LOWER SAN DIEGO RIVER WATER QUALITY

WY24 Water Quality Monitoring Report Appendices A-I

Winter Ludwigia growth at lower Walmart Pond (WQM Site 13E)

Water Quality Monitoring Data and Supporting Information

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LOWER SAN DIEGO RIVER
WY24 WATER QUALITY REPORT APPENDICES A-I

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Appendix A
RiverWatch Water Quality Monitoring Program

Appendix A provides an overview of SDRPF's RiverWatch water quality monitoring (WQM) program teams that have been engaged in collecting and assessing basic data pertaining to the Lower San Diego River (LSDR) watercourse on a continuous, monthly basis since Sept. 2004.

Monitoring Period & Coverage: Monthly monitoring over past 19 years (Oct. 2004 – Sept. 2023) covering the main course of the San Diego River and tributary streams extending some 18 miles downstream from Lakeside (elev. 340 ft amsl) to the Estuary (elev. 5 ft amsl) just below the I-5/ Pacific Hwy. overpasses nearly 3 miles inland from the river's mouth at the Pacific Ocean. The lower river watershed and monitoring sites are shown on **Figure A.1.**

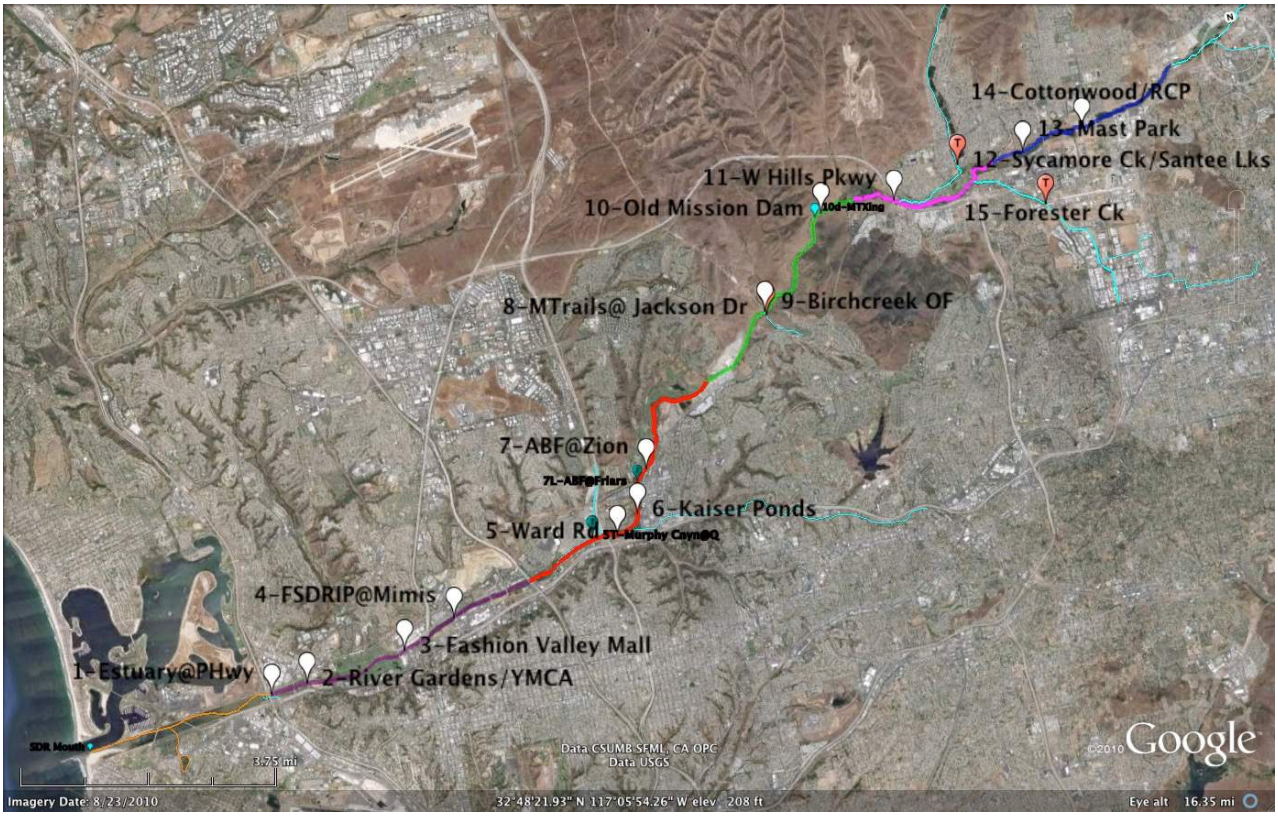

Figure A.1 - Lower San Diego River Drainage Area and WQM Sites

Color Code for LSDR reaches on figure above: Estuary (orange), LMV (purple), UMV (red), MG (dark green), LSB (violet), USB (dark blue), Lakeside (light green), key tributaries (light blue). Figure details can be downloaded through Google Earth from SDRPF website/River Monitoring page: file <Fig1.1WQMR.kmz>

Mo**nitoring Sites**: 17 total - 14 on main course (Mission Valley Section - sites 1-7, Mission Gorge Section - sites 8-10, Santee Basin Section - sites 11-15) plus three key tributary stream sites are listed in **Table A.1.**

Table A.1 LSDR Sections, Reaches and WQ Monitoring Sites

Section/Reach/Tributary	Site #s	Comments
Estuary entrance	1E/1W	Tidal influence at transition from estuary to river
Lower Mission Valley (LMV)	2E/W, 3	3-mile reach of lower river from I-5 to SR163
Mid-Mission Valley (MMV)	4, 5	2-mile reach extending from SR163 to I805
Upper Mission Valley (UMV)	6, 7	3-mile stretch from I-805 to Princess View Dr
West Sites - Mission Valley Section	(1-7)	8-mile western portion through Mission Valley
Mission Gorge (MG) Mid-Section	(8,9T,10)	5-mile midsection, Princess View Dr to Hollis Lk
Lower Santee Basin (LSB)	11,12T,15T	2-mile reach from Hollis Lk to Carlton Hills Blvd
Upper Santee Basin (USB)	13E/W, 14	3-mile reach from Carlton Hills Blvd to SR67
Santee Basin (SB) Section	(11-15T)	5-mile eastern portion from Mission Trails Regional Park to Lakeside (SR67)
East Sites - MG and SB	(8 -15T)	10-mile upper portions incl. MG and Santee Basin
LSDR Tributaries:		
Murphy Canyon/Qualcom [a)]	*{5}* [a)]	Enters LSDR southwest of Aztec Stadium
Jackson Dr/Birchcreek Outfall [b)]	9T	Enters LSDR at SD River/Aqueduct trail crossing (Suycott Wash)
Santee Lakes/E. Sycamore Cnyn Ck	12T	Enters LSDR at Carlton Oaks CC golfcourse (u/s)
Forester Creek [c)]	15T	Enters LSDR at W. Hills Pkwy. (u/s of Site 11)
Lower SDR Watershed (LSDR)	(1-15T)	Weighted average of all 5 reaches /all 3 sections

(a) Monthly monitoring discontinued in WY07; nearby Ward Rd bridge site (oriignally #6) renumbered as 5.
(b) Monthly monitoring initiated in 2008; site also termed Jackson Dr. Outfall (OF) is along the SDR Xing trail.
(c) Monthly monitoring initiated in 2007 with adjusted site locations in 2009 and 2015 during channel improvements, reverted back to near original location at Mission Gorge Rd. Bridge in 2018.

WQ Parameters: Seven key parameters are measured and recorded: Temp, pH, SpC, DO, DO%Sat, two nutrients; nitrogen (NO_3) and phosphrous (PO_4), plus subjective field observations regarding environs and general water characteristics, as listed in **Table A.2.** Nutrient testing is carried out at six river sites; two in West (2, 6) and four in East (11, 13W, 14, 15T).These monitoring data are used in performing statistical analyses regarding each identified reach and section of the river. The number of datum for each physical-chemical parameter monitored at each site compiled over the 20-year period exceeds several hundred providing a firm statistical basis in performing analyses. Two additional parameters compiled at several sites by other entities include streamflow derived from USGS (Poway Office) gauging station data and coliform counts from the SDCoastKeeper database. Both data sets have been used for purposes of computing the LSDR water quality index.

Protocol: *Eastern Sites* – (Santee Basin & Mission Gorge sections). Nine sites located within the three upper reaches (MG, LSB, USB) are typically monitored the 3rd Fri. of every month by the RiverWatch East Team. *Western Sites* - (Mission Valley section). Seven sites within the three

lower reaches (LMV, MMV, UMV) of the watershed are typically monitored by the RiverWatch West Team preceding or immediately following east site monitoring.

Table A.2 - LSDR Water Quality Monitoring Parameters

WQ Parameter	unit	Comments
Measured monthly at all sites:		
1. Temperature (Water Temp)	°C	Basic characteristic and WQ driver (see Table C.1)
2. pH	-	Degree of acidity (<7.0) or alkalinity (>7.0) (see Table C.3)
3. Specific Conductivity (SpC)	mS/cm	Measure of ionic content or dissolved solids (see Table C.2)
4. Dissolved Oxygen (DO)	mg/L	Good indicator of relative water quality (see Table C.4)
5. Percent of DO Saturation (DO%Sat)	%	Good indicator of general water quality (see Table C.5)
Sampled/tested monthly at selected sites: (typically 3-5 East & 2 West)		
6. Nitrate (NO_3-N)	mg/L	Basic nutrient for biological activity (see Table C-6)
7. Phosphate (PO_4-P)	mg/L	Key nutrient for biological activity; in excess, can be limiting
8. Turbidity	NTU	General indicator of amount of suspended/settleble solids
9. Barometric Pressure	mBars	Atomosphiric (air) pressure that along with water temperature affects dissolved oxygen levels/other readings.
Environmental Observations recorded at all sites:		
Atypical or notable conditions (scum, discoloration, odors, etc.), trash/debris, homeless encampments, biological activity (aquatic, avian, terrestrial), expansion of invasive species, erosion, scouring, other noteworthy comments re: watercourse, shoreline and adjacent environs. Special note as to invasive aquatic plant growth on water surface.		
General WQ Conditions observed at all sites: (numerical coding added in 2010)		
Weather Condition, Presence of Algae, Clarity, Color, Odor, Flow, Foam, Litter, Odor, Oil and Grease (O&G), e		
Parameters measured by others at selected sites		
10. Streamflow	cfs	USGS gauging stations at Fashion Valley and Mast Rd. near Santee (see Table B.1)
11. Coliform counts: (Escheria-coli, Enterococcus, Total Coliform bacteria)	MPN/ 100mL	SD CoastKeeper data taken at Fashion Valley Rd and Old Mission Historic Dam monitoring sites (see archives).

Team Leaders (1-2) and citizen volunteers (2-6) typically meet at an appointed location, organize field equipment, transportation, drive to sites, measure physical-chemical water quality parameters using a YSI Sonde device, note special conditions/observations, collect samples for subsequent nutrient testing, return to a designated field site or office, perform (NO_3 & PO_4) tests, store samples for subsequent analyses as needed, clean/check-in/store field equipment and, if time, further discuss findings, observations/results.

Table A-3 - San Diego RiverWatch Water Quality Monitoring Site Locations

Site #	Site Name	u/s mi.	Elev. ft.	Location	GIS Coordinates Lat.	Long.
LMV - Lower Reach W Mission Valley: I-5 extending 2.5 miles upstream to SR163 (incl. sites 1-3)						
1	Estuary E/W	2.96	6	between PCHwy & I-5 on encased sewer main	32.76131	-117.20373
2	River Gardens E/W	3.50	11	W of YMCA, d/s of trolly at sewer/ped X-ing	32.7623	-117.1944
3	Fashion Valley Mall W	5.08	22	below T&C foot bridge by FV Transit Center	32.76517	-117.16869
MMV - Middle Reach Mission Valley: SR163 extending 3.1 miles upstream to I-15 (incl. sites 4,5)						
4	FSDRIP at Mimi's	5.98	36	d/s on Mission Center Rd. bridge W	32.76986	-117.15482
5	Ward Rd Bridge	8.89	50	below trolly overpass at Camino. del Rio N	32.78024	-117.11029
UMV - Upper Reach E Mission Valley: I-15 extending 2.5 miles upstream to N end of Admiral Baker Field (Sites 6,7)						
6	Kaiser Ponds	9.46	56	E. of Mission SD de Acala at SD Mission Rd.	32.78406	-117.10419
7	Admiral Baker Field ABF - Zion/Riverdale	9.98	58	L - Lower (below Friars Rd bridge)	32.79038	-117.10314
		10.2	62	Z - Terminus of Zion Ave at Riverdale St.	32.79304	-117.09984
West (MV) - Mission Valley Section: I-5 to Admiral Baker Field E (incl. sites 1-7) [LMV,MMV,UMV]						
MG - Mission Gorge Reach: ABF-E extending 3.5 miles upstream to Old Mission Dam (incl. sites 8-10)						
8	Mission Trails @ Jackson D	13.82	159	SDCWA d/s of Suycott Crossing	32.82124	-117.06205
9T	Jackson/Birchcreek OF	13.86	198	San Marcos stormdrain by River Xing Trail	32.82268	-117.06224
10	Old Mission Dam W/E	15.65	265	Downstream side of Old Mission Dam	32.83977	-117.04332
Mid-Section (MG) -Mission Gorge Section: Quarry Area to Old Mission Dam (incl. sites 8-10)						
LSB - Lower Reach Santee Basin: W Hills Pkwy to Carlton Hills Bridge (incl sites 11,12T,15T)						
11	West Hills Pkwy	17.03	300	below West Hills Pkwy overpass at USGS sta.	32.83936	-117.02436
12T	Carlton Oaks Dr/Santee L	18.23	320	W Sycamore Ck/Santee Lakes @ Carlton Oaks	32.84431	-117.00635
15T	Forester Creek at Mission Gorge Rd (Rt 52/Prospect)	18.86	334	Primary tributary entering SDR just u/s of Site 11 past W.Hills Pkwy/Rt 52 at W end of CGC	32.83221	-116.98658
USB - Upper Reach Santee Basin: Carlton Hills Blvd extending 3 miles upstream to Riverford Rd (incl. sites 13W/E,14						
13W	Mast Park West	18.35	328	below Carlton Hills Blvd. Bridge	32.4691	-116.97333
13E	Mast Park East (Wallmart Ponds foot bridge)	18.50	330	Pedestrian bridge behind (N of) Walmart and trail at end of River Rock Ct.	32.84696	-116.97335
14W	Cottonwood Ave/RCP	19.84	340	N. of Chubb Ln. d/s of old RCP plant culvert	32.84434	-116.98947
14E	Magnolia Ave. bridge	19.9	342	Under Magnolia Bridge/west end of culverts	32.84424	-116.98950
East (SB) - Santee Basin Section: West Hills Parkway to Lakeside (Sites 11-15 above) [LSB+USB]						
LSDR - Lower San Diego River Watershed: SD Estuary extending 18.5 miles to Lakeside @ SR67 (Sites 1-15T above) [LMV+MMV+UMV+MG+LSB+USB]						

Data Management: Water quality data recorded by team volunteers are regularly managed via a three-step process.

1. *Raw (source) data* - each site, several of which have two monitoring locations (e.g. upstream/downstream of dam, riffle or crossing), date/time, measured WQ parameters, and non-quantifiable supporting observations and comments.

2. *Compiled (vetted/proofed) data* - provided on website w/date, site location, parameter value and additional observations of general interest.

