

## LOWER SAN DIEGO RIVER WATER QUALITY 2014

### WY14 Water Quality Monitoring Report



*RiverWatch Water Quality Monitoring Results (October 2013 - September 2014)*

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# Lower San Diego River Water Quality - 2014

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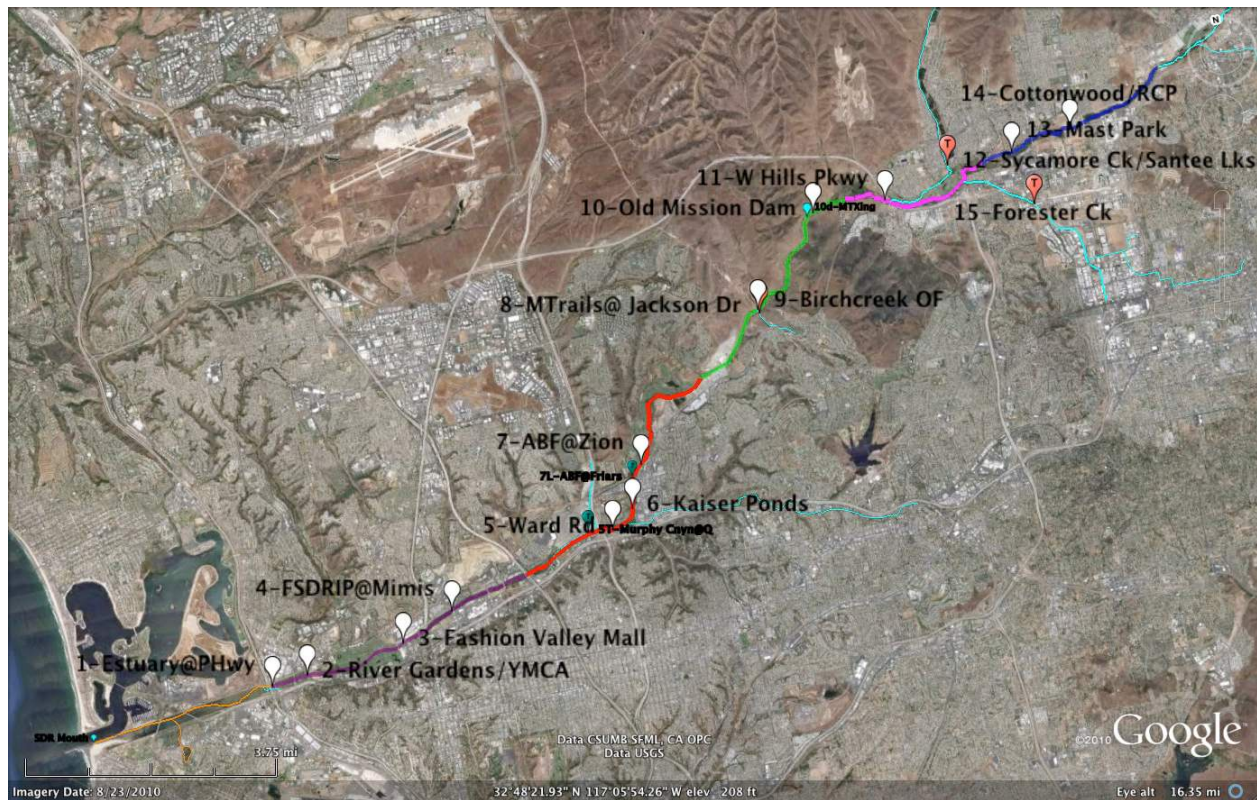
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Questions regarding the San Diego River WQM database or interpretation of results expressed in this report can be directed to the attention of John C. Kennedy, through contacting SDRPF at [info@SanDiegoRiver.org](mailto:info@SanDiegoRiver.org), or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



## Section 1 - Introduction

This report provides a summary of patterns and trends in water quality monitoring results gathered by SDRPF's RiverWatch citizen volunteers. WQM data collected monthly over the past 10 years at 15 sites within the Lower San Diego River (LSDR) watershed have been aggregated, in conjunction with hydrologic data on stream flow to create a numeric water quality index (WQI). Basic monthly data regarding individual water quality parameters and river hydrology for each of the sites monitored are maintained in an excel database file available at the SDRPF offices; this report examines Water Year 2014 (WY14) data in comparison to previous year's results. The LSDR watershed and water quality monitoring site locations are shown on **Figure 1-1**.



**Figure 1-1 LSDR Watershed and Water Quality Monitoring Sites**

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

Figure 1-1 can be viewed in greater detail through Google Earth by accessing file "Fig1.1WQMR.kmz" from the SDRPF website/River Monitoring page at: <http://www.sandiegoriver.org/riverwatch.php>. The RiverWatch monthly water quality monitoring data at each site, as well as associated WQI values, are also provided at: <http://www.ecolayers.biz/sdrpf%20riverwatch/> through clicking on access to 'Web-based Information Center' on the RiverWatch webpage. In addition to water quality monitoring data, the portal also contains: River Blitz data, SDR Conservancy Project information, SD StreamTeam Bio-assessment data, 401 Project information and USGS realtime streamflow data on daily peak discharge and gauge height for two San Diego River stations (Fashion Valley & Mast Bridge in Santee).

The SDRPF RiverWatch water quality index (WQI) represents the monitoring team's response to questions and concerns regarding overall health of the Lower San Diego River. The index is a numeric (0-100) where increasing values signify better water quality. The numerical index encapsulates basic physical, chemical and bacteriological water quality data by integrating six parameters: temperature (Temp), pH, specific conductivity (SpC), dissolved oxygen (DO and/or %DOSat), mean coliform count (MCC) and streamflow (Q); by determination of weighted factors for each. The resulting values are aggregated to arrive at an overall score for each site, reach, section and the river (LSDR) as a whole. The index values, grade, color codes and general conventions employed are presented in **Table 1.1**.

**Table 1.1 LSDR Water Quality Index**

SDR WQI (0-100)	Grade	Color Code	Percentile Range	Water Quality Threshold	General
75 or >	A - Very Good	Dark Blue	25%	Well Above Acceptable WQ Criteria	Healthy (>50)
50 - 74	B - Good	Light Blue	25%	Exceeds Acceptable WQ Criteria	
38 - 49	C - Fair	Green	12.5%	Meets Many WQ Criteria	Impaired/Ailing (25-50)
25 - 37	D - Marginal	Yellow	12.5%	Meets Limited Minimum WQ Criteria	
13 - 24	E - Poor	Brown	12.5%	Meets Few Minimum WQ Criteria	Unhealthy (< 25)
0 - 12	F - Very Poor	Red	12.5%	Well Below Minimum WQ Criteria	

In general, sites with WQI values of 50 or above exceed expectations for acceptable water quality and are indicative of 'Healthy' conditions. Scores between 25 and 49 describe 'Impaired or Ailing' quality levels where evidence exists regarding failure to meet acceptable water quality criteria at all times. Water quality with scores of less than 25 do not meet minimum expectations and are considered 'Unhealthy or harmful to life forms'. For WQ parameters monitored by RiverWatch, the index expresses results relative to levels necessary to sustain designated beneficial water uses based on State of California Water Quality Standards. Where criteria are non-specific, results are expressed relative to southern California freshwater coastal area norms. The index can not be applied to estuaries and ocean waters.

Index values have been computed using two formulas; one involving four key parameters (Temp, SpC and DO) monitored by RiverWatch combined with streamflow (Q), the second with two additional parameters (pH and MCC) combined with streamflow. The equations used for both formulas (WQI<sub>4</sub> and WQI<sub>6</sub>) are presented in Appendix B. Differences between the two determinations are found to be small. The initial determination (WQI<sub>4</sub>) typically presents a broader range (from low to high value) than the second as the 'normalizing' effect of pH and MCC (both of which present less spatial and temporal variance) are not included. The broader range WQI<sub>4</sub> values are expressed in this report.

The index was developed specifically for the San Diego RiverWatch program, however, it can also be applied to other southern California coastal area watercourses where comparable water quality metrics are monitored on a regular and consistent basis. A separate report comparing relative water qualities in three San Diego County watercourses; Los Penasquitos Creek below Poway, the Santa Margarita River below Temecula and near Fallbrook, and the Lower San Diego River below Santee and in Mission Valley is currently being prepared by the RiverWatch program.

