LOWER SAN DIEGO RIVER
WATER QUALITY 2015

Water Quality Monitoring Supplemental Report Appendices D-I

LSDR upstream of Morena Blvd. Bridge (Presidio in background)

Supporting Water Quality Monitoring Data for the Lower San Diego River

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Lower San Diego River Water Quality - 2015 Annual Report

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

Appendix D -
LSDR Water Quality Monitoring Metrics Summary

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

	WY05	WY06	WY07	WY08	WY09	WY10	WY11	WY12	WY13	WY14	WY15	11YrAvg
Annual (October-September):												
ADF, cfs	63	12	8	16	18	29	41	13	8	4	10	**20**
Temp, °C	17.7	18.3	17.7	17.7	17.7	18.1	17.8	18.0	17.3	17.9	18.7	**17.9**
SpC, uS/cm	2.13	2.19	2.42	2.32	2.49	2.36	2.21	2.39	2.50	2.58	2.19	2.345
DO, mg/L	6.84	5.87	5.91	6.28	6.17	5.4	5.82	5.59	5.68	4.09	4.70	5.67
DO%Sat,	67	58	59	65	64	57	61	58	58	42	50	58
pH	7.58	7.33	7.49	7.89	7.61	7.85	7.89	7.72	7.77	7.63	7.77	7.68
MCC, #/uL	-	-	-	-	440	600	420	510	800	-	-	550
WQI	41	37	37	38	37	35	38	33	32	22	29	35
Grade	C	D+	D+	C-	D+	D	C-	D	D	E	D	D
Summer (June-September) Period:												
ADF, cfs	3.0	2.1	1.3	1.3	1.0	1.7	2.3	1.5	1.0	0.8	7.7	2.2
Temp, °C	21.8	23.7	21.8	22.9	22.8	21.9	21.7	22.9	21.7	22.7	22.9	22.4
SpC, uS/cm	2.62	2.48	2.78	3.07	3.25	3.04	2.86	3.13	3.09	3.02	2.18	2.864
DO, mg/L	5.11	5.02	4.85	5.39	4.94	3.94	4.03	4	3.5	2.63	3.87	4.30
DO%Sat, %	53	56	52	62	56	46	46	47	40	41	45	49
pH	7.58	7.33	7.7	8.08	7.72	7.7	7.85	7.47	7.75	7.52	7.78	7.68
MCC, #/uL	-	-	-	-	350	90	260	430	400	-	-	310
WQIa	26	26	22	25	22	22	23	19	16	11	21	21
Grade	D-	D-	E	D-	E	E	E+	E	E	F	E	E
Winter (December-March) Period:												
ADF, cfs	105	20	15	30	34	55	76	23	14	8	12	36
Temp, °C	13.5	12.8	13.8	12.4	13.3	14.2	13.7	12.4	12.4	13.4	15.3	13.4
SpC, uS/cm	1.45	1.99	2.04	1.57	1.55	1.38	1.33	1.69	2.02	2.24	1.89	1.741
DO, mg/L	9.55	6.72	6.97	7.17	7.39	6.35	7.66	7.24	8.1	5.32	5.50	7.09
DO%Sat	89	60	67	68	73	64	75	68	76	50	55	68
pH	7.51	7.46	7.42	7.89	7.52	7.85	7.96	7.96	7.74	7.99	7.85	7.74
MCC, #/uL	-	-	-	-	560	1480	470	720	1640	-	-	970
WQIa	59	46	50	53	55	52	52	43	50	32	37	48
Grade	B	C	B-	B-	B	B-	B-	C	B-	D	D+	C+

(a) Values in red are below 11-Yr norms; above are in blue.

Table D.2 WQM Metrics Summary by Section and Reach (WY15, WY14 & 11-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	15/6 (31)	10/4 (28)	8/5 (20) [b]	7/4 (17)	4/2 (8)	**11/5 (24)**
Temp, °C	19.8/18.9 (19.21)	18.6/17.8 (17.77)	17.8/17.1 (17.06)	19.0/17.2 (17.35)	18.3/18.4 (18.08)	**18.7/17.9 (17.90)**
SpC, mS/cm	2.015/2.781 (2.550)	2.247/2.935 (2.549)	2.326/2.413 (2.259)	2.367/2.315 (2.245)	1.990/2.081 (1.795)	**2.192/2.582 (2.345)**
DO, mg/L	2.89/2.68 (5.07)	3.09/3.03 (4.60)	7.98/7.21 (7.82)	7.27/5.06 (6.75)	2.05/2.08 (3.38)	**4.70/4.09 (5.67)**
DO %of Sat, %	31/28 (54)	33/32 (47)	73/80	52/65	22/35	**50/42 (58)**
pH	7.56/7.70	7.53/7.55	7.65/7.69	7.73/7.76	7.77/7.70	**7.77/7.68**
WQIa	23/18 (36)	22/19 (31)	46/37 (50)	43/28 (38)	10/10 (19)	**29/22 (35)**
Grade	E/E (D+)	E/E (D)	C/D+ (B-)	C/D (D+)	F/F (E)	**D/E (D)**
FY15 Rating	Poor		Fair		Very Poor	**Marginal**
FY14 Rating	Poor		Marginal		Very Poor	**Poor**
11-Year Norm	Marginal	Marginal	Good	Marginal	Poor	**Marginal**
Summer (June-Sept) Period:						
ADF, cfs	13.6/1.3 (3.3)	10/1 (2.5)	6.2/0.8(2.1) [c]	4.4/0.6(1.8)	2.0/0.2(0.8)	**7.6/0.8 (2.1)**
Temp, °C	24.0/23.9 (24.15)	23.1/22.3 (21.80)	22.2/22.2 (21.77)	22.9/21.4 (21.72)	22.3/23.5 (22.76)	**22.9/22.7 (22.44)**
SpC, mS/cm	1.743/3.150 (3.178)	2.260/3.445 (3.159)	2.318/3.080 (2.816)	2.614/2.539 (2.595)	1.972/2.300 (2.011)	**2.178/3.024 (2.864)**
DO, mg/L	1.82/1.11 (3.57)	1.79/2.17 (2.95)	7.13/4.51 (6.42)	6.98/3.35 (5.73)	1.94/2.03 (2.59)	**3.87/2.63 (4.30)**
DO % of Sat, %	22/13 (42)	21/25 (34)	81/51 (73)	38/59	22/24 (29)	**45/41 (49)**
WQI	15/10 (21)	11/11 (16)	34/12 (33)	38/16 (26)	9/8 (10)	**21/11 (21)**
Grade	E/F (E)	F/F (E)	D/F+ (D)	C-/E (D-)	F/F (F)	**E/F (E)**
FY15 Rating	Poor	Very Poor	Marginal	Fair	Very Poor	Poor
FY14 Rating	Very Poor	Very Poor	Very Poor	Poor	Very Poor	Very Poor
11-Year Norm	Poor	Poor	Marginal	Marginal	Very Poor	Poor

WY15 and WY14 WQ metric values below (less than) 11-Yr Norms shown in red; above in blue.
(a) Weighted average of all reaches within the Lower SDR watershed.
(b) Stream flow based on averaged river gains and losses between Santee Basin and Mission Valley.

Table D.2 WQM Metrics (Continued)

Reach	LMV	UMV	MG	LSB	USB	**LSDR [a]**
Winter (Dec-March) Period:						
ADF, cfs	26/13 (72)	24/11 (70)	16/10 (46)	14/9 (39)	7/4 (20)	**17/9 (47)**
Temp, °C	16.4/13.9 (14.27)	15.5/13.4 (13.55)	14.2/12.5 (12.62)	15.7/13.4 (13.05)	14.8/13.8 (13.44)	**15.3/13.4 (13.38)**
SpC, mS/cm	1.941/2.528 (1.887)	1.608/2.608 (1.798)	2.048/1.963 (1.619)	2.069/2.006 (1.832)	1.861/1.923 (1.485)	**1.890/2.241 (1.741)**
DO, mg/L	4.02/3.71 (6.73)	3.69/4.23 (6.41)	8.97/8.89 (9.01)	8.20/6.47 (7.94)	1.77/2.56 (4.32)	**5.50/5.32 (7.09)**
DO % of Sat, %	41/36 (66)	37/40 (62)	87/83 (86)	84/62 (72)	18/25 (40)	**55/50 (68)**
WQI	33/25 (51)	28/26 (47)	59/55 (64)	52/40 (50)	11/15 (29)	**37/32 (48)**
Grade	D/D- (B-)	D/D-(C)	B/B (B)	B/C (B-)	F/E (D)	**D+/D (C+)**
WY15 Rating	Marginal		Good		Very Poor	**Marginal**
WY14 Rating	Marginal		Good	Fair	Poor	**Marginal**
11-Year Norm	Good	Fair	Good	Good	Marginal	**Fair**

WY15 and WY14 WQ metric values below (less than) 11-Yr Norms shown in red; above in blue.
(a) Weighted average of all reaches within the Lower SDR watershed.
(b) Stream flow based on averaged river gains and losses 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 past 10 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 10 years (Oct. 2004 – Sept. 2014) 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.**

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.** Site locations, river milage, bed elevations and coordinates are provided in **Table E.2.**

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)	11-15	5-mile eastern section from Kumeyaay Lk to Lakeside
Eastern Sections (East Sites)	8 -15	10-mile eastern/upper 3 reaches (2 sections)
Tributaries:		
Murphy Canyon/Qualcom [a)]	5a	Enters LSDR southwest of Qualcom Stadium
Jackson Dr/Birchcreek Outfall [b)]	9T	Enters LSDR at Sycott Wash (d/s of Site 8)
Santee Lakes/E. Sycamore Cnyn Ck	12T	Enters LSDR d/s of Carlton Oaks GC (u/s of #11)
Forester Creek [c)]	15T	Enters LSDR at Carlton Oaks GC (u/s of Site 12T)
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.