3. *Processed (formatted/aggregated) data* - with statistical computations associated with LSDR sites, reaches, sections and tributaries for each WQ parameter of interest. Monthly and annual summary results presented on SDRPF website/RiverWatch Online Info. Center webpage.

Statistical Computations: Basic statistical values calculated from the data include

Mean – average of a series (sum of values divided by number of values)
Median – middle value of an ordered series (50% larger - 50% smaller)
Minimum – lowest or smallest value measured
Maximum – highest or greatest value measured
Range – Difference between maximum and minimum values
1st Quartile (Q1) – 25% of values smaller - 75% larger
2nd Quartile (Q2) – 50% of values larger - 50% smaller (same as median value)
3rd Quartile (Q3) – 75% of values smaller - 25% larger
Variance – sum of the squares of deviation from the mean or average value
Standard Deviation (SD) – square root of the Variance
Skew – third moment about the Mean divided by the Standard Deviation
Coefficient of Variance (CoV)– Variance divided by the Mean
Trendlines - Moving/running average values taken over 12-month period.

Riverwatch WQM Program Reporting: Monthly and annual reports regarding the quantifiable water quality data monitored and resultant metrics for the lower San Diego River watershed are prepared on a regular basis and posted to the SDRPF website (see **https://www.sandiegoriver.org** (click on <Our Work/Conserve/Healthy River, Healthy Communities/RiverWatch/Online Information Center>). Additionally the field data are compiled to a master database for both record keeping purposes and sharing with interested parties.

Appendix B
Lower San Diego River Hydrology and Water Quality

Streamflow or river discharge, is the volume of water moving past a designated location over a fixed period of time. It constitutes one of the primary drivers of changes in water quality. Often expressed as cubic feet per second (cfs) or million gallons per day (mgd), flow is the amount of water moving off a watershed or catchment area into the watercourse, as affected by weather (e.g., increasing during after rainstorms and decreasing during dry spells) and continually changing throughout each season. River flow rapidly decreases during summer months when rainfall is minimal, evaporation rates high and riparian vegetation extracts water from adjacent lands. August and September, the last two months of summer (and the water year), are commonly, but not always, months of lowest flow. A function of both volume and velocity, streamflow has a major impact on living organisms, riparian habitat, benthic conditions and overall river water quality. Velocity of flow, typically increasing as volume increases, determines the kinds and types of organisms that live in an aquatic system and also affects the amount of silt and sediment transported. Fast moving water typically contains much higher DO concentration levels than sluggish flows, as its better aerated, whereas eutrophication most often occurs in reaches with very low velocity.

LSDR average daily flow (ADF) values as recorded at two USGS gauging stations in the lower watershed are expressed for the 20-yr monitoring period (Oct 2004 - Sept 2024) and over the past 60 years (1965-2024) of record in **Tables B.1** through **B.3.** WY24 ADF values by season and associated 20-yr norms are presented in **Table B.1**. Long term total annual rainfall and average annual streamflow are expressed in **Table B.2. Table B.3** provides annnual rainfall and streamflow over the last two decades. Recent streamflow norms are roughly 20% less than long-term (60-yr) values in Mission Valley and 26% less for the Santee Basin. Average LSDR streamflow for WY24 is 47% greater than the current norm and 66% more than the long-term average.

In terms of total annual rainfall (TARF), as shown in **Table B.3**, WY05 has been the only "Very Wet" (TARF > 20") hydrologic year occuring over the last twenty annual cycles. On the other hand, there have been four water year's (07,13,14, and 21) that were all "Very Dry" (TARF <5"). WY24 total rainfall of 14 inches (350 mm) is 45% above the 20-yr norm of 9.54 inches (242 mm). The 20-yr ADF's for the East and West sections of the lower river are roughly 25% below long-range values while average daily flows for this year (WY24) were 60% above 20-yr norms and greater than the long-range (60-yr) values.

Monthly discharge data (min, max and average daily flow) for the two USGS gauging stations extending from Oct. 2004 through Sept. 2023 have been plotted on **Chart B.1.** Average daily flow (ADF) for the Lower San Diego River varies from less than 0.2 cfs (0.1 mgd) during the summer (dry) months to nearly 220 cfs (142 mgd) during several winter (wet) periods in the East (Santee Basin) and up to 390 cfs (252 mgd) in the West (Mission Valley) section. Running average ADF values, trending downward in WY12-WY14 began a slight increase in WY15, tempered by slight declines in WY18 and again in WY21&22. WY23&WY24 streamfow increased significantly to where running average values were/are considerably above norms.

Table B.1 - Lower SDR Average Daily Streamflow (WY24 and 20-yr Norms)

Location	West - Mission Valley		East - Santee Basin		LSDR [a]	
Season	WY24	*20yr Norm*	WY24	*20yr Norm*	WY24	*20yr Norm*
Fall (Oct-Nov) ADF, cfs	27.1	*15.2*	18.4	*9.8*	22.0	*12.0*
Winter (Dec-Mar) ADF, cfs	33.3	*74.7*	17.0	*40.5*	21.5	*54.8*
Spring (April-May) ADF, cfs	31.1	*22.2*	22.1	*12.8*	25.9	*16.8*
Summer (June-Sept) ADF, cfs	19.7	*3.3*	9.6	*1.9*	12.8	*2.5*
Annual ADF [b], cfs	49.1	*32.3*	30.9	*18.3*	38.5	*23.9*
(Annual ADF, mgd)	(26.4)	*(17.4)*	(16.6)	*(9.8)*	(20.7)	*(12.9)*
Wet Season (Nov-April)	89.9	*58.0*	55.5	*31.9*	69.8	*42.8*
Dry Season (May-Oct)	6.1	*5.4*	5.3	*3.2*	6.0	*3.8*
River Discharge, AFY [c]	29,568	*19,488*	18,592	*10,976*	23,184	*14,448*

a) Lower San Diego River average daily flow represents mean hydrologic conditions based on averaging the two USGS gauging station streamflow values.
(b) ADF values are expressed in cubic feet per second (cfs) and million gallons per day (mgd); 1 cfs = 0.583 mgd.
(c) Total average annual discharge expressed in acre-feet (1 mgd = 1120 AFY).

Table B.2 - Total Annual Rainfall (1914-2024) and Average Daily Streamflow

Type	# of Years	Percent of Total Years		Total Annual Rainfall [a]			Average Daily Streamflow, cfs		
				inches	mm	Avg.,	East [b]	West [c]	LSDR
Very Wet	3	3%	32%	>20″	>500	580/23″	68	113	92
Wet	11	10%		15-20	380-499	430/17″	48	81	66
Above Norm	22	20%		12-15	300-379	340/13″	26	44	35
Normal	40	36%	36%	8-12	200-299	250/10″	10	18	15
Dry	28	25%	32%	5-8	125-199	160/6″	7	12	10
Very Dry	8	7%		<5″	<125	100/4″	5	9	7
Total/AAvg	112	100%			254	9.98″	14	23	17

a) Total annual rainfall accumulated from 1 October through September 31 of a water year.
b) Santee Basin USGS Stream Gauge Station 11022480 below West Hills Pkwy Bridge near Mast Blvd. in Santee.
c) Mission Valley USGS Stream Gauge Station 11023000 at Fashion Valley Mall; incomplete data prior to 1968.

Monthly and seasonal average daily flow (lines) and annual rainfall (bars/columns) over the monitoring period for both stations are shown in **Chart B.2.** As wet season flows are several hundred times greater than dry-season summer-time flows, the flow values are expressed on log scale, whereas the rainfall scale is arithmetic. Seasonal flow patterns express range, variance and a strong positive correlation between log ADF values and monthly rainfall over the past 20 years of record.

Table B.3 - Annual Rainfall and Average Daily Flow (WY05-WY24)

(Type of Year)	Annual Rainfall		Variance [a]	ADF, cfs (mgd)			Variance [d]
	mm	inches		East [b]	West [c]	LSDR	
WY05 (Very Wet)	574	22.60	137%	50.9 (33)	100 (65)	71.5 (46)	207%
WY06 (Dry)	152	6.00	-37%	10.7 (7)	17.5 (11)	13.6 (9)	-42%
WY07 (Very Dry)	98	3.85	-60%	7.2 (5)	12.8 (8)	9.5 (6)	-59%
WY08 (Dry)	183	7.20	-24%	13.3 (9)	25.0 (16)	18.2 (12)	-22%
WY09 (below normal)	232	9.15	-4%	15.0 (10)	27.2 (18)	20.1 (13)	-14%
WY10 (above normal)	282	10.6	11%	25.1 (16)	42.5 (27)	32.4 (21)	39%
WY11 (above normal)	323	12.70	33%	43.3 (28)	61.9 (40)	46.9 (30)	102%
WY12 (Dry)	201	7.90	-17%	11.9 (8)	19.1 (12)	14.9 (10)	-36%
WY13 (Very Dry)	165	6.56	-31%	8.1 (5)	10.6 (7)	9.1 (6)	-61%
WY14 (Very Dry)	129	5.09	-47%	4.3 (3)	6.1 (4)	5.1 (3)	-78%
WY15 (above normal)	302	11.91	25%	7.1 (5)	15.2 (10)	10.5 (7)	-55%
WY16 (Dry)	208	8.20	-14%	12.2 (8)	20.4 (16)	15.6 (10)	-33%
WY17 (above normal)	323	12.53	31%	27.7 (18)	57.3 (37)	40.0 (26)	72%
WY18 (Very Dry)	85	3.24	-66%	5.5 (4)	7.2 (5)	5.9 (4)	-75%
WY19 (above normal)	327	12.89	34%	20.1 (13)	35.5 (24)	27.0 (17)	13%
WY20 (above normal)	345	13.60	43%	22.3 (14)	48.6(31)	33.1 (21)	46%
WY21 (Very Dry)	120	4.76	-50%	7.2 (5)	11.6 (9)	9.0 (6)	-62%
WY22 (Dry)	171	6.75	-29%	6.9 (5)	15.3(10)	10.3 (7)	-55%
WY23 (Wet)	399	15.72	65%	44.3 (27)	68.1 (39)	49.1 (32)	131%
WY24 (above normal)	**350**	**14.01**	**45%**	**29.5 (16)**	**47.5 (26)**	**33.6 (20)**	**58%**
20-yr Norm (05-24)	*242*	*9.54*	*0%*	*18.1 (6)*	*30.8 (20)*	*21.2(14)*	*0%*
60-yr AAD	*250*	*10.0*	*5%*	*21.8/(14)*	*36.7 (24)*	*28.4 (18)*	*22%*

a) Percent difference from 20-yr average total annual rainfall (9.54 in/yr); black-above, red-below average.
b) Santee Basin USGS Stream Gauge Station 00067556 near Mast Rd., Santee (West Hills Pkwy.)
c) USGS Stream Gauge Station 00459999 at Fashion Valley Mall; incomplete data prior to 1965.
d) Percent difference from 20-yr LSDR average daily streamflow..

Average daily streamflow (lines) and total annual rainfall (columns) are also expressed in **Chart B.3** on a water-year basis. Highest flows during the monitoring period at both gauging stations were recorded in WY05 (very wet year); while the lowest was in WY14 (very dry year) following three years of well below normal rainfall. (WY12-14). All years of well below low rainfall (WY's 07,14,18&21) also experienced below normal streamflow. The years of highest rainfall were all above normal in terms of streamflow. Both WYs23&24 experienced above normal rainfall and streamflow. The variances and patterns in rainfall and streamflow are consistant for both summer and winter results and for eastern and western sections of the river.

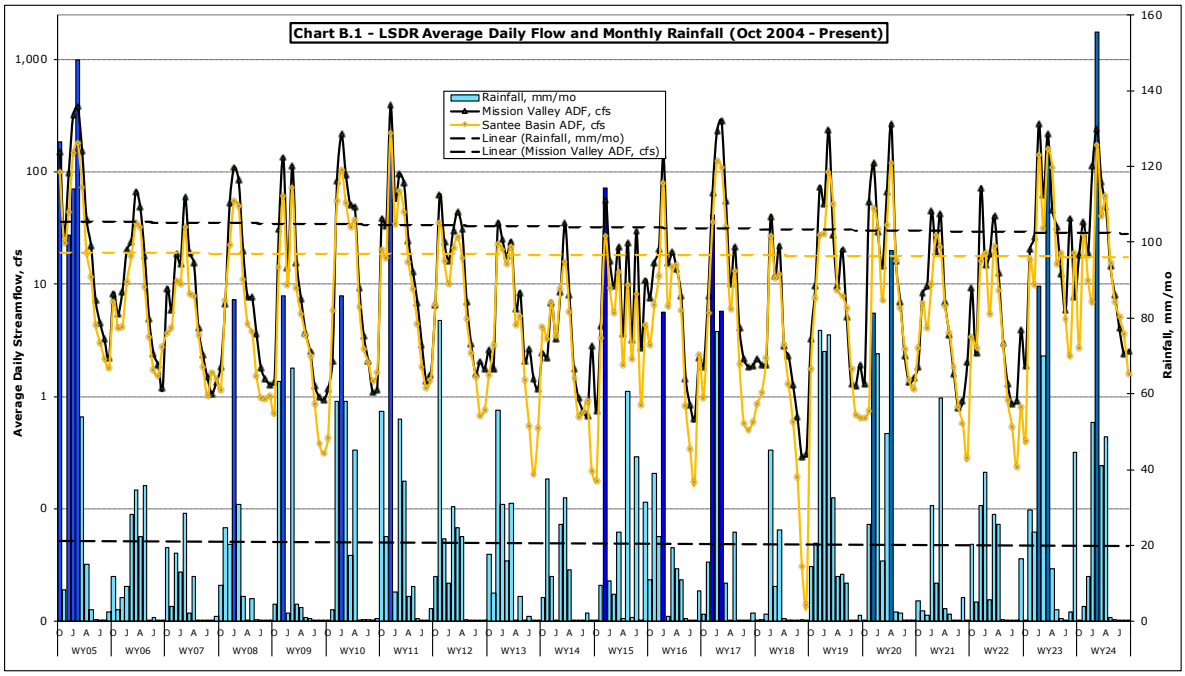
Chart B.1 - LSDR Average Daily Flow and Monthly Rainfall (Oct 2004 - Present)
Rainfall, mm/mo
Mission Valley ADF, cfs
Santee Basin ADF, cfs
Linear (Rainfall, mm/mo)
Linear (Mission Valley ADF, cfs)
Average Daily Streamflow, cfs
Rainfall, mm/mo
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
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WY23
WY24

