LOWER SAN DIEGO RIVER WATER QUALITY

Annual Water Quality Monitoring Report for WY21

Kaiser Ponds outlet (WQM Site #6) viewing downstream from SD Mission Rd. culverts *(Sept. 2021)*

WQM Results (October 2004 - September 2021)

John C. Kennedy, PE

November 2021

PO Box 80126, San Diego, CA 92138 • telephone: 619 297 7380 • fax: 619 297 7385 • info@SanDiegoRiver.org

Lower San Diego River Water Quality 2005 - 2021

Table of Contents

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 17 years at 15+ 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 2021 (WY21) data in comparison to previous year results and 17-yr averages henceforth refered to as 'norms'. The LSDR water quality monitoring site locations are shown on **Figure 1-1**.

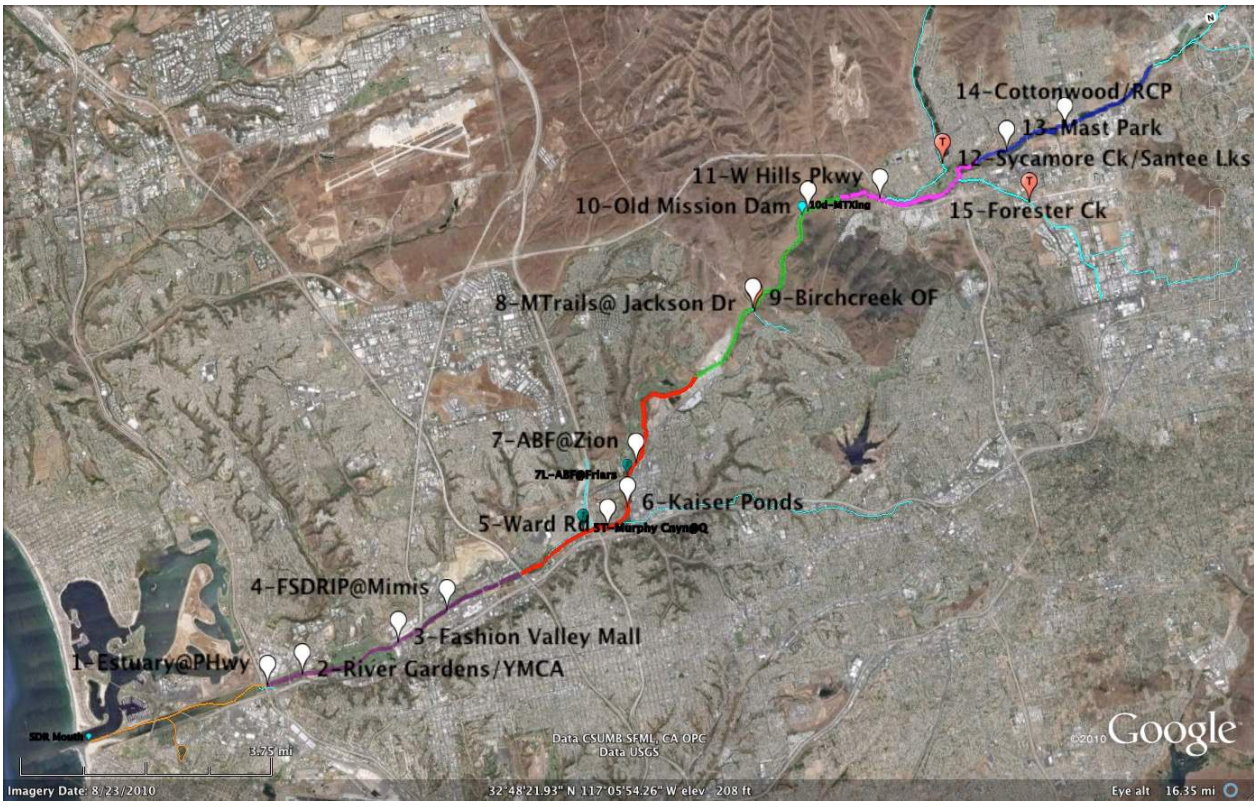


Figure 1-1 LSDR Watershed and Water Quality Monitoring Sites

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 (via fieldscope) is currently being updated.

The water quality index (WQI) represents SDRPF staff response to general questions and concerns by the public regarding the 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 conductivity (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 employed 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%	Meets few 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 quantitiable 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 multiple 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 freshwater objectives for Southern California coastal areas. As such, the index does not apply to esturine or ocean waters. Fresh water is often defined as having an overall salt concentration of less than one percent.

Index values have been 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 the appendicies. Differences between the two determinations were found to be very 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 for LSDR) are excluded. The broader range WQI_4 values are expressed in both annual and monthly water quality reports. Although specifically developed for the Lower San Diego River, the index can also be applied to other coastal region watercourses where the same metrics (i.e., DO, SpC, water temperature and streamflow) are monitored/measured on a regular and 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.

Section 2 - Spatial Analysis of WY21 Water Quality Metrics and 17-yr Norms

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 WY21 and 'norms' i.e., averaged values over the past 17 years of monthly monitoring, are presented in **Table 2.1**. WY21 values greater than the norms (shown in italics) are expressed in blue, whereas current values below norms are expressed in red. This year's overall LSDR averages for all of the sites are shown in bold face type.

Table 2.1 Average Annual WQ Metrics for WY21 and 17-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	**19.8**/*19.7*	**3.2**/2.7	**7.8**/7.8	5.9 (65) / *6.1* (67)	11/*29*	32/*37* (-5)	D/D+
2			18.7/*19.0*	**3.1**/2.7	**7.8**/7.7	**4.8 (50)** / *4.4* (47)		**31**/*30* (+1)	**D**/*D*
3			18.8/*19.2*	**2.9**/2.6	**7.8**/7.8	4.4 (46) / *4.6* (49)		29/*31* (-2)	**D**/*D*
4	MMV		18.6/*19.6*	**2.7**/2.5	**7.9**/7.8	5.2 (55) / *6.1* (65)		32/*40* (-8)	D/*C*
5	MV		16.9/*17.2*	**2.9**/2.6	**7.7**/7.6	**5.4 (55)** / *4.8* (49)		**34**/*32* (+2)	**D**/*D*
6	UMV		17.8/*18.3*	**2.9**/2.6	**7.6**/7.6	3.3 (34) / *3.6* (36)	10/*25*	22/*24* (-2)	E/E+
7			**18.4**/*18.1*	**2.6**/2.5	**7.8**/7.6	**5.3 (56)** / *5.1* (53)		**34**/*34* (0)	**D**/*D*
8	MG	Mid	16.2/*17.1*	**2.3**/2.3	**7.9**/7.7	6.2 (60) / *7.2* (74)	8/*19*	39/*48* (-9)	C/C+
9T[b]			13.3/*15.6*	4.5/4.8	**8.0**/7.9	**9.4 (89)** / *9.2* (93)	<1	27/*35* (-8)	D-/*D*
10			16.4/*17.6*	**2.3**/2.3	**8.1**/7.8	6.8 (69) / *7.0* (72)	7/*17*	41/*44* (-3)	C/C
11	LSB	East	16.0/*16.7*	**2.3**/2.2	**7.9**/7.6	**6.6 (67)** / *6.1* (60)		42/*38* (+4)	C/C-
12T[b]			16.0/*17.6*	**1.6**/1.6	**8.3**/7.9	7.1 (70) / *7.1* (72)	ur	35/*36* (-1)	D/*D*
15T[b]			16.0/*17.9*	2.6/2.7	**8.0**/8.1	6.4 (62) / *7.4* (70)	4/*9*	35/*38* (-3)	D/C-
13W[c]	USB		**15.2**/—	**1.8**/—	**7.9**/—	**2.7 (29)** / — (—)	3/*7*	**26**/—	D-/—
13E			16.9/*18.3*	**2.0**/1.9	**7.8**/7.7	2.4 (26) / *2.8* (29)		13/*16* (-3)	E-/*E*
14			16.9/*17.7*	**1.7**/1.5	**8.0**/7.8	4.6 (48) / *3.5* (35)		**28**/*25* (+3)	D/*D*-
all	LSDR Avg.		17.2/*18.0*	**2.4**/*2.3*	**7.9/7.7**	**5.3 (54)** / *5.3* (54)	9/*23*	31/33 (-2)	D/D
1-15	**DwtAvg** [d]		17.2/*17.9*	**2.5**/*2.4*	7.9/7.8	**5.4 (51)** / *5.4* (51)	8/*21*	31/32 (-1)	D/D

a) *Average annual water quality index values, change (+/-) and resultant WQ letter grade for WY21 (bold) and the 17yr norms (italics); values below 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 last year; multiple year 'norms' not yet valid.
d) Distance-weighted (Dwt) WQI values calculated based on site reach relative to total length of lower river.
e) DO>7.0 mg/L shown in light blue cells; DO<5 mg/L shown in light tan cells.

Five monitoring sites (2,5,7,11&14) present WY21 average annual WQI values greater than or equal to their 17-yr norms while ten others are below. Average annual water temperatures in WY21 exceeded 17-yr norms at only two sites (1&7); resulting in overall decline of 0.8 degree from the 17-yr annual average of 18.0 C. Specific Conductivity values in WY21 were above 17-yr norms at all but two (9&15T) monitoring sites. The overall SpC (LSDR average) for WY21 is 4% above the 17-yr average annual norm of 2.3 mS/cm. DO values were greater than 17-yr norms at 6 sites and less at the other ten. Overall this year's average DO values for the LSDR are the same as the 17-yr annual norm (5.3 mg/L/54%Sat). DO values for WY21 are slightly below those from last year (WY20) by approximately 0.1 mg/L (2%Sat). The annual avaerage remains well above the poorest year (WY14 at 3.95 mg/L) by 1.5 mg/L. The highest average annual DO level, 6.84 mg/L (62% Sat.), occured in WY05.

Average annual, seasonal and monthly min.-max. range water quality metrics for WY21 and the 17-yr norms are also presented by river reach and section in **Table 2.2.** Two reaches of the river (LMV & MG) present slightly lower index values for the past year than associated with their 17-yr norms. Average annual water temperatures for all five reaches were below norms, while Specific conductivity and pH values for all reaches and sections of the river were slightly above 17-yr norms. Streamflow exceeded 17-yr norms in all reaches and sections in WY21 with exception of the winter period. The largest declines in water quality metrics monitored within the lower river watershed occurred in the Lower Mission Valley (sites 1-4) and Mission Gorge (sites 8-10) reaches. Average annual water quality remained unchanged in the Upper Santee Basin (sites 13&14).

