**Rincon Consultants, Inc.** 

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January 2, 2024 Project No: 20-10008

Bryan Bondy, PG, CHG Executive Director Upper Ventura River Groundwater Agency 202 West El Roblar Drive Ojai, California 93023 Via email: bbondy@uvrgroundwater.org

#### Subject: Aquatic Groundwater Dependent Ecosystems Monitoring for Water Year 2023 Upper Ventura River Groundwater Agency, Ventura County, California

Dear Mr. Bondy:

Rincon Consultants, Inc. (Rincon) has prepared the following Annual Data Deliverable for the 2023 Water Year (October 1, 2022, through September 30, 2023) for Aquatic Groundwater Dependent Ecosystem (GDE) monitoring activities performed at two Aquatic GDEs (Confluence Aquatic Habitat Area and Foster Park Aquatic Habitat Area) located within the Upper Ventura River Groundwater Basin in Ventura County, California (Figure 1). This memorandum was prepared for Upper Ventura River Groundwater Agency (UVRGA) in accordance with UVRGA's *Monitoring and Data Collection Protocols and Data Quality Control Review Procedures*.

# **Summary of Monitoring Activities**

An initial habitat mapping survey was conducted in November 2022 at the onset of this monitoring program. Mesohabitats (i.e., pools, runs, riffles, etc.) were mapped and monitoring locations were established for subsequent routine surveys. Field monitoring activities planned to occur during the winter of Water Year 2023 were suspended due to above average precipitation and intense flooding in the Ventura River that made for unsafe and difficult fieldwork conditions through June 2023.

Descriptions of data collected for each of the monitoring program components are provided in Table 1 below. Attachment 1 provides the ArcGIS Online Web Map used to maintain the biological field monitoring data collected using electronic tablets with ArcGIS Collector software and high accuracy GPS units. Table 2 provides a summary of the ArcGIS Online web map layers and features. This database stores and presents all Aquatic GDE monitoring data except for the water quality and flow monitoring components. Attachment 2 provides the excel files for water quality and flow monitoring raw and processed data, including quality assurance and control notes along with time series charts for data visualization and assessment.

## Water Quality and Flow Monitoring

Field monitoring activities were reinitiated in July 2023 when flow rates receded to levels conducive to instream field work. On July 5 and 6, 2023 field work was conducted to install water quality data loggers (pH, dissolved oxygen, and temperature) and stream gages equipped with Solinst Levelogger automated pressure transducers at the upstream and downstream reaches of the Aquatic GDEs. See Figure 1 for locations of data loggers and pressure transducers. The United States Geological Survey (USGS) stream gage located at Downstream Foster Park (Ventura R NR Ventura – 11118500) is being



used for this project and a UVRGA stream gage was not established at this site. All water quality and level loggers were collecting data by July 18, 2023.

Instantaneous discharge measurements collected to support rating curve development were measured for a limited range of flow conditions observed during the 2023 Water Year monitoring period (Figure 2). This prevents the development of robust empirical rating curves spanning water depth ranges outside of those measured by the continuous pressure transducers. To address this, Rincon developed a stage-discharge rating curve using HydroCalc Version 3.0c software (HydroCalc), which utilizes Manning's equation to model flow rates from observed depth of water and channel dimensions (Figure 3 and Figure 4). Manning's roughness coefficients were selected based on substrate type and slope was back calculated using a normal depth calculator provided by the National Weather Service.<sup>1</sup>

Calibration of the rating curves involved utilizing field-derived flow measurements, and a best-fit curve was applied to the HydroCalc outputs to establish an equation for calculating discharge rates based on stream depths at the thalweg. See Figure 5, Figure 6, and Figure 7 for Upstream Confluence, Downstream Confluence, and Upstream Foster Park rating curves, respectively. While Manning's equation-derived rating curves may exhibit inaccuracies beyond the calibration data range, the pressure transducer-derived depths consistently fell within the established calibration range, resulting in reliable calculated flow rates (Figure 8, Figure 9, and Figure 10) throughout the monitoring period. The hydrograph for Downstream Foster Park developed by USGS is provided in Figure 11.

See Figure 12, Figure 13, and Figure 14 for pH, dissolved oxygen, and temperature data logger and in situ measurements.

## Initial Habitat Mapping, Fish Stranding and Mortality, Routine Habitat Suitability, Snorkel Surveys, and Repeat Ground Photography

Flooding events in early 2023 altered the channel geometry and reset the mesohabitats within both Aquatic GDEs, as well as throughout the river corridor. Bank-to-bank and wetted widths expanded, and instream bars and riparian vegetation were scoured with the channel forming braided conditions. As such, a second habitat mapping event was conducted for both Aquatic GDEs in late July 2023. During the habitat mapping effort, specific monitoring locations were established for subsequent routine surveys. Observations made by fisheries biologists through the 2023 monitoring period indicated that no significant changes to the habitat structure occurred. As such, Habitat Suitability Index (HSI) parameters were not adjusted during subsequent routine habitat suitability and snorkel survey events.