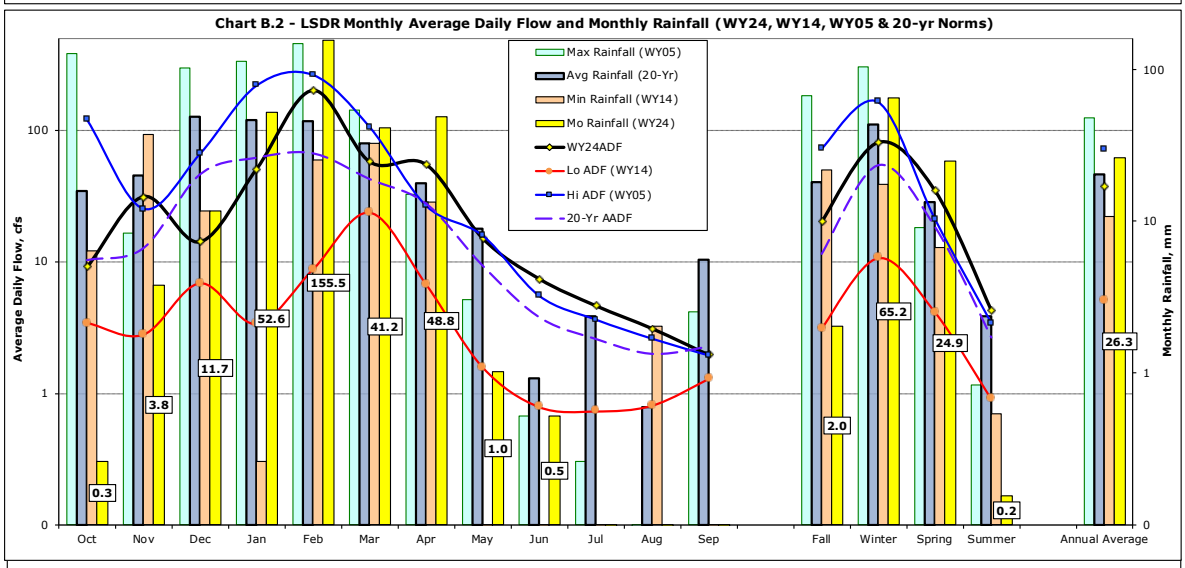
Chart B.2 - LSDR Monthly Average Daily Flow and Monthly Rainfall (WY24, WY14, WY05 & 20-yr Norms)
Max Rainfall (WY05)
Avg Rainfall (20-Yr)
Min Rainfall (WY14)
Mo Rainfall (WY24)
WY24ADF
Lo ADF (WY14)
Hi ADF (WY05)
20-Yr AADF
Average Daily Flow, cfs
Monthly Rainfall, mm
0.3
3.8
11.7
52.6
155.5
41.2
48.8
1.0
0.5
2.0
65.2
24.9
0.2
26.3
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Fall
Winter
Spring
Summer
Annual Average

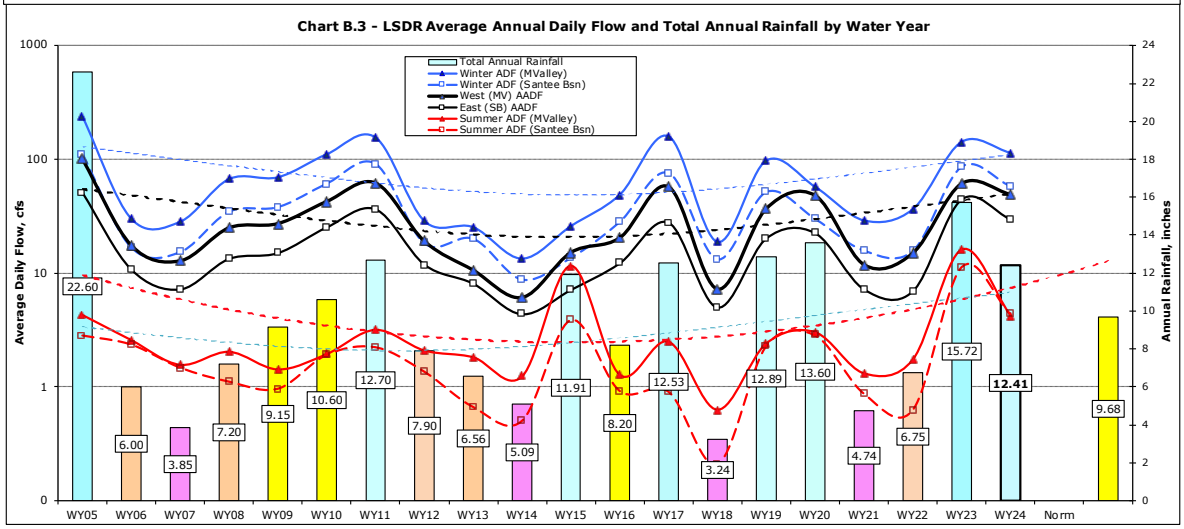
Chart B.3 - LSDR Average Annual Daily Flow and Total Annual Rainfall by Water Year
Total Annual Rainfall
Winter ADF (MValley)
Winter ADF (Santee Bsn)
West (MV) AADF
East (SB) AADF
Summer ADF (MValley)
Summer ADF (Santee Bsn)
Average Daily Flow, cfs
Annual Rainfall, inches
22.60
6.00
3.85
7.20
9.15
10.60
12.70
7.90
6.56
5.09
11.91
8.20
12.53
3.24
12.89
13.60
4.74
6.75
15.72
12.41
9.68
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22
WY23
WY24
Norm

Appendix C
Monthly WQM Site Data for WY24 and WY23

Appendix C contains 12 tables incorporating this year's (WY24) and last year's (WY23) RiverWatch water quality monitoring data by month (down) and site (across). Tables C.1(W&E) list water temperature in degrees Celsius, Tables C.2 (W&E) - Specific Conductance in mS/cm, C.3(W&E) - pH, C.4(W&E) - Dissolved Oxygen concentrations in mg/L, C.5(W&E) - DO as Percent of Saturation and C.6-Nutrient (NO3 & PO4) concentrations at selected west and eastern sites.

Table C.1(W) West Section Water Temperatures WY24/WY23 Data

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley			Mid Mission Valley		Upper Mission Valley	
Oct	21.1/21.8	22.6/19.3	22.4/19.9	22.8/19.6	20.1/18.9	21.2/19.6	21.4/20.4
Nov	16.3/13.4	14.7/13.1	14.5/13.5	14.0/13.1	14.0/11.9	13.6/12.5	13.5/12.4
Dec	13.4/11.3	13.3/11.2	13.3/11.2	13.0/11.1	12.1/10.2	12.9/10.4	12.5/10.7
Jan	11.7/11.8	11.6/11.8	11.3/11.5	11.4/11.7	10.3/11.4	10.9/11.7	10.5/11.4
Feb	17.3/14.1	14.1/12.6	14.2/12.2	13.8/12.2	14.8/11.3	14.0/11.6	14.7/11.1
Mar	18.1/15.0	18.0/14.9	17.9/15.0	17.5/14.5	17.3/14.6	17.1/14.6	16.6/14.5
Apr	19.4/18.0	19.3/17.9	19.2/17.8	19.3/17.7	18.3/17.0	18.5/17.7	18.3/17.2
May	20.6/20.5	20.5/20.1	21.9/20.1	20.5/20.0	19.8/19.9	20.5/20.5	20.5/19.9
Jun	22.2/23.6	22.2/23.5	22.2/23.5	22.3/24.2	21.5/21.5	22.3/22.4	22.3/22.6
Jul	24.4/25.5	25.2/25.5	25.3/24.9	26.2/25.5	23.4/23.3	25.3/24.1	24.0/22.7
Aug	25.7/25.2	26.0/24.4	25.4/24.9	26.2/25.5	23.0/21.8	25.2/23.6	23.8/22.6
Sept	24.5/22.1	25.0/22.7	25.3/23.0	26.7/23.1	21.4/21.2	24.4/22.5	22.7/22.1
AAvg	**19.5/18.5**	**19.4/18.1**	**19.4/18.1**	**19.5/18.2**	**18.0/16.9**	**18.8/17.6**	**18.4/17.3**
Norm	*(19.66)*	*(18.97)*	*(19.15)*	*(19.54)*	*(17.21)[d]*	*(18.27)*	*(18.10)*

Table C.1(M/E) Middle and East Section Water Temperature WY24/WY23 Data

Site	8	9T	10	11	15T	12T	13W	13E	14
Reach	Mission Gorge			Lower Santee Basin			Upper Santee Basin		
Oct	18.7/19.3	15.7/20.6	18.6/21.2	18.7/20.0	19.4/20.4	21.5/21.9	17.2/19.8	19.1/21.2	22.0/22.5
Nov	14.4/11.4	14.8/8.3	14.3/11.2	14.2/12.0	17.0/11.1	15.0/12.9	14.3/11.1	16.6/12.8	14.7/14.8
Dec	9.6/10.0	8.0/8.5	9.5/9.8	10.5/11.3	10.6/10.2	11.4/11.2	9.8/10.1	12.0/9.3	12.8/11.9
Jan	8.9/11.9	7.3/13.0	9.0/11.8	9.6/11.9	11.5/11.4	10.6/11.6	5.2/11.8	11.0/10.3	11.7/12.0
Feb	12.9/9.8	13.4/8.6	12.8/9.9	12.8/9.9	13.0/11.1	12.8/10.4	12.9/9.7	14.5/10.6	13.4/12.2
Mar	15.7/13.9	13.2/13.8	15.9/13.9	15.3/13.5	17.2/13.1	16.4/12.7	14.6/14.1	17.8/15.6	15.4/15.0
Apr	17.5/15.4	18.4/13.5	17.9/15.6	17.4/15.3	17.2/14.4	18.6/14.4	17.4/13.9	17.5/16.6	17.0/17.6
May	19.1/18.5	16.6/16.2	19.0/18.6	18.4/18.8	20.0/19.1	17.4/19.6	18.5/19.6	19.6/18.1	21.7/21.8
Jun	21.3/20.1	18.4/18.2	22.2/19.8	19.9/18.7	22.7/21.3	18.3/19.5	20.0/18.5	21.9/20.5	24.9/22.9
Jul	22.9/21.9	19.8/17.9	23.3/22.7	22.3/20.9	23.6/22.4	-	21.3/19.5	23.0/22.5	26.5/25.6
Aug	23.6/23.1	20.9/20.5	23.8/22.7	23.1/21.8	24.0/22.7	-	22.4/-	23.7/23.1	27.2/25.6
Sep	22.3/21.9	19.3/19.1	21.9/21.4	21.1/20.9	21.9/21.6	-	21.0/20.2	22.6/22.1	26.0/21.6
AAvg	**17.2**/16.4	**15.5**/14.9	**17.4**/16.6	**16.9**/16.3	18.2/16.6	15.8/14.9	16.2/15.3	18.3/16.9	**19.4**/18.6
Norm	*(17.09)*	*(15.62)* [e]	*(17.53)*	*(16.67)*	*(17.80)*	*(17.35)*	*(15.78)*	*(18.19)*	*(17.87)*

a) All values are expressed in oC.
b) Annual average water year values and 20-yr norms are based on unweighted averaging of monthly data (Oct-Sept); water temps >20 oC are shown in red, and <15 oC in blue.
c) Forester Creek discharges within the Lower Santee Basin below Carlton Hills Golfcourse just upstream of SR52.
d) Site 5 (Mast Rd Bridge) monthly water temperatures are typically several degrees less than other west section readings due to groundwater exfiltration (springs) located just upstream.
e) Site 9T (Birchcreek Outfall) temperture values are typically lower than at other sites as the water source is nearby groundwater seeps draining a small upstream catchment.

Table C.2(W) West Section WY24/WY23 Specific Conductance Data

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	7.56/18.73	2.92/3.22	2.77/ /3.01	2.63/3.07	2.74/3.69	2.54/4.43	2.59/2.29
Nov [c]	1.45/2.85	1.28/1.93	1.25/1.73	1.21/1.82	1.07/2.08	1.03/1.59	0.99/1.86
Dec	19.45/2.45	2.01/2.35	1.99/2.26	2.00/2.15	1.89/1.89	1.77/1.53	1.77/1.49
Jan	10.95/1.60	1.86/1.53	1.77/1.58	1.85/1.66	1.63/1.58	1.54/1.52	1.51/1.59
Feb	5.53/19.75	1.10/2.94	1.07/2.95	1.09/2.87	0.99/2.34	1.00/2.26	1.04/2.31
Mar	1.80/0.86	1.62/0.82	1.54/0.81	1.50/0.84	1.35/0.78	1.35/0.79	1.40/0.82
Apr	1.60/1.94	1.58/1.89	1.49/1.82	1.51/1.78	1.40/1.69	1.39/1.68	1.37/1.66
May	2.20/2.72	2.08/2.48	2.03/2.39	1.97/2.27	1.87/2.09	1.76/2.07	1.74/1.91
Jun	3.34/3.19	2.42/2.46	2.32/2.34	2.26/2.28	2.18/2.36	2.05/2.06	2.01/2.14
Jul	5.72/8.49	2.83/2.92	2.71/2.77	2.66/2.75	2.58/2.87	2.43/2.49	2.34/2.55
Aug	9.97/15.57	3.32/3.30	3.16/3.13	3.04/2.95	3.05/3.28	2.94/2.96	2.64/2.89
Sep	6.06/15.53	3.41/2.44	3.33/2.36	3.31/2.28	3.26/2.46	3.25/1.97	3.63/2.17
AAvg	**6.30/7.81**	**2.20/2.36**	**2.12/2.26**	**2.09/2.23**	**2.00/2.26**	**1.92/2.11**	**1.92/1.97**
Norm	*(9.255)*	*(2.634)*	*(2.520)*	*(2.432)*	*(2.571)*	*(2.551)*	*(2.412)*

a) All values expressed in milli-Siemens/cm; SpC values >4.0 mS/cm are shown in blue, values < 2.0 mS/cm are in green.
b) Average annual WY23/24 SpC values are less than 20-yr norms at all west section sites (1-7).

Table C.2(M-E) Middle and East Section WY24/WY23 Specific Conductance Data

Site	8	9T	10	11	12T	13E	14	15T	13W
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]	LSB
Oct	2.20/3.66	2.83/5.54	2.20/3.24	2.08/2.98	1.71/2.30	1.09/2.63	0.83/2.06	2.20/2.84	0.83/2.06
Nov	0.87/2.77	2.31/5.54	0.87/2.79	0.86/2.83	1.78/3.0	0.74//2.41	0.55/2.07	1.56/2.54	0.55/2.08
Dec	1.64/1.92	4.40/4.51	1.64/2.10	1.62/2.27	1.73/2.28	1.10/1.40	0.91/1.96	2.61/2.48	0.91/1.96
Jan	1.13/1.34	3.46/2.63	1.52/1.31	1.38/1.25	1.47//0.84	1.16/1.54	1.09/0.76	0.97/2.16	1.09/0.76
Feb	0.98/2.20	2.30/5.43	1.01/2.28	1.03/2.44	0.58/1.16	0.86/1.21	0.73/1.11	2.50/4.00	0.73/1.11
Mar	1.26 /0.60	3.63/1.52	1.30/0.63	1.36/0.71	0.73/0.24	1.19/0.73	0.73/0.65	2.45/0.23	0.73/0.65
Apr	1.28/1.58	3.67/3.02	1.31/1.58	1.38/1.61	0.76//0.96	1.15/1.20	1.13/1.10	1.61/2.62	1.13/1.10
May	1.56/1.80	3.90/3.18	1.59/1.70	1.65/1.64	0.56/0.98	1.43/1.77	1.34/1.44	2.55/2.75	1.34/1.44
Jun	1.79/1.76	3.90/3.07	1.81/1.78	1.83/1.80	0.58/1.09	1.56/1.29	1.45/0.96	2.56/2.74	1.45/0.96
Jul	2.00/2.21	4.28/2.94	1.32/2.25	2.08/2.32	dry	1.71/1.54	1.49/1.19	2.66//2.95	1.49/1.19
Aug	1.44/2.47	4.71/3.25	1.82/2.49	2.27/2.58	dry	1.86/1.87	1.66/1.35	2.80/2.84	1.66/1.35
Sep	2.37/2.06	4.72/2.99	2.40/2.10	2.34/2.15	dry	1.91/0.96	1.67/0.70	2.86/2.66	1.67/0.70
AAvg	**1.54**/2.03	**3.68**/3.64	**1.56**/2.02	**1.66**/2.05	**1.10**/1.49	**1.31**/1.54	**1.13**/1.28	**2.25**/2.62	**1.13**/1.24
Norm	*(2.261)*	*(4.614)*	*(2.201)*	*(2.198)*	*(1.582)*	*(1.861)*	*(1.492)*	*(2.645)*	*(1.572)*

a) All values expressed in milli-Siemens/cm; values < 2.0 mS/cm are in green: > 4.0 mS/cm are in blue.
b) WY24/WY23 annual averages and 20-yr norms (in italics) are based on averaging of monthly data (Oct-Sept).
c) Forester Creek discharges within the Lower Santee Basin enter just upstream from W Hills Pkwy Bridge.
d) Average WY24 SpC values are less than last year's (WY23) values and 20-yr norms at all Mid and East sites (8-15T).