## Section 2 - Spatial Water Quality Data Comparison WY14 and 10-Yr Averages

Annual average water quality values for each of the 15 monitoring sites for WY14 and the 10-Yr norm are presented in **Table 2.1**. Monthly water quality data collected and recorded at each site by RiverWatch used to determine annual averages, seasonal patterns and trend lines are presented in the appendices together with supplemental data collected by other monitoring organizations for streamflow (USGS) and coliform counts (SD CoastKeepers). RiverWatch raw data are also available through the SDRPF web site.

**Table 2.1 Annual WQ Data for WY14 & 10-Yr Norms by Site, Reach and Section**

Site:	LSDR Reach & Section		Temp, oC	SC, mS/cm	pH	DO, mg/L	DO %Sat	Flow, cfs	WQI Value <sup>a</sup> , (Change), & Grade	
1	LMV	West	19.9/19.3	15.62/7.32	7.6/7.7	5.3/6.3	59/68	6/32	26/38 (-12)	D/C
2			18.7/18.8	2.92/2.66	7.5/7.6	2.7/4.9	27/51		17/32 (-15)	E/D
3			18.2/19.0	2.72/2.57	7.5/7.7	2.3/5.2	23/55		14/34 (-20)	E/D+
4			18.8/19.5	2.48/2.48	7.6/7.8	2.5/7.0	26/76		15/44 (-29)	E/C
5	UMV		16.7/17.1	3.04/2.58	7.5/7.6	3.3/5.4	33/55	5/29	19/34 (-15)	E/D+
6			18.0/18.2	2.79/2.37	7.5/7.6	2.1/4.3	22/44		13/28 (-15)	E-/D
7			18.8/17.8	2.42/2.26	7.5/7.5	4.2/5.2	45/53		24/34 (-10)	E+/D
8	MG	Mid	17.2/16.8	2.58/2.27	7.5/7.6	5.0/8.2	50/84	4.5/25	31/52 (-21)	D/B-
9 <sup>b</sup>			15.2/16.1	5.10/5.08	7.7/7.7	8.5/8.8	85/91		28/36 (-8)	D/D+
10			17.8/17.6	2.24/2.22	7.8/7.8	7.1/7.3	73/76	4.3/18	42/47 (-5)	C/C
11	LSB	East	16.6/16.6	2.33/2.21	7.5/7.5	5.0/6.4	50/62		30/39 (-9)	D/C
12 <sup>b</sup>			15.7/17.5	1.70/1.69	8.1/7.8	7.1/6.9	72/69		31/32 (-1)	D/D
15 <sup>b</sup>			18.0/17.7	2.48/2.72	7.9/8.1	4.7/8.0	49/73	2.5/8	26/38 (-12)	D-/C-
13	USB		18.9/18.5	2.22/1.90	7.7/7.6	1.8/3.8	20/38	1.5/5	8/19 (-11)	F/E
14			17.3/17.2	1.75/1.52	7.9/7.8	2.6/3.5	26/34		12/18 (-6)	F+/E
(1-15)	LSDR		17.9/17.8	2.58/2.36	7.6/7.7	4.1/6.0	42/61	5.2/25	22/35 (-13)	E/D+

a) Average annual water quality index value, change (+/-) over last 12 months and resultant WQ letter grade; declines in water quality values from 10Yr norms are expressed in red. All 15 sites showed declines over the past 12 months.

b) Lower San Diego River tributary stream water quality monitoring sites.

Average annual, seasonal and minimum-to-maximum range water quality values for this year (WY14) and the 10-Yr norms are presented in **Table 2.2** by river reach, section and overall. The spatial water quality values listed in Tables 2.1 and 2.2 for the Lower San Diego River system monitoring sites are expressed in subsequent **Charts 2.1** (Water Quality Data) and **2.2** (Water Quality Index and Streamflow). The overall water quality index of 22 (E-Poor) is down 13 points from the 10-Yr norm of 35 (D-Marginal). Index values are also down considerably from last year's averages in three (LSB, MG & UMV) of the five reaches. All three average annual section values are lower than the previous year.

**Table 2.2 Water Quality Data for WY14 & 10-Yr Norms by Season, Reach and Section**

Parameter, units	Temp, oC	SC, mS/cm	pH	DO, mg/L	DO %Sat	Flow, cfs	WQI Value, <sup>a</sup> (Change), & Grade	
Maximum Month	23.1/25.3	3.15/3.56	7.8/8.3	6.9/10.6	62/98	25/71	42/65(-23)	C/B
Winter (D,J,F,M)	14.5/14.2	2.24/1.73	8.0/7.7	5.3/7.3	50/69	11/58	32/49(-17)	D/C+
<b>Avg. Annual</b>	<b>17.9/17.8</b>	<b>2.58/2.36</b>	<b>7.6/7.7</b>	<b>4.1/6.0</b>	<b>42/61</b>	<b>5.2/25</b>	<b>22/35(-13)</b>	<b>E/D</b>
Summer (J,J,A,S)	22.7/22.4	3.02/2.93	7.5/7.7	2.6/4.5	41/51	1.0/1.9	11/21(-10)	F/E
Minimum Month	10.5/9.2	1.64/0.98	7.4/7.0	2.0/2.0	24/24	0.7/1.3	8/8	F/F
<i>LSDR Section Averages:</i>								
East	SB	17.7/17.6	2.20/2.00	7.7/7.7	3.5/5.4	36/52	4.3/18	19/28 (-9) E/D-
Mid	MG	17.1/17.0	2.41/2.25	7.5/7.7	7.2/7.9	73/81	5/25	36/50(-14) D/C+
West	MV	18.5/18.5	2.85/2.59	7.6/7.6	3.2/5.4	34/57	6/32	18/35(-17) E/C-
<i>LSDR Reach Averages:</i>								
USB	East	19.4/18.2	2.08/1.78	7.6/7.7	2.1/3.7	22/37	2/9	10/19 (-9) F/E
LSB		18.2/17.3	2.32/2.23	7.7/7.8	5.1/6.9	52/66	4/18	28/37 (-9) D/C
MG	Mid	18.1/17.1	2.41/2.25	7.5/7.7	7.2/7.9	73/81	5/25	36/50(-14) D/B
UMV	West	18.8/17.8	2.94/2.58	7.6/7.7	3.2/4.9	33/51	5.5/30	17/32(-15) E/C-
LMV		19.9/19.3	2.78/2.60	7.5/7.6	2.5/5.6	26/59	6/32	18/37(-19) E/C-

