S A N D I E G O R I V E R P A R K F O U N D A T I O N

LOWER SAN DIEGO RIVER WATER QUALITY

Annual Water Quality Monitoring Report for WY22

YMCA-Sefton Field crossing (WQM Site #2) viewing upstream over Ludwiggia-chocked channel toward trollyline (June, 2022)

Compilation of WQM data (October 2004 - September 2022)

John C. Kennedy, PE

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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 - 2022

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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 18 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 2022 (WY22) data in comparison to previous year results and 18yr averages henceforth refered to as 'norms'. The LSDR water quality monitoring site locations are shown on **Figure 1-1**.

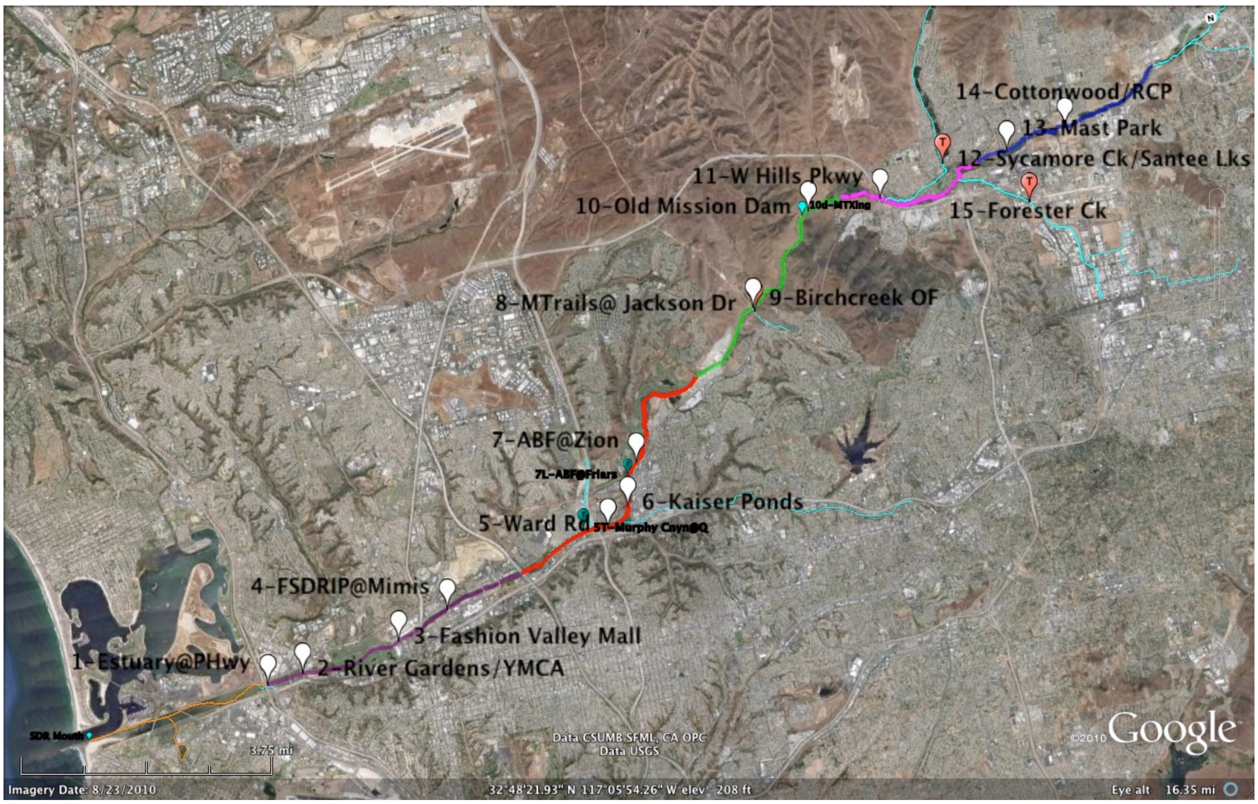

Figure 1-1 LSDR Watershed and Water Quality Monitoring Sites

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 general questions and concerns from SDRPF staff and the 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 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%	Below many 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 many 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 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 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 the 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 WY22 Water Quality Metrics and 18yr 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 WY22 and 'norms' i.e., averaged values over the past 18 years of monthly monitoring, are presented in **Table 2.1**. WY22 values (bold type) equal to or greater than site norms (expressed in italics) are shown in black, whereas current values below norms are in red. This year's overall LSDR averages (of all sites) are displayed in bottom rows of the table.

Table 2.1 Average Annual WQ Metrics for WY22 and 18yr 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	L M V	West	**20.5**/*19.7*	**2.9**/2.7	**7.7**/7.8	**5.7(63)** / *6.1(67)*	**15**/*27*	**32**/*37* (-5)	**D**/D+
2			**19.6**/*19.0*	**2.8**/2.7	**7.5**/7.7	**4.0(42)** / *4.4(46)*		**27**/*30* (-3)	**D**/*D*
3			**19.2**/*19.2*	**2.4**/2.6	**7.6**/7.8	**3.2(34)** / *4.6(48)*		**22**/*31* (-9)	**E**/*D*
4	M M V		**19.7**/*19.6*	**2.3**/2.5	**7.7**/7.8	**5.2(58)** / *6.0*(65)		**34**/*39* (-5)	**D**/*C*
5			**16.9**/*17.2*	**2.5**/2.6	**7.6**/7.6	**4.3(44)** / *4.8*(49)	**12**/*25*	**29**/*32* (-3)	**D**/*D*
6	U M V		**18.0**/*18.3*	**2.8**/2.6	**7.5**/7.6	**2.2(22)** / *3.5*(36)		**16**/*24* (-8)	**E**/E+
7			**18.7**/*18.1*	**2.4**/2.5	**7.5**/7.6	**5.3(56)** / *5.1*(53)		**35**/*34* (+1)	**D**/*D*
8	M G	Mid	**17.5**/*17.1*	**2.3**/2.3	**7.7**/7.7	**6.7(67)** / *7.2*(73)	**9**/*18*	**45**/*48* (-3)	**C**/C+
9T [b]			**16.4**/*15.7*	**4.1**/4.7	**8.1**/7.9	**9.5(98)** / *9.2*(93)	<1	**35**/*33* (+2)	**D**/*D*
10			**17.8**/*17.6*	**2.2**/2.3	**7.9**/7.8	**5.6(57)** / 6.9(72)	**7**/*16*	**34**/*44* (-10)	**D**/*C*
11	L S B	East	**17.1**/*16.7*	**2.3**/2.2	**7.6**/7.6	**5.9(61)** / *6.1*(60)		**37**/*38* (-1)	**D+**/C-
12T [b]			**16.5**/*17.6*	**1.6**/1.6	**7.8**/7.9	**4.6(47)** / *7.0(70)*	ur	**25**/*36* (-11)	**D**/*D*
15T [b]			**17.3**/*17.9*	**2.4**/2.7	**7.7**/*8.0*	**5.6(58)** / *7.3*(70)	**4**/*9*	**32**/*39* (-7)	**D**/C-
13W[c]	U S B		**16.2**/15.8	**1.6**/1.8	**7.5**/7.7	**2.7(29)** /3.2 (34)	**3**/*7*	**20**/*22* (-2)	E/*E*
13E			**17.7**/*18.3*	**1.9**/1.9	**7.5**/7.7	**2.1(22)** / *2.8(29)*		**11**/*16* (-5)	**F+**/*E*
14			**19.2**/*17.8*	**1.6**/1.5	**7.9**/7.8	**4.5(46)** / *3.5*(36)		**26**/*20* (+6)	**D**/*E*
all	LSDR Avg.		**18.1**/*18.0*	**2.3**/*2.3*	**7.6**/*7.7*	**4.6(48)** / *5.3(54)*	**10**/*19*	**29**/33 (-4)	**D**/*D*
1-16	**Dwt Avg [d]**		**18.1**/*17.9*	**2.3**/*2.3*	**7.7**/*7.7*	**4.7(48)** / *5.4(51)*	**10**/*19*	**29**/*33* (-4)	**D**/*D*

a) *Average annual water quality index values, change (+/-) and resultant WQ letter grade for WY22 (bold) and the 18yr norms (italics); values below sites 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' are statistically unsound.*
d) *Distance-weighted (Dwt) WQI values calculated based on reach of each site relative to total length of the lower river.*
e) *DO>7.0 mg/L shown in blue cells; DO<5 mg/L shown in tan cells.*

Only three monitoring sites (7,9&14) show average annual WQI values for WY22 greater than or equal to their 18yr norms; whereas 13 others are below. Average water temperatures exceeded 18yr norms at 11 sites in WY22, resulting in a slight increase (0.1-0.2 oC) overall from the 18yr annual average of 18.0 C. Specific Conductivity values for WY22 are above 18yr norms at seven monitoring sites and below at nine. The overall SpC (LSDR average) for WY22 is within 1% of the 18yr average annual norm of 2.30 mS/cm. DO values are greater than 18yr norms at only three sites in WY22. Overall this year's average DO values are well below the 18yr annual norm (5.35 mg/L/53%Sat). WY22 DO values are also considerably below (0.68 mg/L) last year's average. This year's annual average DO is above the lowest year (WY14 @ 3.95 mg/L) by only 0.78 mg/L while well below (2.11 mg/L) the highest value of 6.84 mg/L recorded in WY05. Average daily streamflows (ADF) for WY22 (bold, red type) were lower at all sites than the 18yr norms.