Table 2.2 Water Quality Metrics for WY21 and 17-yr Norms by Season, Reach and Section

Parameter, units		Temp, oC	SpC, mS/cm	pH	Dissolved Oxygen, mg/L (%Sat)	ADF, cfs	WQI, (Difference) and Grade [a]	
Maximum Month		**23.9**/*23.3*	**3.2**/*2.9*	**8.2**/*7.8*	**7.5 (62)** / *8.1 (68)*	**167**/*230*	**52**/*50* (+2)	**A-**/*A-*
Winter (D,J,F,M)		**12.2**/*13.5*	**1.9**/*1.7*	**8.0**/*7.7*	**7.1 (66)** / *7.1 (62)*	**18**/*45*	**44**/*47* (-3)	**C**/*C*
Annual Avg.		**17.2**/*18.0*	**2.4**/*2.3*	**7.9**/*7.7*	**5.3 (54)** / *5.3 (54)*	**33**/*23*	**31**/*33* (-2)	**D**/*D*
Wt Avg.Annual		**17.2**/17.9	**2.5**/2.3	**7.9**/7.8	**5.4 (51)** / *5.4 (51)*	**30**/20	**31**/*32* **(-1)**	**D**/***D***
Summer (J,J,A,S)		**22.4**/*22.4*	**3.1**/2.9	**7.8**/*7.7*	**2.9 (32)** / *3.7 (42)*	**2.7**/*2.1*	**13**/*19* (-3)	**E-**/*E*
Minimum Month		**10.6**/*11.8*	**1.3**/*1.6*	**7.7**/*7.7*	**2.4 (29)** / *3.5 (36)*	**0.9**/*0.1*	**9**/*15* (-7)	**F**/*E*
LSDR Reach & Section Averages:								
USB	East	**17.6**/*18.1*	**1.9**/*1.8*	**7.8**/*7.7*	**3.2 (33)** / *3.0 (31)*	**9**/*5*	**17**/*17* (0)	**E**/*E*
LSB		**16.3**/*17.4*	**2.3**/*2.3*	**7.8**/*7.8*	**6.5 (65)** / *6.5 (64)*	**21**/*16*	**38**/*37* (+1)	**C-**/*D+*
MG	Mid	**15.7**/*17.0*	**2.3**/*2.3*	**8.1**/*7.8*	**7.3 (72)** /*7.5 (76)*	**26**/*19*	**40**/*46* (-6)	**C**/*C*
UMV	West	**17.7**/*17.9*	**2.8**/*2.6*	**7.7**/*7.6*	**4.7 (48)** / *4.5 (46)*	**46**/*28*	**29**/*28* (+1)	**D**/*D*
LMV		**19.0**/*19.4*	**3.0**/*2.6*	**7.8**/*7.8*	**4.8 (50)** / *5.0 (53)*	49/*30*	**31**/*35* (-4)	**D**/*D*

a) *Average annual water quality index value, difference (+/-) from 17-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 grade above norms in black.*
b) DO>7.0 mg/L shown in light blue cells; DO<5 mg/L shown in light tan cells.

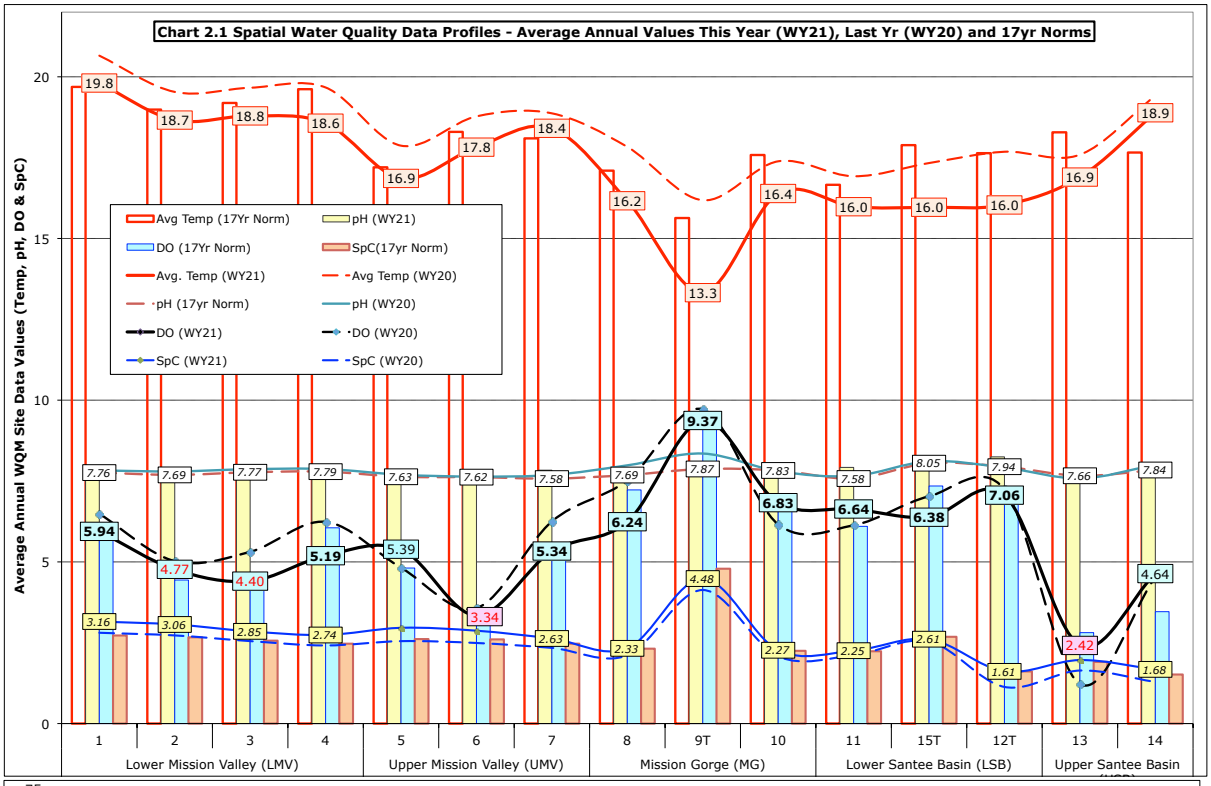


Chart 2.1 Spatial Water Quality Data Profiles - Average Annual Values This Year (WY21), Last Yr (WY20) and 17yr Norms
Average Annual WQM Site Data Values (Temp, pH, DO & SpC)
Avg Temp (17Yr Norm)
pH (WY21)
DO (17Yr Norm)
SpC(17yr Norm)
Avg. Temp (WY21)
Avg Temp (WY20)
pH (17yr Norm)
pH (WY20)
DO (WY21)
DO (WY20)
SpC (WY21)
SpC (WY20)
Lower Mission Valley (LMV)
Upper Mission Valley (UMV)
Mission Gorge (MG)
Lower Santee Basin (LSB)
Upper Santee Basin

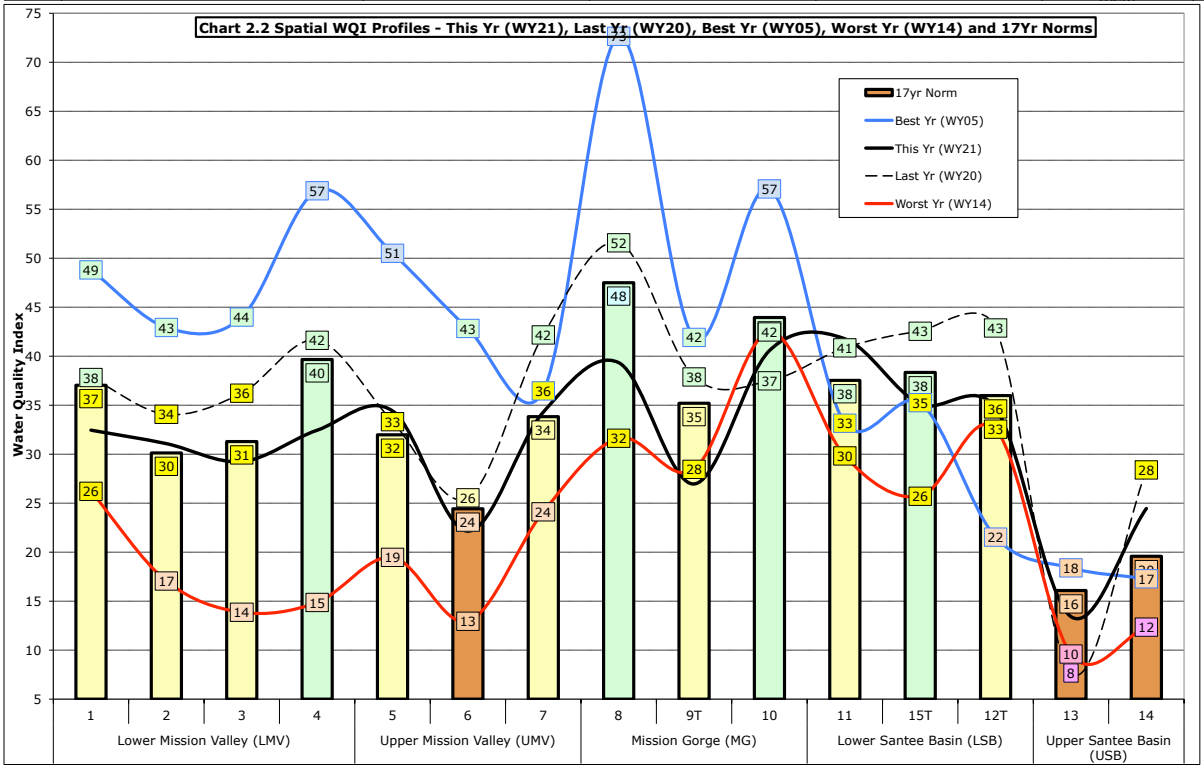


Chart 2.2 Spatial WQI Profiles - This Yr (WY21), Last Yr (WY20), Best Yr (WY05), Worst Yr (WY14) and 17Yr Norms
Water Quality Index
17yr Norm
Best Yr (WY05)
This Yr (WY21)
Last Yr (WY20)
Worst Yr (WY14)
Lower Mission Valley (LMV)
Upper Mission Valley (UMV)
Mission Gorge (MG)
Lower Santee Basin (LSB)
Upper Santee Basin (USB)

Spatial water quality values expressed in Tables 2.1 and 2.2 for the Lower San Diego River 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 previous page. The overall water quality index for WY21 of 31 (D Marginal) is but one point below the 17-yr average annual norm of 32 (D Marginal). This year's value is nine points above the lowest average annual WQI of 22 (E Poor) experienced in WY14. The river's highest overall average annual index of 40 (Fair) occurred in WY05. Only two water year's (WY14 and WY18) have shown an overall average index values in the Poor E (WQI 13-24) range, while two others (WY05 and WY11) had values in the Fair C (WQI 38-49) range. Marginal (D) water quality (an average annual index between 25 and 37) has occurred 13 of the past 17 years, or 76% of the time.

Average annual water quality values for water temperature, pH, dissolved oxygen and specific conductivity at each monitoring site, river reach and section in order of their location upstream for WY21 (Oct.'20-Sept.'21) and the 17-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 (WY20) results and the red lines are 17-yr annual averages (or norms) for each site. Average annual water temperatures (solid red line) for WY21 are below (less than) both 17-yr norms (red bars) and last year values (dashed red line) at all monitoring sites. Downstream average water temperatures are greater (higher) than monitored upstream. There is little variance in average pH values between sites and from the 17-yr norms (yellow bars). DO levels for WY21 (solid black line) are generally above those from last year (dashed black line) and near the 17-yr norms (blue bars). Average annual DO values at five sites (2,3,6,13E&14) were below a threshold level of 5 mg/L; whereas only two sites were below 5 mg/L last year. Monitored DO values represent the greatest variation between sites. Lowest values are typically recorded in the Upper Santee Basin (sites 13&14) and Upper Mission Valley (site 6) whereas highest values are observed in the Mission Gorge section (sites 8&10), Site 4 and 15T. Excluding tributary sites, average annual conductivity (SpC) values generally increase along the mainstem from upstream to downstream similar to water temperatures. SpC averages for WY21 (solid blue line) are slightly above 17-yr 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 (WY20) and the 17-yr norms are associated with dissolved oxygen and water temperature values.

The WQI, an aggregate or composite index of water quality monitoring metrics for WY21, the 17-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 (17-yr norms), the two sites furthest upstream, Mast Park (13E) and Magnolia Ave (14), continue to experience Poor (E) to Very Poor (F) water quality as does the 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 WY21 (black line) is generally near the 17-yr norms (colored bars) but slightly below last year's (WY20) results (dashed black line). Greatest departures (variance) from the 17-yr WQI norms for WY21 are found at site 8. WY21 water quality conditions throughout Mission Valley (both Upper and Lower reaches) are noticably improved from last year's (WY20) values. As evidenced in the past, below normal flows tend to cause greater degregation resulting in poorer water quality. WY21 experienced well below normal dry weather flows that resulted in an overall slight decline in the river water quality index.