During the routine habitat suitability and snorkel surveys, Rincon documented localized hyporheic flow from groundwater within the Aquatic GDEs. These areas were identified by the change in temperature along small sections within specific habitat units. Rincon also observed large secondary or side channels within the Foster Park and Confluence Aquatic GDEs that formed following the flood events earlier in the year. These additional channels were surveyed during the Confluence Aquatic GDE fish stranding and mortality surveys. These channels were new features that could become isolated, and cause fish stranding.

Figure 15 through Figure 20 depict the mesohabitat survey locations along with snorkel survey locations for the Confluence and Foster Park Aquatic GDEs. Table 3 and Table 4 presents the habitat and snorkel survey data, respectively. No stranding or mortality occurrences were observed during the

<sup>&</sup>lt;sup>1</sup> https://www.weather.gov/aprfc/NormalDepthCalc



water year. Repeat ground photography can be found in Attachment 1 and a visual analysis with photo comparisons will be presented and evaluated as part of the final monitoring assessment report.

## Aerial Photography

Aerial photography collected during the 2023 Water Year for the South Santa Ana and Foster Park Riparian GDE Units is provided in Figure 21 through Figure 26. The figures present orthomosaic raster images collected using a drone flown along predesignated flight paths. A Light Detection and Ranging (LiDAR) derived digital evaluation models (DEM) model for both the South Santa Ana and Foster Park Riparian GDE Units are provided in Figure 27 and Figure 28. Note that this DEM was developed under a separate work order but will be incorporated into the final monitoring assessment report.

# **Preliminary Data Assessment**

The monitoring data from Water Year 2023 is characterized by above average precipitation and instream flows. Visual observations made during the routine habitat and snorkel surveys indicated that generally good aquatic habitat conditions persisted throughout the monitoring period. Continuous and instantaneous water quality measurements showed diurnal fluctuations as expected, and remained within ranges that would not cause concern for aquatic species. Instream flow rates remained elevated with the lowest flows measured at stream gages at the upstream locations for both the Confluence and Foster Park Aquatic Habitat Areas. Surface water conditions remained continuous within the Aquatic GDEs without isolation of instream mesohabitats (specifically pools) throughout the monitoring period. Finally, while sensitive aquatic species were observed and documented, neither the southern California steelhead (*Oncorhynchus mykiss*) nor the pacific lamprey (*Entosphenus tridentatus*) were observed during the field monitoring activities.

Flows during the entire water year were approximately 10 times greater than the flows that could potentially cause undesirable results as defined in the Upper Ventura River Valley Basin Groundwater Sustainability Plan (GSP). Thus, the data collected during Water Year 2023 are not particularly relevant for evaluating the depletions of interconnected surface water sustainability criteria established in the GSP for the Foster Park Aquatic Habitat Area or evaluating stranding in the Confluence Aquatic Habitat Area. Nonetheless, the data collection efforts during Water Year 2023 have laid the foundation for monitoring in drier years and will provide a comprehensive data set over a range of flows that may be useful for other agencies and interested parties.

### Table 1 Water Year 2023 Monitoring Summary

Monitoring Component	Data Collected	Date Collected	Raw Data Transmittal Location
Habitat Mapping	Map aquatic mesohabitats in the Confluence Aquatic Habitat Area Aquatic GDE	November 22 -23, 2022 and July 24-26, 2023	Attachment 1 ArcGIS Online UVRGA Aquatic GDE Monitoring Web Map
Fish Stranding and Mortality Surveys <sup>1</sup>	Document any observed fish stranding and/or mortality that might occur as streamflow recedes. The extent of wetted and dry portions of the river will also be documented.	July 27, August 23, and September 26, 2023	No stranding or mortality occurrences were observed. If or when observed these observations will be provided in ArcGIS Online.
Routine Habitat Suitability and Snorkel Surveys	If significantly different from initial habitat mapping efforts, Habitat Suitability Index (HSI) parameters were surveyed, including sediment type, riparian vegetation/cover, water depth, and various in-stream structure, as well as all species observed, within predetermined pools, riffles, and glides. Steelhead presence/ absence will be documented during snorkel surveys. Fish stranding/morality will also be documented.	July 27 and August 23, 2023	Attachment 1 ArcGIS Online UVRGA Aquatic GDE Monitoring Web Map
Water Quality and Flow Monitoring	D0, pH, temperature, water level, instantaneous discharge, river cross sections and slope.	Continuous data loggers operational by July 18, 2023 Cross Sections: July 5-6, 2023 In Situ Water Quality and Data Downloads: August 16, September 21, October 13, and November 16, 2023 Instantaneous Discharge: July 17 and 18, August 16 and 24, September 21 and 26, October 13 and 19, November 16	Attachment 2 Excel file for water quality monitoring component: UVRGA_Water_Quality Data.xlsx Sheets included: "In-Situ," "pH"," DO","pH_Chart", "DO_Chart" Excel sheets for flow monitoring component: UVRGA_Flow_Data.xlsx Sheets included: "Field Flow Rate Summary" and individual monitoring location sheets for "Rating Curves," "Hydrographs" (stage and calculated flow), and "Morphology" (cross section and slope)
Aerial Photography	Aerial images	December 19, 2022, March 24, 2023, July 26, 2023	Attachment 1 ArcGIS Online UVRGA Aquatic GDE Monitoring Web Map
	Digital Elevation Model (DEM)	June 27 through June 29, 2023	
Repeat Ground Photography	Photographs of instream and riparian habitat from fixed locations.	Photos collected concurrently with all field visits	Attachment 1 ArcGIS Online UVRGA Aquatic GDE Monitoring Web Map
<sup>1.</sup> For Confluence Aqu	atic GDE only		

