LOWER SAN DIEGO RIVER WATER QUALITY

WY18 Supplemental Water Quality Monitoring Report

(Appendices D through I)

Summer Algal Bloom - Lower Mission Valley Monitoring Site #4 (mid-FSDRIP Channel)

Supporting Water Quality Monitoring Data for the Lower San Diego River

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LOWER SAN DIEGO RIVER WATER QUALITY SUPPLEMENTAL REPORT (APPENDICES D-I)

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Appendix D -
LSDR Water Quality Monitoring Metrics 14-yr Summary

Table D.1 WQM Metrics Summary (Annual & Seasonal Averages)

	WY05	WY06	WY07	WY08	WY09	WY10	WY11	WY12	WY13	WY14	WY15	WY16	WY17	**WY18**	*14yr Norms*
Annual (October-September):															
ADF, cfs	58	13	9	17	19	32	25	13	9	5	9	14	42	**7**	*19.3*
Temp, °C	17.8	18.3	17.8	17.8	17.9	18.1	17.9	18.1	17.4	18.0	18.7	18.2	18.6	**18.3**	*18.05*
SpC, uS/cm	2.05	2.14	2.37	2.22	2.40	2.26	2.15	2.30	2.42	2.53	2.16	2.23	2.15	**2.78**	*2.298*
DO, mg/L	6.32	5.66	5.52	5.99	5.92	4.85	5.10	4.73	4.90	3.52	3.93	4.10	4.70	**3.95**	*4.94*
DO%Sat,	60	56	56	61	61	50	53	49	50	37	42	43	50	**41**	*50.6*
pH	7.57	7.34	7.47	7.88	7.61	7.83	7.86	7.68	7.75	7.64	7.76	7.73	7.78	**7.95**	*7.70*
WQI	40	35	34	36	35	32	36	31	30	20	25	25	31	**22**	*31*
Grade	C	D+	D	D+	D+	D	D+	D	D	E	D-	D-	D	**E**	*D*
Summer (June-September) Period:															
ADF, cfs	3.4	3.8	1.4	1.9	1.2	1.9	3.2	1.6	1.1	0.8	5.2	0.7	1.8	**0.5**	*2.0*
Temp, °C	21.7	23.6	21.8	23.0	23.0	22.0	21.8	23.0	21.7	22.8	22.9	21.9	23.3	**23.0**	*22.54*
SpC, uS/cm	2.52	2.37	2.69	2.93	3.10	2.88	2.75	2.96	2.95	2.94	2.16	3.05	2.73	**3.16**	*2.799*
DO, mg/L	4.02	4.20	3.81	4.56	4.20	3.45	3.28	3.20	2.91	2.26	3.06	2.60	3.13	**2.53**	*3.37*
DO%Sat, %	42	49	43	51	49	39	38	38	34	27	35	30	37	**29**	*38.6*
pH	7.51	7.47	7.41	7.91	7.50	7.84	7.92	7.94	7.71	7.94	7.81	7.80	7.74	**8.00**	*7.75*
WQIa	24	23	20	22	20	19	20	17	14	11	17	11	17	**9**	*18*
Grade	E+	E	E	E	E	E	E	E	E	F	E	F	E	**F**	*E*
Winter (December-March) Period:															
ADF, cfs	147	19	18	45	53	83	50	20	20	11	18	34	116	**18**	*46.5*
Temp, °C	13.7	12.9	13.9	12.5	13.4	14.2	13.8	12.4	12.4	13.4	15.3	14.1	14.4	**13.8**	*13.58*
SpC, uS/cm	1.38	2.00	2.02	1.53	1.49	1.32	1.32	1.65	1.99	2.22	1.86	1.69	1.22	**2.16**	*1.703*
DO, mg/L	9.16	6.40	6.59	6.96	7.31	5.76	7.01	6.30	7.26	4.68	4.56	5.56	7.24	**5.46**	*6.46*
DO%Sat	83	58	64	66	71	57	68	59	68	45	46	54	72	**53**	*61.7*
pH	7.57	7.33	7.69	8.06	7.72	7.68	7.84	7.41	7.76	7.53	7.79	7.57	7.77	**7.89**	*7.69*
WQIa	58	46	47	52	53	49	50	41	48	29	32	37	53	**36**	*45*
Grade	B	C	C	B-	B-	C+	B-	C	C+	D	D	D+	B-	**D+**	*C*

(a) Values in red text are below 14-yr norms; values above norms are shown in blue.

Table D.2 WQM Metrics Summary by Section and Reach (WY18 and 14-yr Norms)

Section	Mission Valley		Mission Gorge	Santee Basin		**Watershed**
Sites	1-4	5-7	8-10	11,12T &15T	13&14	**all (1-15T)**
Reach	LMV	UMV	MG	LSB	USB	**LSDR** [a]
Annual (Oct-Sept):						
ADF, cfs	9.4 (28)	8.9 (26)	6.5 (18) [b]	5.8 (16)	3.8 (4.5)	**6.7 (19.3)**
Temp, °C	19.75 (19.36)	17.66 (17.85)	17.23 (17.12)	17.37 (17.46)	18.88(18.13)	**18.27 (18.05)**
SpC, mS/cm	3.214 (2.587)	3.096 (2.563)	3.032 (2.305)	2.561 (2.273)	2.035(1.806)	**2.778 (2.298)**
DO, mg/L	4.04 (5.01)	3.73 (4.44)	6.39 (7.51)	5.21 (6.60)	2.03 (3.11)	**3.95 (4.94)**
DO %of Sat, %	43 (53)	38 (46)	65 (77)	54 (65)	22 (32)	**41 (51)**
WQIa	26 (34)	22 (30)	33 (46)	28 (36)	10 (17)	**22 (31)**
Grade	D- (D+)	E (D)	D (C)	D (D+)	F (E)	**E (D)**
WY18 Rating	**Marginal**	**Poor**	**Marginal**		**Very Poor**	**Marginal**
WY17 Rating	Marginal	Marginal	Fair	Fair	Poor	Marginal
WY16 Rating	Marginal	Poor	Fair	Marginal	Very Poor	Marginal
WY15 Rating	Poor		Fair		Very Poor	Marginal
WY14 Rating	Poor		Marginal		Very Poor	Poor
14-yr Norm	*Marginal*	*Marginal*	*Fair*		*Poor*	*Marginal*
Summer (June-Sept) Period:						
ADF, cfs	0.8 (3.1)	0.8 (2.8)	0/3 (1.7) [c]	0.2 (1.7)	0.1 (0.3)	**0.5 (2.0)**
Temp, °C	24.74 (24.27)	22.23 (21.85)	22.11 (21.82)	20.79 (21.60)	24.04(22.85)	**23.01 (22.54)**
SpC, mS/cm	3.707 (3.252)	3.443 (3.188)	3.675 (2.891)	2.818 (2.636)	2.246(2.052)	**3.159 (2.799)**
DO, mg/L	2.45 (3.16)	1.81 (2.54)	3.90 (5.58)	4.30 (5.34)	1.79 (2.23)	**2.53 (3.37)**
DO % of Sat, %	30 (38)	21 (29)	43 (64)	49/57	21 (26)	**29 (39)**
WQI	12 (20)	8 (15)	8 (28)	16 (24)	6 (10)	**9 (18)**
Grade	F+ (E)	F (E)	F (D)	E (E+)	F (F)	**F (E)**
WY18 Rating	**Very Poor**			**Poor**	**Very Poor**	
WY17 Rating	Poor	Poor	Poor		Very Poor	Poor
WY16 Rating	Poor	Very Poor	Poor		Very Poor	Poor
WY15 Rating	Poor	Very Poor	Marginal		Very Poor	Poor
WY14 Rating	Very Poor			Poor	Very Poor	
14-yr Norm	*Poor*		*Marginal*		*Very Poor*	*Poor*

Table D.2 WQM Metrics by Section and Season (Continued)

Reach	LMV	UMV	MG	LSB	USB	**LSDR [a]**
Winter (Dec-March) Period:						
ADF, cfs	24.6 (69.1)	23.2 (62.9)	17.2 (43.5)	15.3 (37.2)	7.4 (11.3)	**17.5 (46.5)**
Temp, °C	14.89 (14.44)	13.44 (13.69)	12.33 (12.65)	14.19 (13.38)	14.29(13.53)	**13.82 (13.58)**
SpC, mS/cm	2.432 (1.881)	2.453 (1.792)	2.125 (1.643)	2.043 (1.839)	1.728(1.464)	**2.163 (1.703)**
DO, mg/L	5.56 (6.76)	5.66 (6.38)	8.84 (9.11)	6.46 (7.89)	2.56 (4.04)	**5.46 (6.46)**
DO % of Sat, %	55 (67)	55 (62)	83 (87)	63 (72)	26 (38)	**53 (62)**
WQI	38 (49)	37 (47)	58 (62)	41 (49)	16 (28)	**36 (45)**
Grade	C- (C+)	D+(C)	B (B)	C (C+)	E (D)	**D+ (C)**
WY18	**Fair**	**Marginal**	**Good**	**Fair**	**Poor**	**Marginal**
WY17 Rating	Good				Fair	Good
WY16 Rating	Fair		Good		Poor	Fair
WY15 Rating	Marginal		Good		Very Poor	Marginal
WY14 Rating	Marginal		Good	Fair	Poor	Marginal
14-yr Norm	*Good*	*Fair*	*Good*		*Marginal*	*Fair*

WY18 WQ metrics below (less than) 14-yr norms are shown in red text; values above norms are shown in blue.
(a) Weighted average of all five reaches within the Lower SDR watershed.
(b) Flow based on river channel gains/losses averaged between Santee Basin and Mission Valley.