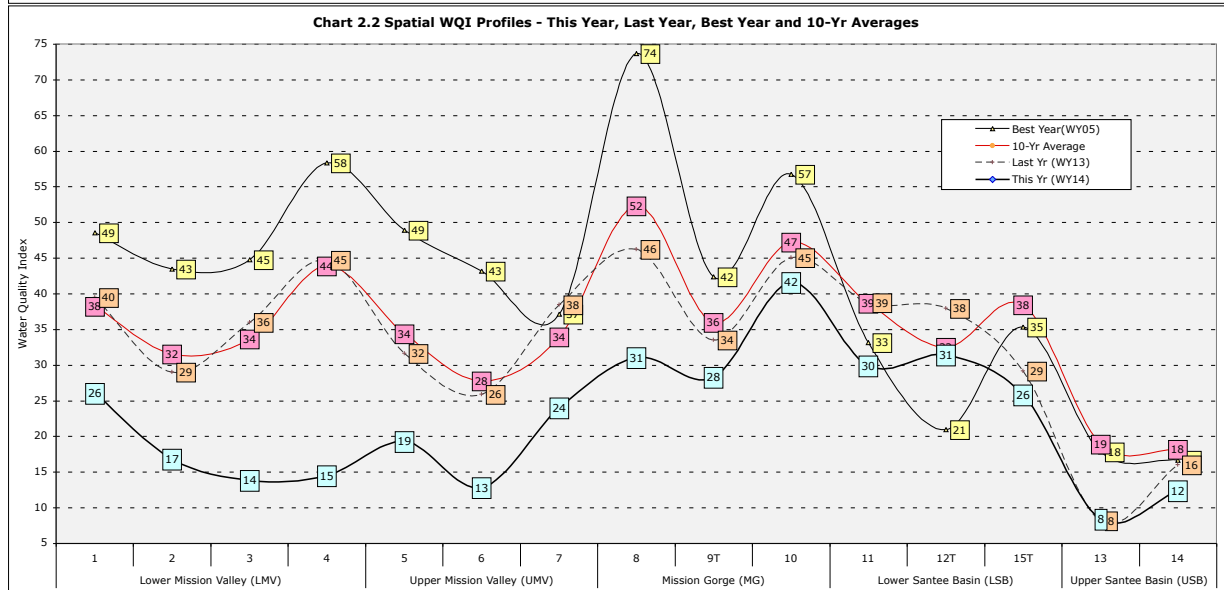
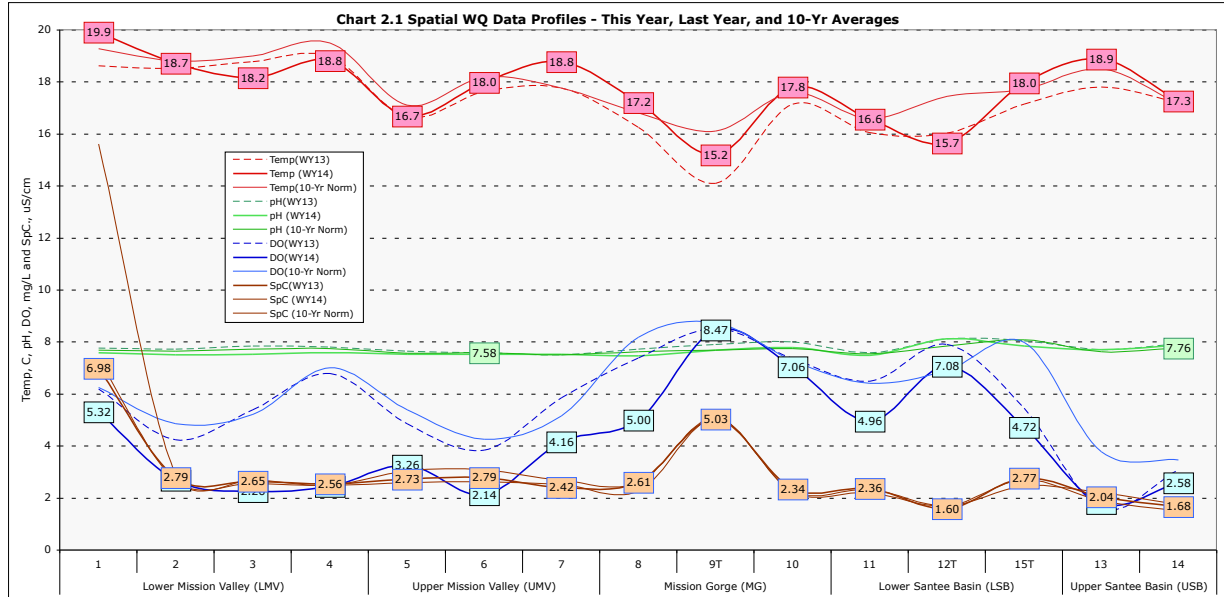
a) Average annual water quality index value, change (+/-) over past 12 months and resultant WQI letter grade. Declines in water quality values from the 10-Yr norms are expressed in red.

**Chart 2.1** presents average annual water quality values for Temp (red), pH (green), DO (black) and SpC (blue) at each monitoring site, river reach and section in order of their location upstream for WY14 (Oct'13-Sept'14), last year (WY13) and the 10-Yr norms. The heavy solid lines with values shown are this year's average annual results, the dashed lines are last year's (WY13) results and the light solid lines represent 10-yr annual norms for each site. Average annual water temperatures for WY14 are higher than last year's values and the norms at about half the sites while pH and SpC values are approximately the same as for WY13 and the 10-Yr norms. DO levels, with exception of several tributary sites (9T and 12T), are significantly lower than last year's results and the norms. Average annual SpC and water temperature values increase from upstream to downstream with exception of tributary sites. DO values show the greatest variation between sites. Lowest values are typically recorded in the Upper Santee Basin (Sites 13 and 14) whereas highest values are observed in the Mission Gorge (middle reach) section. Nearly all sites present DO levels below both the 10-yr norms and last year's results.

The WQI, an aggregate or composite index of water quality monitoring results for WY14, WY13, the 10-Yr norm and the best overall year (WY05) are presented in **Chart 2.2**. The two sites furthest upstream, 13 (Mast Park) and 14 (RCP/Cottonwood), continue to experience Very Poor (grade F) water quality. On an average annual basis, highest values continue to be associated with the Mission Gorge reach (sites 8-10).



The overall WQI profile for WY14 (heavy black line with values in blue) is noticeably lower than last year's averages (dashed black with values in brown) as well as the 10-Yr norms (red) and best year (light black with values in yellow) at all sites with exception of 12T (CarltonOaks Dr./Sycamore Ck) where discharge has not been observed since April of this year. Greatest departures (variance) from the 10-Yr WQI norms for WY14 are found in the Mission Valley portion, especially the lower reach (sites 1-4).



### Section 3 -Temporal Water Quality Data Comparison WY14 and 10-Yr Norms

Monthly and seasonal water quality monitoring data and WQI averages for the Lower San Diego River are presented in **Table 3.1** for WY14 and the 10-Yr norms. All of the last 12 months have shown declines in overall river water quality as expressed by the index. The greatest declines in quality from both last year and the 10-Yr norms occurred during the winter and spring months (Dec-May) of this year.

**Table 3.1 LSDR WQM Data for WY14 and 10-Yr Norms by Month and Season**

		Temp	SC	pH	DO	DO%	Flow	WQI <sup>(a)</sup>	
Month	Season:	oC	mS/cm		mg/L	% Sat	cfs	Value & Grade	
Oct	Fall	16.9/18.4	2.73/2.85	7.3/7.5	4.42/4.64	45/48	3.3/18	22/25	E/D-
Nov		15.2/14.9	2.59/2.58	7.6/7.6	4.53/6.19	45/61	2.7/15	22/35	E/D
Dec	Winter	11.5/11.7	1.74/1.75	7.3/7.6	6.07/7.15	56/65	6.2/66	42/45	C/C
Jan		10.5/11.3	2.54/1.91	7.5/7.6	6.89/8.55	62/77	3.4/60	32/51	D/B-
Feb		14.1/13.3	2.39/1.64	7.8/7.7	4.20/7.62	41/72	8.8/71	24/49	E/C+
Mar		17.5/16.4	1.95/1.67	7.8/7.8	4.14/7.12	43/72	25/39	30/51	D/B-
Apr	Spring	18.5/17.7	2.32/1.95	7.5/7.7	3.68/6.25	39/66	6.9/19	24/45	E/C
May		19.6/20.4	2.63/2.42	7.6/7.5	4.71/5.11	52/56	1.6/7.7	24/33	E/D
June	Summer	21.2/22.1	2.84/2.69	7.8/7.7	4.00/4.62	45/53	0.8/3.1	18/27	E/D
July		22.3/23.0	3.02/2.85	7.6/7.6	2.27/3.88	26/44	0.7/1.8	9/20	F/E
Aug		23.2/23.1	2.94/3.07	7.5/7.8	2.19/4.10	26/47	0.8/1.3	8/19	F/E
Sept		23.9/21.4	3.29/3.15	7.3/7.7	2.04/3.95	24/44	1.5/1.4	9/19	F/E
Seasonal & Annual Averages									
Fall (O&N)		16.1/16.6	2.66/2.72	7.4/7.5	4.09/5.41	4/55	12/17	22/30	E/D
Winter (D,J,F,M)		13.4/13.2	2.15/1.74	7.7/7.7	8.10/7.24	76/68	20/58	32/49	D/C+
Spring (A&M)		19.0/19.1	2.48/2.19	7.6/7.6	5.38/5.17	57/57	5/13	24/39	E/C
Summer (J,J,A,S)		22.7/22.4	3.02/2.94	7.6/7.7	3.50/4.00	40/47	0.4/1.9	11/21	F/E
Annual (O-S)		17.9/17.8	2.58/2.36	7.7/7.6	4.09/5.59	42/61	8/25	22/35	E/D+