Monitoring Component	Web Map Layer/ Feature Name	Layer Description
Habitat Mapping	"Habitat Data"	Habitat mapping data points are provided to indicate mesohabitats that were identified within the Confluence and Foster Park Aquatic GDEs during initial and follow-up habitat mapping events.
Routine Habitat Suitability and Snorkel Surveys	"Habitat Data"	Routine habitat survey data points present the applicable habitat suitability parameter data for mesohabitats that were both randomly identified monitoring locations and selected "bias" sites deemed as important aquatic habitat areas.
	"Snorkel Data"	Snorkel survey data points present observations and pertinent information for mesohabitats that were both randomly identified monitoring locations and selected "bias" sites deemed as important aquatic habitat areas.
	"Cross Section Point and Misc. Bio Point"	Presents snorkel points used to collect field notes for follow-up snorkel surveys and cross section elevations used to provide elevations of the wetted area where the LiDAR was not able to obtain.
Water Quality and Flow Monitoring	"Data Logger Location"	Data logger location presents the locations of DO, pH, temperature, and/or water level data loggers.
Aerial Photography	"Master Aerial Photography"	Aerial photography presents orthomosaic raster images collected using a drone flown along predesignated flight paths spanning both the Confluence and Foster Park Aquatic GDEs.
	"DEM and Hillshade"	DEM/hillshade presents digital elevation model data and hillshade data that were developed for UVRGA under a separate Work Order, and which will be used to assess changing GDE conditions.
Repeat Ground Photography	"Habitat Data" & "Snorkel Survey"	Repeat ground photographs are included at designated photo monitoring locations. Photographs are also collected for each routine survey and snorkel survey monitoring location.

## **Table 2 ArcGIS Online Layer Description**

We appreciate Rincon's opportunity to support this project. Please do not hesitate to contact us if you have any questions.

Sincerely, **Rincon Consultants, Inc.** 

Thomas for

Thomas Sanford Watershed Scientist

#### Attachments

Kiernan Brtalik Director Watershed Sciences

Attachment 1 ArcGIS Online UVRGA Aquatic GDE Monitoring Web Map (https://experience.arcgis.com/experience/ 1154e1f8252444a1972d831cff528df7)

Attachment 2 Water Quality and Flow Data





Figure 1 Habitat Area Aquatic GDEs

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Figure 2 Instantaneous Discharge Measurements











Figure 5 Upstream Confluence Rating Curve







Figure 6 Downstream Confluence Rating Curve

Figure 7 Upstream Foster Park Rating Curve







Figure 8 Upstream Confluence Hydrograph









Figure 10 Upstream Foster Park Hydrograph

Figure 11 Downstream Foster Park Hydrograph- USGS Site: Ventura R NR Ventura - 11118500







Figure 12 pH Data Logger and In Situ Measurements

Figure 13 Dissolved Oxygen Data Logger and In Situ Measurements







Figure 14 Water Temperature Data Logger and In Situ Measurements





Figure 15 Confluence Aquatic GDE Habitat and Snorkel Survey Locations

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Figure 16 Confluence Aquatic GDE Habitat and Snorkel Survey Locations

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Figure 17 Confluence Aquatic GDE Habitat and Snorkel Survey Locations

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Figure 18 Foster Park Aquatic GDE Habitat and Snorkel Survey Locations

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Figure 19 Foster Park Aquatic GDE Habitat and Snorkel Survey Locations

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Figure 20 Foster Park Aquatic GDE Habitat and Snorkel Survey Locations

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#### **Table 3 Mesohabitat Data**