Appendix E - San Diego RiverWatch WQ Monitoring Program

Appendix E provides an overview of SDRPF's RiverWatch water quality monitoring (WQM) program that, over the last 14 years, has been engaged in collecting and assessing data pertaining to the Lower San Diego River (LSDR) watershed on a continuous monthly basis.

Monitoring Period & Coverage: Monthly monitoring over past 14 years (Oct. 2004 – Sept. 2018) covering the Lower San Diego River and its tributaries extending downstream from Lakeside (river mile 19.8 elev. 340 ft amsl) to the Estuary (river mile 2.96, elev. 5.8 ft amsl) under the I-5/ Pacific Hwy. overpasses. The LSDR watershed and monitoring sites are shown on **Figure E.1.**

Figure E.1 - Lower San Diego River Catchment and WQM Sites

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

Monitoring Sites: 15 total - 12 on main course (Mission Valley Section - sites 1-7, Mission Gorge Section - sites 8-10, Santee Basin Section - sites 11-15) plus three tributary stream sites are listed in **Table E.1.**

Table E.1 LSDR Sections, Reaches and Monitoring Sites

Section/Reach/Tributary	Site #s	Comments
Estuary Entrance	1E/1W	Tidal influence at transition from river to estuary
Lower Mission Valley (LMV)	2E/W, 3 & 4	4 miles of lower river extending to I-805
Upper Mission Valley (UMV)	5,6 & 7	4-mile stretch from I-805 to Princes View Dr
Mission Valley (West Sites)	1-7	8-mile western portion through Mission Valley
Mid-Section : Mission Gorge (MG)	8,9T & 10	5-mile mid-section, Princess View Dr to Kumeyaay Lk
Lower Santee Basin (LSB)	11,12T&15T	2-mile stretch from Kumeyaay Lk to Carlton Hills Blvd
Upper Santee Basin (USB)	13 & 14	3-mile stretch from Carlton Hills Blvd to Riverford Rd
Santee Basin (SB)	11-15T	5-mile eastern section from Kumeyaay Lk to Lakeside
Eastern Sections (East Sites)	8 -15T	10-mile eastern/upper 3 reaches (2 sections)
Tributaries:		
Murphy Canyon/Qualcom [a)]	5a	Enters LSDR southwest of SDSSU Stadium
Jackson Dr/Birchcreek Drain [b)]	9T	Enters LSDR at Sycott Wash (d/s of Site 8)
Santee Lakes/E. Sycamore Cnyn Ck	12T	Enters LSDR at Carlton Oaks GC (u/s of 15T)
Forester Creek [c)]	15T	Enters LSDR d/s of Carlton Oaks GC at Site 11
Lower SDR Watershed (LSDR)	1-15T	Weighted average of all 5 reaches or all 3 sections

(a) Monthly monitoring discontinued in WY07; nearby Ward Rd Bridge site renumbered as 5.
(b) Monthly monitoring initiated in 2008; site also termed Jackson Dr. Outfall (OF).
(c) Monthly monitoring initiated in 2007 with adjusted site location in 2009 and again in 2017 back to original location in vicinity of SR 52.

WQ Parameters: Seven measured and recorded parameters (Temp, pH, SpC, DO, DO%Sat, NO_3 & PO_4) plus subjective field observations re: environs and characteristics are listed in **Table E.2.** As nutrient testing for NO_3 and PO_4 is carried out at five selected sites; two in West (2 & 6) and three in East (11,14 & 15T), respectively, results are not used in performing statistical analyses regarding reaches/sections of the river. Number of datum for each of the five physical-chemical parameters monitored monthly at each site over the 13-yr period (Oct. 04 - Sept. 17) are in the range of 100 to 120. Two other water quality parameters monitored by others at several sites, streamflow from USGS (Poway Office) and coliform counts from SDCoastKeeper, are also recorded for purposes of computing the water quality index.

Protocol: *East Side* – (Santee Basin & Mission Gorge Sections). The 8 sites within upper three reaches (MG, LSB & USB) typically monitored 3rd Fri. or Sat. of month. *West Side* - (Mission Valley Section). Seven sites within the lower two reaches (LMV & UMV) monitored monthly, typically 3rd Sun. of month.

Table E.2 - LSDR Water Quality Monitoring Parameters

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

Team Leaders (1-2) and citizen volunteers (3-8) meet at an appointed location, organize field equipment/transportation, drive to sites, measure physical-chemical water quality using the YSI Sonde meter, note special conditions/observations, collect samples for subsequent testing, then return to office, perform nutrient (NO_3 & PO_4) tests, store samples for subsequent laboratory analyses and clean/check-in/store field equipment.

Data Management: Water quality data are typically managed in a three-step process.

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

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

Table E-3 - WQM Site Locations

Site #	Site Name	u/s mi.	Elev. ft.	Location	GIS Coordinates Lat.	Long.
LMV - Lower Reach W Mission Valley: I-5 Bridge to I-805 Bridge (Sites 1-4)						
1	Estuary W/E	2.96	6	between PCH & I-5 on encased sewer main	32.76131	-117.20373
2	River Gardens E/W	3.50	11	W of YMCA, d/s of Trolly at foot bridge	32.7623	-117.1944
3	Fashion Valley Mall W	5.08	22	below Town & Country Pedestrian Bridge	32.76517	-117.16869
4	FSDRIP	5.98	36	N of Mimi's on Mission Center Rd. Bridge	32.76986	-117.15482
UMV - Upper Reach E Mission Valley: I-805 Bridge to N end of Admiral Baker Field (Sites 5-7)						
5	Ward Rd Bridge	8.89	50	S. of Trolly overpass at Del Rio S intersection	32.78024	-117.11029
6	Kaiser Ponds	9.46	56	E. of Mission SD de Acala at SD Mission Rd.	32.78406	-117.10419
7	Admiral Baker Field	9.98	58	L - Lower (below Friars Rd bridge)	32.79038	-117.10314
	ABF - Zion Rd	10.2	62	Z - Terminus of Zion Ave at Riverdale St.	32.79304	-117.09984
West (MV) - Mission Valley Section: Estuary to Admiral Baker Field (Sites 1-7) [LMV+UMV]						
MG - Mission Gorge Reach: Quarry Area to Old Mission Dam (Sites 8-10)						
8	Mission Trails @ Jackson Dr	13.82	159	SDCWA downstream of Scycott Crossing	32.82124	-117.06205
9T	Jackson Dr/Birchcreek Outfall	13.86	198	San Marcos area drainage by Jackson Dr. Trail	32.82268	-117.06224
10	Old Mission Dam W/E	15.65	265	Downstream side of Old Mission Dam	32.83977	-117.04332
Mid-Section (MG) -Mission Gorge Section: Quarry Area to Old Mission Dam (Sites 8-10)						
LSB - Lower Reach Santee Basin: W Hills Pkwy to Carlton Hills Bridge (Sites 11,12 &15)						
11	West Hills Pkwy	17.03	300	at/below West Hills Pkwy Bridge	32.83936	-117.02436
12T	Carlton Oaks Dr/Santee	18.23	320	W Sycamore Ck/Santee Lakes @ Carlton Oaks Dr.	32.84431	-117.00635
15T	Forester Creek at Rt 52	18.86	334	Forester Ck (primary tributary) at Rapture/Atlas View Dr. (enters SDR just u/s Site 11)	32.83221	-116.98658
USB - Upper Reach Santee Basin: Carlton Hills Bridge to Riverford Rd (Sites 13-14)						
13	Mast Park	18.50	330	Pedestrian Bridge behind (N of) Walmart, end of River Rock Ct.	32.84696	-116.97335
14	Cottonwood Ave/RCP	19.84	340	N. of Chubb Ln. at N. Magnolia Ave.	32.84434	-116.98947
East (SB) - Santee Basin Section: West Hills Parkway to Lakeside (Sites 11-15 above) [LSB+USB]						
LSDR - Lower San Diego River Watershed: SD Estuary to Lakeside (Sites 1-15 above) [LMV+UMV+MG+LSB+USB]						

3. *Processed* (formatted/aggregated) data - with statistical computations associated with LSDR sites, reaches, sections and tributaries for each WQ parameter of interest including those monitored by others.

Statistical Computations: Various basic statistical values have been calculated from the data.

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

Appendix F - LSDR Hydrology and Water Quality

Stream flow or discharge, is the volume of water moving past a designated location over a fixed period of time. It constitutes a primary driver of changes in water quality. Often expressed as cubic feet per second (cfs) or million gallons per day (mgd), flow is the amount of water moving off a watershed into a watercourse, as affected by weather (increasing during rainstorms and decreasing during dry spells) and changing during each season. River flow rapidly decreases during summer months when rainfall is minimal, evaporation rates high and riparian vegetation extracts water from the ground. August and September, the last two months of summer and the water year, are typically months of lowest flow. A function of both volume and velocity, stream flow has a major impact on living organisms, riparian habitat, benthic conditions and overall water quality. Velocity of flow, typically increasing as volume increases, determines the kinds of organisms that live in the system and also affects the amount of silt and sediment transported. Fast moving waters typically contain much higher levels of DO than sluggish flows, as they are better aerated.