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.3.** 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 11-yr period (Oct. 04 - Sept. 15) 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 determining the water quality index.

Table E.2 - LSDR WQM Site Information

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 PC Hwy & I-5 on encased sewer main	32.76131	-117.20373
2	River Gardens E/W	3.5	11	W. of YMCA, d/s of Trolly overpass at riffle	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 Cafe on Mission Center Rd Bridge	32.76986	-117.15482
UMV - Upper Reach E. Mission Valley: I-805 Bridge to North 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 at Jackson Dr	13.82	159	at SDCWA down stream of Scycott Crossing	32.82124	-117.06205
9T	Jackson Dr/Birchcreek OF	13.86	198	San Marcos area tributary 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 Blvd 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	Sycamore Ck/Santee Lakes at Carlton Oaks Dr.	32.84431	-117.00635
15T	Forester Creek	18.86	336	Forester Ck (tributary) at Prospect Ave.	32.83221	-116.98658
USB - Upper Reach Santee Basin: Carlton Hills Blvd Bridge to Riverford Rd (Sites 13-14)						
13	Mast Park	18.50	330	Pedestrian Bridge behind (N of) Walmart	32.84696	-116.97335
14	Cottonwood Ave/RCP	19.84	340	W of RCP plant at Chubb Ln/Cottonwood 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) [MV2+MG+SB]						

Reaches (5) - averaged values for combination of adjacent sites excluding tributaries within identified portions of river (LMV, UMV, MG, LSB, USB) .
Sections (3) - averaged values for adjacent reaches (MV = LMV+UMV, MG = MG, SB = LSB+USB)
Tributaries (3) – sites located on small creeks/drainages tributary to main stream watercourse.
LSDR – computed values for entire lower watershed (distance-weighted average of all 5 reaches or all 3 sections); average (LMV+UMV+MG+LSB+USB) or average (MV+MG+SB).

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.3 - LSDR Water Quality Monitoring Parameters

WQ Parameter	unit	Comments
Measured monthly at all sites:		
1. Temperature (Temp)	°C	Basic characteristic and WQ driver (Table C.1)
2. pH	-	Degree of acidity (<7.0) or alkalinity (>7.0) (Table C.3)
3. Specific Conductivity (SpC)	mS/cm	Measure of ionic content or dissolved solids (Table C.2)
4. Dissolved Oxygen (DO)	mg/L	Good indicator of relative water quality (Table C.4)
5. Percent of DO Saturation (DO%Sat)	%	Good indicator of general water quality (Table C.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
Discontinued on regular basis in 2006:		
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)		
Parameters measured by others at selected sites		
10. Stream Flow	cfs	USGS gauging stations at Fashion Valley and Mast Rd near Santee (Table H.1)
11. Coliform counts	MPN/100mL	SD CoastKeeper data taken at Fashion Valley Rd and Old Mission Dam monitoring sites (Table H.2)

Team Leaders and multiple citizen volunteers (typically 3-8 persons) meet at an appointed location, organize field equipment/transportation, drive to sites, measure physical-chemical water quality using the Sonde instrument, note special conditions/observations, collect samples for subsequent testing, return to office, perform nutrient (NO_3 & PO_4) tests, store samples for any 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.
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 average value taken over 12 month period

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>

Appendix F - LSDR Hydrology and Water Quality

Stream flow or discharge, the volume of water moving past a designated location over a fixed period of time, is a primary driver of changes in water quality. Flow, often expressed as cubic feet per second (cfs) or million gallons per day (mgd), constitutes 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 different seasons. Flow decreases during summer months when rainfall is minimal, evaporation rates high and actively growing riparian vegetation extracts water from the ground. August and September are typically months of lowest flow. A function of both volume and velocity, stream flow has a major impact on living organisms, watercourse habitats and on 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 thats transported. Fast moving watercourses usually contain higher levels of DO than slow streams, 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 11-yr monitoring period (Oct 2004 - Sept 2015) and the past 52 years (1965-2015) of official records**.** The average daily flow values are in close accord for both stations; river discharge over the past 11 years has run about 12 percent below the 52-year norm.

Table F.1 - Lower SDR Average Daily Flows (WY05-WY15)

Season	West - Mission Valley		East - Santee Basin		LSDR [a]	
Units [b]	cfs	mgd	cfs	mgd	cfs	mgd
Fall (Oct-Nov)	18.3	11.8	12.1	7.8	14.6	9.4
Winter (Dec-Mar)	71.9	46.4	39.0	25.2	52.2	33.7
Spring (April-May)	16.1	10.4	10.0	6.5	12.4	8.0
Summer (June-Sept)	3.1	2.0	1.8	1.2	2.3	1.5
Annual Avg. (WY15)	15.2	9.8	7.1	4.6	10.3	6.7
11-Yr Annual Avg. (2005-2015)	30.7	19.8	17.9	11.6	22.7	14.7
52-Yr Annual Avg. (1965-2015)	36	23	22	14	27	17
Annual Discharge, AF [c]	11,000 / 26,000		5,100 / 15,900		7,500 / 19,500	

(a) Lower San Diego River average daily flow represents a mean hydrologic condition based on averaging the two USGS gauging station streamflow 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); WY15 and 52-Yr averages.

Correlations between total annual rainfall and ADF considered over the past 52 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" hydrologic year, whereas WY07 was "Very Dry". WY06 & WY08 were both "Dry" years while WY09 & WY10 were considered "Normal" in terms of both total annual rainfall and average daily flow. The 11-yr ADF in the East and West is 18 and 31 cfs, respectively; the values are 15-20% below the long-range LSDR average daily discharges.

Table F.2 - Rainfall and Long-Term Average Daily Flow (1914-2015)

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	39	38%	38%	8-12	200-299	250	10	18	15
Dry	26	26%	31%	5-8	125-199	160	7	12	10
Very Dry	6	6%		<5	<125	100	5	9	7
Annual Average	102	100%		9.85		250	16	25	21

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-WY15)

(Type of Year)	Annual Rainfall		Variance [a]	ADF, cfs/(mgd)			Variance [d]
	mm	inches		East [b]	West [c]	LSDR	
WY05 (Very Wet)	571	22.49	128%	51/(33)	100/(65)	71/(46)	119%
WY06 (Dry)	154	6.06	-38%	11/(7)	18/(11)	14/(9)	-57%
WY07 (Very Dry)	98	3.85	-61%	7.2/(5)	13/(8)	9.4/(6)	-71%
WY08 (Dry)	184	7.25	-26%	13/(9)	25/(16)	18/(12)	-43%
WY09 (Below Normal)	232	9.15	-7%	15/(10)	27/(18)	20/(13)	-38%
WY10 (Normal)	268	10.55	7%	25/(16)	43/(27)	32/(21)	0%
WY11 (Above Normal)	321	12.62	28%	43/(28)	62/(40)	47/(30)	52%
WY12 (Dry)	204	8.03	-18%	12/(8)	19/(12)	15/(10)	-52%
WY13 (Dry)	169	6.65	-32%	8.1/(5)	11/(7)	9.1/(6)	-71%
WY14 (Dry)	129	5.1	-48%	4.3/(3)	6.1/(4)	5.0/(3)	-84%
WY15 (Above Normal)	302	11.86	21%	7.1/(5)	15/(10)	10/(7)	-67%
11-Yr Average (05-15)	245	9.63	-2%	18/(12)	31/(20)	23/(15)	-23%
102-Yr Average	250	9.85	0%	25/(16)	39/(25)	32/(21)	0%

a) Percent difference from 102-Yr average annual rainfall (250 mm/yr or 9.85 in/yr); black-above, red-below average.
b) Santee Basin USGS Stream Gauge Station at Mast Rd.
c) USGS Stream Gauge Station at Fashion Valley Mall; incomplete data prior to 1965.
d) Percent difference from average annual daily flow (i.e., 21 mgd).

Monthly discharge data (min, max and average daily flow) at the two gauging stations extending from Oct 2004 through Oct 2015 are presented in **Chart F.1.** Average daily flow (ADF) for the lower San Diego River varies from less than 1 cfs (0.6 mgd) during the summer (dry) months to nearly 200 cfs (130 mgd) during some winter (wet) periods in the East (Santee Basin) and up to 380 cfs (245 mgd) in the West (Mission Valley) section. Running average ADF values, trending downward between WY11 and WY14 began to improve/increase in WY15 as shown in **Chart F.1**.

