LOWER SAN DIEGO RIVER
WATER QUALITY CHARACTERISTICS

Cyclic Patterns, Averages, Variances and Trends in Water Quality Data

RiverWatch Water Quality Monitoring Results (October 2004 - December 2010)

John C. Kennedy, PE
Lower San Diego River Water Quality Characteristics

Section 1. SDRiverWatch Monitoring and Water Quality Data Summary ......................... pg 1

- Description (Intro, Coverage, Sites, Parameters, Protocol, Data Management and Stats)
- Figure 1.1 - Lower SDR Watershed and WQM Sites (Google Earth)
- Table 1.1 - SDR Sections, Reaches and Monitoring Sites
- Table 1.2 - SDR WQM Site Information
- Table 1.3 - SDR WQM Parameters
- WQM Data Summary ................................................................. pg 6
- Table 1.4 - WQM Data Summary (Mid-SDR Temporal Averages)
- Table 1.5 - WQM Data Summary (SDR 6-Yr Spatial Averages)

Section 2. SDR Hydrology & Water Quality ................................................................. pg 8

- Description (Intro, River Discharge and Rainfall)
- Table 2.1 - Lower SDR Average Daily Flow (WY05-WY10)
- Table 2.2 - SDR Annual Rainfall and Long-Term ADF (1914-2010)
- Table 2.3 - WY05-WY10 Annual Rainfall and ADF
- Charts 2.1, 2.2 & 2.3 - Lower SDR Monthly ADF (Oct. 2004 - Dec. 2010) .......... pg 10

Section 3. SDR Water Quality Index ........................................................................ pg 11

- Interpretation and Communication of WQM Data Using an Index
- SDR Water Quality Index ............................................................... pg 12
- Table 3.1 - SDR Water Quality Index
- Table 3.2 - 6-Yr Average WQI Values By SDR Reach and Section
- Table 3.3 - Average Annual and Seasonal WQI by SDR Reach and Section

Section 4. WQM Data Patterns, Variances and Trends ................................................. pg 17

- Description (A-Temp, B-pH, C-SpCond. and D-Dissolved Oxygen/DO%Sat)
- Table C4.1 - Typical Specific Conductivity & Salinity Ranges .............................. pg 20
- Charts D4.1, D4.2 & D4.3 - Lower SDR DO/%DOSat Data (Oct. 2004 - Dec. 2010)

Glossary (Abbreviations, Formulas and Equivalents) ................................................. pg 25
References ........................................................................................................ pg 26
SDRPF RiverWatch Team ......................................................................................... pg 27
Section 1 - SDRiverWatch Monitoring and Water Quality Data Summary

Introduction: This report provides a synopsis of the past 6+ years of water quality monitoring (WQM) data collected by the San Diego River Park Foundation’s (SDRPF) RiverWatch Team. The information allows interested readers an understanding of the cyclic patterns, variances and trends in water quality characteristics evident within the lower San Diego River (SDR) watershed.

Monitoring Period & Coverage: Monthly monitoring over past 6 years (Oct. 2004 – Dec. 2010) covering Lower San Diego River extending downstream from Lakeside (river mile 19.8 elev. 340 ft amsl) to the Estuary (river mile 2.96, elev. 4.8 ft amsl) at I-5/Pacific Hwy. overpasses. The lower watershed and monitoring sites are shown on Figure 1.1.

Monitoring Sites: 15 total - 12 on main course (Mission Valley Section - sites 1-7, Mission Gorge Section - sites 8-10, Santee Basin Section - sites 11-15T) plus 3 tributary (‘T’) stream sites are listed in Table 1.1. Site locations, river milage, bed elevations and coordinates are provided in Table 1.2.

<table>
<thead>
<tr>
<th>Table 1.1 SDR Sections, Reaches and Monitoring Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section/Reach/Tributary</td>
</tr>
<tr>
<td>-------------------------</td>
</tr>
<tr>
<td>Estuary Entrance</td>
</tr>
<tr>
<td>Lower Mission Valley (LMV)</td>
</tr>
<tr>
<td>Upper Mission Valley (UMV)</td>
</tr>
<tr>
<td>Mission Valley (West Sites)</td>
</tr>
<tr>
<td>Mission Gorge (MG)</td>
</tr>
<tr>
<td>Mission Gorge (MG)</td>
</tr>
<tr>
<td>Lower Santee Basin (LSB)</td>
</tr>
<tr>
<td>Upper Santee Basin (USB)</td>
</tr>
<tr>
<td>Santee Basin (SB)</td>
</tr>
<tr>
<td>Eastern Portions (East Sites)</td>
</tr>
<tr>
<td>Tributaries:</td>
</tr>
<tr>
<td>Murphy Canyon Creek a)</td>
</tr>
<tr>
<td>Birchcreek Oultfall b)</td>
</tr>
<tr>
<td>Santee Lakes/Sycamore Creek</td>
</tr>
<tr>
<td>Forester Creek c)</td>
</tr>
<tr>
<td>Lower SDR Watershed (Mid-SDR)</td>
</tr>
</tbody>
</table>

(a) Monthly monitoring discontinued in WY07; site also termed Qualcomm Stadium.
(b) Monthly monitoring initiated in WY08; site also termed Jackson Drive Outfall at Mission Trails Park.
(c) Monthly monitoring initiated in 2007.

Color Codes:
- 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 watercourse.
- Mid-SDR: computed values for entire lower watershed (distance-weighted average of all 5 reaches or all 3 sections); average (LMV+UMV+MG+SB) or average (MV2+MG+SB).
Table 1.2 - SDR WQM Site Information