oint ID	urvey Date	abitat Type	ain Channel /pe	econdary hannel Habitat pe	econdary hannel Type	r Temp. (°C)	'ater Temp. (°C)	tream Dry	əngth (ft)	lean Width (ft)	ean Depth (ft)	lax. Depth (ft)	lt/Clay (%)	and (%)	ravel (%)	obble (%)	oulder (%)	edrock (%)	oncrete (%)	otal (%)
1	0 7/04/0002		ΣĹ	ù C N	U N	N N	195	Ś	ٽ ٥٥	X	2	$\geq$	S S	ő	G	Ö	<b>m</b>	ň	Ö	100
	7/24/2023	rifflo		-	-	24	10.0	-	00 20	4	1.9	2.0	- 60 	0	10	5	20	0	0	100
2	7/04/2023		MCD	-	-	25	10	-	32	10	0.5	0.5		60	10			0	0	100
	7/04/2023	rifflo		-	-	20	19	-	20	20	0.7	0.9	20 E		-	50	-	-	-	100
4 	7/24/2023			-	-	20	10	-	120	20	0.5	0.5	5		5 	20	40 55	0	0	100
5	7/24/2023	pool_main	MCP	рооі_раск	врв	26	18	-	138	- 15	0.8	1.3	5	5	5	- 30	55	0	0	100
	7/24/2023	pool_main	MCP	-	-	26	22	-	36	5	1.2	1.4	80	5	-	5	10	-	-	100
8	7/24/2023	riffle	LGR	-	-	26	23	-	32	6	0.1	0.3	50	0	0	30	20	0	0	100
9	7/24/2023	other	DRY	-	-	-	-	yes	156	-	-	-	-	-	-	-	-	-	-	0
10	7/24/2023	pool_main	MCP	-	-	27	20	-	90	4	0.9	1.4	45	5	5	5	40	-	-	100
11	7/24/2023	pool_main	-	-	-	-	-	yes	35	-	-	-	-	-	-	-	-	-	-	0
12	7/24/2023	riffle	LGR	-	-	26	22	-	240	35	1.5	2.5	5	10	70	5	10	0	0	100
13	7/24/2023	pool_back	DPL	-	-	25	22	-	30	20	2	2.6	5	20	40	25	10	0	0	100
14	7/24/2023	pool_main	MCP	-	-	25	22	-	80	25	2.7	3.3	0	60	10	15	15	0	0	100
15	7/24/2023	riffle	HGR	-	-	25	22	-	265	25	1.8	3	5	10	40	30	15	0	0	100
16	7/24/2023	riffle_flatwater	RUN	riffle	LGR	25	23	-	290	50	0.8	1.1	10	20	50	15	5	0	0	100
17	7/24/2023	pool_scour	CRP	pool_back	BPB	25	23	-	122		2.5	3	5	20	40	25	0	0	0	90
18	7/24/2023	pool_main	STP	pool_back	BPB	25	23	-	46		2.4	3.3	0	5	5	25	0	0	65	100
19	7/24/2023	riffle_flatwater	RUN			25	22	-	140	35	1.8	2.7	0	0	20	80	0	0	0	100
20	7/24/2023	pool_main	STP	pool_main	STP	25	25	-	136	25	3.2	4	5	15	30	20	0	0	15	85
21	7/25/2023	riffle_flatwater	RUN	pool_back	SCP	31	23	-	859	40	1.1	2.5	0	5	45	40	10	0	0	100
22	7/25/2023	pool_main	MCP	no_hab	None	32	23	-	210	30	2.1	3	10	30	35	20	5	0	0	100
23	7/25/2023	riffle_flatwater	RUN	no_hab	None	32	22	-	68	20	1.5	2.5	0	5	15	70	10	0	0	100
24	7/25/2023	riffle	HGR	riffle	LGR	32	22	-	50	30	1.3	1.8	0	0	10	35	55	0	0	100
25	7/25/2023	riffle_flatwater	RUN	no_hab	None	32	22	-	93	12	1.7	2.5	0	5	15	55	25	0	0	100
26	7/25/2023	riffle	LGR	no_hab	None	33	23	-	132	20	1.6	1.9	0	0	10	55	35	0	0	100
27	7/25/2023	pool_main	MCP	-	-	23	19	-	38	25	1.7	2.1	5	20	50	25	0	0	0	100
28	7/25/2023	riffle_flatwater	RUN	-	-	23	19	-	59	30	1.7	1.9	5	5	15	75	0	0	0	100

Canopy Cover (%)	Gravel Embed. (%)	Instream Cover (%)	Algae Cover (%)	Migration Barrier
15	75_100_perc	35	90	no
75	50_75_perc	30	80	no
75	50_75_perc	15	85	-
55	0_25_perc	45	90	no
25	25_50_perc	15	95	no
15	0_25_perc	25	5	-
10	25_50_perc	5	95	no
-	-	-	-	-
85	0_25_perc	15	25	no
-	-	-	-	-
10	25_50_perc	65	75	no
5	25_50_perc	20	65	yes
5	25_50_perc	15	60	no
5	25_50_perc	35	70	no
5	0_25_perc	20	65	no
2	0_25_perc	20	80	no
0	0_25_perc	15	80	yes
2	0_25_perc	15	55	no
2	0_25_perc	45	35	yes
5	25_50_perc	65	80	no
15	0_25_perc	75	90	no
5	75_100_perc	55	95	no
5	75_100_perc	60	80	no
40	75_100_perc	80	95	no
25	75_100_perc	70	80	no
5	0_25_perc	15	30	no
2	25_50_perc	30	95	no