Chart F.1 - LSDR Average Daily Flow and Monthly Rainfall (Oct 2004 - Present)

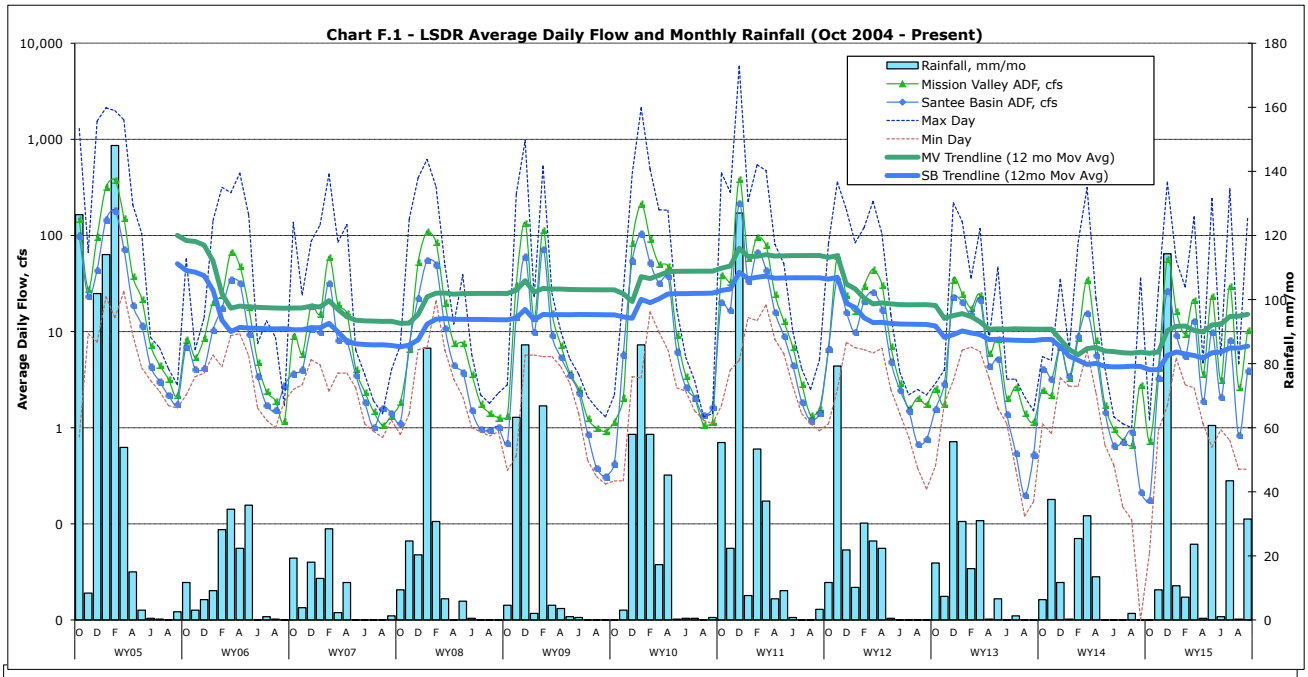


Chart F.2 - LSDR Monthly Streamflow and Monthly Rainfall (WY15, WY14, 11-Yr and 35-Yr Averages)

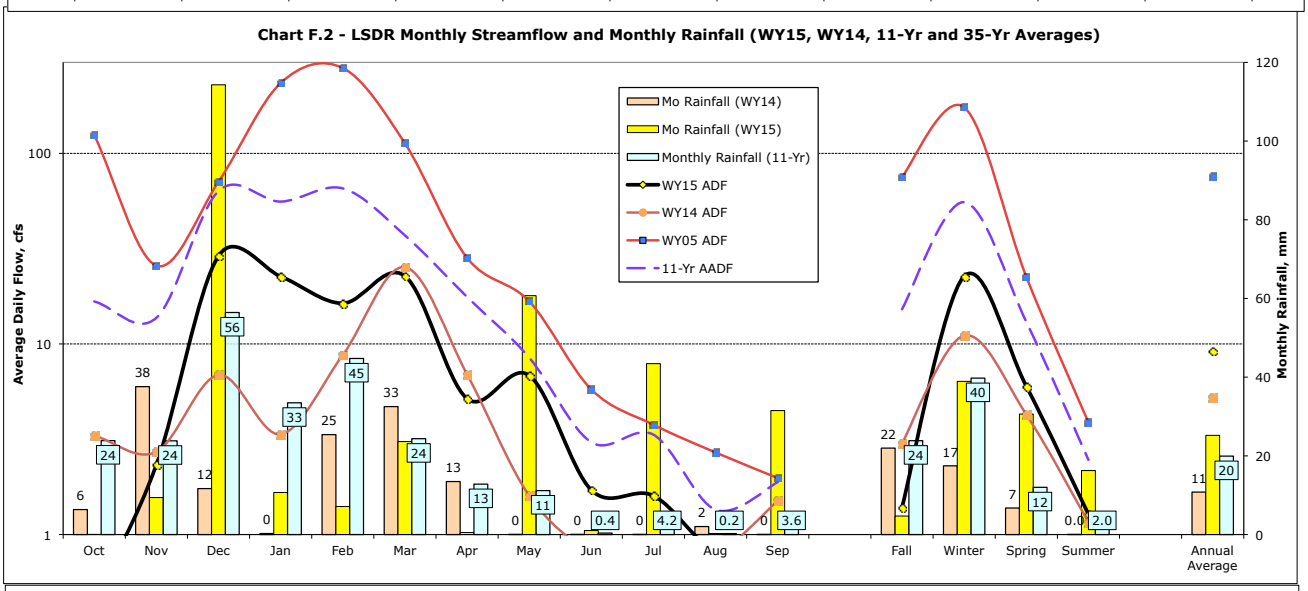
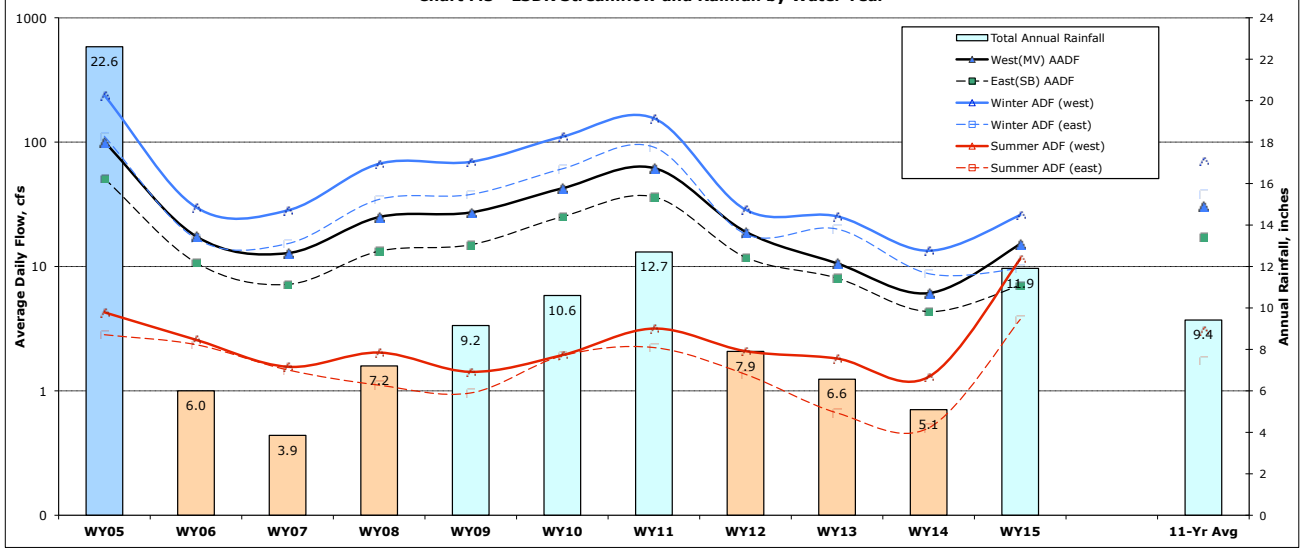


Chart F.3 - LSDR Streamflow and Rainfall by Water Year



Monthly and seasonal average annual flows and rainfall over the monitoring period for both stations are shown in **Chart F.2.** The seasonal flow patterns express range, variance and correlation in monthly ADF and rainfall over the last 11 years. Winter season streamflow within the lower watershed is several hundred times greater than summer, dry season flows. Average annual, winter and summer flows and rainfall for each of the water years are presented in **Chart F.3.** Highest flows during the monitoring period at both gauging stations were recorded in WY05 (very wet year); the lowest in WY07 (very dry year). Water years '06, '08, '12, '13 and '14 were all below norm, witnessing both below average rainfall and runoff/streamflow. WY09 witnessed near normal rainfall and river discharge. Water years 2010 and 2011 were slightly above normal years in terms of total annual rainfall and average daily streamflow. Lowest total annual rainfall occurred in WY05, whereas lowest average annual streamflow, both upstream at Santee and downstream in Mission Valley occurred last year (WY14). In WY15, total annual rainfall amounting to 10.4 inches was 11% above the norm (9.3 inches) while average annual streamflow remained 52% below the 11-yr norm and 74% below the 52-year average.