Section 3 - Temporal Analysis of WY21 Data and 17-yr Norms

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 (WY21) with comparison to 17-yr norms (shown italicized). WY21 values above the 17-yr norms are in blue; values below in red. Temporal water quality values in WY21 varied little from the 17-yr norms on an annual basis with the exception of streamflow where this years values were consistantly lower. The annual average WQI for WY21 is only one point below the 17-yr norn of 32.

Table 3.1 Average LSDR WQM Metrics for WY21 and 17-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	**16.6**/*18.7*	**2.99**/*2.89*	**7.9**/*7.7*	**5.81**/*4.11*	**52**/*40*	**1.9**/*11*	**32**/*21*	**D**/*E*
Nov		**15.1**/*14.9*	**2.47**/*2.74*	**8.1**/*7.7*	**7.17**/*5.61*	**66**/*50*	**7.5**/*12*	**43**/*30*	**C**/*D*
Dec	Winter	**10.6**/*11.9*	**2.62**/*1.88*	**8.2**/7.8	**7.32**/*6.96*	**61**/*59*	**6.3**/*50*	**36**/*42*	**D+**/*C*
Jan		**11.2**/*11.8*	**1.98**/*1.76*	**7.8**/7.7	**7.51**/**8.05**	**62**/*68*	**25**/*58*	**42**/*49*	**C**/C+
Feb		**13.0**/*14.0*	**1.76**/*1.70*	**8.0**/7.8	**7.00** /*7.25*	**61**/*65*	**24**/*64*	**45**/*47*	**C**/*C*
Mar		**13.7**/*16.7*	**1.29**/*1.59*	**7.8**/7.8	**7.39** /*7.04*	**66**/*66*	**30**/*34*	52/*50*	**B-**/*B-*
Apr	Spring	**17.3**/*18.0*	**2.21**/*1.93*	**7.8**/7.8	**6.20**/*5.96*	**60**/*58*	**6.4**/*24*	**44**/*41*	**C**/*C*
May		**19.1**/*20.0*	**2.54**/*2.26*	**7.9**/7.8	**4.12** / *5.16*	**41**/*51*	**3.7**/*8.7*	**23**/*34*	**E+**/*D*
June	Summer	**22.3**/*21.9*	**2.80**/*2.62*	**7.7**/*7.8*	**3.45**/*4.35*	**40**/*45*	**1.7**/*3.0*	**17**/*24*	**E**/*E+*
July		**23.6**/*23.1*	**3.02**/*2.82*	**7.8**/*7.7*	**3.78**/*3.60*	**43**/*38*	**0.9**/*2.4*	**15**/*17*	**E**/*E*
Aug		**22.8**/*23.3*	**3.17**/***3.03***	**7.9**/*7.7*	**2.42**/*3.54*	**29**/*37*	**0.7**/*1.1*	**9**/*15*	**F**/*E-*
Sept		**20.1**/*21.4*	**3.22**/*3.04*	**7.8**/*7.7*	**2.69**/*3.51*	**27**/*36*	**1.0**/*1.6*	**10**/*17*	**F**/*E*
Fall (O&N)		**15.8**/*16.8*	**2.73**/*2.82*	**8.0**/*7.7*	**6.27**/*4.86*	**63**/*45*	**3.9**/*11*	**38**/*25*	**C-**/*D-*
Winter (D,J,F,M)		**12.2**/*13.6*	**1.91**/*1.73*	**8.0**/*7.8*	**7.06**/*7.33*	**66**/*67*	**19**/*51*	**44**/*47*	**C**/C+
Spring (A&M)		**18.2**/*19.0*	**2.37**/*2.10*	**7.8**/*7.7*	**5.18**/*5.56*	**55**/*56*	**5.8**/*16*	**34**/*38*	D+/C-
Summer (J,J,A,S)		**22.2**/*22.4*	**3.05**/*2.88*	**7.8**/*7.7*	**2.52**/*3.75*	**30**/*39*	**0.9**/*2.0*	**13**/*18*	**E-**/*E*
Annual (O-S)		**17.1**/*17.9*	**2.51**/*2.35*	**7.9**/*7.8*	**5.41**/*5.43*	**51**/*51*	**9.1**/*23*	**31**/*32*	**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). WY21 values/grades (in bold type) below 17-yr norms (in italics) are in red; those equal to or above norms in black.

b) *DO>7.0 mg/L shown in light blue cells; DO<5 mg/L shown in light yellow cells.*

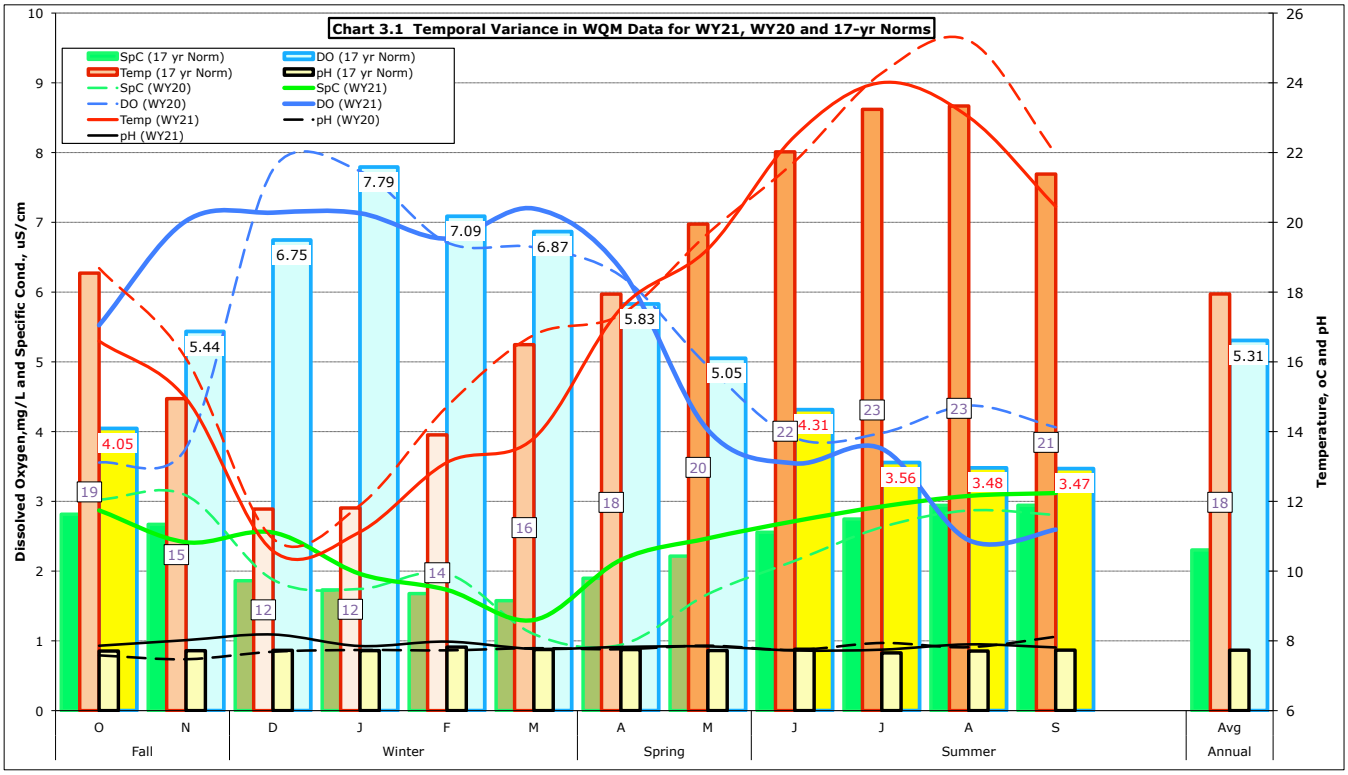


Chart 3.1 Temporal Variance in WQM Data for WY21, WY20 and 17-yr Norms
SpC (17 yr Norm)
DO (17 yr Norm)
Temp (17 yr Norm)
pH (17 yr Norm)
SpC (WY20)
SpC (WY21)
DO (WY20)
DO (WY21)
Temp (WY21)
pH (WY20)
pH (WY21)
Dissolved Oxygen,mg/L and Specific Cond., uS/cm
Temperature, oC and pH
O N D J F M A M J J A S Avg
Fall
Winter
Spring
Summer
Annual

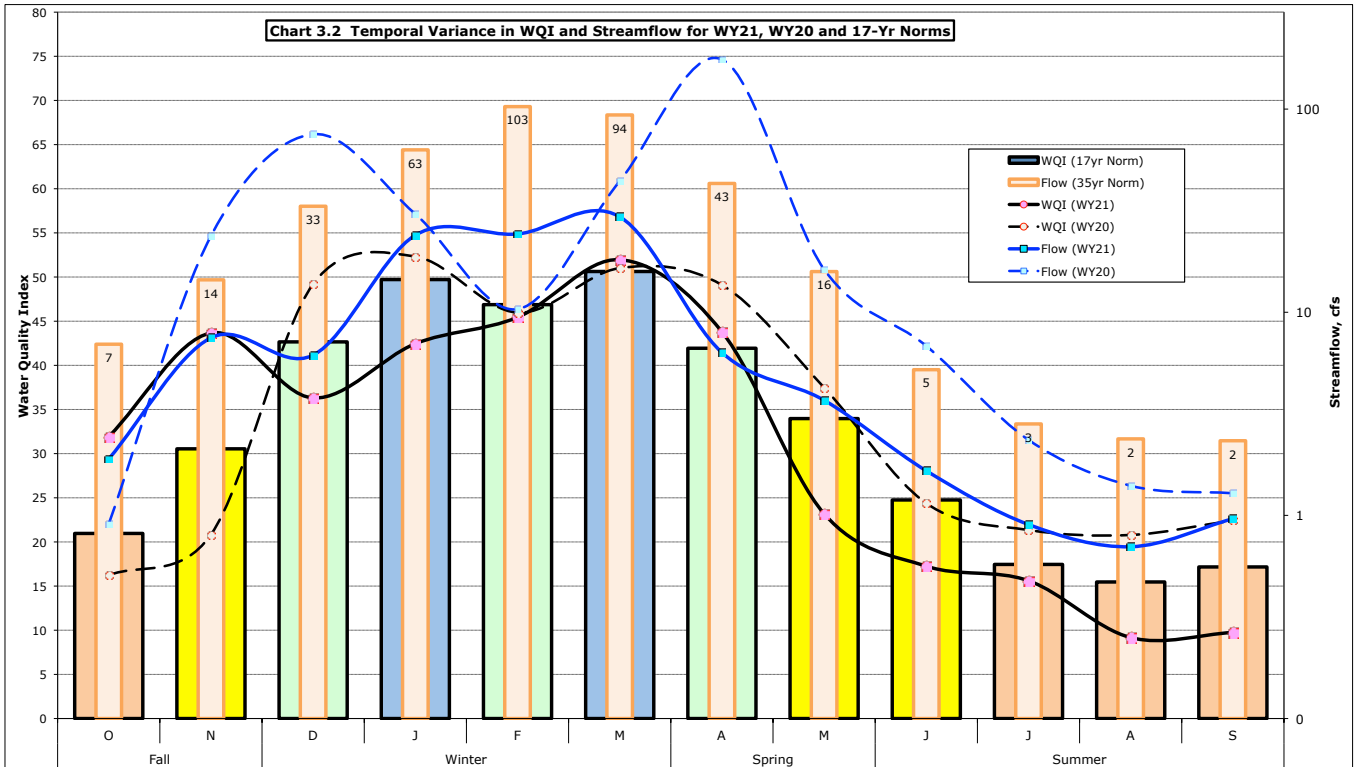


Chart 3.2 Temporal Variance in WQI and Streamflow for WY21, WY20 and 17-Yr Norms
WQI (17yr Norm)
Flow (35yr Norm)
WQI (WY21)
WQI (WY20)
Flow (WY21)
Flow (WY20)
Water Quality Index
Streamflow, cfs
O N D J F M A M J J A S
Fall
Winter
Spring
Summer

Monthly and seasonal variances in water quality monitoring metrics for the past two water years and the 17-yr norms are expressed in **Chart 3.1.** (WQM Data) on the previous page. Dissolved oxygen values are highest during the winter/spring months (Dec-May) whereas specific conductivity and water temperatures are greatest during the dry summer months (June-Sept) and into early Fall (Oct). pH values show less seasonal fluctuation, although some variance from norms in the monthly values are also evident. The broad range in DO, SpC and temperature values monitored at all sites throughout the year provide the best indications of temporal variance in water quality. Seasonal variances between this year's data (WY21), shown as solid lines, last year's results (dashed lines) and the 17-yr norms (bars) are similar. In general, temporal variance in WY21 water quality data closely match patterns in the 17-yr norms, although slightlyless so than last year's values. This year's temporal water quality metrics are indicative of both normalized monthly occurrences as well as those monitored during the previous year (WY20). The greatest distinction between last year's metrics and this year's occur during the dry-weather (summer) season. Streamflows, as shown on the next chart, present a significant impact on variances in the other temporal WQ metrics.