Point ID	Survey Date	Habitat Type	Main Channel Type	Secondary Channel Habitat Type	Secondary Channel Type	Air Temp. (°C)	Water Temp. (°C)	Stream Dry	Length (ft)	Mean Width (ft)	Mean Depth (ft)	Max. Depth (ft)	Silt/Clay (%)	Sand (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Concrete (%)	Total (%)	Canopy Cover (%)	Gravel Embed. (%)	Instream Cover (%)	Algae Cover (%)	Migration Barrier
29	7/25/2023	pool_back	DPL	-	-	23	19	-	50	25	2.2	3.4	5	10	60	15	10	0	0	100	15	0_25_perc	70	55	yes
30	7/25/2023	riffle_flatwater	RUN	-	-	24	18	-	56	15	2.6	3	5	5	15	55	20	0	0	100	10	50_75_perc	45	90	no
31	7/25/2023	riffle	HGR	-	-	24	18	-	58	25	0.8	1	0	5	10	35	50	0	0	100	15	75_100_perc	35	90	no
32	7/25/2023	riffle_flatwater	RUN	pool_back	BPB	24	18	-	110	55	1.1	1.4	0	5	20	60	15	0	0	100	15	25_50_perc	40	80	no
33	7/25/2023	riffle	LGR	pool_back	BPB	25	18	-	191	40	0.6	1.1	5	10	40	40	5	0	0	100	20	25_50_perc	65	80	no
34	7/25/2023	pool_main	MCP	-	-	25	18	-	200	15	3.3	4.2	10	40	25	20	5	0	0	100	25	0_25_perc	65	75	no
35	7/25/2023	riffle	LGR	no_hab	None	25	18	-	85	35	0.6	0.8	0	5	10	70	10	0	0	95	45	50_75_perc	60	90	yes
36	7/25/2023	pool_main	MCP	no_hab	None	26	19	-	177	20	4.2	5.5	5	25	50	15	5	0	0	100	10	0_25_perc	65	80	no
37	7/25/2023	riffle	LGR	pool_back	BPR	26	20	-	70	20	1.2	1.8	0	10	45	40	5	0	0	100	10	25_50_perc	30	75	yes
38	7/25/2023	pool_back	DPL	no_hab	None	27	20	-	115	25	3.5	4.2	0	10	25	45	20	0	0	100	5	25_50_perc	60	80	yes
39	7/25/2023	riffle	HGR	no_hab	None	27	21	-	77	20	1.4	2.2	0	5	10	50	35	0	0	100	0	75_100_perc	75	50	no
40	7/25/2023	riffle	LGR	riffle_flatwater	None	28	22	-	723	15	1.2	2.3	0	5	10	55	25	0	5	100	10	50_75_perc	75	80	yes
41	7/25/2023	riffle_flatwater	RUN	no_hab	None	28	22	-	114	12	1.7	1.4	0	20	10	40	30	0	0	100	15	50_75_perc	40	60	no
42	7/25/2023	pool_main	MCP	no_hab	None	27	21	-	134	8	0.6	1.1	80	5	5	5	5	0	0	100	30	0_25_perc	20	80	no
43	7/25/2023	other	DRY	no_hab	None	-	-	-	144	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
44	7/25/2023	pool_main	MCP	no_hab	None	29	22	-	52	4	0.4	0.8	65	5	5	20	5	0	0	100	45	75_100_perc	60	50	no
45	7/25/2023	other	DRY	no_hab	None	-	-	-	205	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
46	7/25/2023	pool_main	MCP	no_hab	None	29	20	-	412	10	0.5	1.1	0	45	40	10	5	0	0	100	20	75_100_perc	95	95	no
47	7/25/2023	riffle	LGR	pool_main	MCP	29	21	-	77	5	0.3	1.3	10	10	10	65	5	0	0	100	10	50_75_perc	95	90	no
48	7/25/2023	riffle	LGR	no_hab	None	29	22	-	522	18	0.6	1.4	0	5	20	70	4	0	1	100	-	25_50_perc	85	95	-
49	7/25/2023	pool_main	MCP	no_hab	None	29	22	-	160	15	0.8	1.6	5	35	35	20	5	0	0	100	25	75_100_perc	100	100	no
50	7/25/2023	riffle	LGR	pool_back	SCP	-	-	-	407	6	0.8	1.6	0	50	20	25	5	0	0	100	15	25_50_perc	95	95	no
51	7/25/2023	pool_main	MCP	no_hab	None	29	19	-	118	20	1	1.4	20	45	20	10	5	0	0	100	5	0_25_perc	85	85	no
52	7/26/2023	riffle_flatwater	RUN	no_hab	None	-	20	-	107	20	2.2	2.7	0	5	15	45	35	-	-	100	65	25_50_perc	80	75	no
53	7/26/2023	riffle	LGR	no_hab	None	24	20	-	121	12	1.7	2.6	0	-	10	50	40	-	-	100	30	25_50_perc	75	80	no
54	7/26/2023	riffle	HGR	pool_back	BPL	24	20	-	266	22	1.6	2.9	0	0	5	40	55	-	-	100	60	25_50_perc	80	60	no
55	7/26/2023	pool_main	MCP	no_hab	None	25	20	-	186	28	4	6	0	10	35	55	-	-	-	100	15	0_25_perc	45	80	-
56	7/26/2023	riffle	LGR	no_hab	None	25	20	-	83	-	0.9	1.3	0	5	15	65	10	-	5	100	0	25_50_perc	65	80	no
57	7/26/2023	riffle_flatwater	RUN	pool_scour	LSBk	25	20	-	303	35	0.7	1.9	0	15	15	70	-	-	-	100	45	25_50_perc	35	80	-