LSDR average daily flow (ADF) values as recorded at the two USGS gauging stations in the lower watershed are expressed in **Table F.1** for both the 14-yr monitoring period (Oct 2004 - Sept 2018) and over the past 54 years (1965-2018) of official record**.** The average daily flow values are in close accord for both stations; river discharge over the past 14 years is about 11 percent below the 54-year norm in Mission Valley and 18% below the Santee norm. WY18 discharge is 60% less than than the 54-yr norm at the Fashion Valley Site and 26% below the norm at Santee. River discharge on average for WY18 is 48 percent less than the long-range norm and 64 percent below the 14 year norm.

Correlations between total annual rainfall and ADF over the past 54 years of hydrologic record and during the period of SDRPF RiverWatch monitoring for the two lower SDR gauging stations are presented in **Tables F.2 and F.3**, respectively. WY05 was a "Very Wet" (>20") hydrologic year, whereas WY07 was "Very Dry"(<5"). WY17, WY15 and WY11 were each "Above Normal" rainfall years (12-15") while WY09 and WY10 (8-12") were considered "Normal" in terms of total annual rainfall. The 14-yr ADF in the East and West sections are 18 and 32 cfs, respectively; the values are 15-20 percent below long-range LSDR average daily discharges. WY18 total rainfall (3.42 inches) was 28% under the long-range average while average daily flow for the year was 41% less than the long-range norm (54-yr average) of 28 cfs.

Monthly discharge data (min, max and average daily flow) for the two USGS gauging stations extending from Oct. 2004 through Sept. 2018 are plotted in **Chart F.1.** Average daily flow (ADF) for the Lower San Diego River varies from less than 0.2 cfs (0.1 mgd) during the summer (dry) months to nearly 220 cfs (142 mgd) during several winter (wet) periods in the East (Santee Basin) and up to 390 cfs (252 mgd) in the West (Mission Valley) section. Running average ADF values, trending downward in WY12-WY14 increased in WY15, fell in WY16 then increased again in WY17 as expressed on **Charts F.1** and **F.3**. Seasonal flux is shown on **Chart F.2.**

Table F.1 - Lower SDR Average Daily Flows (WY05-WY18)

Season	West - Mission Valley		East - Santee Basin		LSDR [a]	
Units [b]	cfs	mgd	cfs	mgd	cfs	mgd
Fall (Oct-Nov)	2.1/4.9	1.3/3.1	1.0/3.45	0.6/2.2	1.3/4.0	0.8/2.6
Winter (Dec-Mar)	18.8/59	17.4/102.7	13.2/75.8	8.5/49	17.6/111	3.2/20.3
Spring (April-May)	2.6/17.8	1.7/11.5	1.5/9.6	1.0/6.2	2.9/12.2	1.9/7.8
Summer (June-Sept)	0.65/2.55	0.4/1.6	0.19/0.93	0.1/0.6	0.45/1.6	0.3/1.0
Annual Avg. (WY18/WY17)	7.2/57.3	4.6/37.0	4.9/27.7	3.0/18.0	6.7/41.7	4.0/26.0
14-yr Annual Avg. (2005-2018)	30.2	19.5	16.8	10.8	19.3	12.4
54-yr Annual Avg. (1965-2018)	36.0	23.3	22.0	14.2	27.0	17.4
Annual Discharge, AFY [c]	41,440 {26,095}		20,050 {15,920}		32,255 {19,490}	

(a) Lower San Diego River average daily flow represents a mean hydrologic condition based on averaging the two USGS gauging station flow values.
(b) ADF values are expressed in both cubic feet per second (cfs) and million gallons per day (mgd); 1 cfs = 0.646 mgd.
(c) Annual discharge volume expressed in acre-feet (1 AF = 325,900 gallons); WY18 and {54-Yr averages}.

Table F.2 - Rainfall and Long-Term Average Daily Flow (1914-2018)

Type	# of Years	Percent of Total Years		Total Annual Rainfall [a]			Average Daily Stream Flow, mgd		
				inches	mm	Avg., mm	East [b]	West [c]	LSDR
Very Wet	3	3%	31%	>20	>500	580	68	113	92
Wet	10	10%		15-20	380-499	430	48	81	66
Above Norm [d]	18	18%		12-15	300-379	340	26	44	35
Normal	40	38%	38%	8-12	200-299	250	10	18	15
Dry	26	25%	31%	5-8	125-199	160	7	12	10
Very Dry	7	7%		<5	<125	100	5	9	7
Sum/An. Avg	104	100%		9.94		253	14	24	18

a) Total annual rainfall from 1 October through September 31.
b) Santee Basin USGS Stream Gauge Station #11022480 at Mast Road in Santee.
c) Mission Valley USGS Stream Gauge Station #11023000 at Fashion Valley Mall; incomplete data prior to 1968.
d) Above normal annual rainfall (12-15 in/yr) resulting in LSDR average daily flows in the 25-50 mgd range.

Table F.3 - Annual Rainfall and Average Daily Flow (WY05-WY18)

(Type of Year)	Annual Rainfall		Variance [a]	ADF, cfs/(mgd)			Variance [d]
	mm	inches		East [b]	West [c]	LSDR	
WY05 (Very Wet)	574	22.60	127%	50.9 (33)	100 (65)	71.5 (46)	152%
WY06 (Dry)	152	6.00	-40%	10.7 (7)	17.5 (11)	13.6 (9)	-52%
WY07 (Very Dry)	98	3.85	-61%	7.2 (5)	12.8 (8)	9.5 (6)	-67%
WY08 (Dry)	183	7.20	-28%	13.3 (9)	25.0 (16)	18.2 (12)	-36%
WY09 (Below Normal)	232	9.15	-8%	15.0 (10)	27.2 (18)	20.1 (13)	-29%
WY10 (Normal)	282	11.10	12%	25.1 (16)	42.5 (27)	32.4 (21)	14%
WY11 (Above normal)	323	12.70	28%	43.3 (28)	61.9 (40)	46.9 (30)	65%
WY12 (Dry)	201	7.91	-20%	10.1 (8)	19.0 (12)	14.9 (10)	-48%
WY13 (Very Dry)	166	6.55	-34%	8.2 (5)	10.9 (7)	9.1 (6)	-68%
WY14 (Very Dry)	129	5.06	-49%	4.3 (3)	6.1 (4)	5.1 (3)	-82%
WY15 (Above normal)	302	11.91	20%	7.1 (5)	15.2 (10)	10.5 (7)	-63%
WY16 (Dry)	208	8.20	-18%	12.2 (8)	24.4 (16)	15.6 (10)	-45%
WY17 (above normal)	323	12.72	28%	27.7 (18)	57.3 (37)	40.0 (26)	41%
WY18 (Very Dry)	**83**	**3.24**	**-67%**	**5.5 (4)**	**7.2 (5)**	**5.9 (4)**	**-79%**
14-yr Average (05-18)	232	9.11	-8%	10.8 (6)	30.2 (20)	22.4 (14)	-21%
54-yr Average	252	9.92	0%	21.8/(14)	36.7 (24)	28.4/(18)	0%

a) Percent difference from 54-yr average annual rainfall (252 mm/yr or 9.92 in/yr); black-above, red-below average.
b) Santee Basin USGS Stream Gauge Station 00067556 at Mast Rd., Santee.
c) USGS Stream Gauge Station 00459999 at Fashion Valley Mall; incomplete data prior to 1965.
d) Percent difference from average annual daily flow.

Monthly and seasonal average annual flows (lines) and rainfall (bars/columns) over the monitoring period for both stations are shown in **Chart F.2.** The seasonal flow patterns express range, variance and positive correlation in monthly ADF and rainfall over the past 14 years. Winter season flows within the lower watershed is several hundred times greater than summer, dry-season flow.

Average annual, winter and summer flows and rainfall for each of the last 14 years are expressed graphically in **Chart F.3.** Highest flows during the monitoring period at both gauging stations were recorded in WY05 (very wet year); the lowest in WY14 (very dry year). Water years '06, '07, '08, '12, '13, and '14 were all below normal, witnessing both below average rainfall and runoff/streamflow. WY09 witnessed near normal rainfall and river discharge. Water years '11, '15 and '17 were slightly above normal years in terms of total annual rainfall (verticle bars) and average daily streamflow (lines). Lowest total annual rainfall occurred in WY07, whereas lowest average annual streamflow, both upstream at Santee and downstream in Mission Valley occurred in WY14 following three years of well below normal rainfall.