<table>
<thead>
<tr>
<th>Site #</th>
<th>Site Name</th>
<th>u/s mi.</th>
<th>Elev. ft</th>
<th>Location</th>
<th>GIS Coordinates Latitude Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>LMV</td>
<td>Lower Reach W. Mission Valley: I-5 Bridge to I-805 Bridge (Sites 1-4 below)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Estuary W/E</td>
<td>2.96</td>
<td>6</td>
<td>Between PC Hwy &amp; I-5 on encased sewer main</td>
<td>32.76131 -117.2037</td>
</tr>
<tr>
<td>2</td>
<td>River Gardens E/W</td>
<td>3.50</td>
<td>11</td>
<td>W of YMCA past Trolley overpass at riffle</td>
<td>32.76230 -117.1944</td>
</tr>
<tr>
<td>3</td>
<td>Fashion Valley Mall W</td>
<td>5.08</td>
<td>22</td>
<td>Behind Parking Structure at T&amp;C Ped. Bridge</td>
<td>32.76517 -117.1687</td>
</tr>
<tr>
<td>4</td>
<td>FSDRIP</td>
<td>5.98</td>
<td>36</td>
<td>N. of Mimi’s Cafe on Mission Center Rd Bridge</td>
<td>32.76986 -117.1548</td>
</tr>
<tr>
<td>UMV</td>
<td>Upper Reach E. Mission Valley: I-805 Bridge to North end of Admiral Baker Field (Sites 5-7 below)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Ward Rd Bridge</td>
<td>8.89</td>
<td>50</td>
<td>S of Trolley at Del Rio S intersection</td>
<td>32.78024 -117.1103</td>
</tr>
<tr>
<td>6</td>
<td>Kaiser Ponds</td>
<td>9.46</td>
<td>56</td>
<td>Mission SD de Acala at SD Mission Rd</td>
<td>32.78406 -117.1042</td>
</tr>
<tr>
<td>7</td>
<td>Admiral Baker Field Z. ABF - Zion</td>
<td>9.98</td>
<td>58</td>
<td>L. Lower (below Friars Rd bridge)</td>
<td>32.79038 -117.1031</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Z. Terminus of Zion Ave at Riverdale St</td>
<td>32.79304 -117.0998</td>
</tr>
<tr>
<td>MV</td>
<td>Mission Valley Section: Estuary to Admiral Baker Field (Sites 1-7 above) [LMV+UMV]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MG</td>
<td>Mission Gorge Reach: Quarry Area to Old Mission Dam (Sites 8-10 below)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Mission Trails at Jackson Dr</td>
<td>13.8</td>
<td>159</td>
<td>At SDCWA/Scycott Crossing</td>
<td>32.82124 -117.0621</td>
</tr>
<tr>
<td>9</td>
<td>Birchcreek OF</td>
<td>13.9</td>
<td>198</td>
<td>San Marcos Tributary along Jackson Dr. trail</td>
<td>32.82268 -117.0622</td>
</tr>
<tr>
<td>10</td>
<td>Old Mission Dam W/E</td>
<td>15.7</td>
<td>265</td>
<td>Downstream side of OMD</td>
<td>32.83977 -117.0433</td>
</tr>
<tr>
<td>MG</td>
<td>Mission Gorge Section: Quarry Area to Old Mission Dam (Sites 8-10 above) [MG]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LSB</td>
<td>Lower Reach Santee: W. Hills Pkwy to Carlton Hills Blvd Bridge (Sites 11-12T below)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>West Hills Pkwy</td>
<td>17</td>
<td>300</td>
<td>at/below West Hills Pkwy Bridge</td>
<td>32.83936 -117.0244</td>
</tr>
<tr>
<td>12T</td>
<td>Carlton Oaks Dr/Santee</td>
<td>18.2</td>
<td>320</td>
<td>Sycamore Ck (Santee Lakes) at Carlton Oaks Dr.</td>
<td>32.84431 -117.0064</td>
</tr>
<tr>
<td>USB</td>
<td>Upper Reach Santee Basin: Carlton Hills Blvd Bridge to Riverford Rd (Sites 14-15T below)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Mast Park</td>
<td>18.5</td>
<td>330</td>
<td>Pedestrian Bridge behind (N of) Walmart</td>
<td>32.84696 -116.9734</td>
</tr>
<tr>
<td>14</td>
<td>Cottonwood Ave/RCP</td>
<td>19.8</td>
<td>340</td>
<td>W of RCP plant at Chubb Ln/Cottonwood Ave</td>
<td>32.84434 -116.9895</td>
</tr>
<tr>
<td>15T</td>
<td>Forester Creek</td>
<td>18.9</td>
<td>336</td>
<td>Forester Ck (tributary) at Prospect Ave.</td>
<td>32.83221 -116.9866</td>
</tr>
<tr>
<td>SB</td>
<td>Santee Basin Section: West Hills Parkway to Lakeside (Sites 11-15T above) [LSB+USB]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid-SDR</td>
<td>Lower San Diego River Watershed: Estuary to Lakeside (Sites 1-15T above) [MV2+MG+SB]</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**WQ Parameters**: Seven measured and recorded parameters (Temp, pH, SpC, DO, DO%Sat, NO3 & PO4) plus subjective field observations re: environs and characteristics are listed in **Table 1.3**. As nutrient testing for NO3 and PO4 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 6-yr period (Oct. 04 - Dec. 10) is in the range of 60 to 75.

**Protocol**: **East Side** – (Santee Basin & Mission Gorge Sections). The eight sites within upper three reaches (MG, LSB & USB) typically monitored 3rd Fri./Sat. of month. **West Side** - (Mission Valley Section). Seven sites within lower two reaches (LMV & UMV) monitored monthly, typically 3rd Sun. morning of month.
### Table 1.3 - Lower SDR Water Quality Monitoring Parameters

<table>
<thead>
<tr>
<th>WQ Parameter</th>
<th>unit</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured Monthly at All Sites:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Temperature (Temp)</td>
<td>°C</td>
<td>Basic characteristic and WQ driver</td>
</tr>
<tr>
<td>2. pH</td>
<td>-</td>
<td>Degree of Acidity or Alkalinity (7.0 pH neutral)</td>
</tr>
<tr>
<td>3. Specific Conductivity (SpC)</td>
<td>mS/cm</td>
<td>Measure of ionic content or dissolved solids</td>
</tr>
<tr>
<td>4. Dissolved Oxygen (DO)</td>
<td>mg/L</td>
<td>Good indicator of relative/overall water quality</td>
</tr>
<tr>
<td>5. Percent of DO Saturation (DO%Sat)</td>
<td>%</td>
<td>Same as DO, good indicator of general water quality</td>
</tr>
<tr>
<td>Sampled/Tested Monthly at Selected Sites: (typically 4 - 2 East &amp; 2 West)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Nitrate (NO₃-N)</td>
<td>mg/L</td>
<td>Important nutrient for biological activity</td>
</tr>
<tr>
<td>7. Phosphate (PO₄-P)</td>
<td>mg/L</td>
<td>Key nutrient for biological activity</td>
</tr>
<tr>
<td>Discontinued on regular basis in 2006:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Turbidity</td>
<td>NTU</td>
<td>Discontinued due to inaccurate/invalid readings</td>
</tr>
<tr>
<td>9. Barometric Pressure</td>
<td>mBars</td>
<td>Suspended readings as data available externally</td>
</tr>
<tr>
<td>Environmental Observations Recorded at All Sites:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Abnormal conditions (scum, discoloration, odors, etc.), trash/debris, homeless encampments, biological activity (aquatic, avian, terrestrial), expansion of invasive species, erosion, scouring, other noteworthy comments re: water-course, shoreline and adjacent environs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General WQ Conditions Observed at All Sites: (numerical coding added in 2010)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weather Conditions, Presence of Algae, Clarity, Color, Odor, Flow, Foam, Litter, Odor, Oil &amp; Grease</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A Team Leader and Volunteers (typically 3-8 persons) meet at an appointed site, organize field equipment/transportation, drive to sites, measure physical-chemical water quality using Sonde instrument, note special conditions/observations, collect samples for subsequent testing, return to office, perform nutrient (NO₃ & PO₄) tests, store samples for subsequent laboratory (e.g., sediment toxicity) analyses and clean/check in equipment.

**Data Management:** Water quality data are 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 SDR sites, reaches, sections and tributaries for each WQ parameter of interest.

**Statistical Computations:** Various basic statistical values have been calculated from the data.  
- Mean – average of a series (sum of values/number of values)  
- Median – middle value of an ordered series (50% larger/50% smaller)  
- Minimum – lowest/smallest value measured  
- Maximum – highest/greatest value measured  
- Range – Difference between Maximum and Minimum
Statistical Computations (cont.):
- 1st Quartile (Q1) – 25% of values smaller (75% larger)
- 2nd Quartile (Q2) – 50% of values larger/smaller (same as median)
- 3rd Quartile (Q3) – 75% of values smaller (25% larger)

WQM Data Summary:
A temporal (WY05 through WY10) summary of SDRPF RiverWatch water quality monitoring data for overall Mid-SDR (Lower SDR Watershed) annual, summer and winter values is provided in Table 1.4. The percent change in most recent (WY10) values from the previous year (WY09), from the initial year (WY05) and from the 6-year Average is also presented for each parameter. Overall annual average physical-chemical water quality within the lower watershed, as expressed by the WQI, has declined by approximately 15 percent over the past 6 years. Winter season values (Dec-March) are down approximately 8 percent, while summer values (June-Sept) are down 21 percent over the 6-yr period. The average annual WQI for WY10 is down 10 percent from the previous (WY09) year.

A spatial (by distance and reach) summary of SDRPF RiverWatch water quality monitoring data for average annual, summer and winter values for each parameter is provided in Table 1.5. The Mission Gorge reach/section consistently presents the best water quality within the lower SDR watershed, whereas the Upper Mission Valley reach (just downstream) presents the lowest. The lower/west section of the river (Mission Valley) consistently presents poorer water quality both on an average-annual and summer-season basis than evident in either upstream section. Overall (Mid-SDR) 6-yr average water quality within the lower watershed ranges from low ‘Marginal’ (D-) in summer to ‘Good’ (B) in winter, or ‘Fair’ (C) expressed on an average annual basis.

