LOWER SAN DIEGO RIVER WATER QUALITY

WY2023 Annual Water Quality Monitoring Report

Ludwigia (water primrose) growth extending across river channel at Admiral Baker Field (WQM Site #7) June, 2023

Compilation of WQM Data (October 2004 - September 2023)

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Lower San Diego River Water Quality 2005 - 2023

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Questions regarding the San Diego RiverWatch WQM database or interpretation of results expressed in this and similar SDR WQ data monitoring reports can be directed to the attention of John C. Kennedy, through contacting SDRPF at info@SanDiegoRiver.org or the RiverWatch Coordinator at 619-297-7380.

Section 1 - Introduction

This report provides a summary of monthly values, seasonal patterns and annual trends in water quality monitoring data gathered and evaluated by SDRPF's RiverWatch citizen volunteers. WQM data collected monthly over the past 19 years at all monitoring sites within the Lower San Diego River (LSDR) watershed have been aggregated, in conjunction with hydrologic streamflow data to develop a numeric water quality index (WQI). Basic monthly data regarding individual water quality parameters and river hydrology for each of the sites monitored are maintained in an extensive database file maintained at the SDRPF offices; this annual report examines Water Year 2023 (WY23) data in comparison to previous year results and 19-yr averages henceforth refered to as 'norms'. The LSDR water quality monitoring site locations are shown on **Figure 1-1**.

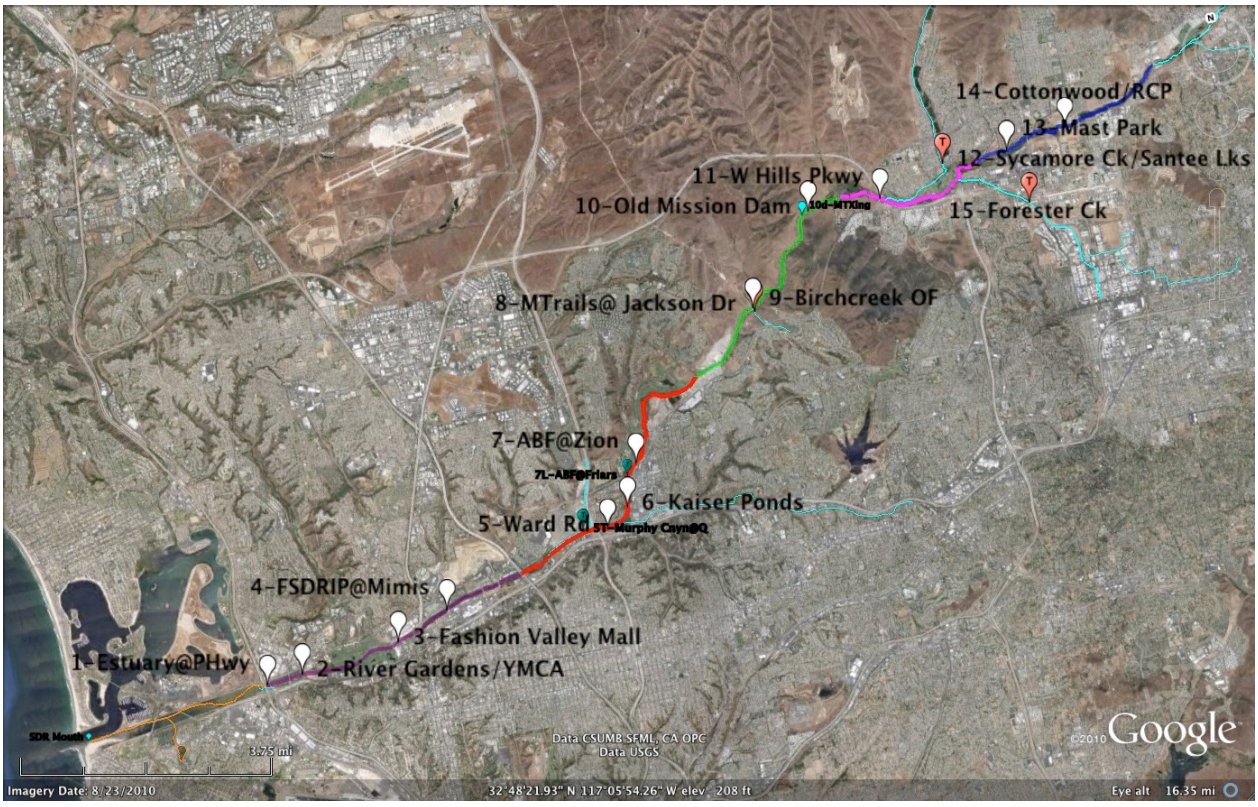

Figure 1-1 LSDR Watershed and Water Quality Monitoring Sites

Color Code for LSDR reaches on Figure 1-1 above: Estuary (orange), Lower Mission Valley (purple), Upper Mission Valley (red), Mission Gorge (green), Lower Santee Basin (pink), Upper Santee Basin (dark blue), Lakeside to El Capitan Reservoir (light green) and principal tributaries (light blue)

The water quality sites on Figure 1-1 and monthly water quality data can be viewed in detail on the SDRPF RiverWatch Online Information Center webpage available at <www.sandiegoriver/river_watch.html>. Clicking on the right-hand side of the page allows access to the data portal. In addition to water quality monitoring data, the portal also contains: San Diego StreamTeam Bio-assessment data, 401 Project information and USGS real-time streamflow data regarding daily peak discharge and gauge height for the two San Diego River gauging stations (Fashion Valley & Mast/W.Hills Pkwy Bridge near Santee). The RiverWatch data portal is updated on a monthly basis.

The water quality index (WQI) represents a response to questions and concerns from SDRPF staff and the general public regarding overall health of the lower river system. The index is a numeric (0-100) where increasing values indicate improving water quality. The numerical index incorporates basic physical, chemical and bacteriological water quality data by integrating six parameters: water temperature (Temp), pH, specific conductance (SpC), dissolved oxygen (DO), percent saturation (%DOSat) and streamflow (ADF); through determination of weighted factors for each metric. The resulting values are aggregated to arrive at an overall score for each site, reach, section as well as the entire lower watershed (LSDR). The range in index values, grades, color codes and general conventions utilized are presented in **Table 1.1.**

Table 1.1 LSDR Water Quality Index

SDR WQI (0-100)	Grade	Color Code	Percentile Range	Water Quality Threshold	General
75 or >	A - Very Good	Dark Blue	25%	Well above acceptable WQ criteria	Healthy (>50)
50 - 74	B - Good	Light Blue	25%	Meets all acceptable WQ criteria	
38 - 49	C - Fair	Green	12.5%	Meets many (but not all) WQ criteria	Marginal (25-49)
25 - 37	D - Marginal	Yellow	12.5%	Meets some acceptable WQ criteria	
13 - 24	E - Poor	Brown	12.5%	Below most minimum WQ criteria	Unhealthy (< 25)
0 - 12	F - Very Poor	Pink/ Rose	12.5%	Well below minimum WQ criteria	

Note: The WQI has been developed for inland fresh water quality metrics only; not applicable to estuarine or ocean waters.

In general, sites with WQI values of 50 or above (blue zone) exceed expectations for acceptable water quality and are indicative of relatively 'healthy' conditions. Scores between 25 and 49 (yellow zone) describe 'impaired or ailing' quality where quantifiable evidence exists regarding failure to meet specific water quality criteria. Waters' with scores of less than 25 (red zone) do not meet minimum expectations and are considered 'unhealthy' and/or stressful to numerous aquatic life forms. For WQ parameters monitored by RiverWatch, the index expresses results relative to those levels necessary to sustain designated beneficial water uses for the LSDR (Hydrologic Area 907.1) based on California Water Quality Standards. Where criteria are non-specific, results are expressed relative to general freshwater objectives established for Southern California inland coastal areas. As such, the index does not apply to esturine or ocean waters. Fresh water is typically defined as having an overall salt content of less than one percent.

Index values were calculated using two formulas; one involving four metrics (Temp, SpC and DO) monitored by RiverWatch combined with streamflow (ADF); the second with two additional parameters (pH and MCC). The equations used for both formulas (WQI_4 and WQI_6) are presented in Appendix F. Differences between the two determinations were found to be minor, however, the initial determination (WQI_4) provides a broader range in values than the second, as the 'normalizing' effects of pH and MCC values (both of which present less spatial and temporal variance) are excluded. The broader range WQI_4 values are expressed in both the annual and monthly water quality reports. Although specifically developed for the Lower San Diego River, the index can also be applied to other coastal and inland watercourses where the same metrics (i.e., DO, SpC, water temperature and streamflow) are monitored and available on a consistent basis. A technical report comparing relative water quality in three San Diego County watercourses; Los Penasquitos Creek below Poway, Santa Margarita River below Temecula/near Fallbrook, and Lower San Diego River near Santee and in Mission Valley, prepared through the RiverWatch program in 2015, is on file at SDRPF offices.

Section 2 - Spatial Analysis of WY23 Water Quality Metrics

Monthly water quality data collected and recorded at each site by RiverWatch WQM Team volunteers are used to determine averages, seasonal patterns and trends as presented in this annual report and appendices. Supporting USGS streamflow data are also included in the analyses. The annual average water quality values for each of the monitoring sites for WY23 and 'norms' i.e., averaged values over the past 19 years of monthly monitoring, are presented in **Table 2.1**. WY23 values (bold type) equal to or greater than site norms (expressed in italics) are shown in black, whereas values below norms are in red. This year's overall LSDR averages (of all sites) are displayed in bottom two rows of the table.

Table 2.1 Average Annual WQ Metrics for WY23 and 19-yr Norms by Site, Reach and Section

WQM Site	*LSDR Reach/Sect.*		Temp, oC	SpC, mS/cm	pH	Dissolved Oxygen, mg/L (%Sat)	ADF, cfs	WQI, (Diff) & Grade[a]	
1	LMV	West	**18.5**/*19.7*	**2.43**/2.72	**7.7**/7.8	**5.7(63)** / *6.1(67)*	**62**/*29*	**37**/*37* (0)	**D**/D
2			**18.1**/*19.0*	**2.36**/2.66	**7.5**/7.7	**4.0(42)** / *4.4(46)*		**36**/*30* (+6)	**D**/*D*
3			**18.1**/*19.1*	**2.26**/2.54	**7.6**/7.8	**3.2(34)** / *4.6(48)*		**29**/*31* (-2)	**D**/*D*
4	MMV		**18.2**/*19.6*	**2.23**/2.45	**7.7**/7.8	**5.2(58)** / *6.0*(65)		**35**/*39* (-4)	**D**/*C*
5			**16.9**/*17.2*	**2.26**/2.60	**7.6**/7.6	4.3(44) / *4.8*(49)	**59**/*27*	**35**/*32* (+2)	**D**/*D*
6	UMV		**17.6**/*18.2*	**2.11**/2.59	**7.5**/7.6	**2.2(22)** / *3.5*(36)		**24**/*24* (0)	**E+**/E+
7			**17.3**/*18.1*	**1.97**/2.44	**7.5**/7.6	**5.3(56)** / *5.1*(53)		**39**/*34* (+5)	**C**/*D*
8	MG	Mid	**16.4**/*17.1*	**2.03**/2.30	**7.7**/7.7	**6.7(67)** / *7.2*(73)	**46**/*20*	**54**/*48* (+6)	**B**/*C+*
9T [b]			**14.9**/*15.6*	**3.64**/4.67	**8.1**/7.9	**9.5(98)** / *9.2*(93)	<1	**43**/*33* (+10)	**C**/*D*
10			**16.6**/*17.5*	**2.02**/2.23	**7.9**/7.8	**5.6(57)** / 6.9(72)	**38**/*16*	**40**/*43* (-3)	**C**/*C*
11	LSB	East	**16.3**/*16.7*	**2.05**/2.23	**7.6**/7.6	**5.9(61)** / *6.1(60)*		**42**/*38* (+4)	**C**/*C-*
12T [b]			**14.9**/*17.4*	**1.17**/1.60	**7.8**/7.9	**4.6(47)** / *7.0(70)*		**49**/*37* (+12)	**C**/*D+*
15T [b]			**16.6**/*17.8*	**2.57**/2.66	**7.7**/*8.0*	**5.6(58)** / *7.3(70)*	**20**/*9*	**46**/*39* (+7)	**C**/*C-*
13W[c]	USB		**15.3**/15.6	**1.69**/1.28	**7.5**/*7.7*	**2.7(29)** /3.2 (34)	**19**/*8*	**21**/*22* (-1)	E/*E*
13E			**16.9**/*18.2*	**1.54**/1.89	**7.5**/7.7	**2.1(22)** / *2.8(29)*		**13**/*15* (-2)	**E-**/*E*
14			**18.6**/*17.8*	**1.28**/1.51	**7.9**/7.8	**4.5(46)** / *3.5(36)*		**30**/*21* (+9)	**D**/*E*
all	LSDR Avg.		**17.1**/*17.9*	**1.98**/*2.28*	**7.6**/*7.7*	**4.6(48)** / *5.3(54)*	**47**/*23*	**35**/*33* (+2)	**D**/*D*
1-16	**Dwt Avg [d]**		**17.1**/*17.9*	**1.97**/*2.28*	**7.7**/*7.7*	**4.7(48)** / *5.4(51)*	**45**/*21*	**35**/*33* (+2)	**D**/*D*

a) *Average annual water quality index values, change (+/-) and resultant WQ letter grade for WY23 (bold) and 19-yr norms (italics); WY23 values below site norms for each metric are in red; values above norms in black.*
b) Lower San Diego River water quality monitoring sites located on tributary (T) streams; all others are main channel.
c) Mast Park West site (below Carlton Hill Blvd. bridge) was added in WY21; yearly'norms' are less statistically sound.
d) Distance-weighted (Dwt) WQI values are calculated based on reach of each site relative to total length of the lower river.
e) DO>7.0 mg/L values shown in blue cells; DO<5 mg/L values are shown in tan cells.