Chart 3.2 provides an overall graphic showing temporal variance in WQI values and streamflow throughout WY21 compared to monthly averages for the previous water year (WY20) and the 17-year norms. As shown in **Chart 3.2**, the WQI values for WY21 (heavy red line), also listed in Table 3.1 (far left coulumn), are relatively close to the 17-yr norms (colored bars) for most months of the year. The strong relationship between flow (both wet weather and dry) and water quality continues to effect results. 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) when flows are greatest during the Winter months (Dec-March) and poorest (Poor to Very Poor) in Summer (June-Sept) when streamflow is lowest and water temperatures highest. The overall annual average WQI for the LSDR in WY21 of 31 (D mid-Marginal) is one point below the 17-yr average index value of 32.3. Last year's two point (34) above normal WQI occured during an above averge rainfall and runoff year.

Section 4 - Variances in Water Quality Metrics (WY05 through WY21)

Variances in SDRPF monitored water quality metrics, based on data collected by RiverWatch from September 2005 through September 2021, are discused in this chapter. The metrics include water temperature, specific conductivity, pH, dissolved oxygen, streamflow and the water quality index. Twelve month running average values considered with overall best-fit equations represent a rational indication of relative change over the past 17 years of monitoring for each metric.

Table 4.1 presents 12-month running average values for each of the key water quality metrics monitored over the last 17 years. Running averages above norms are listed in blue; values below norms are in red. The 17-yr norms for each metric are expressed in italics in the bottom row.

Table 4.1 - 12-mo Running Average WQM Metrics (WY05-WY21)

	Temp, *oC*	SpC, *mS/cm*	pH, *unit*	Dissolv. Oxygen, *mg/L*	(*%ofSat*)	ADF, *cfs*	WQI [a] *Values, Grade & (Diff.)*
WY05	17.81	2.064	7.62	6.84	(61%)	71.5	40 C Fair (-)
WY06	18.29	2.141	7.39	6.04	(57%)	13.6	35 D+ Marginal (-5)
WY07	17.62	2.342	7.52	5.95	(58%)	9.5	35 D+ Marginal (-)
WY08	17.55	2.223	7.90	6.20	(62%)	18.2	36 D+ Marginal (+1)
WY09	17.65	2.393	7.64	6.20	(62%)	20.1	36 D+ Marginal (-)
WY10	18.03	2.287	7.86	5.35	(51%)	32.4	33 D Marginal (-3)
WY11	17.76	2.170	7.88	5.76	(53%)	46.9	38 C- Fair (+5)
WY12	18.00	2.339	7.69	5.41	(49%)	14.9	33 D Marginal (-5)
WY13	17.29	2.437	7.78	5.51	(51%)	9.1	32 D Marginal (-1)
WY14	17.81	2.498	7.67	3.95	(36%)	5.1	22 E Poor (-10)
WY15	18.70	2.175	7.79	4.62	(42%)	10.5	29 D Marginal (+7)
WY16	18.23	2.259	7.75	4.82	(45%)	15.6	28 D Marginal (-1)
WY17	18.54	2.146	7.80	5.19	(50%)	40.0	33 D Marginal (+5)
WY18	18.09	2.784	7.97	4.41	(42%)	5.9	24 E+ Poor (-9)
WY19	17.74	2.165	7.77	5.11	(48%)	26.9	31 D Marginal (+7)
WY20	18.29	2.154	7.83	5.50	(52%)	33.1	34 D Marginal (+3)
WY21	17.23	2.442	7.89	**5.41**	**(51%)**	9.1	**31 D Marginal (-2)**
17yr Norm	17.92	2.295	7.75	*5.43*	*(51%)*	22.5	*32 (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.

b) LSDR RADO<5 mg/L (<50% Sat) shown in light brown cells (WYs 14,15,16 & 18); also yrs w/lowest WQIs.

Monthly, 12-mo running average, maximum and minimum **water temperature**s for the LSDR system are expressed on **Chart 4.1**. Seasonal variance patterns are cyclic with warmest water temps (27.1oC) occuring in Aug. and coolest (8.8oC) in Dec. Summertime maximum water temps. (27 oC) are 150% greater than the average annual (17-yr norm) of 17.92oC, while the winter lows of 11.8oC reach 50% below. Variances in running average water temperature over the past 17 years fall in the range of 3% above to 3% below the norm. The WY21 running average of 17.23 oC represents the largest variance (-4.5%) in water temperature below a 17-yr norm of 17.92^{o}C. Maximum monthly water temperatures have trended slightly higher than monthly minimums over the past decade. Higher running average water temperatures observed in some years (WY's 06,10,12,15-18&20) are considered the result of higher 24-hr daytime and nighttime lows recorded for both air and ground temperatures in San Diego as well as throughout much of Southern California. The warmest running average water temperature (18.7 oC) occured in WY15. As can be observed on Chart 4.1, although monthly variance in max., min. and average water temperatures for the LSDR are large as well as cyclic, 12-month running averages for each metric present minimal variance over the 17-year period. The greatest variance in water temperatures is associated with minimum winter season (D-M) readings. It is possible a very slight warming trend in running avarge water temperature is occuring in the the western section (sites 1-7) of the lower river system where variance has increased from 3% above average to more than 6% over the 17-years of monitoring. This has been offset by declines in river water temperatures throughout the middle (Mission Gorge) and Santee Basin sections of the system of 1 to 2% so that the overall change in variance is near neutral.

Variance in monthly monitored **Specific Conductivity** (SpC) values for the LSDR are presented in **Chart 4.2**. Min. and max. running averages for all sites monitored have varied little over the 17-yr period, however, the overall LSDR running average rose from a low 2.06 mS/cm range (*10% below average*) during the initial years of monitoring to 2.78 mS/cm (21% *above average)* three years ago (WY18). Considerably greater rainfall during WY19 and WY20 and resultant above normal dry-weather stream flow caused SpC running averages to fall below the 17-yr norm of 2.295 mS/cm. The current LSDR running average SpC of 2.442 mS/cm is 6% above norm due to below average stramflows. The overall trend in SpC for all sections of the river has shown slight decline over the past six years. The variance in minimums at all sites (blue) have remained fairly steady over of the 17 years of monitoring, however, average values (black line) have increased due to less average streamflow (upstream) and rising daily air temperatures, resulting in noticably higher evaporation rates. The range from max to min variance has also decreased in recent years. Variance below the 2.295 mS/cm norm has been most pronounced in the East (Sante Basin) and Mission Gorge sections.

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 17 years (WY05-WY21). The initial years (WY05-WY09) of below average pH may have been 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 17-yr norm of 7.75. The overall trend in pH for the lower 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 be becoming slightly more alkiline (basic) as average flows have declined and water temperatures a bit warmer. The most common cause of higher pH water is less available carbon dioxide caused by elevated rates of aerobic resperation (decomposition) that accompany warmer, still waters. Tracking the trend in pH can be important as a general indicator of the natural process of eutrophication occuring throughout in the lower portions of the river. WY21 marks the seventh consecutive year that 12-mo. running average pH values have exceeded the 17-year norm.

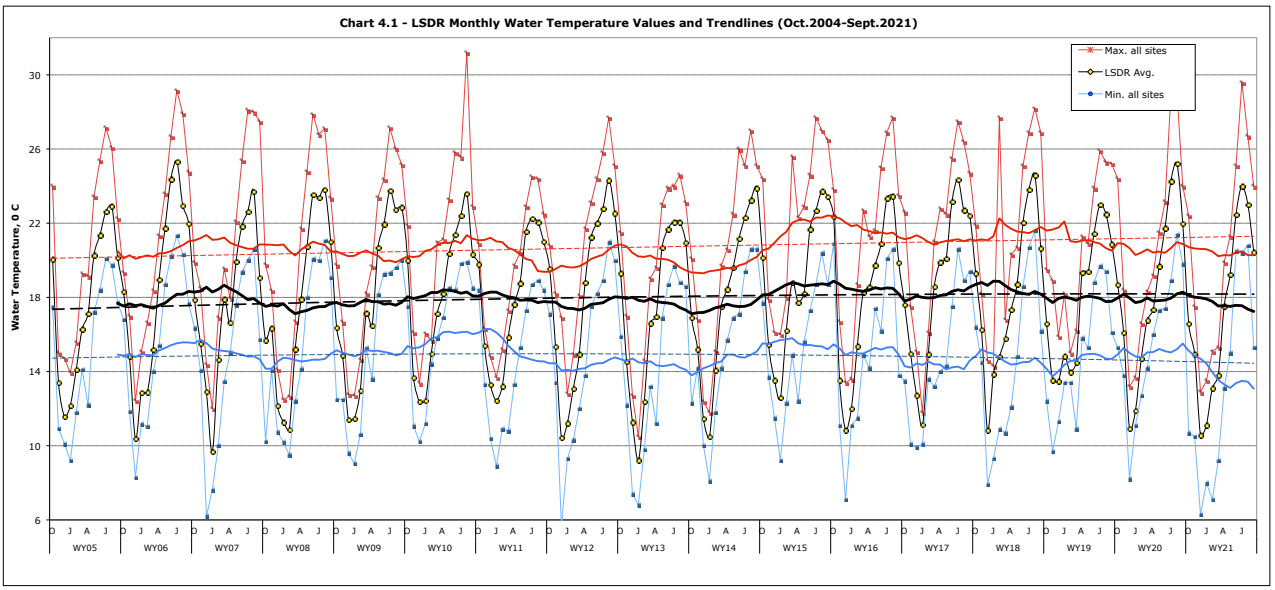


Chart 4.1 - LSDR Monthly Water Temperature Values and Trendlines (Oct.2004-Sept.2021)
Water Temperature, 0 C
Max. all sites
LSDR Avg.
Min. all sites
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21