Average annual and monthly min.-max. range water quality metrics for WY22 and 18yr norms are expressed for the entire river (LSDR) and by reach/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 18yr 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 18yr norms. Streamflow exceeded 18yr norms in all reaches and sections in WY22 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 WY22 and 18yr 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.		**23.9**/*23.3*	**3.1**/*2.9*	**8.2**/*7.8*	**7.6(69)** / *8.0(68)*	**31**/*230*	**51**/*51* (0)	**A-**/*A-*
Winter (D,J,F,M)		**13.8**/*13.5*	**1.7**/*1.7*	**8.0**/*7.7*	**7.0(65)** / *7.1(63)*	**22**/45	**47**/*47* (0)	**C**/*C*
Annual Avg.		**18.1**/*18.0*	**2.3**/*2.3*	**7.9**/*7.7*	**4.6(48)** / *5.3(54)*	**10**/*22*	**29**/*33* (-4)	**D**/*D*
Wt Avg. Annual		**18.1**/17.9	**2.3**/*2.3*	**7.9**/7.8	**4.7(46)** / *5.4(51)*	**10**/19	**29**/*33* **(-4)**	**D**/***D***
Summer (J,J,A,S)		**22.9**/*22.5*	**2.9**/*2.8*	**7.8**/*7.7*	**3.0(33)** / *3.7(39)*	**1.1**/2.0	**13**/*19* (-6)	**E-**/*E*
LSDR Min. Mo.		**11.8**/*11.8*	**1.3**/*1.6*	**7.7**/*7.7*	**2.3(27)** / *3.5(35)*	**0.5**/*0.1*	**16**/*16* (0)	**E**/*E*
LSDR Individual Reach & Section Averages:								
USB	East	**18.2**/*18.1*	**1.8**/*1.8*	**7.7**/*7.7*	**3.9(41)** / *4.5(46)*	**4**/*5*	**17**/*17* (0)	**E**/*E*
LSB	East	**17.4**/*17.4*	**2.2**/*2.2*	**7.6**/*7.8*	**4.1(45)** / *5.0(53)*	**7**/*16*	**38**/*37* (+1)	**C-**/*D+*
MG	Mid	**17.4**/*17.0*	**2.2**/*2.3*	**7.9**/*7.8*	**6.8(69)** /*7.4(76)*	**9**/*18*	**40**/*46* (-6)	**C**/*C*
UMV	West	**17.9**/*17.9*	**2.6**/*2.6*	**7.5**/*7.6*	**3.9(41)** / *4.5(46)*	**14**/*27*	**29**/*28* (+1)	**D**/*D*
LMV	West	**19.7**/*19.4*	**2.6**/*2.6*	**7.6**/*7.7*	**4.1(45)** / *5.0(53)*	**15**/28	**31**/*35* (-4)	**D**/*D*

a) *Average annual water quality index value, difference (+/-) from 18-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 are in black.*
b) DO>7.0 mg/L shown in light blue cells; DO<5 mg/L shown in tan cells.

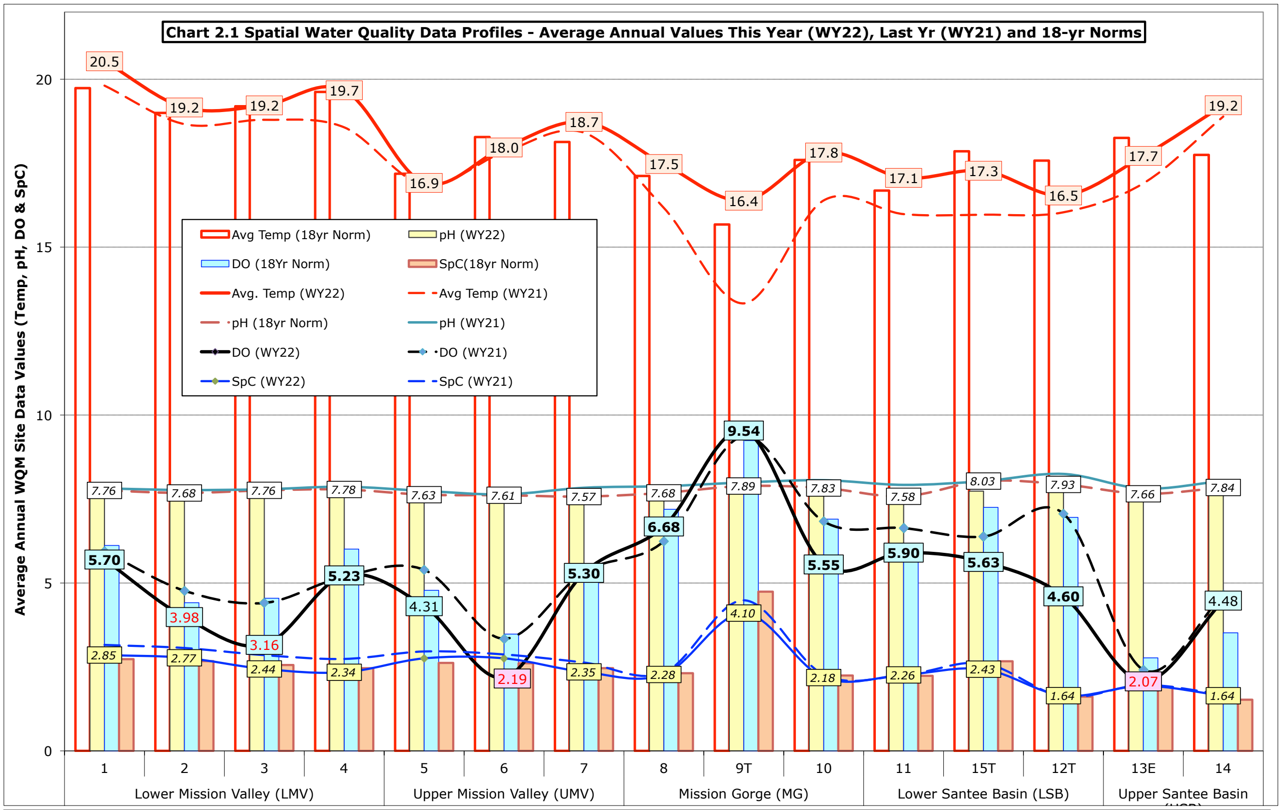
Chart 2.1 Spatial Water Quality Data Profiles - Average Annual Values This Year (WY22), Last Yr (WY21) and 18-yr Norms
Average Annual WQM Site Data Values (Temp, pH, DO & SpC)
Avg Temp (18yr Norm)
pH (WY22)
DO (18Yr Norm)
SpC(18yr Norm)
Avg. Temp (WY22)
Avg Temp (WY21)
pH (18yr Norm)
pH (WY21)
DO (WY22)
DO (WY21)
SpC (WY22)
SpC (WY21)
Lower Mission Valley (LMV)
Upper Mission Valley (UMV)
Mission Gorge (MG)
Lower Santee Basin (LSB)
Upper Santee Basin

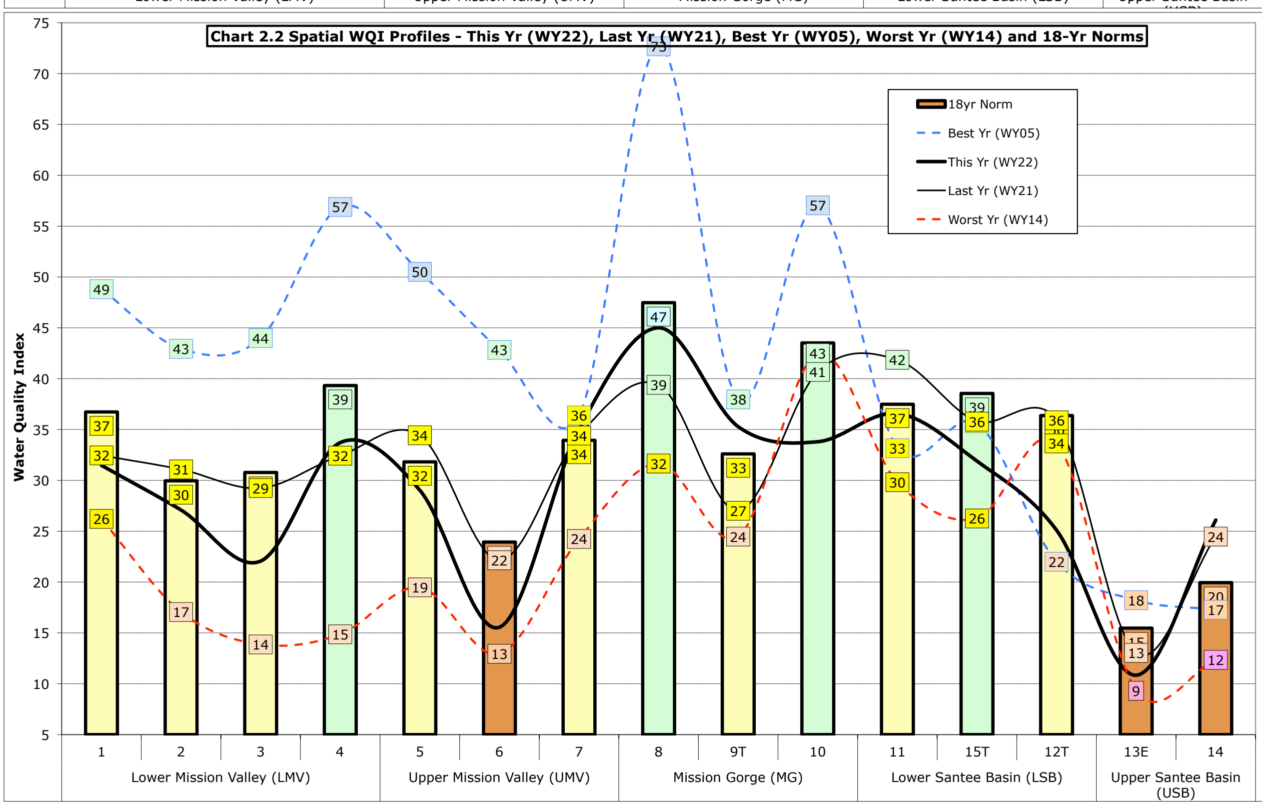
Chart 2.2 Spatial WQI Profiles - This Yr (WY22), Last Yr (WY21), Best Yr (WY05), Worst Yr (WY14) and 18-Yr Norms
Water Quality Index
18yr Norm
Best Yr (WY05)
This Yr (WY22)
Last Yr (WY21)
Worst Yr (WY14)
Lower Mission Valley (LMV)
Upper Mission Valley (UMV)
Mission Gorge (MG)
Lower Santee Basin (LSB)
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 LSDR WY22 Data and 18yr 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 (WY22) with comparison to 18yr norms (shown italicized). WY22 values above the 18yr norms are in blue; values below in red. Temporal water quality values in WY22 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 trsultant annual average WQI for WY22 is four points below the 18yr norn of 33.