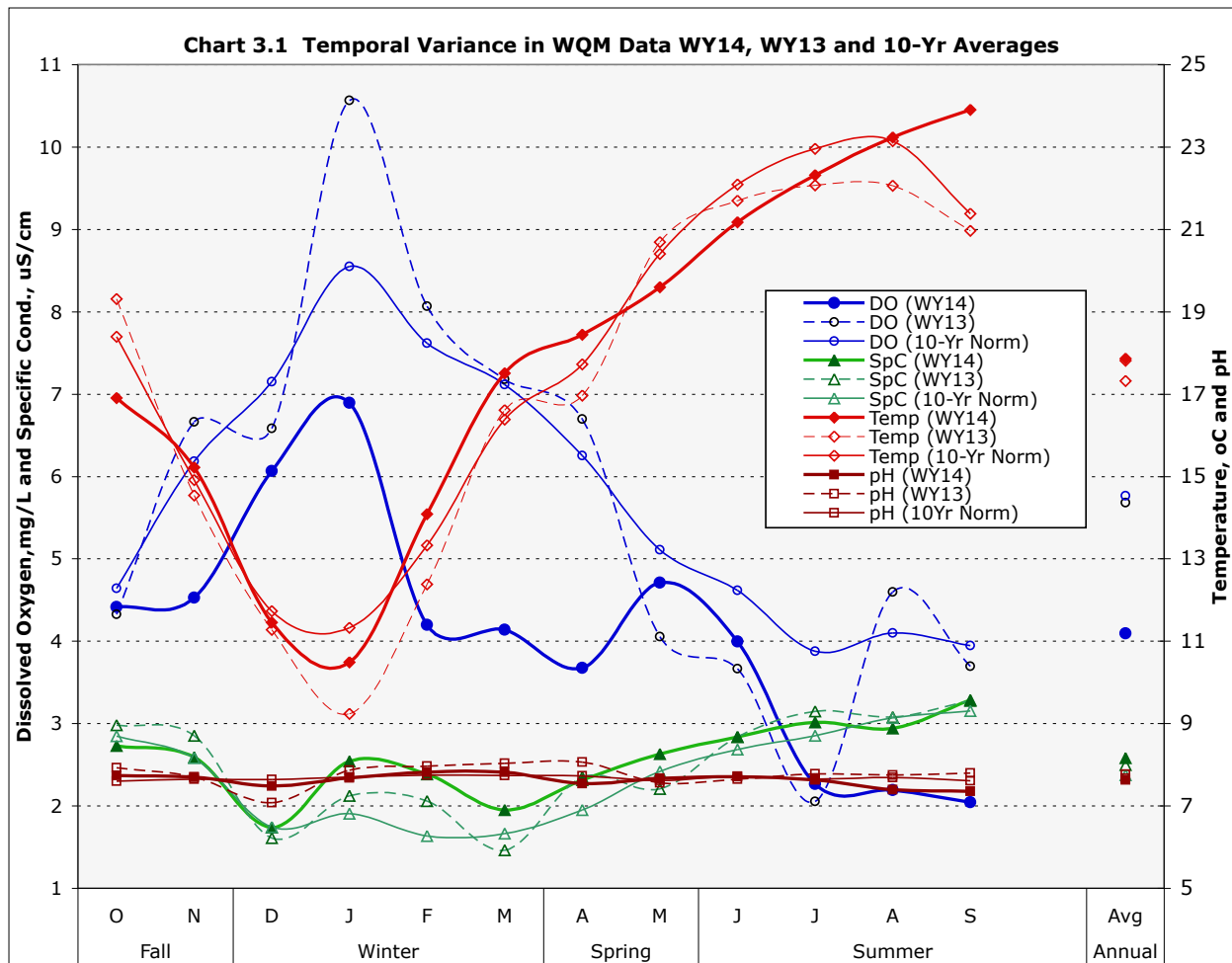
a) Values based on SD RiverWatch physical-chemical parameters (WQI<sub>4</sub>) combined with USGS recorded stream flow for eastern (West Hill Pkwy) and western sections (Fashion Valley). Negative departures in WY14 values and grades from the 10-Yr norms are presented in red.

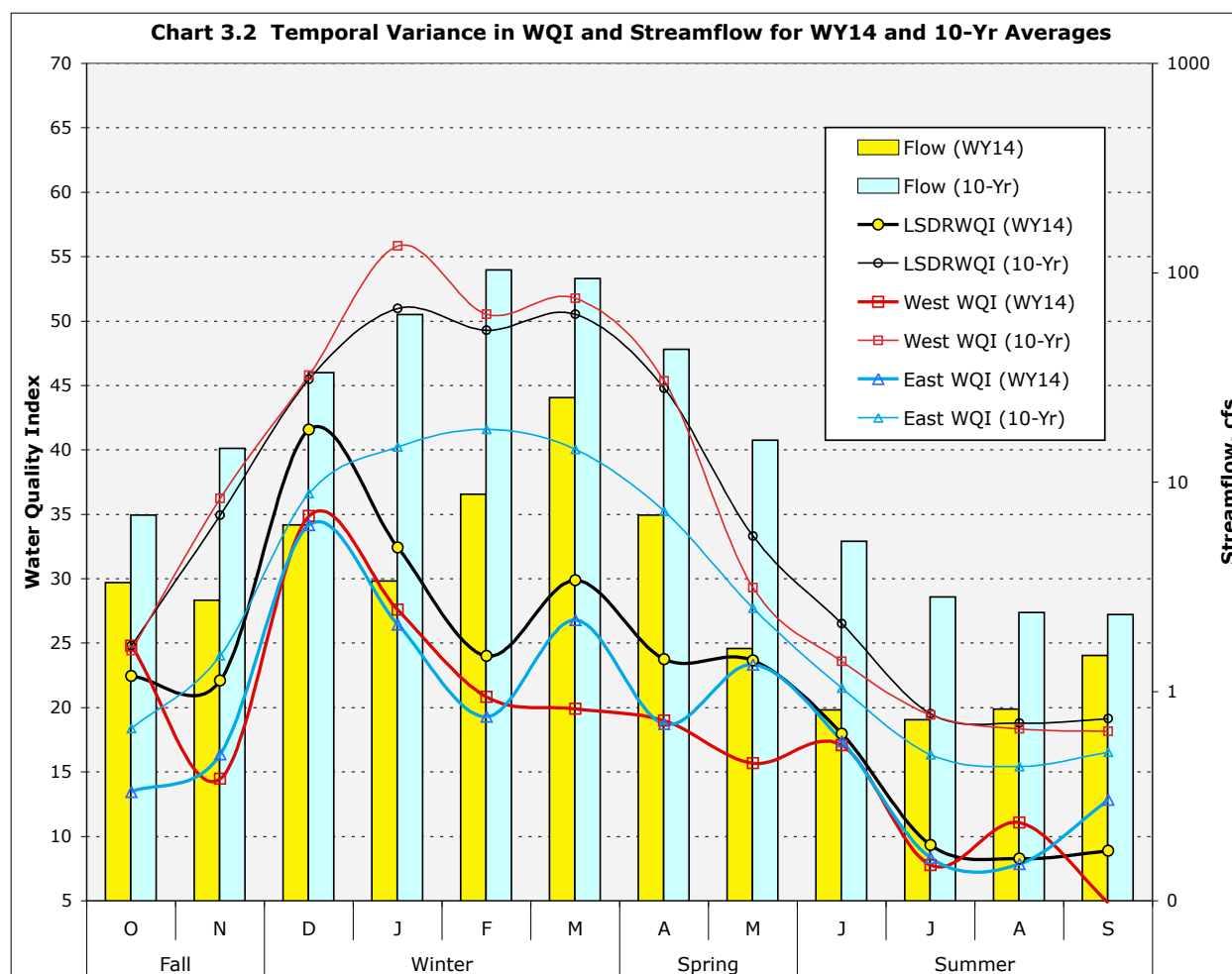
Monthly and seasonal variances in monitoring results for the past two water years and the 10-Yr norms are expressed in Charts 3.1 (WQM Data) and 3.2 (LSDR Water Quality Index and streamflow). The



temporal patterns in the WY14 and WY13 water quality monitoring data for the LSDR system are shown in **Chart 3.1**. Dissolved Oxygen values are highest during the winter months (Dec-March) whereas specific conductivity and water temperatures are greatest during the dry summer months (June-Sept). Mean coliform count (MCC) and pH values exhibit considerably less seasonal fluctuation than the other water quality parameters considered, although slight variances in monthly values do occur. **Chart 3.2** provides an overall perspective of temporal variance in WQI values and streamflow for the average (LSDR), Eastern (Santee Basin) and Western (Mission Valley) sections of the river during WY14 compared to averages over the 10-year period.