Appendix G - LSDR Monthly WQM Site Data

Table G.1(W) West Section Water Temperature (WY15/WY14 Data)

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	22.7/20.1	20.6/18.8	20.0/18.7	20.3/19.1	17.7/17.2	19.0/17.3	20.2/18.2
Nov	16.7/16.8	16.0/16.2	15.8/15.4	15.9/15.0	14.1/14.2	14.7/14.6	14.1/14.6
Dec	14.3/11.7	14.3/11.7	14.1/11.8	13.9/11.9	13.4/10.9	13.6/11.3	13.7/10.9
Jan	13.6/11.7	13.5/11.4	13.4/11.2	13.4/11.0	12.4/9.7	12.9/11.1	12.9/10.1
Feb	18.0/14.4	17.6/14.8	17.9/14.1	17.6/13.8	15.1/13.2	16.4/14.3	17.2/14.5
Mar	20.2/18.1	20.0/18.1	20.2/18.1	20.7/18.2	18.7/17.4	20.0/18.4	19.6/18.4
Apr	21.2/20.6	20.2/19.5	20.9/19.1	22.3/19.2	16.4/18.1	18.8/19.8	18.2/19.6
May	17.8/22.5	17.5/21.8	18.2/19.9	18.8/20.4	17.8/18.6	18.2/20.3	17.3/21.4
Jun	23.7/26.0	23.5/22.0	23.6/20.9	24.6/23.3	19.8/18.8	22.0/20.2	23.0/23.3
Jul	22.5/25.1	22.1/22.4	21.9/21.6	21.6/23.8	22.2/20.3	23.8/21.5	24.5/24.0
Aug	25.6/27.0	24.6/23.1	24.5/22.8	25.3/25.4	21.6/21.3	22.9/22.1	24.2/25.7
Sept	25.0/25.1	24.8/24.9	24.9/24.5	26.0/24.9	23.8/20.6	24.6/25.0	24.5/24.7
WYAv [b]	**20.1/19.9**	**19.6/18.7**	**19.6/18.2**	**20.0/18.8**	**17.8/16.7**	**18.9/18.0**	**19.1/18.8**

a) All values expressed in °C; WY15 values greater than WY14 data are shown in red; below in blue.
b) Water Year results are based on straight (unweighted) averaging of monthly data (Oct- Sept).

Table G.1(E) Middle and East Section Water Temperature (WY14/WY15 Data)

Site	8	9T	10	11	12T	13	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	15.7/20.0	12.3/18.4	14.6/19.1	15.1/19.4	17.6/24.0	18.4/20.8	15.4/—	15.4/20.0
Nov	15.1/15.8	14.7/15.5	14.5/13.7	15.4/15.9	16.7/17.9	14.9/16.1	16.0/14.1	15.4/16.6
Dec	11.3/12.9	10.0/11.5	11.4/12.8	11.4/13.2	12.4/16.1	11.9/13.8	11.6/13.9	11.2/11.9
Jan	9.4/11.5	8.1/9.2	9.4/11.6	10.7/12.0	9.9/11.5	11.8/11.6	9.9/11.1	10.8/11.1
Feb	13.8/12.6	11.8/11.8	14.1/12.9	13.6/12.6	--/13.4	15.1/13.6	14.0/13.0	14.5/12.6
Mar	16.7/16.0	14.2/14.9	17.0/16.5	16.3/15.5	19.7/17.0	17.7/16.8	17.4/16.1	17.5/15.6

Site	8	9T	10	11	12T	13	14	15T
Apr	17.6/16.2	15.7/15.4	18.8/17.3	16.8/16.0	17.7/18.0	18.1/18.4	18.6/17.4	18.7/16.4
May	18.6/19.5	16.9/18.7	20.1/20.6	17.4/18.3	--/20.2	20.2/21.4	19.0/19.9	19.5/19.7
Jun	19.9/21.0	17.1/18.2	22.3/22.5	18.2/19.7	--/22.3	24.0/23.8	19.1/21.2	21.8/21.6
Jul	22.0/21.5	19.4/18.9	24.1/23.5	20.0/20.7	--/22.6	24.4/24.1	20.6/22.0	23.0/24.1
Aug	23.7/21.6	20.6/21.0	23.8/23.5	21.0/21.4	--/23.2	25.0/24.4	20.7/21.9	23.7/24.3
Sep	22.7/20.7	21.6/20.0	23.6/21.6	22.9/20.2	--/21.5	25.1/21.9	25.0/20.6	24.2/22.9
WY Avg [b]	**17.2/16.8**	**15.2/16.1**	**17.8/17.6**	**16.6/16.6**	**15.7/17.5**	**18.9/18.5**	**17.3/17.2**	**18.0/17.7**

a) All values expressed in oC; WY15 values greater than WY14 data are shown in red; below in blue.
b) Water year (WY15/WY14) values are based on straight (unweighted) averaging monthly data (Oct-Sept).
c) Forester Creek discharges within the Lower Santee Basin reach just downstream of Carlton Hills Golf course.

Table G.2(W) West Section Specific Conductivity (WY14/WY15 Data)

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	10.2/24.0	3.27/3.27	2.81/2.63	2.42/2.30	2.97/3.83	4.09/4.47	3.01/3.17
Nov	33.7/21.4	2.89/2.76	2.82/2.33	2.15/2.43	2.90/2.73	3.73/3.86	2.78/3.13
Dec	2.95/2.57	2.81/1.26	2.30/1.23	2.00/1.23	2.52/1.18	2.45/0.82	1.72/0.86
Jan	35.0/2.22	3.02/1.93	2.94/1.97	2.73/2.02	2.79/1.89	2.49/1.70	2.41/1.60
Feb	2.99/5.97	2.40/2.79	2.45/2.73	2.60/2.66	2.72/0.81	2.59/2.22	2.29/2.64
Mar	2.05/6.25	1.90/1.84	1.83/1.75	1.88/1.75	2.10/1.95	1.94/1.67	2.16/1.95
Apr	7.00/22.8	2.49/2.74	2.44/2.65	2.47/2.66	2.71/2.97	2.47/2.45	2.26/2.65
May	16.1/0.86	2.89/0.94	2.46/1.41	2.53/1.84	3.38/1.54	2.74/1.45	3.10/1.02
Jun	22.6/5.43	3.23/2.63	3.01/2.53	2.92/2.44	3.48/3.13	3.05/2.02	3.06/2.69
Jul	26.1/1.18	3.48/1.09	3.31/0.78	3.06/0.53	3.68/2.00	3.39/2.23	3.06/2.47
Aug	24.3/8.01	3.74/2.63	3.60/2.44	3.04/2.30	3.79/3.05	3.81/1.78	3.15/2.98
Sep	4.48/1.22	2.86/0.98	2.70/1.04	2.00/1.09	3.45/2.29	4.25/2.10	3.18/1.58
WY Avg [b]	**15.6/8.50**	**2.92/2.07**	**2.72/1.96**	**2.48/1.94**	**3.04/2.28**	**3.08/2.23**	**2.68/2.23**

a) All values expressed in milli-Siemens/cm; WY14/WY15 values greater than 11-yr monthly norms are in red.
b) Water Year 2014/2015 values are based on averaging monthly data (Oct-Sept).

Table G.2(E) Middle and East Section Specific Conductivity (WY14/WY15 Data)

Site	8	9T	10	11	12T	13	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	2.27/4.60	5.57/6.03	2.30/3.45	2.75/2.72	1.92/2.21	2.27/2.52	1.83/—	2.67/2.70
Nov	2.40/2.79	5.15/1.77	2.40/2.79	2.37/1.73	1.82/1.86	2.13/2.42	1.70/2.07	2.54/3.10
Dec	0.81/1.54	3.03/3.72	0.69/1.59	1.22/1.70	1.69/1.90	1.91/1.80	1.38/1.83	0.60/2.43
Jan	2.45/1.97	5.12/4.25	2.51/2.00	2.51/1.92	1.86/1.69	2.17/1.82	1.75/1.72	2.59/1.39
Feb	2.20/2.43	4.78/4.94	2.24/2.48	2.26/2.54	—/1.63	2.15/2.14	1.84/1.80	2.45/2.70
Mar	1.97/2.17	4.79/4.81	1.96/2.20	1.98/2.28	1.04/1.60	1.90/1.89	1.66/1.68	2.53/2.89
Apr	2.13/1.38	4.77/5.23	2.22/2.65	2.36/2.71	1.85/—	2.03/2.23	1.72/1.76	2.88/3.27
May	2.28/1.73	5.40/4.32	2.45/1.82	2.56/1.99	—/1.71	2.24/1.72	1.83/1.52	3.00/2.66
Jun	2.60/2.50	5.29/5.37	2.61/2.64	2.61/2.84	—/—	2.38/2.18	1.81/1.76	2.94/3.33
Jul	3.06/2.68	5.61/5.51	2.77/2.58	2.64/2.94	—/1.82	2.46/2.47	1.83/1.84	2.62/3.88
Aug	2.60/2.47	5.78/5.41	1.80/2.62	2.37/2.88	— /1.92	2.45/2.31	1.85/1.81	3.28/3.21
Sep	6.22/1.43	5.90/4.16	2.98/1.62	2.38/1.50	—/—	2.51/2133	—/1.67	1.63/2.50
WY Avg [b]	**2.58/2.28**	**5.10/4.63**	**2.24/2.37**	**2.33/2.31**	**1.70/1.82**	**2.22/2.07**	**1.75/1.77**	**2.48/2.84**

a) All values expressed in milli-Siemens/cm; WY14/WY15 values greater than 11-Yr norms are in red.
b) Water Year 2014/2015 values are based on averaging of monthly data (Oct-Sept).
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 (WY14/WY15 Data)