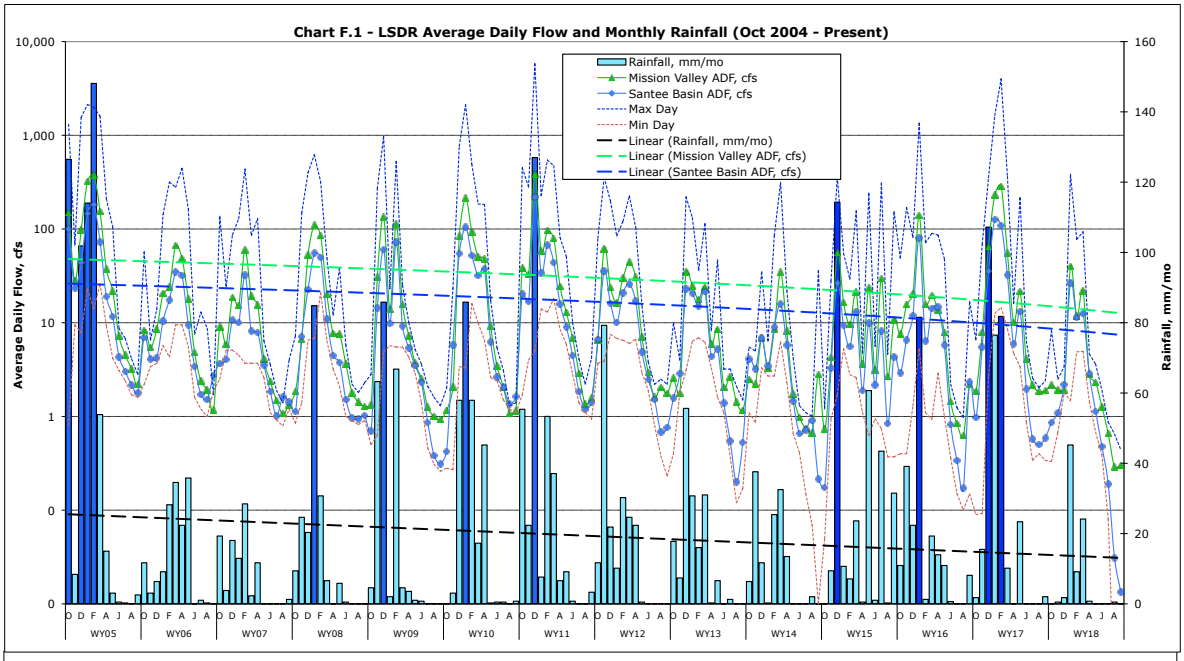
Chart F.1 - LSDR Average Daily Flow and Monthly Rainfall (Oct 2004 - Present)
Rainfall, mm/mo
Mission Valley ADF, cfs
Santee Basin ADF, cfs
Max Day
Min Day
Linear (Rainfall, mm/mo)
Linear (Mission Valley ADF, cfs)
Linear (Santee Basin ADF, cfs)
Average Daily Flow, cfs
Rainfall, mm/mo
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18

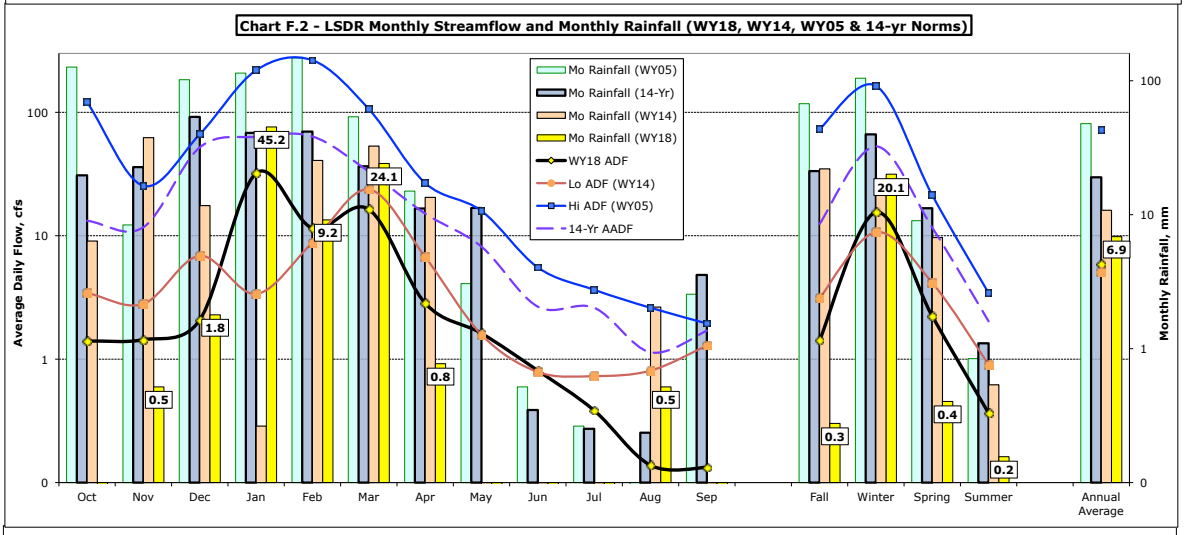
Chart F.2 - LSDR Monthly Streamflow and Monthly Rainfall (WY18, WY14, WY05 & 14-yr Norms)
Mo Rainfall (WY05)
Mo Rainfall (14-Yr)
Mo Rainfall (WY14)
Mo Rainfall (WY18)
WY18 ADF
Lo ADF (WY14)
Hi ADF (WY05)
14-Yr AADF
Average Daily Flow, cfs
Monthly Rainfall, mm
45.2
24.1
9.2
1.8
0.5
0.8
0.5
20.1
0.3
0.4
0.2
6.9
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Fall
Winter
Spring
Summer
Annual Average

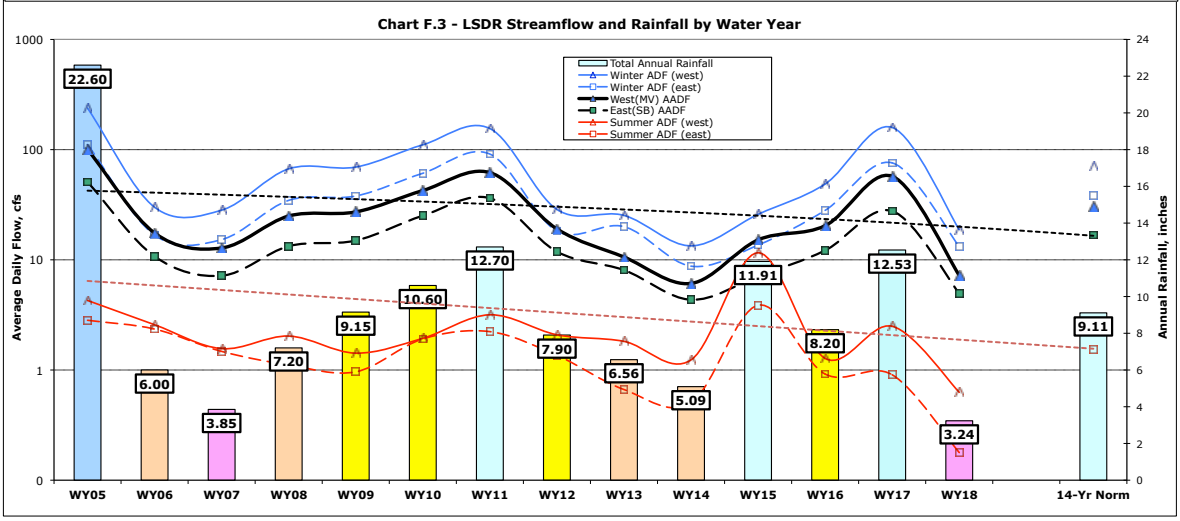
Chart F.3 - LSDR Streamflow and Rainfall by Water Year
Total Annual Rainfall
Winter ADF (west)
Winter ADF (east)
West(MV) AADF
East(SB) AADF
Summer ADF (west)
Summer ADF (east)
Average Daily Flow, cfs
Annual Rainfall, inches
22.60
6.00
3.85
7.20
9.15
10.60
12.70
7.90
6.56
5.09
11.91
8.20
12.53
3.24
9.11
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18
14-Yr Norm

Appendix G - LSDR Monthly WQM Site Data

Table G.1(W) West Section Water Temperature (WY18 Data)

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	20.50	20.10	20.50	20.80	16.40	18.40	18.20
Nov	18.20	17.30	17.70	17.80	16.50	16.00	15.30
Dec	14.60	12.20	12.30	12.40	10.10	10.60	9.50
Jan	14.10	14.20	14.30	14.30	12.70	13.60	13.20
Feb	15.70	15.50	16.10	16.40	14.10	15.00	14.30
Mar	16.80	16.50	16.50	16.40	15.20	16.70	16.30
Apr	20.30	19.40	20.00	20.30	17.30	18.70	17.20
May	20.50	20.00	19.80	20.40	17.90	19.40	18.60
Jun	25.10	22.50	22.50	23.80	18.60	21.00	21.20
Jul	26.80	24.00	25.00	26.90	22.00	23.90	24.90
Aug	28.20	23.70	25.80	27.60	22.40	24.40	25.50
Sept	26.90	20.40	22.50	24.20	19.70	21.00	22.10
Avg.	20.6 (*19.6*)	18.8 (*19.0*)	19.4 (*19.2*)	20.1 (*19.7*)	16.7 (*17.2*)	18.2 (*18.3*)	18.0 (*18.0*)

a) All values expressed in °C; WY18 averages greater than 14-yr norms (in parenthese) are shown in red; below in blue.
b) Water year results are based on unweighted averaging of monthly data (Oct- Sept); temps greater than 22oC in tan cells, values less than 15oC within blue.