Eleven of 16 monitoring sites show average annual WQI values for WY23 greater than or equal to the 19-yr norms. Five others are slighty below norms. Average WY23 water temperatures were below norms at all but one site (#14), resulting in an overall decrease of 0.8 oC from the annual average of 17.9 C. Specific Conductance values for WY23 are below norms at all monitoring sites. The overall SpC (LSDR average) for WY23 is 13% below the annual norm of 2.28 mS/cm. DO values are greater than norms at only three sites in WY23. Overall this year's average DO value of 4.65 mg/L (48%Sat) remains below the annual norm of 5.35 mg/L (52%Sat). This year's annual average DO is 18% above the lowest year (WY14 @ 3.95 mg/L) while 32% below the highest average value of 6.84 mg/L recorded in WY05. Average daily streamflows (ADF) for WY23 (bold, blacktype) were considerably greater at all sites than 19-yr norms.

Average annual and monthly min.-max. range water quality metrics for WY23 and 19-yr norms are expressed for the river (LSDR) and by reach/section in **Table 2.2.** All reaches of the lower river present higher index values for this year than site norms. Average annual water temperatures and Specific Conductance (SpC) for all five reaches were below norms, while pH and DO values varied. Overall both pH and DO value for WY23 were close to 19-yr norms. Streamflow (ADF) exceeded 19-yr norms in all reaches and sections in WY23. The greatest improvement in water quality metrics monitored within the lower river watershed occurred in the Lower Santee Basin (sites 13W,12,15T,&11) reach. Average annual water quality remained unchanged from the norm in the Lower Mission Valley (sites 1,2&3) reach.

Table 2.2 Water Quality Metrics for WY23 and 19-yr Norms by Range, Reach and Section

Parameter, units		Temp, oC	SpC, mS/cm	pH	Dissolved Oxygen, mg/L (%Sat)	ADF, cfs	WQI, (Difference) and Grade [a]	
LSDR Max. Mo.		**23.1**/*25.2*	**3.1**/*4.0*	**7.8**/*7.9*	9.2**(79)**/10.4*(102)*	**189**/*231*	**56**/*51* (+5)	**A**/*A-*
Winter (D,J,F,M)		**11.9**/*13.4*	**1.6**/*1.7*	**7.8**/*7.7*	**7.7(66)**/*7.2(63)*	**93**/47	**48**/*47* (+1)	**C+**/*C*
Annual Wt Avg.		**18.1**/*17.9*	**2.0**/*2.3*	**7.7**/*7.7*	**5.5(51)**/5.4(51)	**45**/*21*	**35**/33 (+2)	**D**/*D*
Summer (J,J,A,S)		**23.3**/*22.4*	**2.1**/*2.8*	**7.7**/*7.7*	**3.9(41)**/*3.7(39)*	**13**/3	**25**/*19* (+6)	**D-**/*E*
LSDR Min. Mo.		**10.5**/*9.3*	**1.3**/*0.6*	**7.8**/*7.6*	**3.0(31)**/1.8*(16)*	**0.9**/*0.1*	**8**/*16* (-8)	**F**/*E*
LSDR Individual Reach & Section Averages:								
USB	East	**17.5**/*18.1*	**1.5**/*1.8*	**7.7**/*7.7*	**2.7(28)**/3.0*(31)*	**19**/*8*	**19**/*17* (+2)	**E**/*E*
LSB		**16.4**/*17.3*	**2.0**/2.2	**7.6**/7.8	**6.7(68)**/6.5*(64)*	**42**/*17*	**44**/*37* (+7)	**C**/*D+*
MG	Mid	**16.2**/*17.0*	**2.0**/2.3	**7.9**/7.8	**7.7(78)**/*7.4(76)*	**46**/*20*	**47**/*46* (+1)	**C**/*C*
UMV	West	**17.3**/*17.8*	**2.1**/2.5	**7.5**/*7.6*	**4.7(48)**/*4.5(46)*	**59**/*28*	**32**/*29* (+3)	**D**/*D*
LMV		**18.2**/*19.3*	**2.3**/2.6	**7.6**/*7.7*	**4.8(51)**/*5.0(53)*	**62**/*29*	**34**/34 (0)	**D**/*D*

a) *Average annual water quality index value, difference (+/-) from 19-yr norms and resultant WQI letter grades. Current values (bold-face type) and grades below norms (shown in italics) are expressed in red; values and grades above norms are in black.*
b) DO>7.0 mg/L shown in light blue cells; DO<5 mg/L shown in tan cells.

Spatial water quality values expressed in Tables 2.1 and 2.2 for the LSDR system monitoring sites are presented in **Chart 2.1** (Water Quality Data Profiles) and **Chart 2.2** (Water Quality Index and LSDR Streamflow) on the next page. The overall water quality index for WY23 of 35 (D Marginal) is two points greater than the 19-yr average annual norm of 33. This year's value is 13 points above the lowest average

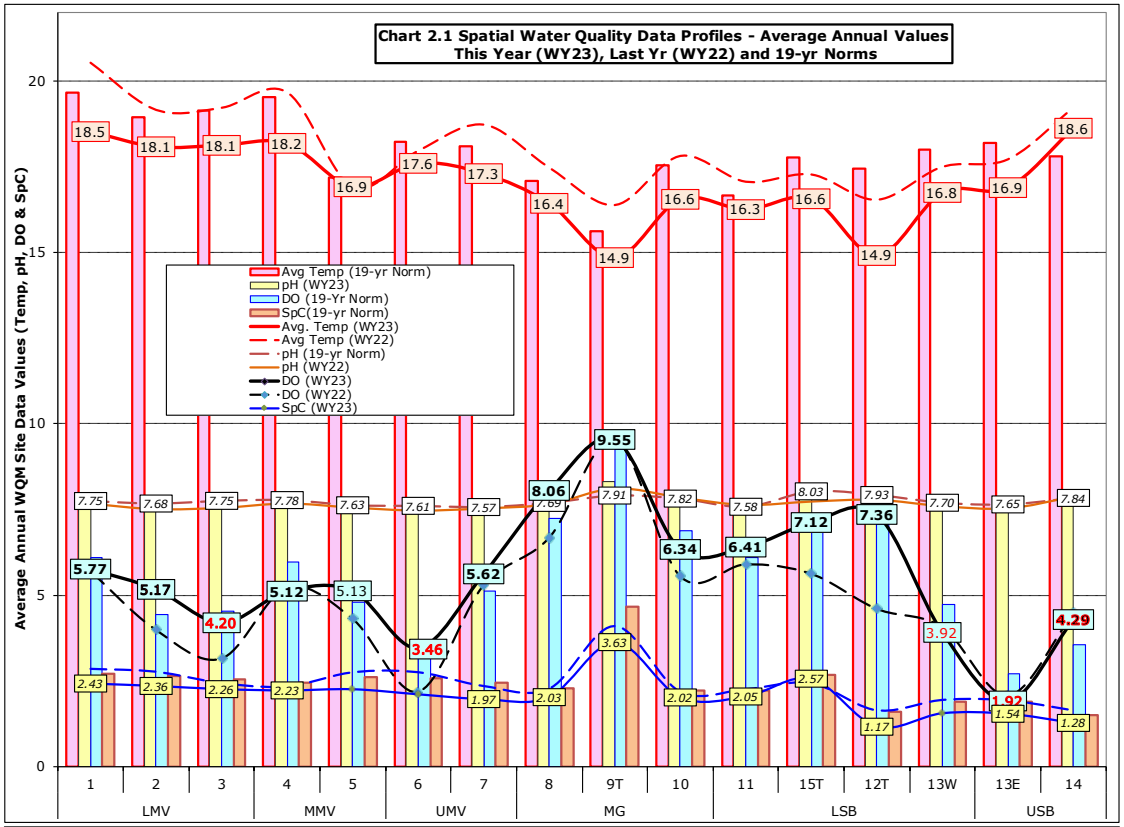
Chart 2.1 Spatial Water Quality Data Profiles - Average Annual Values
This Year (WY23), Last Yr (WY22) and 19-yr Norms
Average Annual WQM Site Data Values (Temp, pH, DO & SpC)
Avg Temp (19-yr Norm)
pH (WY23)
DO (19-Yr Norm)
SpC(19-yr Norm)
Avg. Temp (WY23)
Avg Temp (WY22)
pH (19-yr Norm)
pH (WY22)
DO (WY23)
DO (WY22)
SpC (WY23)
1 2 3 4 5 6 7 8 9T 10 11 15T 12T 13W 13E 14
LMV MMV UMV MG LSB USB

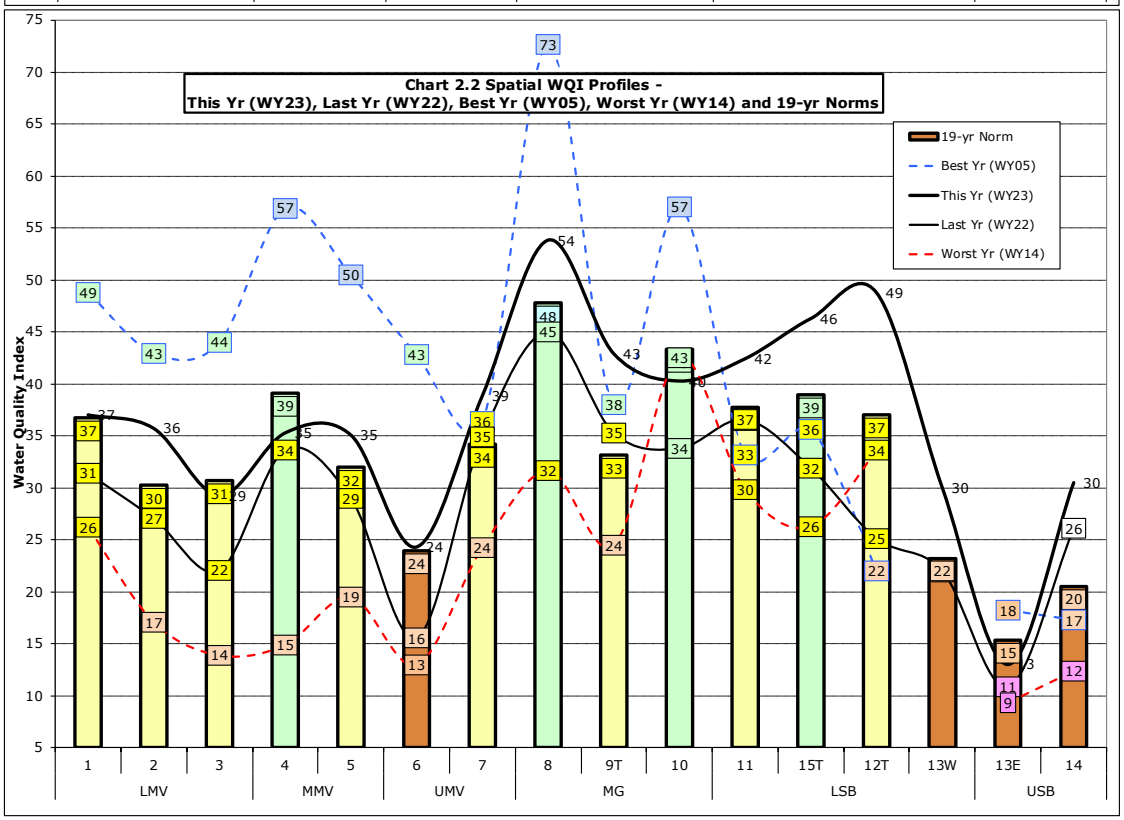
Chart 2.2 Spatial WQI Profiles -
This Yr (WY23), Last Yr (WY22), Best Yr (WY05), Worst Yr (WY14) and 19-yr Norms
Water Quality Index
19-yr Norm
Best Yr (WY05)
This Yr (WY23)
Last Yr (WY22)
Worst Yr (WY14)
1 2 3 4 5 6 7 8 9T 10 11 15T 12T 13W 13E 14
LMV MMV UMV MG LSB USB

annual WQI of 22 (E Poor) experienced in WY14. The river's highest overall average annual index of 40 (Fair) occurred in WY05. Two water year's (WY14&WY18) presented an overall average index value in the Poor E (WQI 13-24) range, while two others (WY05&WY11) had values in the Fair C (WQI 38-49) range. Marginal (D) water quality (WQI 25-37) has occurred 13 of the past 19 years (68% of the time).

Average annual water quality values for water temperature, pH, DO and SpC at each monitoring site, river reach and section in order of their location upstream for WY23 and 19-yr norms are presented on **Chart 2.1**. This year's average annual results are shown as heavy solid lines with values listed; blue lines are last year's (WY22) values and the red lines are 19-yr annual averages (or norms) for each site. Average annual water temperatures (solid red line) for WY23 are below (less than) both 19-yr norms (red bars) and last year values (dashed red line) at all 16 monitoring sites. Downstream water temperatures are consistantly higher than those monitored upstream. There is little difference in average pH values between sites and from the 19-yr norms (yellow bars). There is also little variance in pH values between upstream and downstream sites. DO values for WY23 (solid black line) are generally above those from last year (dashed black line) and close to the 19-yr norms (blue bars). Average annual DO values at five sites (3,6,13W,13E&14) are below a depletion threshold level of 5 mg/L. Monitored DO and DO%Sat results represent the greatest variation between sites. Lowest values are typically recorded in the Upper Santee Basin and Upper Mission Valley reaches whereas highest values are observed in the Mission Gorge section (sites 8&10). Excluding tributary sites, average annual SpC values generally increase along the mainstem from upstream to downstream, similar to water temperatures. SpC averages for WY23 (solid blue line) are slightly below both norms (brown bars) and last year's values (dashed blue line) at all sites. The greatest variances in this year's spacial metrics both from last year (WY22) and the norms are associated with DO and water temperatures.