Winter and average annual SDR water quality is anticipated to generally improve should WY11 continue to be an above average rainfall and runoff -river discharge year. Summer water quality results could, however, continue to remain poor, should dry-weather flows next summer be significantly below season norms.

Questions regarding this WQM database or interpretation of results can be directed to the attention of the report’s author, John C. Kennedy, through contacting SDRPF at info@SanDiegoRiver.org, or calling the WaterWatch Coordinator at 619-297-7380.

Figure 1.1 - Lower SDR Watershed and WQM Sites

(Google Earth) - see next full page
Table 1.4 WQM Data Summary (Mid-SDR Temporal Averages)

<table>
<thead>
<tr>
<th></th>
<th>WY05</th>
<th>WY06</th>
<th>WY07</th>
<th>WY08</th>
<th>WY09</th>
<th>WY10</th>
<th>Percent Change</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6-Yr Avg.</td>
<td>1 Yr (a)</td>
</tr>
<tr>
<td>Annual (Oct-Sept):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADF, cfs</td>
<td>76</td>
<td>14</td>
<td>10</td>
<td>19</td>
<td>21</td>
<td>36</td>
<td>29</td>
</tr>
<tr>
<td>Temp, °C</td>
<td>18.0</td>
<td>18.4</td>
<td>17.7</td>
<td>17.6</td>
<td>17.6</td>
<td>18.1</td>
<td>17.9</td>
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<tr>
<td>SpC, uS/cm</td>
<td>2.08</td>
<td>2.15</td>
<td>2.37</td>
<td>2.28</td>
<td>2.45</td>
<td>2.32</td>
<td>2.28</td>
</tr>
<tr>
<td>DO, mg/L</td>
<td>6.91</td>
<td>5.80</td>
<td>5.60</td>
<td>6.11</td>
<td>5.93</td>
<td>5.17</td>
<td>5.92</td>
</tr>
<tr>
<td>DO%Sat, %</td>
<td>73</td>
<td>61</td>
<td>58</td>
<td>64</td>
<td>62</td>
<td>54</td>
<td>62</td>
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<tr>
<td>pH</td>
<td>7.6</td>
<td>7.3</td>
<td>7.4</td>
<td>7.5</td>
<td>7.5</td>
<td>7.5</td>
<td>7.45</td>
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<td>WQ Index</td>
<td>48</td>
<td>43</td>
<td>40</td>
<td>40</td>
<td>36</td>
<td>36</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6-Yr Avg.</td>
<td>1 Yr (a)</td>
</tr>
<tr>
<td>Summer (June-Sept):</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>ADF, cfs</td>
<td>3.6</td>
<td>2.5</td>
<td>1.5</td>
<td>1.6</td>
<td>1.2</td>
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<td>2.0</td>
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<td>Temp, °C</td>
<td>21.1</td>
<td>23.6</td>
<td>21.7</td>
<td>22.9</td>
<td>22.7</td>
<td>22.0</td>
<td>22.5</td>
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<td>SpC, uS/cm</td>
<td>2.40</td>
<td>2.17</td>
<td>2.59</td>
<td>2.73</td>
<td>2.89</td>
<td>2.61</td>
<td>2.57</td>
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<tr>
<td>DO, mg/L</td>
<td>5.17</td>
<td>4.83</td>
<td>4.48</td>
<td>5.24</td>
<td>4.47</td>
<td>4.28</td>
<td>4.74</td>
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<td>DO%Sat, %</td>
<td>60</td>
<td>56</td>
<td>50</td>
<td>60</td>
<td>51</td>
<td>48</td>
<td>54</td>
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<tr>
<td>pH</td>
<td>7.5</td>
<td>7.4</td>
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<tr>
<td>Grade</td>
<td>D+</td>
<td>D</td>
<td>D-</td>
<td>D</td>
<td>E+</td>
<td>E+</td>
<td>D</td>
</tr>
<tr>
<td>Rating</td>
<td>MAR</td>
<td>MAR</td>
<td>MAR</td>
<td>MAR</td>
<td>POOR</td>
<td>POOR</td>
<td>MAR</td>
</tr>
<tr>
<td>Winter (Dec-March):</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>ADF, cfs</td>
<td>175</td>
<td>23</td>
<td>22</td>
<td>51</td>
<td>54</td>
<td>91</td>
<td>67</td>
</tr>
<tr>
<td>Temp, °C</td>
<td>13.9</td>
<td>13.0</td>
<td>13.8</td>
<td>12.3</td>
<td>13.1</td>
<td>14.2</td>
<td>13.4</td>
</tr>
<tr>
<td>SpC, uS/cm</td>
<td>1.76</td>
<td>2.13</td>
<td>2.16</td>
<td>1.82</td>
<td>2.01</td>
<td>2.04</td>
<td>1.99</td>
</tr>
<tr>
<td>DO, mg/L</td>
<td>8.65</td>
<td>6.77</td>
<td>6.73</td>
<td>6.98</td>
<td>7.40</td>
<td>6.05</td>
<td>7.10</td>
</tr>
<tr>
<td>DO%Sat, %</td>
<td>86</td>
<td>66</td>
<td>67</td>
<td>68</td>
<td>73</td>
<td>61</td>
<td>70</td>
</tr>
<tr>
<td>pH</td>
<td>7.5</td>
<td>7.3</td>
<td>7.4</td>
<td>7.7</td>
<td>7.5</td>
<td>7.3</td>
<td>7.47</td>
</tr>
<tr>
<td>WQ Index</td>
<td>61</td>
<td>56</td>
<td>54</td>
<td>54</td>
<td>56</td>
<td>51</td>
<td>56</td>
</tr>
<tr>
<td>Grade</td>
<td>B</td>
<td>B</td>
<td>B</td>
<td>B-</td>
<td>B</td>
<td>B-</td>
<td>B</td>
</tr>
<tr>
<td>Rating</td>
<td>GOOD</td>
<td>GOOD</td>
<td>GOOD</td>
<td>GOOD</td>
<td>GOOD</td>
<td>GOOD</td>
<td>GOOD</td>
</tr>
</tbody>
</table>

(a) Percent change in this year’s value (WY10) from last year (WY09).
(b) Percent change in this year’s value (WY10) from first year (WY05).
(c) Percent change in this year’s value (WY10) above (+) or below (-) 6-yr Average.
(d) Changes in red represent periods of declining quality.
Table 1.5 WQM Data Summary (SDR 6-Yr Spatial Averages)