Table G.1(E) Middle and East Section Water Temperature (WY18 Data)

Site	8	9T	10	11	12T	13	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	19.40	17.40	20.10	18.60	21.90	18.90	21.30	18.70
Nov	17.70	14.60	14.80	16.40	-	15.70	17.80	15.40
Dec	9.70	7.90	8.60	10.10	13.30	10.30	12.30	12.10
Jan	13.50	12.50	13.40	13.90	15.90	14.20	14.20	14.30
Feb	13.60	10.90	14.10	13.60	18.10	15.30	15.70	14.60
Mar	14.80	10.70	14.60	14.60	18.20	16.70	16.30	16.10
Apr	16.40	12.10	16.40	14.70	-	16.90	19.40	18.00
May	19.30	14.80	18.80	16.90	-	18.80	20.70	17.70
Jun	22.20	19.10	23.30	19.40	-	24.20	24.50	21.60
Jul	22.80	20.70	25.20	20.90	-	24.80	25.60	22.40
Aug	24.00	21.60	25.30	22.70	-	25.70	26.00	22.90
Sep	20.00	16.20	19.50	17.80	-	21.00	-	21.00
Avg [b]	**17.8** ***(17.1)***	**14.9** ***(15.8)***	**17.8** ***(17.2***	**16.6** ***(16.7***	**17.5** ***(17.8***	**18.5** ***(18.5***	**19.4** ***(17.2***	**17.9** ***(18.1***

a) All values expressed in oC; WY18 values greater than 14-yr norms are shown in red; below in blue.
b) Water year WY18 and 14-yr values are based on unweighted averaging monthly data (Oct-Sept); temps greater than 22oC in tan cells, less than 15oC blue cells.
c) Forester Creek discharges within the Lower Santee Basin section beyond Carlton Hills Golfcourse just upstream of Site 11.

Table G.2(W) West Section Specific Conductivity (WY18 Data)

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	14.500	3.710	3.500	3.260	3.820	3.940	3.080
Nov	33.820	4.840	4.610	4.110	4.950	5.300	3.980
Dec	37.990	3.810	3.710	3.290	4.120	4.400	3.200
Jan	1.750	1.610	1.680	1.760	1.710	1.680	1.880
Feb	3.960	2.860	2.830	2.810	2.760	2.590	2.600
Mar	1.630	1.550	1.440	1.430	1.470	1.500	1.520
Apr	3.350	2.580	2.510	2.390	2.450	2.080	2.170
May	10.490	3.360	3.230	3.050	3.240	2.800	2.910
Jun	24.740	3.610	3.460	3.210	3.500	3.130	3.040
Jul	21.322	3.398	3.800	3.352	3.617	3.570	2.931
Aug	33.750	4.110	3.720	3.540	3.870	3.790	2.990
Sep	33.240	4.110	3.930	3.390	3.860	3.950	3.070
Avg [b]	11.33 ***(8.61)***	3.30 ***(2.64)***	3.20 ***(2.55)***	2.97 ***(2.47)***	3.28 ***(2.60)***	2.23 ***(2.60)***	2.78 ***(2.48)***

a) All values expressed in milli-Siemens/cm; values >4.0 are in tan cells, values < 2.0 uS/cm are in blue cells.
b) Water Year 18 average values greater than 14-yr norms are in red; blue values below.

Table G.2(E) Middle and East Section Specific Conductivity (WY18 Data)

Site	8	9T	10	11	12T	13	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	4.820	5.520	3.120	2.840	1.980	2.390	1.600	3.040
Nov	4.400	6.920	3.930	3.750	-	3.110	2.120	3.650
Dec	3.040	5.490	2.860	2.610	2.030	2.600	1.740	2.820
Jan	2.050	4.740	2.050	2.040	1.640	1.440	1.290	2.750
Feb	2.440	5.050	2.450	2.330	1.540	1.940	1.520	2.530
Mar	1.080	3.000	1.030	1.620	1.440	1.370	1.480	0.740
Apr	2.340	4.480	2.310	2.240	-	1.760	1.460	1.9580
May	2.750	4.950	2.700	2.700	-	2.100	1.680	3.230
Jun	2.810	4.800	2.810	2.953	-	2.640	1.670	3.410
Jul	3.920	4.712	3.079	2.796	-	2.347	1.733	3.483
Aug	4.790	4.760	3.400	2.600	-	2.100	1.790	3.570
Sep	3.660	4.800	4.930	2.400	1.580	2.530	-	1.860
Avg [b]	**3.18** ***(2.33)***	**4.95** ***(4.90)***	**2.89** ***(2.31)***	**2.57** ***(2.25)***	**1.73** ***(1.68)***	**2.19** ***(1.93)***	**1.64** ***(1.51)***	**2.72** ***(2.72)***

a) All values expressed in milli-Siemens/cm; WY18 values greater than 14-yr norms are in red, below in blue.
b) Water Year 18 and 14-yr values based on averaging of monthly data (Oct-Sept); cells in blue <2.0, cells in tan >4 uS/cm
c) Forester Creek discharges within the Lower Santee Basin enter SDR at west end of Carlton Hills Golf Course.

Table G.3(W) West Section pH (WY18 Data)

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	7.85	7.65	7.87	7.77	7.70	7.69	7.24
Nov	7.68	7.87	7.98	7.90	7.93	7.87	7.84
Dec	7.76	7.87	8.10	8.03	8.11	8.01	7.52
Jan	7.78	7.61	7.57	7.53	7.63	7.48	7.43
Feb	8.13	7.88	8.03	7.97	7.88	8.02	7.90
Mar	8.10	7.91	8.05	7.99	7.98	7.98	7.94
Apr	8.30	7.93	8.13	7.95	8.16	8.08	8.30
May	8.02	8.05	8.13	8.08	8.20	8.01	8.16
Jun	7.57	7.63	7.78	7.65	7.76	7.60	7.76
Jul	7.84	7.26	7.67	7.81	7.42	7.29	7.09
Aug	8.01	7.40	8.00	8.02	7.58	7.51	7.35
Sep	8.81	8.46	8.97	8.99	8.69	8.59	8.48
Avg [b]	**7.99** ***(7.74)***	**7.79** ***(7.67)***	**8.02** ***(7.75)***	**7.97** ***(7.77)***	**7.92** ***(7.61)***	**7.84** **(7.61)**	**7.75** **(7.55)**

a) All values are unit-less; monthly values above 8 in tan cells, and above 8.5 in brown.
b) WY18 and 14-yr annual average values based on averaging monthly results (Oct-Sept); annual averages greater than 14-yr norms are shown in blue.

Table G.3(E) Middle and East Section pH (WY18 Data)

Site	8	9T	10	11	12T	13	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	7.28	8.07	7.96	7.22	8.11	7.50	7.87	7.73
Nov	7.53	8.12	8.01	7.42	-	7.66	7.96	8.08
Dec	8.08	8.29	8.54	7.74	8.52	7.96	8.49	7.44
Jan	8.00	8.21	7.52	7.32	8.42	7.77	7.92	7.99
Feb	8.06	8.31	8.28	7.50	8.38	8.22	8.29	8.28
Mar	8.33	8.48	8.29	8.15	8.50	8.02	8.06	8.60
Apr	8.04	8.52	8.35	7.84	-	8.35	8.33	8.66
May	8.12	8.35	7.91	8.04	-	7.89	8.51	8.41
Jun	7.40	7.84	-	7.16	-	7.63	8.18	8.08
Jul	7.10	7.94	7.98	7.44	-	7.13	7.22	7.47
Aug	7.38	8.19	8.48	7.78	-	7.89	7.03	7.65
Sep	8.18	9.15	8.83	8.96	-	8.65	-	9.17
Avg [b]	**7.79 (7.65)**	***8.29 (7.80)***	***8.20 (7.79)***	**7.71 (7.55)**	***8.39 (7.87)***	***7.89 (7.69)***	***7.99 (7.81)***	**8.13 (8.06)**

a) All values are unit-less; manthly values above 8 in tan cells, and above 8.5 in brown.
b) WY18 and 14-yr values are based on averaging of monthly data (Oct-Sept); averages greater than 14-yr norms are shown in blue.
c) Forester Creek discharges within the Lower Santee Basin section of the river downstream of Carlton Oaks Golf course; just upstream of Site 11.

Table G.4(W) West Section Dissolved Oxygen (WY18 Data)

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	4.94 (55)	1.20 (13)	2.74 (31)	4.17 (47)	2.92 (30)	1.32 (14)	6.23 (67)
Nov	4.00 (42)	2.93 (31)	4.85 (51)	6.13 (65)	4.61 (46)	2.66 (27)	5.63 (57)
Dec	3.99 (38)	4.65 (44)	5.65 (53)	6.83 (65)	5.56 (50)	2.92 (28)	9.36 (82)
Jan	4.83 (47)	4.97 (49)	4.85 (48)	6.03 (59)	6.22 (59)	5.61 (54)	6.47 (62)
Feb	8.47 (86)	6.38 (65)	5.67 (58)	6.53 (65)	5.04 (50)	3.63 (36)	6.37 (65)
Mar	5.05 (53)	4.87 (50)	4.61 (47)	5.67 (59)	6.01 (60)	4.20 (43)	6.56 (67)
Apr	7.32 (82)	4.71 (52)	4.27 (48)	6.73 (75)	4.57 (48)	1.90 (21)	4.23 (44)
May	5.53 (62)	3.30 (37)	2.95 (33)	5.27 (59)	5.02 (53)	1.22 (13)	4.09 (45)
Jun	6.51 (80)	0.62 (8)	1.77 (21)	2.97 (36)	2.98 (32)	0.44 (5)	1.74 (20)
Jul	6.12 (81)	0.32 (4)	2.20 (27)	3.74 (47)	2.51 (29)	0.24 (4)	3.76 (42)
Aug	6.44 (70)	0.145 (2)	3.92 (49)	5.44 (60)	1.67 (19)	0.33 (4)	3.07 (38)
Sep	4.49 (54)	0.15 (2)	3.10 (36)	5.02 (59)	2.66 (29)	0.32 (4)	2.04 (24)
Avg.	**5.64 (63)**	**2.37 (30)**	**3.88 (42)**	**5.38 (59)**	**4.15 (42)**	**2.07 (21)**	**4.96 (51)**
Norm	*6.07 (66)*	*4.37 (46)*	*4.59 (48)*	*6.07 (65)*	*4.76 (49)*	*3.56 (36)*	*4.99 (51)*

a) All values expressed in milligrams/liter and (Percent of Saturation); WY18 and 14-yr averages less than 4 mg/L (hypoxic threshold) shown in red and less than 2.5 mg/L (hypoxic level) cells highlighted in yellow.