Table C.3(W) West Section WY24/WY23 pH Data

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	7.62/7.51	8.00/7.42	7.44/7.41	7.99/7.37	7.56/7.56	7.46/7.56	7.69/7.50
Nov	7.67/7.60	7.62/7.58	7.67/7.68	7.61/7.62	7.65/7.65	7.60/7.64	7.74/7.66
Dec	7.49/7.58	7.40/7.59	7.31/7.59	7.40/7.58	7.31/7.50	7.22/7.48	7.63/7.51
Jan	7.85/7.65	7.94/7.62	8.03/7.72	7.85/7.69	7.94/7.65	7.76/7.62	7.77/7.62
Feb	7.81/7.65	7.66/7.74	7.79/7.80	7.72/7.77	7.87/7.70	7.73/7.62	7.83/7.73
Mar	7.90/7.64	7.89/7.59	7.93/7.87	7 .80/7.70	7.89/7.76	7.78/7.72	7.91/7.82
Apr	7.81/7.74	7.79/7.66	7.93/7.70	8.10/7.66	8.00/7.67	8.12/7.65	8.32/7.84
May	7.75/7.76	7.75/7.68	7.72/7.67	7.70/7.71	7.70/7.77	7.64/7.66	7.81/7.87
Jun	7.86/7.92	7.88/7.81	7.80/7.80	7.87/7.81	7.78/7.53	7.73/7.57	7.86/7.74
Jul	7.85/7.68	7.67/7.63	7.71/7.69	7.84/7.76	7.65/7.45	7.54/7.39	7.62/7.36
Aug	8.02/7.66	7.67/7.62	7.95/7.68	7.93/7.71	7.80/7.47	7.63/7.46	7.47/7.19
Sep	7.98/7.43	7.64/7.57	7.73/7.61	7.90/7.54	7.59/7.43	7.59/7.33	7.20/7.37
AAvg	**7.80/7.65**	**7.74/7.63**	**7.75/7.69**	**7.81/7.66**	**7.73/7.60**	**7.65/7.56**	**7.74/7.60**
Norm	*(7.75)*	*(7.68)*	*(7.75)*	*(7.78)*	*(7.63)*	*(7.61)*	*(7.58)*

a) All pH values are unit-less; values of 8.0 or greater are listed in red and 7.5 or below in green.
b) WY24& WY23 pH values and 20-yr norms are based on averaging of monthly data (Oct-Sept).

Table C.3(M-E) Middle and East Section WY24/WY23 pH Data

Site	8	9T	10	11	12T	13E	14	15T	13W
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]	LSB
Oct	8.00/7.19	8.37/8.11	7.90/7.54	7.56/7.63	7.73/7.16	7.42/7.58	7.76/7.68	7.79/7.74	7.42/7.58
Nov	8.01/8.04	8.29/8.38	7.74/7.64	7.62/7.69	7.57/8.09	7.41/7.79	7.67/7.80	7.66/8.07	7.41/7.79
Dec	8.01/8.06	8.21/8.33	7.58/7.90	7.67/7.69	7.40/7.76	7.40/7.73	7.58/7.89	7.53/7.86	7.40/7.73
Jan	8.21/7.89	8.30/8.39	7.76/7.59	7.67/7.55	8.03/7.77	7.94/7.27	7.49/7.78	7.76/8.05	7.94/7.27
Feb	8.21/8.09	8.55/8.48	7.66/7.85	7.69/7.74	7.99/7.94	7.57/7.65	7.59/7.79	8.27/8.31	7.57/7.65
Mar	8.31/7.93	8.30/8.34	7.70/7.62	7.74/7.55	7.77/7.77	7.60/7.46	8.67/8.15	8.13/8.22	7.60/7.46
Apr	8.44/8.18	8.35/8.41	7.71/7.64	7.73/7.70	7.76/7.70	7.48/7.65	7.10/7.79	8.32/8.20	7.48/7.65
May	8.26/7.93	8.21/8.26	7.77/7.74	7.78/7.75	7.63/7.93	7.59/7.58	7.87/7.88	8.03/8.04	7.59/7.58
Jun	8.30/8.18	8.26/8.21	8.02/7.84	7.84/7.68	7.68/7.70	7.62/7.38	8.11/7.64	8.14/8.09	7.62/7.38
Jul	8.08/7.72	8.20/8.19	7.78/7.64	7.76/7.57	dry	7.54/7.22	8.07/7.70	7.97/7.76	7.54/7.22
Aug	7.94/7.58	8.21/8.29	7.92/7.55	7.77/7.45	dry	7.57/7.31	7.93/7.81	7.74/7.82	7.57/-
Sep	7.59/7.90	8.10/8.56	7.61/7.68	7.68/7.53	dry	7.68/8.31	8.00/7.60	7.78/7.98	7.68/-
AAvg	**8.11/7.89**	**8.27/8.33**	**7.76/7.69**	**7.71/7.63**	**7.73/7.76**	**7.57/7.52**	**7.82/7.79**	**7.93/8.01**	**7.57/7.52**
Norm	*(7.72)*	*(7.93)*	*(7.82)*	*(7.59)*	*(7.92)*	*(7.64)*	*(7.84)*	*(8.03)*	*(7.62)*

a) All pH values are unit-less; monthly values of 8.0 or above are in red, while those at 7.5 or below are in green.
b) WY24/WY23 and 20-yr norms are based on averaging monthly results (Oct-Sept).
c) Forester Creek discharges within the Lower Santee Basin section of the river just upstream of Site 11 under the W Hills Pkwy. Bridge.

Table C.4(W) West Section WY24/WY23 Dissolved Oxygen Concentration Data

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	4.90/3.08	5.07/1.06	4.54/ /0.39	6.39/0.29	4.06/2.54	1.27/0.27	4.36/4.19
Nov	4.54/4.21	6.48/2.60	6.07/1.43	6.72/3.50	6.62/5.07	6.37/1.62	7.44/6.17
Dec	4.90/5.93	6.37/4.94	7.55/3.36	6.22/4.73	7.61/6.38	6.34/2.76	6.42/5.99
Jan	6.84/7.39	8.17/7.16	7.36/7.20	7.53/7.75	7.45/7.97	6.71/7.65	9.68/9.25
Feb	6.44/8.26	7.94/9.53	7.73/9.93	7.88/8.66	7.80/9.02	8.37/6.61	8.46/8.67
Mar	6.50/8.49	6.72/7.54	6.56/7.45	6.91/7.72	6.79/8.21	6.17/8.16	7.64/8.87
Apr	7.40/7.35	6.98/6.97	7.09/5.64	7.77/6.60	6.77/6.48	7.28/5.90	7.36/6.38
May	7.27/5.50	5.35/4.70	4.34/4.90	5.34/4.54	4.16/5.55	3.22/4.34	5.74/5.91
Jun	5.47/5.89	6.53/6.23	4.17/3.84	5.74/5.92	4.92/2.83	4.56/1.44	5.57/5.24
Jul	6.79/4.34	5.84/4.33	3.61/2.35	4.49/4.44	4.20/2.68	1.02/0.72	3.17/2.08
Aug	7.88/5.24	5.29/3.70	3.15/2.09	4.19/4.45	3.57/2.64	0.37/1.21	2.41/2.38
Sep	9.33/3.52	3.40/3.31	0.85/1.79	3.71/2.85	3.60/2.20	0.37/0.88	1.80/2.37
AAvg	**6.52/5.77**	**6.18/5.17**	**5.25/4.20**	**6.07/5.12**	**5.63/5.13**	**4.33/3.46**	**5.84/5.62**
Norm	*(6.12)*	*(4.52)*	*(4.56)*	*(5.97)*	*(4.84)*	*(3.52)*	*(5.17)*

d) All values expressed in milligrams/liter and (Percent of Saturation); WY23 and 19-yr averages less than 5 mg/L (DO depletion threshold) shown in red, less than 2.5 mg/L (hypoxic level) cells highlighted in yellow and <1.0 mg/L (exaerobic zone) in pink. DO levels of 7.0 mg/L or greater are shown in blue.

Table C.4(ME) Mid and East Section WY24/23 DO Concentration Data

Site	8	9T	10	11	12T	13E	14	15T	13W
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]	LSB
Oct	5.51/1.05	8.20/5.48	4.25/0.66	4.48/0.66	4.74/2.88	1.33/0.37	3.79/1.59	4.23/4.07	2.32/1.93
Nov	8.64/10.4	8.74/11.9	6.07/9.14	6.73/9.14	6.44/6.99	6.16/1.21	6.41/2.14	3.93/6.92	5.60/4.36
Dec	9.10/9.77	11.5/10.3	7.99/7.86	7.39/7.86	5.65/6.49	3.01/2.08	6.14/4.53	8.50/7.29	3.50/5.59
Jan	11.4/11.7	13.7/11.1	8.36/7.36	9.26/7.36	9.32/8.06	3.63/3.56	4.71/5.96	7.99/9.46	8.61/4.22
Feb	8.97/13.3	8.58/13.9	7.77/10.3	8.89/10.3	8.70/9.37	8.24/3.56	6.42/8.01	8.43/12.2	7.70/6.54
Mar	9.03/9.95	10.7/10.3	7.47/8.06	7.02/8.06	6.73/9.61	1.54/3.8	11.3/5.9	7.48/9.18	6.57/3.82
Apr	8.74/10.3	8.40/11.4	5.95/6.71	5.90/6.70	5.96/6.56	2.45/2.14	5.78/7.55	7.12/9.15	5.12/1.93
May	7.77/6.83	10.3/8.48	5.89/5.06	6.35/5.06	6.10/9.63	1.01/1.55	3.86/6.21	6.07/4.90	4.87/2.57
Jun	7.09/8.22	9.61/7.86	6.44/7.32	6.20/7.32	6.42/6.62	0.76/2.11	5.84/4.11	7.08/7.61	3.11/2.04
Jul	6.96/6.21	7.67/9.33	5.48/5.31	5.82/5.31	dry	1.03/.04	4.13/1.95	5.88/5.30	2.37/1.94
Aug	6.88/3.47	8.94/5.88	6.33/3.53	5.53/3.53	dry	1.01/0.44	2.87/1.17	6.10/4.63	1.65/dry
Sep	4.18/5.54	9.27/8.55	2.43/4.81	5.13/4.81	dry	1.09/1.15	3.47/2.37	5.84/4.73	1.25/2.26
WY24/23	**7.86/8.06**	**9.62/9.55**	**6.20/6.34**	**6.56/6.41**	**6.67/7.36**	**2.61/1.92**	**5.39/4.29**	**6.55/7.12**	**4.39/3.38**
Norm	*(7.27)*	*(9.28)*	*(6.86)*	*(6.13)*	*(7.07)*	*(2.72)*	*(3.65)*	*(7.21)*	*(3.77)*

a) *All values expressed in milligrams/liter; values less than 5 mg/L (DO depletion threshold) are expressed in red,< 2.5 mg/L (hypoxic level) cells highlighted in yellow and <1 mg/L (exaerobic zone) in pink. DO levels of 7.0 mg/L or greater are shown in blue.*

b) Tributary discharges within the Lower Santee Basin reach enter the main stream below the west end of Carlton Oaks Golf Course just upstream of SR 67.

Table C.5(W) West Section WY24/WY23 DO Percent Saturation Data

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	55/35	61/12	53/4	75/3	45/29	14/2	50/47
Nov	47/41	66/25	60/14	66/34	65/47	61/15	72/58
Dec	47/55	61/46	74/31	60/44	72/57	61/25	61/54
Jan	63/68	76/67	68/67	69/72	67/74	61/71	87/85
Feb	67/80	78/91	77/94	78/82	78/83	82/62	84/80
Mar	70/87	72/75	70/75	73/76	72/81	64/81	79/88
Apr	82/78	76/77	78/60	85/69	73/68	79/62	79/67
May	82/62	60/53	49/59	56/51	46/61	36/49	64/65
Jun	63/70	77/74	49/46	68/71	57/32	54/17	65/61
Jul	78/53	70/50	44/29	57/55	49/31	12/9	38/24
Aug	97/63	63/45	39/25	52/55	42/31	5/14	29/28
Sept	113/40	42/39	11/21	47/34	41/25	4/10	21/28
WY24/23	**72/61**	**67/54**	**56/44**	**66/54**	**59/52**	**44/35**	**61/57**
Norm	*(66.9)*	*(47.7)*	*(48.1)*	*(64.2)*	*(49.5)*	*(36.0)*	*(53.4)*

a) All values expressed as percent of saturation; WY23 results are listed in bold red; otherwise in bold black.
b) WYs 24/23 values < DO depletion threshold (55%) are expressed in red ,< 25% (hypoxic level) cells highlighted in yellow and <10% (exaerobic zone) pink. DO% Sat values of 70% or greater are shown in blue cells.
c) WY24/23 annual average and 20-yr norms are based on averaging of monthly data (Oct-Sept).

Table C.5(M-E) Mid and East Section WY24/WY23 DO Percent Saturation Data

Site	8	9T	10	11	12T	13W	13E	14	15T
Reach	Mission Gorge			Lower Santee Basin			Upper Santee Basin		LSB [c]
Oct	60/12	84/61	46/8	49/34	54/33	24/21	15/4	43/19	47/46
Nov	85/96	82/103	60/85	66/70	64/66	55/41	60/11	67/22	42/65
Dec	81/87	98/90	74/70	68/71	53/60	47/51	28/18	59/42	79/65
Jan	99/109	115/106	73/68	82/65	85/75	70/39	34/34	44/56	75/88
Feb	86/119	83/122	76/91	85/85	82/84	70/58	82/32	67/75	81/112
Mar	92/97	103/101	77/78	71/76	69/91	66/38	16/36	117/59	79/89
Apr	93/100	89/110	63/68	63/68	64/66	55/19	27/23	62/80	76/92
May	85/74	107/87	64/55	68/65	64/106	43/28	12/17	44/74	67/55
Jun	80/92	104/85	76/81	69/65	64/73	35/22	9/24	68/48	83/98
Jul	81/72	85/100	66/61	67/68	-	27/21	13/12	52/24	70/62
Aug	82/41	101/66	76/42	66/46	-	19/-	12/5	37/15	73/54
Sep	48/64	102/94	28/55	58/65	-	14/28	13/14	43/28	67/54
WY24/23	**81/80**	**96/94**	**65/64**	**68/65**	**67/73**	**45/33**	**27/19**	**59/45**	**70/73**
Norm	*(73.9)*	*(93.6)*	*(70.9)*	*(60.5)*	*(72.3)*	*(38.0)*	*(28.1)*	*(37.0)*	*(70.0)*

a) All values expressed as percent of saturation; WY24 values < 55% (DO depletion threshold) are expressed in red; < 25% (hypoxic level) cells highlighted in yellow and <10% (exaerobic zone) in dark yellow.. DO% Sat values of 70% or greater are shown in blue.

b) All WY24/WY23 annual averages (bold print) are based on averaging of monthly data (Oct-Sept).

c) Forester Ck (15T) discharges within the Lower Santee Basin reach just u/s of Site 11.