The WQI, an aggregate or composite index of water quality monitoring metrics for WY23, the 19-yr norms, the overall best (WY05) and worst (WY14) year results are presented in **Chart 2.2**. As shown by the solid black line (this year's results) in comparison to the colored bars (19-yr norms), the three sites furthest upstream, Mast Park (13E&13W) and Magnolia Ave (14), continue to experience the poorest water quality as does Kaiser Ponds (site 6). On an average annual basis, highest WQI values continue to be associated with the Mission Gorge sites (8&10). The overall WQI profile for WY23 (black line) is generally similar to the 19-yr norms (colored bars) and consistantly above last year's (WY22) results (dashed black line). In general WY23 water quality conditions throughout Mission Valley (Upper, Mid and Lower reaches) are noticably improved from last year's (WY22) results. As evidenced in the past, above normal streamflows tend to reduce degregation thus resulting in improved water quality. WY23 experienced well above normal dry weather flows as well as average annual flow that resulted in an overall improvement in the river water quality index. Lower water temperatures and Specific Conductance values as monitored throughout the water year, combined with slightly higher Dissolved Oxygen levels at many of sites.

Section 3 - Temporal Analysis of LSDR WY23 Data

Monthly, seasonal and annual water quality monitoring metrics data and index results for the Lower San Diego River are presented in **Table 3.1** for this year (WY23) with comparison to 19-yr norms (shown italicized). WY23 values above norms are listed in black; values below norms in red. Temporal water quality values in WY23 vary little from the 18yr norms on an annual basis with the exception of DO and streamflow where this year's values are below norms for all but two months of the water year. The resultant annual average WQI for WY23 is two points above the 19-yr norn of 33 and six points above the resultant WY22 value.

Table 3.1 LSDR WQM Metrics for WY23 and 19-yr Norms by Month and Season

Month	Season:	Temp, oC	Sp Cond, mS/cm	pH	Dissolved Oxygen, mg/L	Dissolved Oxygen, (%Sat)	ADF, cfs	WQI Value [a]	and Grade
Oct	Fall	**20.3**/*18.5*	**3.06**/*2.81*	**7.6**/*7.7*	**1.83**/*4.02*	**16**/*38*	**0.9**/*2.2*	**7**/*21*	**F**/*E*
Nov		**12.2**/*14.8*	**2.31**/*2.65*	**7.8**/*7.7*	**5.36**/*5.54*	**41**/*48*	**15.6**/*7.0*	**30**/*30*	**D**/*D*
Dec	Winter	**10.5**/*11.7*	**1.96**/*1.84*	**7.8**/7.8	**5.91**/*6.95*	**47**/*58*	**11.9**/*26.5*	**35**/*42*	**C**/*C*
Jan		**11.6**/*11.9*	**1.43**/*1.73*	**7.7**/7.8	**7.82**/7.98	**67**/*68*	**189**/*59.8*	**48**/*49*	**C**/C+
Feb		**11.0**/*13.7*	**2.22**/*1.72*	**7.8**/7.8	**9.23** /*7.37*	**79**/*66*	**35.1**/*50.3*	**55**/*48*	**B**/*C*
Mar		**14.3**/*16.4*	**0.68**/*1.53*	**7.8**/7.8	**7.94**/*7.09*	**72**/*67*	**133**/*52*	**54**/*51*	**B**/*B-*
Apr	Spring	**16.4**/*17.9*	**1.59**/*1.87*	**7.8**/7.8	**6.76**/*5.93*	**65**/*58*	**85.3**/*26.7*	**50**/*42*	**B-**/*C*
May		**19.4**/*19.9*	**1.92**/*2.20*	**7.8**/7.8	**5.37**/ *5.06*	**55**/*51*	**19.3**/*10.5*	**41**/*34*	**C**/*D*
June	Summer	**21.3**/*21.9*	**1.87**/*2.52*	**7.7**/*7.8*	**5.19**/*4.33*	**55**/*45*	**17.8**/*4.5*	**36**/*25*	**D**/*D-*
July		**23.0**/*23.1*	**2.33**/*2.73*	**7.6**/*7.7*	**3.89**/*3.53*	**40**/*38*	**4.9**/*2.1*	**23**/*18*	**E+**/*E*
Aug		**23.1**/*23.3*	**2.47**/*2.92*	**7.6**/*7.7*	**2.99**/*3.44*	**31**/*37*	**3.1**/*1.2*	**19**/*16*	**E**/*E*
Sept		**21.8**/*21.5*	**1.85**/*2.87*	**7.8**/*7.7*	**3.48**/*3.49*	**35**/*36*	**25.4**/*2.6*	**21**/*18*	**E**/*E*
Fall (O&N)		**16.3**/*16.7*	**2.68**/*2.73*	**7.7**/*7.7*	**3.45**/*4.78*	**34**/*43*	**8.2**/*4.6*	**18**/*26*	**E**/*D-*
Winter (D,J,F,M)		**11.9**/*13.4*	**1.57**/*1.70*	**7.8**/*7.8*	**7.49**/*7.35*	**70**/*65*	**92.1**/*47.0*	**48**/*47*	**C+**/*C*
Spring (A&M)		**17.9**/*18.9*	**1.60**/*2.04*	**7.8**/*7.8*	**5.91**/*5.49*	**63**/*54*	**52.3**/*18.6*	**46**/*38*	**C**/*C-*
Summer (J,J,A,S)		**22.3**/*22.4*	**2.13**/*2.76*	**7.7**/*7.7*	**3.81**/*3.70*	**44**/*39*	**12.8**/*2.6*	**25**/*19*	**D-**/*E*
Annual (O-S)		**17.1**/*17.9*	**1.97**/*2.28*	**7.7**/*7.7*	**5.48**/*5.39*	**50**/*50*	**45.1**/*20.4*	**35**/*33*	**D**/*D*

a) WQ index values based on RiverWatch physical-chemical metrics combined with USGS streamflow data for East (West Hills Pkwy) and West sections (Fashion Valley). WY23 values/grades (shown in bold type) below 19-yr norms (shown in italics) are in red; those values equal to or above norms are in black.
b) DO>7.0 mg/L (65%Sat) shown in light blue cells; DO<5 mg/L (55% Sat) shown in tan cells.
c) WQI color coding as listed in Table 1.1.

Monthly and seasonal variances in water quality monitoring metrics for the past two water years (WY22 &23) and current 19-yr norms are expressed in **Chart 3.1.** (WQM Data) as shown on the next page. The numeric values presented in the chart are drawn from columns 1-4 of Table 3.1. Dissolved oxygen is highest during the winter months (Dec-March) whereas specific conductivity and water temperatures are greatest during the summer months (June-Sept) extending into early Fall (Oct). pH values show little overall temporal fluctuation. The broad range in DO, SpC and water temperature metrics monitored at nearly all sites throughout the year provides strong indication of the significant variance in water quality. Temporal variance between this year's data (WY23), shown as solid lines, last year's results (dashed lines) and the 19-yr norms (colored bars) are similar. In general, temporal variance in WY23 water quality data match closely temporal patterns in the 19-yr norms; somewhat more so than WY22 values. This year's temporal water quality values are reflective of both normalized monthly occurrences as well as those monitored during previous years.

Chart 3.2 provides an overall graphic showing temporal variance in streamflow and WQI values throughout WY23 compared to monthly averages for the previous water year (WY22) and the 19-yr norms. As shown in the chart, WQI values for WY23 (heavy black line), also listed in Table 3.1 (far right column), are reasonably close to 19yr norms (colored bars) for most months of the year. The strong correlation between streamflow (both wet weather and dry) and montly water quality is evident. Low DO levels throughout the Spring and Summer months combined with below normal dry-weather flows constitute the primary drivers in index values. In general, water quality for the Lower San Diego River watershed is highest (i.e., Good to Fair grades) when flows are greatest during the Winter months (Dec-March) and poorest (Poor to Very Poor) in Summer (June-Sept) when streamflow and DO are lowest and water temperatures highest. The overall annual average WQI for the LSDR in WY23 of 3x (D mid-Marginal) is x points above the overall 19yr average index value of 32.7 and x points greatwr than the WY22 index of 30.

Temporal patterns in river water quality data, as expressed in this section of the report, are most evident when considering monthly and seasonal values. The next section of this report examines the same temporal variances in river water quality data extending over the entire 19-year period based on computed 12-mo running average values. Examining the temporal patterns in running averages provides a reasonable indication of trends in the various data.

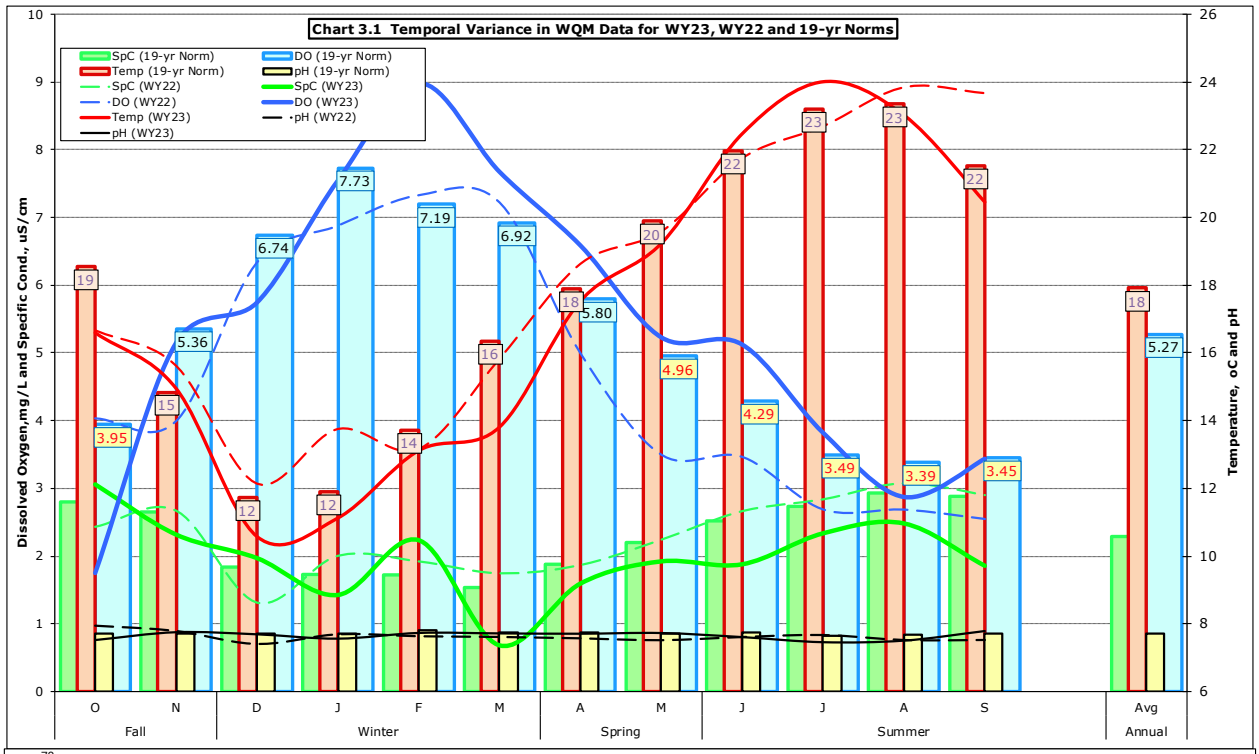
Chart 3.1 Temporal Variance in WQM Data for WY23, WY22 and 19-yr Norms
SpC (19-yr Norm)
Temp (19-yr Norm)
SpC (WY22)
DO (WY22)
Temp (WY23)
pH (WY23)
DO (19-yr Norm)
pH (19-yr Norm)
SpC (WY23)
DO (WY23)
pH (WY22)
Dissolved Oxygen,mg/L and Specific Cond., uS/cm
Temperature, oC and pH
O N D J F M A M J J A S Avg
Fall
Winter
Spring
Summer
Annual

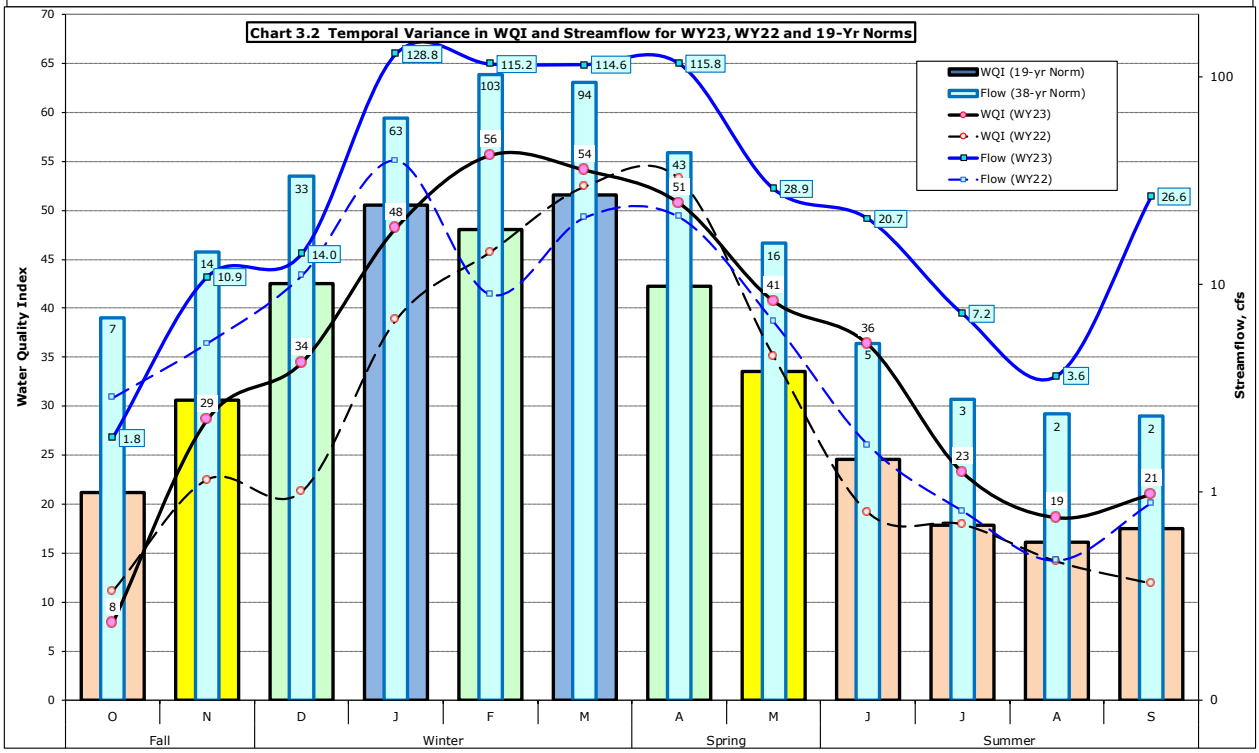
Chart 3.2 Temporal Variance in WQI and Streamflow for WY23, WY22 and 19-Yr Norms
WQI (19-yr Norm)
Flow (38-yr Norm)
WQI (WY23)
WQI (WY22)
Flow (WY23)
Flow (WY22)
Water Quality Index
Streamflow, cfs
O N D J F M A M J J A S
Fall
Winter
Spring
Summer