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	7.34/7.40	7.45/7.21	7.56/7.11	7.48/7.14	7.38/7.42	7.26/7.34	6.91/7.23
Nov	7.44/7.89	7.63/7.40	7.63/7.28	7.67/7.28	7.66/7.49	7.55/7.44	7.50/7.37
Dec	7.46/7.63	7.39/7.51	7.38/7.45	7.36/7.43	7.25/7.45	7.04/7.54	7.09/8.11
Jan	7.27/7.51	7.56/7.47	7.52/7.50	7.45/7.49	7.40/7.91	7.46/7.54	7.81/7.47
Feb	7.84/7.76	7.71/7.84	7.77/7.70	7.78/7.69	7.77/8.09	7.77/8.22	8.01/8.40
Mar	7.82/7.58	7.72/7.53	7.70/7.59	7.76/7.58	7.77/7.54	7.75/7.58	7.82/7.65
Apr	7.50/7.62	7.47/7.89	7.54/7.92	7.57/7.82	7.51/7.73	7.46/7.79	7.67/7.45

Site #	1	2	3	4	5	6	7
May	7.52/8.03	7.54/7.92	7.65/8.08	7.64/7.78	7.57/7.79	7.60/7.84	7.58/8.02
Jun	7.71/7.94	7.65/8.02	7.81/8.03	7.89/7.92	7.77/7.73	7.87/7.86	7.84/8.23
Jul	7.86/7.87	7.47/7.56	7.44/7.86	7.70/8.21	7.57/7.75	7.77/7.59	7.48/7.64
Aug	8.00/7.55	7.26/7.64	7.14/7.70	7.62/7.63	7.42/7.52	7.46/7.67	7.42/7.41
Sep	7.41/7.54	7.21/7.58	7.19/7.51	7.24/7.59	7.34/7.52	7.39/7.30	7.34/7.37
WY Avg [b]	**7.60/7.69**	**7.51/7.63**	**7.53/7.64**	**7.60/7.63**	**7.53/7.66**	**7.53/7.64**	**7.54/7.70**

a) All values are unit-less.
b) b) Water Year 2014/2015 based on averaging monthly results (Oct-Sept).

Table G.3(E) Middle and East Section pH (WY14/WY15 Data)

Site	8	9T	10	11	12T	13	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	7.86/7.20	7.73/7.91	8.24/7.04	7.61/7.58	8.80/7.34	7.99/7.36	8.17/—	8.19/7.47
Nov	7.55/7.44	7.62/8.14	7.86/7.52	7.39/7.58	8.16/7.76	7.76/7.54	7.95/—	7.88/8.20
Dec	7.58/7.98	7.55/8.24	7.96/7.88	7.50/7.48	7.86/8.38	7.55/7.52	7.72/—	7.93/8.03
Jan	7.65/7.90	7.69/8.02	7.95/8.09	7.87/7.58	8.06/8.18	7.87/7.77	8.05/8.10	8.10/8.20
Feb	7.66/7.98	7.73/8.06	7.90/7.98	7.97/7.60	—/8.41	7.87/7.88	8.06/7.91	8.10/8.28
Mar	7.67/7.88	7.75/8.02	8.04/7.98	7.54/7.58	—/8.19	7.93/7.85	8.03/8.03	8.00/7.99
Apr	7.35/7.65	7.29/7.78	7.61/7.96	7.10/7.41	7.74/—	7.63/7.65	7.74/7.91	7.63/8.29
May	7.69/8.31	7.58/8.07	7.82/8.26	7.42/7.52	—/8.41	7.82/8.06	8.06/8.21	7.97/8.08
Jun	7.37/8.04	7.39/8.01	7.90/8.13	7.48/7.55	—/—	7.71/8.10	8.07/8.34	7.99/8.19
Jul	7.24/7.66	7.99/7.55	7.93/8.02	7.39/7.53	—/8.30	7.59/7.84	7.47/8.09	7.56/8.01
Aug	6.89/7.31	7.88/7.38	7.17/7.76	7.37/7.60	—/8.03	7.33/7.71	7.52/7.96	7.40/7.77
Sep	7.16/7.77	8.04/7.64	7.18/7.92	7.32/7.54	—/—	7.35/7.76	--/7.82	7.40/7.90
WY Avg [b]	**7.47/7.76**	**7.69/7.90**	**7.80/7.88**	**7.50/7.67**	**8.12/8.11**	**7.70/7.75**	**7.89/8.04**	**7.85/8.03**

a) All values are unit-less; WY14/WY15 values less than 11-Yr norms are shown in red.
b) Water Year 2014/2015 values are based on averaging of monthly data (Oct-Sept).
c) Forester Creek discharges within the Lower Santee Basin reach just upstream of Carlton Oaks Golf course.

Table G.4(W) West Section Dissolved Oxygen (WY14/WY15 Data)

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	4.74/3.23	3.73/1.29	6.99/0.41	2.15/0.09	4.55/2.29	1.50/0.81	4.77/2.79
Nov	3.71/3.55	4.43/2.57	2.18/0.10	0.55/0.08	2.58/2.88	2.13/0.33	3.88/4.45
Dec	6.86/6.23	5.97/4.30	4.14/3.32	3.40/4.35	5.96/4.06	5.04/3.19	6.07/5.98
Jan	6.90/6.28	5.80/5.51	5.17/4.36	4.42/4.99	5.98/5.20	4.59/3.61	4.79/6.31
Feb	4.27/5.44	3.55/5.00	3.18/3.29	2.73/3.29	3.65/4.80	2.82/0.71	2.90/3.13
Mar	2.91/5.26	3.29/4.33	0.84/2.32	2.06/3.14	3.02/2.99	2.42/1.19	3.50/3.17
Apr	5.79/6.62	2.92/3.36	0.88/2.46	1.69/4.97	3.44/3.19	1.25/1.45	3.79/3.72
May	4.63/4.73	0.98/6.87	0.76/5.78	3.61/6.11	2.96/6.84	1.73/5.41	5.39/11.14
Jun	7.46/6.82	0.80/1.70	1.43/3.27	5.07/6.51	2.20/1.02	2.69/3.71	6.03/6.05
Jul	6.34/1.85	0.26/1.74	0.34/1.64	1.04/1.37	1.99/1.60	0.52/0.13	2.19/4.12
Aug	9.64/4.25	0.33/0.64	0.09/1.23	2.74/1.01	1.70/0.47	0.73/0.33	4.04/2.19
Sep	0.58/2.13	0.11/1.70	1.10/0.18	0.06/0.91	1.15/0.44	0.26/0.25	2.51/1.22
WY Avg [b]	**5.32/4.70**	**2.68/3.25**	**2.26/2.36**	**2.46/3.07**	**3.26/2.98**	**2.14/1.76**	**4.16/4.52**

a) All values expressed in milligrams/liter; WY14/WY15 values less than 4 mg/L shown in red.

Table G.4(E) Middle and East Section Dissolved Oxygen (WY14/WY15 Data)

Site	8	9T	10	11	12T	13	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	5.45/4.72	7.31/8.05	7.19/0.07	3.59/2.89	5.85/3.37	0.91/3.06	3.16/—	3.87/1.86
Nov	8.41/3.87	9.88/9.77	9.96/8.68	5.92/6.36	8.70/5.81	0.41/0.14	1.69/4.23	4.96/6.00
Dec	10.2/9.83	9.49/10.58	7.84/7.73	6.75/6.50	9.32/10.58	1.14/0.33	4.51/2.58	8.05/9.59
Jan	9.93/10.17	11.62/11.03	12.16/9.30	8.59/7.67	6.31/9,08	3.15/1.45	4.55/4.04	6.99/13.04
Feb	6.00/7.32	7.07/9.20	7.31/7.66	5.28/5.97	—/9.12	1.93/2.52	2.75/1.87	4.27/11.56
Mar	6.76/7.32	9.13/9.04	7.84/7.83	5.73/5.46	7.17/7.62	2.51/1.04	1.45/2.03	3.81/9.48
Apr	5.73/6.98	8.32/11.72	6.73/8.43	5.10/5.75	5.14/—	1.25/2.80	1.89/3.20	3.31/11.40

Site	8	9T	10	11	12T	13	14	15T
May	3.46/11.24	11.23/8.96	10.24/9.21	5.75/11.39	—/10.93	2.96/2.15	2.06/2.44	6.95/6.01
Jun	0.80/6.41	6.61/13.55	7.47/8.19	4.13/7.54	—/—	2.04/3.24	2.22/2.50	8.12/9.44
Jul	1.00/2.13	6.48/8.15	5.54/5.33	3.28/3.31	—/6.56	1.60/1.60	1.22/3.15	1.70/8.72
Aug	1.26/0.36	6.90/8.46	0.48/5.08	3.06/3.43	—/8.20	0.23/1.16	2.90/3.24	3.22/9.42
Sep	1.07/5.68	7.64/8.15	1.93/7.14	2.38/7.49	—/—	3.42/0.33	—/1.77	1.40/9.52
WY Avg [b]	**5.00/6.34**	**8.47/9.72**	**7.06/7.06**	**4.96/6.15**	**7.08/7.92**	**1.80/1.65**	**2.58/2.82**	**4.72/8.84**

a) All values expressed in milligrams/liter; WY14/WY15 values less than 4 mg/L are expressed in red.
b) WY14/15 values are based on averaging of monthly data (Oct-Sept).
c) Tributary discharges within the Lower Santee Basin reach enter at west end of Carlton Oaks Golf Course.

