
		2024	13	100%	Pleurosira laevis	78%	Hydrosera whampoensis	20%	Cladophora glomerata	2%
	LAR08661	2021	26	99%	Hydrosera whampoensis	90%	Cladophora glomerata	7%	Pleurosira laevis	1%
LAR Reach 5	LAR5 Balboa	2024	15	100%	Cladophora glomerata	59%	Pleurosira laevis	38%	Hydrosera whampoensis	2%
LAR Reach 6	412M08672	2021	18	100%	Cladophora glomerata	100%	Oedogonium sp 1	0%	Homoeothrix stagnalis	0%
	412M08688	2022	14	100%	Rivularia biasolettiana	100%	Rivularia cf biasolettiana	0%	Cladophora glomerata	0%
	LAR01208	2010	13	100%	Cladophora glomerata	99%	Scenedesmus obliquis	1%	Pediastrum integrum	0%
		2020	17	100%	Cladophora glomerata	100%	Calothrix	0%	Leptolyngbya foveolarum	0%
		2023	14	77%	Calothrix	41%	Schizothrix lacustris	21%	Cosmarium subcrenatum	15%
	412PS0052	2008	22	84%	Rhizoclonium hieroglyphicum	71%	Pediastrum integrum	9%	Synechococcus ambiguus	4%
		2022	13	100%	Rivularia biasolettiana	94%	Homoeothrix stagnalis	6%	Rivularia cf biasolettiana	0%
	SMC02680	2014	31	99%	Rhizoclonium hieroglyphicum	62%	Cladophora glomerata	35%	Pediastrum integrum	2%

Table 5.6. Dominant Soft Algae Taxa Summary for Tributaries to the LA River in the Study Area

This table has been truncated to show only the top three taxa based on percentage total count for each historical station/year record. See text for additional details

Reach	Station ID	Year	# Taxa	% Top Taxa	Taxa 1	T1%	Taxa 2	T2%	Taxa 3	T3%
Compton Creek	SMC01358	2011	17	84%	Tribonema viride	34%	Oocystis parva	29%	Oocystis solitaria	21%
Rio Hondo Reach 1	SMC00830	2011	16	100%	Symploca cf elegans	99%	Oocystis pusilla	0%	Tribonema cf utriculosum	0%
Rio Hondo Reach 3	412M08662	2021	11	100%	Spirogyra	100%	Symploca sp 1	0%	Pleurocapsa minor	0%
	SMC00684	2011	23	84%	Symplocastrum sp 1	47%	Calothrix parietina	28%	Schizothrix lacustris	10%
Alhambra Wash	412M08630	2017	22	93%	Cladophora glomerata	61%	Schizothrix fragilis	19%	Stigeoclonium cf lubricum	13%
	412PS0020	2016	24	64%	Chaetophorales 2	38%	Chlorophyta 14	18%	Pleurocapsa minor	8%
		2022	4	100%	Homoeothrix stagnalis	94%	Chaetophorales	4%	Oocystis pusilla	2%
		2023	13	98%	Leptolyngbya foveolarum	93%	Scenedesmus dimorphus	3%	Homoeothrix stagnalis	2%
	SMC01772	2012	20	100%	Cladophora glomerata	97%	Gongrosira sp 1	2%	Cosmarium sportella var subnudum	0%
Rubio Wash	SMC00748	2011	20	58%	Chaetophorales 2	24%	Scenedesmus dimorphus	24%	Chroococcus minutus	10%
Eaton Wash	SMC01452	2010	24	99%	Rhizoclonium hieroglyphicum	91%	Cladophora glomerata	5%	Vaucheria sp 1	3%
	412M08646	2019	10	79%	Chlorophyta	33%	Leptolyngbya foveolarum	32%	Scenedesmus obliquus	14%
Arroyo Seco Reach 1	412M08658	2020	17	64%	Heteroleibleinia sp 1	30%	Scenedesmus dimorphus	22%	Pediastrum boryanum	11%
	412M08694	2023	16	100%	Homoeothrix stagnalis	50%	Phormidium	50%	Heteroleibleinia sp 1	0%
	SMC02028	2012	8	100%	Cladophora glomerata	100%	Chroococcopsis fluviatilis	0%	Leibleinia epiphytica	0%
Arroyo Seco Reach 2	SMC01004	2009	6	100%	Leptolyngbya foveolarum	18%	Phormidium subfuscum	82%	Pleurocapsa minor	0%
		2019	14	71%	Scenedesmus raciborskii	43%	Oocystis pusilla	15%	Scenedesmus obliquus	12%
	412M08686	2022	7	99%	Homoeothrix stagnalis	71%	Calothrix	23%	Stigeoclonium lubricum	5%
Tujunga Wash	SMC02996	2014	20	95%	Cladophora glomerata	67%	Chroococcus turgidus	23%	Pediastrum integrum	5%
	SMC02484	2013	39	100%	Cladophora glomerata	95%	Symploca elegans	4%	Geitlerinema amphibium	1%
Big Tujunga Canyon Creek	412M08683	2022	3	100%	Cladophora glomerata	100%	Heteroleibleinia sp 1	0%	Cyanophyceae	0%
Bull Creek	SMC01716	2010	16	71%	Gongrosira schmidlei	42%	Scenedesmus dimorphus	17%	Pediastrum integrum	12%
	412M08693	2022	17	100%	Rivularia biasolettiana	100%	Symploca elegans	0%	Rivularia cf biasolettiana	0%
	SMC01972	2010	28	99%	Cladophora glomerata	97%	Gongrosira debariana	1%	Dichothrix orsiniana	1%
	412PS0040	2016	34	61%	Gongrosira schmidlei	31%	Calothrix linearis	20%	Calothrix kossinskajae	10%
		2022	10	100%	Cladophora glomerata	100%	Chaetophorales	0%	Leptolyngbya tenuis	0%
	412M08645	2019	3	100%	Heteroleibleinia sp 1	86%	Leptolyngbya tenuis	13%	Anabaena	1%

Reach	Station ID	Year	# Taxa	% Top Taxa	Taxa 1	T1%	Taxa 2	T2%	Taxa 3	T3%
Aliso Canyon Wash	412M08640	2018	13	97%	Symploca sp 1	89%	Chaetophorales 2	5%	Oocystis parva	4%
	SMC01464	2012	10	100%	Cladophora glomerata	99%	Oedogonium sp 2	1%	Calothrix parietina	0%
	SMC00440	2009	3	100%	Heteroleibleinia kossinskajae	73%	Phormidium sp 4	16%	Leptolyngbya foveolarum	11%
		2018	19	100%	Vaucheria geminata	100%	Leptolyngbya tenuis	0%	Homoeothrix stagnalis	0%
Limekiln Canyon Wash	SMC02232	2013	25	99%	Symploca elegans	95%	Oocystis solitaria	4%	Oocystis pusilla	0%
Santa Susana Pass Wash	412M08632	2012	34	85%	Gongrosira cf debaryana	65%	Calothrix parietina	13%	Pediastrum integrum	8%
		2017	33	67%	Gongrosira debaryana	25%	Cladophora glomerata	23%	Schizothrix fragilis	18%
Bell Creek (South Fork)	SMC02936	2013	9	100%	Cladophora glomerata	99%	Chlorophyta 1	0%	Cosmarium laeve	0%
Cabellero Creek	SMC01656	2012	31	100%	Cladophora glomerata	92%	Rhizoclonium hieroglyphicum	6%	Oedogonium sp 1	2%

Appendix 6. Cluster Analysis Using Biological Data from the LA River Mainstem and Its Tributaries

Presented in the report are qualitive and quantitative approaches to evaluating the potential impact of WRP temperature addition using bioassessment data. To further support the quantitative analyses, an additional analysis was conducted to answer the following question: Are there differences in community composition within organism type (BMI, diatoms, and soft algae) among stations on the mainstem Los Angeles (LA) River and Burbank Western Channel (BWC), which are influenced by discharges from the Water Reclamation Plants (WRPs), and other stations on the LA River and urbanized tributaries, which are not influenced by WRP discharges? The answer to this question was pursued using cluster analysis of the Study-derived and historical BMI and algae bioassessment data. If there were differences in community composition due to WRP temperature addition one would expect to see a unique cluster of stations influenced by WRP discharges and a different cluster (or clusters) of stations that are not influenced by WRP discharges.

The BMI and benthic algae bioassessment data were analyzed for similarities in relative abundance (the numeric contribution of a taxa in proportion to the overall community count) of BMI and diatoms and the relative dominance (the percentage of a taxa's biovolume in proportion to total biovolume) of soft algae. A cluster analysis allows for the comparison of large and complex data sets to detect statistical groupings, in this case, among BMI and algae community composition data at stations with and without the presence of WRP flow (Boesch 1977, Kaufman and Rousseeuw 2009). Clustering was used, because unlike ordination which is better suited for exploring patterns and gradients within a bioassessment dataset, clustering is more useful when one wants to identify distinct groups within the dataset, which better aligns with the purpose of the analysis to answer the question posed.

For the cluster analysis, datasets were first compiled in R for each organism type (BMI, diatom, and soft algae), composed of the relative abundance (BMI and diatom) or dominance (soft algae) for all taxa collected and identified at a bioassessment monitoring station in a given year (station/year combination). A distance matrix of Bray-Curtis similarity values was then calculated for BMI and diatom relative abundance and soft algae relative dominance for all station/year combinations. Notably, because the cluster analysis incorporated all taxa collected and identified at stations, the analysis provides a statistical means to determine if there are differences in community composition due to WRP temperature. Additionally, cluster analysis allowed the incorporation of bioassessment data for sites in relevant tributaries to the LA River mainstem, which do not receive WRP discharge.

The analysis began by determining how many cluster groups reasonably defined the BMI and algae response in the system, using Ward's minimum variance method (Ward and Hook 1963, Szekely and Rizzo 2005). The goal was to form as many statistically different groups as the variance in the observed data allowed, without forming so many groups such that their interpretation became difficult. Four, five, six and eight cluster groupings were initially evaluated, depending on organism group. A four-cluster group membership was found to be sufficient to differentiate BMI and algae response and draw meaningful conclusions. All four groups were found to be statistically different using a pairwise comparison test. All cluster-analysis work was done in R using the package named vegan (Oksanen et al. 2025).

Figure 1, **Figure 2**, and **Figure 3** display dendrograms (tree diagrams) showing the four statistically-distinct groupings (in red boxes) for the combined datasets for BMI, diatoms, and soft algae, respectively. Dendrograms were created to show the hierarchical relationship between station/year combinations and was created from the similarity matrix between the stations and their individual sampling years (i.e., 91, 92, and 155 total station/year events for diatoms, soft algae, and BMI, respectively; refer to **Table 1** through **Table 3**).

Figure 4, **Figure 5**, and **Figure 6** map the stations by cluster group membership for BMI, diatoms, and soft algae by color, respectively. If there were differences in community composition due to WRP temperature addition one would expect to see a unique cluster of stations influenced by WRP discharges and a different cluster (or clusters) of stations that are not influenced by WRP discharges. As shown on the maps, stations downstream of WRP discharges appear in multiple cluster groups that also include tributary and/or upstream stations not influenced by WRP discharges. As such, there is no indication that community composition is impacted by WRP temperature addition.

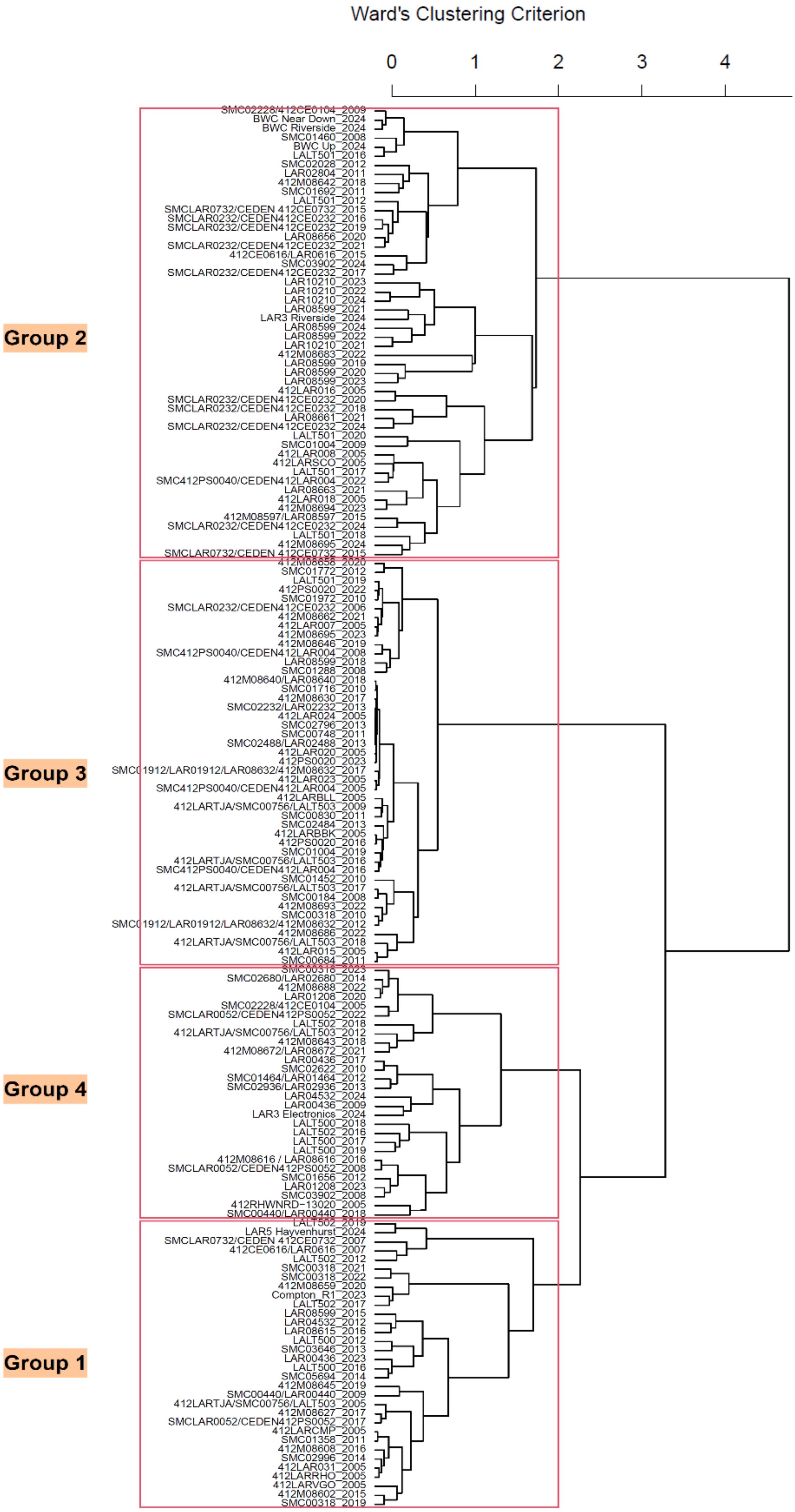


Figure 1. Dendrogram showing results of hierarchical clustering on 155 BMI station/year events along with four-group cluster membership (red box)

Each leaf in the dendrogram (far left) represents one event (a station/year) and is labeled as such. The width of the horizontal lines (or branch points) in the dendrogram indicates the distance or dissimilarity between the clusters being merged at that width. A longer width means that the clusters being merged at that point are more dissimilar or farther apart in terms of the distance metric used in the hierarchical clustering algorithm.