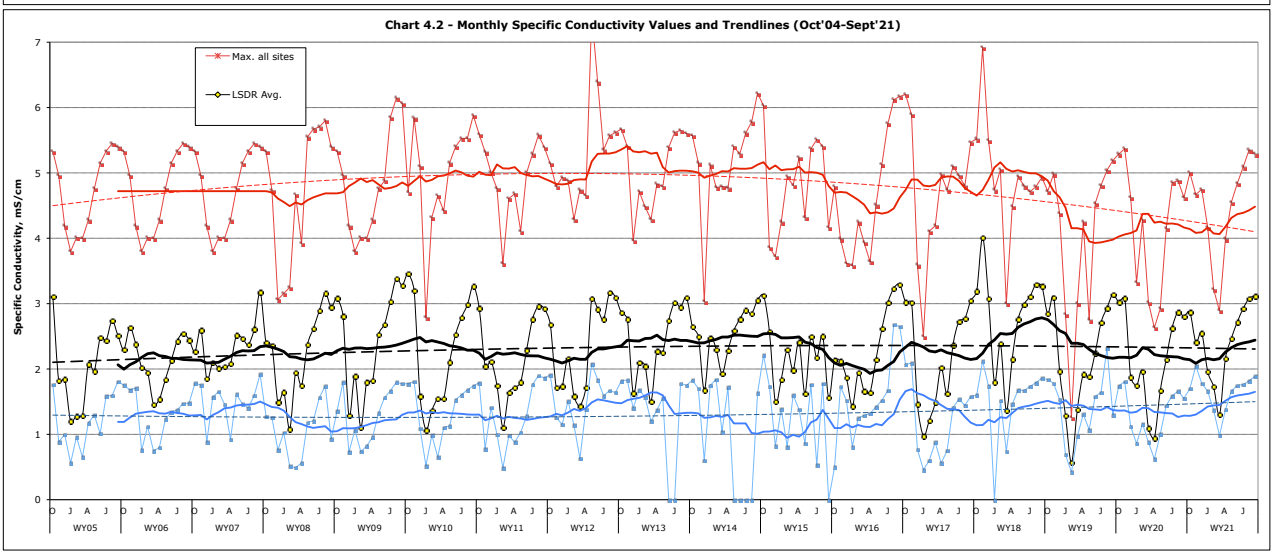


Chart 4.2 - Monthly Specific Conductivity Values and Trendlines (Oct'04-Sept'21)
Specific Conductivity, mS/cm
Max. all sites
LSDR Avg.
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21

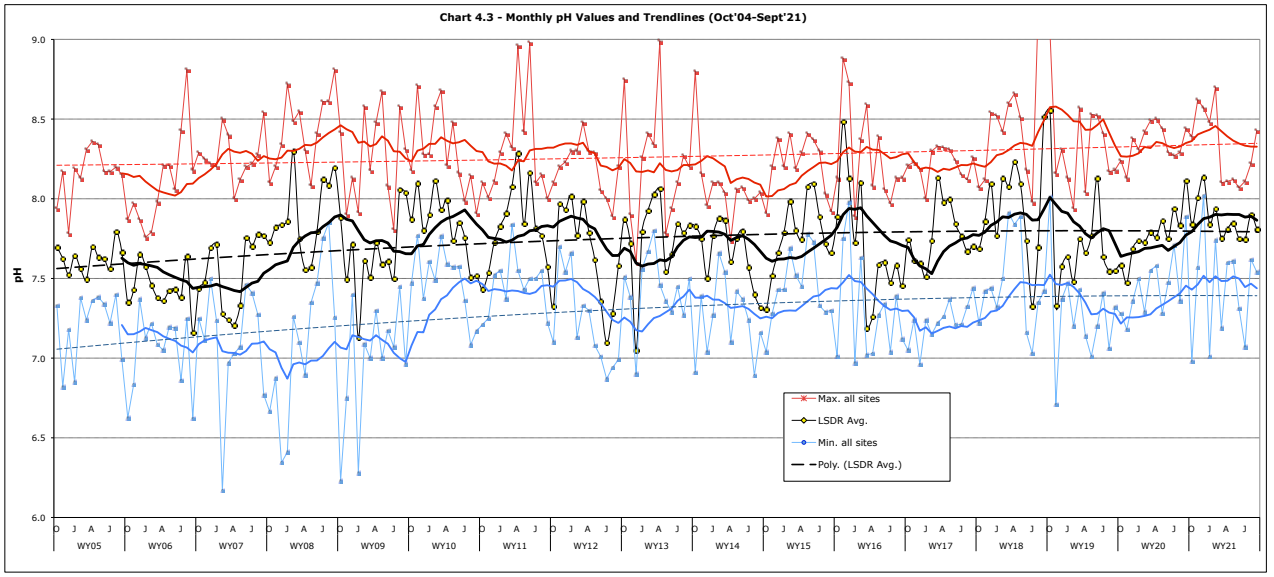


Chart 4.3 - Monthly pH Values and Trendlines (Oct'04-Sept'21)
pH
Max. all sites
LSDR Avg.
Min. all sites
Poly. (LSDR Avg.)
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21

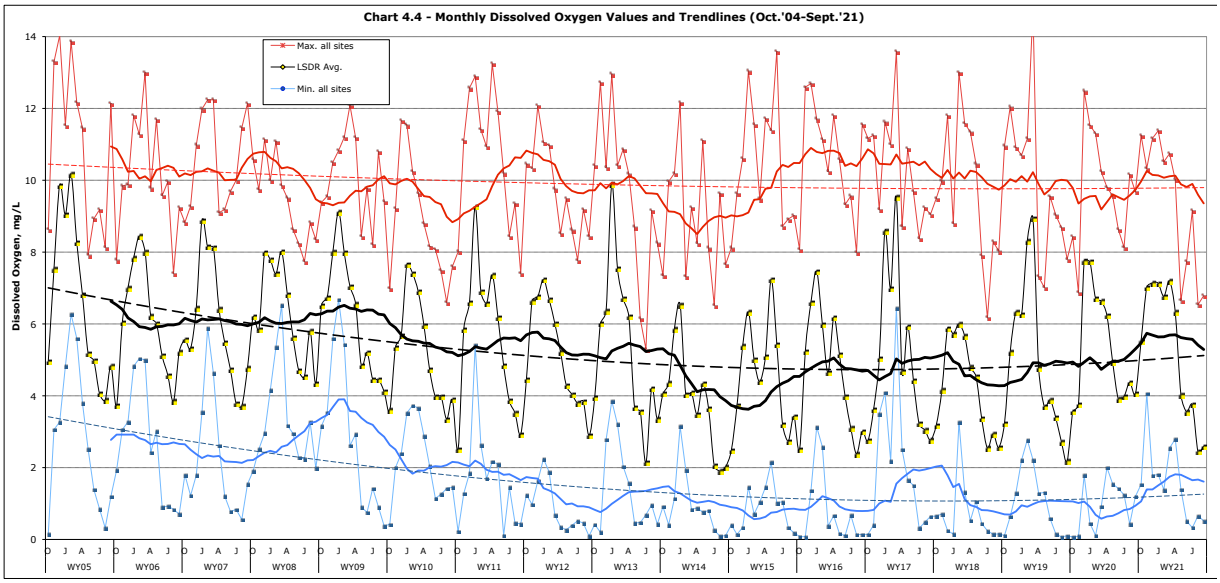


Chart 4.4 - Monthly Dissolved Oxygen Values and Trendlines (Oct.'04-Sept.'21)
Max. all sites
LSDR Avg.
Min. all sites
Dissolved Oxygen, mg/L
0
2
4
6
8
10
12
14
O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J
WY05 WY06 WY07 WY08 WY09 WY10 WY11 WY12 WY13 WY14 WY15 WY16 WY17 WY18 WY19 WY20 WY21

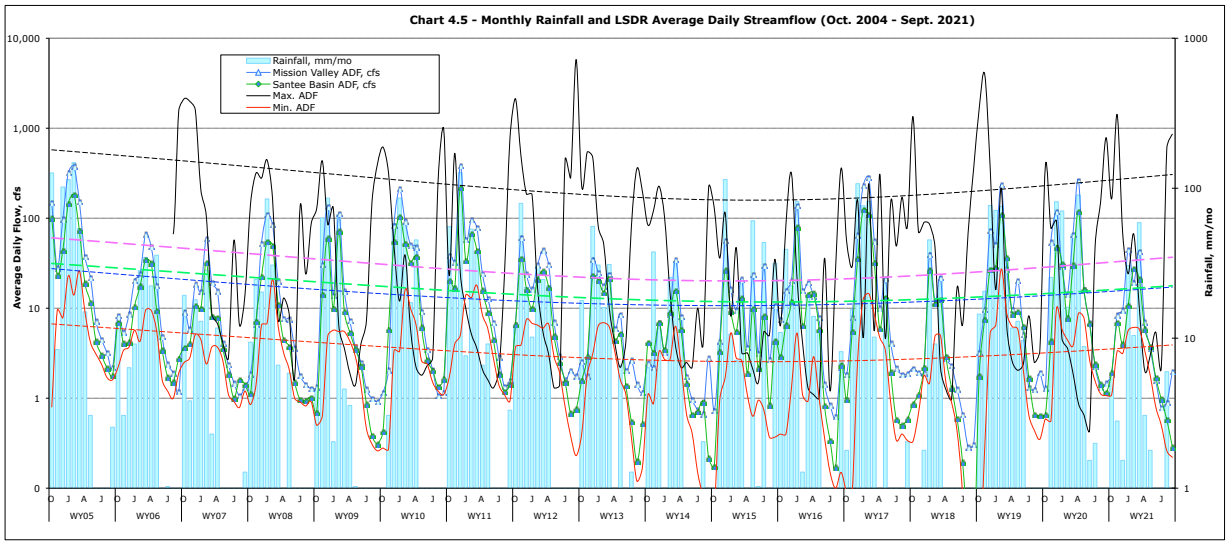


Chart 4.5 - Monthly Rainfall and LSDR Average Daily Streamflow (Oct. 2004 - Sept. 2021)
Rainfall, mm/mo
Mission Valley ADF, cfs
Santee Basin ADF, cfs
Max. ADF
Min. ADF
Average Daily Flow, cfs
Rainfall, mm/mo
0
1
10
100
1,000
10,000
1
10
100
1000
O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J
WY05 WY06 WY07 WY08 WY09 WY10 WY11 WY12 WY13 WY14 WY15 WY16 WY17 WY18 WY19 WY20 WY21

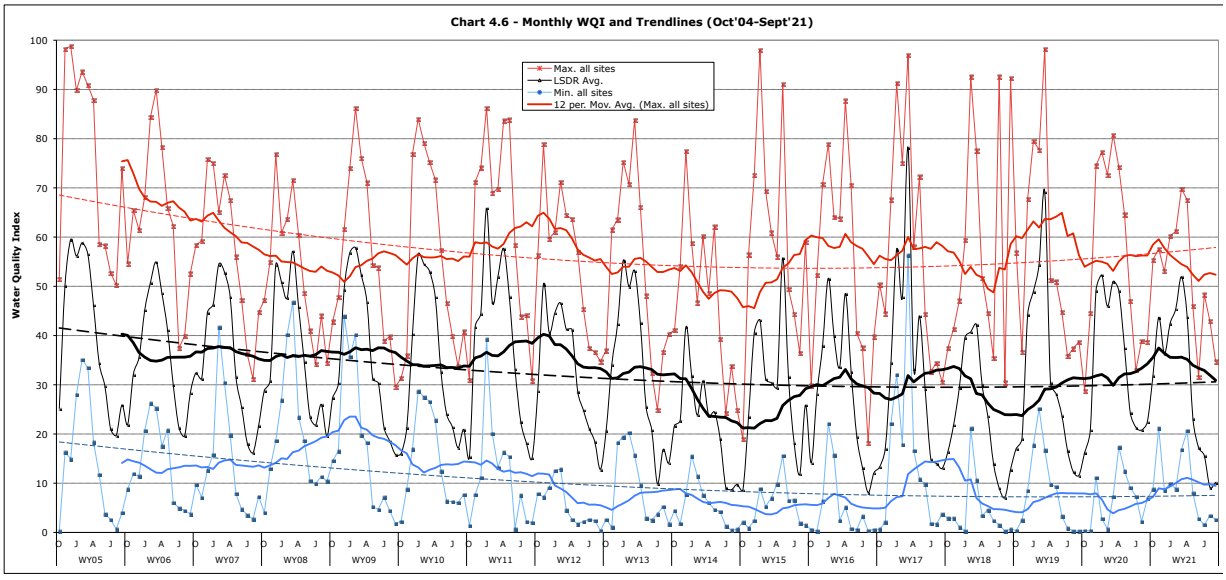


Chart 4.6 - Monthly WQI and Trendlines (Oct'04-Sept'21)
Max. all sites
LSDR Avg.
Min. all sites
12 per. Mov. Avg. (Max. all sites)
Water Quality Index
0
10
20
30
40
50
60
70
80
90
100
O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J O J A J
WY05 WY06 WY07 WY08 WY09 WY10 WY11 WY12 WY13 WY14 WY15 WY16 WY17 WY18 WY19 WY20 WY21

Running average **dissolved oxygen (DO)** values and monthly minima-maxima are presented in **Chart 4.4** on the previous page. An overall, but somewhat irregular decline in average as well as min/max values from Oct. 2004 through late 2014 can be observed. LSDR maximum monthly values from WY15 through WY20 have increased to near 17-yr norms. The current running average DO value of 5.41 mg/L (Sept 2021) is less than 1% (-0.02 mg/L) below the 17-yr norm of 5.43 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 driest-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 relatively mild storm flow events 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 improve 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 17 years, declined in excess of 2 mg/L from roughly 7 mg/L to 5.0 mg/L. This represents an average annual drop in DO of 0.12 mg/L since RiverWatch monitoring was inniated. As can be seen on Chart 4.4, the rate of decline in minimum values (-3 % per annum) 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. Minima values are expected to continue to decline at greater rates than maxima untill a major hydrologic flushing of the lower system were to occur.