Table G.5(W) West Section DO Percent Saturation (WY15/WY14 Data & 11-yr Norms)

Site #	1	2	3	4	5	6	7
Reach	Lower Mission Valley				Upper Mission Valley		
Oct	38/53 (48)	15/41 (33)	5/76 (40)	1/24 (53)	24/48 (49)	9/16 (22)	31/51 (42)
Nov	37/39 (59)	26/46 (61)	1/22 (50)	1/6 (63)	28/26 (51)	3/21 (33)	44/39 (55)
Dec	62/64 (66)	43/56 (61)	33/39(62)	43/32 (71)	39/55 (56)	31/47 (50)	58/56 (66)
Jan	61/64 (80)	54/54 (75)	42/48(80)	48/41 (86)	49/53 (71)	35/42 (72)	60/43 (77)
Feb	58/42 (69)	53/35 (65)	35/31(68)	35/27 (80)	48/35 (69)	7/28/(64)	33/29 (68)
Mar	59/31 (70)	48/35 (63)	26/9 (66)	35/23 (79)	32/32 (63)	13/26 (58)	35/38 (68)
Apr	76/65 (71)	38/32 (56)	28/10(58)	58/19 (77)	33/37 (53)	16/14/51)	40/42 (62)
May	50/54 (58)	73/11 (41)	62/8 (43)	67/41 (67)	73/32 (44)	58/19 (37)	118/62(53)
Jun	82/93 (70)	20/9 (34)	39/16(37)	79/60 (64)	11/24 (39)	43/30 (33)	71/72 (39)
Jul	22/78 (63)	20/3 (27)	19/4 (32)	16/13 (53)	19/22 (40)	2/6 (19)	50/26 (31)
Aug	52/122(79)	8/4 (24)	15/1 (31)	12/34 (65)	5/19 (37)	4/8 (20)	26/50 (34)
Sep	26/7 (56)	21/1 (30)	2/1 (28)	11/1 (56)	5/13 (40)	3/3 (16)	15/31 (29)
WY Avg [b]	**52/59 (66)**	**35/27 (47)**	**26/23 (49)**	**34/26 (68)**	**31/33 (51)**	**19/22 (40)**	**49/45 (52)**

a) All values expressed in percent; WY15/WY14 values less than 11-yr Norms (in parentheses) are expressed in red.
b) Water Year values are based on averaging of monthly data (Oct- Sept).

Table G.5(E) Middle and East Section DO Percent Saturation (WY15/WY14 & 11-Yr Norms)

Site	8	9T	10	11	12T	13	14	15T
Reach	Mission Gorge			Lower Santee Basin		Upper Santee Basin		LSB [c]
Oct	56/53	69/87	72/1	36/32	62/41	10/35	32/—	39/21
Nov	85/40	99/99	99/85	60/65	91/62	4/1	17/42	50/62
Dec	94/94	85/98	73/74	63/63	88/109	11/3	42/25	74/90
Jan	88/94	100/97	107/86	78/72	56/93	29/14	41/38	64/133
Feb	59/75	66/91	72/79	51/62	—/86	19/26	27/19	42/124
Mar	70/78	90/91	82/84	59/57	80/94	27/11	15/22	40/103
Apr	61/73	85/111	73/90	53/58	55/—	13/30	21/32	36/126
May	38/120	118/91	114/99	61/121	—/129	33/23	23/27	77/64
Jun	9/73	69/143	87/96	44/83	—/—	25/38	24/27	94/112
Jul	12/25	71/91	67/64	37/37	—/84	19/19	14/34	20/109
Aug	15/4	78/96	6/62	35/39	—/104	3/14	33/36	39/119
Sep	13/67	88/89	23/84	28/86	—/—	42/4	—/21	17/119
WY Avg [b]	**50/66(79)**	**85/99(91)**	**73/75(76)**	**50/65(61)**	**72/89(71)**	**20/18(35)**	**26/29(33)**	**49/98(73)**

a) All values expressed as percent; WY15/WY14 values less than 40% of Sat. are shown in red.
b) Water Year 2014/2015 values are based on averaging of monthly (Oct-Sept) data.
c) Tributary discharges within the Lower Santee Basin enter SDR at west end of Carlton Oaks golf course.

Appendix H - WY15 LSDR WQM Data by Others

U.S. Geological Survey (USGS) stream flow 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 revision. Processing and review of the 2012 data is typically completed in December 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 Stream Flow Data (WY15/WY14 Values)

	Fashion Valley (Sta. 11023000)				Santee Basin (Sta. 11022480)			
Month	Min.	Max.	ADF_3 [a]	ADFm [b]	Min.	Max.	ADF_3 [a]	ADFm [b]
Oct	0.6/0.8	1.2/5.5	0.6/2.1	0.7/2.5	0.1/1.1	0.6/30	0.2/1.3	0.2/4.1
Nov	1.5/0.8	28/5.0	4.3/1.2	4.2/2.2	0.9/0.9	34/16	5.0/1.1	3.3/3.2
Dec	1.6/1.4	360/35	34.7/26.7	56.4/6.9	1.7/3.3	126/47	18.3/23.0	26.6/6.9
Jan	8.4/1.9	55/6.4	14.0/2.7	16.4/3.3	5.3/2.7	53/6.8	9.5/2.8	9.3/3.5
Feb	5.9/2.1	29/85	10.5/4.2	9.6/8.6	2.8/2.7	44/108	2.9/3.3	5.6/9.0
Mar	4.9/7.7	156/315	6.9/8.5	21.2/34.9	2.6/6.3	138/135	5.0/8.9	13.0/15.7
Apr	3.1/3.0	4.7/22	3.4/3.7	3.6/8.1	1.1/2.3	5.1/29	1.4/4.1	1.9/5.8
May	3.3/1.1	242/4.2	57.7/1.3	23.6/1.7	0.6/0.7	105/2.2	6.3/1.4	9.9/1.5
Jun	2.1/0.7	5.6/1.3	2.4/0.8	3.1/1.0	1.0/0.4	4.9/1.1	1.6/0.8	2.1/0.7
Jul	1.7/0.6	309/1.1	174.6/0.7	29.7/0.7	0.7/0.2	95/8.3	0.8/0.4	8.2/0.7
Aug	1.8/0.5	4.6/1.0	2.1/0.6	2.7/0.7	0.4/0.1	1.6/16	0.7/0.4	0.8/0.9
Sep	1.0/0.5	154/36	10.8/2.5	10.8/2.8	0.4/0.04	70/1.3	7.1/1.1	4.3/0.2
WY Avg.			**26.8/4.6**	**15.2 /6.1**			**4.9 /4.0**	**7.1/4.3**

a) Average daily flow over the antecedent 3-day period of water quality monitoring.
b) Average daily flow for entire month (30 days).
c) WY15 streamflow values lower (less) than WY14 results in red; above (greater than) in blue.

Average daily flow in WY15 was up 65% (2.8 cfs) in the eastern portion of the lower river and 150% (9.1 cfs) in the western portion from last year's (WY14) averages. LSDR discharge in WY15 amounted to 11,000 AF compared to 3,800 AF for WY14 and 26,000 AFY on average over the past 52 years of record. Average annual streamflow for WY15 amounted to 42% of the 52-year mean flow for LSDR. The summer season (June-Sept) of WY15 represented one of the highest periods of dry weather flow recorded at Fashion Valley due to periodic summer storm events. WY15 monthly ADFs were approximately double WY14 values in both the eastern and western sections.

San Diego CoastKeeper (SDCK) coliform count values (in MPN/100 mL) from the organization's two San Diego River monitoring stations for WY15 and WY14 are presented in **Table H.2**. Monitoring results from 2009 through 2011 for selected San Diego area watersheds, including the lower San Diego River (HSU 907.1), 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 (WY15/WY14 Values)

	Fashion Valley Road (SDG-010)			Old Mission Historical Dam (SDG-020)		
Month	EColi [a]	Enterocc [b]	TCB [c]	EColi [a]	Enterocc [b]	TCB [c]
Oct	213/-	108/280	1,423/3,080	10/620	132/100	301/11,200
Nov	1,236/40	345/80	19,863/13,800	98/40	52/100	3,076/2,600
Dec	6,488/30	9,208/70	24,192/1,050	4,352/50	6,488/30	24,192/1,370
Jan	4,350/-	2,750/70	120,331/-	-/50	-/40	-/620
Feb	20/30	63/20	3,130/-	31/-	63/-	836/-
Mar	41/10	41/120	867/1,515	31/20	63/50	836/790
Apr	253/20	52/-	1,515/3,448	20/100	74/-	657/910
May	1,850/98	2,909/41	3,448/24,192	1,130/10	3,076/60	24,192/5,170
June	134/190	160/150	3,654/3,654	20/10	31/10	2,142/1,060
July	-/-	-/-	-/-	-/-	-/-	-/-
Aug	63/-	20/-	2,014/-	20/-	10/-	1067/-
Sept	318/30	805/120	9,804/540	-/10	-/10	-/2310
WY Avg.	**1,361/56**	**1,496/84**	**17,295/1,159**	**537/37**	**915/36**	**5,503/3,072**
GMCC [d]	**343/80**	**283/140**	**1,205/2,170**	**68/55**	**116/80**	**1,755/2,360**
Summer	110/35	135/50	1,220/1,640	10/10	10/20	1,685/640
Winter	25/160	85/310	1,160/2,670	52/190	55/220	1,258/6,290

a) Escherichia-coli (E.coli) bacteria expressed in MPN/100mL
b) Enterococcus (faecalis) bacteria expressed in MPN/100mL
c) Total Coliform bacteria (common) expressed in MPN/100mL.
d) GeoMean coliform counts for WY15/WY14 calculated by SDRPF RiverWatch for comparative purposes only; values are neither endorsed nor validated by the San Diego CoastKeeper organization.
e) WY15 values greater than WY14 counts are shown in red; less in blue.