Section 4 - LSDR Running Average Water Quality Metrics (WY05-WY23)

Variances in SDRPF monitored water quality metrics for the LSDR, based on data collected by RiverWatch from Sept. '04 through Sept. of this year, are discused in this chapter. The metrics include water temperature, specific conductance, pH, dissolved oxygen, streamflow and the water quality index. Twelve month running average values considered with overall best-fit trendline equations represent a rational expression of relative change in value over the 19 years of continous monthly monitoring for each metric.

Table 4.1 presents 12-month running average values for each of the key water quality metrics monitored by RiverWatch over the last 19 years. Running averages above norms are listed in black; values below norms are in red. Norms for each metric are expressed in italics in the bottom row of the table. Running average water temperature for WY23 of 17.08 oC (4.5% below norm) is the lowest value experienced. Likewise, the WY23 SpC average of 1.973 mS/cm (13.3% below norm) is the lowest recorded in the past 19 yrs. Running average pH for WY23 is slighly up from last year to just below the norm. The average DO level for WY23 increased to just above the norm for only the second time in the last decade; the other being WY20. Running average daily flow for this year is more than twice the norm. The resultant average LSDR WQI for WY23 is up six points from last year to six percent above the 19-yr norm. A more detailed look at the changes in the LSDR running averages, their range and trendlines for each metric over the past 19-years is provided in subsequent charts (4.1-4.7) of this section.

Monthly water temperatures, running averages and trends are shown on **Chart 4.1**. Temperatures are cyclic with warmest temps occuring in Aug. and coolest in Dec. Summertime maximum water temps. are 150% greater than the average annual (norm) of 17.9 oC, while the winter lows reach 50% below the 19-yr norm. Variance in running average water temperature over the past 19 years falls within the range of 3% above to 3% below the norm. Although monthly variance in max.(red), min. (blue) and average (black) water temperatures for the LSDR are both large and cyclic, the 12-month running average values present minimal variance. A very slight warming trend in running average water temperatures may be occuring over the monitoring period. Maxium water temperature values monitored at all sites seeem to have increased slighlty (<1 oC), while minimums have remained near constant. A small but descernable increase in avarage LSDR water temperatures from sub-18.0 oC to slightly above the normative value by (approx. 0.2-0.4 oC) is evident from the site data analysied of the past two decades.

Variance in monthly monitored **Specific Conductance** (SpC) values for the LSDR are presented in **Chart 4.2**. Min. (blue) and max. (red) running averages for all sites monitored have varied measurably over the 19-yr period, however, the overall LSDR running average ranged from a low 1.97 mS/cm range (*13% below norm*) this year to 2.77 mS/cm (22% *above)* in WY18. The overall trend in maximum SpC for all sections of the river has shown a stready decline over the last decade of monitoring. The variance in minimums at all sites (blue) has remained fairly steady, however, overall average values (black line) have declined slightly over the last decade due to higher daily air temperatures, resulting in somewhat greater evaporation rates occuring throughout the dry weather months of May thru October.

Variance in monthly **pH** values are presented in **Chart 4.3**. The overall or general trend in values monitored for the LSDR has been relatively consistant over the last 19 years (WY05-WY23). The initial years (WY05-WY09) of below average pH were due, at least in part, to faulty equipment as monthly minima and maxima values (since WY10) have recorded higher on a consistant basis. Excluding the initial year's, there has been but small variance (<3%) in the overall running average pH from the 19-yr norm of 7.74. The overall trend in pH for the river is, however, slightly positive. Values have increased by an average of about 0.3% per annum since RiverWatch monitoring began, primarily as minima values have risen. It is concluded that the lower river may gradually becoming slightly more alkiline (basic) as average flow has declined, water temperature become warmer and increased aerobic resperation occurs.

Table 4.1 - LSDR 12-mo Running Average WQM Metrics (WY05-WY23)

	Temp, *oC*	SpC, *mS/cm*	pH, *unit*	Disslov. Oxygen, *mg/L*	*(%ofSat)*	ADF, *cfs*	WQI [a] *Values, Grade & (Diff.)*
WY05	17.81	2.061	7.62	6.84	(61%)	57.7	41 C Fair (+8)
WY06	18.29	2.140	7.39	6.04	(57%)	12.5	37 D+ Marginal (+4)
WY07	17.62	2.344	7.52	5.95	(58%)	8.6	37 D+ Marginal (+4)
WY08	17.55	2.222	7.90	6.20	(62%)	16.6	37 D+ Marginal (+4)
WY09	17.65	2.390	7.64	6.20	(62%)	19.6	37 D Marginal (+4)
WY10	18.03	2.281	7.86	5.35	(50%)	28.0	34 D Marginal (+1)
WY11	17.76	2.170	7.88	5.76	(53%)	26.4	38 C- Fair (+5)
WY12	18.00	2.331	7.69	5.41	(49%)	13.2	33 D Marginal (0)
WY13	17.29	2.433	7.78	5.51	(51%)	8.3	32 D Marginal (-1)
WY14	17.81	2.500	7.67	3.95	(36%)	4.9	22 E Poor (-11)
WY15	18.70	2.177	7.79	4.62	(42%)	9.6	29 D Marginal (-5)
WY16	18.23	2.257	7.75	4.82	(45%)	14.1	28 D Marginal (-6)
WY17	18.54	2.141	7.80	5.19	(49%)	44.9	33 D Marginal (0)
WY18	18.09	2.774	7.97	4.41	(42%)	5.4	24 E+ Poor (-9)
WY19	17.74	2.162	7.77	5.11	(48%)	24.0	32 D Marginal (-1)
WY20	18.29	2.149	7.83	5.52	(52%)	30.1	34 D Marginal (+1)
WY21	17.23	2.439	7.89	5.37	(50%)	8.2	31 D Marginal (-2)
WY22	18.08	2.306	7.68	4.73	(46%)	9.7	29 D Marginal (-4)
WY23	**17.08**	**1.973**	**7.72**	**5.48**	**(51%)**	**45.1**	**35 D Marginal (+2)**
19-yr Norm	*17.88*	*2.276*	*7.74*	*5.39*	*(50%)*	*20.4*	*33 (D Marginal)*

a) Values based on SDRPF RiverWatch phys-chem monitoring results combined with USGS streamflow records for eastern (West Hills Pkwy) and western (Fashion Valley) gauging stations.WY23 values/grades (in bold type) below 19-yr norms (in italics) are in red; those equal to or above norms in black.

b) LSDR RADO<5 mg/L (<50% Sat) shown in light brown cells (WYs 14,15,16,18&22) are years with low (i.e., <30) WQIs also shown in light brown.

The most common cause of higher pH water is less available carbon dioxide caused by elevated rates of aerobic resperation (decomposition) that typically accompany warmer, still waters. Tracking the trend in pH can be important as a general indicator of the natural process of eutrophication occuring throughout many portions of the lower river. WY23 marks the first time in the last eight years that 12-mo. running average pH has fallen below the overall 19 year norm. The slight variances in pH have not been taken into consideration when calculating individual site WQI_4 values.

Running average **dissolved oxygen (DO)** values and monthly minima-maxima are presented in **Chart 4.4**. An overall, but somewhat irregular decline in average as well as min/max values from Oct. 2004 through 2015 can be observed. LSDR max. monthly values from WY15 through WY21 increased to nea

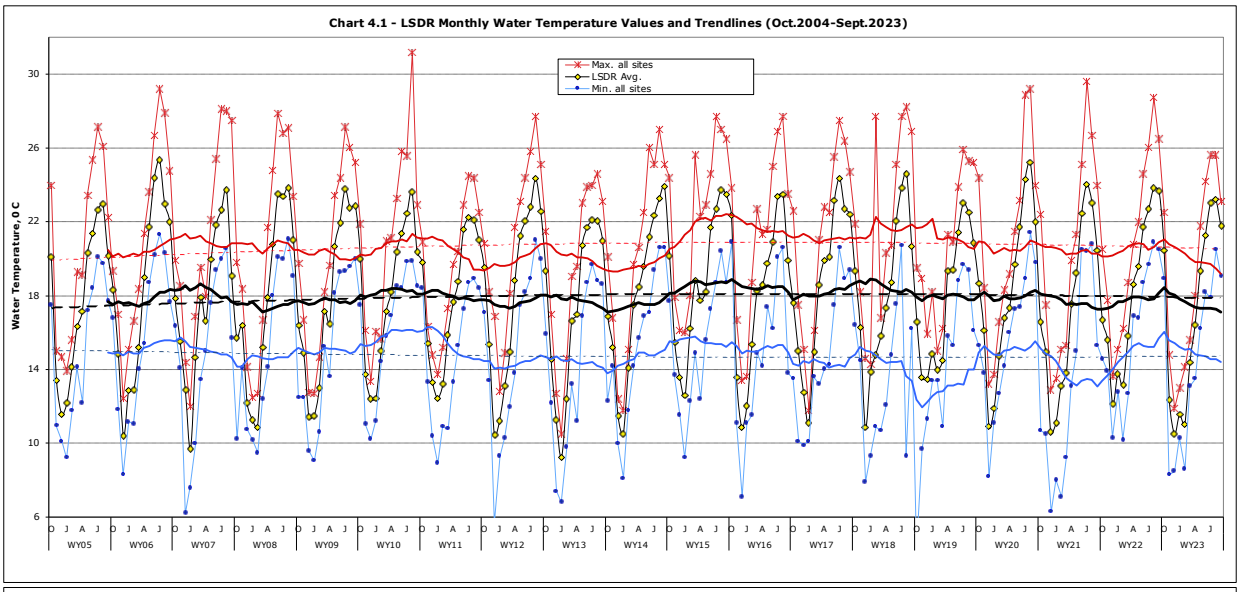
Chart 4.1 - LSDR Monthly Water Temperature Values and Trendlines (Oct.2004-Sept.2023)
Max. all sites
LSDR Avg.
Min. all sites
Water Temperature, 0 C
30
26
22
18
14
10
6
O J A J
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22
WY23

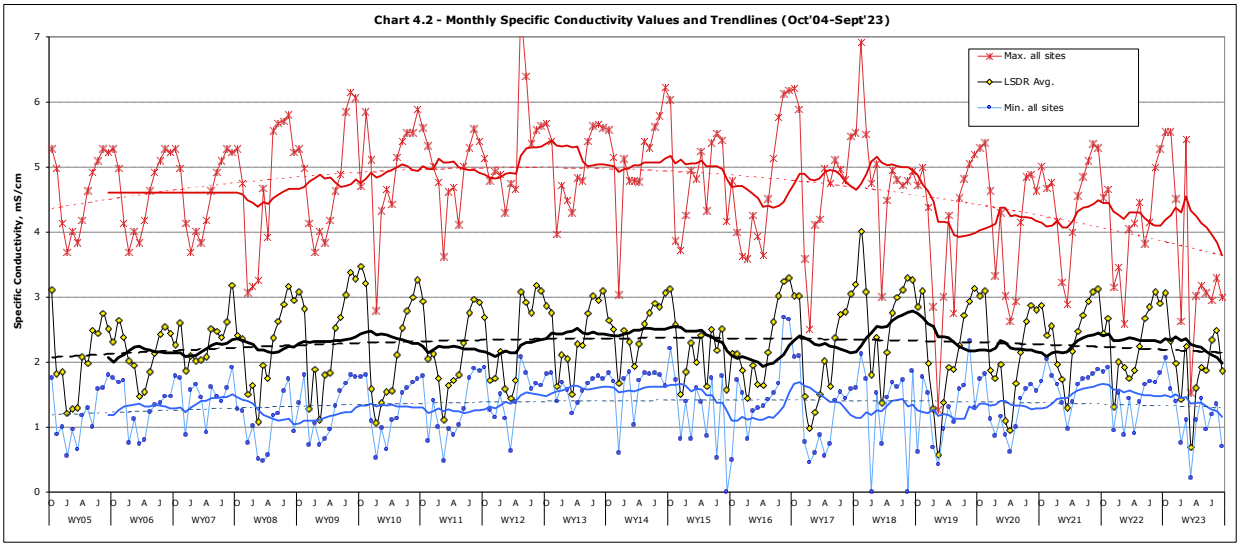
Chart 4.2 - Monthly Specific Conductivity Values and Trendlines (Oct'04-Sept'23)
Max. all sites
LSDR Avg.
Min. all sites
Specific Conductivity, mS/cm
7
6
5
4
3
2
1
0
O J A J
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22
WY23