<table>
<thead>
<tr>
<th>Section Sites</th>
<th>Mission Valley</th>
<th>Mission Gorge</th>
<th>Santee Basin</th>
<th>Watershed</th>
<th>Mid-SDR (a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reach</td>
<td>LMV</td>
<td>UMV</td>
<td>MG</td>
<td>LSB</td>
<td>USB</td>
</tr>
<tr>
<td>Annual (Oct-Sept):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADF, cfs</td>
<td>37</td>
<td>32</td>
<td>23 (b)</td>
<td>23</td>
<td>17</td>
</tr>
<tr>
<td>Temp, °C</td>
<td>19.1</td>
<td>17.9</td>
<td>17.3</td>
<td>17.6</td>
<td>18.1</td>
</tr>
<tr>
<td>SpC, mS/cm</td>
<td>2.58</td>
<td>2.57</td>
<td>2.17</td>
<td>2.00</td>
<td>1.95</td>
</tr>
<tr>
<td>DO, mg/L</td>
<td>5.75</td>
<td>4.88</td>
<td>7.83</td>
<td>6.49</td>
<td>5.82</td>
</tr>
<tr>
<td>DOSat, %</td>
<td>62</td>
<td>51</td>
<td>82</td>
<td>67</td>
<td>62</td>
</tr>
<tr>
<td>pH</td>
<td>7.4</td>
<td>7.4</td>
<td>7.4</td>
<td>7.5</td>
<td>7.7</td>
</tr>
<tr>
<td>WQ Index</td>
<td>39</td>
<td>33</td>
<td>54</td>
<td>48</td>
<td>33</td>
</tr>
<tr>
<td>Grade</td>
<td>C</td>
<td>D+</td>
<td>B-</td>
<td>C</td>
<td>D+</td>
</tr>
<tr>
<td>Rating</td>
<td>FAIR</td>
<td>MARG</td>
<td>GOOD</td>
<td>FAIR</td>
<td>MARG</td>
</tr>
<tr>
<td>Summer (June-Sept):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADF, cfs</td>
<td>2.3</td>
<td>2.0</td>
<td>1.7 (c)</td>
<td>1.6</td>
<td>1.2</td>
</tr>
<tr>
<td>Temp, °C</td>
<td>24.5</td>
<td>20.9</td>
<td>21.8</td>
<td>21.2</td>
<td>23.0</td>
</tr>
<tr>
<td>SpC, mS/cm</td>
<td>3.27</td>
<td>3.20</td>
<td>2.73</td>
<td>2.48</td>
<td>2.17</td>
</tr>
<tr>
<td>DO, mg/L</td>
<td>3.83</td>
<td>2.97</td>
<td>6.95</td>
<td>5.46</td>
<td>4.86</td>
</tr>
<tr>
<td>DOSat, %</td>
<td>47</td>
<td>34</td>
<td>79</td>
<td>60</td>
<td>57</td>
</tr>
<tr>
<td>WQ Index</td>
<td>20</td>
<td>15</td>
<td>43</td>
<td>39</td>
<td>24</td>
</tr>
<tr>
<td>Grade</td>
<td>E</td>
<td>E</td>
<td>C</td>
<td>C</td>
<td>E+</td>
</tr>
<tr>
<td>Rating</td>
<td>POOR</td>
<td>POOR</td>
<td>FAIR</td>
<td>FAIR</td>
<td>POOR</td>
</tr>
<tr>
<td>Winter (Dec-March):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ADF, cfs</td>
<td>87</td>
<td>73</td>
<td>55</td>
<td>47</td>
<td>35</td>
</tr>
<tr>
<td>Temp, °C</td>
<td>19.3</td>
<td>17.3</td>
<td>17.1</td>
<td>17.0</td>
<td>18.0</td>
</tr>
<tr>
<td>SpC, mS/cm</td>
<td>1.82</td>
<td>1.77</td>
<td>1.49</td>
<td>1.47</td>
<td>1.62</td>
</tr>
<tr>
<td>DO, mg/L</td>
<td>7.06</td>
<td>6.57</td>
<td>8.72</td>
<td>7.53</td>
<td>6.78</td>
</tr>
<tr>
<td>DOSat, %</td>
<td>71</td>
<td>63</td>
<td>85</td>
<td>73</td>
<td>66</td>
</tr>
<tr>
<td>WQ Index</td>
<td>58</td>
<td>53</td>
<td>62</td>
<td>55</td>
<td>42</td>
</tr>
<tr>
<td>Grade</td>
<td>B</td>
<td>B-</td>
<td>B</td>
<td>B-</td>
<td>C</td>
</tr>
<tr>
<td>Rating</td>
<td>GOOD</td>
<td>GOOD</td>
<td>GOOD</td>
<td>GOOD</td>
<td>FAIR</td>
</tr>
</tbody>
</table>

(a) Distance-weighted average of all reaches within the Lower SDR watershed.
(b) Estimated flow based on averaged river gains and losses between Santee Basin and Mission Valley.
(c) Intermittent - there have been a number of summer months when river flow in the Mission Gorge reach has been non-detectable (below ground); 1.3 cfs represents an average daily value determined during portions of the summer season (J,J,A,S) when flows were detectable.
Section 2 - SDR Hydrology and Water Quality

Stream flow or discharge, the volume of water that moves 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), is the amount of water moving off a watershed into a channel, as affected by weather (increasing during rainstorms and decreasing during dry spells) and changing during different seasons. It decreases during summer months when rainfall is minimal, evaporation rates high and actively growing riparian vegetation is extracting water from the ground. August and September are typically our months of lowest flow. A function of both volume and velocity, flow has a major impact on living organisms, watercourse habitats and on overall stream water quality. Velocity, typically increasing as volume increases, determines the kinds of organisms that live in the system and also affects the amount of silt and sediment that is transported. Fast moving watercourses usually have higher levels of DO than slow streams as they are better aerated.

SDR average daily flow (ADF) values as recorded at the two USGS gauging stations located in the lower watershed are expressed in Table 2.1 for both the monitoring period (Oct 2004 - Sept 2010) and the past 45 years (1965-2010) of official records. The six- and 45-year average annual values are in close accord.

Table 2.1 - Lower SDR Average Daily Flows (WY05-WY10)

<table>
<thead>
<tr>
<th>Season</th>
<th>Units (b)</th>
<th>Fashion Valley</th>
<th>Santee Basin</th>
<th>Mid-SDR (a)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>cfs</td>
<td>mgd</td>
<td>cfs</td>
</tr>
<tr>
<td>Fall (Oct/Nov)</td>
<td></td>
<td>21</td>
<td>13.5</td>
<td>14</td>
</tr>
<tr>
<td>Winter (Dec-Mar)</td>
<td></td>
<td>83</td>
<td>53.4</td>
<td>41</td>
</tr>
<tr>
<td>Spring (April/May)</td>
<td></td>
<td>17</td>
<td>11.1</td>
<td>10</td>
</tr>
<tr>
<td>Summer (June-Sept)</td>
<td></td>
<td>2.4</td>
<td>1.5</td>
<td>1.7</td>
</tr>
<tr>
<td>6-Yr Annual Avg. (Oct-Sept)</td>
<td></td>
<td>37.1</td>
<td>24.0</td>
<td>21.0</td>
</tr>
<tr>
<td>Recent 45-Yr Avg. (1965-2010)</td>
<td></td>
<td>36.3</td>
<td>23.5</td>
<td>21.7</td>
</tr>
<tr>
<td>Annual Discharge, AF (c)</td>
<td></td>
<td>26,320</td>
<td>15,680</td>
<td>20,940</td>
</tr>
</tbody>
</table>

(a) Lower SDR watershed average daily flow represents a theoretical mean hydrologic condition based on averaging the two USGS stream gauging station values.
(b) ADF values are expressed in both cubic feet per second (cfs) and million gallons per day (mgd); 1 mgd = 1.7 cfs.
(c) Average annual total discharge expressed in acre-feet (1 AF = 325,900 gallons) between 1965 and 2010.

Correlations between total annual rainfall and ADF considered over the past 97 years of hydrologic record and during the period of SDRPF RiverWatch monitoring for the two lower SDR gauging stations are presented in Tables 2.2 and 2.3, respectively. WY05 was a “Very Wet” hydrologic year, whereas WY07 was “Very Dry”. WY06 & 08 were “Dry” years while the past two years (WY09 & 10) were considered “Normal” in terms of both total annual rainfall and average daily flow. The 6-yr ADF in the East and West is 21 and 37 cfs, respectively; both values are approximately the same as the past 45- and 97-yr SDR average daily discharges. Based on December rainfall, WY11 shows indications of being an “Above Normal” or “Wet” in terms of total annual rainfall, watershed runoff and river discharge.