As shown in the Section 3 tables and charts, the WQI values for WY14 are considerably less than the 10 year norms the for all months of the water year. The most significant decline in WQI values has occurred during the wet weather period of this past year. Significant depletion in dissolved oxygen levels combined with extremely low flows are the primary drivers in declining index values. In general, water quality for the Lower San Diego River system was highest (C-Good) during the initial winter months with greatest streamflow and lowest (F-Very Poor) during the hottest, minimal flow months of summer. The overall annual average WQI for the LSDR in WY14 of 22 (E-Poor) is down 13 units from the 10-Yr average of 34. The spatial and temporal trends in monitored WQ data and resultant index are presented in the final section 4 of this report.





## Section 4 - Water Quality Trends WY05 through WY14

Annual and seasonal LSDR WQI values are presented in **Table 4.1** (next page) by river reach, section, and overall (LSDR) average for each water year over the last 10 years (WY05-WY14) of RiverWatch monitoring. Trend lines (12-month running averages) that have been calculated for each individual water quality parameter (**Charts 4.1-4.4**) and the resultant water quality index (**Chart 4.5**) are summarized in **Table 4.2**.

Temporal WQ data and trend lines (12 month running averages) are presented by river section and reach in **Charts 4.1-4.4**. Running average water temperatures, plus maximums and minimums for all sites (**Chart 4.1**) have changed little over the 10 year period. With a mean temperature of 18.0°C for the lower segment; the monitoring sites present a repetitive annual cyclic pattern ranging from 8°C (winter minimums) to 30°C (summer maximums) with minimal variance in running averages. Running average Specific Conductivity (**Chart 4.2**) has been trending slightly upward since 2005, however, the changes are small and likely reflective of prevailing streamflow. As shown in **Chart 4.3**, pH running averages increased noticeably in 2010, especially minimum values. Replacement of a deteriorating pH probe (giving low readings) in WY09 is believed to be the principal cause of this change as pH averages have remained fairly consistent/steady over the past 36 months. Dissolved oxygen running averages (**Chart 4.4**) present a slow, steady decline since February 2010. Sustained minimum monthly values monitored throughout the year in all five reaches are the primary cause of this trend.

**Table 4.1 - Average Annual and Seasonal WQI by Reach and Section (WY05-WY14)**

Annual Avg.	LMV Reach	UMV Reach	MV Section	MG Section	LSB Reach	USB Reach	SB Section	LSD River Overall Avg.	
WY05	49	43	46	65	31	17	24	41	C (highest)
WY06	40	33	37	54	34	20	27	36	D
WY07	37	28	33	50	40	26	33	36	D
WY08	39	31	36	46	40	32	36	38	C
WY09	38	29	34	47	42	30	36	37	D
WY10	36	33	35	49	37	17	27	35	D
WY11	40	38	39	56	43	15	29	38	C
WY12	35	35	35	48	38	9	24	33	D
WY13	37	32	35	46	35	11	23	32	D
<b>WY14</b>	<b>18</b>	<b>19</b>	<b>18</b>	<b>36</b>	<b>28</b>	<b>10</b>	<b>19</b>	<b>22</b>	<b>E-(lowest)</b>
<i>10-Yr Avg</i>	37	32	35	50	37	19	28	35	<i>D Marginal</i>
Winter	LMV	UMV	MV	MG	LSB	USB	SB	LSDR Overall	
WY05	64	65	64	85	44	33	39	58	B (highest)
WY06	54	47	51	61	40	28	34	46	C
WY07	50	42	46	64	55	38	47	50	B-
WY08	57	48	53	55	52	50	51	52	B-
WY09	57	47	53	63	61	49	55	55	B
WY10	55	54	55	68	55	29	42	52	B-
WY11	57	57	57	67	53	26	40	52	B-
WY12	48	49	49	60	44	14	29	43	C
WY13	58	54	56	67	49	20	35	50	B-
<b>WY14</b>	<b>25</b>	<b>26</b>	<b>26</b>	<b>55</b>	<b>39</b>	<b>14</b>	<b>27</b>	<b>32</b>	<b>D (lowest)</b>
<i>10-Yr Avg</i>	53	49	51	65	49	30	40	49	<i>C+ Fair</i>
Summer	LMV	UMV	MV	MG	LSB	USB	SB	LSDR Overall	
WY05	31	25	29	47	20	5	13	26	D-
WY06	23	14	19	44	30	17	24	26	D- (highest)
WY07	23	15	20	35	23	12	18	22	E
WY08	24	20	23	34	29	16	23	25	D-
WY09	21	14	18	33	25	15	20	22	E
WY10	21	18	20	33	26	9	17	21	E
WY11	23	17	21	38	30	5	17	23	E
WY12	22	18	21	25	27	4	16	19	E
WY13	18	13	16	21	23	5	14	16	E
<b>WY14</b>	<b>10</b>	<b>11</b>	<b>10</b>	<b>12</b>	<b>16</b>	<b>7</b>	<b>12</b>	<b>11</b>	<b>E (lowest)</b>
<i>10-Yr Avg</i>	22	17	20	32	25	10	17	21	<i>E Poor</i>

Table 4.1 footnotes.

**WQI Letter/Color Code:** A (>75) Very Good (dark blue), B (50-74) Good (light blue), C (38-49) Fair (green), D (25-37) Marginal (yellow), E (13-24) Poor (brown), and F (0-12) Very Poor (red); WQI values in red are below 10-Yr averages/norms (expressed in italics) for the same reach or section of the river.

The monthly and running average WQI values from WY05 up to present are shown on **Chart 4.5**. The continued decline in the running averages is a function of depressed oxygen levels at multiple sites exacerbated by elevated water temperatures and record low streamflows. **Chart 4.6** provides a look at trends in streamflow and rainfall over the 10-year period. Specific trends in the WQI by individual river reach are presented in Appendix A (Charts A.1-A.6). WQI values are expected to improve when streamflow returns to more normalized patterns and invasive aquatic growth abatement measures are undertaken along specific reaches of the lower river. Higher minimum values during the summer months are likely to result in positive gradients for trend lines (running averages) over time.

The WQI trend lines for LSDR reaches, sections and the aggregated average value (LSDR) presented in Section 4 and Appendix A charts are summarized in **Table 4.2**. The present (WY14) running average WQI value of 22 (E-Poor) for the LSDR system is 12 points (37%) below the 10-Yr norm of 34 (D-Marginal). The current running average WQI for the Upper Santee Basin reach of 11 (F-Very Poor) is 10 points below the 10-yr norm. The current average running average for the best section (Mission Gorge) of 44 (C-Fair) is 7 points below the 10-yr WQI of 51 (B-Good).

**Table 4.2 Summary of LSDR WQI Running Average Values**

	Chart	High / WY	Low / WY	10-Yr Norm	End WY14 <sup>(a)</sup>
East Section:	D.1, D.2	70(B) WY09	7(F) WY13	30(D)	22(E-Poor)
USB	D.1	68(B) WY09	3(F) WY11-WY13	21(E)	11(F-Very Poor)
LSB	D.2	71(B) WY09	11(E) WY13	39(C)	33(D-Marginal)
Mid Section (MG)	D.3	90(A) WY05	8(F) WY13	51(B-)	44(C-Fair)
West Section:	D.4, D.5	73(B+) WY05	6(F) WY13	37(D+)	34(D-Marginal)
UMV	D.4	72(B) WY05	8(F) WY13	34(D)	31(D-Marginal)
LMV	D.5	79(A) WY05	5(F) WY13	39(C)	36(D-Marginal)
<b>LSDR Overall Average</b>	D.6	<b>39(C) WY05</b>	<b>22(E) WY14</b>	<b>34 (D)</b>	<b>22 (E-Poor)</b>
Best Site (#10 OMD)	D.3	74(A) WY05	31(D) WY14	55(B)	46(C-Fair)
Greatest Range (#12)	D.2	63(B) WY10	7(F) WY05	39(C)	45(C-Fair)
Poorest site (14) Overall	D.1	41(C) WY09	9(F+) WY05,07&11	20(E)	16(E-Poor)
Poorest site (13) Currently	D.1	62(B) WY09	2(F-) WY12	22(E)	8 (F-Very Poor)

a) End of WY14 (Sept) running averages shown in red are below 10-yr average trend line norms.