Table 3.1 LSDR WQM Metrics for WY22 and 18-yr Norms by Month and Season

Month	Season:	Temp, oC	Sp Cond, mS/cm	pH	Dissolved Oxygen, mg/L	(%Sat)	ADF, cfs	WQI Value (a)	and Grade
Oct	Fall	**16.6**/*18.4*	**2.47**/*2.79*	**7.9**/*7.7*	**3.71**/*4.11*	**32**/*40*	**4.9**/*2.2*	**24**/*21*	**E+**/*E*
Nov		**15.6**/*15.0*	**2.68**/*2.67*	**7.8**/*7.7*	**4.10**/*5.61*	**33**/*50*	**2.9**/*6.6*	**23**/*30*	**E+**/*D*
Dec	Winter	**12.1**/*11.8*	**1.31**/*1.83*	**7.5**/*7.8*	**6.22**/*6.96*	**53**/*59*	**21**/**27**	**40**/*42*	**C**/*C*
Jan		**13.8**/*11.9*	**2.00**/*1.74*	**7.8**/*7.7*	**6.88**/*8.05*	**65**/*68*	**31**/*53*	**46**/*49*	**C**/*C+*
Feb		**13.4**/*13.9*	**1.93**/*1.69*	**7.7**/*7.8*	**7.63** /*7.25*	**69**/*65*	**8**/*51*	**51**/*47*	**B-**/*C*
Mar		**15.9**/*16.5*	**1.74**/*1.59*	**7.7**/*7.8*	**7.30** /*7.04*	**74**/*66*	**26**/*47*	**52**/*50*	**B-**/*B-*
Apr	Spring	**18.7**/*18.0*	**1.85**/*1.89*	**7.7**/*7.8*	**5.24**/*5.96*	**50**/*58*	**14**/*24*	**36**/*41*	**D**/*C*
May		**19.5**/*19.9*	**2.24**/*2.21*	**7.5**/*7.8*	**3.81**/ *5.16*	**38**/*51*	**4.1**/*10*	**19**/*34*	**E**/*D*
June	Summer	**21.7**/*21.9*	**2.65**/*2.56*	**7.7**/*7.8*	**3.92**/*4.35*	**40**/*45*	**1.1**/*3.8*	**17**/*24*	**E**/*E+*
July		**22.6**/*23.1*	**2.83**/*2.75*	**7.7**/*7.7*	2.81/*3.60*	**32**/*38*	**0.6**/*2.0*	**13**/*17*	**E-**/*E*
Aug		**23.8**/*23.3*	**3.06**/*2.94*	**7.6**/*7.7*	**2.79**/*3.54*	**33**/*37*	**0.4**/*1.1*	**11**/*15*	**F+**/*E-*
Sept		**23.4**/*21.5*	**2.90**/*2.93*	**7.6**/*7.7*	**2.29**/*3.51*	**27**/*36*	**2.0**/*1.2*	**12**/*17*	**F+**/*E*
Fall (O&N)		**16.1**/*16.7*	**2.58**/*2.74*	**7.9**/*7.7*	**3.76**/*4.81*	**39**/*44*	**3.9**/*4.4*	**22**/*25*	**E+**/*D-*
Winter (D,J,F,M)		**13.8**/*13.5*	**1.75**/*1.71*	**7.7**/*7.8*	**6.88**/*7.31*	**67**/*65*	**21**/*45*	**48**/*47*	**C+**/*C*
Spring (A&M)		**19.1**/*19.0*	**1.94**/*2.05*	**7.6**/*7.7*	**4.43**/*5.50*	**48**/*54*	**9**/*17*	**27**/*38*	**D+**/*C-*
Summer (J,J,A,S)		**22.9**/*22.5*	**2.86**/*2.80*	**7.6**/*7.7*	**2.93**/*3.45*	**35**/*39*	**1.1**/*2.0*	**14**/*18*	**E**/*E*
Annual (O-S)		**18.1**/*17.9*	**2.31**/*2.29*	**7.7**/*7.7*	**4.73**/*5.39*	**46**/*51*	**9.1**/*23*	**29**/*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). WY22 values/grades (in bold type) below 18-yr norms (in italics) are in red; those equal to or above norms 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.*

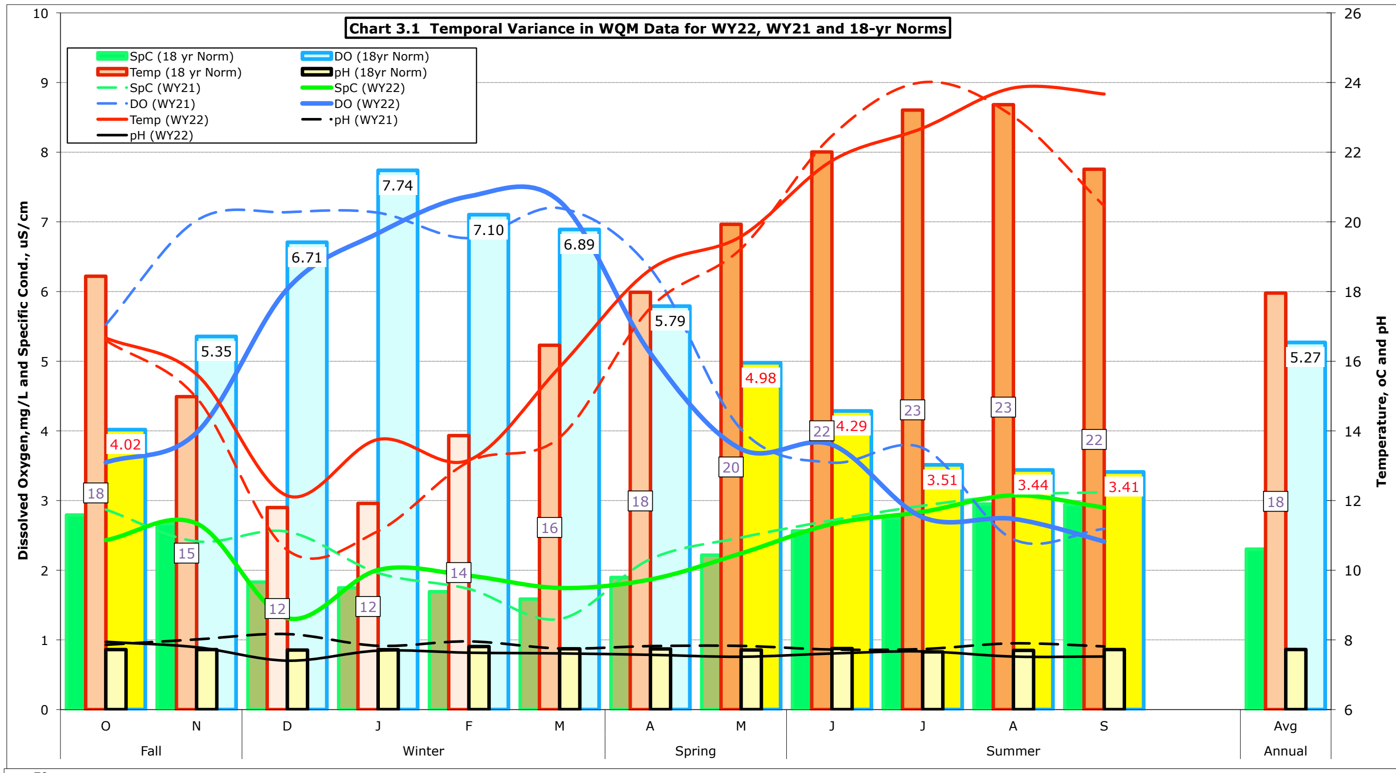
Chart 3.1 Temporal Variance in WQM Data for WY22, WY21 and 18-yr Norms
SpC (18 yr Norm)
DO (18yr Norm)
Temp (18 yr Norm)
pH (18yr Norm)
SpC (WY21)
SpC (WY22)
DO (WY21)
DO (WY22)
Temp (WY22)
pH (WY21)
pH (WY22)
Dissolved Oxygen,mg/L and Specific Cond., uS/cm
Temperature, oC and pH
Fall
Winter
Spring
Summer
Annual
Avg

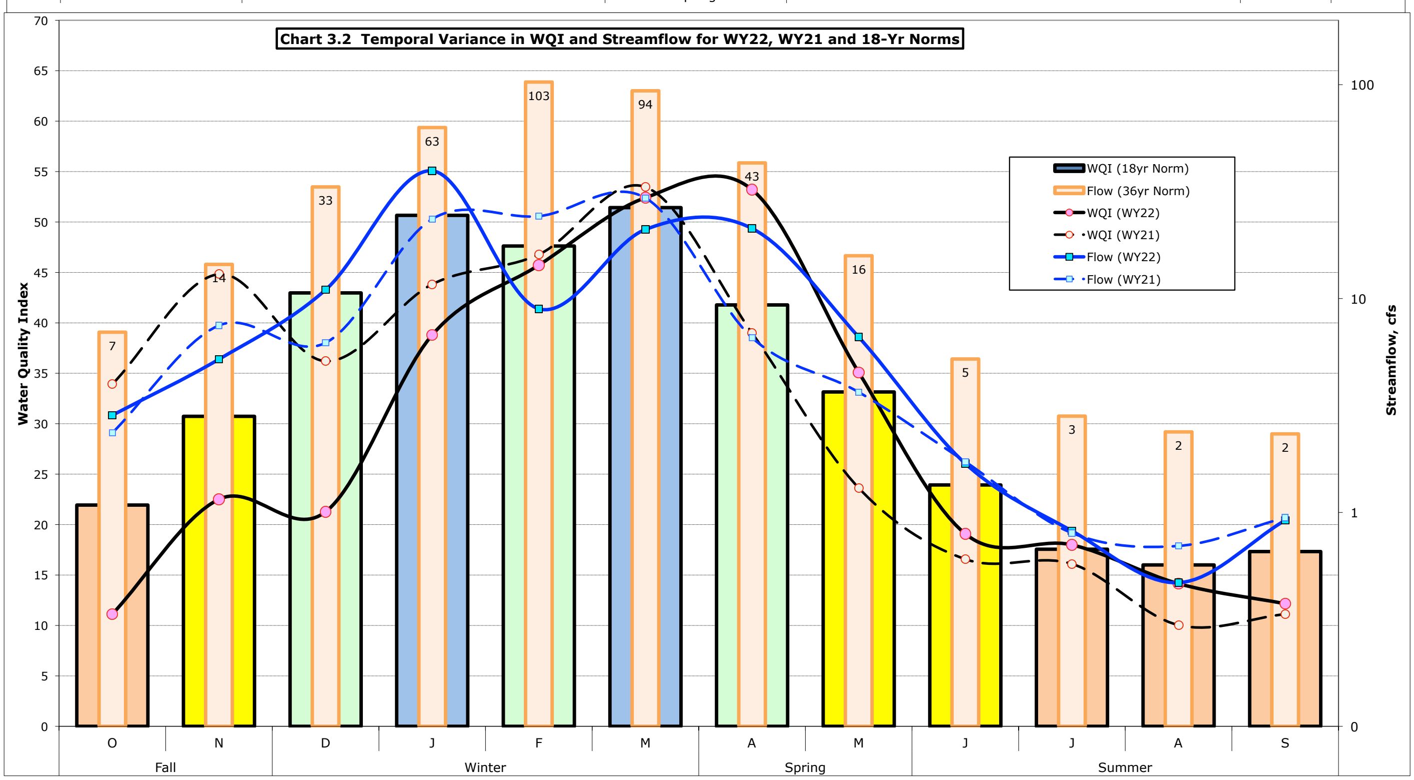
Chart 3.2 Temporal Variance in WQI and Streamflow for WY22, WY21 and 18-Yr Norms
WQI (18yr Norm)
Flow (36yr Norm)
WQI (WY22)
WQI (WY21)
Flow (WY22)
Flow (WY21)
Water Quality Index
Streamflow, cfs
Fall
Winter
Spring
Summer

Monthly and seasonal variances in water quality monitoring metrics for the past two water years (WY21 & WY22) and current 18yr norms are expressed in **Chart 3.1.** (WQM Data) as shown on the previous 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 (WY22), shown as solid lines, last year's results (dashed lines) and the 18yr norms (colored bars) are similar. In general, temporal variance in WY22 water quality data match closely temporal patterns in the 18yr norms; somewhat more so than WY21 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 WY22 compared to monthly averages for the previous water year (WY21) and the 18year norms. As shown in the chart, WQI values for WY22 (heavy black line), also listed in Table 3.1 (far right column), are reasonably close to 18yr 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 grades) in Summer (June-Sept) when streamflow and DO are lowest and water temperatures highest. The overall annual average WQI for the LSDR in WY22 of 29 (D mid-Marginal) is four points below the overall 18yr average index value of 33 and two points less than the WY21 index value of 31.