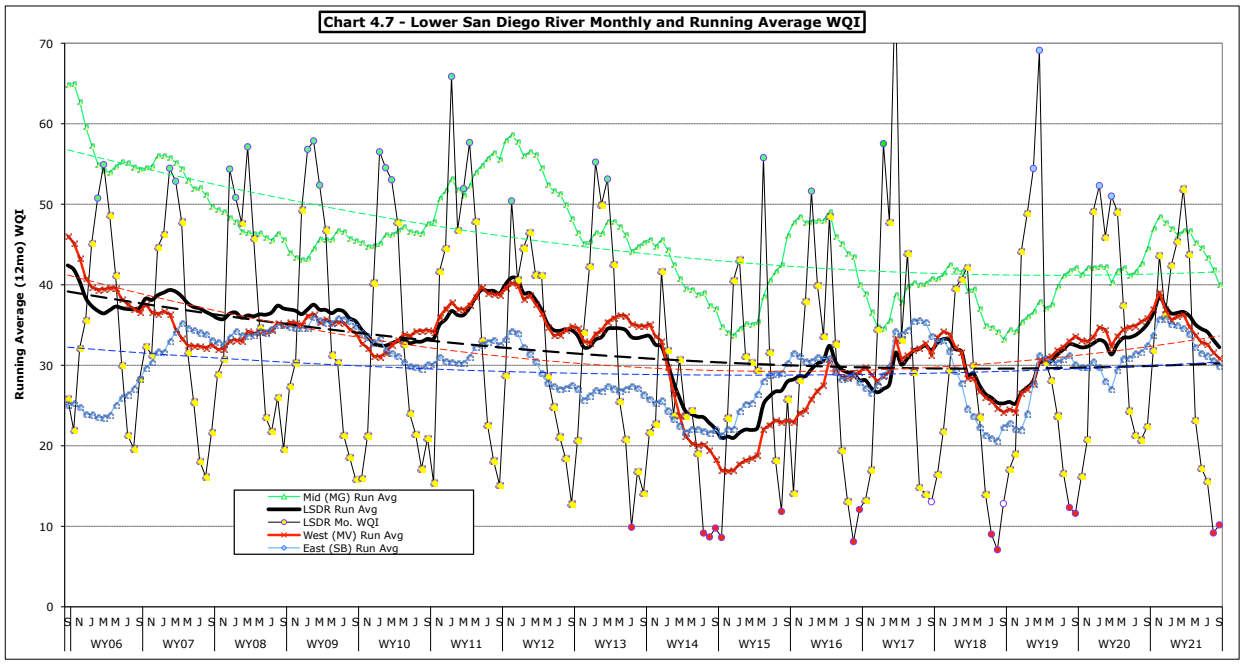
Variances and their trends for total monthly rainfall and running average streamflow in the Santee Basin (SB) and Mission Valley (MV) sections are expressed in **Chart 4.5.** The trend in average daily streamflow throughout the LSDR watershed fell by an order of magnitude (from 70+ cfs to 9 cfs) between WY05 to WY07, then slowly rose to 47 cfs by WY11. Lowest running average streamflows 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 streamflows rose back to 15-20 cfs (Mission Valley) and 8-12 cfs (Santee Basin), but still below 17-yr norms. WY18 streamflows fell sharply as the watershed recieved near record low rainfall. Dry weather flows in June through September of last year were some of the lowest recorded in the past 4-5 decades. With above normal rainfall in WY19 and WY20, streamflows at climbed back to above long-term norms. As WY21 witnessed well below normal rainfall, streamflows again fell to considerably below normal. The current running average flow of 9.1 cfs is 60% below the 17-yr LSDR norm of 22.5 cfs. Significant variance in average annual streamflow, as well as maxima and minima that are experienced within the watershed can be expected to continue.

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 **Charts 4.6 and 4.7. Chart 4.6** expresses average, minimum and maxium variance for the entire LSDR system based on distance (reach) averaging of index values for each monitoring site. **Chart 4.7** expresses the distanced-averaged index values for each of the principal portions of the lower river system (i.e., the Santee Basin (East-blue), Mission Gorge (Midddle-green) and Mission Valley (West-red) sections as well as the overall LSDR reach averaged values (black lines). The trend lines for each section and overall are shown as dashed lines in the same four colors. Monthly LSDR index values at 12 or below (Very Poor) are shown as red dots while values of 50 or greater (Good) are shown as blue dots. Further detail regarding index values for individual reaches of the lower river is provided in Section 5 of this report.

The WQI provides a general indication of the relative condition of the river based on individual water quality parameters monitored by RiverWatch and streamflow (river discharge) as measured by the USGS at two gauging stations. Similar to trends in DO (Chart 4.4), running average WQI values that were in general decline from late WY09 to early WY15 slowly increased through 2017. LSDR running averages reached their lowest value of 22 (E Poor) in 2014, at 30% below the 17-yr norm of 32 (D Marginal). WY18

presented the second lowest index at 24, 25% below the norm. This year's running average WQI of 31 (D Marginal) is just 3% below the norm. This year's below normal rainfall and streamflow resulted in running average index values equivalent to those experienced in WY19 and WY13. Above average rainfall year next year would likely result in an overall rise in the index. Much depends on hydrodynamics of the river as experienced during both wet and dry-weather periods. A major flushing flow at some point in time could also have a an impact on the index trend. The overall index has declined almost ten points at an average of 0.55 points per annum since the inception of RiverWatch monitoring. Both minima and maxima index values have fallen at comperable rates.

The relative variances and general trends in the water quality metrics exresssed in **Charts 4.1-4.7** are inter-related. Less rainfall results in less streamflow (runoff) which results in declining dissolved oxygen concentrations and increased specific conductivities. As all of the parameters monitored are incorporated in computation of the water quality index, trends over the 17-year period are similar. The lower river system experienced its best water quality during the wettest year (WY05) followed by general declines during the well-below average rainfall and river discharge period from WY10 through WY16. The river experienced its poorest water quality during the driest, lowest average annual streamflow (WY14) recorded over the last 17 years. An uptrend toward normalized values was evident over several years (WY15-WY17), but again declined in WY18. WYs 19 & 20 witnessed slight recovery with evident decines at multiple sites in WY21. Section 4 provided perspective on overall variance and trends for individual water quality metrics. WQI trendlines by individual river reache, specific segment and for the overall lower system based of distance-weighted averages are presented in Section 5.



Section 5 - Trends in LSDR Water Quality Index (WY05 through WY21)

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-WY21) of monitoring. Values and grades above 17-yr norms are listed in black; values below norms (expressed in italics) are shown in red. The WY21 values, expressed in bold font, have declined from last year's results for all reaches and sections of the lower river. Overall the LSDR average annual WQI fell three points from last year's value of 34 to 31, one point below the 17-year norm of 32. The overall annual WQI average has been in the Marginal grade (D) for the past three water years. The running averages, as well as 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 20. Trends in values taken over the 17-year monitoring period are expressed as dashed lines based on best-fit, using second-order polynomial equations.

Table 5.1 - Average Annual and Seasonal WQI by Reach and Section (WY05-WY21)

	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	31	18	24	40	C (high)
WY06	39	47	30	37	54	34	22	28	35	D+
WY07	36	43	23	33	50	40	27	34	35	D+
WY08	38	39	27	35	46	38	34	36	36	D+
WY09	38	37	30	34	45	38	32	35	36	D+
WY10	36	36	31	34	48	37	18	27	33	D
WY11	39	39	39	39	56	44	15	29	38	C-
WY12	35	38	35	35	48	39	9	24	33	D
WY13	37	38	32	35	45	35	11	23	32	D
WY14	18	17	19	18	37	28	11	19	22	E (low)
WY15	24	22	22	23	46	43	11	27	29	**D**
WY16	35	30	22	29	40	36	9	22	28	D
WY17	34	34	33	33	41	39	19	29	33	D
WY18	26	28	21	24	33	29	11	20	24	E+
WY19	36	37	30	34	42	35	14	24	31	D
WY20	37	37	34	36	45	41	15	28	34	D
WY21	**31**	**33**	**28**	**31**	**40**	**38**	**17**	**27**	**31**	**D**
17yr Norm	*35*	*36*	*29*	*33*	*46*	*37*	*17*	*27*	*32*	*Marginal*
Winter	*LMV*	*MMV*	*UMV*	*MV*	*MG*	*LSB*	*USB*	*SB*	*LSDR Overall*	
WY05	63	72	61	64	87	44	33	39	57	B (high)
WY06	54	63	49	52	61	40	29	35	46	C
WY07	49	54	41	46	62	55	40	48	49	C+
WY08	56	52	48	52	55	52	52	52	52	B-
WY09	57	53	49	53	61	54	49	52	54	B
WY10	54	55	54	54	66	54	28	41	51	B-
WY11	57	55	58	56	67	54	27	40	52	B-
WY12	48	52	50	49	60	44	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	58	57	69	58	29	43	54	B
WY20	54	55	57	55	63	54	19	37	49	C+
WY21	**47**	**48**	**44**	**47**	**58**	**50**	**20**	**35**	**44**	**C**
17yr Norm	*50*	*51*	*48*	*49*	*63*	*50*	*27*	*38*	*47*	*C+ Fair*
Summer	*LMV*	*MMV*	*UMV*	*MV*	*MG*	*LSB*	*USB*	*SB*	*LSDR Overall*	
WY05	31	36	18	28	46	20	5	13	23	E+
WY06	23	31	8	19	45	30	18	24	24	E+ (high
WY07	23	31	7	19	35	24	14	19	20	E
WY08	23	28	16	22	32	25	18	21	22	E
WY09	21	21	14	18	32	25	16	20	21	E
WY10	21	22	16	20	33	26	9	17	21	E
WY11	23	21	16	20	38	30	5	17	22	E
WY12	22	23	18	20	25	27	4	15	19	E
WY13	18	23	11	16	19	23	5	14	15	E
WY14	10	10	12	10	12	16	9	12	12	F+
WY15	15	12	14	14	35	37	9	23	22	E
WY16	18	14	7	13	17	19	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**	**13**	**E-**
17yr Norm	*20*	*21*	*13*	*18*	*27*	*24*	*9*	*17*	*18*	*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 in red are below 17yr norms (expressed in black italics) for the same reach/section of the river; values at or above 17yr norms are in black. Overall LSDR WQI values are distance-weighted averages.