Monthly discharge data (min, max and average daily flow) at the two gauging stations extending from Oct 2004 through Sept 2010 are presented in Chart 2.1. Average daily flow (ADF) for the SDR system varies from less than 1 cfs during the summer (dry) months to nearly 200 cfs during some winter (wet) seasons in the East (Santee Basin) and up to 380 cfs in the West (Mission Valley) section. ADF values have been trending upward since WY07 as shown by the 12-month moving average.
The relationship between rainfall, discharge and general physical-chemical water quality within the Mal rainfall and runoff/flow. The past two years presented normal rainfall/runoff and flow conditions.

Monthly and seasonal average annual flows and rainfall over the 6-yr monitoring period for both stations are shown in Chart 2.2. The seasonal flow patterns describe the range, variance and correlation in monthly ADF and rainfall over the past 6 years. Winter wet season SDR flows within the lower water shed are 100 to 250 times greater on average than the summer, dry season flows.

Average annual, winter and summer flows and rainfall for each of the last 6 water years are presented in Chart 2.3. 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 (WY06-08) each witnessed below normal rainfall and runoff/flow. The past two years presented normal rainfall/runoff and flow conditions. The relationship between rainfall, discharge and general physical-chemical water quality within the lower SDR watershed is further explored in subsequent sections of this report.

---

**Table 2.2 - Rainfall and Long-Term ADF (1914-2010)**

<table>
<thead>
<tr>
<th>Type</th>
<th># of Years</th>
<th>Percent of Total Years</th>
<th>Total Annual Rainfall (inches)</th>
<th>Average Daily Flow, cfs</th>
<th>Percent of Variance</th>
<th>Type of Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Wet</td>
<td>3</td>
<td>3%</td>
<td>&gt;20</td>
<td>East (b): 105</td>
<td>-12%</td>
<td>Normal</td>
</tr>
<tr>
<td>Wet</td>
<td>10</td>
<td>10%</td>
<td>15-20</td>
<td>West (c): 125</td>
<td>-22%</td>
<td>Wet</td>
</tr>
<tr>
<td>Above Norm (d)</td>
<td>16</td>
<td>17%</td>
<td>12-15</td>
<td>Mid-SDR: 102</td>
<td>-25%</td>
<td>Normal</td>
</tr>
<tr>
<td>Normal</td>
<td>38</td>
<td>39%</td>
<td>8-12</td>
<td>East (b): 14</td>
<td>-26%</td>
<td>Normal</td>
</tr>
<tr>
<td>Dry</td>
<td>25</td>
<td>26%</td>
<td>5-8</td>
<td>West (c): 24</td>
<td>-25%</td>
<td>Normal</td>
</tr>
<tr>
<td>Very Dry</td>
<td>5</td>
<td>5%</td>
<td>&lt;5</td>
<td>Mid-SDR: 18</td>
<td>-26%</td>
<td>Normal</td>
</tr>
<tr>
<td>Long-Term Avg.</td>
<td>97</td>
<td>100%</td>
<td>10.2</td>
<td>East (b): 26</td>
<td>-25%</td>
<td>Normal</td>
</tr>
</tbody>
</table>

(a) Total Annual Rainfall (October 1 through September 31).
(b) Santee Basin USGS Stream Gauge Station # 11022480 at Mast Rd.
(c) Mission Valley USGS Stream Gauge Station # 11023000 at Fashion Valley Mall; incomplete data prior to 1968.
(d) Slightly Above Normal annual rainfall (12-15 in/yr) and SDR Average Daily Flows (40-100 cfs).

---

**Table 2.3 - Annual Rainfall and Average Daily Flow (WY05-WY10)**

<table>
<thead>
<tr>
<th>Type of Year</th>
<th>Total Annual Rainfall (mm)</th>
<th>Variance (a)</th>
<th>Average Daily Flow, cfs</th>
<th>Variance (d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WY05 (Very Wet)</td>
<td>576</td>
<td>22.7</td>
<td>122%</td>
<td>118%</td>
</tr>
<tr>
<td>WY06 (Dry)</td>
<td>153</td>
<td>6.02</td>
<td>-41%</td>
<td>-59%</td>
</tr>
<tr>
<td>WY07 (Very Dry)</td>
<td>98</td>
<td>3.86</td>
<td>-62%</td>
<td>-71%</td>
</tr>
<tr>
<td>WY08 (Dry)</td>
<td>185</td>
<td>7.28</td>
<td>-29%</td>
<td>-45%</td>
</tr>
<tr>
<td>WY09 (Normal)</td>
<td>232</td>
<td>9.13</td>
<td>-11%</td>
<td>-39%</td>
</tr>
<tr>
<td>WY10 (Normal)</td>
<td>269</td>
<td>10.60</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>6-Yr Average (2005-10)</td>
<td>254</td>
<td>10.0</td>
<td>-2%</td>
<td>-17%</td>
</tr>
<tr>
<td>27-Yr Avg. (1983-2010)</td>
<td>261</td>
<td>10.3</td>
<td>1%</td>
<td>-9%</td>
</tr>
<tr>
<td>97-yr Long-Term Avg.</td>
<td>260</td>
<td>10.2</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

(a) Percent difference from long term average annual rainfall (260 mm/yr or 10.2 in/yr); black-above, red-below.
(b) Santee Basin USGS Stream Gauge Station at Mast Rd.
(c) Mission Valley USGS Stream Gauge Station at Fashion Valley Mall; incomplete data prior to 1965.
(d) Percent difference from long-term average annual daily flow (i.e., 26 cfs at Santee and 43 cfs in Mission Valley).

Charts 2.1, 2.2 & 2.3

MV (blue lines) USGS 11023000 SDR @ Fashion Valley
SB (green lines) USGS 11022480 SDR @ Mast Rd Nr Santee

> 100
Well Above Normal (Wet Winter Month)

50--99.9
Above Normal (Typical of Winter period)

10--49.9
Normal (Typical of Spring & Fall periods)

3--9.9
Below Normal (Typical of Summer period)

0.1--2.9
Well Below Normal (Dry Summer Month)

Chart 2.1 - Monthly SDR Average Daily Flows

Chart 2.2 - SDR Monthly Rainfall and Seasonal ADF (6-Yr Averages)

Chart 2.3 - SDR Annual Rainfall and ADF by Water Year

SDR Water Quality Monitoring Report
SDRPF RiverWatch
Section 3 - SDR Water Quality Index

Interpretation and Communication of WQM Data Using an Index

Background: SDRPF’s RiverWatch monitoring team’s water quality index (WQI) is an attempt at an imperfect answer to non-technical questions regarding Lower San Diego River water quality. The index constitutes a single unit-less number ranging from 1 to 100; a higher number indicative of better water quality. In general, sites scoring 75 or above exceed expectations for water quality and are of “least concern,” scores of 25 to 75 indicate “intermediate concern,” while quality at sites or sections with scores below 25 do not meet expectations and are of “greatest concern.” For temperature, pH, specific conductivity and dissolved oxygen, the index expresses results relative to generally acceptable concentration levels required to maintain beneficial uses based on State of California Water Quality Standards. For flows, where standards are non-specific, results are expressed relative to general conditions in coastal southern California’s non-estuarine watercourses. The multiple physical-chemical parameters are combined and results aggregated to produce a score for each site, river reach and section over time and distance.

Political decision-makers, non-technical water managers, vested watershed stakeholders and the general public usually have neither time nor training to study and understand a traditional, detailed technical review of water quality data. Over the past several decades numerous indexes have been developed to summarize water quality data in an easily expressed and readily understood format. Water quality professionals are frequently resistant to the automated, uncritical summarization represented by such indexes and there are sound reasons to use results with caution. Professionals often prefer to give no answer rather than an imperfect answer that can lead to misunderstanding. Layman, however, prefer an imperfect answer to no answer at all. While the use of an index may not be the best way to understand large-scale water quality conditions, it is for many the only way. Professionals must understand the need for imperfect answers, while others need to recognize and accept any answer’s limitations.