Appendix I - Water Quality Indexing

Decision-makers, non-technical water managers, numerous vested watershed stakeholders as well as the general public usually have neither time nor training to study and understand detailed technical assessments of water quality data. Over the last several decades numerous indexes have been developed to summarize water quality data in an easily expressed and readily understood format. Water quality professionals are often resistant to any automated, uncritical summarization represented by such indexes; there are sound reasons to use results with caution. Often scientists and water resource professionals prefer to provide no answer rather than an imperfect answer that can lead to misunderstanding. Layman and many decision makers, however, prefer an imperfect answer to no answer at all. Using an index may not be the optimal way to fully understand large-scale water quality issues, but it does provide a reasonable tool for gaining insight. Professionals can appreciate the need for imperfect answers and conversely others need to recognize and accept an answer's limitations.

Water quality indexing was first proposed and demonstrated in the 1970s, however, prior to the personal computer, calculations were fairly labor-intensive so the technique was not widely used or accepted by many monitoring agencies. As use and limitations were commonly misunderstood, the potential of using an index for communicating water quality status and trends was often overlooked. Evaluation of water quality in terms of raw data can be very misleading and confusing not only for the layman but also to stakeholders with diverse and sometimes conflicting perspectives. It is typically difficult for individuals interested in water quality to interpret reams of raw data in order to gain an understanding of water quality conditions. This quest often results in faulty conclusions regarding water quality status and watershed management practices. An index is simply an attempt to integrate complex analytical data and generate a single number expressing the relative degree of impairment of a water body at a given point in time or given locale. The underlying objective of the exercise is to enhance communications with the general public, interested stakeholders, public agencies and increase citizen awareness of water quality conditions.

By design indexes contain less information than the raw data they summarize; many uses of water quality data cannot be met with an index. An index is generally most useful for comparative purposes (e.g., what river sites or reaches have particularly poor water quality?) and for temporal questions (e.g., how is the water quality at present relative to what is has been in the past?). Indexes are less suited to specific questions. Site-specific decisions need to be based on analysis of original water quality data. Basically, an index can be a useful tool for "communicating water quality information to the lay public and to legislative decision makers," it is not, however "a complex predictive model for technical and scientific application". This index was developed as a mechanism to summarize and report routine monitoring data to interested parties. SDRPF's RiverWatch team does not monitor biological constituents or toxic substances, thus issues related to public health, body contact recreation and aquatic life are not effectively addressed by the index.

Besides being general in nature (i.e., imprecise), there are several reasons that an index may fail to accurately communicate water quality information. First, most indexes are based on pre-identified sets of water quality constituents. For example, a specific site may show a good WQI score, and yet have water quality impaired by other constituents not included in the index. Another reason, data aggregation can mask, normalize or over-emphasize short-term water quality issues. A satisfactory WQI at a particular site or reach does not necessarily mean that water quality is or always was satisfactory. A good score, however, does at least indicate that inferior water quality for those constituents evaluated is not chronic during the period included for the index.

The 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 other monitoring groups; it is intended to aid in assessment of the Lower San Diego River watershed primarily for non-body contact recreational uses and environmental enhancement. It 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 anyone to easily interpret large amounts of aggregated data and relate overall water quality variation to changes, be they from natural causes or man-made impairments. The WQI is used to identify general water quality trends over the past 8 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 the many San Diego River water quality improvement programs and also assist responsible agencies and organizations in establishing priorities for watershed management.

Running average LSDR WQI values from WY05 through WY15 are expressed by river reach and river section on **Charts I.1 and I.2**, respectively. **Chart I.1** also presents overall LSDR monthly WQI values over the 10-year period. Both seasonal patterns and trends in WQI values can be seen. **Chart I.2** provides the range (max-min) in monthly WQI values as well as average monthly streamflow. The water quality fluctuations over time in individual reaches, sections and the overall (average) Lower San Diego River expressed on both a running average basis and the annual cycle can be observed. The Upper Santee Basin reach (Sites 13&14) presents lowest index values since March of 2010, whereas the Mission Gorge (middle section) reach consistently shows highest values. There was a general decline in overall water quality of the river, as evidenced by the WQI values, from November of 2011 through early 2015. The running (12-mo) average index value fell by 19 units (47.5%) from high of 40 (15% above the 11-yr norm of 35) over a two year period. The current (Sept. 2015) running average WQI of 29 is 16% below the 11-yr norm and trending upward.

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 each river reach and the overall LSDR average. These variances are compared to changes in streamflow on the same basis. The positive correlations are evident, i.e., increase in average daily flow results in improved water quality. Low flow throughout the summer period results in poorest water quality. This summer's elevated dry-weather flows (due to occurrence of several unseasonal storm events) resulted in improved overall water quality compared to last year.

Chart I.4 provides a spatial profile of average annual WQI by river monitoring site, reach and section for this year (WY15), last (WY14) and the 11-Yr winter, summer and annual averages. The sites are in chronological order ascending upstream. The current (WY15) average annual WQI values shown in black are measurably greater than those from last year (WY14) shown in red at all monitoring sites. The WQI values for WY15 however remain below the 11-Yr averages (yellow bars) at all but two (7&12T) monitoring sites. For the third consecutive year, Site 13 (Mast Park) has demonstrated lowest water quality values. The Mission Gorge reach (sites 8, 9T and 10) continues to present the best overall water quality.

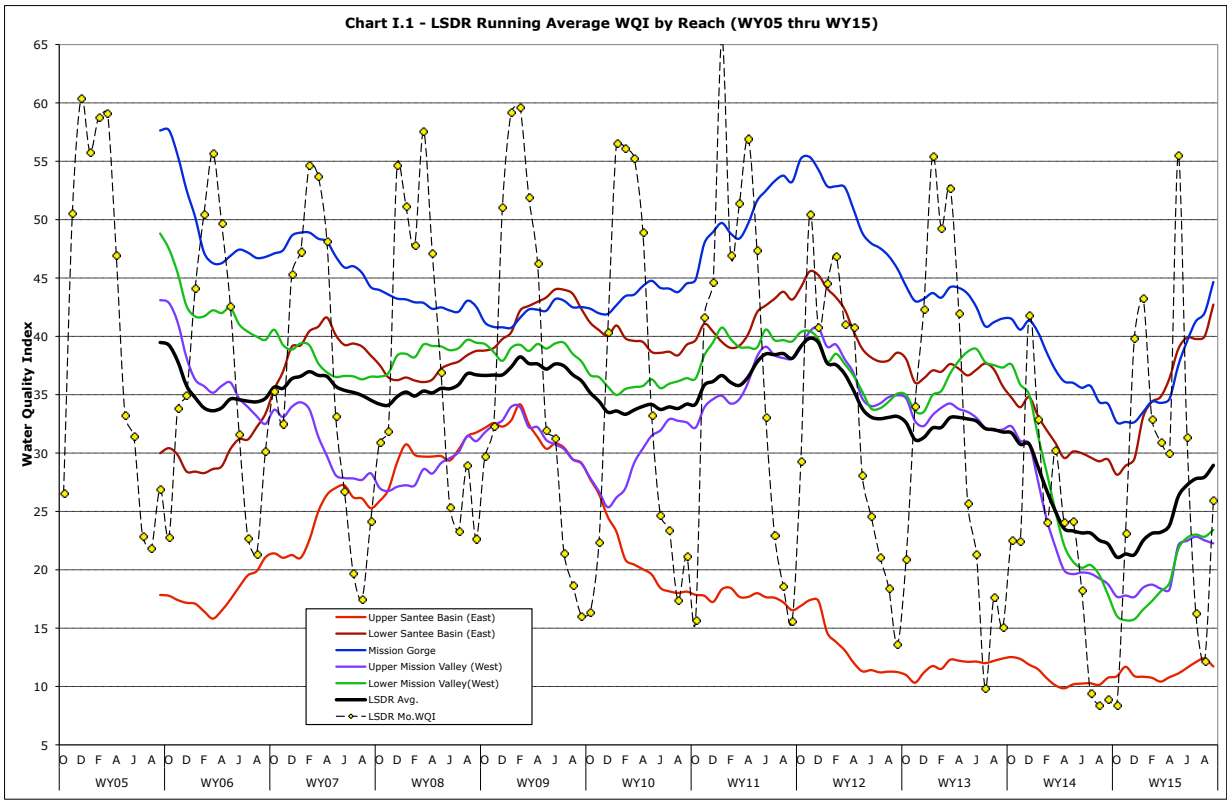


Chart I.1 - LSDR Running Average WQI by Reach (WY05 thru WY15)
Water Quality Index
Upper Santee Basin (East)
Lower Santee Basin (East)
Mission Gorge
Upper Mission Valley (West)
Lower Mission Valley(West)
LSDR Avg.
LSDR Mo.WQI
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15