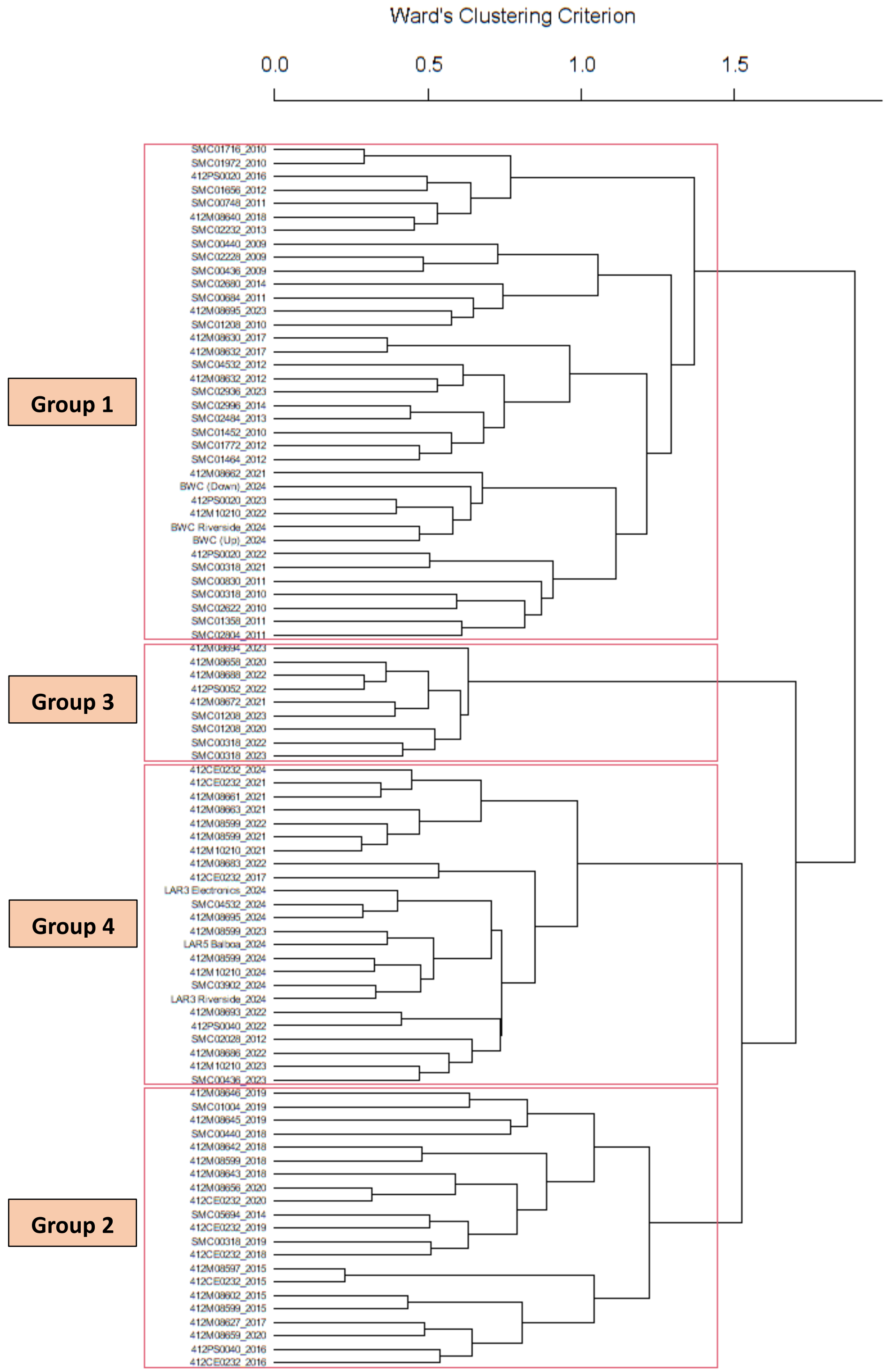


Figure 2. Dendrogram showing results of hierarchical clustering on 91 <u>diatom</u> station/year events along with four-group cluster membership (red box)

Each leaf in the dendrogram (far left) represents one event (a station/year) and is labeled as such. The width of the horizontal lines (or branch points) in the dendrogram indicates the distance or dissimilarity between the clusters being merged at that width. A longer width means that the clusters being merged at that point are more dissimilar or farther apart in terms of the distance metric used in the hierarchical clustering algorithm.

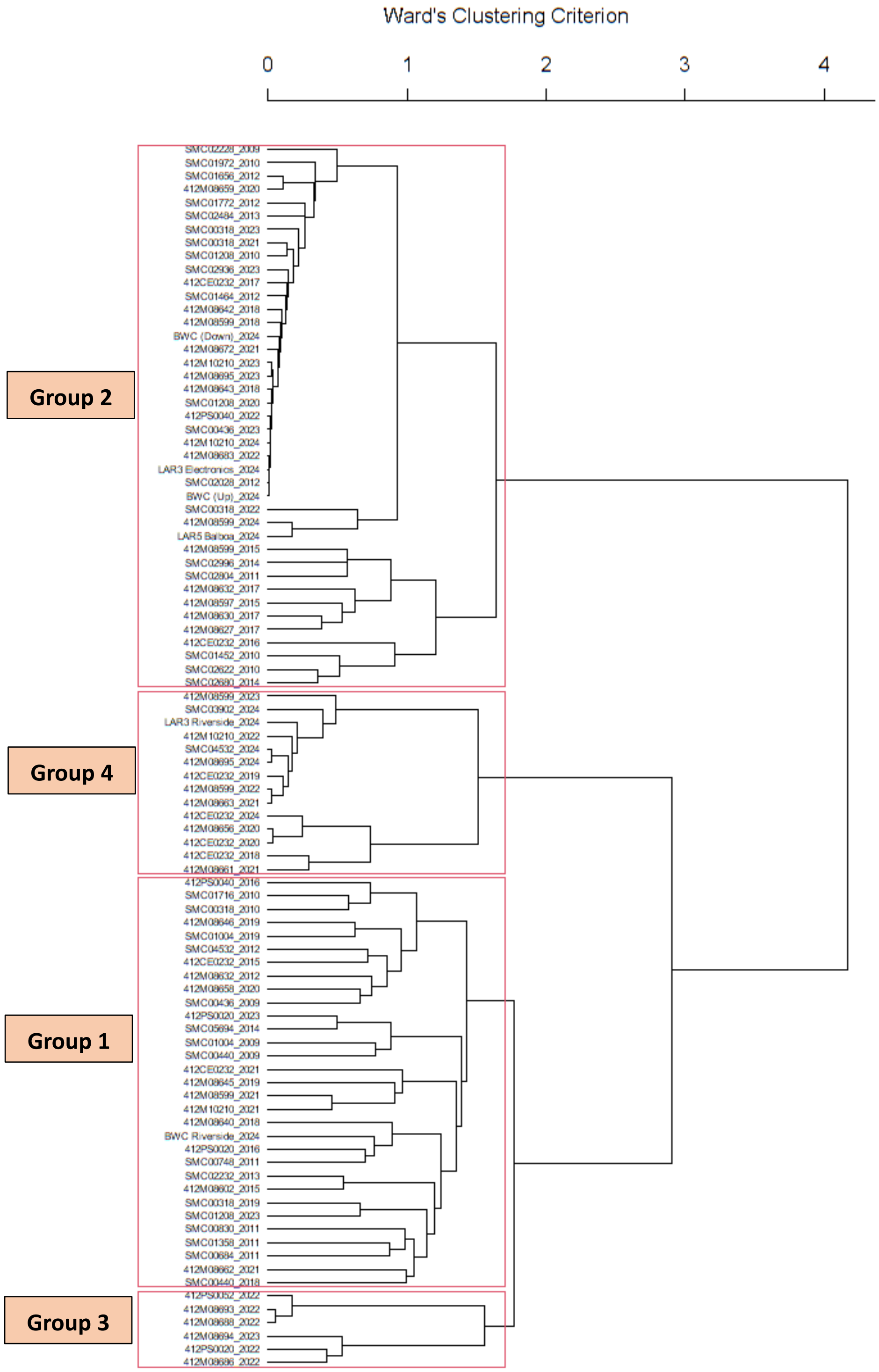


Figure 3. Dendrogram showing results of hierarchical clustering on 92 soft algae station/year events along with four-group cluster membership (red box)

Each leaf in the dendrogram (far left) represents one event (a station/year) and is labeled as such. The width of the horizontal lines (or branch points) in the dendrogram indicates the distance or dissimilarity between the clusters being merged at that width. A longer width means that the clusters being merged at that point are more dissimilar or farther apart in terms of the distance metric used in the hierarchical clustering algorithm.

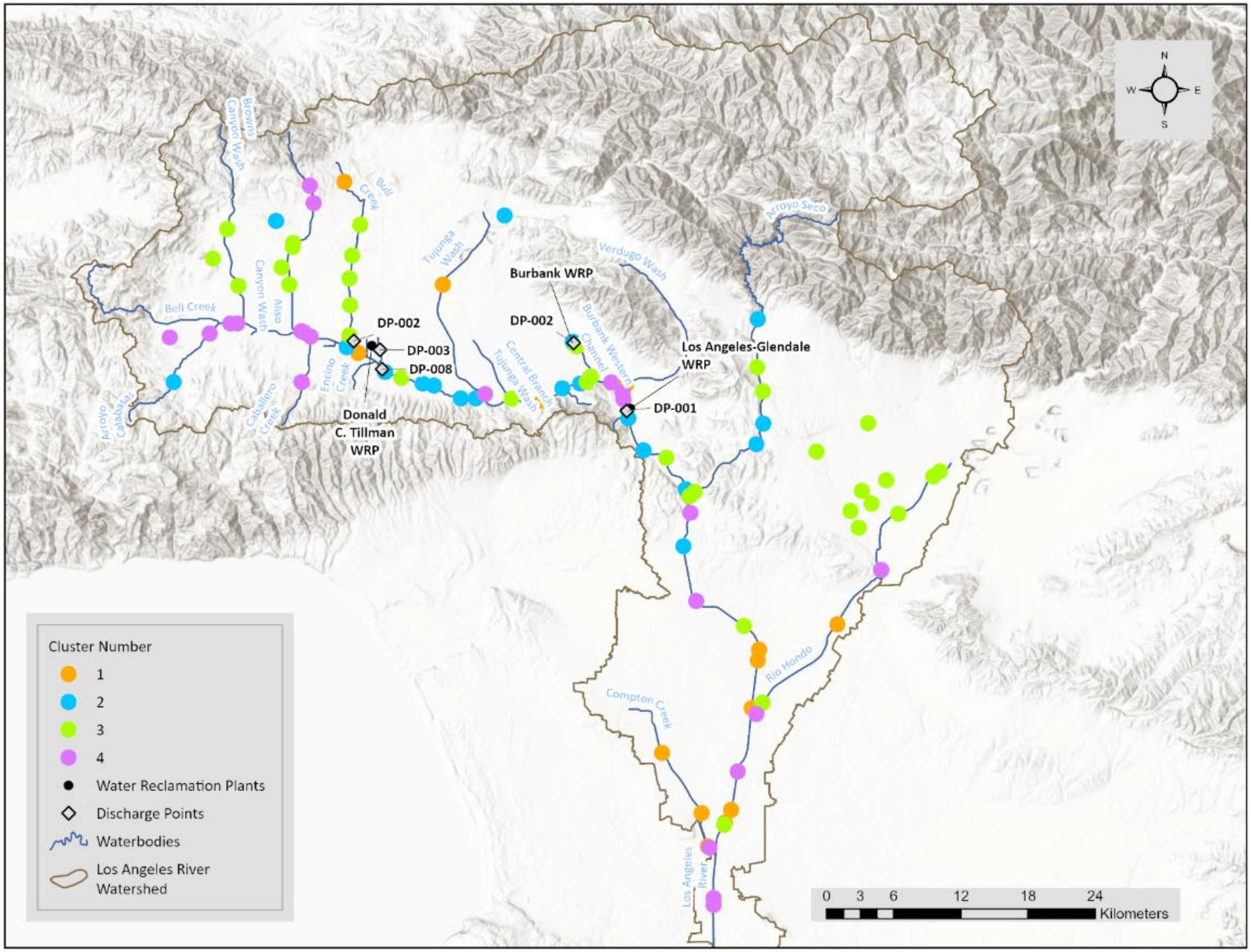


Figure 4. Map showing distribution of BMI sampling stations by cluster group (color of circle)