Point ID	Survey Date	Habitat Type	Main Channel Type	Secondary Channel Habitat Type	Secondary Channel Type	Air Temp. (°C)	Water Temp. (°C)	Stream Dry	Length (ft)	Mean Width (ft)	Mean Depth (ft)	Max. Depth (ft)	Silt/Clay (%)	Sand (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Concrete (%)	Total (%)	Canopy Cover (%)	Gravel Embed. (%)	Instream Cover (%)	Algae Cover (%)	Migration Barrier
58	7/26/2023	pool_main	MCP	no_hab	None	25	20	-	197	25	2.6	4.3	0	0	10	80	10	-	-	100	15	25_50_perc	45	80	-
59	7/26/2023	riffle	LGR	no_hab	None	26	20	-	60	30	1.1	2.6	0	5	10	70	15	-	-	100	5	25_50_perc	55	80	-
60	7/26/2023	riffle_flatwater	RUN	no_hab	None	26	20	-	202	30	2.1	3.3	0	5	25	55	15	-	-	100	25	25_50_perc	55	80	-
61	7/26/2023	riffle	HGR	no_hab	None	27	20	-	83	28	1.4	2.3	0	-	10	35	55	-	-	100	50	25_50_perc	75	80	-
62	7/26/2023	riffle_flatwater	RUN	riffle	LGR	28	21	-	118	25	1.4	2.9	0	15	25	55	5	-	-	100	0	25_50_perc	45	90	-
63	7/26/2023	pool_main	CCP	riffle	LGR	28	21	-	59	15	2.9	3.9	0	30	25	45	-	-	-	100	50	25_50_perc	45	90	-
64	7/26/2023	riffle	LGR	riffle	HGR	28	21	-	64	30	1.1	2.6	0	10	25	65	-	-	-	100	0	0_25_perc	75	70	-
65	7/26/2023	riffle_flatwater	RUN	no_hab	None	28	20	-	136	18	1.1	2.4	0	10	25	65	-	-	-	100	5	25_50_perc	35	85	-
66	7/26/2023	riffle	LGR	other	DRY	29	21	-	138	15	0.9	1.4	0	0	15	65	15	-	5	100	5	25_50_perc	45	80	-
67	7/26/2023	riffle_flatwater	RUN	no_hab	None	29	22	-	125	15	0.9	1.6	15	10	45	30	-			100	15	25_50_perc	45	80	-
68	7/26/2023	riffle	LGR	no_hab	None	29	21	-	71	12	0.8	1.7	15	10	15	35	25	-	-	100	80	25_50_perc	65	80	-
69	7/26/2023	riffle	HGR	riffle	LGR	29	21	-	-	-	-	-	-	-	-	-	-	-	-	0	-	-	-	-	-
70	7/26/2023	riffle	HGR	riffle	LGR	29	21	-	77	6	0.8	1	5	5	35	50	5	-	-	100	0	0_25_perc	45	70	-
71	7/26/2023	riffle_flatwater	RUN	riffle	LGR	29	21	-	197	25	1.7	3	5	15	20	45	15	-	-	100	0	25_50_perc	65	65	-
72	7/26/2023	riffle_flatwater	RUN	no_hab	None	29	21	-	129	20	1	1.5	0	45	30	25	-	-	-	100	20	25_50_perc	25	90	-
73	7/26/2023	riffle	LGR	riffle	LGR	29	21	-	163	5	0.6	0.8	5	35	25	35	-	-	-	100	45	25_50_perc	45	80	-
74	7/26/2023	riffle	LGR	riffle	LGR	29	21	-	127	10	0.7	1	0	10	35	55	-	-	-	100	10	25_50_perc	25	80	-
75	7/26/2023	riffle_flatwater	RUN	riffle	LGR	30	21	-	312	65	1.1	1.7	0	5	15	75	5	-	-	100	15	50_75_perc	35	90	-
76	7/26/2023	riffle	LGR	riffle	HGR	30	21	-	255	6	0.6	1.3	0	5	15	70	10	-	-	100	20	25_50_perc	45	80	-
77	7/26/2023	pool_main	CCP	riffle	LGR	30	21	-	92	25	2.7	3.7	0	15	25	45	15	-	-	100	0	25_50_perc	65	80	-
78	7/26/2023	riffle	HGR	riffle	LGR	30	22	-	83	25	1.2	1.7	0	5	10	70	15	-	-	100	0	25_50_perc	45	55	-
79	7/26/2023	riffle_flatwater	RUN	riffle	HGR	31	23	-	66	12	1.6	2.7	0	5	15	25	55	-	-	100	15	25_50_perc	65	65	-
80	7/26/2023	riffle	HGR	no_hab	None	31	23	-	76	12	1.3	2.4	0	-	-	45	55	-	-	100	70	25_50_perc	45	65	-
81	7/26/2023	pool_back	DPL	no_hab	None	31	23	-	43	15	1.1	1.4	0	5	35	45	15	-	-	100	30	25_50_perc	55	85	-
82	7/26/2023	riffle_flatwater	RUN	riffle	LGR	31	23	-	642	30	1.1	1.8	0	35	15	45	5	-	-	100	65	-	55	75	-
83	7/26/2023	pool_back	DPL	no_hab	None	31	23	-	32	20	1.1	1.9	0	25	45	15	15	-	-	100	15	25_50_perc	15	45	-
84	7/26/2023	riffle	LGR	no_hab	None	31	23	-	72	15	0.9	1.6	0	5	15	65	15	-	-	100	25	50_75_perc	45	65	-
85	7/26/2023	riffle	LGR	no_hab	None	31	24	-	292	20	1.3	2	0	15	35	45	5	-	-	100	55	25_50_perc	65	85	-
86	7/26/2023	riffle	LGR	riffle	LGR	31	25	-	170	10	0.8	1	-	5	25	55	15	-	-	100	55	25_50_perc	45	80	-