Water quality indexing was first proposed and demonstrated back in the 1970s, however, prior to the personal computer era, calculations were somewhat labor intensive and it was not widely used or accepted by many monitoring agencies. As use and limitations were commonly misunderstood, the potential of using an index in communicating status and trends was often overlooked. Evaluation of water quality only in terms of raw data can be very misleading and confusing not only for the general public but also to multiple stakeholders with diverse and sometimes conflicting perspectives. As a result, 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 an attempt to integrate complex analytical data and generate a single number expressing the relative degree of impairment of a given 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.

Limitations. 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 is 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 SDRPF 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.

**SDR Index.** The San Diego River Water Quality Index (SDR WQI) is a number that expresses basic physical-chemical river quality by integrating aggregate data of four key water quality parameters (Temp, pH, SpC and DO) combined with stream discharge (ADF) through determination of “Q-values” (numerical ratings) for each. The resulting normalized values have then been combined, without weighting, to arrive at an overall index ranging in value from 0 to 100. The SDR WQI values, grade, color coding, range and general conventions employed are presented in Table 3.1.

<table>
<thead>
<tr>
<th>SDR WQI (0-100)</th>
<th>GRADE</th>
<th>COLOR CODE</th>
<th>RANGE</th>
<th>PHYSICAL-CHEMICAL WATER QUALITY STANDARDS</th>
<th>GENERAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>75 or Greater</td>
<td>A - Very Good</td>
<td>Dark Blue</td>
<td>25%</td>
<td>Well Above Acceptable WQ Criteria</td>
<td>Least Concern</td>
</tr>
<tr>
<td>50 - 74</td>
<td>B - Good</td>
<td>Light Blue</td>
<td>25%</td>
<td>Exceeds Minimum Acceptable Criteria</td>
<td>Intermediate</td>
</tr>
<tr>
<td>35 - 49</td>
<td>C - Fair</td>
<td>Green</td>
<td>15%</td>
<td>Meets Most Criteria</td>
<td>Greatest Concern</td>
</tr>
<tr>
<td>25 - 34</td>
<td>D - Marginal</td>
<td>Yellow</td>
<td>10%</td>
<td>Meets Some Minimum Criteria</td>
<td></td>
</tr>
<tr>
<td>10 - 24</td>
<td>E - Poor</td>
<td>Brown</td>
<td>15%</td>
<td>Meets Few Minimum Acceptable Criteria</td>
<td></td>
</tr>
<tr>
<td>0 - 9</td>
<td>F - Very Poor</td>
<td>Red</td>
<td>10%</td>
<td>Well Below Minimum Acceptable Criteria</td>
<td></td>
</tr>
</tbody>
</table>

In summary the index has been developed for the purpose of providing a simple and concise expression of regularly monitored physical-chemical water quality data compiled by the SDRPF RiverWatch Team as well as several other monitoring agencies; 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 6 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 San Diego River water quality improvement programs and also assist responsible agencies and organizations in establishing priorities for watershed management purposes.
Annual, monthly and seasonally averaged SDR WQI values are presented on subsequent pages in Table 3.2 by river reach, section, overall (Mid-SDR) average and in Table 3.3 for each water year over the past 6 years (WY05-WY10) of monitoring. The tabulated results are presented temporally in Charts 3.1 (monthly values over past 6 years for each reach plus trend-lines - 12-mo moving average) and 3.2 (6-yr averaged monthly, seasonal and annual values) and spatially in Chart 3.3 by site number in chronological order ascending upstream. The average river distance between individual sites is approximately 1 mile although there is a considerable range (from <0.1 to >1.8 miles) from one locale to another.

Comments/Observations/Findings: The recurrent cyclic pattern of water quality data expressed on a monthly and averaged basis within the lower SDR watershed is evidenced in both Charts 3.1 and 3.2, respectively. Index values at all river monitoring sites, reaches and sections are highest in the winter (wettest period) and lowest in the summer (driest) months. Regardless of time of year or season, WQI values are highest in the Mission Gorge reach/section (Sites 8-11), and lowest in the UMV (Sites 5-7) reach. Eastern upstream sites (8-15T) typically present slightly higher values throughout the year than the downstream western sites (1-7) as evidenced in Chart 3.3.

WQI trend-lines for the SDR reaches, sections and an aggregated average value (Mid-SDR) are shown on Chart 3.1. Values have declined by approximately 10 points over the 6-yr monitoring period in each of the river’s sections and for the entire lower watershed as a whole. Mid-SDR annual average values (35-50) for lower watershed remain in the C (Fair) water quality range. This past water year (WY10) presented the lowest overall Mid-SDR WQI for all river sections as shown in Chart 3.3; with summer values running 40% below the 6-yr seasonal average and the annual value 20% below the 6-yr annual average.

As presented in the three charts, the SDR WQI, extending from Oct 2004 through Dec 2010, typically fluctuates between the low 20’s (E Poor) during the dry season and the high 50’s (B Good) during the winter (wet) season. Greater river discharges (flow) results in improved water quality (higher DO levels and lower specific conductivity and temperature). Water quality values decline significantly as river temperatures and conductivity increase while flow and dissolved oxygen levels decrease during the summer. With lowered temperatures, increased discharges and elevated DO levels, river water quality noticeably improves in the fall and early winter months.

Should WY11 be a year of above average rainfall and runoff, an increase in index value would be anticipated. Continued decline in the WQI can be expected should the watershed experience another below normal wet season. Local climate, river hydrology and water quality, irrespective of specific monitoring site, reach or section of the watercourse, are closely inter-tied. The individual patterns, variances and trends in specific water quality parameters that have been monitored over the past 6 years are presented in Section 4.
Table 3.2 - 6-Yr Average WQI Values by SDR Reach and Section

<table>
<thead>
<tr>
<th></th>
<th>LMV Reach</th>
<th>UMV Reach</th>
<th>MV Section</th>
<th>MG Section</th>
<th>LSB Reach</th>
<th>USB Reach</th>
<th>SB Section</th>
<th>Overall Watershed</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-Yr Average</td>
<td>39</td>
<td>33</td>
<td>36</td>
<td>54</td>
<td>48</td>
<td>33</td>
<td>40</td>
<td>C - Fair</td>
</tr>
<tr>
<td>Maximum</td>
<td>81</td>
<td>75</td>
<td>74</td>
<td>87</td>
<td>78</td>
<td>78</td>
<td>79</td>
<td>B - Good</td>
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<td>Minimum</td>
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<td>8</td>
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<td>26</td>
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<td>24</td>
<td>25</td>
<td>44</td>
<td>39</td>
<td>28</td>
<td>33</td>
<td>D - Marginal</td>
</tr>
<tr>
<td>Nov</td>
<td>42</td>
<td>31</td>
<td>37</td>
<td>59</td>
<td>52</td>
<td>30</td>
<td>41</td>
<td>C - Fair</td>
</tr>
<tr>
<td>Dec</td>
<td>53</td>
<td>46</td>
<td>50</td>
<td>60</td>
<td>53</td>
<td>34</td>
<td>43</td>
<td>B - Good</td>
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<tr>
<td>Jan</td>
<td>58</td>
<td>54</td>
<td>56</td>
<td>57</td>
<td>53</td>
<td>41</td>
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<tr>
<td>Feb</td>
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<td>59</td>
<td>61</td>
<td>52</td>
<td>45</td>
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<td>B - Good</td>
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<tr>
<td>March</td>
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<td>54</td>
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<td>70</td>
<td>63</td>
<td>50</td>
<td>57</td>
<td>B - Good</td>
</tr>
<tr>
<td>April</td>
<td>51</td>
<td>41</td>
<td>47</td>
<td>65</td>
<td>55</td>
<td>40</td>
<td>48</td>
<td>B - Good</td>
</tr>
<tr>
<td>May</td>
<td>34</td>
<td>23</td>
<td>29</td>
<td>58</td>
<td>51</td>
<td>34</td>
<td>43</td>
<td>C - Fair</td>
</tr>
<tr>
<td>June</td>
<td>24</td>
<td>18</td>
<td>21</td>
<td>52</td>
<td>42</td>
<td>28</td>
<td>35</td>
<td>D - Marginal</td>
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<tr>
<td>July</td>
<td>20</td>
<td>15</td>
<td>18</td>
<td>38</td>
<td>36</td>
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<td>28</td>
<td>D - Marginal</td>
</tr>
<tr>
<td>Aug</td>
<td>18</td>
<td>13</td>
<td>16</td>
<td>37</td>
<td>38</td>
<td>19</td>
<td>28</td>
<td>E - Poor</td>
</tr>
<tr>
<td>Sept</td>
<td>18</td>
<td>14</td>
<td>16</td>
<td>47</td>
<td>41</td>
<td>27</td>
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<td>Seasonal Avg:</td>
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<tr>
<td>Fall (O-N)</td>
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<td>27</td>
<td>31</td>
<td>51</td>
<td>41</td>
<td>25</td>
<td>33</td>
<td>C - Fair</td>
</tr>
<tr>
<td>Winter (D-M)</td>
<td>58</td>
<td>53</td>
<td>56</td>
<td>62</td>
<td>55</td>
<td>42</td>
<td>46</td>
<td>B - Good</td>
</tr>
<tr>
<td>Spring (A-M)</td>
<td>42</td>
<td>32</td>
<td>38</td>
<td>62</td>
<td>53</td>
<td>37</td>
<td>45</td>
<td>C - Fair</td>
</tr>
<tr>
<td>Summer (J-S)</td>
<td>20</td>
<td>15</td>
<td>18</td>
<td>43</td>
<td>39</td>
<td>24</td>
<td>31</td>
<td>D - Marginal</td>
</tr>
</tbody>
</table>