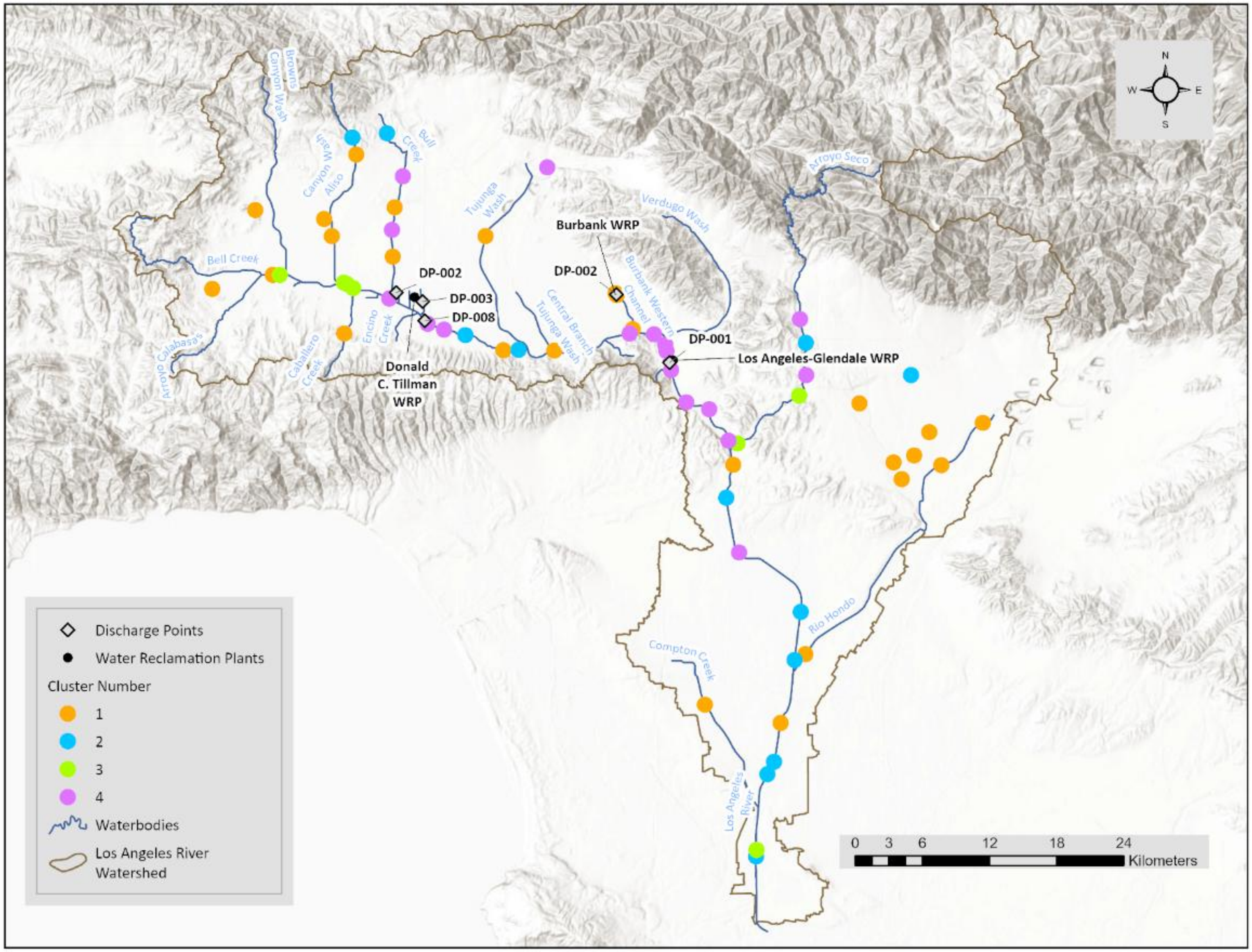


Figure 5. Map showing distribution of <u>diatom</u> sampling stations by cluster group (color of circle)

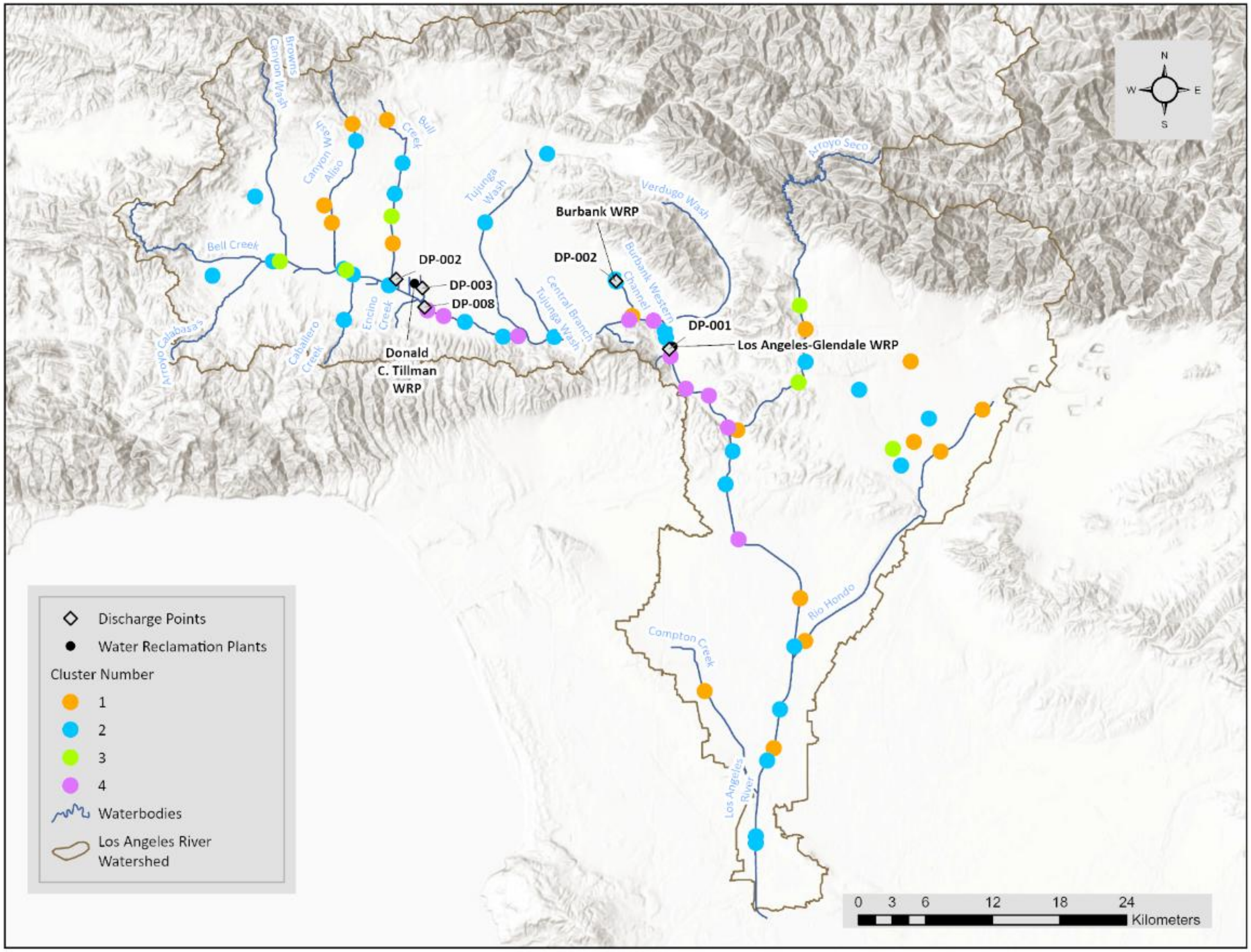


Figure 6. Map showing distribution of <u>soft algae</u> sampling stations by cluster group (color of circle)

Table 1. Grouping Results of Cluster Analysis of BMI Relative Abundance using All Taxa Collected and Identified for each Bioassessment Monitoring Station and Year Combination (similar groups have the same color)

Station_Year	Waterbody	BMI Cluster Group	WRP flow?	Considered Tributary in the Analysis?
412CE0616/LAR0616_2007	LAR Reach 4	1	Yes	No
412LAR031_2005	Rio Hondo Reach 2	1	No	Yes
412LARCMP_2005	Compton Creek	1	No	Yes
412LARRHO_2005	Rio Hondo Reach 1	1	No	Yes
412LARTJA/SMC00756/ LALT503_2005	Tujunga Wash	1	No	Yes
412LARVGO_2005	Verdugo Wash Reach 1	1	No	Yes
412M08602_2015	LAR Reach 2	1	Yes	No
412M08608_2016	Bull Creek	1	No	Yes
412M08627_2017	LAR Reach 2	1	Yes	No
412M08645_2019	Bull Creek	1	No	Yes
412M08659_2020	LAR Reach 2	1	Yes	No
Compton_R1_2023	Compton Creek	1	No	Yes
LALT500_2012	Rio Hondo Reach 1	1	No	Yes
LALT500_2016	Rio Hondo Reach 1	1	No	Yes
LALT502_2012	Compton Creek	1	No	Yes
LALT502_2017	Compton Creek	1	No	Yes
LALT502_2019	Compton Creek	1	No	Yes
LAR00436_2023	LAR Reach 3	1	Yes	No
LAR04532_2012	LAR Reach 3	1	Yes	No
LAR08599_2015	LAR Reach 3	1	Yes	No
LAR08615_2016	LAR Reach 4	1	Yes	No
LAR5 Hayvenhurst_2024	LAR Reach 5	1	Yes	No
SMC00318_2019	LAR Reach 1	1	Yes	No
SMC00318_2021	LAR Reach 1	1	Yes	No
SMC00318_2022	LAR Reach 1	1	Yes	No
SMC00440/LAR00440_2009	Aliso Canyon Wash	1	No	Yes
SMC01358_2011	Compton Creek	1	No	Yes
SMC02996_2014	Tujunga Wash	1	No	Yes
SMC03646_2013	LAR Reach 2	1	Yes	No
SMC05694_2014	LAR Reach 2	1	Yes	No
SMCLAR0052/CEDEN412PS0052_2017	LAR Reach 6	1	No	No
SMCLAR0732/CEDEN 412CE0732_2007	LAR Reach 4	1	Yes	No
412CE0616/LAR0616_2015	LAR Reach 4	2	Yes	No
412LAR008_2005	Limekiln Canyon Wash	2	No	Yes
412LAR016_2005	Arroyo Calabasas	2	No	Yes
412LAR018_2005	Browns Canyon Wash	2	No	Yes
412LARSCO_2005	Arroyo Seco Reach 1	2	No	Yes

Station_Year	Waterbody	BMI Cluster Group	WRP flow?	Considered Tributary in the Analysis?
412M08597/LAR08597_2015	LAR Reach 4	2	Yes	No
412M08642_2018	LAR Reach 2	2	Yes	No
412M08683_2022	Tujunga Wash	2	No	Yes
412M08694_2023	Arroyo Seco Reach 1	2	No	Yes
412M08695_2024	LAR Reach 4	2	Yes	No
BWC Near Down_2024	Burbank Western Channel	2	Yes	No
BWC Riverside_2024	Burbank Western Channel	2	Yes	No
BWC Up_2024	Burbank Western Channel	2	No	No
LALT501_2012	Arroyo Seco Reach 1	2	No	Yes
LALT501_2016	Arroyo Seco Reach 1	2	No	Yes
LALT501_2017	Arroyo Seco Reach 1	2	No	Yes
LALT501_2018	Arroyo Seco Reach 1	2	No	Yes
LALT501_2020	Arroyo Seco Reach 1	2	No	Yes
LAR02804_2011	LAR Reach 4	2	Yes	No
LAR08599_2019	LAR Reach 3	2	Yes	No
LAR08599_2020	LAR Reach 3	2	Yes	No
LAR08599_2021	LAR Reach 3	2	Yes	No
LAR08599_2022	LAR Reach 3	2	Yes	No
LAR08599_2023	LAR Reach 3	2	Yes	No
LAR08599_2024	LAR Reach 3	2	Yes	No
LAR08656_2020	LAR Reach 4	2	Yes	No
LAR08661_2021	LAR Reach 4	2	Yes	No
LAR08663_2021	LAR Reach 3	2	Yes	No
LAR10210_2021	LAR Reach 3	2	Yes	No
LAR10210_2022	LAR Reach 3	2	Yes	No
LAR10210_2023	LAR Reach 3	2	Yes	No
LAR10210_2024	LAR Reach 3	2	Yes	No
LAR3 Riverside_2024	LAR Reach 3	2	Yes	No
SMC01004_2009	Arroyo Seco Reach 2	2	No	Yes
SMC01460_2008	LAR Reach 4	2	Yes	No
SMC01692_2011	Arroyo Seco Reach 3	2	No	Yes
SMC02028_2012	Arroyo Seco Reach 1	2	No	Yes
SMC02228/412CE0104_2009	LAR Reach 2	2	Yes	No
SMC03902_2024	LAR Reach 2	2	Yes	No
SMC412PS0040/CEDEN412LAR004_2022	Bull Creek	2	No	Yes
SMCLAR0232/CEDEN412CE0232_2015	LAR Reach 4	2	Yes	No
SMCLAR0232/CEDEN412CE0232_2016	LAR Reach 4	2	Yes	No
SMCLAR0232/CEDEN412CE0232_2017	LAR Reach 4	2	Yes	No
SMCLAR0232/CEDEN412CE0232_2018	LAR Reach 4	2	Yes	No
SMCLAR0232/CEDEN412CE0232_2019	LAR Reach 4	2	Yes	No

Station_Year	Waterbody	BMI Cluster Group	WRP flow?	Considered Tributary in the Analysis?
SMCLAR0232/CEDEN412CE0232_2020	LAR Reach 4	2	Yes	No
SMCLAR0232/CEDEN412CE0232_2021	LAR Reach 4	2	Yes	No
SMCLAR0232/CEDEN412CE0232_2024	LAR Reach 4	2	Yes	No
LAR5 Balboa_2024	LAR Reach 5	2	No	No
SMCLAR0732/CEDEN 412CE0732_2015	LAR Reach 4	2	Yes	No
412LAR007_2005	LAR Reach 2	3	Yes	No
412LAR015_2005	Rio Hondo Reach 3	3	No	Yes
412LAR020_2005	Browns Canyon Wash	3	No	Yes
412LAR023_2005	LAR Reach 2	3	Yes	No
412LAR024_2005	Wilbur Wash	3	No	Yes
412LARBBK_2005	Burbank Western Channel	3	Yes	No
412LARBLL_2005	Bull Creek	3	No	Yes
412LARTJA/SMC00756/LALT503_2009	Tujunga Wash	3	No	Yes
412LARTJA/SMC00756/LALT503_2016	Tujunga Wash	3	No	Yes
412LARTJA/SMC00756/LALT503_2017	Tujunga Wash	3	No	Yes
412LARTJA/SMC00756/LALT503_2018	Tujunga Wash	3	No	Yes
412M08630_2017	Alhambra Wash	3	No	Yes
412M08640/LAR08640_2018	Aliso Canyon Wash	3	No	Yes
412M08646_2019	Eaton Wash	3	No	Yes
412M08658_2020	Arroyo Seco Reach 2	3	No	Yes
412M08662_2021	Rio Hondo Reach 3	3	No	Yes
412M08686_2022	Arroyo Seco Reach 2	3	No	Yes
412M08693_2022	Bull Creek	3	No	Yes
412M08695_2023	LAR Reach 4	3	Yes	No
412PS0020_2016	Alhambra Wash	3	No	Yes
412PS0020_2022	Alhambra Wash	3	No	Yes
412PS0020_2023	Alhambra Wash	3	No	Yes
LALT501_2019	Arroyo Seco Reach 1	3	No	Yes
LAR08599_2018	LAR Reach 3	3	Yes	No
SMC00184_2008	Browns Canyon Wash	3	No	Yes
SMC00318_2010	LAR Reach 1	3	Yes	No
SMC00684_2011	Rio Hondo Reach 3	3	No	Yes
SMC00748_2011	Rubio Wash	3	No	Yes
SMC00830_2011	Rio Hondo Reach 1	3	No	Yes
SMC01004_2019	Arroyo Seco	3	No	Yes
SMC01288_2008	Burbank Western Channel	3	Yes	No
SMC01452_2010	Eaton Wash	3	No	Yes
SMC01716_2010	Bull Creek	3	No	Yes
SMC01772_2012	Alhambra Wash	3	No	Yes
SMC01912/LAR01912/LAR08632/ 412M08632_2012	Santa Susana Pass Wash	3	No	Yes