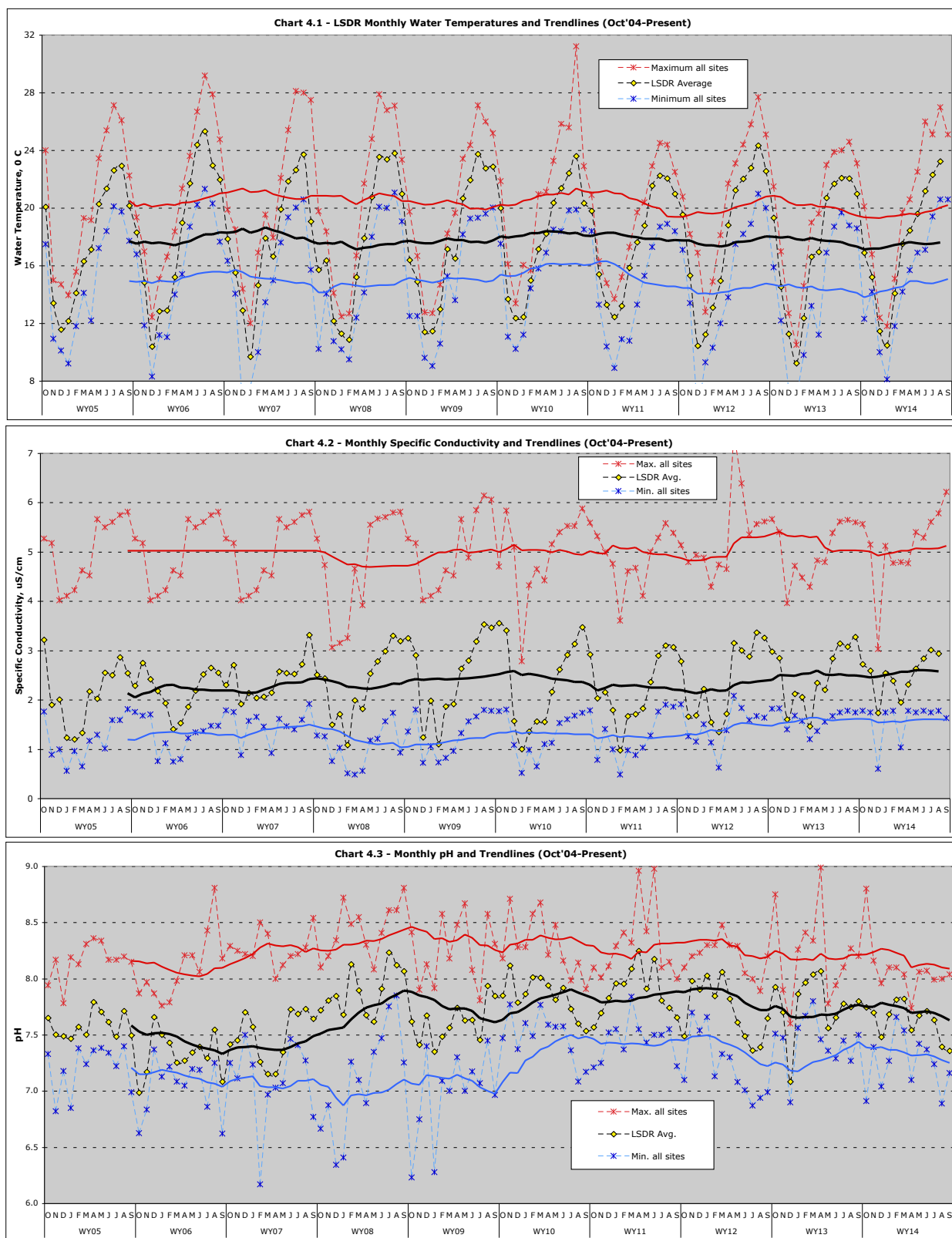
b) Highest overall WQI winter values are associated with Site 8 (Jackson Dr) in the Mission Gorge Reach/Mid-Section of LSDR.

c) Lowest overall WQI summer values are associated with sites 13 & 14 (Mast Park & Cottonwood/RCP) in USB reach.

Water year 2014 presents the lowest overall LSDR WQI of 22 (E-Poor) with both winter and summer values of 32 (D-Marginal) and 11 (F-Very Poor), respectively, running well below 10-yr annual (34 D-Marginal) and seasonal averages (49-C+ in winter & 21-E in summer). Next year (WY15) is anticipated to be closer to annual rainfall and streamflow (runoff) norms, thus average annual LSDR water quality values are expected to improve over this year's results. However, upper reaches in both the Santee Basin and Mission Valley sections are expected to continue to show poorer water quality values than found in the lower reaches and mid-section (Mission Gorge) of the river due to invasive plant infestations.