As shown on **Chart 5.1**, average annual WQI values associated with the **Lower Mission Valley Reach** (Sites 1-4) of the river have varied from a high of 48 (B+ Good) in WY05 to a low of 18 (E Poor) in WY14. The general trend in running average WQI for the reach, as well as for four individual monitoring sites, declined from the mid 40's (C Fair) during WY's '05 and '06 to the mid-teens (E Poor) by early WY15. The running average WQI (*black line*) improved to the mid-30's during WYs16/17, droped to the mid 20's in WY18 and climbed back during WYs19/20, to fall back to 31 in WY21. Site 3 (Fashion Valley Mall, *blue line*) has consistently exhibited the lowest running average WQI, while Site 4 (FSDRIP at Mission Valley Rd., *red line*) has consistently witnessed the highest values for the reach. The most significant decline in the WQI for the reach over the 16-year monitoring period occurred in WY14. There was a steady, general improvement from WY14 lows during the second half of WY15 and throughout WY16 into WY17. A general decline occurred throughout WY18, followed by recovery to WY17 values in WY19 and WY20. The running average index for this reach has declined from 45 to 35 (approximatly ten percent) over the 17-year monitoring period.

As shown in **Chart 5.2** , the range in monthly WQI values for the **Upper Mission Valley Reach** (Sites 5-7) of the river are similar to those in Lower Mission Valley, although somewhat less variable. Site 6 (Kaiser Ponds 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 the highest values on an extended basis since mid-2008. The highest average annual WQI

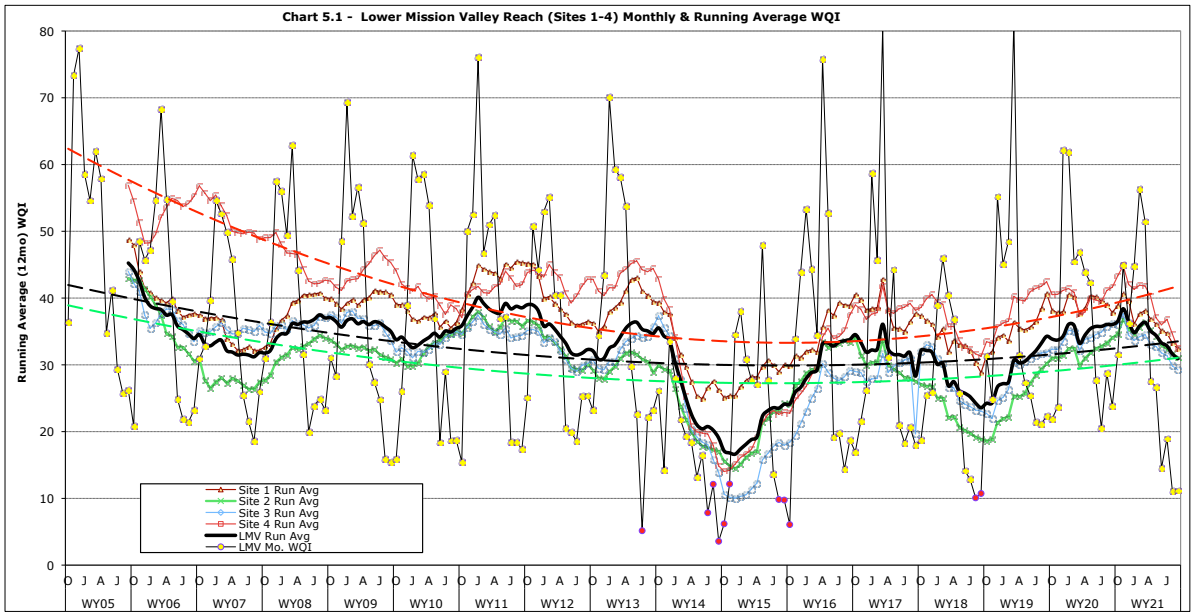


Chart 5.1 - Lower Mission Valley Reach (Sites 1-4) Monthly & Running Average WQI
Running Average (12mo) WQI
Site 1 Run Avg
Site 2 Run Avg
Site 3 Run Avg
Site 4 Run Avg
LMV Run Avg
LMV Mo. WQI
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21

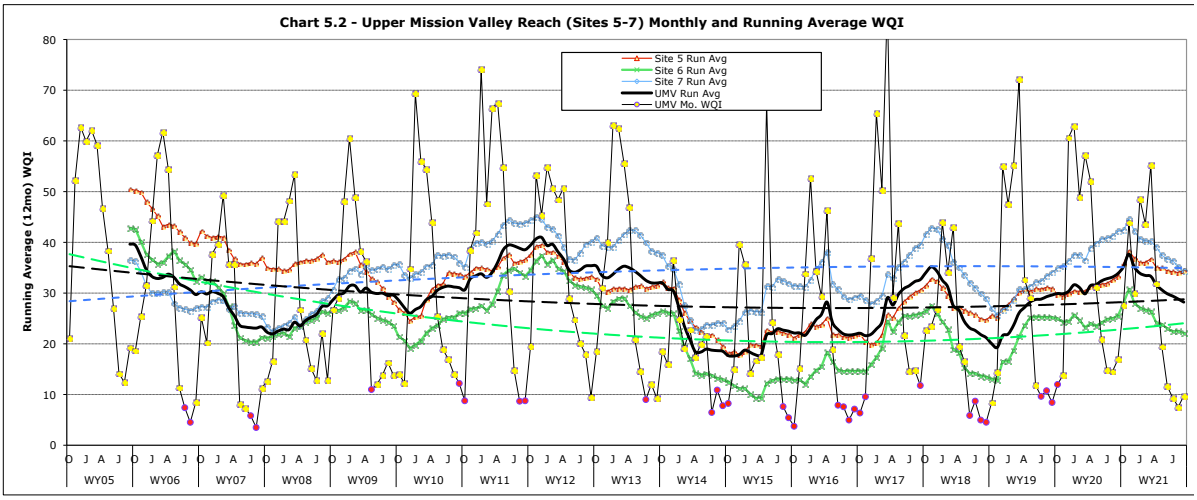


Chart 5.2 - Upper Mission Valley Reach (Sites 5-7) Monthly and Running Average WQI
Running Average (12mo) WQI
Site 5 Run Avg
Site 6 Run Avg
Site 7 Run Avg
UMV Run Avg
UMV Mo. WQI
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21

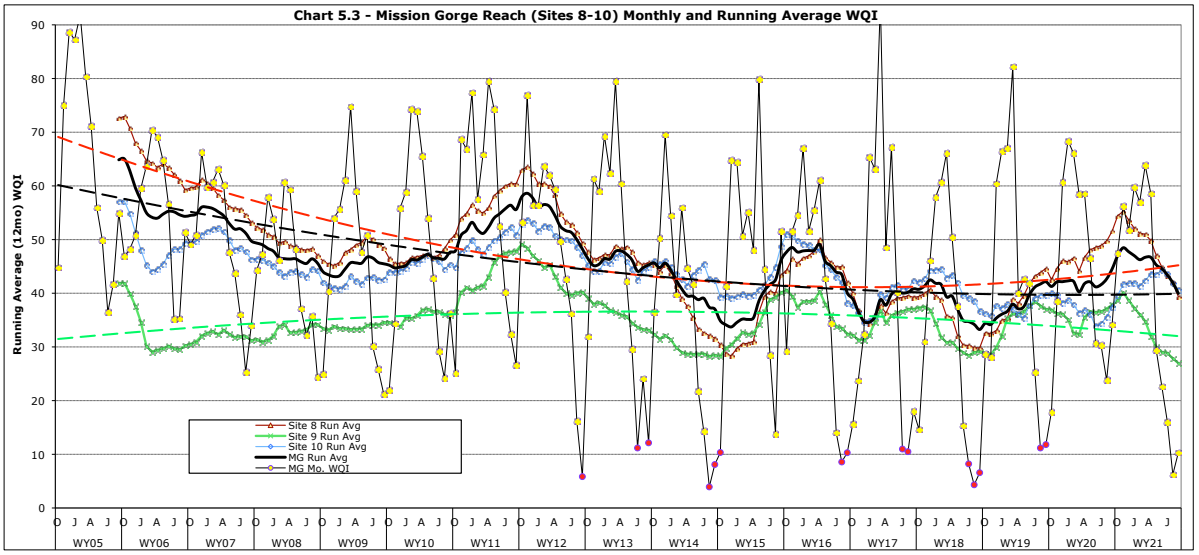


Chart 5.3 - Mission Gorge Reach (Sites 8-10) Monthly and Running Average WQI
Running Average (12mo) WQI
Site 8 Run Avg
Site 9 Run Avg
Site 10 Run Avg
MG Run Avg
MG Mo. WQI
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21

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 trend in running average WQI values (*black line*) from mid 2010 through 2013 was generally positive. Index values for each site and for the entire reach that trended downward through WY18 have recovered to prior year levels in WY19 and WY20. WY21 witnessend a plataue with little variation in running average values. The overall trend since WY06 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 minimal flow. The rate of decline in running average index in this reach over 17 years is about 1.8 percent/year, decreasing from 40 in WY05 to the present value of 28. Significant recovery in this reach is problemmatic without improved channel maintence due to the extensive accrual of biomass and insufficient channel flushing.

Running average WQI for the **Mission Gorge Reach** (Sites 8-10) of the river, as shown in **Chart 5.3**, 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 the 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 to 40 by the end of WY21. The overal index has declined 20 points (from 60 down to 40) over 17 years in this section of the river. The running average has remained below the 17-yr norm of 46 since WY13.

The **Lower Santee Basin Reach** (Sites 11, 15T and 12T) WQI values and running averages are shown in **Chart 5.4**. 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 last year and 38 in WY21. 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 average index improved to values comperable to those experienced in WY07 through WY11. The overall change in the index between WY05 and WY21 is less than one percent. This reach of the river has shown the least amout of change in water quality metrics over the 17 years of monitoring, due in large part to Forester Creek improvements and permitted discharge of reclaimed water from Santee Lakes.

C**hart 5.5** presents monthly and running average WQI values for the **Upper Santee Basin Reach** (Sites 13 & 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 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

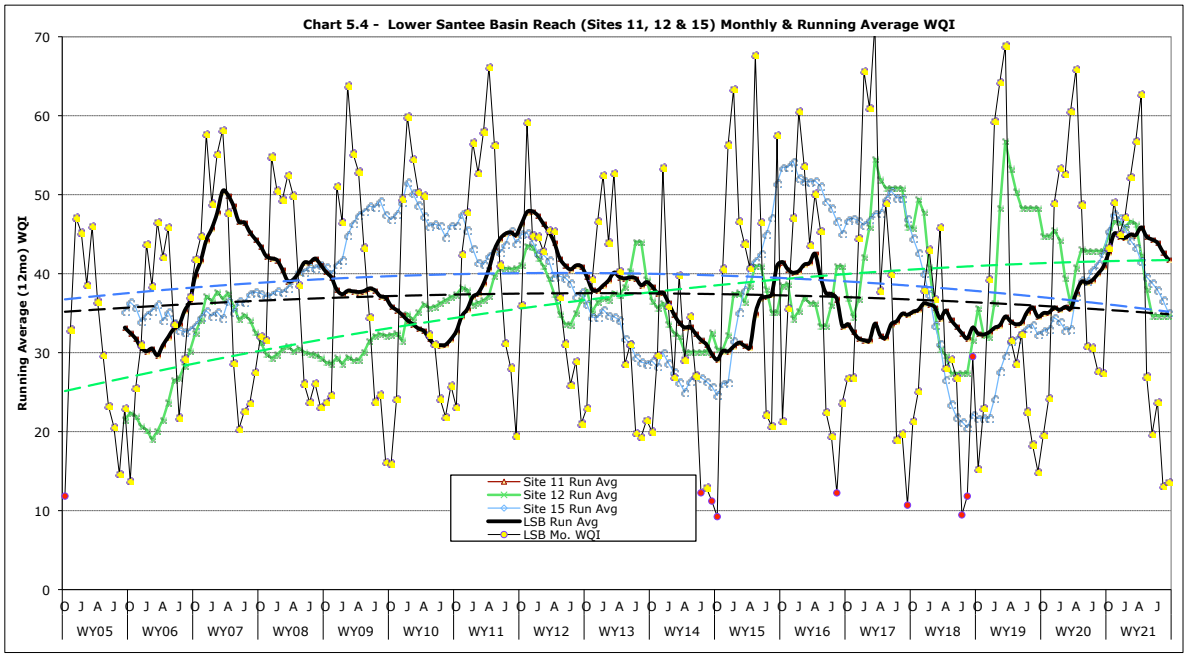


Chart 5.4 - Lower Santee Basin Reach (Sites 11, 12 & 15) Monthly & Running Average WQI
Running Average (12mo) WQI
Site 11 Run Avg
Site 12 Run Avg
Site 15 Run Avg
LSB Run Avg
LSB Mo. WQI
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21