Station_Year	Waterbody	BMI Cluster Group	WRP flow?	Considered Tributary in the Analysis?
SMC01912/LAR01912/LAR08632/ 412M08632_2017	Santa Susana Pass Wash	3	No	Yes
SMC01972_2010	Bull Creek	3	No	Yes
SMC02232/LAR02232_2013	Limekiln Canyon Wash	3	No	Yes
SMC02484_2013	Tujunga Wash	3	No	Yes
SMC02488/LAR02488_2013	Wilbur Wash	3	No	Yes
SMC02796_2013	Rubio Wash	3	No	Yes
SMC412PS0040/CEDEN412LAR004_2005	Bull Creek	3	No	Yes
SMC412PS0040/CEDEN412LAR004_2008	Bull Creek	3	No	Yes
SMC412PS0040/CEDEN412LAR004_2016	Bull Creek	3	No	Yes
SMCLAR0232/CEDEN412CE0232_2006	LAR Reach 4	3	Yes	No
412LARTJA/SMC00756/LALT503_2012	Tujunga Wash	4	No	Yes
412M08616 / LAR08616_2016	Arroyo Calabasas	4	No	Yes
412M08643_2018	LAR Reach 1	4	Yes	No
412M08672/LAR08672_2021	LAR Reach 6	4	No	No
412M08688_2022	LAR Reach 6	4	No	No
412RHWNRD-13020_2005	Rio Hondo Reach 3	4	Yes	Yes
LALT500_2017	Rio Hondo Reach 1	4	No	Yes
LALT500_2018	Rio Hondo Reach 1	4	No	Yes
LALT500_2019	Rio Hondo Reach 1	4	No	Yes
LALT502_2016	Compton Creek	4	No	Yes
LALT502_2018	Compton Creek	4	No	Yes
LAR00436_2009	LAR Reach 3	4	Yes	No
LAR00436_2017	LAR Reach 3	4	Yes	No
LAR01208_2020	LAR Reach 6	4	No	No
LAR01208_2023	LAR Reach 6	4	No	No
LAR04532_2024	LAR Reach 3	4	Yes	No
LAR3 Electronics_2024	LAR Reach 3	4	Yes	No
SMC00318_2023	LAR Reach 1	4	Yes	No
SMC00440/LAR00440_2018	Aliso Canyon Wash	4	No	Yes
SMC01464/LAR01464_2012	Aliso Canyon Wash	4	No	Yes
SMC01656_2012	Cabellero Creek	4	No	Yes
SMC02228/412CE0104_2005	LAR Reach 2	4	Yes	No
SMC02622_2010	LAR Reach 2	4	Yes	No
SMC02680/LAR02680_2014	LAR Reach 6	4	No	No
SMC02936/LAR02936_2013	Bell Creek (South Fork)	4	No	Yes
SMC03902_2008	LAR Reach 2	4	Yes	No
SMCLAR0052/CEDEN412PS0052_2008	LAR Reach 6	4	No	No
SMCLAR0052/CEDEN412PS0052_2022	LAR Reach 6	4	No	No

Table 2. Grouping Results of Cluster Analysis of Diatom Relative Abundance using All Taxa Collected and Identified for each Bioassessment Monitoring Station and Year Combination (similar groups have the same color)

Station_Year	Waterbody	Diatom Cluster Group	WRP flow?	Considered Tributary in the Analysis?
412M08640_2018	Aliso Canyon Wash	1	No	Yes
SMC01464_2012	Aliso Canyon Wash	1	No	Yes
SMC00440_2009	Aliso Canyon Wash	1	No	Yes
SMC02936_2023	Bell Creek (South Fork)	1	No	Yes
SMC01716_2010	Bull Creek	1	No	Yes
SMC01972_2010	Bull Creek	1	No	Yes
BWC (Down)_2024	Burbank Western Channel	1	Yes	No
BWC (Up)_2024	Burbank Western Channel	1	No	No
BWC Riverside_2024	Burbank Western Channel	1	Yes	No
SMC01656_2012	Cabellero Creek	1	No	Yes
SMC01358_2011	Compton Creek	1	No	Yes
SMC02232_2013	Limekiln Canyon Wash	1	No	Yes
SMC00318_2010	LAR Reach 1	1	Yes	No
SMC00318_2021	LAR Reach 1	1	Yes	No
SMC02228_2009	LAR Reach 2	1	Yes	No
SMC02622_2010	LAR Reach 2	1	Yes	No
412M10210_2022	LAR Reach 3	1	Yes	No
SMC00436_2009	LAR Reach 3	1	Yes	No
SMC04532_2012	LAR Reach 3	1	Yes	No
412M08695_2023	LAR Reach 4	1	Yes	No
SMC02804_2011	LAR Reach 4	1	Yes	No
SMC01208_2010	LAR Reach 6	1	No	No
SMC02680_2014	LAR Reach 6	1	No	No
412M08662_2021	Rio Hondo Reach 3	1	No	Yes
SMC00684_2011	Rio Hondo Reach 3	1	No	Yes
SMC00830_2011	Rio Hondo Reach 1	1	No	Yes
412M08630_2017	Alhambra Wash	1	No	Yes
412PS0020_2016	Alhambra Wash	1	No	Yes
412PS0020_2022	Alhambra Wash	1	No	Yes
SMC01772_2012	Alhambra Wash	1	No	Yes
SMC01452_2010	Eaton Wash	1	No	Yes
SMC00748_2011	Rubio Wash	1	No	Yes
412M08632_2012	Santa Susana Creek	1	No	Yes
412M08632_2017	Santa Susana Creek	1	No	Yes
SMC02996_2014	Tujunga Wash	1	No	Yes
SMC02484_2013	Tujunga Wash	1	No	Yes
SMC00440_2018	Aliso Canyon Wash	2	No	Yes
SMC01004_2019	Arroyo Seco Reach 2	2	No	Yes

Station_Year	Waterbody	Diatom Cluster Group	WRP flow?	Considered Tributary in the Analysis?
412M08645_2019	Bull Creek	2	No	Yes
412PS0040_2016	Bull Creek	2	No	Yes
412M08643_2018	LAR Reach 1	2	Yes	No
SMC00318_2019	LAR Reach 1	2	Yes	No
412M08602_2015	LAR Reach 2	2	Yes	No
412M08627_2017	LAR Reach 2	2	Yes	No
412M08642_2018	LAR Reach 2	2	Yes	No
412M08659_2020	LAR Reach 2	2	Yes	No
SMC05694_2014	LAR Reach 2	2	Yes	No
412M08599_2015	LAR Reach 3	2	Yes	No
412M08599_2018	LAR Reach 3	2	Yes	No
412CE0232_2015	LAR Reach 4	2	Yes	No
412CE0232_2016	LAR Reach 4	2	Yes	No
412CE0232_2018	LAR Reach 4	2	Yes	No
412CE0232_2019	LAR Reach 4	2	Yes	No
412CE0232_2020	LAR Reach 4	2	Yes	No
412M08597_2015	LAR Reach 4	2	Yes	No
412M08656_2020	LAR Reach 4	2	Yes	No
412M08646_2019	Eaton Wash	2	No	Yes
412M08658_2020	Arroyo Seco Reach 1	3	No	Yes
SMC00318_2022	LAR Reach 1	3	Yes	No
SMC00318_2023	LAR Reach 1	3	Yes	No
412M08672_2021	LAR Reach 6	3	No	No
412M08688_2022	LAR Reach 6	3	No	No
412PS0052_2022	LAR Reach 6	3	No	No
SMC01208_2020	LAR Reach 6	3	No	No
SMC01208_2023	LAR Reach 6	3	No	No
412M08686_2022	Arroyo Seco Reach 2	4	No	Yes
SMC02028_2012	Arroyo Seco Reach 1	4	No	Yes
412M08683_2022	Big Tujunga Canyon Creek	4	No	Yes
412M08693_2022	Bull Creek	4	No	Yes
412PS0040_2022	Bull Creek	4	No	Yes
SMC03902_2024	LAR Reach 2	4	Yes	No
412M08599_2021	LAR Reach 3	4	Yes	No
412M08599_2022	LAR Reach 3	4	Yes	No
412M08599_2023	LAR Reach 3	4	Yes	No
412M08599_2024	LAR Reach 3	4	Yes	No
412M08663_2021	LAR Reach 3	4	Yes	No
412M10210_2021	LAR Reach 3	4	Yes	No
412M10210_2023	LAR Reach 3	4	Yes	No
412M10210_2024	LAR Reach 3	4	Yes	No

Station_Year	Waterbody	Diatom Cluster Group	WRP flow?	Considered Tributary in the Analysis?
LAR3 Electronics_2024	LAR Reach 3	4	Yes	No
LAR3 Riverside_2024	LAR Reach 3	4	Yes	No
SMC00436_2023	LAR Reach 3	4	Yes	No
SMC04532_2024	LAR Reach 3	4	Yes	No
412CE0232_2017	LAR Reach 4	4	Yes	No
412CE0232_2021	LAR Reach 4	4	Yes	No
412CE0232_2024	LAR Reach 4	4	Yes	No
412M08661_2021	LAR Reach 4	4	Yes	No
412M08695_2024	LAR Reach 4	4	Yes	No
LAR5 Balboa_2024	LAR Reach 5	4	No	No

Table 3. Grouping Results of Cluster Analysis of Soft Algae Relative Dominance using All Taxa Collected and Identified for each Bioassessment Monitoring Station and Year Combination (similar groups have the same color)

Station_Year	Waterbody	Soft Algae Cluster Group	WRP flow?	Considered Tributary in the Analysis?
412M08640_2018	Aliso Canyon Wash	1	No	Yes
SMC00440_2009	Aliso Canyon Wash	1	No	Yes
SMC00440_2018	Aliso Canyon Wash	1	No	Yes
SMC01004_2009	Arroyo Seco Reach 2	1	No	Yes
SMC01004_2019	Arroyo Seco Reach 2	1	No	Yes
412M08658_2020	Arroyo Seco Reach 1	1	No	Yes
412M08645_2019	Bull Creek	1	No	Yes
412PS0040_2016	Bull Creek	1	No	Yes
SMC01716_2010	Bull Creek	1	No	Yes
BWC Riverside_2024	Burbank Western Channel	1	Yes	No
SMC01358_2011	Compton Creek	1	No	Yes
SMC02232_2013	Limekiln Canyon Wash	1	No	Yes
SMC00318_2010	LAR Reach 1	1	Yes	No
SMC00318_2019	LAR Reach 1	1	Yes	No
412M08602_2015	LAR Reach 2	1	Yes	No
SMC05694_2014	LAR Reach 2	1	Yes	No
412M08599_2021	LAR Reach 3	1	Yes	No
412M10210_2021	LAR Reach 3	1	Yes	No
SMC00436_2009	LAR Reach 3	1	Yes	No
SMC04532_2012	LAR Reach 3	1	Yes	No
412CE0232_2015	LAR Reach 4	1	Yes	No
412CE0232_2021	LAR Reach 4	1	Yes	No
SMC01208_2023	LAR Reach 6	1	No	No
412M08662_2021	Rio Hondo Reach 3	1	No	Yes
SMC00684_2011	Rio Hondo Reach 3	1	No	Yes
SMC00830_2011	Rio Hondo Reach 1	1	No	Yes
412PS0020_2016	Alhambra Wash	1	No	Yes
412M08646_2019	Eaton Wash	1	No	Yes
SMC00748_2011	Rubio Wash	1	No	Yes
412M08632_2012	Santa Susana Creek	1	No	Yes
SMC01464_2012	Aliso Canyon Wash	2	No	Yes
SMC02028_2012	Arroyo Seco Reach 1	2	No	Yes
SMC02936_2023	Bell Creek (South Fork)	2	No	Yes
412M08683_2022	Big Tujunga Canyon Creek	2	No	Yes
412PS0040_2022	Bull Creek	2	No	Yes
SMC01972_2010	Bull Creek	2	No	Yes
BWC (Down)_2024	Burbank Western Channel	2	Yes	No
BWC (Up)_2024	Burbank Western Channel	2	No	No

Station_Year	Waterbody	Soft Algae Cluster Group	WRP flow?	Considered Tributary in the Analysis?
SMC01656_2012	Cabellero Creek	2	No	Yes
412M08643_2018	LAR Reach 1	2	Yes	No
SMC00318_2021	LAR Reach 1	2	Yes	No
SMC00318_2022	LAR Reach 1	2	Yes	No
SMC00318_2023	LAR Reach 1	2	Yes	No
412M08627_2017	LAR Reach 2	2	Yes	No
412M08642_2018	LAR Reach 2	2	Yes	No
412M08659_2020	LAR Reach 2	2	Yes	No
SMC02228_2009	LAR Reach 2	2	Yes	No
SMC02622_2010	LAR Reach 2	2	Yes	No
412M08599_2015	LAR Reach 3	2	Yes	No
412M08599_2018	LAR Reach 3	2	Yes	No
412M08599_2024	LAR Reach 3	2	Yes	No
412M10210_2023	LAR Reach 3	2	Yes	No
412M10210_2024	LAR Reach 3	2	Yes	No
LAR3 Electronics_2024	LAR Reach 3	2	Yes	No
SMC00436_2023	LAR Reach 3	2	Yes	No
412CE0232_2016	LAR Reach 4	2	Yes	No
412CE0232_2017	LAR Reach 4	2	Yes	No
412M08597_2015	LAR Reach 4	2	Yes	No
412M08695_2023	LAR Reach 4	2	Yes	No
SMC02804_2011	LAR Reach 4	2	Yes	No
LAR5 Balboa_2024	LAR Reach 5	2	No	No
412M08672_2021	LAR Reach 6	2	No	No
SMC01208_2010	LAR Reach 6	2	No	No
SMC01208_2020	LAR Reach 6	2	No	No
SMC02680_2014	LAR Reach 6	2	No	No
412M08630_2017	Alhambra Wash	2	No	Yes
SMC01772_2012	Alhambra Wash	2	No	Yes
SMC01452_2010	Eaton Wash	2	No	Yes
412M08632_2017	Santa Susana Creek	2	No	Yes
SMC02996_2014	Tujunga Wash	2	No	Yes
SMC02484_2013	Tujunga Wash	2	No	Yes
412M08686_2022	Arroyo Seco Reach 2	3	No	Yes
412M08693_2022	Bull Creek	3	No	Yes
412M08688_2022	LAR Reach 6	3	No	No
412PS0052_2022	LAR Reach 6	3	No	No
412PS0020_2022	Alhambra Wash	3	No	Yes
SMC03902_2024	LAR Reach 2	4	Yes	No
412M08599_2022	LAR Reach 3	4	Yes	No
412M08599_2023	LAR Reach 3	4	Yes	No

Station_Year	Waterbody	Soft Algae Cluster Group	WRP flow?	Considered Tributary in the Analysis?
412M08663_2021	LAR Reach 3	4	Yes	No
412M10210_2022	LAR Reach 3	4	Yes	No
LAR3 Riverside_2024	LAR Reach 3	4	Yes	No
SMC04532_2024	LAR Reach 3	4	Yes	No
412CE0232_2018	LAR Reach 4	4	Yes	No
412CE0232_2019	LAR Reach 4	4	Yes	No
412CE0232_2020	LAR Reach 4	4	Yes	No
412CE0232_2024	LAR Reach 4	4	Yes	No
412M08656_2020	LAR Reach 4	4	Yes	No
412M08661_2021	LAR Reach 4	4	Yes	No
412M08695_2024	LAR Reach 4	4	Yes	No

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Appendix 7. Temperature Tolerance of Taxa Present or Could be Present Given Current Habitat Conditions

This appendix describes the temperature tolerance of the taxa identified as present in the Study area or could be present given current habitat conditions; life stages included, when possible. Temperature tolerance information for these taxa from the literature is provided below, according to major taxa group (vertebrates: freshwater fish and aquatic-life stages of amphibians; BMI and diatoms and soft algae).