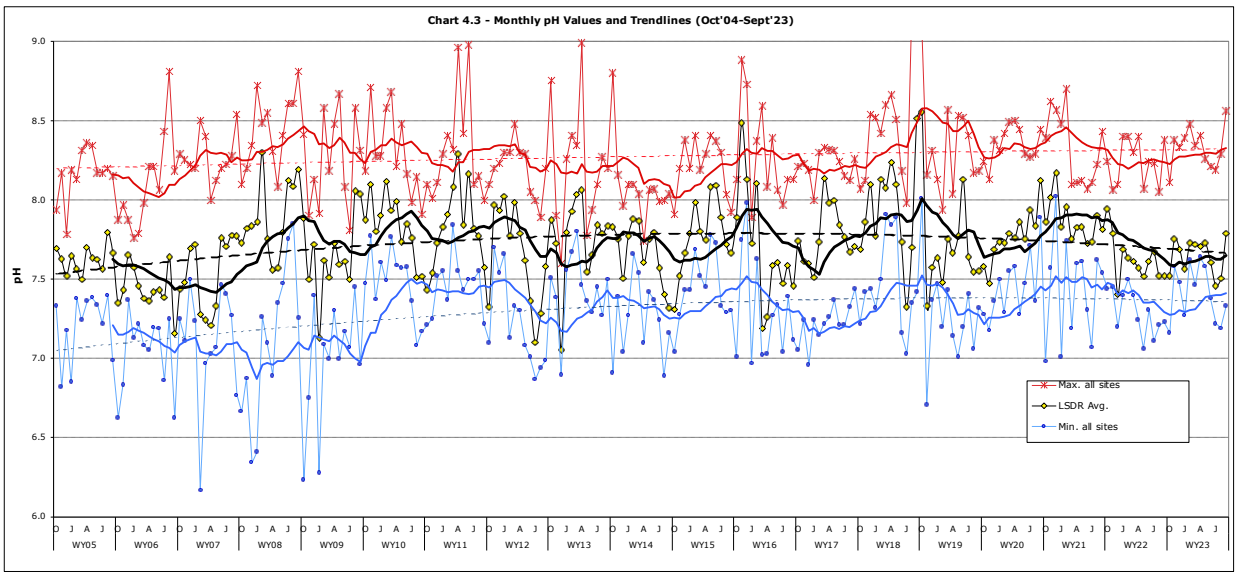
Chart 4.3 - Monthly pH Values and Trendlines (Oct'04-Sept'23)
Max. all sites
LSDR Avg.
Min. all sites
pH
9.0
8.5
8.0
7.5
7.0
6.5
6.0
O J A J
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
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WY18
WY19
WY20
WY21
WY22
WY23

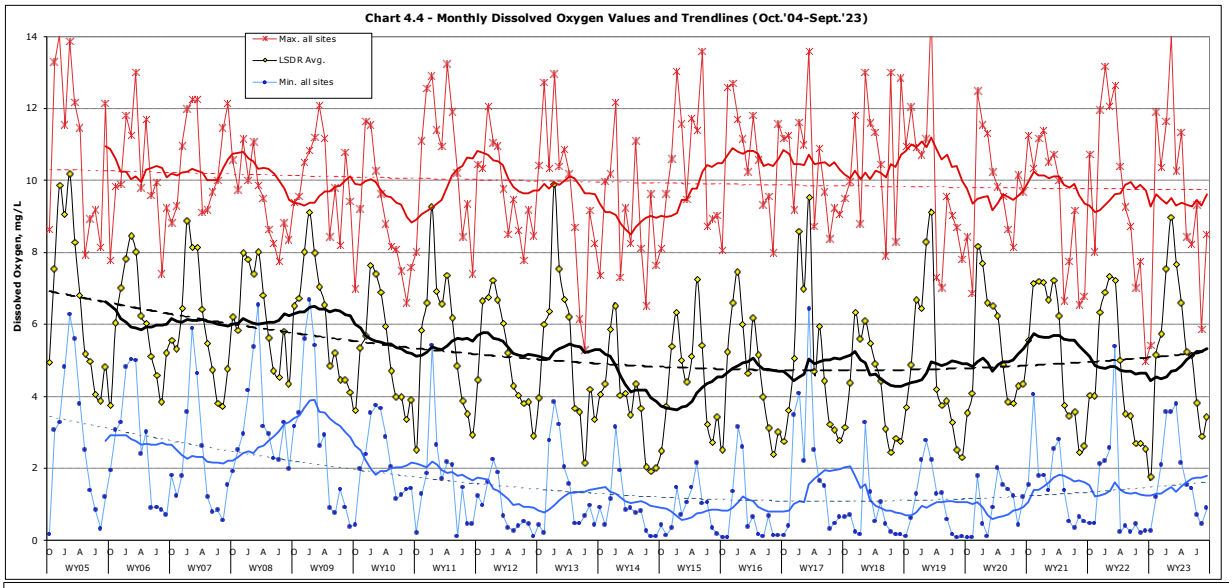


Chart 4.4 - Monthly Dissolved Oxygen Values and Trendlines (Oct.'04-Sept.'23)
Max. all sites
LSDR Avg.
Min. all sites
Dissolved Oxygen, mg/L
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22
WY23

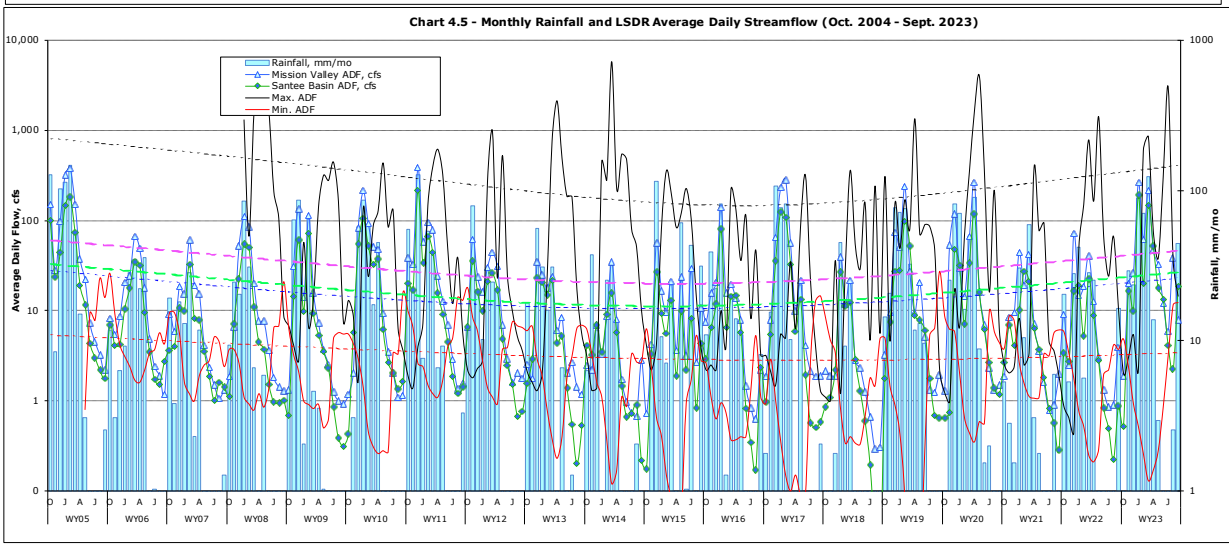


Chart 4.5 - Monthly Rainfall and LSDR Average Daily Streamflow (Oct. 2004 - Sept. 2023)
Rainfall, mm/mo
Mission Valley ADF, cfs
Santee Basin ADF, cfs
Max. ADF
Min. ADF
Average Daily Flow, cfs
Rainfall, mm/mo
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22
WY23

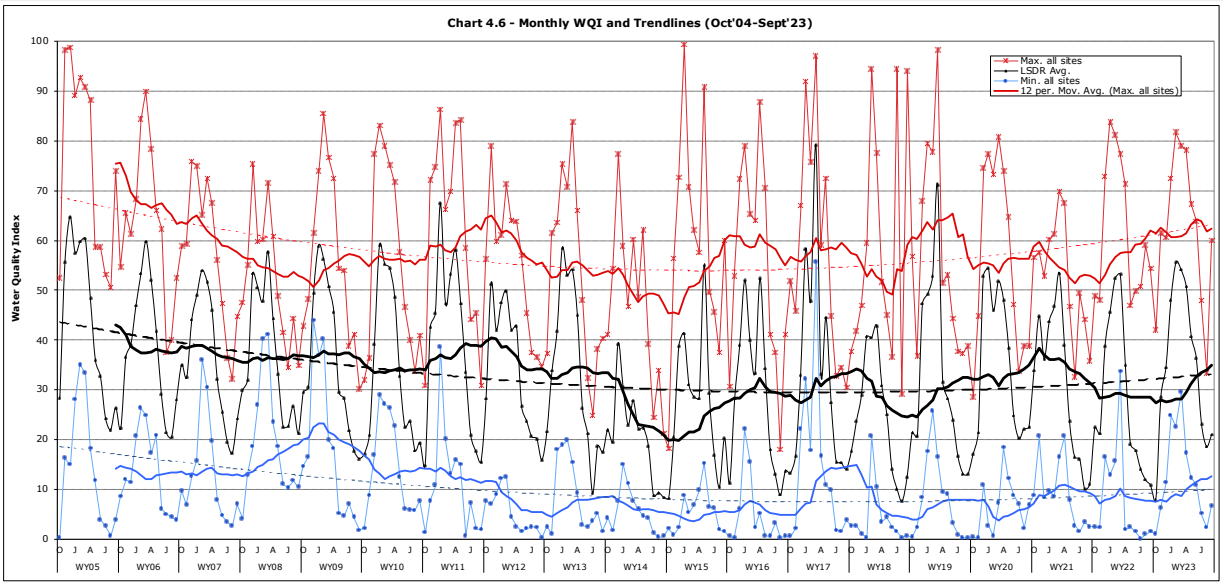


Chart 4.6 - Monthly WQI and Trendlines (Oct'04-Sept'23)
Max. all sites
LSDR Avg.
Min. all sites
12 per. Mov. Avg. (Max. all sites)
Water Quality Index
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22
WY23

19-yr norms. The current running average DO value of 5.48 mg/L (Sept 2023) is 1.7% above the 19-yr norm of 5.39 mg/L. Low dissolved oxygen levels that have been monitored throughout various reaches and segments of the lower river result from low streamflow, especially during the dry-weather months, combined with above average water temperatures and rapid decomposition of oxygen demanding organic materials (biomass). With a lack of significant flushing action during recent relatively mild stormflow events occuring over the past decade, a large amount of decomposing biomass has accrued within slower moving portions of the river. Overall running average DO values often increase subsequent to one or more major stormflow events resulting in significant channel flushing, displacement of organic-rich sediments and significant reduction of poorly-rooted and free-floating invasive aquatic plants*. The trend in overall LSDR DO values has, over the past 18 years, declined in excess of 2 mg/L from roughly 7.0 mg/L to 5.0 mg/L. This represents an average annual decline in DO of 0.11 mg/L since RiverWatch monitoring was inniated. As can be seen on Chart 4.4, the rate of decline in minimum values (-3%/yr) is noticably greater than the rate of decline in maxima (-0.5%/yr). Extended periods of low flow minima have resulted in lower overall average DO levels. WY23 DO averages have increased considerably over the last year due to greater streamflows steming from greater rainfall and lower water temperatures.

Variances and their trends for **total monthly rainfall and running average streamflow** in the Santee Basin (SB) and Mission Valley (MV) sections of the lower river system are expressed in **Chart 4.5.** The trend in average daily streamflow throughout the LSDR watershed fell by a full order of magnitude (from 58 cfs to 5 cfs) between WY05 to WY14, then rose to 45 cfs in WY17. Lowest running average annual streamflow of 7-8 cfs for Mission Valley and 3 cfs for the Santee Basin, occured in WY14. Due to the distribution and magnitude of rainfall in both WY15 and WY16, running average streamflow rose to 15-20 cfs (Mission Valley) and 8-12 cfs (Santee Basin). Streamflow fell sharply in WY18 as the watershed recieved near record low rainfall. With above normal rainfall in WY19 and WY20, streamflows climbed back to above long-term norms. Dry weather flows from June through Sept. of WY21 were some of the lowest recorded in the past 4-5 decades. As WY23 witnessed considerably greater total rainfall than in past years, streamflows were well above normal. The current running average flow of 45 cfs is twice the 19-yr LSDR norm of 20.4 cfs. Significant variance in average annual streamflow, as well as maxima and minima values monitored within the lower river watershed can be expected to persist as rainfall and stormwater runoff remain the driving factors.

The overall **water quality index** (WQI) for LSDR as well as minimum and maximum running average values for all monitoring sites within the watershed are presented in the final two charts of this section**. Chart 4.6** expresses average, minimum and maxium WQI for the entire LSDR system based on distance (reach) averaging of index values calculated for each monitoring site. **Chart 4.7** expresses the same distance-averaged index values as percent variance from the norms. The greatest positive variance from norm (blue line) is associated with the Mission Gorge section (sites 8,9&10) whereas the greatest negative variance is found in the Upper Santee Basin (USB) reach. The overall LSDR reach-averaged running avarage variance from the 19-yr norm are shown as black lines. The trendlines for each section and overall river system are shown as dashed lines in the same colors.