WQI Color Code:
- Dk Blue - (A) Very Good, Lt Blue - (B) Good, Green - (C) Fair, Yellow - (D) Marginal, Brown - (E) Poor, Red - (F) Very Poor

Charts 3.1, 3.2 & 3.3

<table>
<thead>
<tr>
<th>Grade</th>
<th>Description</th>
<th>Value Range</th>
<th>Comment</th>
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<td>Very Good</td>
<td>&gt;75</td>
<td>Well Above Stream Standards</td>
</tr>
<tr>
<td>B</td>
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<td>C</td>
<td>Fair</td>
<td>35-50</td>
<td>Meets Acceptable criteria</td>
</tr>
<tr>
<td>D</td>
<td>Marginal</td>
<td>25-35</td>
<td>Slightly Below Acceptable criteria</td>
</tr>
<tr>
<td>E</td>
<td>Poor</td>
<td>10-25</td>
<td>Below Minimum Acceptable criteria</td>
</tr>
<tr>
<td>F</td>
<td>Very Poor</td>
<td>&lt;10</td>
<td>Well Below Minimum Standards</td>
</tr>
</tbody>
</table>

Intermediate | Least Concern | Greatest Concern

Chart 3.1 - Lower San Diego River Water Quality Index (Oct 2004 - Present)

Chart 3.2 - Lower San Diego River Avg WQI Patterns & Trends

Chart 3.3 - SDR WQI Data Range (Sites 1-15T)
Table 3.3 - Average Annual and Seasonal WQI Values by SDR Reach and Section

<table>
<thead>
<tr>
<th>Annual Avg</th>
<th>LMV Reach</th>
<th>UMV Reach</th>
<th>MV Section</th>
<th>MG Section</th>
<th>LSB Reach</th>
<th>USB Reach</th>
<th>SB Section</th>
<th>Overall Watershed</th>
<th>Mid-SDR</th>
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<tr>
<td>WY05</td>
<td>50</td>
<td>44</td>
<td>48</td>
<td>63</td>
<td>41</td>
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<td>33</td>
<td>48</td>
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</tr>
<tr>
<td>WY06</td>
<td>39</td>
<td>33</td>
<td>36</td>
<td>58</td>
<td>51</td>
<td>32</td>
<td>42</td>
<td>43</td>
<td>C - Fair</td>
</tr>
<tr>
<td>WY07</td>
<td>35</td>
<td>27</td>
<td>32</td>
<td>54</td>
<td>54</td>
<td>34</td>
<td>44</td>
<td>40</td>
<td>C - Fair</td>
</tr>
<tr>
<td>WY08</td>
<td>38</td>
<td>30</td>
<td>35</td>
<td>50</td>
<td>50</td>
<td>45</td>
<td>47</td>
<td>41</td>
<td>C - Fair</td>
</tr>
<tr>
<td>WY09</td>
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<td>29</td>
<td>33</td>
<td>50</td>
<td>51</td>
<td>42</td>
<td>46</td>
<td>40</td>
<td>C - Fair</td>
</tr>
<tr>
<td>WY10</td>
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<td>33</td>
<td>49</td>
<td>41</td>
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<td>30</td>
<td>36</td>
<td>C - Fair</td>
</tr>
<tr>
<td>6-Yr Avg</td>
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<td>33</td>
<td>36</td>
<td>54</td>
<td>48</td>
<td>33</td>
<td>40</td>
<td>41</td>
<td>C - Fair</td>
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<th>LMV</th>
<th>UMV</th>
<th>MV</th>
<th>MG</th>
<th>LSB</th>
<th>USB</th>
<th>SB</th>
<th>Overall Watershed</th>
<th>Mid-SDR</th>
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<td>WY05</td>
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<td>70</td>
<td>70</td>
<td>69</td>
<td>42</td>
<td>30</td>
<td>36</td>
<td>61</td>
<td>B - Good</td>
</tr>
<tr>
<td>WY06</td>
<td>55</td>
<td>51</td>
<td>53</td>
<td>62</td>
<td>62</td>
<td>46</td>
<td>54</td>
<td>56</td>
<td>B - Good</td>
</tr>
<tr>
<td>WY07</td>
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<td>43</td>
<td>47</td>
<td>66</td>
<td>67</td>
<td>49</td>
<td>58</td>
<td>54</td>
<td>B - Good</td>
</tr>
<tr>
<td>WY08</td>
<td>59</td>
<td>50</td>
<td>55</td>
<td>54</td>
<td>55</td>
<td>53</td>
<td>54</td>
<td>54</td>
<td>B - Good</td>
</tr>
<tr>
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<td>54</td>
<td>62</td>
<td>60</td>
<td>52</td>
<td>56</td>
<td>56</td>
<td>B - Good</td>
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<tr>
<td>WY10</td>
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<td>55</td>
<td>56</td>
<td>59</td>
<td>47</td>
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<td>51</td>
<td>B - Good</td>
</tr>
<tr>
<td>6-Yr Avg</td>
<td>58</td>
<td>53</td>
<td>56</td>
<td>62</td>
<td>55</td>
<td>42</td>
<td>49</td>
<td>56</td>
<td>B - Good</td>
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<table>
<thead>
<tr>
<th>Summer</th>
<th>LMV</th>
<th>UMV</th>
<th>MV</th>
<th>MG</th>
<th>LSB</th>
<th>USB</th>
<th>SB</th>
<th>Overall Watershed</th>
<th>Mid-SDR</th>
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<tbody>
<tr>
<td>WY05</td>
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<td>22</td>
<td>26</td>
<td>57</td>
<td>38</td>
<td>20</td>
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<td>34</td>
<td>D - Marginal</td>
</tr>
<tr>
<td>WY06</td>
<td>20</td>
<td>13</td>
<td>17</td>
<td>50</td>
<td>46</td>
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<td>WY07</td>
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<td>16</td>
<td>40</td>
<td>39</td>
<td>19</td>
<td>29</td>
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<td>D - Marginal</td>
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<td>WY08</td>
<td>20</td>
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<td>19</td>
<td>38</td>
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<td>38</td>
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<td>12</td>
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<td>28</td>
<td>D - Marginal</td>
</tr>
</tbody>
</table>

WQI Color Code:
- Dk Blue - (A) Very Good,
- Lt Blue - (B) Good,
- Green - (C) Fair,
- Yellow - (D) Marginal,
- Brown - (E) Poor,
- Red - (F) Very Poor
Section 4 - WQM Data Patterns, Variances and Trends

A. Temperature (Temp) - Chemical and biological processes and their rates depend upon temperature. Aquatic organisms from microbes to fish are dependent on certain temperature ranges for optimal health. In addition to its own toxic effect, temperature also affects the solubility and, in turn, toxicity of many other chemical constituents. Generally, the solubility of solids increases with increasing temperature, while gases such as oxygen tend to be more soluble in cold water. Simply put, “the warmer the water, the less the DO and lower the general WQ, and vice versa.”