A7.1 Vertebrates

Aquatic and aquatic-dependent vertebrate communities of the LA River watershed are well documented. Fish and aquatic-dependent amphibians and reptiles in the Study area are directly affected by the characteristics of the water in which they reside, including variable thermal conditions and influences.

The relationship between vertebrate body temperatures and water temperatures has been a key subject of literature for centuries (Morrow and Mauro 1950, Bayat et al. 2025). In this Study, the presence of freshwater fish and aquatic-dependent amphibians was documented in the LA River in order to investigate how organismal thermal tolerance and water temperature variation are linked.

Given their ecological importance and diversity, freshwater fish have been the focus of extensive research on thermal tolerance. Earlier physiological studies (Heath 1884, Day 1885, Carter 1887, Vernon 1899 and Wells 1914), along with more recent comprehensive reviews (Hutchison 1976, Spotila et al. 1979, Houston 1982, Lutterschmidt and Hutchison 1997, and Beitinger et al. 2000), have significantly expanded fish thermal tolerance database and understanding.

For this study, a distinction was made between cold water and warm water fish species (i.e., those requiring water temperatures below 70°F and inhabiting well-oxygenated waters versus eurythermal species with broader temperature tolerance). Additionally, this study excluded fish that no longer inhabit the Study area, including those that may have historically migrated into the Study area during the winter months. These transient fish species are not relevant to the Study objectives because stream temperatures during the winter are consistently below 80°F, and any thermal addition during the winter is beneficial for growth (Armstrong et al. 2021). Therefore, freshwater fish identified as present or that could be present in the Study area are the primary focus of this report.

In addition to the above, it is important to recognize that temperature adaptation through thermal tolerance comes in many forms for fish. For example, a study on two populations of eastern mosquitofish (*Gambusia holbrooki*) in South Carolina, one in an ambient temperature pond and the other in a pond heated to near-lethal temperatures by nuclear reactor effluents for 60-90 mosquitofish generations, showed that increased thermal tolerance in the heated pond population was likely the result of genetic adaptation (Meffe et al. 1995). Similarly, Huff et al. (2005) used thermal niche values to show that the upper thermal limit for rainbow trout *Oncorhynchus mykiss* was 72°F in the Blue Mountains ecoregion of Oregon but only 62°F in the Cascades ecoregion. Here, the authors noted that intraspecific variation in thermal requirements among populations in both regions may be due to a combination of genetic differences, biotic factors such as competition, and abiotic factors such as substrate and cover. Water temperature should be analyzed alongside a variety of other factors to understand the ecological relevance of a species' thermal response (Reynolds 1977).

Physiological responses of geographically separated fish populations can vary based on prevailing environmental and climate conditions. Laboratory experiments on largemouth bass (*Micropterus* *salmoides*), for example, showed that temperature growth optima were lowest in fish from Ontario, Canada and highest in fish from Texas, indicating that species' thermal niches shift with regional climate (Beitinger and Fitzpatrick 1979). In the coastal plain Study area, a Mediterranean climate characterized by warm, dry summers and mild, wet winters may contribute to local species' thermal niches (Swift et al. 1993).

Among the many biotic, chemical, and physical factors influencing temperature tolerance (Hutchison 1976), acclimation temperature (i.e., how an organisms physiologically adjusts to tolerate changing temperature conditions) may be the most critical. Acclimation temperature has a major effect on the temperature tolerance of most fish species, and it is usually strongly and linearly related to both critical thermal maxima and minima (Beitinger et al. 2000). In other words, the critical thermal maxima and minima of fish shift depending on the temperatures to which they have been acclimated.

For example, Otto (1974) conducted tests to determine the upper incipient lethal temperature (UILT) and critical thermal maximum (CTM) for mosquitofish acclimated to 77°F and 95°F, as well as the effects of various cyclic thermal acclimation regimes on the CTM and severe daily heat stress on the CTM. Fish that were subjected to brief daily exposure to very high temperatures developed a higher CTM, or greater heat tolerance, than fish kept at constant temperatures, suggesting that different acclimation patterns can significantly shape thermal tolerance over the long-term.

Over the short-term, field and laboratory studies indicate that many fish exploit spatiotemporal temperature variations in a waterbody to maximize energy use and survive (Hutchison and Maness 1979). For example, fish have shown behavioral strategies, such as brief voluntary exposure to very high temperatures or utilization of thermal refugia (e.g., shade, deep pools, groundwater), that help induce heat-hardening, a temporary increase in thermal tolerance (Kurylyk et al. 2015). These physiological and behavioral responses are synergistic with diel and seasonal cycles and ultimately help fish survive in their available habitats.

All freshwater fish currently in the Study area are non-native species (**Table 1**). The occurrence of non-native fish species is a consequence of introductions over time, whether purposeful or accidental. While some introduced species that cannot tolerate year-round conditions may persist in an introduced habitat when conditions are optimal, they will not survive and become established. The fish species reported in this study are representative of established non-native fish species in the watershed, which were used for the purpose of evaluating their temperature tolerances. Thermal tolerance information for these fish is summarized in **Table 1,** along with primary sources.

For amphibian taxa, species of frogs that are present or could be present in the Study area were documented, and information with primary sources is summarized in **Table 1**. Two native frog species, arroyo toad and Baja California treefrog, and two non-native frog species, American bullfrog and African clawed frog, are known to occur in the Study area. Both of the native frog species are terrestrial as adults. Tadpoles for both would be expected to be encountered in aquatic habitats only in spring or summer months. Both of the non-native frogs are primarily aquatic during all life stages. Bullfrog tadpoles are large and overwinter so both tadpoles and adults can be encountered year-round.

Two non-native turtle taxa, pond siders and spiny softshell turtle, are known to occur in the Study area. Although considered extirpated in the Study area (Bezy et al. 1993), the native western pond turtle has also been reported occasionally in Sepulveda Basin, and is included for consideration in this appendix. For turtles, critical temperatures are associated with temperature-dependent sex determination during incubation of the eggs, which are laid in terrestrial nests. For juvenile and adult turtles, cold water temperatures result in reduced activity, slower growth, and fewer gravid females, but higher water temperatures result in faster growth rates, and more gravid females. For western pond turtles specifically, exposure to water temperatures above 82°F for more than 30% of the time may shift the sex-ratio of their offspring to favor female offspring (Devereux et al. 2019). Western pond turtles tolerate water temperatures of 100°F, but prefer temperatures of 95°F or less (Hays et al. 1999). Juvenile and adult turtles actively thermoregulate by basking out of the water in the sun to warm up or by resting in algae mats to cool off. Lethal temperatures for turtles for any life stage are reported at temperatures of 105°F and higher (Christie and Geist 2017, Tatum 2018). Since critical temperatures for turtles are in the range of maximum air temperatures for the Study area but not water temperatures, temperature tolerances for turtles are not further evaluated.

While considering the summary information for fish and amphibian species presented in **Table 1**, it is important to recognize that knowledge and perspective of the organisms existing in the water body and of the pertinent non-biological considerations (physical, chemical, hydrological, hydraulic) is essential to describing the most sensitive life stages of each taxa and how these stages may be impacted by temperature regimes (Brungs and Jones 1977). This requires extensive literature review and on-site studies. Two steps are particularly important:

1. Identification of the important species and community (primary production, species diversity, etc.) relevant to this site; and
2. Determination of life patterns of the important species (e.g., seasonal distribution, migrations, spawning areas, nursery and rearing areas, sites of commercial or sport fisheries).

The information presented includes comprehensive, species-specific data on thermal requirements. Unfortunately, native freshwater fish have not occurred in the Study area for decades, partially due to the historic ecological degradation and continued modification of habitats along the LA River.

Based on the information in **Table 1**, the most important seasonal and life stages for fish taxa that may be the most highly and negatively impacted by temperature are the Spring spawning season and early life fish stages, followed by the Summer growth season for juvenile and adult fishes. As summarized by Brungs and Jones (1977), the sequence of events relating to gonad growth and gamete maturation, spawning migration, release of gametes, development of the egg and embryo, and commencement of independent feeding represents one of the most complex phenomena in nature, both for fish (Brett 1971) and invertebrates (Kinne 1970). These events are generally the most sensitive to thermal conditions and changes of all life stages.

Also shown in **Table 1**, tolerable limits and the ability to withstand variations of temperature change throughout development and particularly at the most sensitive life stages differ greatly among species.

Notably, uniform increases of temperature by a few degrees during the spawning period, while maintaining short-term temperature cycles and seasonal thermal patterns, appear to have little overall effect on the reproductive cycle of resident aquatic species, other than to advance the timing for Spring spawners or delay it for Fall spawners (Brungs and Jones 1977). Such shifts are common in nature.

Table 1. Summary of Acute and Chronic Thermal Tolerance from the Literature of Freshwater Fish and Early Amphibian Life Stages that are Present in the Study Area Given Current Habitat Conditions

Status[1]	Common	Scientific	Life Stage[1]	Chronic Growth	Chronic Reproduction	Chronic Survival	Acute Daily Survival	Acute Daily Embryo Survival	Acute Daytime Survival
Fish									
NN	Bluegill	*Lepomis macrochirus*	J	90[2]; 89.6[3] (MWAT)	77[2]	92.8-99.3[3]	95[2]; 95[3] (MDMT)	93[2]	96.4-106.2[4]
NN	Bullhead	*Ameiurus sp.*	J,A	86[34] (MWAT)	75[2]	95.5[3]	91.4[3] (MDMT)	81[2]	100.4[4]
NN	Channel catfish	*Ictalarus punctatus*		90[2]; 89.6[3] (MWAT)	81[2]		95[2]; 93.2[3] (MDMT)	84[2]*	99.3-106.7[3]
NN	Common carp	*Cryprinus carpio*	J,A	89.6[3] (MWAT)	70[2]	96.3[34]	98.6[3] (MDMT)	91[2]	105.1-105.6[3]
NN	Fathead minnow	*Pimephales promelas*	J/A	84.2[3] (MWAT)	75[2]	91.8[3]	89.6[3] (MDMT)	86[2]	97.0-98.4[4]
NN	Golden shiner	*Notemigonus crysoleucas*	A						98[5]
NN	Goldfish	*Carassius auratus*	J	83.4[6] (Aerobic Scope)					110.5[7]
NN	Green sunfish	*Lepomis cyanellus*	A	87.8[3] (MWAT)	77[2]**			84[2]**	99.3-104.4[4]
NN	Largemouth bass	*Micropterus sp.*		90[2]; 89.6[3] (MWAT)	70[2]	90.9-97.5[3]	93[2]; 93.2[3] (MDMT)	84[2]	95-102.4[4]
NN	Silverside	*Menidia audens*	J					94.4[8]	
NN	Mosquito fish	*Gambusia affinis*	J,A	89.6[3] (MWAT)					103.1-106.5[4]
NN	Mozambique tilapia	*Oreochromis mossambicus*	J/A	86[9]	84[10]	95[9]	98.6[9]	82[10]	104[11]
NN	Pond loach	*Misgurus anquillacaudatus*	J/A						
NN	Pacu	*Colossoma macropomum*	J	86[12]		89.6[12]			
NN	Sailfin Armored Catfish	*Pterygoplichthys*							

Status[1]	Common	Scientific	Life Stage[1]	Chronic Growth	Chronic Reproduction	Chronic Survival	Acute Daily Survival	Acute Daily Embryo Survival	Acute Daytime Survival
Amphibians									
NN	American bullfrog	*Lithobates catesbeianus*	J	89.6[13]	87.8[14]				100.8[15]
NN	African clawed frog	*Xenopus laevis*	A						97.2-107.3[16]
N	Baja California treefrog	*Pseudacris hypochondriaca*	J		84.2[17]			91.4[17]	105.6[17]
N	Western toad	*Anaxyrus boreas*	J	86[18] (Field observed)		91.4[18]	98.6[18]		104[18]

*Based on maximum for spawning, **Based on *Lepomis gibbosus* as surrogate

Note: Acute Daily Survival and Acute Daytime Survival based on acclimation temperatures between 77-86°F, unless otherwise specified.

Note: Blank cells indicate data could not be found in available literature.

1. N = Native, NN = Non-native, J = Juvenile, A = Adult.
2. Brungs and Jones (1977)
3. Nevada Department of Environmental Protection (NDEP 2016)
4. Carvath et al. (2006)
5. Beitinger et al. (2000)
6. Ferreira et al. (2014)
7. Ford et al. (2005)
8. Hubbs et al. (1971)
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12. Chu-Koo et al (2011)
13. Govindarajulu et. al. (2006)
14. Degenhardt et al. (1996)
15. Lillywhite (1970)
16. Cortes et al. (2016)
17. Mueller et al. (2019)
18. Beiswenger (1978)

A7.2 Benthic Macroinvertebrates

Macroinvertebrates are excellent bio-indicators of water quality and have been used for decades to evaluate the status of aquatic ecosystems after environmental stresses. However, their responses to temperature are not yet sufficiently documented in the literature and have not been systematically assessed (Bonacina et al. 2023). In general, stream macroinvertebrate communities are highly diversified and adapted to live in a wide range of hydrological and trophic conditions. The prevalence of macroinvertebrates around the world reflects their diverse evolutionary histories, including a wide variety of reproductive, phenological, trophic, metabolic, physiological, and behavioral strategies adapted to their specific environments (Bonacina et al. 2023).