Table G.4(E) Middle and East Section Dissolved Oxygen (WY18 Data)

Site	8	9T	10	11	12T	13	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	1.20 (13)	9.50 (101)	4.01 (45)	4.38 (48)	4.58 (53)	0.65 (7)	2.03 (23)	4.49 (48)
Nov	3.86 (42)	9.97 (100)	8.13 (81)	5.13 (53)	—	0.71 (7)	1.68 (18)	5.11 (51)
Dec	9.43 (84)	11.80 (101)	9.69 (83)	8.01 (72)	8.21 (80)	0.25 (2)	5.89 (55)	7.11 (66)
Jan	7.83 (76)	8.78 (84)	8.32 (80)	6.93 (68)	6.08 (62)	1.44 (14)	3.33 (32)	5.20 (51)
Feb	8.96 (87)	11.63 (108)	8.89 (87)	6.57 (64)	5.93 (64)	3.27 (33)	5.54 (57)	3.93 (39)
Mar	6.66 (66)	11.62 (106)	9.47 (93)	6.50 (64)	6.23 (67)	1.33 (14)	3.38 (35)	4.65 (48)
Apr	8.00 (82)	11.47 (107)	7.64 (78)	6.42 (64)	—	1.91 (20)	4.35 (48)	0.52 (6)
May	6.48 (58)	11.53 (105)	6.48 (84)	5.89 (62)	—	1.06 (11)	4.15 (45)	4.40 (48)
Jun	3.09 (37)	7.90 (87)	3.05 (37)	6.55 (72)	—	2.71 (33)	1.02 (13)	4.16 (49)
Jul	1.69 (20)	6.35 (70)	2.77 (33)	2.76 (30)	—	2.37 (28)	1.74 (21)	2.51 (29)
Aug	0.33 (5)	8.40 (96)	3.47 (42)	5.08 (64)	—	1.00 (11)	2.68 (33)	3.44 (41)
Sep	2.79 (31)	8.04 (83)	2.75 (30)	4.80 (51)	—	1.28 (14)	—	3.11 (35)
Avg [b]	**5.03 (50)**	**9.66 (95)**	**6.22 (65)**	**5.75 (59)**	**6.21 (65)**	**1.50 (16)**	**3.25 (35)**	**4.05 (43)**
Norm	*7.30 (74)*	*9.14 (93)*	*7.09 (74)*	*6.11 (60)*	*7.04 (71)*	*3.08 (32)*	*3.25 (32)*	*7.58 (72)*

a) All values expressed in milligrams/liter; WY18 values less than 4 mg/L (hypoxic threshold) are expressed in red and less than 2.5 mg/L (hypoxic level) cells highlighted in yellow.

b) WY18 and 14-yr values are based on averaging of monthly data (Oct-Sept).

c) Tributary discharges within the Lower Santee Basin reach enter below the west end of Carlton Oaks Golf Course.

Appendix H - WY18 LSDR WQM Data by Other Entities

USGS Streamflow Data

U.S. Geological Survey (USGS) streamflow values (mean daily discharge in cubic feet per second) presented in **Table H.1** for the two Lower San Diego River gauging stations are 'provisional' data subject to future revision. Processing and review of 2018 data is typically completed by January of the following year with subsequent approval for publication. The two stations are managed by the Poway South Field Office. Data for the San Diego River gauging stations as well as other streams and rivers throughout California are available via URL at http://waterdata.usgs.gov/nwis/dv?.

Table H.1 USGS StreamFlow Data (WY18 /14-yr Average Daily Flows)

	Fashion Valley (Sta. 11023000)				Santee Basin (Sta. 11022480)			
Month	Min.	Max.	ADF_3 [a]	ADFm [b]	Min.	Max.	ADF_3 [a]	ADFm [b]
Oct	1.5	8.2	2.0 *(2.5)*	12 *(17)*	0.33	1.9	0.9 *(1.6)*	0.9 *(11)*
Nov	1.6	2.5	2.2 *(9.1)*	1.9 *(15)*	0.67	1.5	1.1 *(4.1)*	1.1 *(9.6)*
Dec	1.3	3.4	1.6 *(31)*	1.9 *(71)*	1.79	2.8	87 *(26)*	2.2 *(39)*
Jan	2.1	384	14 *(34)*	40 *(87)*	1.47	364	113 *(27)*	27 *(46)*
Feb	4.9	77	5.6 *(75)*	12 *(88)*	4.89	111	15 *(33)*	11 *(47)*
Mar	5.0	93	38 *(37)*	22 *(45)*	4.95	44	21 *(14)*	13 *(25)*
Apr	1.9	4.6	2.2 *(12)*	2.8 *(19)*	1.44	5.0	5.6 *(12)*	2.9 *(13)*
May	1.7	3.6	2.3 *(11)*	2.3 *(11)*	0.68	2.3	5.7 *(4.4)*	1.1 *(6.3)*
Jun	0.7	1.9	1.1 *(2.9)*	1.3 *(3.3)*	0.39	0.7	1.3 *(2.0)*	0.5 *(2.2)*
Jul	0.4	0.9	0.7 *(6.9)*	0.7 *(3.9)*	0.8	0.4	0.5 *(1.0)*	0.01 *(1.7)*
Aug	0.1	0.7	0.1 *(1.3)*	0.3 *(1.5)*	0.001	0.1	0.5 *(0.7)*	0.01 *(0.9)*
Sept	0.2	0.4	0.3 *(2.0)*	0.3 *(2.2)*	0.001	0.1	0.4 *(1.4)*	0.01 *(1.4)*
WY Avg			**5.8 *(18)***	**7.2 *(30)***			**3.9 *(11)***	**4.9 *(17)***

a) Average daily flow over the antecedent 3-day period of water quality monitoring.
b) Average daily flow for entire month (30 days).
c) WY18 streamflow values lower (less) than 14-yr station averages are shown in red.

Average daily flows for WY18 were down 71% (12 cfs) in the eastern portion of the lower watershed and 76% (23 cfs) in the western portion from 14-yr norms (shown in italics within parenthese). LSDR discharge in WY18 amounted to 6,327 AF (2,029 Mgal) compared to 4,412 AF (1,438 Mgal) in WY14 (recent year of lowest flow) and 17,480 AF (5,696 Mgal) last year, making WY18 the second lowest year of average annual flow over the last three decades. Annual average discharge over the past 14 years of RiverWatch records is 22,767 AF (7,419 Mgal). Average annual streamflow for WY18 amounted to less than one-forth of the 54-year norm for the LSDR. The summer season (June-Sept) of this year (WY18) presented one of the lowest periods of continuous dry weather flow recorded for the lower San Diego River in recent history. Dry weather flows were considerably below seasonal norms due to the near total absence of measurable rainfall (May-Sept), above averge temperatures, low humidity and lack of any significant replenishment from the watershed's relatively shallow aquifers. Water conservation practices have also had an effect on dry weather flow.

San Diego CoastKeeper Bacteriological Data

San Diego CoastKeeper (SDCK) coliform count values (in MPN/100mL) from the organization's San Diego River monitoring stations for WY18 are presented in **Table H.2**. Sampling results from 2009 through Sept 2018 for seven San Diego area watersheds, including the lower San Diego River (HSU 907.1) are available upon request in CoastKeeper files; the most recent data can be accessed via the organization's URL website at http://www.sdcoastkeeper.org/learn/swimmable/san-diego-water-quality.html.

Table H.2 San Diego CoastKeeper Coliform Count Data (WY18 Values)

	Fashion Valley Road (SDG-010)			Old Mission Historical Dam (SDG-020)		
Month	EColi [a]	Entero [b]	TCB [c]	EColi [a]	Entero [b]	TCB [c]
Oct	181	31	1,198	91	86	278
Nov	712	332	1,497	134	193	320
Dec	520	160	2,924	122	122	-
Feb	148	213	2,481	52	63	1,467
Mar	98	134	759	-	-	-
Apr	63	30	243	20	31	244
June	313	145	1,354	10	10	1,039
Aug	598	857	4,352	10	161	3,448
Sept	717	496	1,956	20	41	8,164
WY18 Avg.	372	266	1,862	57	88	2,137
Values > Threshold	44%	78%	0%	0%	38%	0%

a) Escherichia-coli (E.coli) bacteria expressed in MPN/100m; counts exceeding 406 MPN/100ml threshold shown in red text.
b) Enterococcus (faecalis) bacteria expressed in MPN/100mL; counts exceeding 100 MPN/100ml threshold shown in red text.
c) Total Coliform bacteria (common) expressed in MPN/100mL; counts above 10,000 MPN/100ml level are shown in red text.
d) Percent of total annual samples with values above threshold limits.