Variance from norm as shown in Chart 4.7 is a very good and clear indicator of the relative change in overall (LSDR) phys-chemical water quality considered over the entire period of monitoring. Highest LSDR index values and associated greatest positive variance from norms occured in the inital year of monitoring (WY050), followed by unsteady and fluctuating declines in index values over the next nine years extending through Dec. 2014. Since Jan. 2015 there has been an unstready and fluctuating running average increase in index values through the current water year. The monthly values and variances over time have not been consistant as can be noted by the differences in patterns between the highest (MG) and lowest (USB) reaches shown on both chart 4.6 and 4.7. The running average variance in index values and trends by induvidal river reach and section over the last 19 years are examined in Section 5.

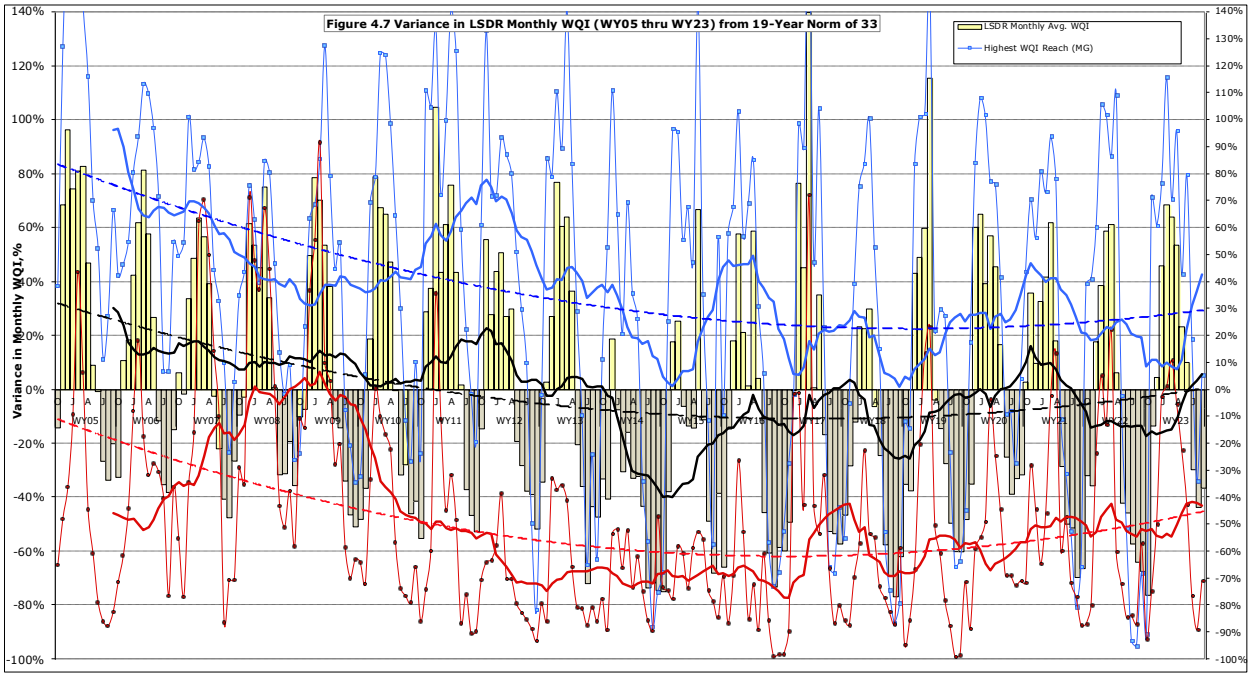
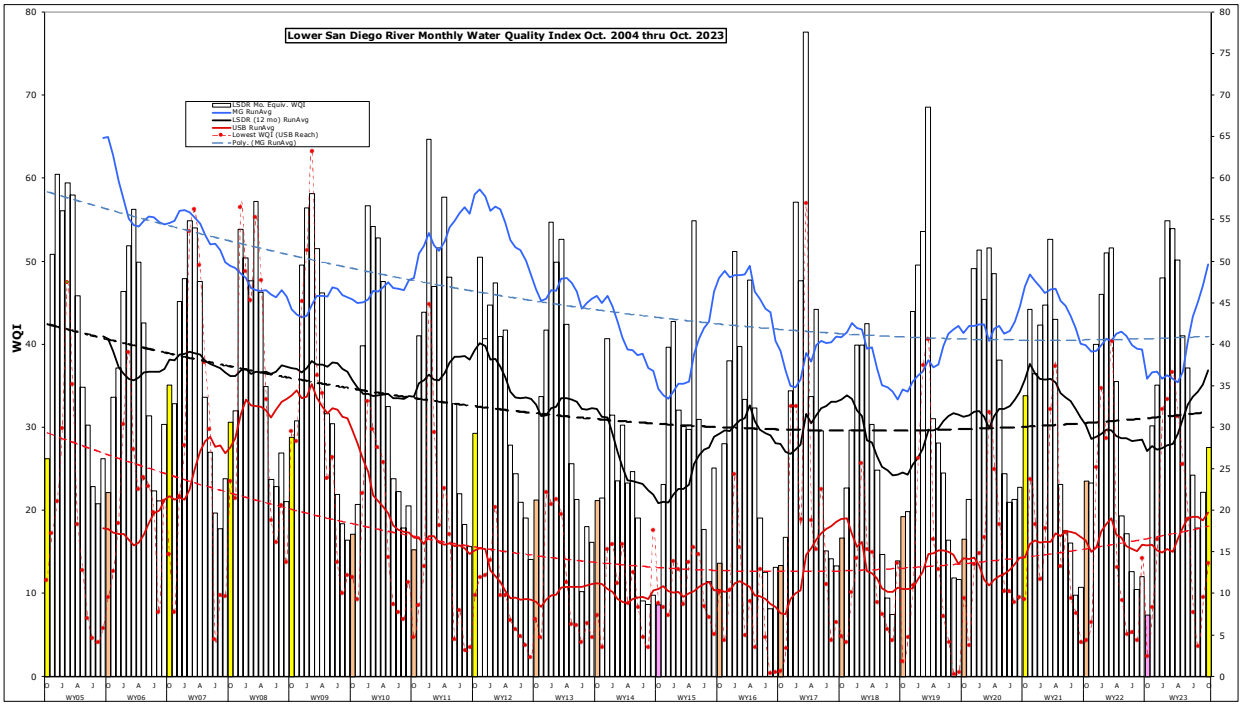


Figure 4.7 Variance in LSDR Monthly WQI (WY05 thru WY23) from 19-Year Norm of 33
LSDR Monthly Avg. WQI
Highest WQI Reach (MG)
Variance in Monthly WQI,%
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22
WY23


Lower San Diego River Monthly Water Quality Index Oct. 2004 thru Oct. 2023
LSDR Mo. Equiv.- WQI
MG RunAvg
LSDR (12 mo) RunAvg
USB RunAvg
Lowest WQI (USB Reach)
Poly. (MG RunAvg)
WQI
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22
WY23

Section 5 - WQ Index by Site, Reach and Section (WY05 through WY23)

Annual and seasonal LSDR WQI values are presented in **Table 5.1** by river reach, section, and overall (LSDR) average for each water year (WY05-WY23) of monitoring. Values and grades above norms are listed in black; values below italized norms (bottom row) are shown in red. The WY23 values, expressed in bold font, have increased from last year's results for all reaches and sections of the lower river. Overall the LSDR average annual WQI rose six points from last year's value of 29 to three points above the 19-year norm of 32.8. The overall annual WQI average has remained in the Marginal grade (D) for the last five water years. In addition to annual averages the seasonal range as represented by winter highs and summer lows are also presented by reach, section and overall. WY23 winter (D-M) WQIs are greater than last year's within all but one reach (USB) while this past summer's (J-S) index values are higher in all reaches as well as overall.

The running averages and variances in monthly index values, for each reach of the lower watershed are presented in the series of charts (5.1 through 5.6) on pages 19 and 21 of this section. Trends in values taken over the monitoring period are shown as dashed lines based on best-fit, using second-order polynomial equations. The range in trendlines between the highest (red) and lowest (blue) sites located within each reach are also expressed.

Table 5.1 - Average Annual and Seasonal WQI by Reach and Section (WY05-WY23)

	LMV Reach	MMV Reach	UMV Reach	West (MV) Section	MG Section	LSB Reach	USB Reach	East (SB) Section	LSDR Overall Avg.	
WY05	48	54	40	46	65	33	18	24	41	C (high)
WY06	39	47	30	37	54	37	21	28	37	D+
WY07	36	43	23	33	50	44	27	34	37	D+
WY08	38	39	28	35	46	41	33	36	37	D+
WY09	38	37	30	34	46	37	31	35	37	D+
WY10	36	36	31	34	48	32	17	27	34	D
WY11	39	39	39	39	56	45	15	29	38	C-
WY12	35	38	35	35	48	41	9	24	33	D
WY13	37	38	32	35	45	39	11	23	32	D
WY14	18	17	19	18	37	30	10	19	22	E (low)
WY15	24	22	23	23	46	41	10	27	29	D
WY16	35	30	22	29	40	33	8	23	28	D
WY17	34	34	33	33	41	35	19	29	33	D
WY18	26	28	21	24	33	33	11	20	24	E+
WY19	36	37	30	34	42	35	14	24	32	D
WY20	37	37	34	36	45	41	14	28	34	D
WY21	31	33	28	31	40	42	17	28	31	D
WY22	29	31	25	28	39	37	16	28	29	D
WY23	**34**	**35**	**32**	**34**	**47**	**44**	**19**	**24**	**35**	**D**
19yr Norm	*34.2*	*35.6*	*29.1*	*32.4*	*45.7*	*37.1*	*16.9*	*27.0*	*32.8*	*Marginal*
Winter	*LMV*	*MMV*	*UMV*	*MV*	*MG*	*LSB*	*USB*	*SB*	*LSDR Overall*	
WY05	63	72	61	64	87	44	33	39	58	B (high)
WY06	54	63	49	52	61	40	29	35	48	C+
WY07	49	54	41	46	63	56	40	48	50	B-
WY08	56	52	47	52	55	52	52	52	52	B-

WY09	57	53	49	53	62	54	49	52	54	B
WY10	54	55	54	54	66	54	28	41	51	B-
WY11	57	55	57	56	67	54	27	40	52	B-
WY12	48	52	50	49	60	45	14	29	43	C
WY13	58	56	55	56	68	49	21	35	50	B-
WY14	26	25	26	26	55	39	15	27	32	D (low)
WY15	33	31	27	31	59	53	11	32	36	D+
WY16	44	42	38	41	57	52	14	33	40	C
WY17	53	55	60	55	64	61	35	48	54	B
WY18	38	40	37	38	58	41	16	29	38	C-
WY19	58	58	57	57	69	58	29	43	54	B
WY20	54	55	57	55	64	54	19	37	49	C+
WY21	47	48	44	47	58	51	20	35	44	C
WY22	47	50	48	47	62	46	32	39	47	C Fair
WY23	**47**	**49**	**48**	**48**	**60**	**56**	**30**	**43**	**48**	**C Fair**
19yr Norm	*49.8*	*50.9*	*47.7*	*48.8*	*62.9*	*50.3*	*26.8*	*38.6*	*47.4*	*C Fair*
Summer	*LMV*	*MMV*	*UMV*	*MV*	*MG*	*LSB*	*USB*	*SB*	*LSDR Overall*	
WY05	31	36	18	28	46	21	5	13	25	D-
WY06	23	31	8	19	45	31	18	24	26	D- (high)
WY07	23	31	7	19	35	24	13	19	22	E
WY08	23	28	16	22	33	25	17	21	24	E
WY09	21	21	14	18	32	25	16	20	22	E
WY10	21	22	16	20	33	26	9	17	21	E
WY11	23	21	16	20	38	30	5	18	22	E
WY12	22	23	18	20	25	27	4	16	20	E
WY13	18	23	11	16	20	23	5	14	16	E
WY14	10	10	12	10	12	16	9	12	12	F+
WY15	15	12	14	14	35	37	9	23	21	E
WY16	18	14	7	13	17	20	5	12	13	E-
WY17	20	20	16	18	20	22	11	17	18	E
WY18	12	14	6	10	9	19	8	14	11	F (low)
WY19	23	19	10	18	23	22	3	13	16	E
WY20	25	24	17	22	30	29	10	20	22	E
WY21	14	16	10	13	14	18	10	14	14	E-
WY22	17	19	12	15	8	19	7	13	13	E-
WY23	**27**	**24**	**15**	**22**	**39**	**37**	**10**	**23**	**25**	**D-**
19yr Norm	*20.3*	*21.5*	*12.7*	*17.7*	*27.0*	*24.8*	*9.1*	*17.0*	*19.2*	*E Poor*

Table 5.1 WQI Letter/Color Code: A (>75) Very Good (dark blue), B (50-74) Good (light blue), C (38-49) Fair (green), D (25-37) Marginal (yellow), E (13-24) Poor (brown), and F (0-12) Very Poor (pink). WQI values below 19-yr norms (bottom row in italics) are in red for the same reach/section of the river; values at or above norms are in black. Overall LSDR WQI values are D-weighted averages.

As shown in **Chart 5.1** on the next page, average annual WQI values associated with the **Lower Mission Valley Reach** (Sites 1-3) have varied from a high of 50 (B-Good) in WY05 to a low of 18 (E Poor) in WY14. The general trend in running average WQI for this lower most reach, as well as the individual monitoring sites, declined from the mid 40's (C Fair) in WY05 to below 25 (E Poor) by WY14&15. The running average WQI (*black line*) recovered to the mid-30's during WYs16/17, declined to the mid 20's in WY18, clrose back up in WY's19-20, to again fall below 30 in WY22. WY23 signifies a year of overall recovery.