While water temperature can be a primary factor affecting macroinvertebrate ecology, a deeper understanding of water temperature-biology relationships is needed to clarify the interacting effects of other aquatic ecosystem stressors like pollution, flow alteration, and habitat reduction (Bonacina et al. 2023). Generally, a strong link exists between temperature, life cycle, and development of aquatic benthic macroinvertebrates, with stenothermal macroinvertebrate species occupying a restricted temperature range and eurythermal species tolerating a much wider one (Jones et al. 2017, Richards et al. 2018). Recent research has focused on temperature effects on aquatic macroinvertebrates at larger spatiotemporal scales, incorporating data on functional traits to better understand macroinvertebrate assemblages (Hering et al. 2009, Poff et al. 2010, Pyne and Poff 2017, Besacier et al. 2019). However, many studies are limited by using air temperature as a proxy for water temperature and often do not account for thermal variation and seasonal or diel fluctuations (Li et al. 2013, Domish et al. 2011, 2013; Jourdan et al. 2018, Besacier et al. 2019, Haase et al. 2019).

Based on experiments involving a number of aquatic macroinvertebrate taxa from 18 rivers across five regions in South Africa , it is clear that much spatial and temporal variation exists in upper thermal limits (i.e., thermal tolerance) across a range of taxa (Dallas et al. 2015). Upper thermal limits expressed as critical thermal maximum (CTM) and upper incipient lethal temperature (UILT; 96 hours) were found to vary spatially amongst regions. Also, the influence of acclimation temperature on upper thermal limits varied amongst taxa, with amphipods exhibiting a trend of increasing CTM as acclimation temperature increased, while mayflies do not. Similarly, the effect of the rate of temperature change varied amongst taxa, with amphipods showing no response, while CTM values for mayflies decreased as rate of temperature change increased. Notably, CTM values varied significantly amongst genera within families for five of the seven comparisons undertaken. Furthermore, maximum weekly allowable temperature (MWAwT) thresholds, which were used in the Dallas et al. (2015) study as an integrator of physiological effects on aquatic organisms, varied amongst taxa and rivers. Two key findings relevant to this study were: 1) taxa from the upper catchment sites generally had lower MWAwT thresholds than taxa from the lower catchment sites, and 2) taxa from a site downstream of a dam releasing warm surface water had higher MWAwT thresholds than taxa from a site upstream of the dam. These results support the recommendation that thermal experiments conducted on a site-specific basis would improve confidence in MWAwT thresholds.

The results of laboratory experiments and a review of macroinvertebrate upper thermal tolerance literature by Stewart et al. (2013) confirmed that considerable taxonomic differences in the ability of macroinvertebrates to tolerate high water temperatures should be expected. Mayflies (Ephemeroptera) and Stoneflies (Plecoptera) were shown to be particularly sensitive to temperature increases (Ward and Stanford 1982, Quinn et al. 1994), supporting their inclusion in the widely used EPT (Ephemeroptera, Plecoptera and

Trichoptera) index for testing environmental water quality. In contrast, many midges (Chironomidae), beetles (Coleoptera), dragonflies (Odonata), and to a lesser extent, planarians, have higher tolerance levels, but these taxa stand in contrast with the higher tolerance levels of many midges (Chironomidae), beetles (Coleoptera), dragonflies (Odonata), and to a lesser extent, planarians. Additionally, while thermal tolerance studies on dragonflies are limited, available studies suggest they are able to tolerate temperatures higher than many other freshwater fauna (Martin and Gentry 1974).

Moreover, the experiments conducted by Stewart et al. (2013) clearly showed that mean upper thermal tolerance (UTT) thresholds differ notably within taxonomic groups. For example, mean UTTs of eurythermic species were significantly higher than that of stenothermic species, even among the EPT taxa. The stenotherm species included in the analysis by Stewart et al. (2013) were either restricted to cold headwater streams or were known to emerge in early spring prior to the occurrence of elevated Summer water temperatures. Eurytherm species were usually more widespread in distribution and had longer life cycles and thus were present in streams at elevated water temperatures. These observations are consistent with those of Calosi et al. (2008, 2010), who found European diving beetle taxa exhibit significantly higher UTTs than temperature restricted taxa.

Whether viewed from a current or a historical perspective, BMI taxa in the Study are or were invariably predominantly eurythermic. **Table 2** provides a summary of thermal grouping and upper thermal tolerance from information reported in Stewart et al. (2013), Dallas et al. (2015), and Richards et al. (2018). Note that in the case of the Richards et al. (2018) study, thermal grouping was established by a large macroinvertebrate database provided by Idaho Department of Environmental Quality from wadeable streams in Idaho used in conjunction with previous analyses by the authors. The analysis reported in Richards et al. (2018) provided threshold change points for over 400 taxa along an increasing temperature gradient and a list of statistically important indicator taxa. However, all these taxa are northern latitude dwellers, so some caution is required to prevent unwarranted or potentially erroneous interpretation.

Table 2. Summary of Thermal Grouping and Upper Thermal Tolerance for BMI Taxa Present or Could be Present in the Study Area

(**Bolded names** represent taxonomic level associated with temperature indicator classification from Richards et al. 2018)

Phylum	Class	Order	Family	Taxon	Richards et al. 2018 - Temp Indicator Classification (Idaho taxa)[1]	Stewart et al. (2013) - Mean Upper Thermal Tolerances-UTT°C±SE (Family/Subfamily)	Dallas et al (2012) - CTM (range) (Family)
Annelida	Hirudinea	Arhynchobdellida	Erpobdellidae	*Dina*	CWS (Erpobdellidae)		
Annelida	Hirudinea	Arhynchobdellida	Erpobdellidae	*Erpobdella*	CWS (Erpobdellidae)		
Annelida	Hirudinea	Arhynchobdellida	Erpobdellidae	*Mooreobdella*	CWS (Erpobdellidae)		
Annelida	**Hirudinea**	Rhynchobdellida	Glossiphoniidae	*Helobdella*	CWE (Hirudinea)		
Annelida	**Hirudinea**	Rhynchobdellida	Glossiphoniidae	*Helobdella stagnalis*	CWE (Hirudinea)		
Annelida	***Oligochaeta***				CWE		
Arthropoda	Arachnida	Trombidiformes	Mideopsidae	*Mideopsis*			
Arthropoda	Arachnida	Trombidiformes	Sperchonidae	*Sperchon sp.*	TGE		
Arthropoda	Arachnida ***(Subclass: Acari)***				TGE		
Arthropoda	Insecta	Coleoptera	Dytiscidae	*Sanfilippodytes*	TGE (Dytiscidae)	112.6 ± 32.7 (Dytiscidae)	
Arthropoda	Insecta	Diptera	Ceratopogonidae	*Atrichopogon*	CWE		
Arthropoda	Insecta	Diptera	Ceratopogonidae	*Bezzia/ Palpomyia*	CWE		
Arthropoda	Insecta	Diptera	Ceratopogonidae	*Dasyhelea sp.*	CWS		
Arthropoda	Insecta	Diptera	***Ceratopogonidae***		TGE (Ceraptogoninae)		
Arthropoda	Insecta	Diptera	Chaoboridae	*Endochironomus*			
Arthropoda	Insecta	Diptera	Chironomidae	*Ablabesmyia sp.*	WWE		
Arthropoda	Insecta	Diptera	Chironomidae	*Alotanypus*			
Arthropoda	Insecta	Diptera	Chironomidae	*Apedilum sp.*	WWE		
Arthropoda	Insecta	Diptera	Chironomidae	*Chironomini (Tribe)*	CWE	75.4 (Chironominae)	
Arthropoda	Insecta	Diptera	Chironomidae	*Chironomus sp.*	CWE		
Arthropoda	Insecta	Diptera	Chironomidae	*Cladopelma*			
Arthropoda	Insecta	Diptera	Chironomidae	*Cladotanytarsus (mancus group)*	CWE		
Arthropoda	Insecta	Diptera	Chironomidae	*Conchapelopia sp.*	CWS		
Arthropoda	Insecta	Diptera	Chironomidae	*Corynoneura*			
Arthropoda	Insecta	Diptera	Chironomidae	*Cricotopus bicinctus group*	TGE		
Arthropoda	Insecta	Diptera	Chironomidae	*Cricotopus sp.*	TGE		
Arthropoda	Insecta	Diptera	Chironomidae	*Cricotopus trifascia group*	TGE		
Arthropoda	Insecta	Diptera	Chironomidae	*Cricotopus/ Orthocladius sp.*	CWE		
Arthropoda	Insecta	Diptera	Chironomidae	*Cryptochironomus sp.*	WWE		

Phylum	Class	Order	Family	Taxon	Richards et al. 2018 - Temp Indicator Classification (Idaho taxa)[1]	Stewart et al. (2013) - Mean Upper Thermal Tolerances- UTT°C±SE (Family/Subfamily)	Dallas et al (2012) - CTM (range) (Family)
Arthropoda	Insecta	Diptera	Chironomidae	*Dicrotendipes sp.*	WWE		
Arthropoda	Insecta	Diptera	Chironomidae	*Endochironomus*			
Arthropoda	Insecta	Diptera	Chironomidae	*Endotribelos*			
Arthropoda	Insecta	Diptera	Chironomidae	*Eukiefferiella brehmi group*	TGE		
Arthropoda	Insecta	Diptera	Chironomidae	*Eukiefferiella sp.*	CWE		
Arthropoda	Insecta	Diptera	Chironomidae	*Eukiiefferiella gracei group*	CWE		
Arthropoda	Insecta	Diptera	Chironomidae	*Goeldichironomus*			
Arthropoda	Insecta	Diptera	Chironomidae	*Micropsectra sp.*	TGE		
Arthropoda	Insecta	Diptera	Chironomidae	*Microtendipes pedellus group*	TGE		
Arthropoda	Insecta	Diptera	Chironomidae	*Nanocladius sp.*	TGE		
Arthropoda	Insecta	Diptera	Chironomidae	*Nilotanypus sp.*	WWE		
Arthropoda	Insecta	Diptera	Chironomidae	*Nilothauma sp.*			
Arthropoda	Insecta	Diptera	Chironomidae	*Orthocladiinae (subfamily)*	CWE	81 ± 36.3 (Orthocladinae)	
Arthropoda	Insecta	Diptera	Chironomidae	*Orthocladius complex*	CWE		
Arthropoda	Insecta	Diptera	Chironomidae	*Orthocladius sp.*	CWE		
Arthropoda	Insecta	Diptera	Chironomidae	*Parachironomus sp.*			
Arthropoda	Insecta	Diptera	Chironomidae	*Paracladopelma sp.*	CWS		
Arthropoda	Insecta	Diptera	Chironomidae	*Paratanytarsus sp.*	CWS		
Arthropoda	Insecta	Diptera	Chironomidae	*Pentaneura sp.*	TGE		
Arthropoda	Insecta	Diptera	Chironomidae	*Phaenopsectra*	CWS		
Arthropoda	Insecta	Diptera	Chironomidae	*Polypedilum sp.*	TGE		
Arthropoda	Insecta	Diptera	Chironomidae	*Procladius*	CWS		
Arthropoda	Insecta	Diptera	Chironomidae	*Psectrocladius*	CWS		
Arthropoda	Insecta	Diptera	Chironomidae	*Pseudochironomus sp.*	WWE		
Arthropoda	Insecta	Diptera	Chironomidae	*Rheocricotopus*	CWE		
Arthropoda	Insecta	Diptera	Chironomidae	*Rheotanytarsus*	CWE		
Arthropoda	Insecta	Diptera	Chironomidae	*Saetheria*			
Arthropoda	Insecta	Diptera	Chironomidae	*Tanypodinae (subfamily)*	TGE	77.5 ± 38.3 (Tanypodinae)	
Arthropoda	Insecta	Diptera	Chironomidae	*Tanytarsini*	CWE		
Arthropoda	Insecta	Diptera	Chironomidae	*Tanytarsus sp.*	TGE		
Arthropoda	Insecta	Diptera	Chironomidae	*Thienemanniella*	CWE		
Arthropoda	Insecta	Diptera	Chironomidae	*Thienemannimyia group*	TGE		
Arthropoda	Insecta	Diptera	***Chironomidae***		TGE		
Arthropoda	Insecta	Diptera	Culicidae	*Aedes*			˜104 (102 - 105) (Culicidae)

Phylum	Class	Order	Family	Taxon	Richards et al. 2018 - Temp Indicator Classification (Idaho taxa)[1]	Stewart et al. (2013) - Mean Upper Thermal Tolerances- UTT°C±SE (Family/Subfamily)	Dallas et al (2012) - CTM (range) (Family)
Arthropoda	Insecta	Diptera	Culicidae	*Culex*			
Arthropoda	Insecta	Diptera	Dolichopodidae	*Dolichopodidae*	CWE		
Arthropoda	Insecta	Diptera	Empididae	*Hemerodromia sp.*	TGE		
Arthropoda	Insecta	Diptera	***Empididae***		CWE		
Arthropoda	Insecta	Diptera	Ephydridae	*Endochironomus*			
Arthropoda	Insecta	Diptera	***Ephydridae***				
Arthropoda	Insecta	Diptera	***Muscidae***		TGE		
Arthropoda	Insecta	Diptera	Pelecorhynchidae	*Glutops sp.*	CWE		
Arthropoda	Insecta	Diptera	Psychodidae	*Pericoma/ Telmatoscopus*	CWE		
Arthropoda	Insecta	Diptera	***Psychodidae***				
Arthropoda	Insecta	Diptera	Simuliidae	*Simulium argus*		77.2 (Simuliidae)	~87 (84 - 90) (Simuliidae)
Arthropoda	Insecta	Diptera	Simuliidae	*Simulium sp.*	TGE		
Arthropoda	Insecta	Diptera	Simuliidae	*Simulium vittatum*			
Arthropoda	Insecta	Diptera	Stratiomyidae	*Caloparyphus/ Euparyphus*	CWE		
Arthropoda	Insecta	Diptera	Stratiomyidae	*Euparyphus*			
Arthropoda	Insecta	Diptera	***Stratiomyidae***				
Arthropoda	Insecta	Diptera	Tipulidae	*Dicranota sp.*	CWE		
Arthropoda	Insecta	Ephemeroptera	Baetidae	*Baetis adonis*			
Arthropoda	Insecta	Ephemeroptera	Baetidae	***Baetis sp.***	CWE; TGE	68.2 (Baetidae)	~94.5 (87 - 98) (Baetidae)
Arthropoda	Insecta	Ephemeroptera	Baetidae	***Callibaetis sp.***	WWE		
Arthropoda	Insecta	Ephemeroptera	Baetidae	*Fallceon*			
Arthropoda	Insecta	Ephemeroptera	Baetidae	***Fallceon quilleri***	WWE		
Arthropoda	Insecta	Ephemeroptera	Caenidae	***Caenis sp.***	WWE		
Arthropoda	Insecta	Ephemeroptera	Leptohyphidae	*Tricorythodes explicatus*			
Arthropoda	Insecta	Ephemeroptera	Leptohyphidae	*Tricorythodes sp.*	WWE		
Arthropoda	Insecta	Ephemeroptera	***Leptohyphidae***				
Arthropoda	Insecta	Hemiptera	Corixidae	*Corisella*			
Arthropoda	Insecta	Hemiptera	Corixidae	*Corisella decolor*			
Arthropoda	Insecta	Hemiptera	***Corixidae***		WWE		
Arthropoda	Insecta	Lepidoptera	Pyralidae	*Petrophila sp.*	WWE		
Arthropoda	Insecta	***Lepidoptera***					
Arthropoda	Insecta	Odonata	***Aeshnidae***			91.8 ± 33.3 (Aeshnidae)	~100 (95 - 104) (Aeshnidae)
Arthropoda	Insecta	Odonata	Coenagrionidae	*Coenagrion*			~107 (100 - 108) (Coenagrionidae)
Arthropoda	Insecta	Odonata	Coenagrionidae	*Coenagrionidae*	WWE		