Table C.6 WY24 Nutrient (NO_3 and PO_4) Data

Site# Name	2 YMCA	7 ABF	11 WHP	13W MPW	14 MAG AV.	15T FSTR CK
Section	Mission Valley Sites		Santee Basin (Eastern Sites)			
Oct	0.1/0.1	0.2/0.2	0.1/0.5	0.0/0.4	0.0/0.5	0.6/0.3
Nov				0.3/0.4		0.8/0.1
Dec	0.0/0.3			0.0/0.4	>3.4/0.0	
Jan				0.0/1.0		0.6/0.3
Feb				0.2/0.5		>3.4/0.1
Mar	0.0/0.1			0.1/0.4		>3.4/0.2
Apr						
May						
Jun	0.0/0.6		0.0/0.0	0.0/0.4		
Jul				0.0/0.4		2.8/0.0
Aug	0.0/0.6			0.1/0.4		2.7/0.1
Sept	0.0/0.3	0.0/0.1		0.0/0.3	0.0/0.2	
Max.	0.1/0.6	0.2/0.2	0.1/0.5	0.3/1.0	>3.4/0.5	>3.4/0.3

a) Nutrient values for nitrate (NO_3, as nitrogen) are in black and phosphate (PO_4, as phosphrous) in red; both are expressed in mg/L. Comperable site values have been meassured in previous years. The natural background level of nitrate in surface water is typically less than 1.0 mg/L while natural levels of phosphate usually range from 0.005 to 0.05 mg/L.

Appendix D
Water Quality Index Values

The Lower San Diego River (LSDR) Water Quality Index (WQI) has been developed to present a simple and concise expression of monitored physical-chemical and bacteriological water quality data compiled by the SDRPF RiverWatch Team on a monthly basis. The index is intended to aid in assessment of the lower river, primarily for multiple non-body contact recreational uses and overall environmental enhancement within the watershed. As designed, the metrics constitute a means to compare averages, variances and trends in normalized values over time (temporally) and by relative location (spatially) within the watershed. The index allows individuals to interpret large amounts of aggregated data and relate overall water quality variations to changes, be they from natural causes or anthropogenic impairments. The WQI has been used to identify basic water quality trends over the past 20 years of monitoring and single out potential problem areas within the lower watershed. Such patterns and specific locations can then screened and evaluated in greater detail through direct observation of pertinent site-specific data by various public agencies and organizations entrusted with protection and enhancement of river water quality. Used in this manner, the index provides a further metric for evaluating effectiveness of many of the San Diego River improvement programs and may also be of support to agencies and organizations responsible in reformulating priorities or updating specific policies.

Running average WQI values from WY05 through WY24 are expressed by river section and reach on **Charts D.1 and D.2**, respectively. The overall variance in *temporal* WQI values and streamflow are expressed on **Chart D.3**. The variances in *spacial* index values for all lower river monitoring sites are presented on **Chart D.4**.

Chart D.1 provides the range (max.-green, min.-red) in monthly values, the running averages by river section as well as monthly streamflow (blue bars) over the 20-yr period (WY05-WY24) of water quality monitoring. The positive correlation in seasonal fluctuation between streamflow and water quality values is apparent. Poorer water quality at all sections occur during years of below average discharge. The overall change in the index over time are shown as a dashed lines. General declines experienced during the first decade were countered by recovery during the second. The current running average index of 40 is 21% above the 20-yr norm of 33. The highest index of 41 in WY05 was 24% above norm. The lowest running average index value of 21 occuring in Nov. ’04 was 37% below the current norm.

Chart D.2 presents overall (LSDR) monthly running avearge WQI values (heavy black lines) over the past 20 years. Seasonal patterns expressed in monthly results and trends described by running averages in values are apparent for each reach of the river. The water quality fluctuations over time in individual reaches, sections and the overall LSDR flow-weaighted values expressed on both a running average and seasonal cycle basis can be observed. The Upper Santee Basin (USB) reach (red line, sites 13&14) have presented the lowest index values since March of 2010. The Mission Gorge portion (blue line, mid-section of the lower river watershed) consistently presents the highest values. As shown on both charts, the greatest rate of decline in lower river water quality occured over a 36 month period (WY12 through early WY15) during well-below normal streamflow brought about by prolonged drought conditions.

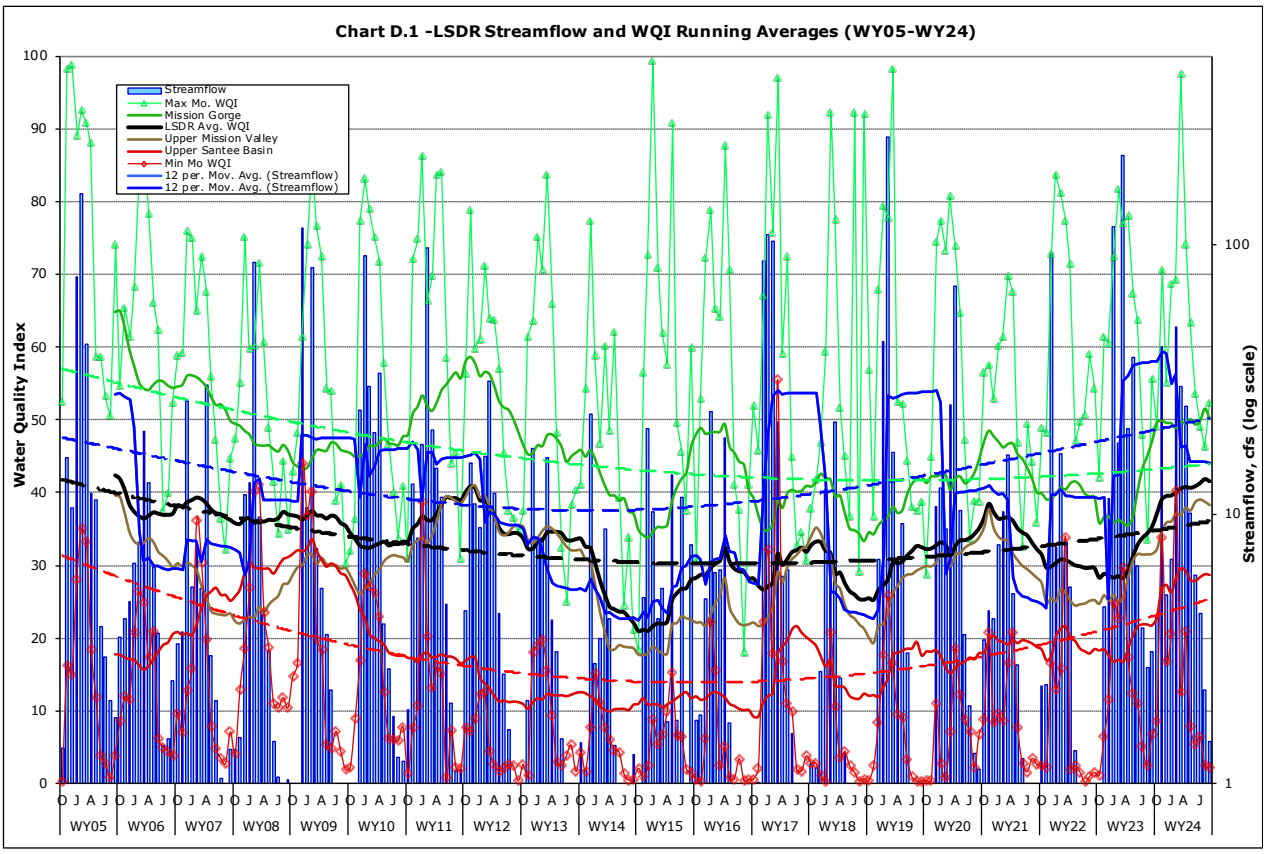
Chart D.1 -LSDR Streamflow and WQI Running Averages (WY05-WY24)
Streamflow
Max Mo. WQI
Mission Gorge
LSDR Avg. WQI
Upper Mission Valley
Upper Santee Basin
Min Mo WQI
12 per. Mov. Avg. (Streamflow)
12 per. Mov. Avg. (Streamflow)
Water Quality Index
Streamflow, cfs (log scale)
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
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WY19
WY20
WY21
WY22
WY23
WY24

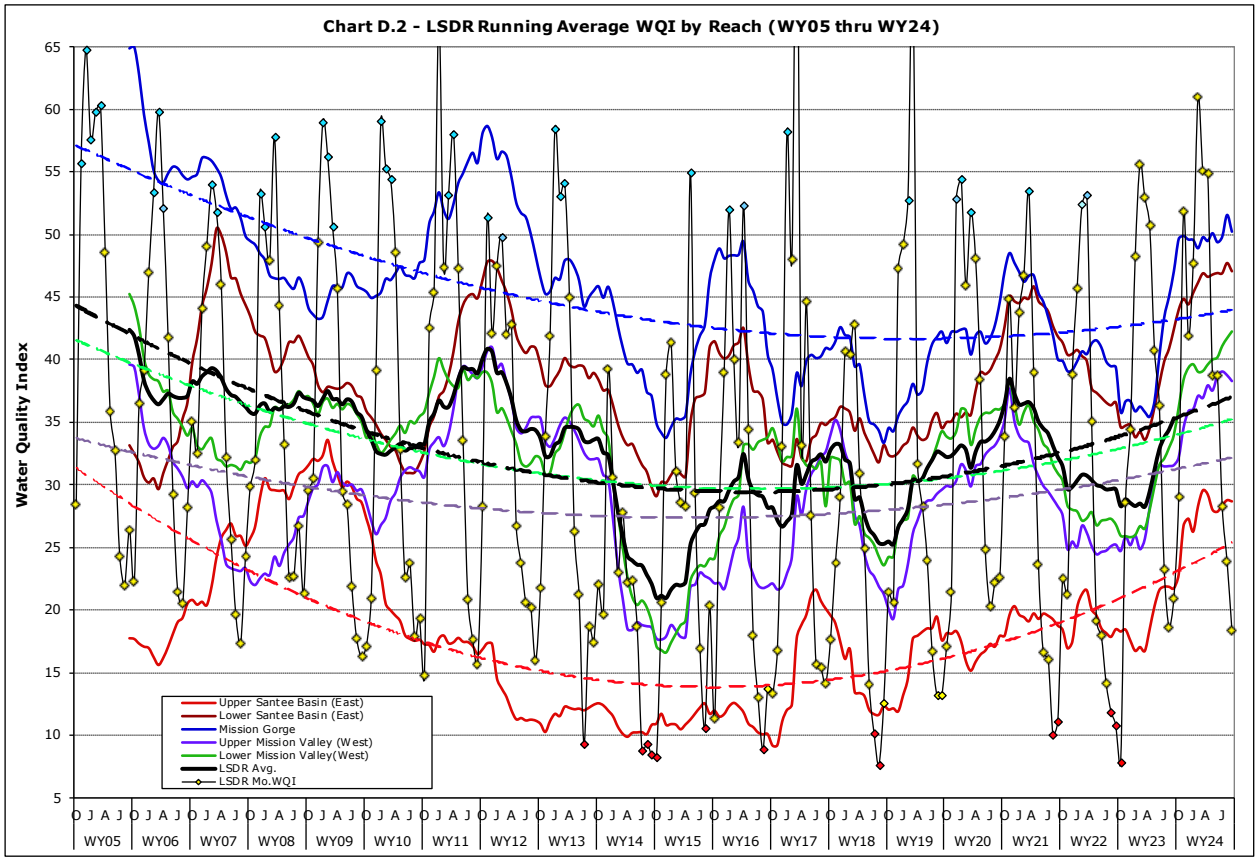


Chart D.2 - LSDR Running Average WQI by Reach (WY05 thru WY24)
Upper Santee Basin (East)
Lower Santee Basin (East)
Mission Gorge
Upper Mission Valley (West)
Lower Mission Valley(West)
LSDR Avg.
LSDR Mo.WQI
Water Quality Index
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22
WY23
WY24

Chart D.3 presents a *temporal* summary of variances in the water quality index values profiled on a monthly, seasonal and average annual water year basis for the five reaches of the river and overall. Variances in the index can be visually compared to changes in 3-day streamflow (blue bars) expressed on the same timelines. Positive correlations are evident, i.e., increased average daily flow and higher water quality values. Low-flows extending throughout the summer and early fall months result in significantly poorer water quality. In year's of above average dry-weather (base) flows, improvements in index values for each of the five reaches and overall (heavy black line) of the lower river system occur. Irrespective of water year, the Mission Gorge reach (blue curve) has presented the highest WQI values while the Upper Santee Basin reach (red curve) has (with exception of WY08/09) carried lowest values. The second poorest water quality reach is Upper Mission Valley (green curve). The second best reach is Lower Santee Basin (brown curve). On a seasonal basis autumn and summer values are consistantly lower than winter (highest) and spring (second highest) values for all reaches and overall. August is typically the month of lowest water quality and lowest streamflow. January and March are typically the months of best water quality for all reaches. Larger flood flows, often occuring in February, typically depress WQI values by several points comparred to the other three winter months.

Chart D.4 provides a *spatial* profile of average annual WQI by river monitoring site, reach and section for this year (WY23), compared to last year (WY21), the best (WY05), the worst (WY14) and the 19-yr winter (Dec-Jan), summer (Jun-Sept) and annual (Oct-Sept) norms. The sites are shown from left-to-right in the order they occur ascending upstream. The current (WY24) average annual WQI values for each site, shown as both a heavy black line and as colored bars, are above norms (dashed color bars) at all but sites 13e/13w (Walmart Pond/Mast Park W). that present the poorest overall WQI values. Site 7 (Kaiser Pond Outfall) in Upper Mission Valley reach also continues to present poor index values. The Mission Gorge portion (sites 8-10) of the lower river continues to demonstrate best overall water quality. The 20-yr winter (dashed blue) and summer (dashed red) WQI norms are also shown in spacial profile in order to provide basic understanding of the range in index values occuring throughout the lower river system extending from Lakeside to the estuary in lower Mission Valley.

Monthly and running average WQI values for each reach of the lower river and overall are presented in Section 5 of the WY24 Annual WQM Report (Charts 5.1-5.6) together with a brief discussion of the individual trends associated with each. It is apparent that some reaches of the river experience water quality changes more rapidly than others and that several sites represent "hotspots" of continued poorer quality waters that are less suseptable to changes in ambient conditions. The general trends in varience from the overall LSDR norms for each of the water quality metrics by river reach are also presented in Appendix F (Charts F.1-F.6).