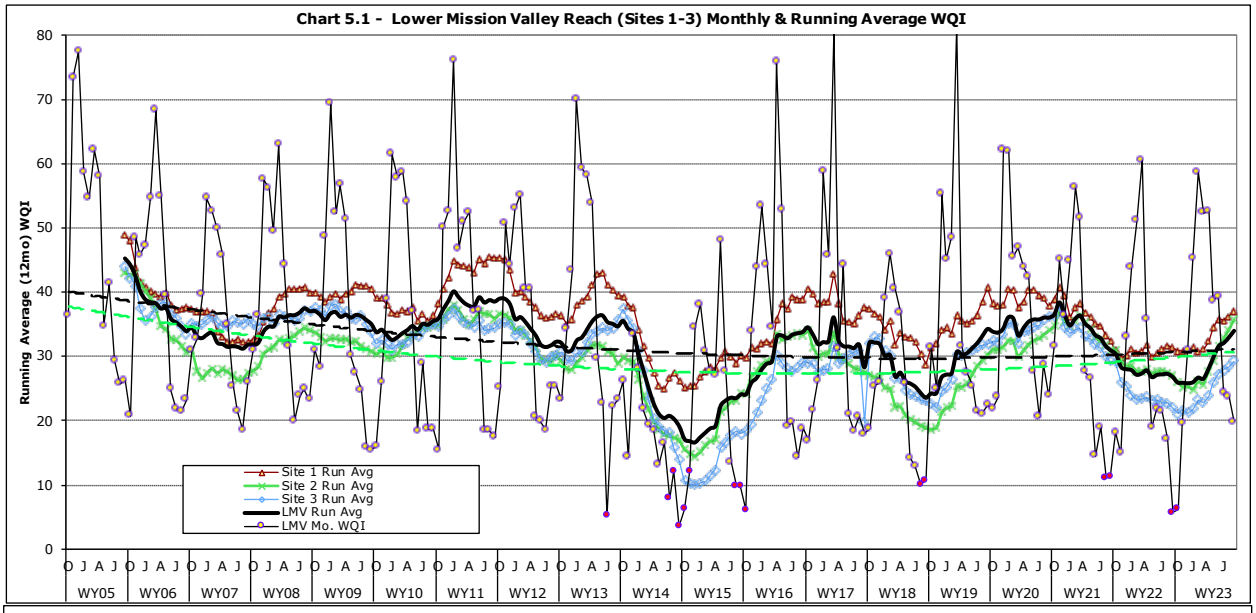


Chart 5.1 - Lower Mission Valley Reach (Sites 1-3) Monthly & Running Average WQI
Running Average (12mo) WQI
Site 1 Run Avg
Site 2 Run Avg
Site 3 Run Avg
LMV Run Avg
LMV Mo. WQI
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22
WY23

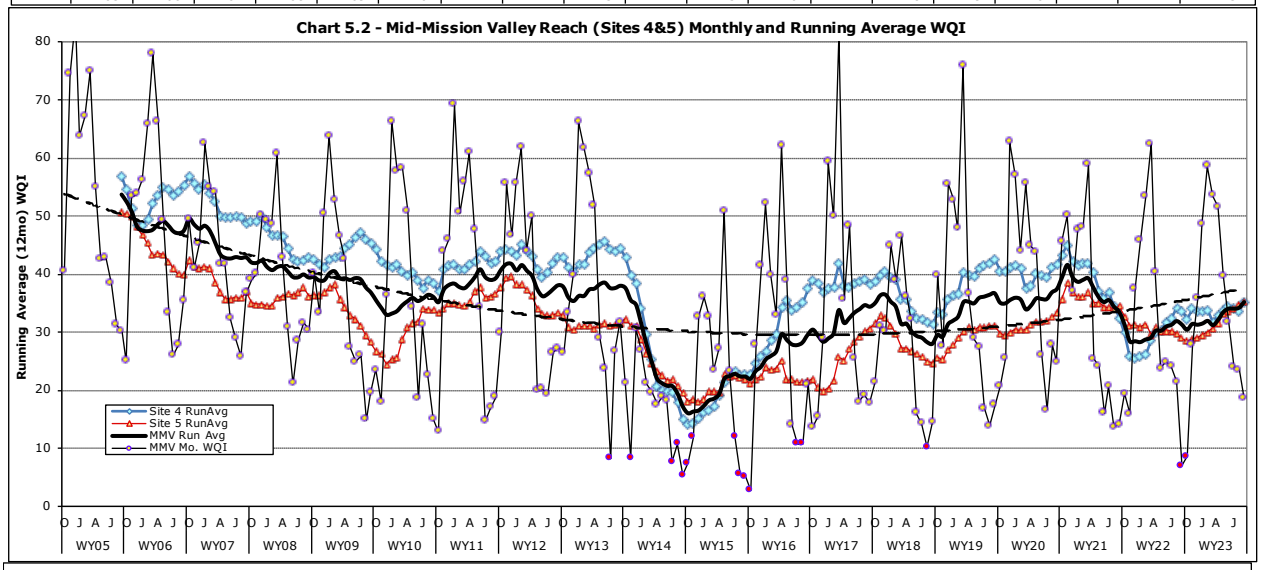


Chart 5.2 - Mid-Mission Valley Reach (Sites 4&5) Monthly and Running Average WQI
Running Average (12mo) WQI
Site 4 RunAvg
Site 5 RunAvg
MMV Run Avg
MMV Mo. WQI
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22
WY23

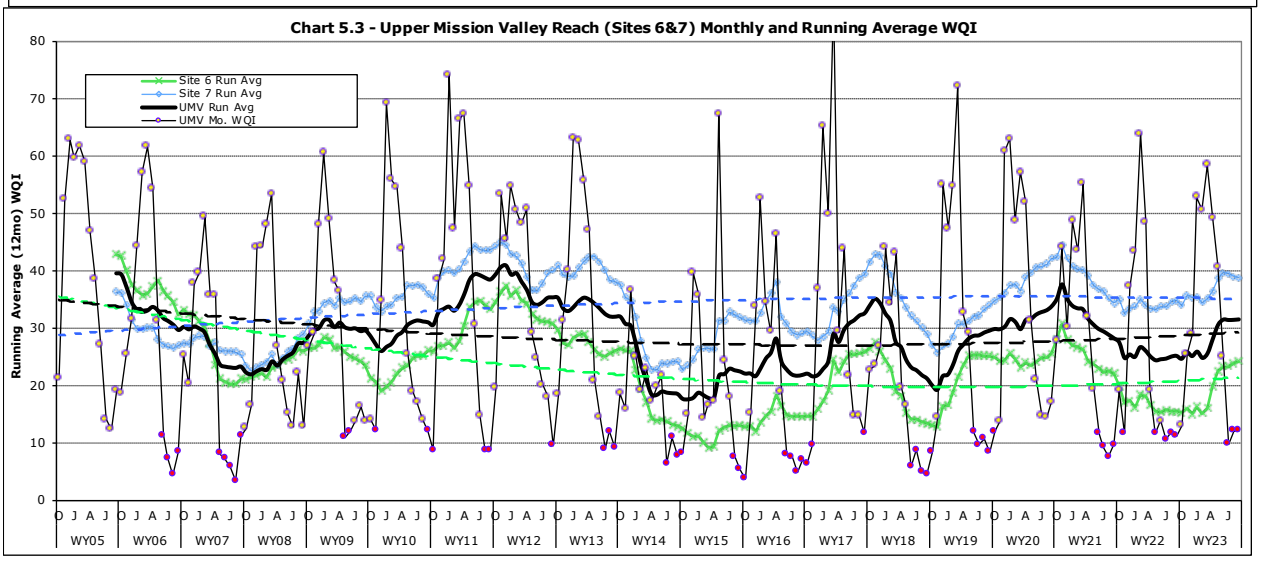


Chart 5.3 - Upper Mission Valley Reach (Sites 6&7) Monthly and Running Average WQI
Running Average (12mo) WQI
Site 6 Run Avg
Site 7 Run Avg
UMV Run Avg
UMV Mo. WQI
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22
WY23

Site 3 (FVM) the *blue line* has since WY11 exhibited the lowest running average WQI, while Site 1 (Estuary at I5 *brown line*) has consistently witnessed the highest values for the Lower Mission Valley reach. The most significant decline in the WQI for the reach and at all three sites occurred in WY14. The running average index for this reach declined from the mid 40's to the present lower 30's (an approximate 10% decline) over the 19-year monitoring period.

As shown in **Chart 5.2** , the range in monthly WQI values for the **Mid-Mission Valley Reach** (Sites 4&5) are similar to those in Lower Mission Valley, although somewhat higher. Site 4 (FSDRIP at Mission Center Rd, *blue line*) presents the highest WQI values of all seven Mission Valley sites. Site 5 (Ward Rd bridge, *red line*) are commonly 5 to 8 points lower, although in recent years index differences are somewhat less (3-5). The patterns of improvement and decline in index values over time are very similar to the three Lower Mission Valley sites. Highest values (grade B Good) were in WY05/06 while minimums (grade E Poor) occured in WY14.

As shown in **Chart 5.3** , the range in monthly WQI values for the **Upper Mission Valley Reach** (Sites 6&7) of the river are similar to those in Lower and Mid Mission Valley, although somewhat less variable. Site 6 (Kaiser Ponds outlet at Mission Valley Rd, *green line*) has continuously presented lowest running average WQI values since early 2017, while Site 7 (Admiral Baker Field at Zion, *blue line*), situated just upstream of the ponds, has presented higher values on an extended basis since mid-2008. The highest average annual WQI reading of 65 (A Very Good) for the Upper Mission Valley reach was in WY05, whereas the lowest reading of 19 (E Poor) was in WY14.. The overall Upper Mission Valley trend since 2006 has been negative (in decline) as growth of invasive aquatic plants and increase in biomass has proliferated throughout much of this reach during extended periods of low flow. The rate of decline in running average index in this reach over 18 years is about 1.8 percent/year, decreasing from 40 in WY05 to the present value of 27. Significant recovery in this reach is problemmatic without improved channel maintence due to the extensive accrual of biomass, deep ponds and insufficient flushing from stormflow.

Running average WQI for the **Mission Gorge Reach** (Sites 8-10) of the river, as shown in **Chart 5.4**, has also declined, especially during WY12 through WY14. Highest annual WQI values of 63 (B Good) occured in WY05, contrasted with a low of 33 (C Marginal) in WY18. In general running average WQI for this reach is the highest of all five reaches with an average WQI of 46 (B Good). The trend in Mission Gorge WQI values (*black line*) are, however, comparable to those in the Mission Valley reaches. General decline in index values from WY06 through WY09, followed by a slight upturns in WY10 and WY11, and a more significant decline in subsequent water years to a low of 33 (D Marginal) in early WY15. WY17 witnessed an overall nine-point recovery in the running average WQI. The index for this reach fell during the second half of WY18 to a record low of 33. WY19 saw recovery to 42 and to 44 by the end of WY20 then back down to 39 by the end of WY22. The overal index has declined 26 points (from 65 down to 39) over 19 years in this section of the river. The running average index value has remained below the 19-yr norm of 46 since WY13. Site 8 (Mission Trails Crossing) has shown the the most positive trend in index value over the 19 years of monitoring.

The **Lower Santee Basin Reach** (Sites 11, 15T, 12T and 13W) WQI values and running averages are shown in **Chart 5.5**. The range from winter month highs in the 50-70 range (B Good) to summer lows in the 10-15 range (E Poor) are fairly common. Water quality improved in this reach from WY06 through WY11, then declined in subsequent water years, reaching a running average low of 27 (D- low-Marginal) in 2015, before recovering to the mid-40s (C Fair) throughout WY16 and low 40's in WY17. The previous low was surpassed by one point in both August and September of WY18. WY19 witnessed partial recovery to the mid 30's reaching 41 in 2020, 42 in WY21 but falling to 37 this year.. Completion of the Forester Creek enhancement project (expressed by the *blue line*) extending from Prospect Ave. to Mission Gorge Rd. has had a significant impact on overall river quality (*black line*) in the Lower Santee Basin portion of the river system. With above normal rainfall experienced in WY19 and WY20, the Lower Santee Basin running

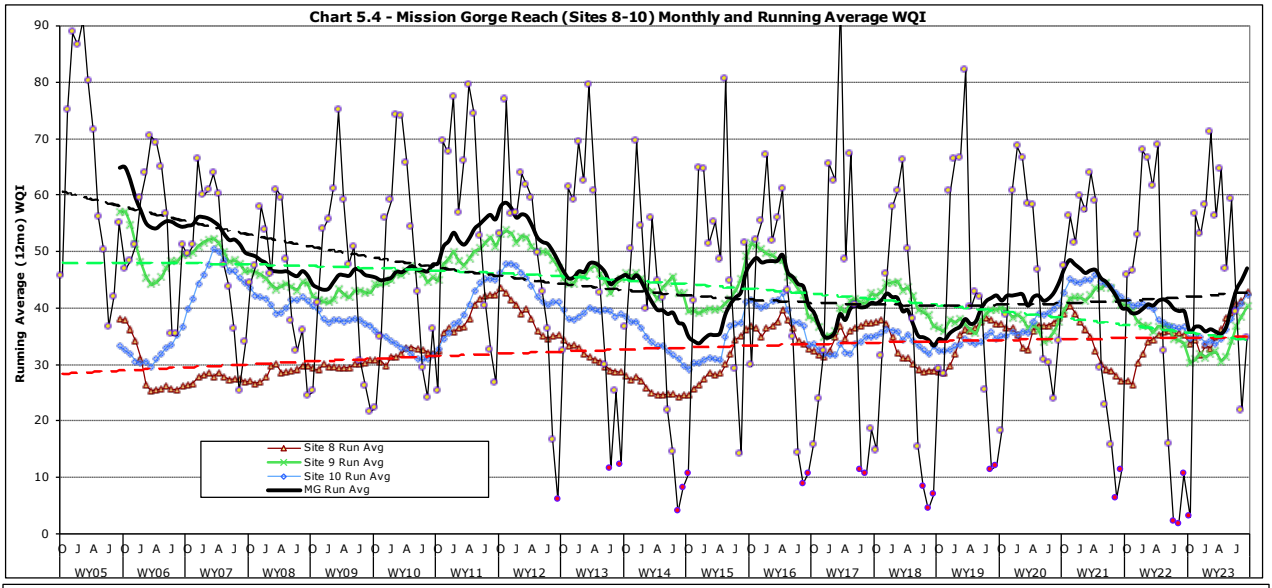


Chart 5.4 - Mission Gorge Reach (Sites 8-10) Monthly and Running Average WQI
Running Average (12mo) WQI
Site 8 Run Avg
Site 9 Run Avg
Site 10 Run Avg
MG Run Avg
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22
WY23