Temporal patterns in river water quality data, as expressed in this section of the report, are clearly evident when considering monthly and seasonal values. The next section of this report examines the same temporal variances in raw water quality data extending over the entire 18 year period based on computed 12-mo running average values. Examining the temporal patterns in running avarages provides a rational indication of trends in the various data.

Section 4 - Variances in Water Quality Metrics (WY05 through WY22)

Variances in SDRPF monitored water quality metrics, based on data collected by RiverWatch from Sept. 2005 through Sept. 2022, 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 expression of relative change in value over the past 18 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 past 18 years. Running averages above norms are listed in black; values below norms are in red. The 18-yr norms for each metric are expressed in italics in the bottom row of the table.

Table 4.1 - 12-mo Running Average WQM Metrics (WY05-WY22)

	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%)	57.8	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%)	19.7	35 D Marginal (+2)
WY10	18.03	2.281	7.86	5.35	(51%)	28.1	33 D Marginal (0)
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%)	13.3	34 D Marginal (+1)
WY13	17.29	2.433	7.78	5.51	(51%)	8.4	33 D Marginal (0)
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%)	9.7	28 D Marginal (-5)
WY16	18.23	2.257	7.75	4.82	(45%)	14.2	27 D Marginal (-6)
WY17	18.54	2.141	7.80	5.19	(50%)	45.0	32 D Marginal (-1)
WY18	18.09	2.774	7.97	4.41	(42%)	5.4	25 E+ Poor (-8)
WY19	17.74	2.162	7.77	5.11	(48%)	24.1	31 D Marginal (-2)
WY20	18.29	2.149	7.83	5.50	(52%)	31.0	35 D Marginal (+2)
WY21	17.23	2.439	7.89	5.41	(51%)	8.2	32 D Marginal (-1)
WY22	**18.08**	**2.306**	**7.68**	**4.73**	**(45.5%)**	**9.7**	**30 D Marginal (-3)**
18yr Norm	*17.93*	*2.296*	*7.74*	*5.39*	*(51%)*	*22.5*	*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.WY22 values/grades (in bold type) below 18yr 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 also years with low (i.e., 30 or below) WQIs also shown in light brown.

Monthly, 12-mo running average (Table 4.1, first column from left), 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 (27.1 oC) occuring in Aug. and coolest (8.8 oC) 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 18yr norm. Variance in running average water temperature over the past 18 years falls within the range of 3% above to 3% below the norm. The WY22 running average of 18.08 oC presents a small elevated variance of 0.8% in water temperature above the 18yr norm of 17.92^{o}C. As also shown on the chart, maximum monthly water temperatures have trended slightly higher than monthly minimums over time. Higher running average water temperatures observed in water years (06,10,12,15-18,20&22) are considered the result of higher 24-hr day 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 (18.70 oC) occured in WY15. As can be observed on Chart 4.1, although monthly variance in max.(red), min. (blue) and average (black) water temperatures for the LSDR are both large and cyclic, 12-month running averages for each metric present minimal variance over the 18 years. 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 18 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 less than one percent.

Variance in monthly monitored **Specific Conductivity** (SpC) values for the LSDR are presented in **Chart 4.2**. Min. (blue) and max. (red) running averages for all sites monitored have varied over the 18yr 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 2.77 mS/cm (21*% above average)* in WY18. Considerably greater rainfall during WY19 and WY20 and resultant above normal dry-weather stream flow caused SpC running averages to fall below the 18yr norm of 2.296 mS/cm. The current LSDR running average SpC of 2.31 mS/cm is 6% above norm due to several years of below average streamflow. The overall trend in maximum SpC for all sections of the river has shown a general decline over the last eight years. The variance in minimums at all sites (blue) has remained fairly steady over the 18 years of monitoring, however, average values (black line) have increased slightly due to lower average streamflow (upstream) and rising daily air temperature, resulting in noticably higher evaporation rates. The range from max.-to - min. variance has also declined in recent years. Variance below the norm has been most pronounced in the East (Sante Basin) and Mission Gorge sections; least so in the Mission Valley portion.

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 18 years (WY05-WY22). 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 18yr norm of 7.74. The overall trend in pH for the lower river is, however, very 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. 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. WY22 marks the first time in the last eight years that 12-mo. running average pH has fallen below the overall 18 year norm. It must be mentioned that the slight variances in pH are not taken into consideration when determining individual site WQI_4 values.

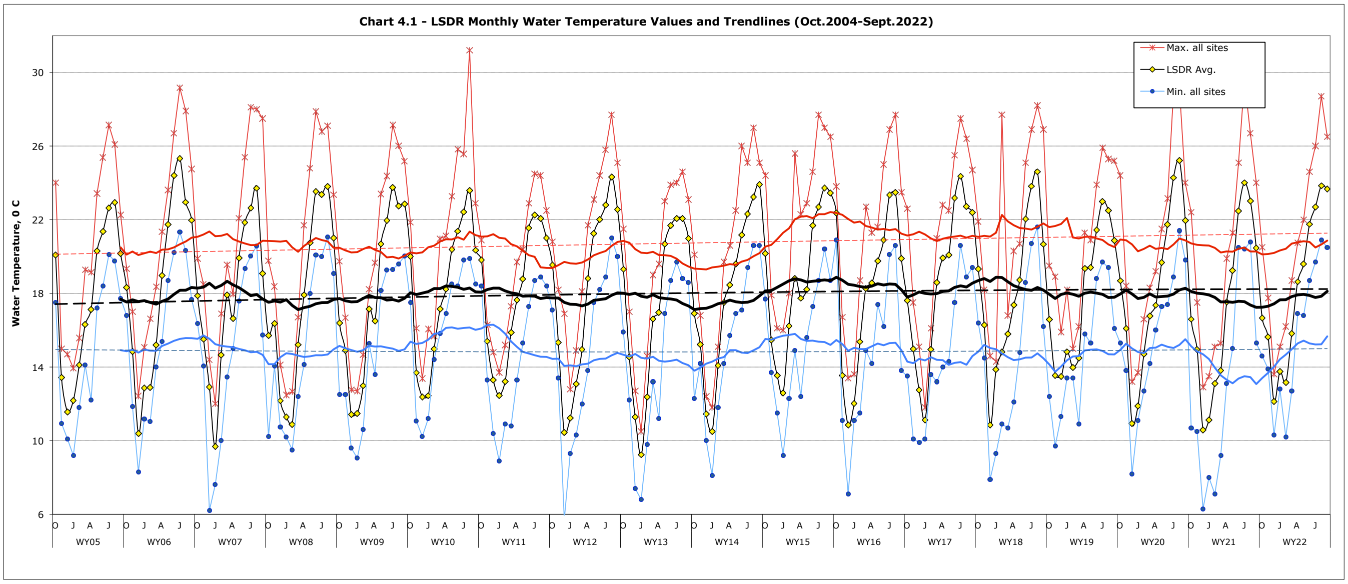
Chart 4.1 - LSDR Monthly Water Temperature Values and Trendlines (Oct.2004-Sept.2022)
Max. all sites
LSDR Avg.
Min. all sites
Water Temperature, 0 C
WY05 WY06 WY07 WY08 WY09 WY10 WY11 WY12 WY13 WY14 WY15 WY16 WY17 WY18 WY19 WY20 WY21 WY22

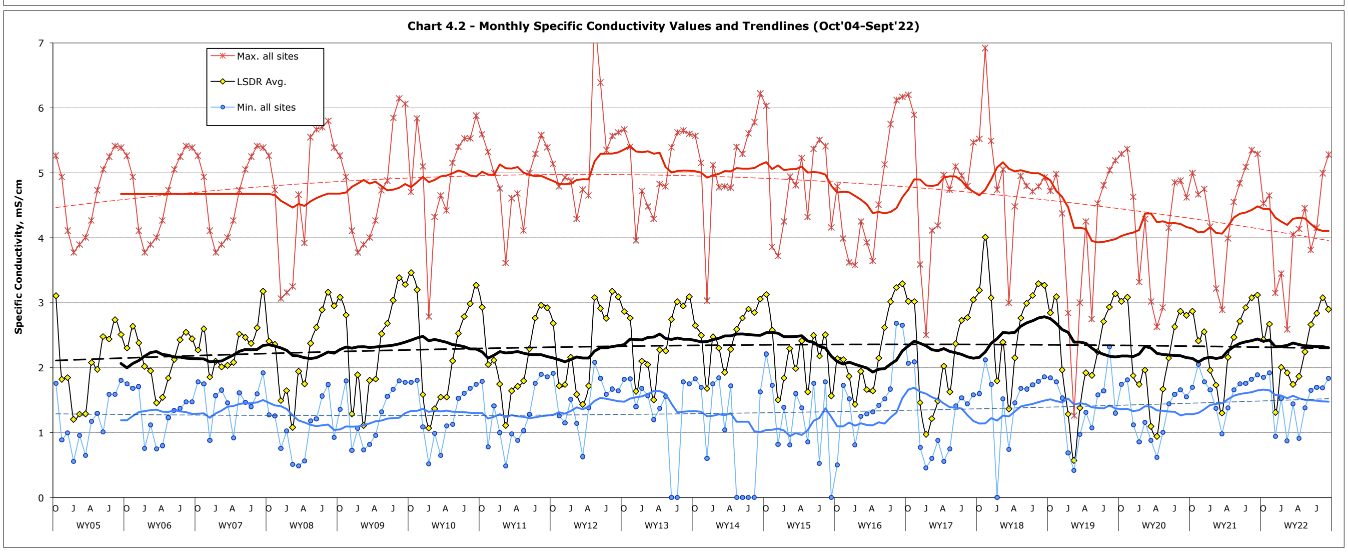
Chart 4.2 - Monthly Specific Conductivity Values and Trendlines (Oct'04-Sept'22)
Max. all sites
LSDR Avg.
Min. all sites
Specific Conductivity, mS/cm
WY05 WY06 WY07 WY08 WY09 WY10 WY11 WY12 WY13 WY14 WY15 WY16 WY17 WY18 WY19 WY20 WY21 WY22