Point ID	Survey Date	Habitat Type	Main Channel Type	Secondary Channel Habitat Type	Secondary Channel Type	Air Temp. (°C)	Water Temp. (°C)	Stream Dry	Length (ft)	Mean Width (ft)	Mean Depth (ft)	Max. Depth (ft)	Silt/Clay (%)	Sand (%)	Gravel (%)	Cobble (%)	Boulder (%)	Bedrock (%)	Concrete (%)	Total (%)	Canopy Cover (%)	Gravel Embed. (%)	Instream Cover (%)	Algae Cover (%)	Migration Barrier
87	7/26/2023	riffle	LGR	riffle	LGR	31	25	-	48	8	0.5	1.1	-	5	15	65	15	-	-	100	70	25_50_perc	55	75	-
Notes: °C ft BPB BPL BPR CCP CRP DPL DRY HGR LGR LSBk MCP RUN SCP STP	degrees Celsius feet backwater pool-t backwater pool-t backwater pool-r channel confluer corner pool dammed pool Dry high gradient riffle Lateral scour poor main channel poor run secondary chanr step pool	boulder form log formed root wad form nce pool fle e ol ool nel pool	ied ned																						

### **Table 4 Snorkel Data**

Point ID	Date	Type	Water Temp (°C)	Macroinvertebrate	Fish Species	Life Stage	Number	Fish Species_1	Life Stage_1	Number_1	Fish Species_2	Life Stage_2	Number2	Fish Notes	Invasive Species
1	7/27/2023	LGR	21	Yes	TSS	juvenile	10	-	-	-	-	-	-	mixed adult/juvenile	-
2	7/27/2023	Pool	21	Yes	Arroyo Chub	juvenile	2500	TSS	adult	21	-	-	-	For arroyo chub, mixed of adults and Juveniles	-
3	7/27/2023	RUN	19	Yes	TSS	adult	4	Arroyo Chub	juvenile	250	-	-	-	For AC, mixed of juvenile/adults	-
4	7/27/2023	RUN	21	Yes	Arroyo Chub	juvenile	370	TSS	adult	55	-	-	-	Arroyo Chub (370 30A/70J)	-
5	7/27/2023	LGR	21	Yes	Arroyo Chub	adult	25	TSS	adult	1	-	-	-	-	-
6	7/27/2023	MCP	21	Yes	Arroyo Chub	juvenile	5760	TSS	adult	165	-	-	-	Arroyo Chub (5760 40A/60J) and TSS (165 90A/10J)	-
7	7/27/2023	DPL	21	Yes	Arroyo Chub	juvenile	1850	TSS	adult	29	-	-	-	Arroyo Chub (1850 80J/20A)	-
8	7/27/2023	HGR	21	Yes	-	-	-	-	-	-	-	-	-	Zero fish observed	-
9	7/27/2023	RUN	21	Yes	Arroyo Chub	adult	155	TSS	adult	15	-	-	-	Arroyo Chub 155 (80A/20J)	-
10	7/27/2023	RUN	21	Yes	Arroyo Chub	juvenile	4725	TSS	adult	4	-	-	-	Arroyo Chub (4725 25A/75J)	-
11	7/27/2023	MCP	22	Yes	Arroyo Chub	juvenile	3700	TSS	adult	76	-	-	-	Arroyo Chub (3700 40A/60J)	-
12	7/27/2023	LGR	22	Yes	Arroyo Chub	adult	85	TSS	adult	5	-	-	-	-	-
13	7/27/2023	MCP	22	Yes	Arroyo Chub	juvenile	3200	TSS	adult	38	-	-	-	Arroyo Chub (3200 30A/70J)	-
14	7/27/2023	LGR	23	Yes	Arroyo Chub	adult	135	-	-	-	-	-	-	-	-