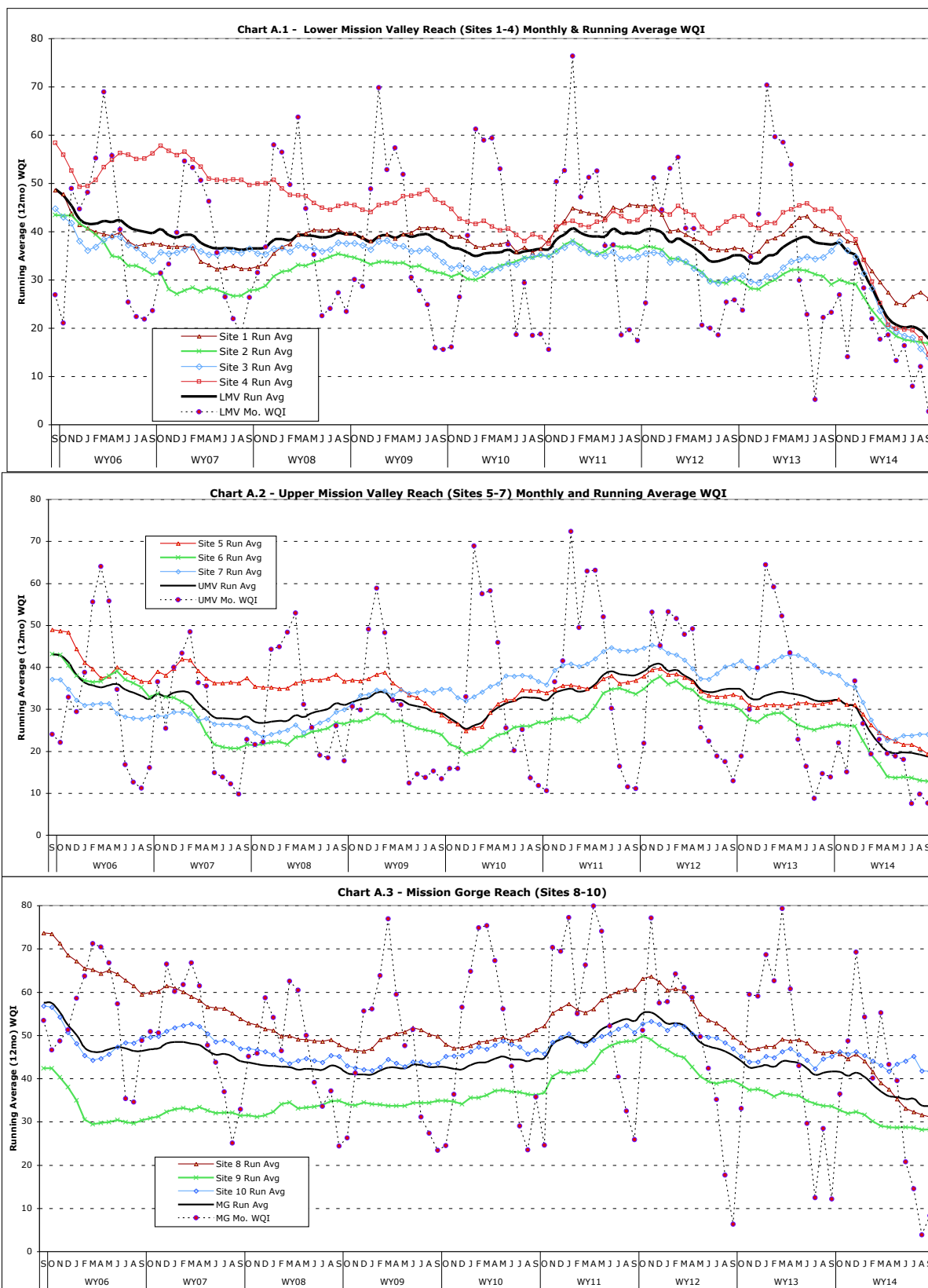


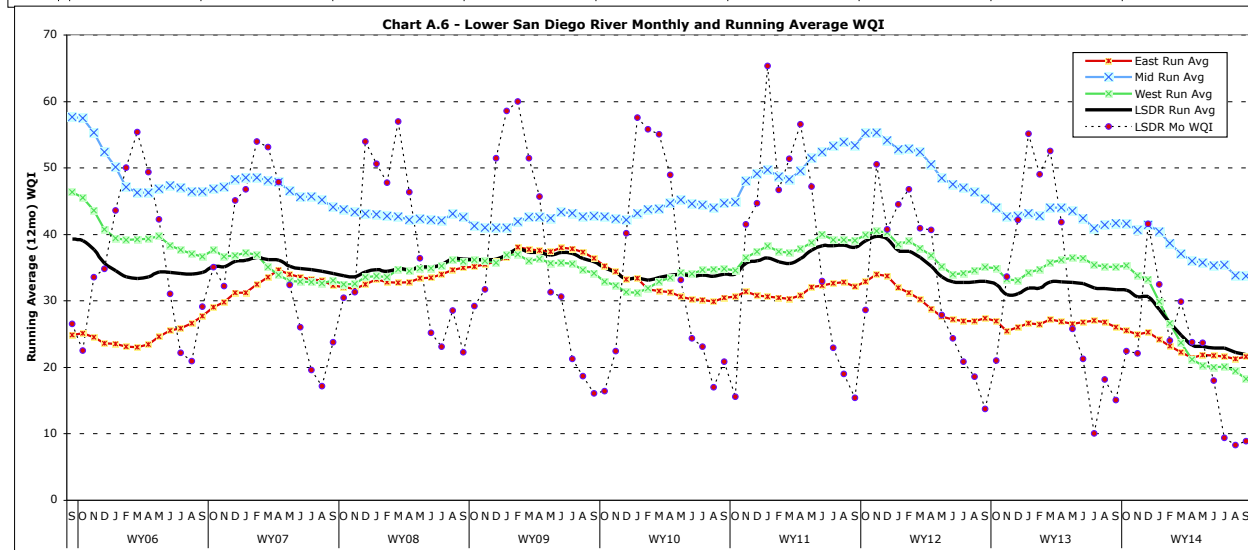
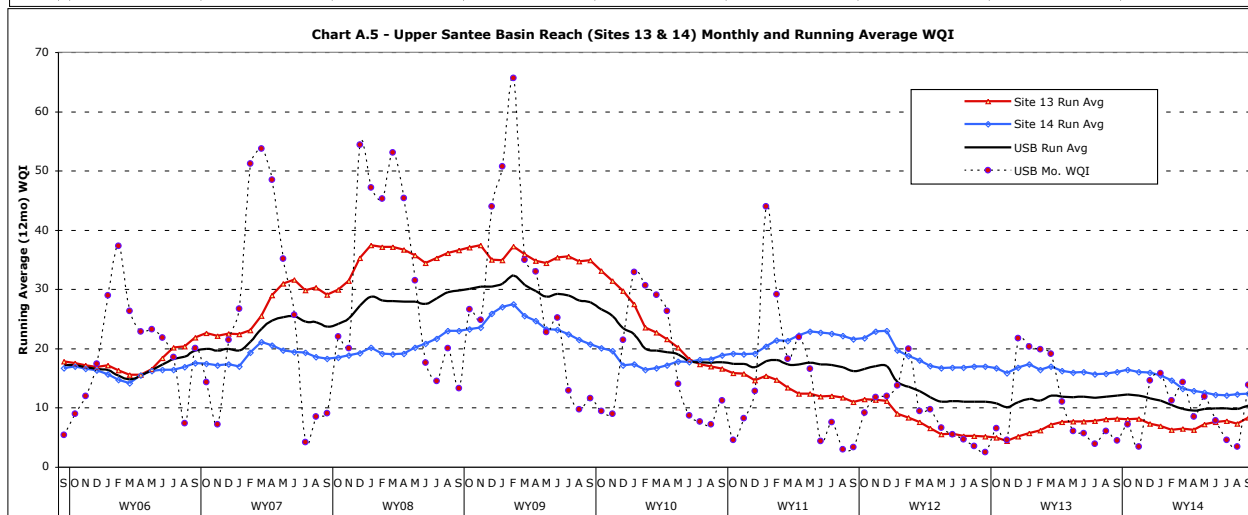
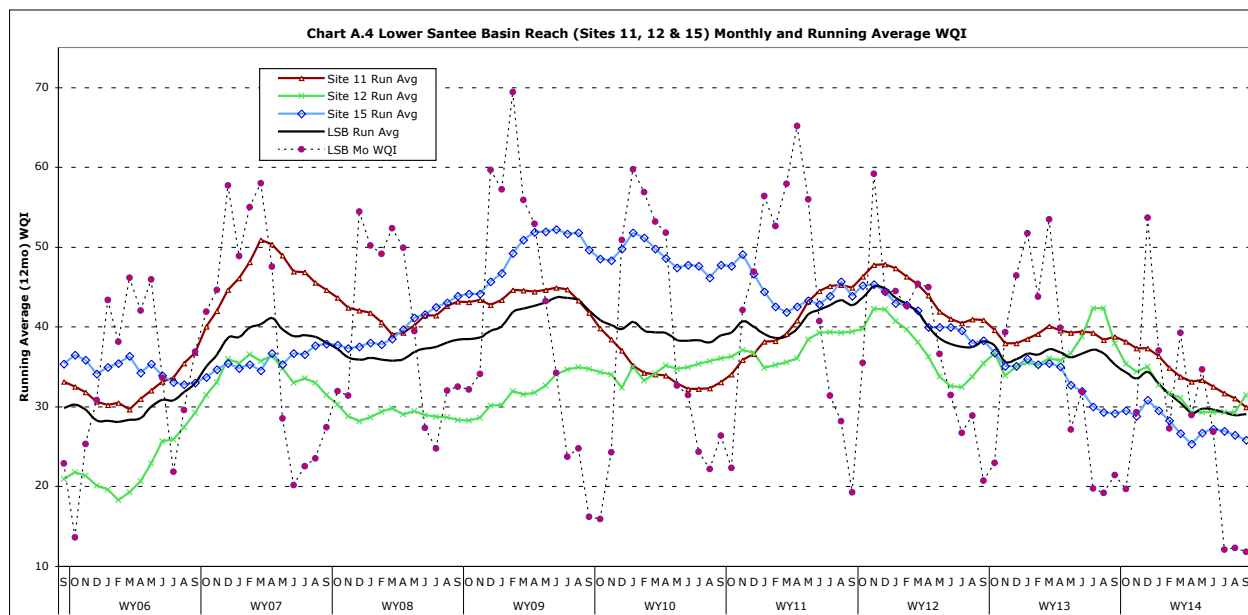
## LSDR Water Quality Monitoring Report



Overall, the downward trends in water quality index values that have occurred over the past several years are expected to plateau unless WY15 is another well below normal rainfall and runoff year.