Chart D.3 LSDR Temporal WQI by Reach and 3-day Streamflow Profiles

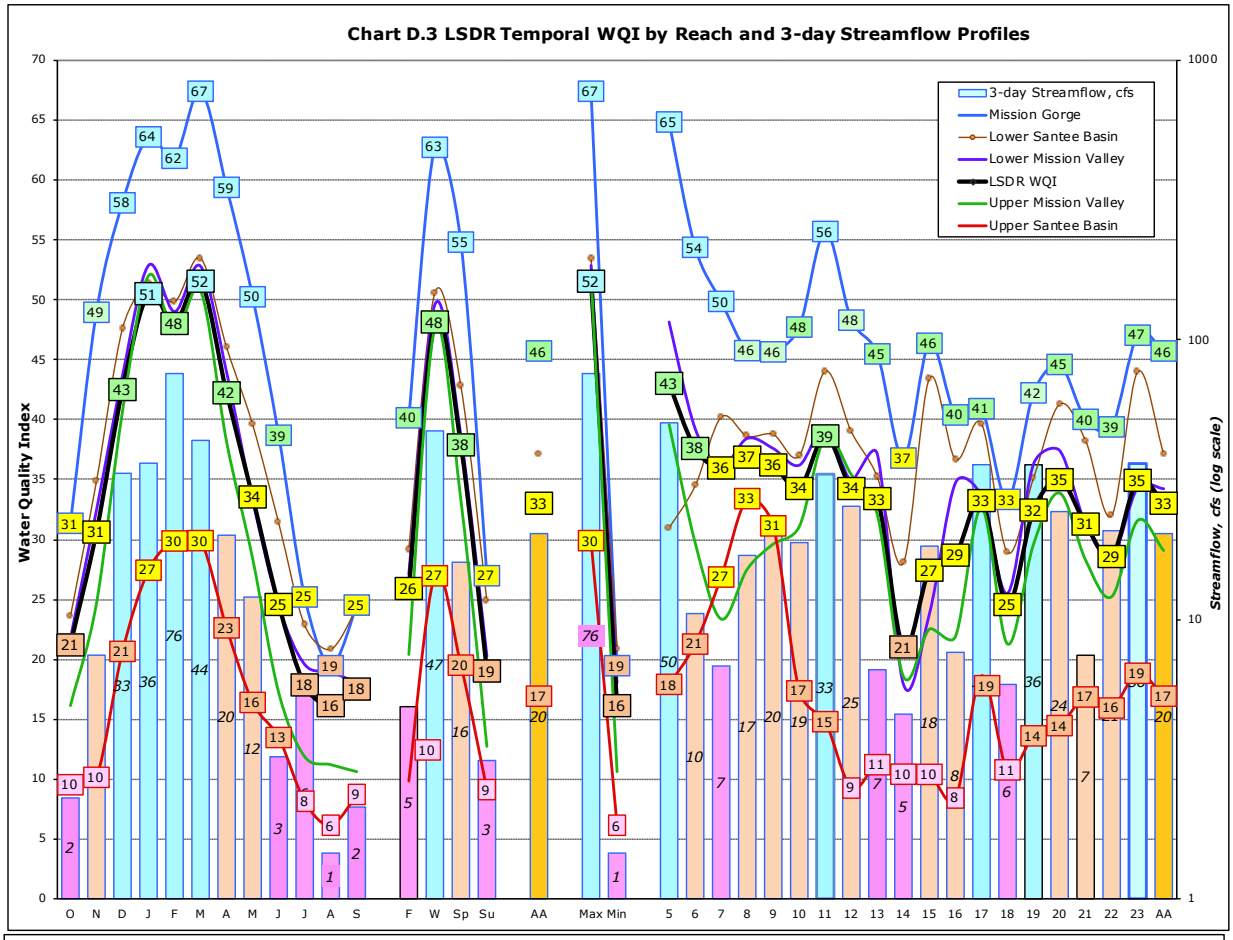
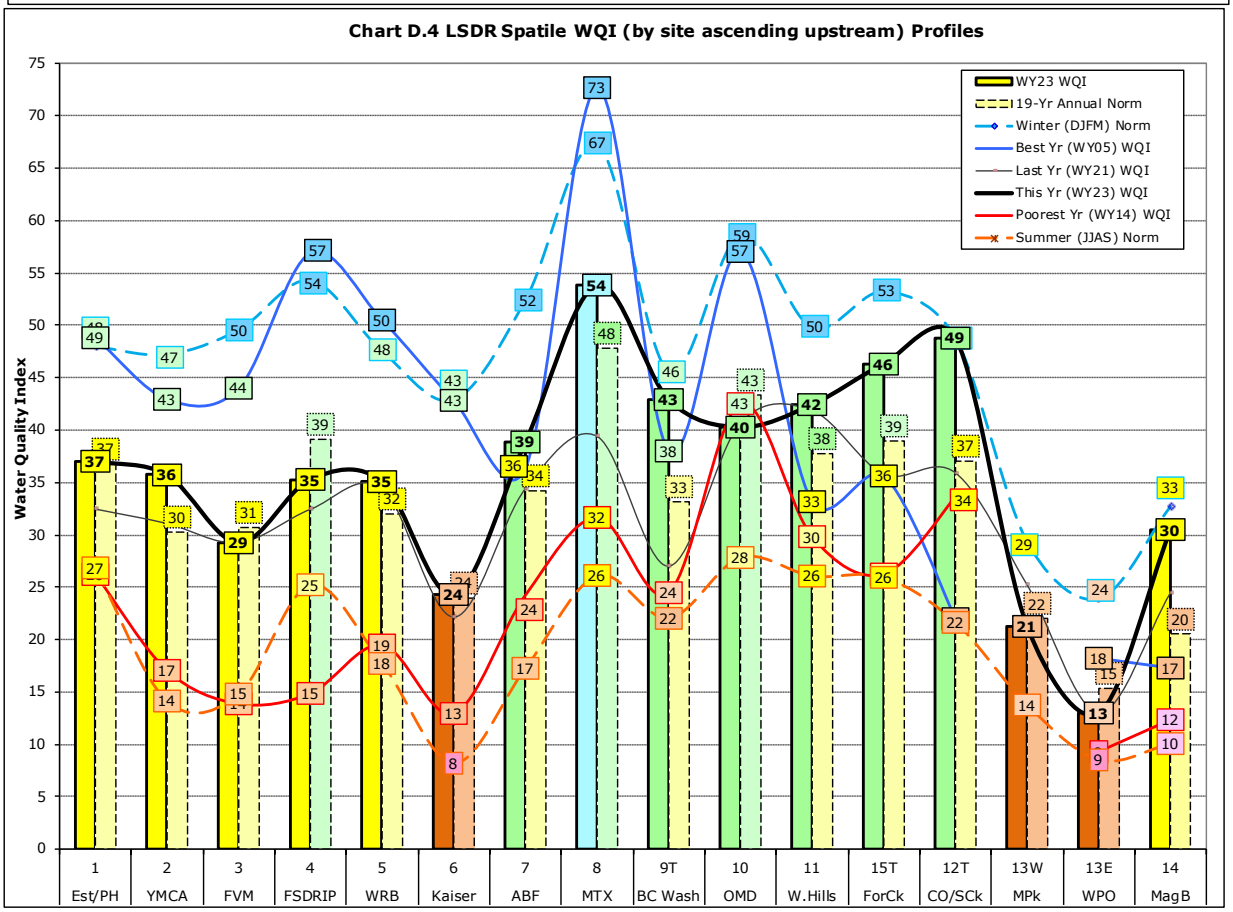


Chart D.4 LSDR Spatile WQI (by site ascending upstream) Profiles



Appendix G - San Diego RiverWatch WQM Team Members

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Appendix H - Glossary

Abreviations:

AADF - Average Annual Daily Flow
ACC - Average Coliform Count (arithmetic mean of fecal coliform, e-Coli & total coliform in MPN/100mL)
ADWF – Average Daily (stream) Dry-Weather Flow
AFY - acre-feet per year
Avg– Average
cfs - cubic feet per second (stream flow/discharge)
Ck – Creek
CY - Calendar Year (Jan 1 - Dec 31)
DO – Dissolved Oxygen
DOD- Dissolved Oxygen Depletion (level below minimum required)
DO%Sat – Dissolved Oxygen expressed as percentage of DO level at Saturation Point
d/s – downstream // {u/s – upstream}
E – East // {W –West}
FSDRIP – First San Diego River Improvement Project
ft. – feet // {mi. - mile}
gal – gallon
Ln(x) - natural logarithm of (x) to base-e (2.718)
log(x) - common logarithm of (x) to base-10
L//U – lower//upper (as in river reaches)
LSDR – Lower San Diego River
max//min – maximum//minimum
MCC - Mean Coliform Count (geometric mean of fecal coliform, e-Coli & total coliform in MPN/100mL)
mg/L – milligrams per litre
mS/cm – milliSeimens per centimetre
(1 mS/cm = 1,000 uS/cm)
MG – Mission Gorge (mid-section of LSDR)
MV – Mission Valley (West section of LSDR)
MPN - Most Probable Number (of coliform organisms)
SB – Santee Basin (East section of LSDR)
PDMWD – Padre Dam Municipal Water District
pH – measure of acidity or basicity (decimal logarithm of hydrogen ion activity)
ppm – parts per million
Q - stream flow or discharge
SB – Santee Basin
SpC – Specific Conductance (also Conductivity sometimes abbreviated SC)
SDRPF – San Diego River Park Foundation
TDS – Total Dissolved Solids
Temp. – Water Temperature
TN/TP – Total Nitrogen/ Total Phosphorus (nutrients)
USGS – U.S. Geological Survey
uS/cm –microSeimens per centimeter
(1 uS/cm = 0.001 mS/cm)
u/s - upstream // {d/s - downstream}
W - West // {E - East}
WQI – Water Quality Index (WQI_a)
$WQI_{(4)}$ - WQI using 4 parameters (current)
$WQI_{(6)}$ - WQI using 6 parameters (early yrs)
WY – Water Year (Oct 1 – Sept 31)
% - percent
%Sat - percent of DO saturation value
C – degrees Celsius $^oC = (^oF-32)*5/9$
^oF – degrees Fahrenheit $^oF = (^oC*9/5) + 32$
Flow (cfs) = Velocity (ft/sec)*Cross-sectional area (sqft)

Constituent Load (lbs/day) = Q (mgd)*Concentration (ppm)*8.34; or Q (cfs)*Concentration (mg/L)*5.39 where Q is streamflow/river discharge.

Total Dissolved Solids (TDS in mg/L) = 670*Specific Conductance, (where SpC is in mS/cm). An approximate relationship for LSDR watershed; other variables (e.g., temperature, pressure, specific ions) are considered negligible).

DO/DO%Sat relationship is defined by the following polynomial equation:
$DO(mg/L)=DO\%Sat*[0.004*T^2-0.343*T+14.2]/100$;
$DO\%Sat = DO(mg/L)*100/[0.004*T^2-0.343T+14.2]$,
where T = temperature is in ^oC.
Other variables, incl. barometric pressure, elevation and conductivity (SpC), have negligible impact on the DO-DO%Sat relationship within the LSDR watershed.

SDR Water Quality Index (WQI) is calculated using the following set of equations:

WQI_4 = DO%Sat*2.5*T factor*Q factor/log(SpC);
where SpC is expressed in *u*S/cm;
the T factor = $0.0055T^3-0.163T^2+1.37T-2.5$, and the Q factor =
$0.56+0.173LnQ-0.002LnQ^2-0.0033LnQ^3$ (M Valley);
$0.72+0.15LnQ-0.0051LnQ^2-0.004LnQ^3$ (M Gorge);
$0.87+0.107LnQ-0.018LnQ^2-0.003LnQ^3$ (Santee);
$0.1+0.05LnQ-0.042LnQ^2-0.0011LnQ^3$ (tributaries)

WQI_6 = Avg.[$DO\%f*wt_{(DO)}$, $SpCf*wt_{(SC)}$, $pHf*wt_{(pH)}$, $MCCf*wt_{(MCC)}$, $Qf*wt_{(Q)}$, $Tempf*wt_{(T)}$]^1.75 where $wt_{(DO)} = 3$, $wt_{(SC)} = 2$, $wt_{(pH)} = 1$, $wt_{(MCC)} = 1$, $wt_{(Q)} = 2$ and $wt_{(T)} = 1$ (formula discontinued in WY08)

The LSDR WQI was specifically developed for the RiverWatch Monitoring Program, however, the equations can also be applied to water quality and hydrologic data for other inland watercourses where metrics are available.

Water Equivalents:

1 cf = 7.48 gal = 62.4 lbs of water
1 AF = 43,560 cf = 325,900 gal
1 psi = 2.31 ft of water (head)
1 mg/L = 1 ppm (in water)
1 cfs = 450 gpm = 0.646 mgd =1.98 AF/day = 724 AFY
1 mgd = 694 gpm =1.547 cfs = 3.06 AF/day = 1,120 AFY
1,000 gpm = 1.436 mgd = 2.23 cfs = 4.42 AF/d = 1,614 AFY
1 inch (rainfall) = 25.4 mm

Formulas:

Appendix I - References

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Table E.1 - RiverWatch WQM Data Summary - WY20						
Section	Mission Valley		Mission Gorge	Santee Basin		Watershed
Sites	1-4	5-7	8-10	11,15T,12T	13W,13E,14	**all (1-15)**
Reach	LMV	UMV	MG	LSB	USB	LSDR [a]
Annual (October 2019 - September 2020):						
ADF, cfs	49 *(30)*	46 (28)	26 (19) [b]	21 *(16)*	9.3 *(5.0)*	**30** *(20)*
Temp, °C	19.9 *(19.4)*	18.5 *(17.9)*	17.3 *(17.1)*	17.5 (17.4)	18.2 *(18.1)*	**18.4** *(18.0)*
SpC, mS/cm	2.63 *(2.58)*	2.46 *(2.55)*	2.09 *(2.28)*	2.07 (2.25)	1.52 *(1.78)*	**2.15** *(2.28)*
DO, mg/L	5.52 *(5.06)*	3.73 *(4.44)*	7.50 *(7.49)*	6.50 *(6.54)*	2.33 *(2.99)*	**5.01** *(4.98)*
DO %of Sat.	60 *(54)*	38 *(46)*	77 *(77)*	67 *(64)*	25 *(31)*	**53** *(51)*
WQIa	37 D+ *(35)*	34 D *(30)*	45 C *(46)*	41 C *(37)*	15 E *(17)*	**32 D** *(31)*
WY20 Grade	**Marginal**	**Marginal**	**Fair**	**Fair**	**Poor**	**Marginal**
Summer Period (June 2020 - September 2020):						
ADF, cfs	3.4 *(3.2)*	3.2 (2.9)	2.9 (1.9) [c]	2.8 (1.8)	1.1 (0.4)	**2.7** *(2.1)*
Temp, °C	25.5 (24.3)	23.6 (21.9)	22.2 (21.8)	21.6 (21.5)	23.7 (22.9)	**23.5** *(22.6)*
SpC, mS/cm	3.32 (3.25)	3.09 (3.17)	2.39 (2.86)	2.07 (2.25)	1.52 (1.78)	**2.61** *(2.78)*
DO, mg/L	4.24 (3.22)	2.88 (2.51)	3.90 (5.58)	6.66 (5.62)	2.13 (2.13)	**3.95** *(3.42)*
DO % of Sat.	52 (39)	34 (29)	42 (61)	76/(64)	26 (25)	**47** *(39)*
WQI	25 D- (20.5)	17 E (14.5)	30 D (27.5)	29 D (24.4)	10 F (9.2)	**21 E** *(18.0)*
WY20 Grade	**Marginal**	**Poor**	**Marginal**	**Marginal**	**Very Poor**	**Poor**
Winter Period (December 2019- March 2020):						
ADF, cfs	27 *(68)*	25 (62)	16 (43)	14 (36)	5.8 (11)	**17** *(45)*
Temp, °C	14.6 (14.5)	14.1 (13.7)	12.7 (12.7)	13.3 (13.4)	13.2 (13.6)	**13.8** *(13.6)*
SpC, mS/cm	1.86 (1.84)	1.75 (1.76)	1.76 (1.63)	1.75 (1.81)	1.24 (1.44)	**1.64** *(1.67)*
DO, mg/L	7.59 (6.91)	7.84 (6.57)	9.64 (9.16)	8.24 (7.92)	2.75 (3.94)	**5.46** *(6.46)*
DO % of Sat.	74 (68)	76 (64)	92 (87)	79 (73)	27 (37)	**53** *(62)*
WQI	54 B (50)	57 B (48)	63 B (63)	54 B (50)	19 E (27)	**47 C** *(46)*
WY20 Grade	**Good**	**Good**	**Good**	**Good**	**Poor**	**Fair**