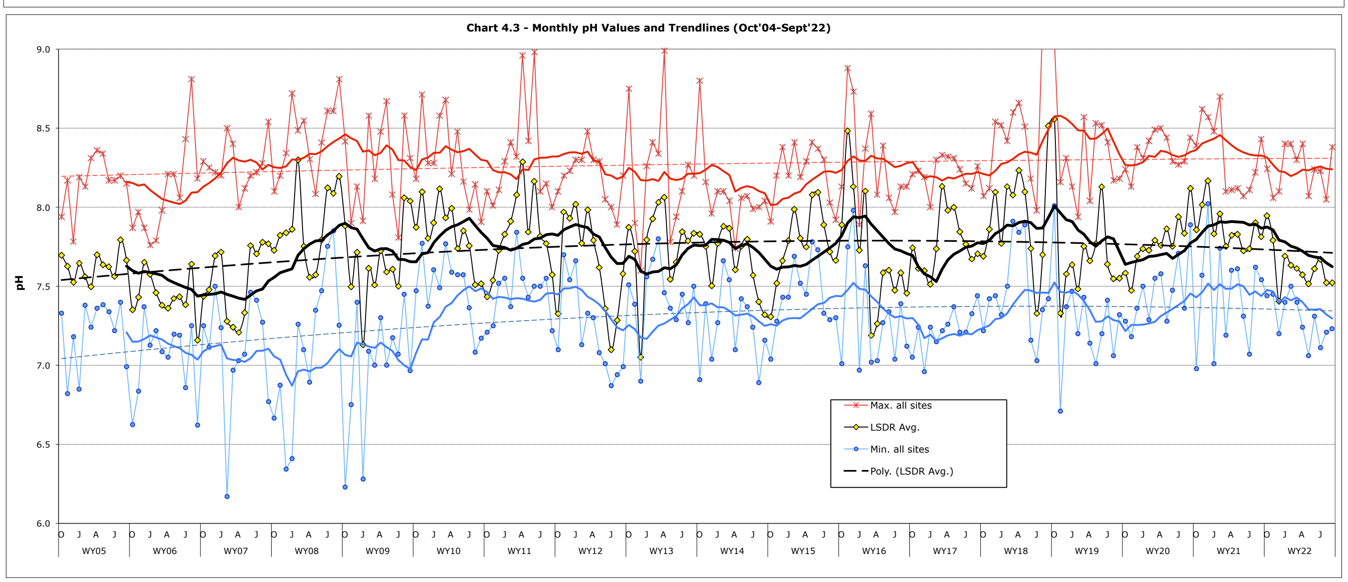
Chart 4.3 - Monthly pH Values and Trendlines (Oct'04-Sept'22)
Max. all sites
LSDR Avg.
Min. all sites
Poly. (LSDR Avg.)
pH
WY05 WY06 WY07 WY08 WY09 WY10 WY11 WY12 WY13 WY14 WY15 WY16 WY17 WY18 WY19 WY20 WY21 WY22

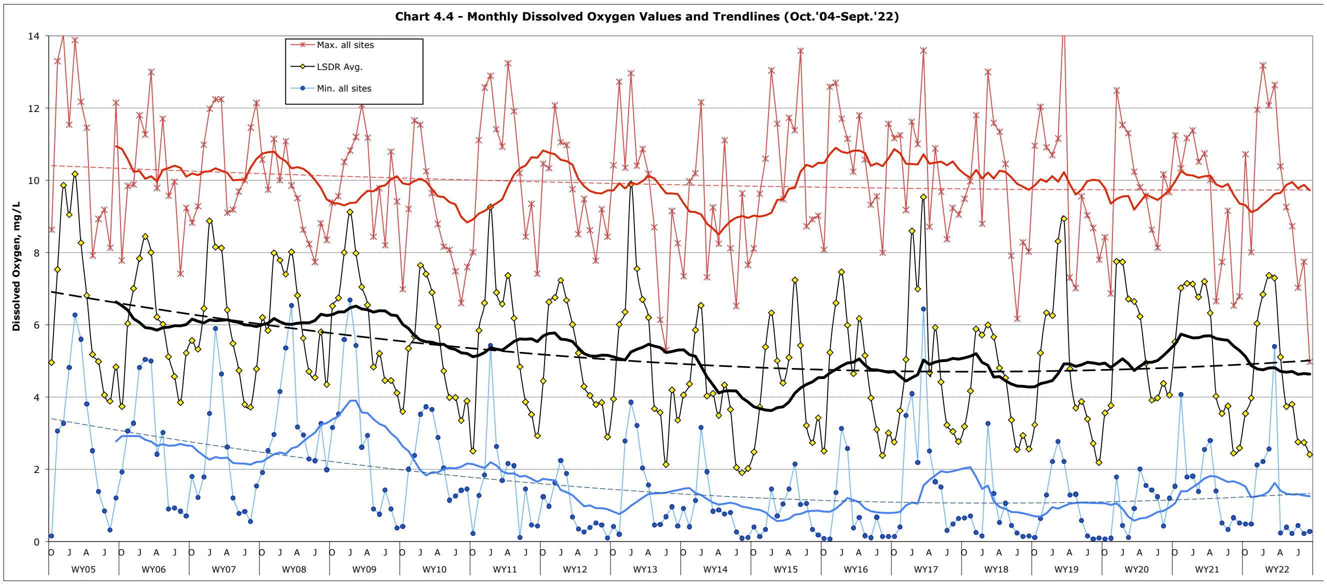
Chart 4.4 - Monthly Dissolved Oxygen Values and Trendlines (Oct.'04-Sept.'22)
Max. all sites
LSDR Avg.
Min. all sites
Dissolved Oxygen, mg/L
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22

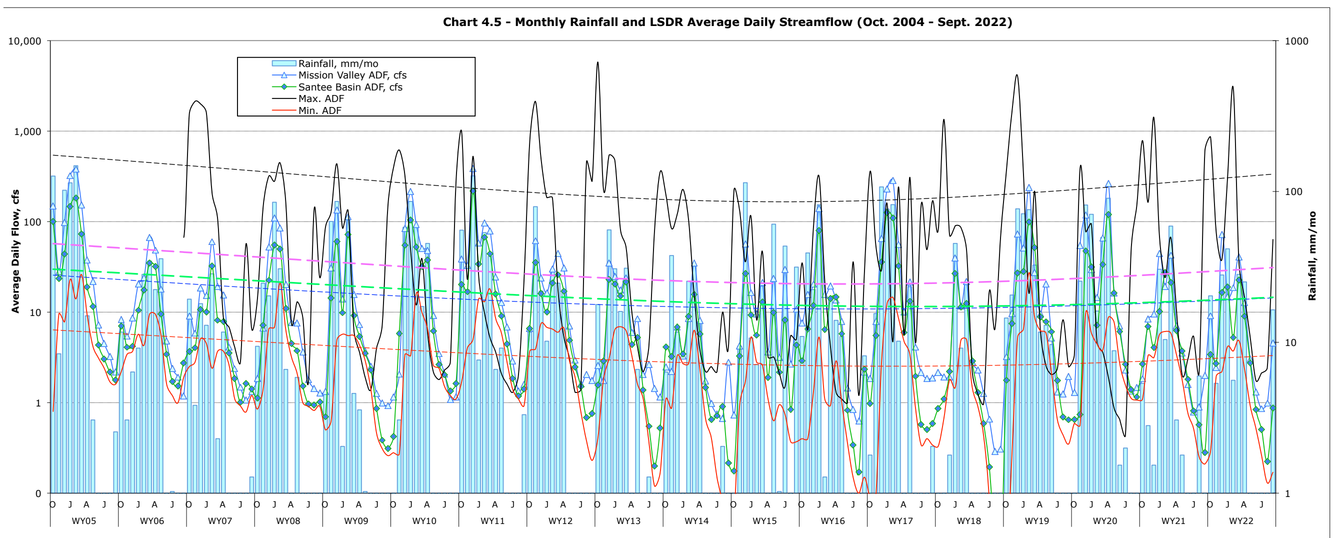
Chart 4.5 - Monthly Rainfall and LSDR Average Daily Streamflow (Oct. 2004 - Sept. 2022)
Rainfall, mm/mo
Mission Valley ADF, cfs
Santee Basin ADF, cfs
Max. ADF
Min. ADF
Average Daily Flow, cfs
Rainfall, mm/mo
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22