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Point ID	Date	Type	Water Temp (°C)	Macroinvertebrate	Fish Species	Life Stage	Number	Fish Species_1	Life Stage_1	Number_1	Fish Species_2	Life Stage_2	Number2	Fish Notes	Invasive Species
15	7/27/2023	RUN	23	Yes	Arroyo Chub	juvenile	1950	TSS	adult	3	-	-	-	Arroyo Chub (1950 40A/60J)	bullfrog
16	7/27/2023	RUN	22	Yes	Arroyo Chub	juvenile	1750	TSS	adult	6	-	-	-	Arroyo Chub (1750 40A/60J)	-
17	7/27/2023	HGR	23	Yes	Arroyo Chub	adult	105	-	-	-	-	-	-	-	-
18	7/27/2023	CCP	23	Yes	Arroyo Chub	adult	1450	TSS	adult	3	-	-	-	-	-
19	8/23/2023	DPL	20	Yes	Arroyo Chub	adult	2250	TSS	adult	425	-	-	-	Arroyo Chub: 60A/40J	mudsnails
20	8/23/2023	HGR	20	Yes	Arroyo Chub	adult	265	TSS	adult	205	-	-	-	-	mudsnails
21	8/23/2023	RUN	20	Yes	Arroyo Chub	adult	125	TSS	adult	75	-	-	-	-	mudsnails
22	8/23/2023	DPL	20	Yes	Arroyo Chub	adult	400	TSS	adult	400	TSS	adult	55	Arroyo Chub, 80A/20J; TSS, 90A/10J	mudsnails
23	8/23/2023	RUN	20	Yes	Arroyo Chub	adult	1090	TSS	adult	115	-	-	-	Arroyo Chub, 80A/20J; TTS, 90A/10J	mudsnails
24	8/23/2023	HGR	21	Yes	Arroyo Chub	adult	4	TSS	adult	2	-	-	-	-	mudsnails
25	8/23/2023	RUN	21	Yes	Arroyo Chub	adult	45	TSS	adult	10	-	-	-	-	mudsnails
26	8/23/2023	LGR	21	Yes	Arroyo Chub	adult	80	TSS	adult	75	-	-	-	Arroyo Chub, 90A/10J	mudsnails
27	8/23/2023	MCP	20	Yes	Arroyo Chub	adult	2300	TSS	adult	205	-	-	-	Arroyo Chub, 70A/30J; TSS, 80A/20J	mudsnails
28	8/23/2023	MCP	23	Yes	Arroyo Chub	adult	2280	TSS	adult	180	-	-	-	Arroyo Chub, 80A/20J;TSS, 90A/10J	mudsnails
29	8/23/2023	LGR	23	Yes	Arroyo Chub	adult	190	TSS	adult	42	-	-	-	Arroyo Chub, 90A/10J	mudsnails



Point ID	Date	Type	Water Temp (°C)	Macroinvertebrate	Fish Species	Life Stage	Number	Fish Species_1	Life Stage_1	Number_1	Fish Species_2	Life Stage_2	Number2	Fish Notes	Invasive Species
30	8/23/2023	RUN	23	Yes	Arroyo Chub	adult	2420	TSS	adult	155	-	-	-	Arroyo Chub, 70A/30J; TSS, 90A/10J	mudsnails
31	8/23/2023	CCP	23	Yes	Arroyo Chub	adult	620	TSS	adult	55	-	-	-	Arroyo Chub, 90A/10J	mudsnails
32	8/23/2023	LGR	23	Yes	Arroyo Chub	adult	125	TSS	adult	28	-	-	-	-	mudsnails
33	8/23/2023	RUN	23	Yes	Arroyo Chub	adult	120	TSS	adult	15	-	-	-	Arroyo Chub, 90A/10J	mudsnails
34	8/23/2023	HGR	23	Yes	Arroyo Chub	adult	37	TSS	adult	8	-	-	-	-	mudsnails
35	8/23/2023	RUN	23	Yes	Arroyo Chub	juvenile	280	TSS	adult	50	-	-	-	Arroyo Chub, 20A/80J	mudsnails
36	8/23/2023	MCP	23	Yes	Arroyo Chub	adult	8000	TSS	adult	115	-	-	-	-	mudsnails
Note CCP DPL HGR LGR MCF RUN TSS	es: channel co dammed p high gradie low gradie main char run Three-spir	onfluenc bool ent pool int riffle inel pool	e pool I Ieback												



Figure 21 Drone Orthoimagery of the South Santa Ana Riparian GDE Unit, December 19, 2022



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Figure 22 Drone Orthoimagery of the South Santa Ana Riparian GDE Unit, March 24, 2023



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ig X South Santa Ana Orthomosaic March 2023





Figure 23 Drone Orthoimagery of the South Santa Ana Riparian GDE Unit July 26, 2023

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Ventura Upper Watershed Fig X South Santa Ana Orthomosaic July 2023



Figure 24 Drone Orthoimagery of the Foster Park Riparian GDE Unit, December 19, 2022



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ig X Foster Park Riparian Orthomosaic December





Figure 25 Drone Orthoimagery of the Foster Park Riparian GDE Unit, March 24, 2023

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Fig X Foster Park Riparian Orthomosaic March 2023





Figure 26 Drone Orthoimagery of the Foster Park Riparian GDE Unit, July 26, 2023

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Fig X Foster Park Riparian Orthomosaic July 2023



Figure 27 Digital Elevation Model of the South Santa Ana Riparian GDE Unit, June 27 through June 29, 2023



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Figure 28 Digital Elevation Model of the Foster Park Riparian GDE Unit, June 27 through June 29, 2023



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