## Appendix A - WQI Values & TrendLine Charts by River Reach





## Appendix B - Glossary

### Abbreviations:

AADF - Average Annual Daily Flow  
 ACC - Average Coliform Count (arithmetic mean of fecal coliform, e-Coli & total coliform in MPN/100mL)  
 ADF - Average Daily (stream) Flow or discharge  
 AFY - acre-foot per year  
 Avg - Average  
 cfs - cubic feet per second (flow/discharge)  
 Ck - Creek  
 CY - Calendar Year (Jan 1 - Dec 31)  
 DO - Dissolved Oxygen  
 DO%Sat - Dissolved Oxygen expressed as percentage of DO level at saturation point  
 d/s - downstream // {u/s - upstream}  
 E - East // {W - West}  
 FSDRIP - First San Diego River Improvement Project  
 ft. - feet // {mi. - mile}  
 gal - gallon  
 Ln(x) - natural logarithm of (x) to base-e (2.718)  
 log(x) - common logarithm of (x) to base-10  
 L/U - lower/upper (as in river reaches)  
 LSDR - Lower San Diego River  
 max/min - maximum/minimum  
 MCC - Mean Coliform Count (geometric mean of fecal coliform, e-Coli & total coliform in MPN/100mL)  
 mg/L - milligrams per litre  
 mi. - mile  
 mS/cm - milliSeimens per centimetre  
 (1 mS/cm = 1000  $\mu$ S/cm)  
 MG - Mission Gorge (mid-section of LSDR)  
 MV - Mission Valley (West section of LSDR)  
 MPN - Most Probable Number (of coliform organisms)  
 SB - Santee Basin (East section of LSDR)  
 PDMWD - Padre Dam Municipal Water District  
 pH - measure of acidity or basicity (decimal logarithm of hydrogen ion activity)  
 ppm - parts per million  
 Q - stream flow or discharge  
 SB - Santee Basin  
 SpC - Specific Conductivity (also Conductivity or Conductance); also commonly abbreviated SC  
 SD - Standard Deviation (also San Diego)  
 SDRPF - San Diego River Park Foundation  
 TDS - Total Dissolved Solids  
 Temp. - Temperature  
 TN/TP - Total Nitrogen/ Total Phosphorus (nutrients)  
 USGS - U.S. Geological Survey  
 $\mu$ S/cm - microSeimens per centimetre  
 (1  $\mu$ S/cm = 0.001 mS/cm)  
 u/s - upstream // {d/s - downstream}  
 W - West // {E - East}  
 WQI - Water Quality Index (WQI<sub>a</sub>)  
 WQI(4) - WQI using 4 parameters  
 WQI(6) - WQI using 6 parameters  
 WY - Water Year (Oct 1 - Sept 31)  
 % - percent  
 °C - degrees Celsius  
 °F - degrees Fahrenheit

### Formulas:

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times 5/9$$

$$^{\circ}\text{F} = (^{\circ}\text{C} \times 9/5) + 32$$

$$\text{Flow (cfs)} = \text{Velocity (ft/sec)} \times \text{Cross-sectional area (sq ft)}$$

$$\text{Constituent Load (lbs/day)} = Q \text{ (mgd)} \times \text{Concentration (ppm)} \times 8.34; \text{ or } Q \text{ (cfs)} \times \text{Concentration (mg/L)} \times 5.39$$

where Q is streamflow/discharge.

$$\text{Total Dissolved Solids (TDS in mg/L)} = 670 \times \text{Specific Conductivity, (where SC is in mS/cm). An approximate relationship for Lower SDR watershed; other variables (e.g., temperature, pressure, specific ions) are considered negligible.}$$

DO - DO%Sat relationship is defined by the following polynomial equation:  

$$\text{DO(mg/L)} = \text{DO\%Sat} \times [0.004 \times T^2 - 0.343 \times T + 14.2] / 100;$$

$$\text{DO\%Sat} = \text{DO(mg/L)} \times 100 / [0.004 \times T^2 - 0.343 \times T + 14.2],$$
 where T = temperature is in °C.  
 Other variables, incl. barometric pressure, elevation and conductivity (SC), have negligible impact on the DO-DO%Sat relationship within the LSDR watershed.

SDR Water Quality Index (WQI) is calculated using the following set of equations:

$$\text{WQI}_4 = \text{DO\%Sat} \times 2.5 \times T \text{ factor} \times Q \text{ factor} / \log(\text{SC});$$

where SC is expressed in  $\mu$ S/cm; the T factor =  $0.0055T^3 - 0.163T^2 + 1.37T - 2.5$ , and the

$$Q \text{ factor} =$$

$$0.56 + 0.173 \text{Ln}Q - 0.002 \text{Ln}Q^2 - 0.0033 \text{Ln}Q^3 \text{ (M Valley);}$$

$$0.72 + 0.15 \text{Ln}Q - 0.0051 \text{Ln}Q^2 - 0.004 \text{Ln}Q^3 \text{ (M Gorge);}$$

$$0.87 + 0.107 \text{Ln}Q - 0.018 \text{Ln}Q^2 - 0.003 \text{Ln}Q^3 \text{ (Santee);}$$

$$0.1 + 0.05 \text{Ln}Q - 0.042 \text{Ln}Q^2 - 0.0011 \text{Ln}Q^3 \text{ (Tributaries)}$$

$$\text{WQI}_6 = \text{Avg.} [\text{DO\%f} \times \text{wt}(\text{DO}), \text{SCf} \times \text{wt}(\text{SC}), \text{pHf} \times \text{wt}(\text{pH}), \text{MCCf} \times \text{wt}(\text{MCC}), \text{Qf} \times \text{wt}(\text{Q}), \text{Tempf} \times \text{wt}(\text{T})]^{\wedge} 1.75$$

where  $\text{wt}(\text{DO}) = 3$ ,  $\text{wt}(\text{SC}) = 2$ ,  $\text{wt}(\text{pH}) = 1$ ,  
 $\text{wt}(\text{MCC}) = 1$ ,  $\text{wt}(\text{Q}) = 2$  and  $\text{wt}(\text{T}) = 1$

The SDR WQI has been developed specifically for the SDRPF RiverWatch Monitoring Program, however, the equations can also be applied to water quality and hydrologic data for other coastal area watercourses.

### Water Equivalents:

$$1 \text{ cf} = 7.48 \text{ gal} = 62.4 \text{ lbs of water}$$

$$1 \text{ AF} = 43,560 \text{ cf} = 325,900 \text{ gal}$$

$$1 \text{ psi} = 2.31 \text{ ft of water}$$

$$1 \text{ mg/L} = 1 \text{ ppm (in water)}$$

$$1 \text{ cfs} = 450 \text{ gpm} = 0.646 \text{ mgd} = 1.98 \text{ AF/day} = 724 \text{ AFY}$$

$$1 \text{ mgd} = 694 \text{ gpm} = 1.547 \text{ cfs} = 3.06 \text{ AF/day} = 1,120 \text{ AFY}$$

$$1000 \text{ gpm} = 1.436 \text{ mgd} = 2.23 \text{ cfs} = 4.42 \text{ AF/day} = 1,614 \text{ AFY}$$

$$1 \text{ inch (rainfall)} = 25.4 \text{ mm}$$



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## Appendix D - SDRPF's RiverWatch Team

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(2008 - 2014)

Kym Hunter (2006 - 2007)

Rob Hutsel (2004 - 2005)

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Amethyst Cruspero	Jalil Ahmad	Melissa Maigler
Amy Cook	Jason Andres	Michael Mikulak
Ang Nguyen	Jim Thornley	Mitchell Manners
Barbara Owen	Joan Semler	Mike Hanna*
Bill Martin	John Kennedy*	Mike Hunter
Birgit Knorr	Joyce Nower	Natolie Rodriguez
Bob Stafford*	Katharyn Morgan	Mitzi Quizon
Brent Redd	Kathryn Stanaway	Nicole Beeler
Calvin Vine*	Kelly Brown	Paul Hormick*
Cameron Bradley	Kevin Bernaldez	Raymond Ngo
Carl Abulencia	Krissy Lovering	Reggie Agarma
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Chris Peter	Laqueta Strawn	Sandra Pentney
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Conrad Brennen*	Lois Dorn	Tim Toole
Craig McCartney	Linda Tarke	Tina Davis
Dani Tran	Lindsey Dornes	Silvana Procopio
David Lapota	Lindsey Teunis	Toni Nguyen
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Doug Taylor	Madison McLaughlin	Trish Narwold
Ebony Quilteret	Maesa Hanhan	Veronika Shevchenko
Edward Garritty	Marcus King	Vidhya Nagarajan
Erin Babich	Mark Carpenter	Wendy Kwong
Fred Ward	Mark Hammer	Yang Jiao
Gabriel Martinez Mercado	Martin Offenhauer*	Yvette Navarro
Gary Strawn*		

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