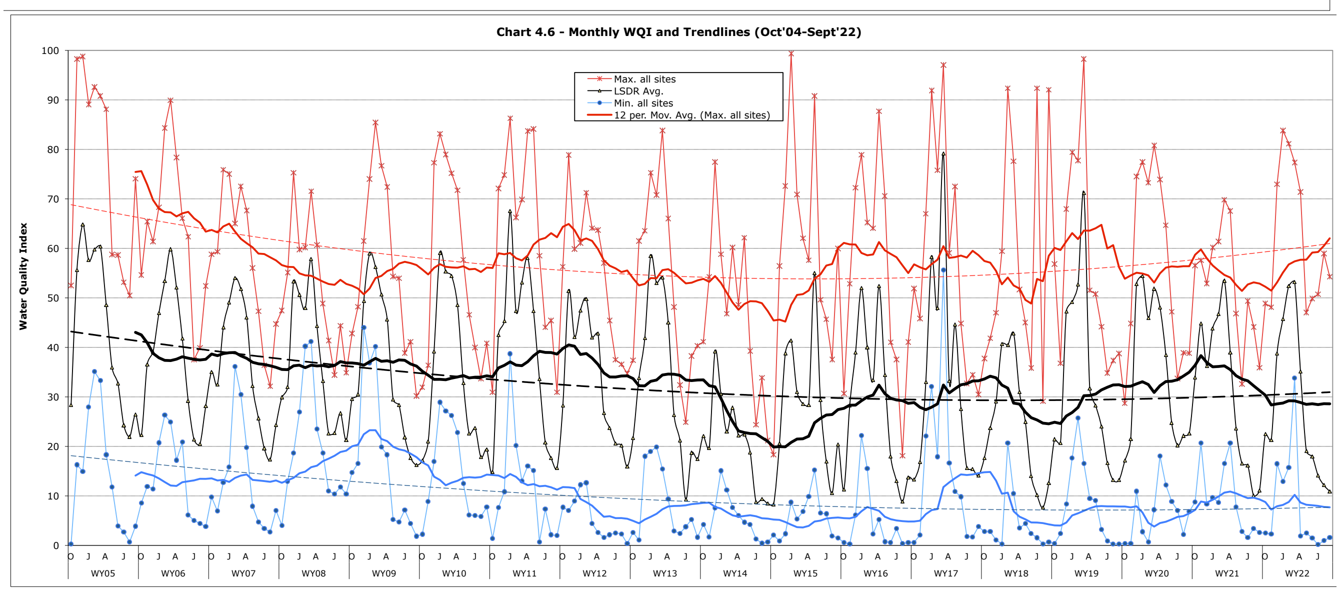
Chart 4.6 - Monthly WQI and Trendlines (Oct'04-Sept'22)
Max. all sites
LSDR Avg.
Min. all sites
12 per. Mov. Avg. (Max. all sites)
Water Quality Index
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22

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 mid-2015 can be observed. LSDR max. monthly values from WY15 through WY20 have increased to near 18yr norms. The current running average DO value of 4.73 mg/L (Sept 2022) is 13% below the 18yr 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 % 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 the next major hydrologic flushing of the lower system occurs. The probability of major flushing action for the lower river during a period of extended drought is very low.

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 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 at 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 WY22 witnessed on slightly more rainfall than last year, streamflows remained considerably below normal. The current running average flow of 9.7 cfs is 57% below the 18yr LSDR norm of 22.5 cfs. Significant variance in average annual streamflow, as well as maxima and minima which are experienced within the lower river watershed can be expected to persist.

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 calculated 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 trendlines for each section and overall river system 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 details related to index values for individual reaches of the lower river are provided in Section 5 of this report.

General Assessment of WQ Variance: The WQI provides a numeric indication of the relative condition of the river based on combining individual water quality parameters monitored by the RiverWatch Team 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 (Table 3.1 and Charts 4.6 and 4.7) 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 WY14, some 33% below the 18yr norm of 33 (D Marginal). WY18 presented the second lowest index at 25; 24% below the current norm. This year's running average WQI of 30 (D Marginal) is nine percent below the norm. This year's below normal rainfall and streamflow resulted in a running average index value nearly the same as experienced in WY19. Predicted below average rainfall for WY23 will likely result in an overall decline 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 would also have a significant impact on the index trend. The overall index has declined approximately 11 points; an average of 0.6 points per annum, since inception of the RiverWatch monitoring program. Both minima and maxima index values, as shown in Chart 4.5, have fallen at comperable rates to the overall index.

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 18year period are very 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 past 18 years. An uptrend toward normalized values was evidenced over several years (WY15-WY17), but again declined in WY18. WY19 & 20 witnessed slight recovery with noticible decines at multiple sites last and this water year. Section 4 provided perspective on overall variance and trends for individual water quality metrics. WQI trendlines by individual river reach, specific segment and for the overall lower system based of distance-weighted averages are presented in Section 5.

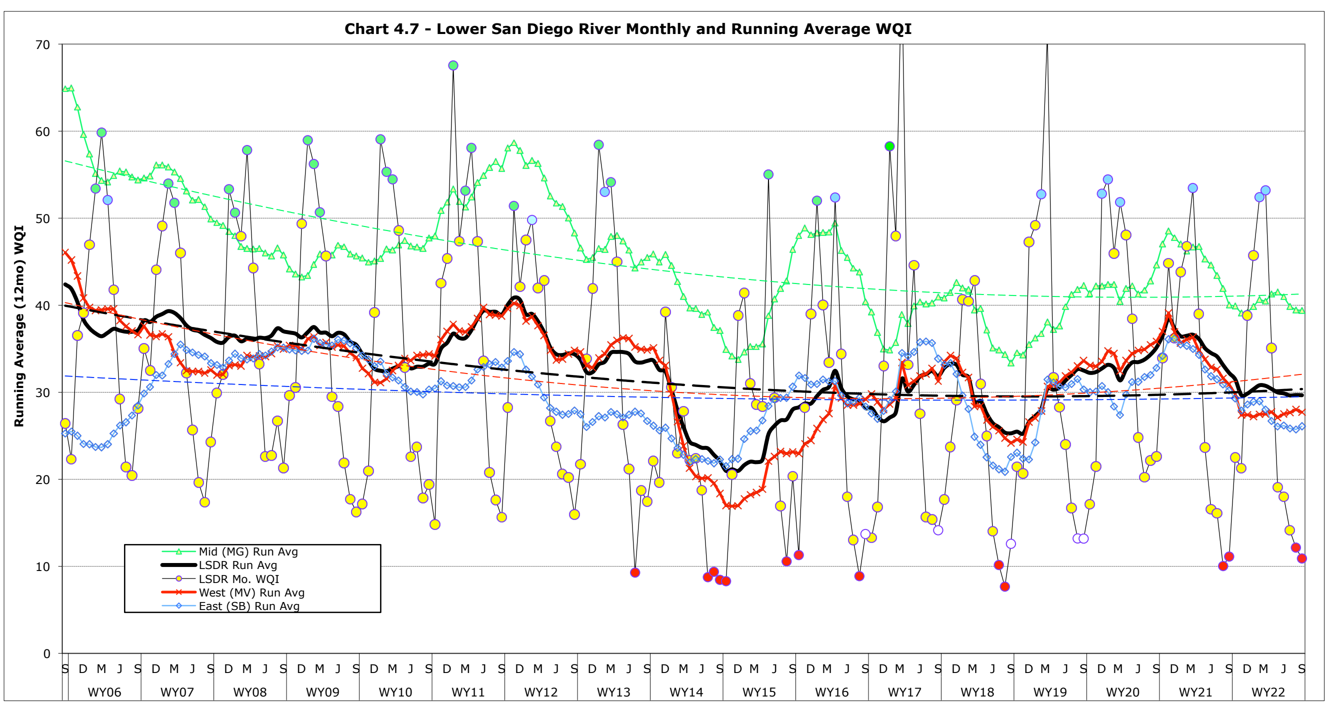

Chart 4.7 - Lower San Diego River Monthly and Running Average WQI

Section 5 - Trends in Water Quality Index by Reach/Section (WY05 through WY22)

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-WY22) of monitoring. Values and grades above 18yr norms are listed in black; values below italized norms (bottom row) are shown in red. The WY22 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 several points from last year's value of 32 to 30, three points below the 18-year norm of 33. The overall annual WQI average has been in the Marginal grade (D) for the last four water years. In addition to annual averages the seasonal range as represented by winter highs and summer lows are presented by reach, section and overall. WY22 winter (D-M) WQIs are greater than last year's within all but one reach (LSB) while this past summer's (J-S) index values are lower in the upper reaches and overall.

The running averages, as well as variances in monthly index values, for each reach of the lower watershed are also presented in the series of charts (5.1 through 5.6) on pages 18 and 19 of this section. Trends in values taken over the 18yr monitoring period are expressed as dashed lines based on best-fit, using second-order polynomial equations. The range in trendines 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-WY22)

	LMV Reach	MMV Reach	UMV Reach	West (MV) Section	MG Section	LSB Reach	USB Reach	East (SB) Section	LSDR Overall Avg.	
WY05	46	54	40	46	65	33	18	24	41	C (high)
WY06	34	47	30	37	54	37	21	28	37	D+
WY07	30	43	23	33	50	44	25	34	36	D+
WY08	37	39	28	35	46	41	31	36	37	D+
WY09	36	37	30	34	46	37	29	35	36	D+
WY10	36	36	31	34	48	32	18	27	33	D
WY11	41	39	39	39	56	45	16	29	39	C-
WY12	33	38	35	35	48	41	11	24	34	D
WY13	34	38	32	35	45	39	12	23	33	D
WY14	22	17	19	18	37	30	11	19	23	E (low)
WY15	27	22	23	23	46	41	11	27	29	D
WY16	36	30	22	29	40	33	9	22	28	D
WY17	33	34	33	33	41	35	19	29	32	D
WY18	24	28	21	24	33	33	12	20	25	E+
WY19	35	37	30	34	42	35	16	24	32	D
WY20	36	37	34	36	45	41	18	28	35	D
WY21	32	33	28	31	40	42	19	27	32	D
WY22	**29**	**31**	**25**	**28**	**39**	**37**	**19**	**28**	**30**	**D**
18yr Norm	*33*	*36*	*29*	*33*	*46*	*38*	*18*	*27*	*32*	*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**
18yr Norm	*50*	*51*	*48*	*49*	*63*	*50*	*27*	*39*	*47*	*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	E+ (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**	**20**	**12**	**15**	**8**	**19**	**7**	**13**	**13**	**E-**
18yr Norm	*20*	*21*	*13*	*18*	*26*	*24*	*9*	*17*	*19*	*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 18yr norms (bottom row in italics) are in red for the same reach/section of the river are in red; values at or above 18yr norms are in black. Overall LSDR WQI values are D-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 50 (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 below 30 in WY22. 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 Lower Mission Valley reach. The most significant decline in the WQI for the reach over the 18yr monitoring period occurred in WY14.