Appendix I - Water Quality Indexing

The LSDR WQM index has been developed for the purpose of providing a simple and concise expression of regularly monitored physical-chemical and bacteriological water quality data compiled by the SDRPF RiverWatch Team as well as several others listed in Appendix H. The index is intended to aid in assessment of the Lower San Diego River watershed primarily for non-body contact recreational uses and environmental enhancement. As designed, the parameter constitutes a mechanism to compare averages, variances and trends in normalized values over time (temporally) and by relative location (spatially) within the watershed. The index allows one to interpret large amounts of aggregated data and relate overall water quality variations to changes, be they from natural causes or man-made impairments. The WQI has been used to identify general water quality trends over the past 13 years of monitoring and potential problem areas within the SDR watershed. Such patterns and locations can then be screened and evaluated in greater detail through direct observation of pertinent site-specific data by public agencies and water quality professionals entrusted with protection and enhancement. Used in this manner, the index provides a supplemental metric for evaluating effectiveness of many San Diego River water quality improvement programs and also assist responsible agencies and organizations in establishing priorities and updating policies for watershed management.

Running average LSDR WQI values from WY05 through WY18 are expressed by river reach and river section on **Charts I.1 and I.2**, respectively. **Chart I.1** presents overall LSDR monthly WQI values over the 14-year period. Cyclic seasonal patterns expressed in monthly results and trends described by running averages in WQI values are apparent for each reach of the river. **Chart I.2** provides the range (max-min) in monthly WQI values, the running averages by river section as well as monthly streamflows over the last 14 year monitoring period. The water quality fluctuations over time in individual reaches, sections and the overall (average) Lower San Diego River expressed on both running average and seasonal cycle bases can be observed. The Upper Santee Basin reach (Sites 13&14) demonstrates the lowest index values since March of 2010, whereas Mission Gorge (middle section) consistently shows the highest index values. It can also be noted (in both charts) that there has been an overall decline in water quality of the river, as evidenced by the WQI values, beginning in 2012. The overall LSDR running (12-mo) average index value fell 19 points from a high of 40 (20% above the 12-yr norm) to 21 over a 24-month period. The current (Sept 31, 2018) running average WQI of 22, down 10 points from the end of the last September, is 28% below the 14-yr flow weighted norm of 31 and trending downward.

Chart I.3 presents a temporal summary of variances in the water quality index values profiled on a monthly, seasonal and average annual water year basis for the five river reaches and the overall flow-weighted LSDR averages. These variances can be visually compared to changes in streamflow (blue bars) on the same basis. The positive correlations are clear, i.e., increased average daily flow results in improved water quality. Low flow throughout the summer period results in poorest water quality. This year's below average dry-weather flows extending from early April through the end of September resulted in a significant decline in water quality from last year (WY17) in all reaches.

Chart I.4 provides a spatial profile of average annual WQI by river monitoring site, reach and section for this year (WY18), compared to the best year (WY05), the worst (WY14) and the 14-yr winter, summer and annual norms. The sites are in chronological order ascending upstream. The current (WY18) average annual WQI values for each site shown in heavy black are below annual norms (colored bars) at all sites. The sites with poorest water quality for both WY17 and WY18 include Kaiser Ponds (#6), Mast Park (#13) and Cottonwood (Magnolia)/RCP (#14). For the sixth consecutive year, the Upper Santee Basin reach (Sites 13 and 14) has experienced the poorest water quality in the Lower SDR watershed. The Mission Gorge reach (sites 8, 9T and 10) continues to demonstrate best overall water quality. This year's WQI profile (heavy black line) is very similar to WY14 average annual results - the year of poorest overall water quality during the past 14 years of monitoring. The most notable difference between the two years is associated with the FSDRIP reach (Site #4) in mid-Mission Valley. WY18 WQI average annual values are somewhat lower than they were in WY14 at several upstream (Eastern) sites including Mission Trails (#8), Old Mission Dam (#10) and Forester Ck (#15).

Questions regarding the San Diego River WQM database or interpretation of results expressed in this document can be directed to the attention of the author, John C. Kennedy, through contacting SDRPF at info@SanDiegoRiver.org, or the RiverWatch Coordinator at 619-297-7380.

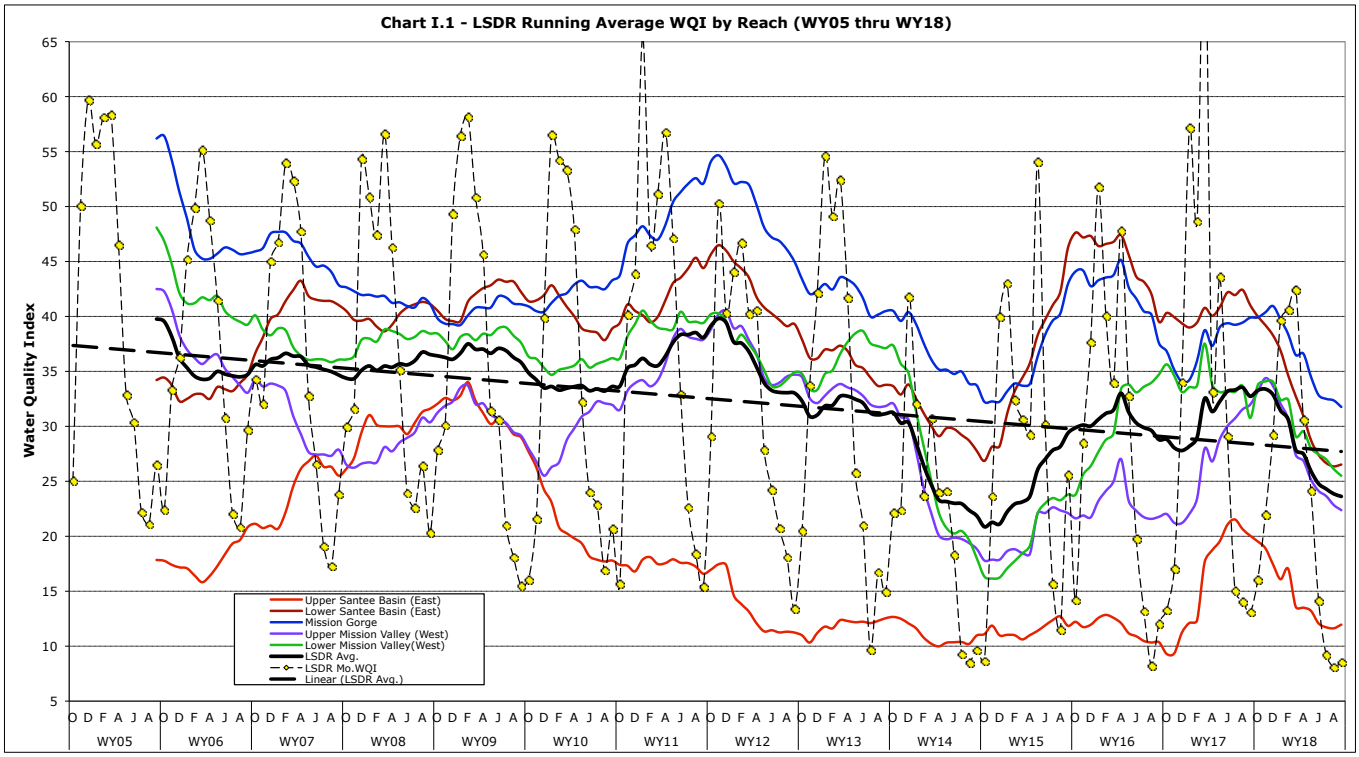
Chart I.1 - LSDR Running Average WQI by Reach (WY05 thru WY18)
Water Quality Index
Upper Santee Basin (East)
Lower Santee Basin (East)
Mission Gorge
Upper Mission Valley (West)
Lower Mission Valley(West)
LSDR Avg.
LSDR Mo.WQI
Linear (LSDR Avg.)
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18

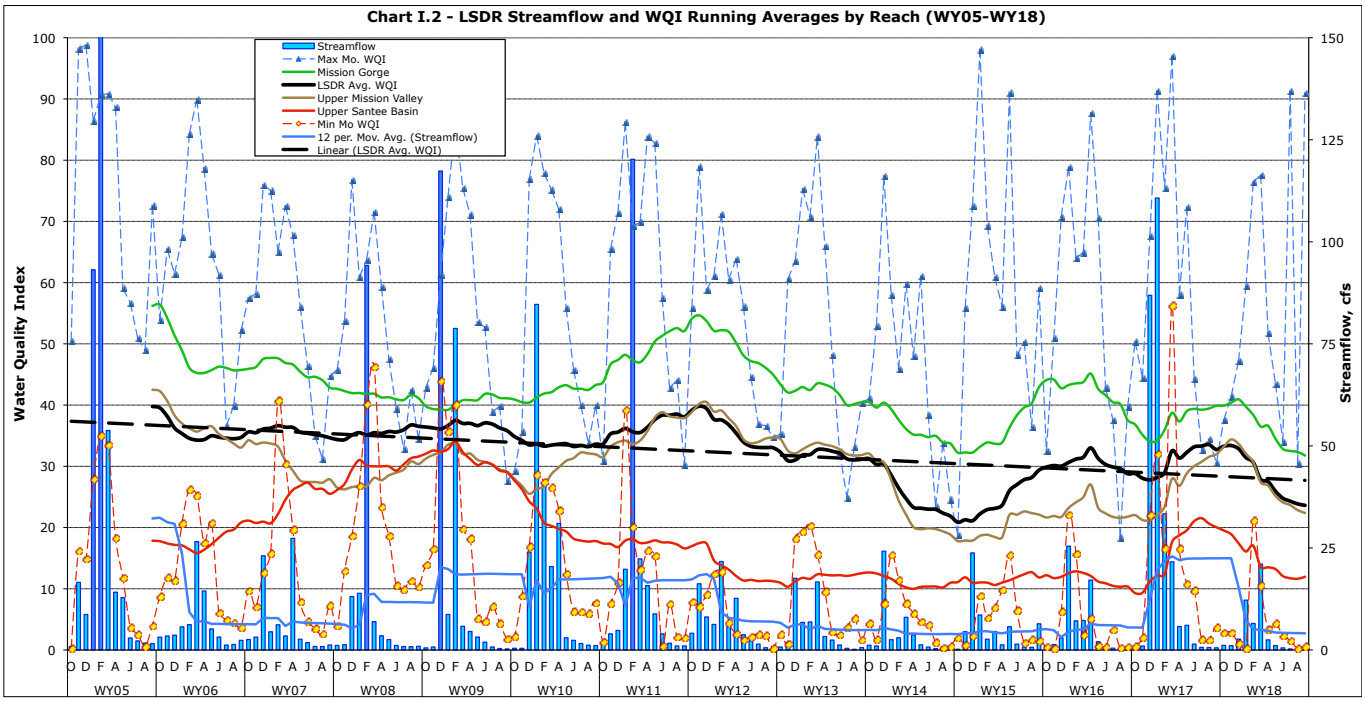
Chart I.2 - LSDR Streamflow and WQI Running Averages by Reach (WY05-WY18)
Water Quality Index
Streamflow, cfs
Streamflow
Max Mo. WQI
Mission Gorge
LSDR Avg. WQI
Upper Mission Valley
Upper Santee Basin
Min Mo WQI
12 per. Mov. Avg. (Streamflow)
Linear (LSDR Avg. WQI)
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15
WY16
WY17
WY18