Phylum	Class	Order	Family	Taxon	Richards et al. 2018 - Temp Indicator Classification (Idaho taxa)[1]	Stewart et al. (2013) - Mean Upper Thermal Tolerances- UTT°C±SE (Family/Subfamily)	Dallas et al (2012) - CTM (range) (Family)
Arthropoda	Insecta	Trichoptera	Hydropsychidae	*Hydropsyche sp.*	TGE		
Arthropoda	Insecta	Trichoptera	***Hydropsychidae***		CWE	86.7 ± 35.1 (Hydropsychidae)	˜93 (82 - 95) (Hydropsychidae)
Arthropoda	Insecta	Trichoptera	Hydroptilidae	*Hydroptila sp.*	TGE		
Arthropoda	Insecta	Trichoptera	***Hydroptilidae***		TGE		
Arthropoda	Malacostraca	Amphipoda	Hyalellidae	*Hyalella sp.*	TGE		
Arthropoda	***Ostracoda***				CWE		
Cnidaria	Hydrozoa		Hydridae	*Hydra sp.*	CWS		
Mollusca	Bivalvia	Sphaeriida	Sphaeriidae	*Pisidium sp.*	TGE	86.9 (Sphaeriidae)	
Mollusca	Bivalvia	Venerida	Cyrenidae	*Corbicula*			
Mollusca	Gastropoda	Basommatophora	***Lymnaeidae***		CWS		˜107 (101 - 109) (Lymaeidae)
Mollusca	Gastropoda	Basommatophora	Planorbidae	*Ferrissia sp.*	WWE		˜107 (101 - 109) (Planorbidae)
Mollusca	Gastropoda	Basommatophora	Planorbidae	*Gyraulus sp.*	TGE		
Mollusca	Gastropoda	Basommatophora	Planorbidae	*Helisoma*			
Mollusca	Gastropoda	Basommatophora	Planorbidae	*Menetus opercularis*			
Mollusca	Gastropoda	Cerithiida	Thiaridae	*Melanoides tuberculata*			
Mollusca	Gastropoda	Lymnaeida	Physidae	*Physa sp.*			
Mollusca	Gastropoda	Littorinida	Tateidae	*Potamopyrgus antipodarum*	CWS		
Nematoda					CWE		
Nemertea	Enopla	Hoplonemertea	Tetrastemmatidae	*Prostoma sp.*	TGE		
Platyhelminthes	***Turbellaria***				CWE		

1. CWE = cool-water eurytherms; CWS = cool-water stenotherms (defined as being found between >55°F and <68°F in Richards et al. 2018) ; TGE = temperature generalist – eurytherm; WWE = warm-water eurytherms

A7.3 Diatoms and Soft Algae

Despite early recognition that temperature is an important aspect of diatom ecology (Patrick, 1971), considerable evidence suggests temperature may be less important than previously thought. For example, it is argued that the relation between diatoms (and periphyton in general) and temperature are weaker (less restrictive) than the relationships between diatoms and other factors such as salinity, pH, and phosphorus (Anderson 2000), and that temperature effects on microalgae are unlikely to be independent of these other factors (Schindler et al. 1996, DeNicola 1996). Nevertheless, diatoms are excellent indicators of environmental changes, particularly in dissolved oxygen (DO) concentrations. Algal indices have been found to be significantly correlated with many water quality indicators. The factors controlling microalgae (diatom/periphyton) distribution in nature are numerous, and the major variables in the Study area are likely highly correlated. That, coupled with the fact that local and regional diatom/microalgae distribution is widespread giving rise to the potential for greater functional redundancy, suggests that water temperature may have variable degrees of importance in structuring algal communities in the region. In the desert southwest region, for example, recent diatom multimetric indices (MMIs) of ecological condition using genus-level taxonomy and trait-based autecological information identified relatively unique diatom communities in comparison to National MMIs because of strong natural gradients in the region (e.g., slope and elevation; cold water mountainous vs warmwater alluvial fan) that cause variance in the MMI metrics and mask some changes associated with human activities, including increases in fine sediment, water temperature, and nutrients (Kaufmann et al. 2022, Riato et al. 2022).

Furthermore, while growth rate, lipid productivity, and fatty acid composition of diatoms are influenced tremendously by temperature (Zhang et al. 2020), the temperature dependency of cellular processes for diatoms is thought to be less important in controlling growth than other factors that result in their dominance at certain times of the year (Anderson 2000). Thus, it is the eurythermal diatom species, which were likely dominant historically and continue to dominate the LA River mainstem now, that are expected to grow well over the relatively wide temperature range and significant diel temperature fluctuations that occur in all seasons in the Study area. The complexity of the natural environment thus far, however, has prevented any firm conclusions being reached about the specific effects of temperature disturbance on diatoms (Zhang et al. 2018). Consequently, several recent studies focused on how to use phytoplankton biomass to reflect temperature effects have produced different, and even contradictory, conclusions (Moss et al. 2003, Lassen et al. 2010, Yvon-Duroche et al. 2015, Kraemer et al. 2017). Adding to the difficulty in the use of phytoplankton biomass to reflect temperature disturbance, recent research using mixed culture systems demonstrates that the responses of diatoms to simulated warming were strongly affected by interspecific interactions, in both the abundance and the timing of their growth peaks (Zhang et al. 2018).

The most prevalent and ubiquitous diatom genera throughout the Study area over the last several years are *Achnanthidium minutissimum, Craticula subminuscula, Halamphora veneta, Nitzschia (amphibia, amphibioides,* and *inconspicua), Cocconeis pediculus, Cyclotella meneghiniana, and Gomphonema parvulum*. Although there are few sources of species or genus-specific thermal tolerance values estimated for diatoms or soft algae, limited data indicate one of these dominant diatom Genera: *Achnanthidium catenatum*, isolated from a drinking-water reservoir (Jinshahe Reservoir) in Hubei province, China, exhibited significantly increased abundance in the spring under a +7°C warming scenario, and therefore favored higher temperatures in Spring (Zhang et al. 2018). In the study, *A. catenatum* was observed to be a Spring–Fall member of the diatoms in the reservoir, but in laboratory experiments it had a wider range of growth temperatures. In a later study by different authors (Zhang et al. 2020), a total of 731 water samples were collected from seven different regions across the Northeast, North, and East of China to identify high temperature-tolerant diatoms. From the samples, 131 diatom strains were isolated to screen strains with high temperature adaptability. Except for five unidentified species of the 131 diatoms strains, 13 were from *Achnanthidium*, one from *Craticula*, seven from *Cyclotella*, 23 from *Fistulifera*, one from *Gomphonema*, two from *Lemnicola*, 65 from *Nitzschia*, three from *Pinnularia*, 10 from *Sellaphora,* and one from *Synedra*, based on morphological characteristics and 18S rRNA gene sequence analysis. Following preliminary experiments, a total of 49 isolated diatom strains were identified that could survive at 30°C (86°F), and these were designated as high temperature-tolerant diatoms. The 49 strains included 26 *Nitzschia*, nine *Fistulifera*, six *Sellaphora*, three *Achnanthidium*, one *Cyclotella,* and three unknown species. The authors found that although diatoms generally prefer low temperatures, screening diatom strains with high temperature tolerance in hot seasons was feasible for identifying strains with high temperature adaptability, especially in Summer. The above findings show that within the genus level (e.g., *Nitzschia*), significant differences in temperature tolerance of individual species were seen from different regional locations.

Similar findings are anticipated for dominant and ubiquitous soft algae species (e.g., *Cladophora glomerata*, *Scenedesmus (bundans, dimorphus*, and *ellipticus*), *Monoraphidium minutum*, and *Heteroleibleinia* sp 1). *Cladophora spp*, for example, is a filamentous alga that commonly occurs in shallow freshwater and marine environments, including the Study area. In the Study area, the algae are particularly important as a habitat and food source for benthic macroinvertebrates, which in turn, serve as a vital food source for wading birds. Growth of *Cladophora spp* is associated with many factors such as light and nutrients (Bach and Josselyn 1978, Salovius and Kraufvelin 2004), which are ample in the Study area. In general, *Cladophora spp* biomass is highest in shallow water and declines with increasing depth (Higgins et al. 2005). Growth and reproduction of the species are expected to be limited below 59°F and mortality begins to occur above 86°F (Whitton 1970), but surface water temperatures at locations within the Study area with *Cladophora* indicate substantial thermal adaptability of this soft algae species both above and below WRP outfalls throughout all reaches, and their presence at water concentrations routinely above daytime maximum temperatures of 95°F is firmly established in the Study area.

Seasonal variation represents one example of the effect that temperature has on algae, but parsing temperature effects from other covarying, controlling variables is challenging. Furthermore, temperature effects on algae can be enhanced by interactions with other algae, as well as bacteria, fungi, viruses, and grazers, but response is not explained by those interactions alone. In general, temperature has a less restrictive effect than pH and nutrients at each of the biological scales of diversity (individuals, populations, species, genera, families, orders, phyla). To date, there have been fewer rigorous studies of temperature effects on algae compared to other factors, such as nutrients.

A7.4 Comparison of Literature Based Thermal Tolerances to Observed Temperatures

Laboratory-derived temperature tolerance information from the literature for the most temperature-sensitive fish species in the Study area were used to represent temperature tolerance for all other less temperature-sensitive vertebrate species based on both short (acute, daily) and longer (chronic, weekly) exposure times and critical life stages. These values were also used to represent the thermal tolerance of BMI and benthic algae , which are similar to or higher than the corresponding lowest thermal tolerance limits for chronic survival for freshwater fish for the Summer dry season. For example, the upper thermal tolerance level and critical thermal maximum (CTM) for the several BMI families/subfamilies in the Study area for which values exist (**Table 2**) are similar to or higher than the corresponding lowest thermal tolerance limits for chronic survival for freshwater fish for the summer dry season. The lowest thermal tolerance limits from the literature values for freshwater fish presented in **Table 1** are provided in **Table 3**.

Table 3. Lowest Thermal Tolerance Limits from the Literature Used for Comparison to Temperature Metrics During Summer Dry and Spring Spawning Season

Summer, Dry Season (June – October)				Spring Spawning Season/ELS present[1] (March – May)	
Chronic Growth	Chronic Survival	Acute Daily Survival	Acute Daytime Survival	Chronic Reproduction	Acute Daily Embryo Survival
83.4°F Goldfish	89.6°F Pacu	89.6°F Fathead Minnow	98.0°F Golden Shiner	70.0°F Common Carp & Largemouth Bass	81.0°F Black Bullhead

[1] ELS = Early life-stage

The values in **Table 3** were compared against receiving water temperatures to evaluate short (acute) and long-term (chronic) temperature exposures. Two acute (daily) and two chronic (weekly) temperature metrics were used in this evaluation. The specific stream temperature metrics utilized were:

- Maximum daily average temperature (MDAT): This value represents the highest average temperature from continuous measurements recorded over a 24-hour (1-day) period. Note that continuous measurements were not always available for the full 24 hours.
- Maximum daily maximum temperature (MDMT): This represents the highest maximum temperature recorded over a 24-hour (1-day) period.
- Maximum weekly average temperature (MWAT): This is the maximum average of average daily temperatures over any seven-day period.
- Maximum weekly maximum temperature (MWMT): This is the maximum average of maximum daily temperatures over any seven-day period; also referred to in the literature as 7DADM.

MWAT, MWMT, MDAT, and MDMT were selected to compare against lowest literature-based species-specific thermal tolerance limits for:

1. Chronic growth of juveniles and adults during summer – compared to MWAT of summer months (**Table 4**);
2. Chronic survival of juveniles and adults during summer – compared to MWMT (aka 7DADM) of summer months (**Table 4**);
3. Acute daily (24-hour) survival of juveniles and adults during summer – compared to MDAT of summer months (**Table 4**);
4. Acute daytime (8-hour) survival of juveniles and adults during summer – compared to MDMT of summer months (**Table 4**);
5. Chronic reproduction during Spring spawning – compared to MWAT of spring months (**Table 5**);
6. Acute embryo survival during hatch and spring grow out of larvae – compared to MDAT of spring months (**Table 5**).

While conservative laboratory-derived temperature tolerance values are useful for an initial assessment of potential for effects, these values do not reflect the physiological and behavioral relief strategies developed by aquatic organisms in response to local temperature profiles and extremes, particularly the aquatic organisms present in the Study area that experience extreme diel temperature fluctuations regularly. These strategies, along with site-specific generational adaptations in response to years of exposure to local temperature and habitat conditions on a long-term basis and heat-hardening on short-term basis (i.e., a rapid acclimation response that increases their tolerance to sudden, acute heat stress), explain why literature-based upper thermal tolerance limits generally under-estimate taxa-specific critical thermal limits in the real world.

The comparison of the lowest thermal tolerance limits for freshwater fish identified in **Table 3** against the temperature metrics reflecting acute and chronic exposure during Summer (**Table 4**) and Spring spawning (**Table 5**) seasons supports a description of the relationship between waterbody temperatures and different aquatic life stages that could be supported based on literature values. The results also allow description of how that support varies based on seasonality, and the critical exposure times, durations, and/or frequencies associated with the temperature relationships (i.e., acute daily for the short term and chronic weekly for the longer term).