Table E.2 - RiverWatch WQM Data Summary - WY21							
Section	Mission Valley			Mission Gorge	Santee Basin		**All**
Sites	1-3	4, 5	6-7	8-10	11,15T,12T	13W,13E,14	**(1-15)**
Reach	LMV	MMV	UMV	MG	LSB	USB	**LSDR** [a]
Annual (October 2020 - September 2021):							
ADF, cfs	**12** *(30)*	**12** *(30)*	**11** *(29)*	**8** *(19)* [b]	**7** *(17)*	**3.1** *(7)*	**8** *(21)*
Temp, °C	**19.0** *(19.4)*	**18.5** (18.6)	**17.7** *(17.9)*	**15.7** *(17.0)*	**16.3** *(17.4)*	**17.6** *(18.1)*	**17.2** *(17.9)*
SpC, mS/cm	**2.95** *(2.61)*	**2.90** *(2.58)*	**2.82** *(2.56)*	**2.30** *(2.28)*	**2.27** (2.25)	**1.87** *(1.78)*	**2.51** *(2.35)*
DO, mg/L	**4.79** *(5.04)*	4.74 (4.76)	4.69 *(4.49)*	**7.29** *(7.47)*	6.52 *(6.54)*	**3.16** *(3.00)*	**5.41** *(5.43)*
DO %of Sat.	**50** *(53)*	**49** *(50)*	**48** *(46)*	**72** *(76)*	**65** *(65)*	**33** *(31)*	**51** *(51)*
WQI	**31 D (35)**	**33 D (36)**	**28 D (29)**	**40 C (46)**	**38 C (37)**	**17 E (17)**	**31 D (32)**
Summer Period (June 2021 - September 2021):							
ADF, cfs	**1.3** *(3.4)*	**1.3** *(3.3)*	**1.2** *(3.2)*	**0.9** *(2.0)* [c]	**0.9** *(1.9)*	**0.3** *(0.7)*	**1.0** *(2.2)*
Temp, °C	**24.3** *(24.3)*	**23.1** *(23.0)*	**22.0** *(22.0)*	**21.8** *(21.8)*	**20.9** *(21.5)*	**23.4** (22.9)	**22.4** *(22.4)*
SpC, mS/cm	**3.70** *(3.28)*	**3.60** *(3.22)*	**3.49** *(3.19)*	**2.81** *(2.85)*	**2.70** *(2.64)*	**2.10** *(2.01)*	**3.05** *(2.87)*
DO, mg/L	**2.70** *(3.19)*	**2.51** *(2.85)*	**2.32** *(2.51)*	**4.17** *(5.50)*	**3.79** *(5.18)*	2.44 *(2.15)*	**3.09** *(3.75)*
DO % of Sat.	**32** *(38)*	**29** *(33)*	**27** *(29)*	**48** *(63)*	**43** *(56)*	**31** *(25)*	**35** *(39)*
WQI	**14 E- (20)**	**16 E (21)**	**10 F (13)**	**14 E- (27)**	**18 E (24)**	**10 F (9)**	**13 E- (18)**
Winter Period (December 2020 - March 2021):							
ADF, cfs	**28** *(70)*	**27** *(68)*	**26** *(66)*	**18** *(44)*	**16** *(38)*	**7** *(17)*	**19** *(47)*
Temp, °C	**13.6** *(14.4)*	**13.5** *(14.1)*	**13.2** *(13.7)*	**10.1** *(12.5)*	**11.9** *(13.3)*	**12.0** *(13.5)*	**12.2** *(13.5)*
SpC, mS/cm	**2.16** *(1.86)*	**2.10** *(1.82)*	**1.99** *(1.77)*	**1.81** *(1.64)*	**1.86** *(1.81)*	**1.61** *(1.45)*	**1.91** *(1.73)*
DO, mg/L	**7.04** (6.91)	**6.90** *(6.75)*	**6.76** *(6.58)*	**9.69** *(9.19)*	**8.40** *(7.95)*	**3.40** *(3.90)*	**7.31** *(7.11)*
DO % of Sat.	**69** (68)	**67** *(66)*	**65** *(64)*	**87** *(87)*	**78** (73)	**32** *(37)*	**62** *(63)*
WQI	**47 C (50)**	**48 C (51)**	**44 C (48)**	**58 B (63)**	**50 B- (50)**	**20 E (27)**	**44 C (47)**

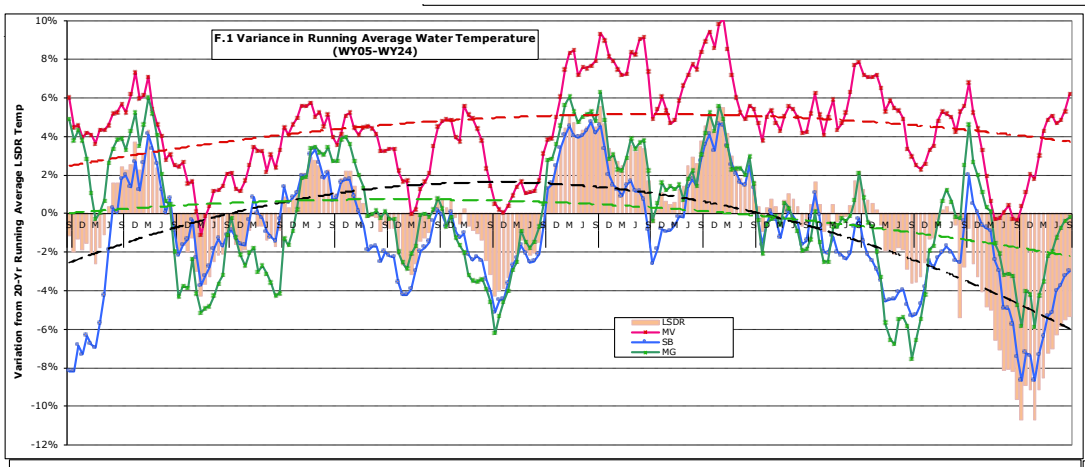
Table E.3 - RiverWatch WQM Data Summary - WY22							
Section	Mission Valley			Mission Gorge	Santee Basin		**All**
Sites	1-3	4, 5	6-7	8-10	11,15T,12T	13W,13E,14	**(1-15)**
Reach	LMV	MMV	UMV	MG	LSB	USB	**LSDR** [a]
Annual (October 2021 - September 2022):							
ADF, cfs	**15** *(27)*	**15** *(26)*	**14** *(25)*	**8.6** *(18)* [b]	**7.0** *(16)*	**3.1** *(7)*	**9.7** *(19)*
Temp, °C	**19.2** *(19.1)*	**18.3** (18.4)	**18.4** *(18.2)*	**16.9** *(16.4)*	**17.1** *(16.7)*	**18.5** *(18.0)*	**17.9** *(17.7)*
SpC, mS/cm	**2.61** *(2.62)*	**2.80** *(2.56)*	**2.71** *(2.55)*	**2.41** *(2.25)*	**2.27** (2.24)	**1.83** *(1.72)*	**2.41** *(2.27)*
DO, mg/L	3.57 (4.48)	4.77 (5.40)	3.74 *(4.29)*	**6.12** *(7.05)*	5.90 *(6.09)*	**3.27** *(3.11)*	**4.65** *(5.10)*
DO %of Sat.	38 *(47)*	51 *(57)*	39 *(44)*	62 *(72)*	**61** *(60)*	**34** *(32)*	48 *(52)*
WQI	**29 D+ (34)**	**31 D+ (36)**	**25 D (29)**	**39 C (46)**	**32 C (37)**	**16 E (17)**	**29 D (33)**
Summer Period (June 2022 - September 2022):							
ADF, cfs	**1.9** *(3.0)*	**1.9** *(3.0)*	**1.8** *(2.9)*	**0.9** *(2.0)* [c]	**0.6** *(1.8)*	**0.2** *(0.7)*	**1.1** *(2.0)*
Temp, °C	**23.8** *(23.7)*	**22.8** *(22.8)*	**22.8** *(22.6)*	**21.3** *(20.8)*	**21.6** *(20.6)*	**23.9** (22.8)	**22.6** *(22.1)*
SpC, mS/cm	**3.52** *(3.33)*	**3.20** *(3.17)*	**3.09** *(3.15)*	**2.47** *(2.43)*	**2.61** *(2.64)*	**1.99** *(1.93)*	**2.71** *(2.68)*
DO, mg/L	1.78 *(2.45)*	3.87 *(3.83)*	2.30 *(2.23)*	1.74 *(4.68)*	3.79 *(5.18)*	2.44 *(2.15)*	2.64 *(3.45)*
DO % of Sat.	22 *(29)*	47 *(45)*	28 *(26)*	21 *(54)*	43 *(56)*	**31** *(25)*	31 *(39)*
WQI	**17 E (20)**	**20 E (21)**	**12 F+ (13)**	**8 F (26)**	**19 E (24)**	**7 F (9)**	**13 E- (19)**
Winter Period (December 2021 - March 2022):							
ADF, cfs	**36** *(69)*	**34** *(65)*	**32** *(62)*	**19** *(43)*	**16** *(37)*	**7.1** *(17)*	**22** *(45)*
Temp, °C	**15.0** *(14.4)*	**14.5** *(14.0)*	**14.6** *(13.8)*	**12.8** *(12.1)*	**12.9** *(12.9)*	**13.6** *(13.5)*	**13.7** *(13.3)*
SpC, mS/cm	**1.94** *(1.85)*	**1.81** *(1.80)*	**1.80** *(1.76)*	**2.32** *(2.02)*	**1.84** *(1.74)*	**1.61** *(1.42)*	**1.88** *(1.75)*
DO, mg/L	**6.10** (6.62)	**6.87** *(7.09)*	**6.76** *(6.58)*	**9.16** *(9.11)*	**8.40** *(7.95)*	3.40 *(3.90)*	**7.18** *(6.79)*
DO % of Sat.	**61** (66)	**68** *(69)*	**66** *(65)*	**87** *(87)*	**78** (73)	32 *(37)*	**70** *(65)*
WQI	**47 C (49)**	**50 C (51)**	**37 D+(42)**	**58 B (60)**	**40 C (47)**	**25 D-(23)**	**41 C (44)**

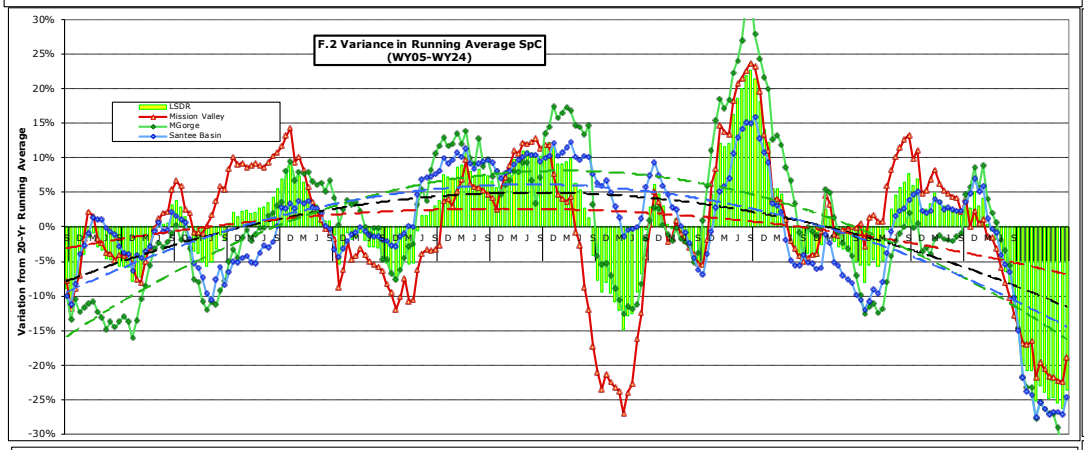
Table E.4 - RiverWatch WQM Data Summary - WY23							
Section	Mission Valley			Mission Gorge	Santee Basin		**All**
Sites	1-3	4, 5	6-7	8-10	11,15T,12T	13W,13E,14	**(1-15)**
Reach	LMV	MMV	UMV	MG	LSB	USB	**LSDR** [a]
Annual (October 2022 - September 2023):							
ADF, cfs	**62** *(29)*	**60** *(28.5)*	**59** *(28)*	**46** *(20)* [b]	**42** *(17)*	**19** *(8)*	**45.2** *(20.5)*
Temp, °C	**18.1** *(19.0)*	**17.6** (18.4)	**17.5** *(18.2)*	**15.6** *(16.4)*	**16.3** *(16.7)*	**17.8***(18.0)*	**17.0** *(17.6)*
SpC, mS/cm	**2.61** *(2.62)*	**2.80** *(2.56)*	**2.71** *(2.55)*	**2.03** *(2.27)*	**2.09** (2.24)	**1.46** *(1.76)*	**1.99** *(2.28)*
DO, mg/L	**4.69** (4.49)	**5.13** (5.38)	**4.54** *(4.30)*	**7.20** *(7.05)*	**6.41** *(6.11)*	**3.10** *(3.11)*	**5.22** *(5.11)*
DO %of Sat.	**49** *(47)*	**53** *(57)*	**46** *(44)*	**72** *(72)*	**65** *(64)*	**32** *(31)*	**53** *(52)*
WQI	**34 D (34)**	**35 D (36)**	**32 D (29)**	**47 C (46)**	**44 C (37)**	**19 E (17)**	**35 D (33)**
Summer Period (June 2023 - September 2023):							
ADF, cfs	**19.7** *(3.9)*	**19.4** *(3.8)*	**18.9** *(3.7)*	**11.7** *(2.4)*	**9.6** *(2.2)*	**4.3** *(0.9)*	**12.8** *(2.6)*
Temp, °C	**23.8** *(23.7)*	**22.8** *(22.8)*	**22.8** *(22.6)*	**21.3** *(20.8)*	**21.6** *(20.6)*	**23.9** (22.8)	**22.6** *(22.1)*
SpC, mS/cm	**3.52** *(3.33)*	**3.20** *(3.17)*	**2.14** *(2,70)*	**2.47** *(2.43)*	**2.61** *(2.64)*	**1.99** *(1.93)*	**2.71** *(2.68)*
DO, mg/L	**3.45** *(2.50)*	**3.50** *(3.82)*	**2.04** *(2.23)*	**5.55** *(4.72)*	**5.39** *(4.80)*	**1.79** *(2.18)*	**3.69** *(3.46)*
DO % of Sat.	41 *(30)*	**42** *(45)*	**24** *(26)*	**64** *(55)*	**61** *(52)*	**21** *(26)*	**43** *(40)*
WQI	**27 D (20)**	**24 E+ (21)**	**15 E (13)**	**39 C- (27)**	**37 D+ (25)**	**10 F (9)**	**14 E- (19)**
Winter Period (December 2022 - March 2023):							
ADF, cfs	**117** *(68)*	**115** *(66.5)*	**113** *(65)*	**98** *(45)*	**93** *(40)*	**42** *(18)*	**92** *(47)*
Temp, °C	**12.6** *(14.3)*	**12.1** *(13.9)*	**12.0** *(13.8)*	**11.2** *(12.1)*	**11.7** *(12.8)*	**12.1** *(13.4)*	**11.9** *(13.3)*
SpC, mS/cm	**1.94** *(1.85)*	**1.81** *(1.80)*	**1.55** *(1.64)*	**2.32** *(2.02)*	**1.84** *(1.74)*	**1.61** *(1.42)*	**1.88** *(1.75)*
DO, mg/L	**7.14** (6.65)	**7.55** *(7.11)*	**7.24** *(6.54)*	**9.78** *(9.14)*	**8.40** *(7.95)*	**4.68** *(4.21)*	**7.18** *(6.79)*
DO % of Sat.	**68** (65)	**71** *(70)*	**68** *(63)*	**90** *(87)*	**78** (73)	**44** *(40)*	**70** *(65)*
WQI	**47 C (50)**	**49 C+ (51)**	**48 C+ (48)**	**60 B (63)**	**56 B (50)**	**30 D (27)**	**48 C (47)**