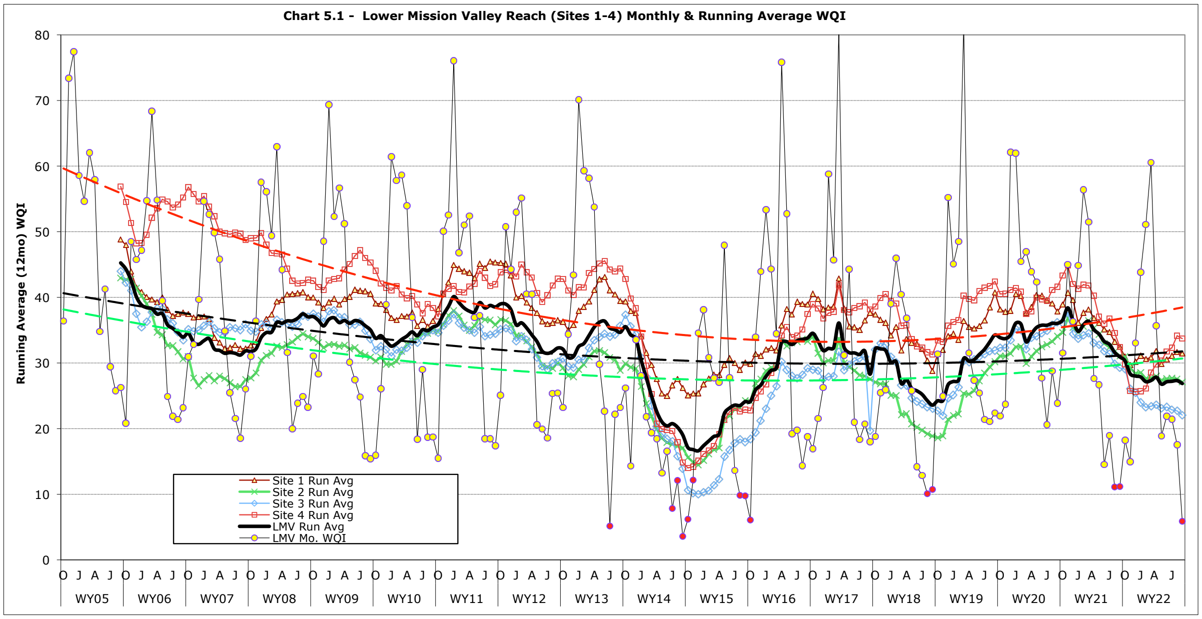
Chart 5.1 - Lower Mission Valley Reach (Sites 1-4) Monthly & Running Average WQI
Running Average (12mo) WQI
Site 1 Run Avg
Site 2 Run Avg
Site 3 Run Avg
Site 4 Run Avg
LMV Run Avg
LMV Mo. WQI
WY05 WY06 WY07 WY08 WY09 WY10 WY11 WY12 WY13 WY14 WY15 WY16 WY17 WY18 WY19 WY20 WY21 WY22

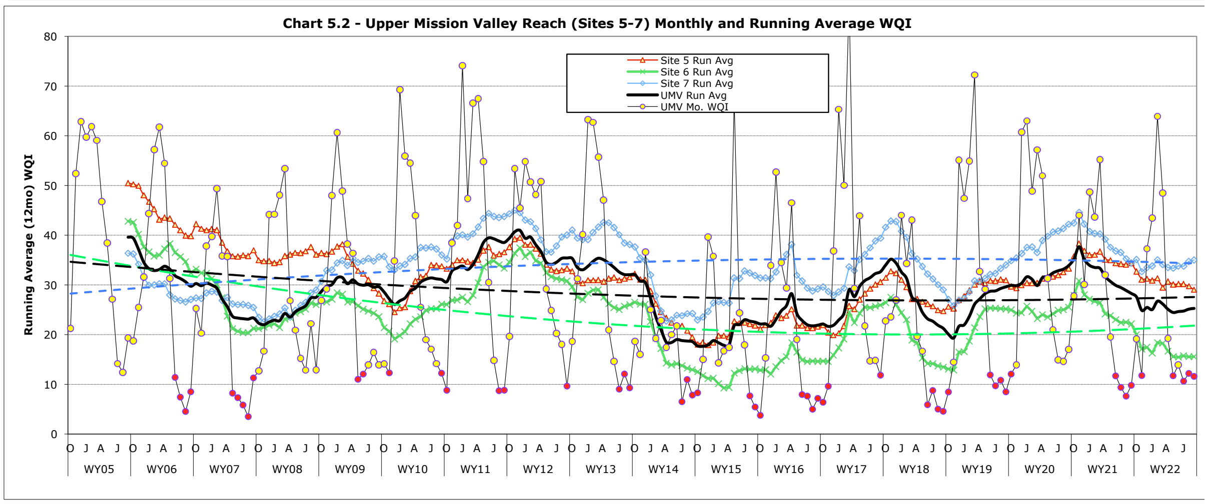
Chart 5.2 - Upper Mission Valley Reach (Sites 5-7) Monthly and Running Average WQI
Running Average (12mo) WQI
Site 5 Run Avg
Site 6 Run Avg
Site 7 Run Avg
UMV Run Avg
UMV Mo. WQI
WY05 WY06 WY07 WY08 WY09 WY10 WY11 WY12 WY13 WY14 WY15 WY16 WY17 WY18 WY19 WY20 WY21 WY22

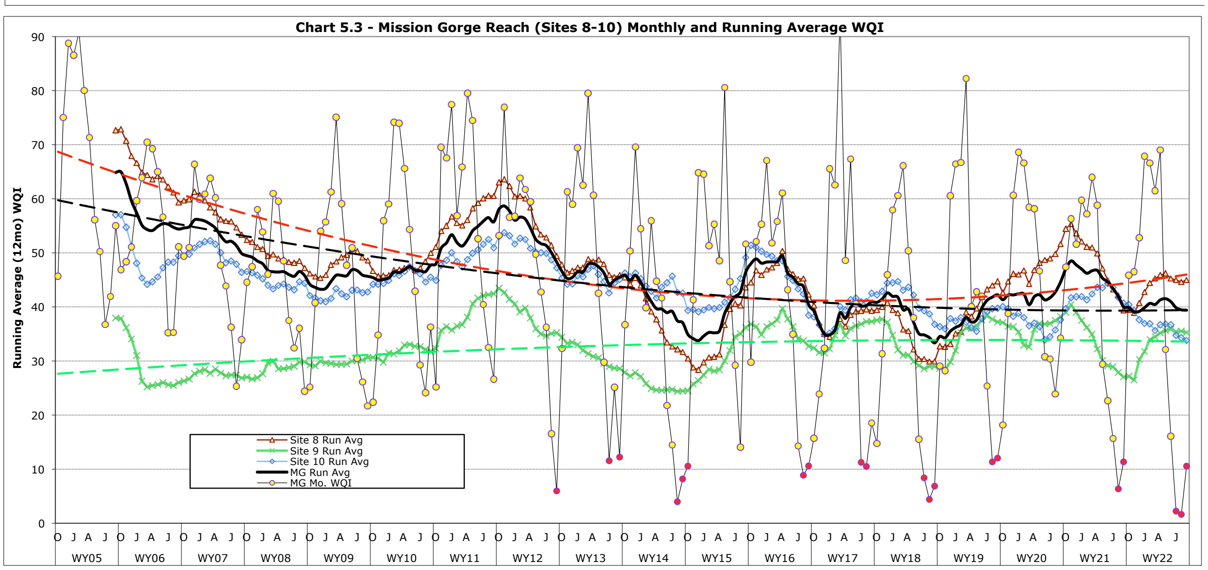
Chart 5.3 - Mission Gorge Reach (Sites 8-10) Monthly and Running Average WQI
Running Average (12mo) WQI
Site 8 Run Avg
Site 9 Run Avg
Site 10 Run Avg
MG Run Avg
MG Mo. WQI
WY05 WY06 WY07 WY08 WY09 WY10 WY11 WY12 WY13 WY14 WY15 WY16 WY17 WY18 WY19 WY20 WY21 WY22

There was a steady, general improvement from WY14 lows during WY15/16 extending into WY17. A general decline occurred throughout WY18, followed by recovery (to WY17 values) in WY19 and WY20. The last two water years (WY21 &22) have seen a general decline. The running average index for this reach has declined from 45 to 35 (approximatly ten percent) over the 18yr 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 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 recovered to prior year levels in WY19 and WY20. WY21 and 22 witnessend a slight declines in running average values. The overall 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 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 down to 39 by the end of WY22. The overal index has declined 26 points (from 65 down to 39) over 18 years in this section of the river. The running average index value has remained below the 18yr 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 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 average index improved to values comperable to those experienced in WY07 through WY11. The overall change in the index between WY05 and WY22 is roughly one percent. This reach of the river has shown the least amount of change in water quality metrics over the 18 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 13E & 14) of the river. This reach presents the poorest water quality values of all sections of the lower

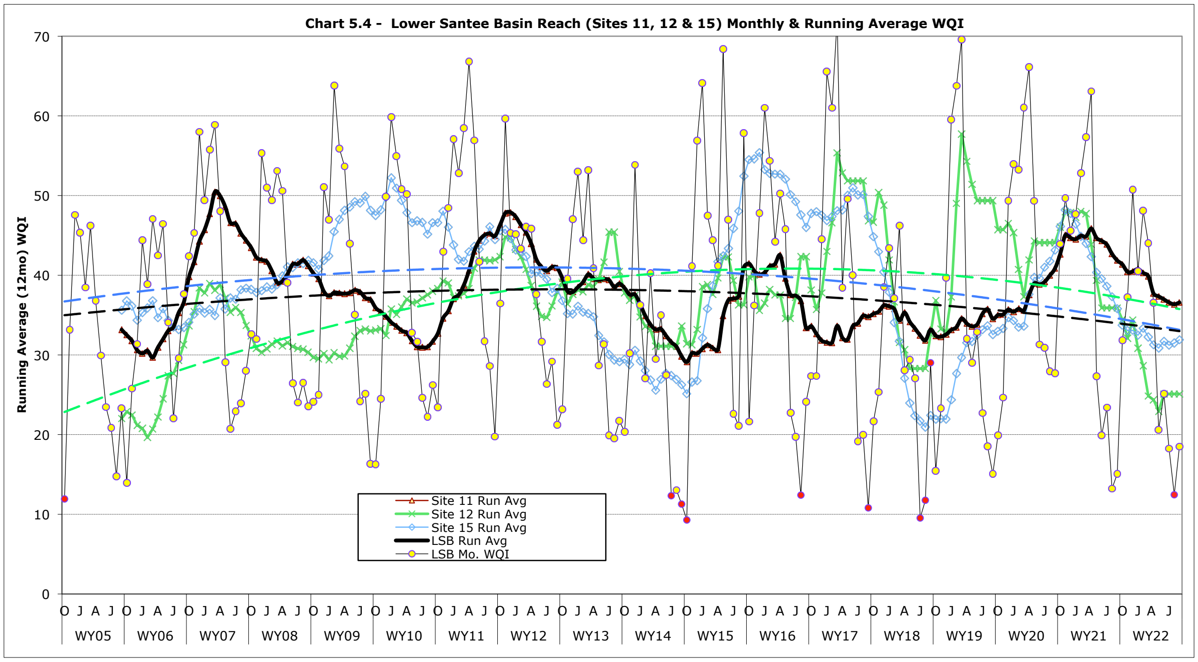
Chart 5.4 - Lower Santee Basin Reach (Sites 11, 12 & 15) Monthly & Running Average WQI
Running Average (12mo) WQI
Site 11 Run Avg
Site 12 Run Avg
Site 15 Run Avg
LSB Run Avg
LSB Mo. WQI
WY05
WY06
WY07
WY08
WY09
WY10
WY11
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WY14
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WY18
WY19
WY20
WY21
WY22