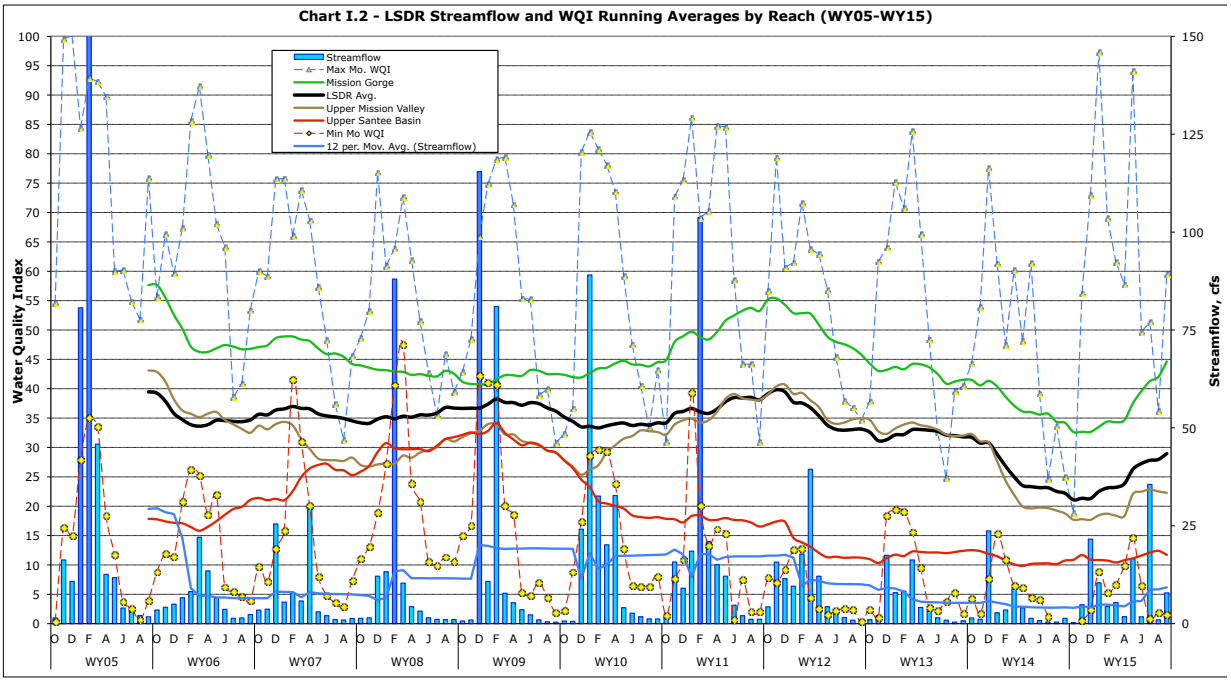


Chart I.2 - LSDR Streamflow and WQI Running Averages by Reach (WY05-WY15)
Streamflow
Max Mo. WQI
Mission Gorge
LSDR Avg.
Upper Mission Valley
Upper Santee Basin
Min Mo WQI
12 per. Mov. Avg. (Streamflow)
Water Quality Index
Streamflow, cfs
WY05
WY06
WY07
WY08
WY09
WY10
WY11
WY12
WY13
WY14
WY15

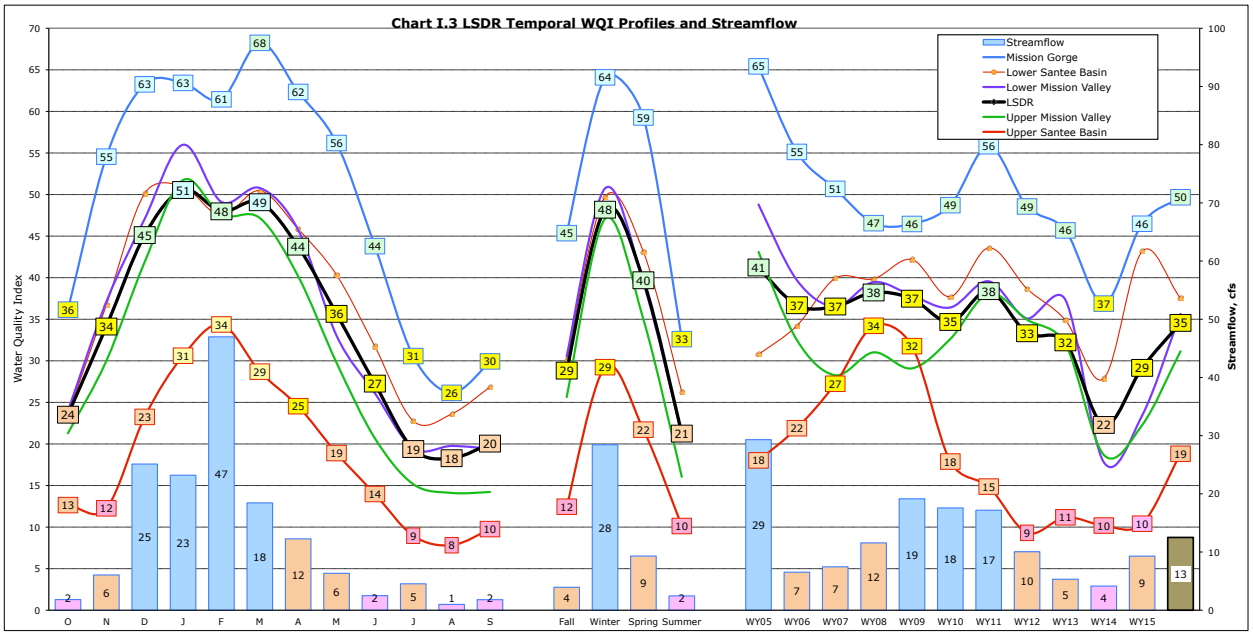


Chart I.3 LSDR Temporal WQI Profiles and Streamflow
Water Quality Index
Streamflow, cfs
Streamflow
Mission Gorge
Lower Santee Basin
Lower Mission Valley
LSDR
Upper Mission Valley
Upper Santee Basin
O N D J F M A M J J A S
Fall Winter Spring Summer
WY05 WY06 WY07 WY08 WY09 WY10 WY11 WY12 WY13 WY14 WY15

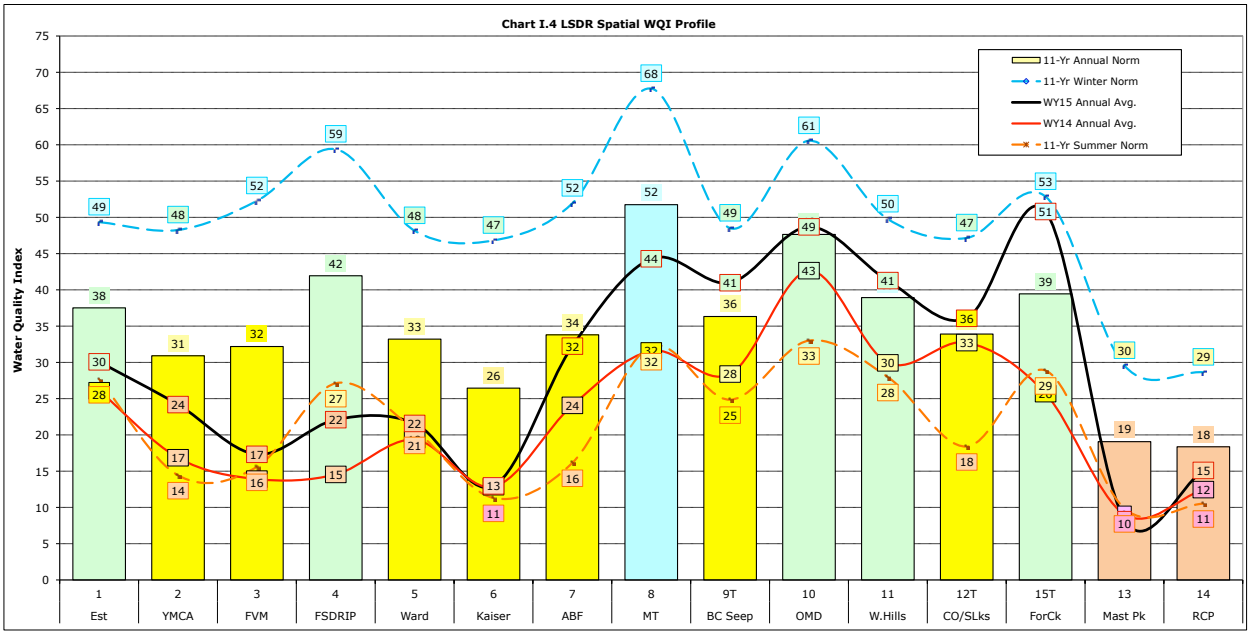


Chart I.4 LSDR Spatial WQI Profile
Water Quality Index
11-Yr Annual Norm
11-Yr Winter Norm
WY15 Annual Avg.
WY14 Annual Avg.
11-Yr Summer Norm
1 Est
2 YMCA
3 FVM
4 FSDRIP
5 Ward
6 Kaiser
7 ABF
8 MT
9T BC Seep
10 OMD
11 W.Hills
12T CO/SLks
15T ForCk
13 Mast Pk
14 RCP