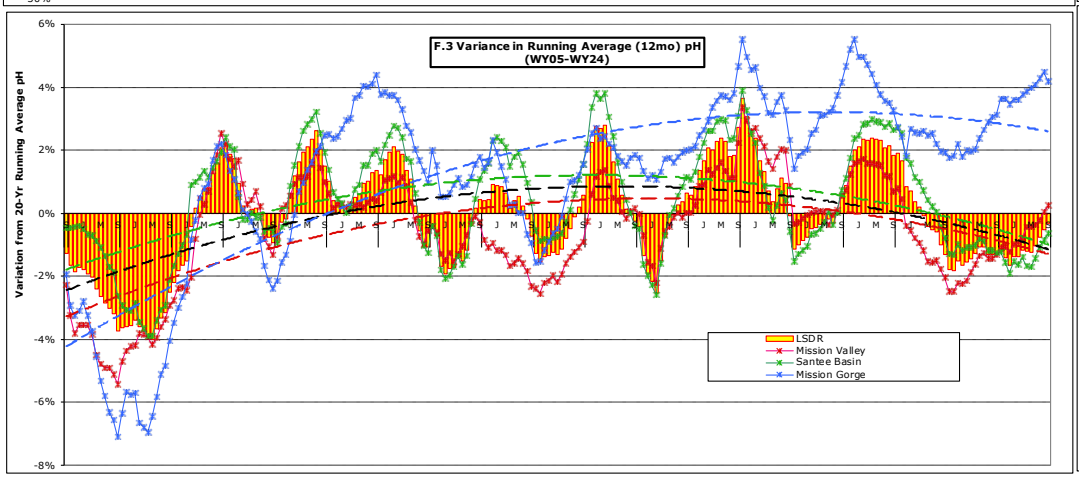
Table E.5 - RiverWatch WQM Data Summary - WY24							
Section	Mission Valley			Mission Gorge	Santee Basin		**All**
Sites	1-3	4, 5	6-7	8-10	11,15T,12T	13W,13E,14	**(1-15)**
Reach	LMV	MMV	UMV	MG	LSB	USB	**LSDR** [a]
Annual (October 2023 - September 2024):							
ADF, cfs	**48** *(30)*	**47** *(29)*	**46** *(28)*	**33** *(20)* [b]	**30** *(18)*	**12** *(7.5)*	**34** *(21)*
Temp, °C	**19.4** *(19.3)*	**18.7** (18.4)	**18.4** *(17.9)*	**17.4** *(17.5)*	**17.4** *(17.3)*	**18.7***(18.1)*	**18.1** *(17.9)*
SpC, mS/cm	**2.61** *(2.62)*	**2.80** *(2.56)*	**2.71** *(2.55)*	**2.03** *(2.27)*	**2.09** (2.24)	**1.46** *(1.76)*	**1.99** *(2.28)*
DO, mg/L	**4.69** (4.49)	**5.13** (5.38)	**4.54** *(4.30)*	**7.20** *(7.05)*	**6.41** *(6.11)*	**3.10** *(3.11)*	**5.22** *(5.11)*
DO %of Sat.	**49** *(47)*	**53** *(57)*	**46** *(44)*	**72** *(72)*	**65** *(64)*	**32** *(31)*	**53** *(52)*
WY24 Grade	**43 C**	**43 C**	**38 C**	**50 B-**	**45 C**	**26 D**	**35 D**
WY23	34 D+	35 D+	32 D	47 C	43 C	19E	29 D
WQI (norm)	*(35) D*	*(36) D*	(30) D	*(46) C*	*(38) C-*	*(17) E*	*(33) D*
Summer Period (June 2024 - September 2024):							
ADF, cfs	**5.8** *(3.9)*	**5.7** *(3.8)*	**5.6** *(3.8)*	**4.6** *(2.6)*	**4.3** *(2.4)*	**1.8** *(0.9)*	**4.4** *(2.7)*
Temp, °C	**23.8** *(23.7)*	**22.8** *(22.8)*	**22.8** *(22.6)*	**21.3** *(20.8)*	**21.6** *(20.6)*	**23.9** (22.8)	**22.6** *(22.1)*
SpC, mS/cm	**3.52** *(3.33)*	**3.20** *(3.17)*	**2.14** *(2,70)*	**2.47** *(2.43)*	**2.61** *(2.64)*	**1.99** *(1.93)*	**2.71** *(2.68)*
DO, mg/L	**3.45** *(2.50)*	**3.50** *(3.82)*	**2.04** *(2.23)*	**5.55** *(4.72)*	**5.39** *(4.80)*	**1.79** *(2.18)*	**3.69** *(3.46)*
DO % of Sat.	41 *(30)*	**42** *(45)*	**24** *(26)*	**64** *(55)*	**61** *(52)*	21 *(26)*	**43** *(40)*
WY24 Grade	**32 D**	**29 D**	**17 E**	**39 C-**	**37 D+**	**11 F**	**14 E-**
WY23	17 E	19 E	12 F+	8 F	19 E	7 F	13 E-
WQI (norm)	*(20) E*	*(21) E*	*(13) E-*	*(27) D*	*(25) D-*	*(9) F*	*(19) E*
Winter Period (December 2023 - March 2024):							
ADF, cfs	**101** *(70)*	**99** *(69)*	**97** *(68)*	**66** *(46)*	**58** *(40)*	**24** *(17)*	**69** *(48)*
Temp, °C	**12.6** *(14.3)*	**12.1** *(13.9)*	**12.0** *(13.8)*	**11.2** *(12.1)*	**11.7** *(12.8)*	**12.1** *(13.4)*	**11.9** *(13.3)*
SpC, mS/cm	**1.94** *(1.85)*	**1.81** *(1.80)*	**1.55** *(1.64)*	**2.32** *(2.02)*	**1.84** *(1.74)*	**1.61** *(1.42)*	**1.88** *(1.75)*
DO, mg/L	**7.14** (6.65)	**7.55** *(7.11)*	**7.24** *(6.54)*	**9.78** *(9.14)*	**8.40** *(7.95)*	**4.68** *(4.21)*	**7.18** *(6.79)*
DO % of Sat.	**68** (65)	**71** *(70)*	**68** *(63)*	**90** *(87)*	**78** (73)	**44** *(40)*	**70** *(65)*
WY24 Grade	**50 B-**	**53 B-**	**55 B**	**60 B**	**56 B**	**30 D**	**48 C**
WY23	47 C	50 B-	48 C+	62 B	46 C	32 D	47 C
WQI (norm)	*(50) B-*	*(51) B-*	*(48) C+*	*(63) B*	*(50) B-*	*(27) D*	*(47) C*

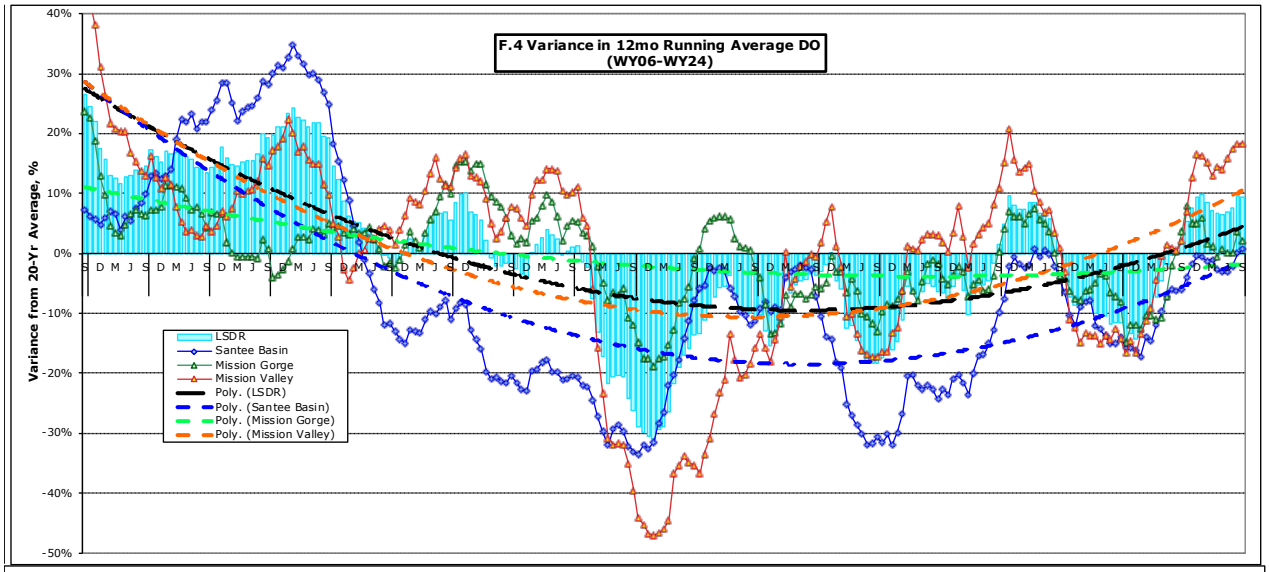
Appendix F - Trends in WQM Running Averages (WY05-WY24)

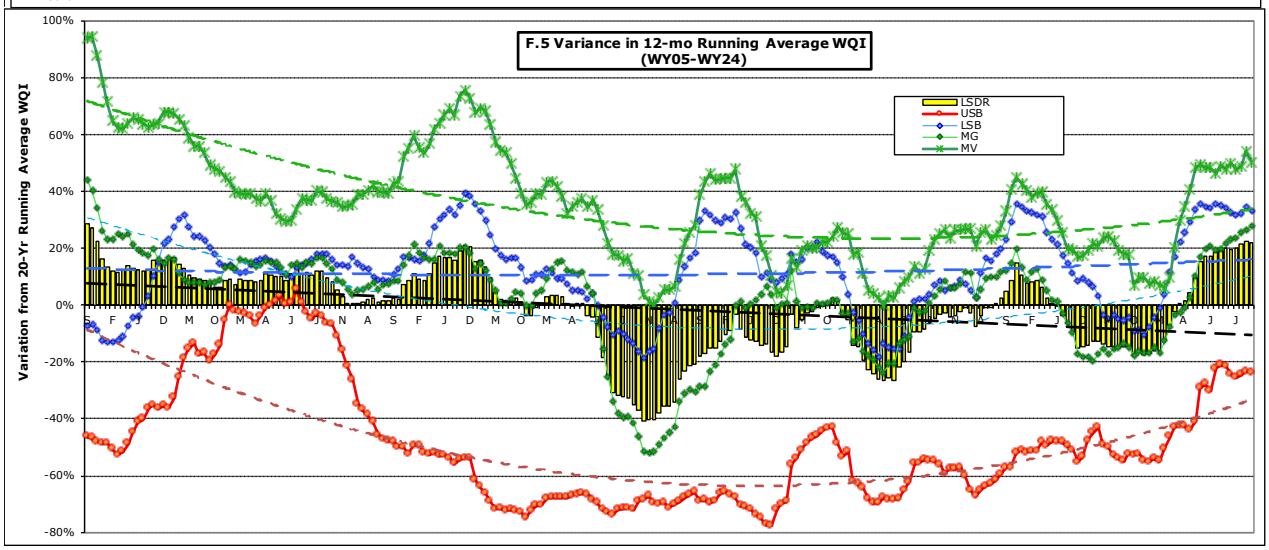
The variances in 12-mo running average values for selected sections of the lower river and overall, extending from Sept. '04 through Sept. '24, for each of the primary WQM metrics are presented in **Charts F.1-F.5** along with associated 20-yr trend lines (dashed) for each portion. The final **Chart F.6** compares overall (LSDR) variances and trends for several key water quality metrics. Extended periods (cycles) of below average rainfall (red line) and streamflow (blue) result in below average DO (green), above average SpC (yellow) and below average WQI values (black line). These relationships, patterns and trends by river reach are further

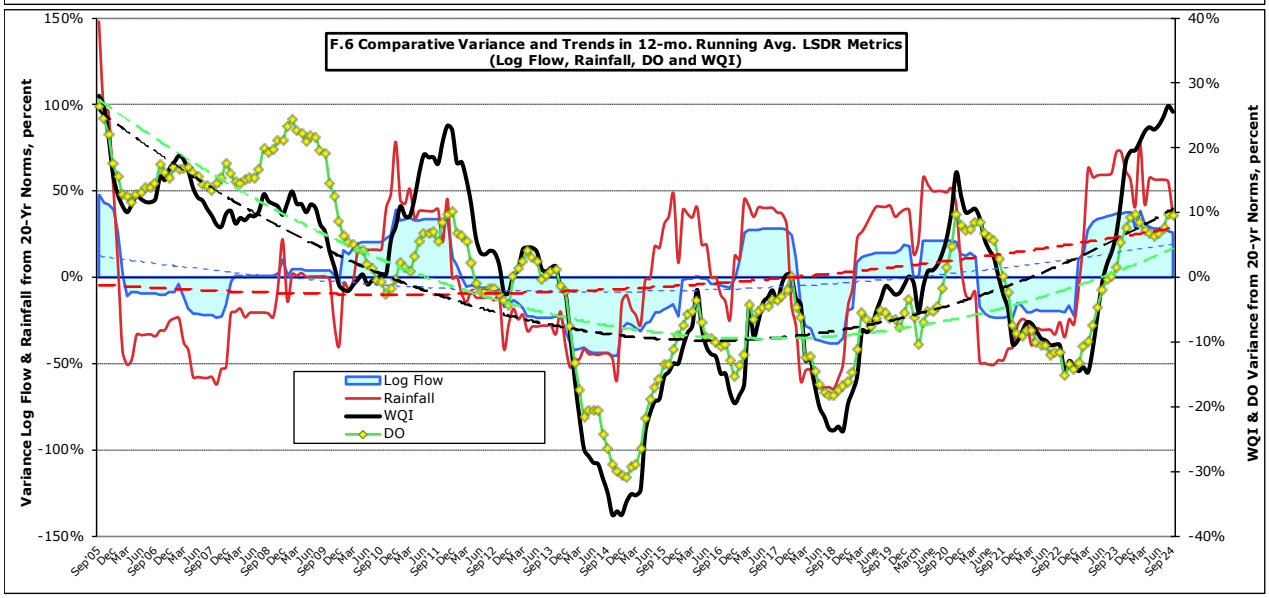







F.4 Variance in 12mo Running Average DO
(WY06-WY24)
Variance from 20-Yr Average, %
LSDR
Santee Basin
Mission Gorge
Mission Valley
Poly. (LSDR)
Poly. (Santee Basin)
Poly. (Mission Gorge)
Poly. (Mission Valley)


F.5 Variance in 12-mo Running Average WQI
(WY05-WY24)
Variation from 20-Yr Running Average WQI
LSDR
USB
LSB
MG
MV


F.6 Comparative Variance and Trends in 12-mo. Running Avg. LSDR Metrics
(Log Flow, Rainfall, DO and WQI)
Variance Log Flow & Rainfall from 20-Yr Norms, percent
WQI & DO Variance from 20-yr Norms, percent
Log Flow
Rainfall
WQI
DO