Comparisons were conducted for the continuous temperature monitoring stations based on the reported sensitive species in the Study area. This was done to allow for the use of the standard recommended stream temperature metrics for comparing lowest thermal tolerance values for chronic (weekly) growth and survival, and acute (24 hour) and maximum acute (daily) survival of aquatic and aquatic-dependent taxa to directly address the relationship between waterbody temperatures and the different aquatic life stages supported. The importance of critical exposure times and duration and frequency based on daytime versus daily and weekly average and maximum water temperatures during certain weeks and months of the year cannot be overstated. Taxa present are primarily warmwater eurythermal and/or temperature generalist taxa, which are acclimated and appear uniquely adapted to the current habitat conditions in the Study area, and thus possess the necessary coping mechanisms and growth and reproductive strategies for withstanding thermal stress and other stress that accounts for their continued presence in the Study area, as well as for successful reproduction, growth, and maintenance on a weekly and seasonal basis.

In summary, critical exposure times are during the Summer dry season (June through October) and during Spring spawning and hatch (March through May), while stream water temperatures the remainder of Fall through Winter are expected to be beneficial for the growth of warmwater organisms. Critical durations and frequencies in the study depend on the season, but should be considered in terms of hours, days and weeks during the Summer dry season, and days and weeks during Spring spawning season.

Table 4. Summary of the Relationship Between Receiving Water Temperatures and Most-Sensitive Adult and Juvenile Thermal Values During the Summer Dry Season (June through October)[1]

Receiving Water Station	Month	Chronic Growth	Chronic Survival	Acute Daily Survival	Acute Daytime Survival
		Weekly Avg Temp	Weekly Max Temp	Daily Max Temp	Daytime Max Temp
		MWAT - 83.4°F	MWMT - 89.6°F	MDAT - 89.6°F	MDMT – 98.0°F
LAR5 Balboa	Jun-24	79.3	84.0	80.4	86.1
	Jul-24	81.5	84.7	82.3	85.6
	Aug-24	80.3	83.7	82.2	85.2
	Sep-24	80.9	83.4	82.3	84.7
	Oct-24	74.3	75.9	74.7	76.6
LAR5 Hayvenhurst	Jun-24	81.6	84.1	82.4	85.0
	Jul-24	82.9	86.0	83.6	86.2
	Aug-24	82.0	85.1	83.1	86.1
	Sep-24	81.9	85.1	83.2	88.5
	Oct-24	76.9	79.0	77.2	80.1
LAR5 Burbank	Jun-24	81.8	85.1	82.8	85.8
	Jul-24	83.3	86.8	83.8	87.1
	Aug-24	82.2	84.7	83.0	85.6
	Sep-24	81.6	83.3	82.9	84.0
	Oct-24	76.5	78.0	76.9	78.8
LAR5 Haskell	Jun-24	80.8	83.4	82.1	84.8
	Jul-24	82.2	85.9	82.9	86.5
	Aug-24	81.5	85.7	82.6	87.0
	Sep-24	82.3	86.1	83.3	88.7
	Oct-24	76.3	79.7	77.0	80.3
LAR4 Kester	Jun-24	80.9	86.2	81.9	86.9
	Jul-24	82.5	87.5	83.6	88.9
	Aug-24	85.7	90.9	85.7	91.9
	Sep-24	82.9	90.2	83.8	92.1
	Oct-24	78.0	83.4	78.5	83.8
LAR4 Van Nuys	Jun-24	79.7	86.5	80.6	86.8
	Jul-24	81.4	88.9	82.4	90.2
	Aug-24	80.7	88.3	81.7	90.4
	Sep-24	80.9	88.5	82.1	90.3
	Oct-24	75.4	81.0	75.8	81.6
LAR4 Zoo	Jun-24	80.9	92.1	82.1	91.9
	Jul-24	81.7	96.3	82.6	98.4
	Aug-24	87.2	91.6	86.4	94.3
	Sep-24	85.5	96.3	88.0	100.4
	Oct-24	75.4	86.5	76.3	89.2
BWC Up	Jun-24	70.9	77.6	71.5	80.5
	Jul-24	71.8	78.2	72.3	79.9
	Aug-24	74.1	80.4	75.4	83.4
	Sep-24	68.6	74.4	68.9	76.4
	Oct-24	68.7	74.9	69.2	75.7
BWC Down	Jun-24	78.5	82.8	80.0	87.2
	Jul-24	79.0	83.4	80.9	85.8
	Aug-24	81.8	84.7	82.2	87.3
	Sep-24	82.4	86.1	83.9	89.5
	Oct-24	80.2	81.9	81.2	82.1
BWC Riverside	Jun-24	80.9	98.8	77.3	97.2
	Jul-24	82.0	99.6	84.6	101.4
	Aug-24	79.3	97.9	84.6	100.6
	Sep-24	80.6	101.2	82.5	104.7
	Oct-24	75.1	93.9	75.6	96.5

Receiving Water Station	Month	Chronic Growth	Chronic Survival	Acute Daily Survival	Acute Daytime Survival
		Weekly Avg Temp	Weekly Max Temp	Daily Max Temp	Daytime Max Temp
		MWAT - 83.4°F	MWMT - 89.6°F	MDAT - 89.6°F	MDMT – 98.0°F
LAR3 Griffith	Jun-24	80.1	94.7	80.9	95.4
	Jul-24	80.7	96.3	81.2	97.5
	Aug-24	80.2	95.3	80.9	96.7
	Sep-24	82.0	96.7	84.0	98.7
	Oct-24	74.8	87.6	75.3	88.3
LAR3 Electronics	Jun-24	79.2	93.3	80.1	94.4
	Jul-24	79.9	95.5	80.4	96.3
	Aug-24	79.6	95.0	80.3	97.3
	Sep-24	81.0	91.8	83.2	94.3
	Oct-24	74.8	84.4	74.7	86.2
LAR3 N. Atwater	Jun-24	78.0	88.4	78.9	89.4
	Jul-24	78.6	88.8	79.3	89.5
	Aug-24	77.9	88.5	78.7	89.4
	Sep-24	80.6	90.3	81.8	91.2
	Oct-24	75.8	84.8	76.4	85.3
LAR3 Greenway	Jun-24	80.0	87.7	80.7	88.2
	Jul-24	79.7	86.8	80.3	89.5
	Aug-24	79.5	85.9	80.4	87.5
	Sep-24	81.2	86.2	82.6	88.4
	Oct-24	74.9	79.6	75.6	80.6
LAR3 Riverside	Jun-24	79.4	83.4	80.2	84.4
	Jul-24	80.0	83.6	80.5	84.5
	Aug-24	79.6	82.6	80.5	83.6
	Sep-24	81.1	83.6	82.1	85.0
	Oct-24	74.9	76.9	75.6	77.5
LAR2 Washington	Jun-24	80.7	93.5	81.4	94.0
	Jul-24	90.2	98.8	92.1	98.8
	Aug-24	79.9	90.2	80.5	91.1
	Sep-24	81.2	90.7	82.3	93.8
	Oct-24	78.0	89.0	81.0	89.7

[1] Values in the header indicate the lowest respective thermal limit among the species present based on laboratory-derived values presented in literature, and shaded cells in the table indicate measured receiving water temperature values that meet or exceed those values.

Table 5. Summary of the Relationship Between Receiving Water Temperatures and Most-Sensitive Early Life Stages During the Spring Spawning and Hatch Season (March through May)[1]

Receiving Water Station	Month	Chronic Reproduction	Acute Embryo Survival
		Weekly Avg Temp	Daily Max Temp
		$_{R}$MWAT - 70.0°F	^{ESL}MDAT - 81.0°F
LAR5 Balboa	May-24	70.8	72.4
LAR5 Hayvenhurst	May-24	73.3	74.7
LAR5 Burbank	May-24	73.4	75.0
LAR5 Haskell	May-24	73.5	74.8
LAR4 Kester	May-24	75.1	76.4
LAR4 Van Nuys	May-24	72.6	74.0
LAR4 Zoo	May-24	72.6	74.5
BWC Up	May-24	68.7	69.2
BWC Down	May-24	73.7	75.2
BWC Riverside	May-24	71.7	73.7
LAR3 Griffith	May-24	73.1	74.5
LAR3 Electronics	May-24	72.7	74.1
LAR3 N. Atwater	May-24	72.2	73.4
LAR3 Greenway	May-24	73.2	74.6
LAR3 Riverside	May-24	72.8	74.3
LAR2 Washington	May-24	73.0	75.4

[1] Values in the header indicate the lowest respective thermal limit among the species present based on laboratory-derived values presented in literature, and shaded cells in the table indicate values that meet or exceed those values.

Results are assessed by counting how often a given receiving water temperature metric value falls above or below the comparable most sensitive temperature tolerance metric value identified in **Table 3**. Two seasonally-based comparisons are made: one based on the number of estimates of the comparable receiving water and temperature tolerance metrics for the June – October timeframe associated with the Summer growth period, and one in May associated with the Spring spawning. Receiving water temperature metrics were calculated from the continuous monitoring data collected at the 16 receiving water temperature monitoring stations selected for the Study. For the comparison, when the receiving water temperature metric value is below the comparable most sensitive temperature tolerance metric value, no biological risk exists due to water temperature. Conversely, when the receiving water temperature metric value is above the comparable most sensitive temperature tolerance metric value, a *potential* for biological risk occurs due to water temperature.

For example, in 25 sampling periods among five stations over the summer of 2024 for LAR3, the receiving water temperature was never above the Chronic Growth temperature tolerance metric (MWAT of 83.4°F) at any of the five stations in the reach. Similarly, for the Chronic Survival metric in LAR3, the receiving water temperatures were also consistently below the Chronic Survival temperature tolerance metric (MWMT of 89.6°F) at the three stations *downstream* of the LAGWRP discharge, while the receiving water temperatures for the two LAR3 stations *upstream* of the discharge were regularly above this value. Additionally, the receiving water temperatures at the two stations bracketing the BWRP discharge were consistently below the Chronic Survival metric while receiving water temperatures at the BWC station farthest downstream of the discharge were regularly above this metric. As a result, water temperatures in the BWC in Summer would support the most sensitive species at the two stations bracketing the BWRP discharge. However, post-discharge warming of the receiving water in the channel moving farther downstream results in water temperatures in the BWC near the confluence with the LA River that were above comparable literature-derived temperature tolerance metrics for Chronic Survival and Acute Daytime Survival of the most sensitive species. In the vicinity of the DCTWRP discharge in the Sepulveda Basin, the receiving water temperature metrics at the four stations (LAR5 Balboa, LAR5 Hayvenhurst, LAR5 Burbank and LAR5 Haskel) were never above the comparable temperature tolerance metric values of the most sensitive species in Summer. High rates of receiving water temperature metrics falling below the comparable fish temperature tolerance metric (indicating no risk) are reported for all locations immediately downstream of the WRPs, compared to other locations either above WRP outfalls or much farther below them where any influence of heat from WRP effluent is negligible or non-existent and where receiving water temperature metrics occasionally occur above the comparable fish temperature tolerance metric indicating potential risk.

For the Spring spawning season, water temperatures were all below the Acute Embryo Survival temperature tolerance metric (MDAT of 81°F). However, it should be noted that only one month (May) of data were collected during the Acute Embryo Survival season for the Study. For this reason, modeled water temperatures were evaluated. Modeled water temperatures lower than the metric value for Acute Embryo Survival are typical throughout Study area in Winter through April. Therefore, risk of biology to alteration of water temperatures immediately downstream of WRP discharges is expected to be negligible. For the BWC, however, while water temperatures would be supportive of Acute Daily Embryo Survival post-WRP discharge, the concrete channel does not support early life stages of fish (RWQCB 2019) so it was not included in the evaluation. Similarly, early life stages of fish are considered absent in the concrete channel of LAR4, downstream of the Sepulveda dam.

All but one (BWC Up) of the receiving water (MWAT) temperature metric values were above the comparable literature-based temperature tolerance metric value for Chronic Reproduction (MWAT of 70°F) during the Spring spawning season, indicating possible risk to fish reproduction. However, it should be noted that only one month (May) of data were collected during the Spring spawning season, so conclusions regarding whether Chronic Reproduction is supported in the Study area are uncertain. As a result, modeled water temperatures were evaluated. Modeled water temperatures lower than the metric value for Chronic Reproduction were typical throughout Study area in Winter through April, therefore, risk of biology to alteration of water temperatures immediately downstream of WRP discharges is expected to be negligible. The continued presence of the most sensitive species in the Study area supports this supposition. Additionally, the comparison made is based on the use of highly conservative, laboratory-derived temperature tolerance values, which, as noted above, may be useful for an initial screening assessment of potential risk but under-estimates taxa-specific critical thermal limits based on real world, local conditions. For these reasons, Chronic Reproduction during the Spring spawning season is fully expected to be occurring in the Study area downstream of the WRPs.

Table 6 summarizes the findings of this evaluation. Black text in **Table 6** indicates locations downstream of the WRPs where Study-derived temperatures indicate support for the most sensitive species based on literature-derived thermal limits. Green text in **Table 6** indicates locations where the metric would be supported based on reported observations of taxa presence in the respective Study reaches below WRPs due to the combination of adaptive strategies that allow for reproduction and the continued occurrence of the species in the receiving waters immediately downstream of the WRPs. Overall, the results of this Study indicate that the non-native and high temperature-tolerant biota that reside in the LA River and BWC are not adversely affected by alterations to receiving water temperatures due to WRP effluent temperatures. Any purported need to modify the discharges to reduce thermal effects of the WRP discharges on the communities in the LA River and BWC is not supported.

Table 6. Do Receiving Water Temperatures Immediately Downstream of the WRP Discharges Support the Thermally Most-Sensitive Fish Species Based on Recorded Temperatures in the Study Area?

Findings presented where the temperature tolerance metrics of the most sensitive species are supported based on literature values (black text) or where the most sensitive biota are supported as described in the discussion provided above this table (green text)

Season	Life Stage / Metric	Species Common Name	Thermal Tolerance (°F) From Literature[2]	Could Temperatures in the Post-Discharge Stream Support the Most Sensitive Species for this Metric?		
				LAGWRP	DCTWRP	BWRP
Summer (Dry Season) June - October	Chronic Growth	Goldfish	83.4°F	YES	YES	YES[1]
	Chronic Survival	Pacu	89.6°F	YES	YES	YES[2]
	Acute Daily Survival	Fathead Minnow	89.6°F	YES	YES	YES[1]
	Acute Daytime Survival	Golden Shiner	98.0°F	YES	YES	YES[2]
Spring (Spawning Season) May	Chronic Reproduction	Common Carp & Largemouth Bass	70.0°F	YES	YES	NA[3]
	Acute Daily Embryo Survival	Black Bullhead	81.0°F	YES	YES	NA[3]

1. This metric was met at all three stations in BWC during the 2024 summer thermistor study.
2. This metric was met at the two stations bracketing the BWRP discharge during the 2024 summer thermistor study.
3. NA = Not Applicable. Indicative of the situation where biota is supported in the BWC using temperature tolerance metrics, but where the concrete channel does not support early life stages of fish (RWQCB 2019) so findings for the life stage are excluded from the evaluation.

A7.5 References

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