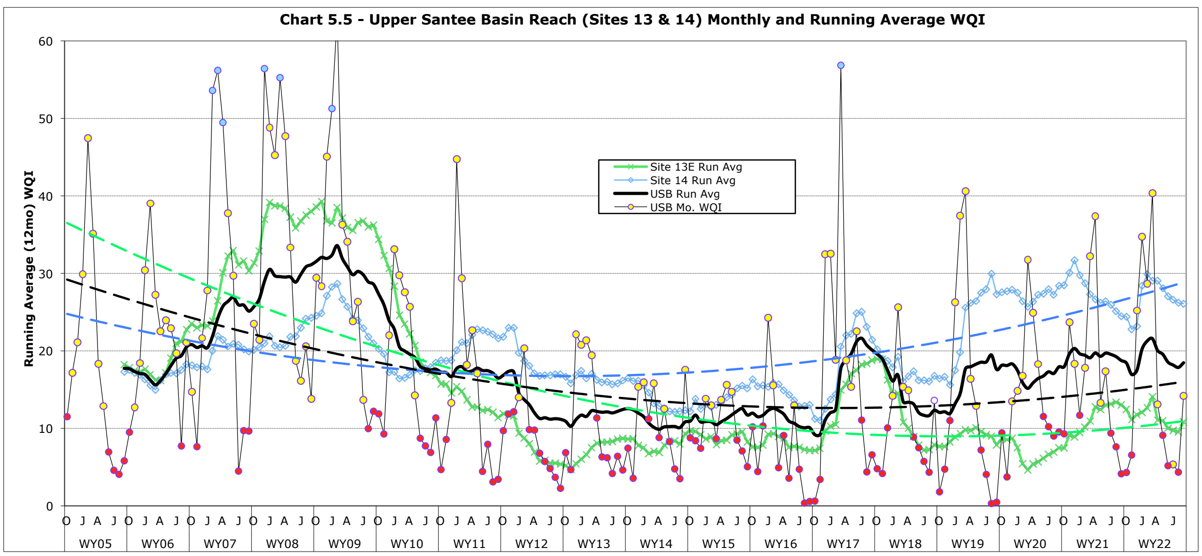


Chart 5.5 - Upper Santee Basin Reach (Sites 13 & 14) Monthly and Running Average WQI
Running Average (12mo) WQI
Site 13E Run Avg
Site 14 Run Avg
USB Run Avg
USB Mo. WQI
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22

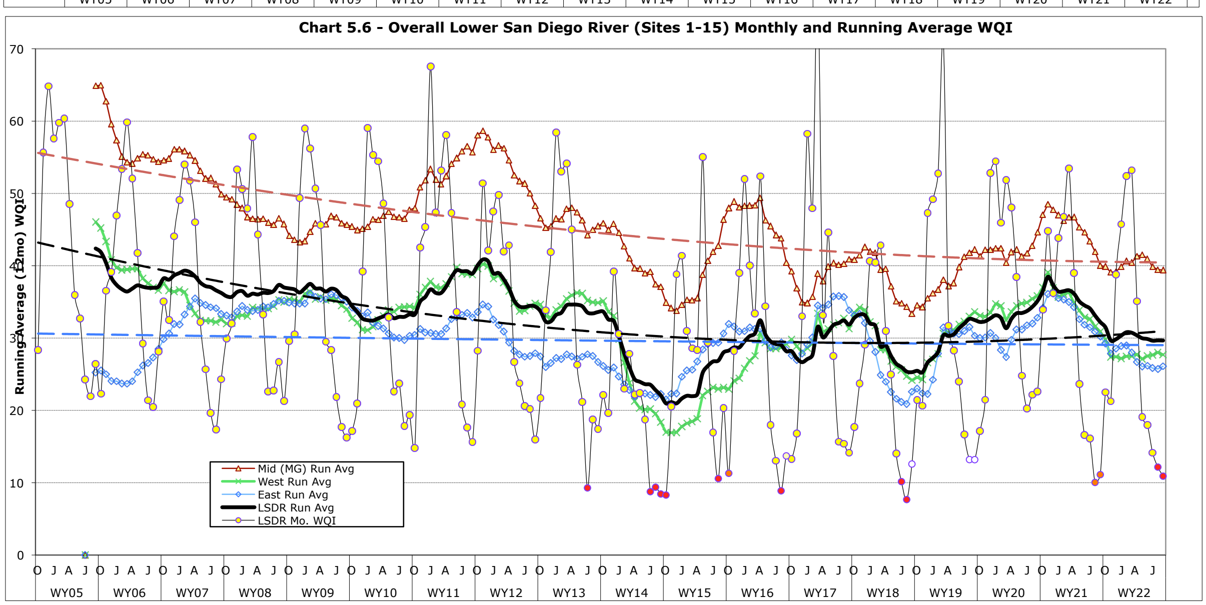


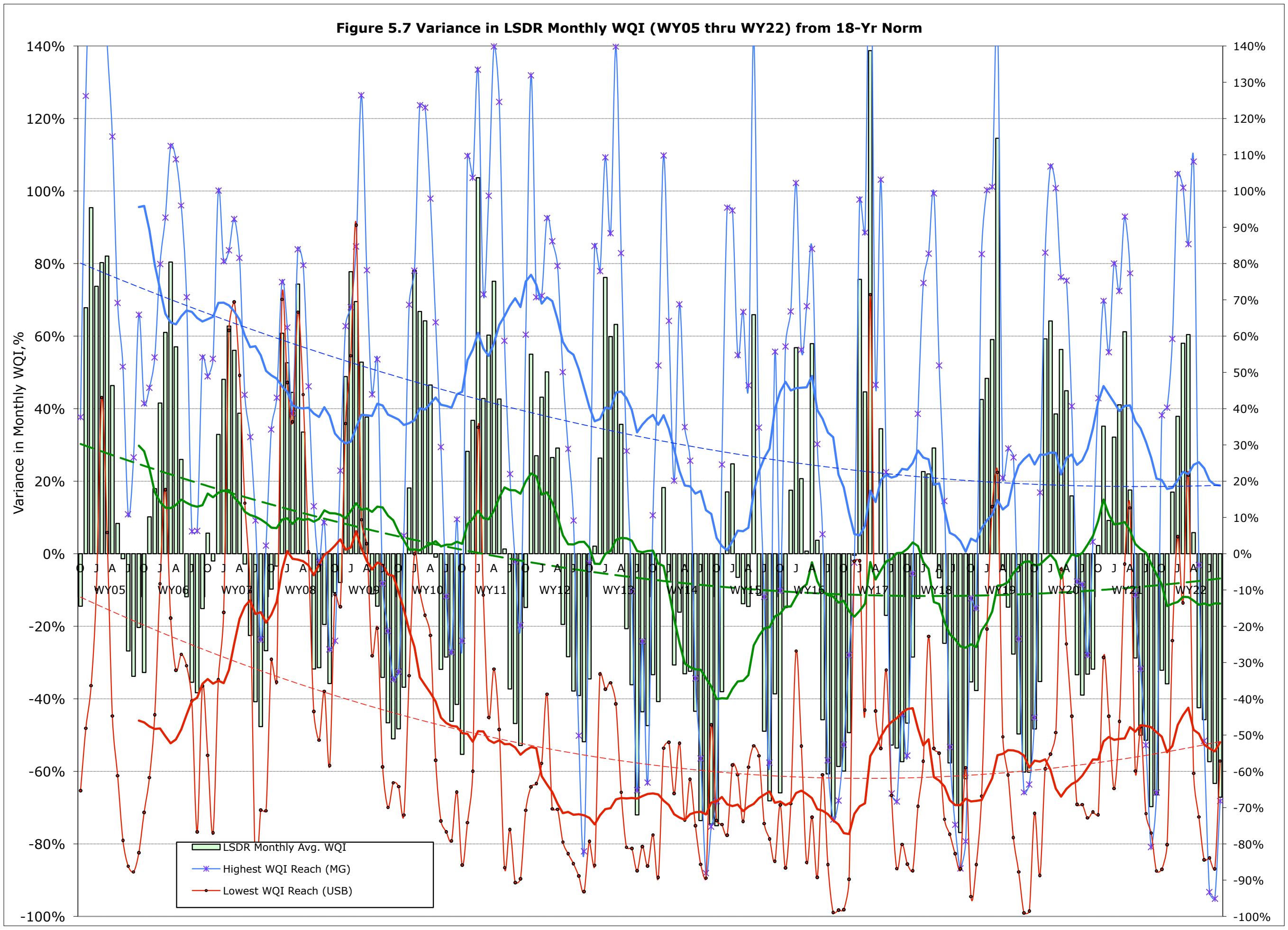
Chart 5.6 - Overall Lower San Diego River (Sites 1-15) Monthly and Running Average WQI
Running Average (12mo) WQI
Mid (MG) Run Avg
West Run Avg
East Run Avg
LSDR Run Avg
LSDR Mo. WQI
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
WY19
WY20
WY21
WY22

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 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 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 (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. 2021 and WY22 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 WY22. The current LSDR running average WQI of 30 (D Marginal) is six percent below the 18yr 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 41 to 32) over 18 years.

Percent variance in monthly index values for the highest (MG-blue), average (LSDR-green) and lowest (USB-red) reaches from 18yr norms are espressed in **Chart 5.7** on the next page. Trendlines are shown as dashed lines with similar colors. The overall decline in the index is the result of lower oxygen concentrations , warmer water temperatures and higher specific conductivities monitored at nearly all sites over the 18 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 most if not all portions of the lower river due to natural processes of deposition and eutrofication.

Section Summary: Depleted dissolved oxygen levels (often < 2.5 mg/L) occuring in conjunction with dry-weather low flows resulting in warmer water and elevated SpC concentrations (greater dissolved solids) constitute the primary drivers of depressed water quality index values. The low DO concentrations are the result of extensive and persistent eutrophication from buildup of organic-rich detritus combined with restricted water movement within multiple reaches 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 controlled and the affects of eutrophication more effectively managed, 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.



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 there. It is a perenial herb (a dicot) termed marsh purslane; a member of famility 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 adversely 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 lower reachs of the river.

(AWQRpt.page JCK 10/10/22)