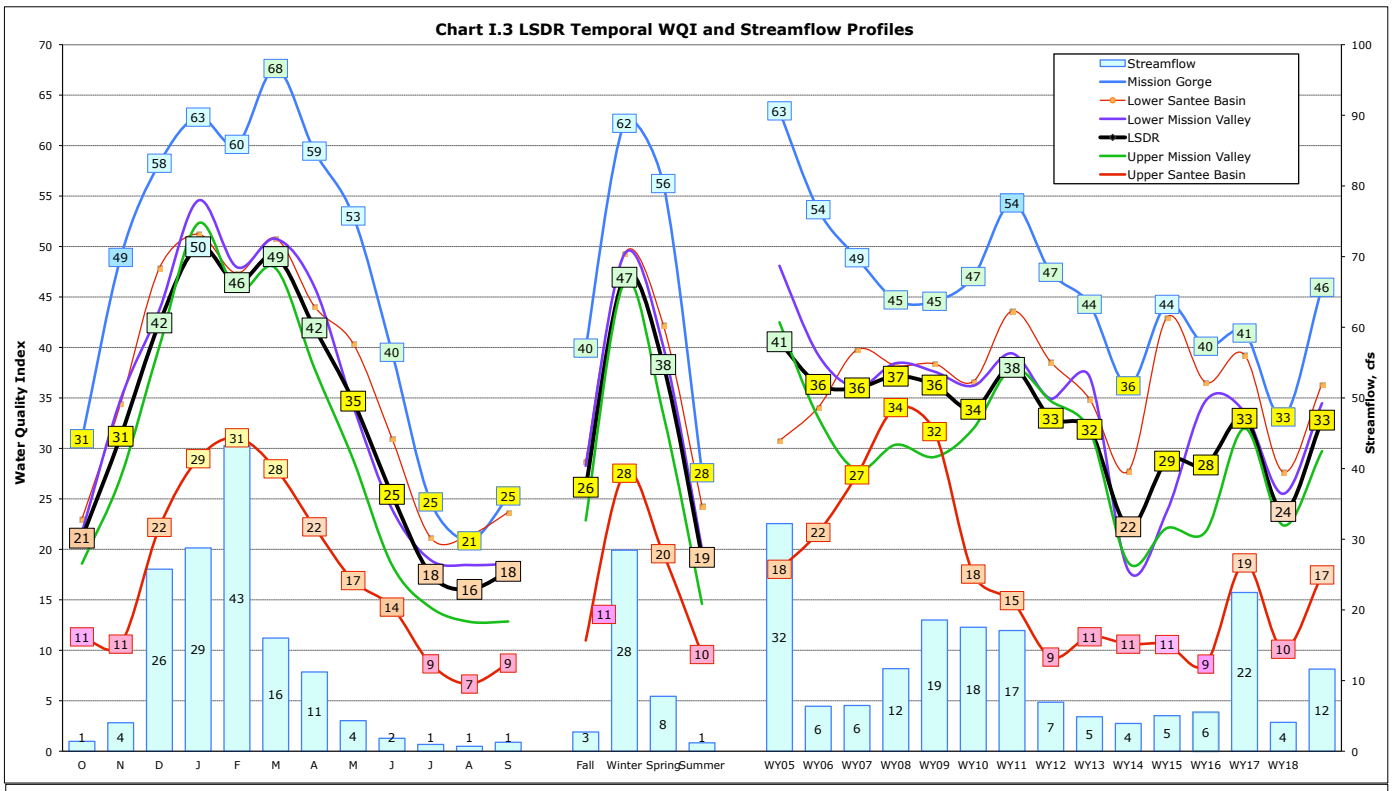
Chart I.3 LSDR Temporal WQI and Streamflow Profiles
Water Quality Index
Streamflow, cfs
Streamflow
Mission Gorge
Lower Santee Basin
Lower Mission Valley
LSDR
Upper Mission Valley
Upper Santee Basin
O N D J F M A M J J A S
Fall Winter Spring Summer
WY05 WY06 WY07 WY08 WY09 WY10 WY11 WY12 WY13 WY14 WY15 WY16 WY17 WY18

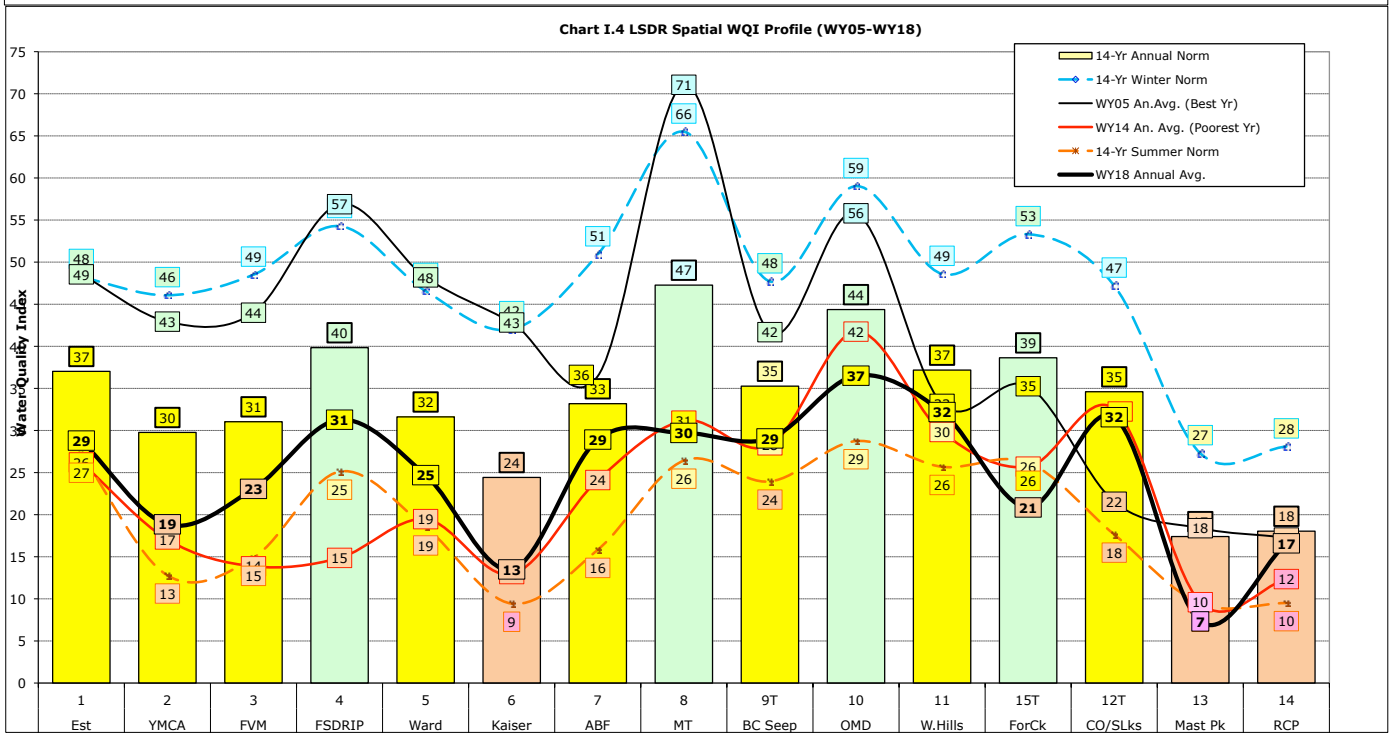
Chart I.4 LSDR Spatial WQI Profile (WY05-WY18)
Water Quality Index
14-Yr Annual Norm
14-Yr Winter Norm
WY05 An.Avg. (Best Yr)
WY14 An. Avg. (Poorest Yr)
14-Yr Summer Norm
WY18 Annual Avg.
1 Est
2 YMCA
3 FVM
4 FSDRIP
5 Ward
6 Kaiser
7 ABF
8 MT
9T BC Seep
10 OMD
11 W.Hills
15T ForCk
12T CO/SLks
13 Mast Pk
14 RCP