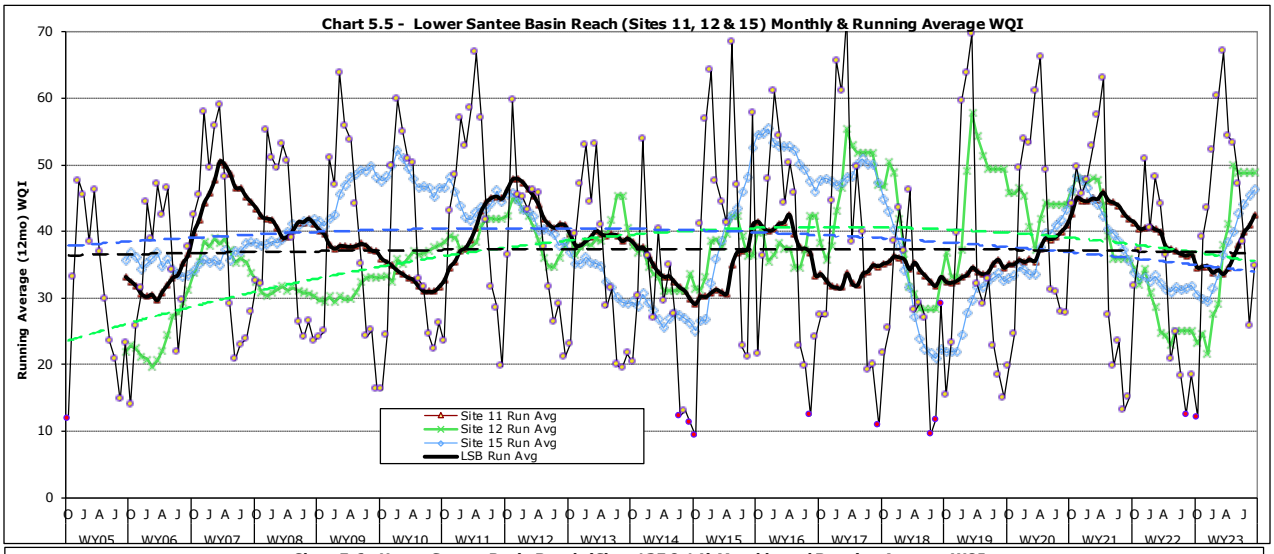


Chart 5.5 - Lower Santee Basin Reach (Sites 11, 12 & 15) Monthly & Running Average WQI
Running Average (12mo) WQI
Site 11 Run Avg
Site 12 Run Avg
Site 15 Run Avg
LSB Run Avg
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22
WY23

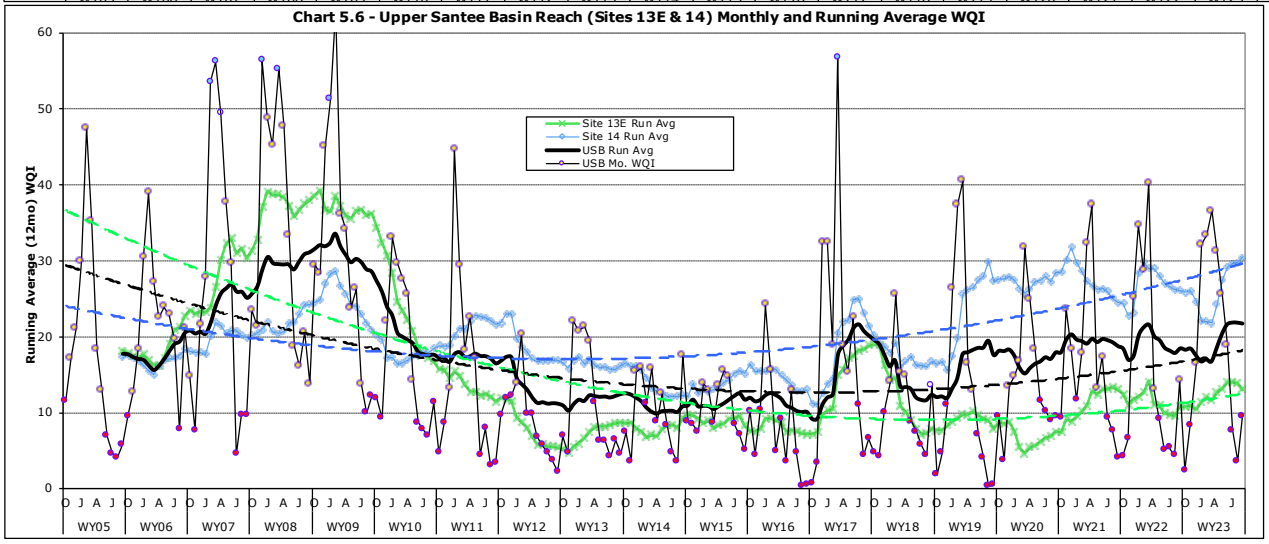


Chart 5.6 - Upper Santee Basin Reach (Sites 13E & 14) Monthly and Running Average WQI
Running Average (12mo) WQI
Site 13E Run Avg
Site 14 Run Avg
USB Run Avg
USB Mo. WQI
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
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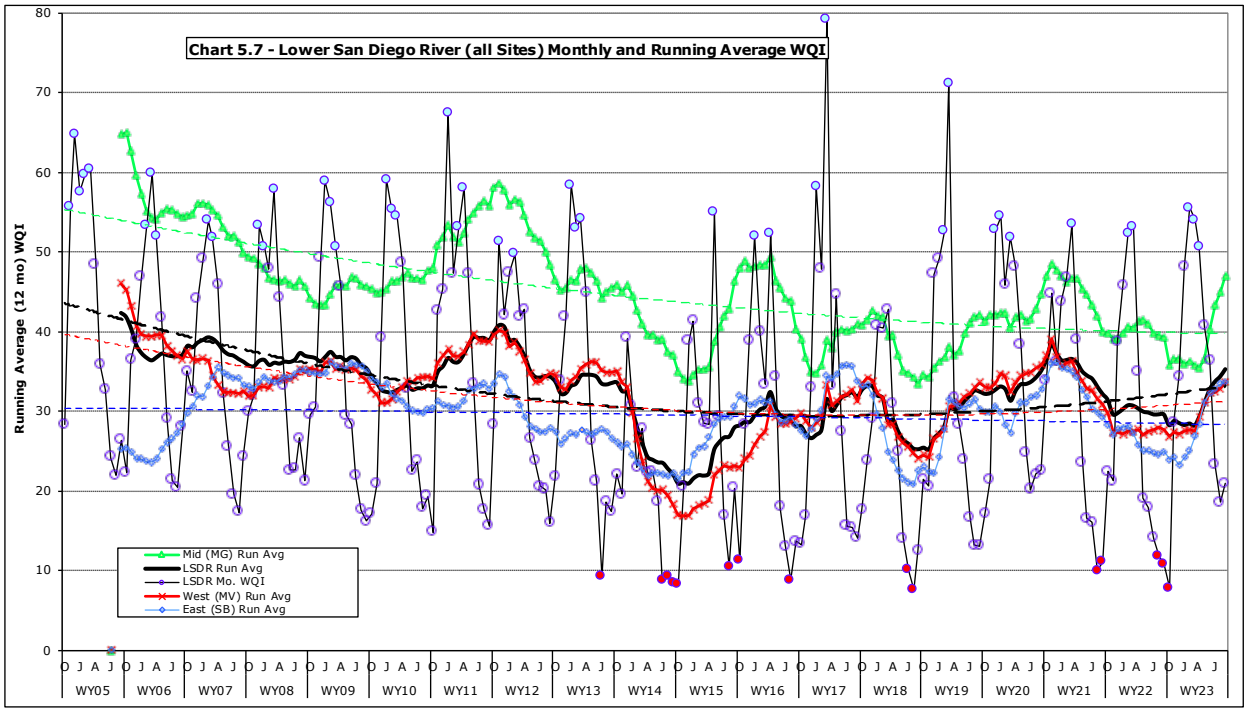
WY17
WY18
WY19
WY20
WY21
WY22
WY23



running average index improved to values comperable to those experienced in WY07 through WY11. The overall change in the index between WY05 and WY23 is roughly one percent per annum. This reach of the river has shown the least amount of change in index values over time.

Chart 5.6 presents monthly and running average WQI values for the **Upper Santee Basin Reach** (Sites 13E & 14) of the river. This reach presents the poorest water quality values of all sections of the lower river system. Monthly values have seldom exceeded 20 (E Poor) since the summer of 2011 and are often less than 12 (F+ Very Poor) throughout all but the wet-weather, winter months. The running average WQI for this reach has declined from highs above 30 (D Marginal) in WY09 to continuously between 10 and 12 (F Very Poor) during the five year period (WY12-WY16). WY17 saw a noticeable increase (ten points) in the running average index from early in the year reaching 18 (E-Poor) in September, however WY18 witnessed a reversal with a steady decline toward previous lows. WY19 witnessed partial recovery to prior highs, especially at site 14. The greatest variability has been associated with site 13, Mast Park East (*green line).* The reach index has fallen 88% (from 32 in WY to 17) over the last 12 years presenting the greatest decline in running average values of all reaches. Advanced eutrophication within multiple ponds and backwaters within and upstream of Mast Park has lead to high levels of oxygen depletion recorderd throughout the year. Hypoxic conditions (DO<2.5 mg/L) are quite common at Site 13E (Walmart Ponds) in all but the highest runoff months of the year.

The monthly and running average variation in WQI values for the three main sections of the lower river (i.e., Santee Basin, Mission Gorge and Mission Valley) and the overall **Lower San Diego River** system (distance-weighted average of all monitoring sites) are presented in **Chart 5.7.** WQI running average values recovered from WY14 lows in all three sections of the lower river system during WY15 through WY17. Values noticably declined in WY18 then rebounded (to WYs13/16 levels) in WYs19/20. WYs21/22

again experienced declines in all three sections of the lower river follwed by recovery in WY23. The Mission Gorge section changed least, while the upstream section (Santee Basin) the most. There were significant increases in index values in all sections of the river (and thus overall) in WY23. The current LSDR running average WQI of 35 (D Marginal) is nine percent above the 19-yr norm of 32. The overall LSDR running average index value has declined by approximately one-half point per year since monitoring was started in Sept. 2004. The overall decline is the result of lower oxygen concentrations, warmer water temperatures and higher specific conductivities monitored at nearly all sites over the 19 year period. These values are also negatively impacted by low streamflows especially during extended months without measurable rainfall within the watershed. WQI values can be expected to increase when overall streamflows rise well above current norms and aquatic growth abatement measures are effectively implemented (or possibly occur through natural flushing) for specific reaches of the river. Higher minimum index values during the dry summer months often result in positive gradients for 12-mo. running averages within a single water year, especially the case in the Mission Gorge section. Without human intervention, however, overall negative trends in WQI values can be expected to persist for many if not all portions of the lower river due to natural processes of organics deposition and eutrofication.

L ow DO levels are primarily the result of extensive and persistent eutrophication from buildup of organic-rich detritus combined with restricted water movement within various portions of the lower river, especially in deeper pools and slack water. Until the spread of creeping water primrose (L*udwigia peploides, et.al.)*[a] and other invasive aquatics are better managed and the affects of eutrophication more effectively controlled, water quality of the lower river system can be expected to remain significantly below that monitored and experienced in portions where improved circulation, mixing and re-oxygenation occurs naturally.

High specific conductance levels are primarily the result of extended below average dry weather streamflow intensified during drought conditions. Low streamflow also effects river water temperatures; where in gerneral less flow results in higher temp values under equivalent ambient air temperature and levels of sunlight. The variance in pH shows a definite cyclic pattern with little discernable trend, irrespective of individual site, reach or section of the river. Both surface and ground waters of the lower river system act as a natural buffer to fluctuations in pH at induvidal sites.

a) Ludwigia peploides, L. grandiflora, L. hexapetala are members of a highly productive emergent aquatic perennial native to the Americas and likely Australia (USDA-ARS, 1997). It was introduced in France in 1830 and rapidly became one of the most damaging invasive plants there. It is a perenial herb (a dicot) termed marsh purslane; a member of family ORAGRACEAE. *from California Invasive Plant Council (CALIPC) website.* More recently it was introduced to areas beyond its native range in the U.S. where it is often considered a noxious weed (INVADERS, 2009; Peconic Estuary Program, 2009). *L. grandiflora, et. al.* are adaptable and tolerate a wide variety of habitats where they can transform ecosystems both physically and chemically. It sometimes grows in nearly impenetrable mats; can displace native flora and interfere with flood control and drainage systems, clog waterways and adversly impact navigation and recreation. The plant also has 'allelopathic' properties that can lead to dissolved oxygen crashes, the accumulation of sulphide and phosphate, 'dystrophic crises' and intoxicated ecosystems (Dandelot et al., 2005). Its common name is "floating water primrose"; it produces a distintive small yellow or white flower during its bloom cycle (May-Nov.). *Ludwigia,* the green plant extending from the lower right-hand corner of the photo on the cover of this report, is now pervasive throughout the lower reaches of the river.

(AWQRpt.page JCK 10/03/23)