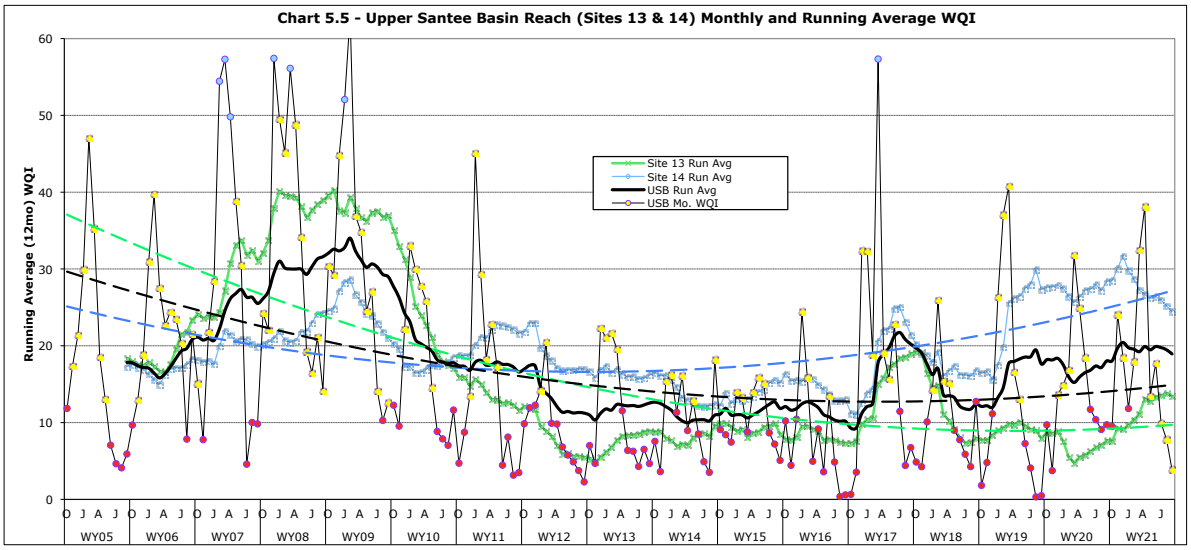


Chart 5.5 - Upper Santee Basin Reach (Sites 13 & 14) Monthly and Running Average WQI
Running Average (12mo) WQI
Site 13 Run Avg
Site 14 Run Avg
USB Run Avg
USB Mo. WQI
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21

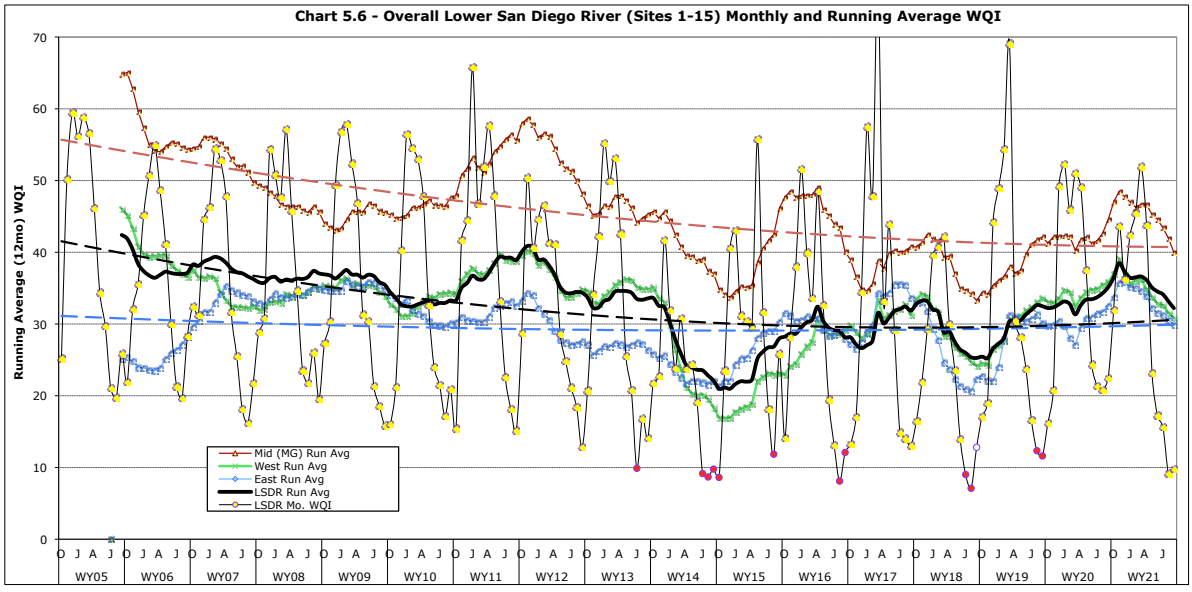
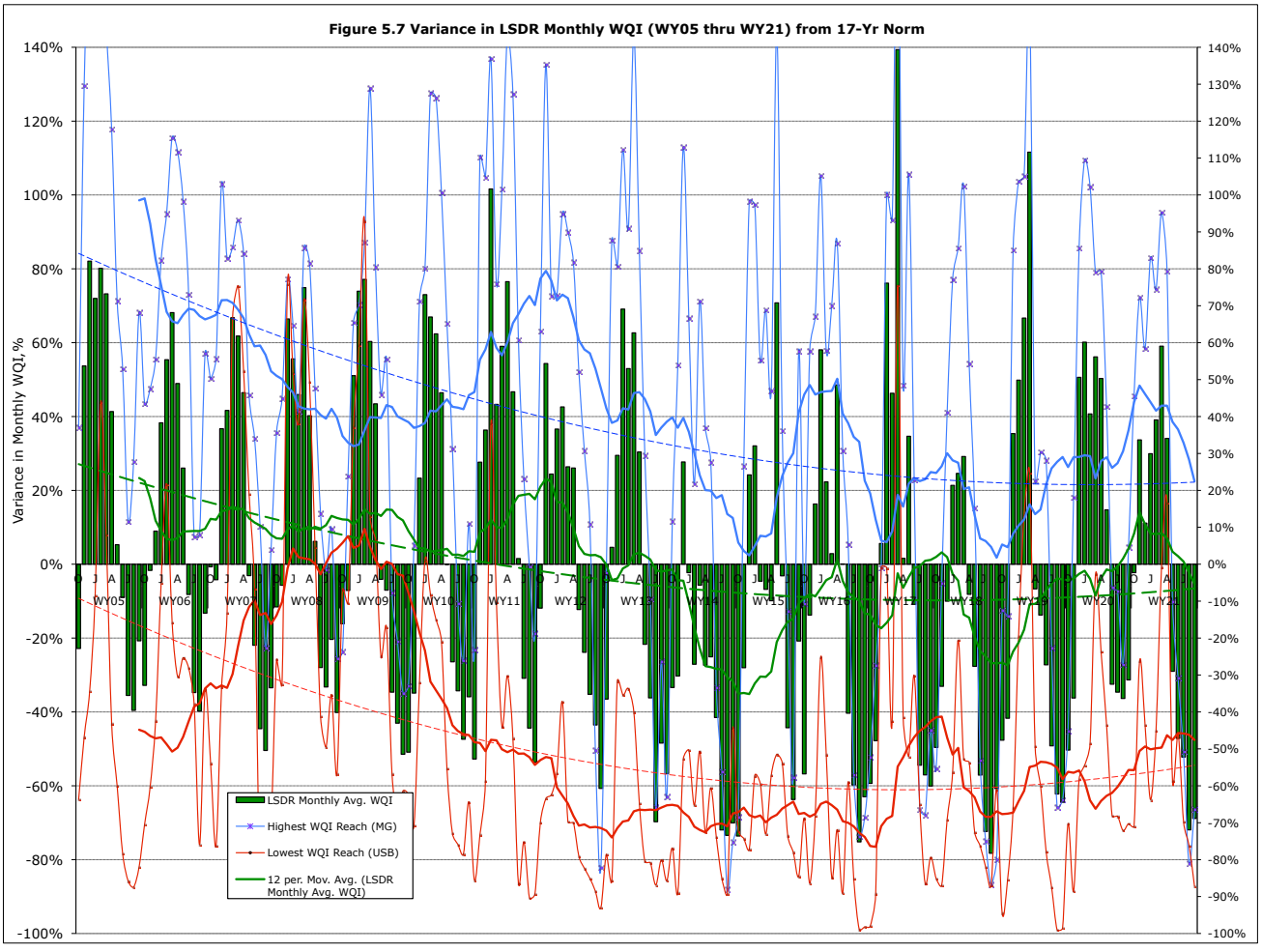


Chart 5.6 - Overall Lower San Diego River (Sites 1-15) Monthly and Running Average WQI
Running Average (12mo) WQI
Mid (MG) Run Avg
West Run Avg
East Run Avg
LSDR Run Avg
LSDR Mo. WQI
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21

and backwaters situated 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 in all but the wettest/greatest 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 (weighted average of all monitoring sites) are presented in **Chart 5.6.** 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 WY13&16 levels) in WYs19&20. WY21 again experienced declines in all three sections of the lower river. The Mission Gorge section changed the least, while the upstream section (Santee Basin) the most. There were noticable decreases in index values in nearly all reaches of the river and thus overall in WY21. The current LSDR running average WQI of 31 (D Marginal) is three percent below the 17-yr norm. The overall trend in running average WQI for the LSDR that remained relatively steady in the range of 35 to 40 from WY06 thru WY12, declined toward the low 20's in WY14 and early WY15, returned to the low 30's for several years then dipped in WY18 and again this year. The overall running average index value has fallen nine points (from 40 to 31) over 17 years.



Percent variance in monthly index values for the highest (MG-blue), average (LSDR-green) and lowest (USB-red) reaches from 17-yr norms are espressed in **Chart 5.7** on the previous page. Trendlines in values are shown as dashed lines with similar colors. The overall decline in the index is a function of lower oxygen concentrations in conjuction with warmer water temperatures and higher specific conductivities monitored at nearly all sites uver the 17 year period. These values are impacted by low streamflows especially during extended months without measurable rainfall. 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 deposition and eutrofication.

Depleted dissolved oxygen levels (often < 2.5 mg/L) in conjunction with minimal dry-weather flow conditions resulting in warmer water and higher SpC (more dissolved solids) are recognized as the primary causes of low water quality index values. The low DO concentrations are believed to be the result of extensive and persistent eutrophication from buildup of organic-rich detritus combined with restricted water movement at a number of reaches. Until the spread of creeping water primrose (L*udwigia peploides, et.al.)*[a] and other invasive aquatics can be better controlled and the effects of eutrophication effectively managed, water quality within several reaches of the lower river system is expected to remain significantly below that monitored and experienced in reaches where improved circulation, mixing and re-oxygenation occurs naturally.

Footnote:
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 in that country. More recently it was introduced to areas beyond its native range in the United States 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 negatively 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). It's common name is "floating water primrose", it produces a distintive small yellow or white flower during its bloom cycle (May-Nov.). It is a perenial herb (a dicot) termed marsh purslane; a member of family ORAGRACEAE. *from California Invasive Plant Council (CALIPC) website. Ludwigia,* the green plant extending from the lower right-hand corner of the photo on the cover of this report, is now pervasive throughout lower reachs of the river.

(AWQRpt.page JCK 11/19/21)