Monthly water temp patterns at all reaches and sections of the river are cyclic being highest in summer months (June-Sept) and lowest in the winter (Dec-March) as evidenced in Chart A4.1. The typical seasonal patterns in temperature variation within the lower watershed are summarized in Chart A4.2. As shown in Chart A4.3, during any time of the year, water temps are slightly lower upstream, in eastern reaches, than to the west (downstream), due to warming/cooling by the landmass as well as ambient air temps. A minor exception in this pattern is at Site 5 (Ward Rd) where recorded temps are slightly lower during extended dry-weather portions of the year and slightly higher during cooler periods than measured upstream at sites 6 (Kaiser Ponds) and 7 (ABF). This anomaly is likely due to groundwater replenishment/return flows along the river channel in the reach where Alvarado Creek joins the main course between Kaiser Ponds and Ward Rd.

Average summer period river water temps range between 21 and 24°C (70-75°F), while average winter season temps range between 12 and 14°C (54-57°F) depending on the specific site. The 6-yr average annual temperature of the river is 17.65°C (63.7°F); with West (Mission Valley) and East (Mission Gorge/ Santee Basin) site temps running approximately 1°C above and below the SDR Avg., respectively. There is little evidence of a statistically significant variance in average annual, winter and summer period temps at any river sites, reaches or sections over the 6-yr period. The highest and lowest recorded river temps during the entire monitoring period were 29.2°C (84.5°F) in July 2006 (Site 4 – FSDRIP) and 7.6°C (45.7°F) in Jan 2006 (Site 8 - Mission Trails@Jackson), respectively.

Although temperature itself is not a direct indicator of water quality, as mentioned above, it affects the amount of DO that can be carried by the river and available for utilization by most aquatic life forms. Cooler water temps allow a greater amount of DO to be entrained, whereas the maximum amount of DO absorbed in water is reduced as water temperatures increase. For example, the saturation level of DO declines from 12.8 mg/L at 5°C (41°F) to less than 7.6 mg/L at 30°C (86°F). Monthly water temps over the entire monitoring period for both reaches and sections as well as an overall SDR average are presented temporally and spatially in the three charts (A4.1, A4.2 & A4.3) on the following page.

B. pH – pH is a term used to indicate the alkalinity (- ions) or acidity (+ ions) of water as ranked on a log scale from 1.0 to 14.0, where the value 7.0 is neutral. Acidity increases as the pH gets lower. Although pH affects many chemical and biological processes in water, a large variety of aquatic animals prefer a range of 6.5 to 8.4. Outside this range, pH commonly reduces biological diversity and reproduction rates. Low pH (more acidic) can also allow toxic elements and compounds to become mobile or 'available' for uptake by aquatic plants and animals.

Monthly pH values and variations by river reach, section and water year are presented in Charts B4.1, B4.2 & B4.3. As shown in B4.1, the range in average pH values throughout the year, as well as from reach-to-reach, is fairly narrow (7.3 to 7.9). There is an insignificant variance in annual average and seasonal values from month, season or water year to the next as shown in B4.2.

Charts A4.1, A4.2 & A4.3

Temperature, °C

-25 Above Normal Range
-20 to -25 Summer Norms
15 to 20 Spring & Fall Norms
10 to 15 Winter Norms
0 to 10 Below Normal Range

Chart A4.1 - Monthly Temps by SDR Reach

Chart A4.2 - Average Monthly, Seasonal and Annual Temps by SDR Reach

Chart A4.3 - Average 6-Yr Temp Ranges by SDR Site, Reach and Section
B - Lower SDR pH Data (Coc. 2004 - Dec. 2010)
Charts B4.1, B4.2 & B4.3

- pH > 8.5: Above Normal
- 6.5 - 8.4: Normal Range
- < 6.5: Below Normal

Chart B4.1 Monthly pH by SDR Segment
- Mid-SDR (Sites 1-15T)
- Mission Valley (Sites 1-7)
- Mission Gorge (Sites 8-10)
- Santee Basin (Sites 11-15T)
- Mid-SDR Trendline (12 mo Moving Avg.)

Chart B4.2 - Average Monthly, Seasonal and Annual pH by SDR Reach
- WY 2005-2010
- Mid-SDR 6-yr Avg
- Lower (W) Mission Valley
- Upper (E) Mission Valley
- Mission Gorge
- Lower (W) Santee Basin
- Upper (E) Santee Basin

Chart B4.3 - Average 6-Yr pH Data Distribution by SDR Site, Reach & Section
- Maximum
- 0-25%
- Below Normal
- Annual Average

SDR Water Quality Monitoring Report
SDRPF RiverWatch
December 2010

19
Individual sites as shown in B4.3, present a reasonably wide range in min-to-max values (6.2 to 8.8), however, seasonal (winter-to-summer) values as well as annual averages do not vary significantly from site to site.

Average pH of the river within the lower watershed is 7.44, indicating a slightly alkaline (7.0 being neutral) water. Winter (higher flow) pH averages are slightly lower (less alkaline) than evident during extended low flow (summer) periods. Downstream sites (Mission Valley) are also just slightly higher (less acidic or more alkaline) in pH than the upstream sections (Mission Gorge and Santee Basin sites). Seawater typically ranges in pH between 8.5 and 10, whereas freshwater streams in Southern California commonly range in pH between 6.5 and 8.5. All pH measurements taken at SDR monitoring sites were found well within the acceptable range. Highest pH values within the lower watershed were measured in Forester Creek (Site 15T).

C. **Specific Conductivity (SpC)** – Conductivity is a measure of the ability of water to pass an electrical current. Conductivity in water is affected by the presence of inorganic dissolved solids (+ and - ions). SpC is also affected by temperature: the warmer the water - the higher the conductivity.

Monthly SpC values also describe recurrent cyclic patterns at all sites/sections, being highest in summer months during lowest flow and lowest during the winter period when flows are greatest. In any given month SpC values are lowest upstream and steadily increasing as moving downstream. Highest SpC values are measured at Site 1 where estuarine waters mix with the upstream freshwater river discharge. Site 1W values are often greater than measured at Site 1E (u/s side of the encased sewer line) dependent on the tidal condition. The repetitive seasonal patterns in SpC values are shown in Charts C4.1 and C4.2 for each reach and river section.

Conductivity is also a reasonably accurate indication of the amount of total dissolved solids (TDS) or salts carried in water. The relationship between SpC and TDS for SDR waters is as follows: TDS (in mg/L) = 670 (a constant) x SpC (in uS/cm) or TDS (in ppm) = 0.67 SpC (in mS/cm). Measuring SpC allows computation of TDS and thus a reasonable estimate (based on flow) of the total salt load carried by the river. SpC, when factored with Temp and DO values, also provides a basis for calculating the water quality index (WQI) for sites, reaches and sections within the system as previously presented in Section 3. Typical conductivity and TDS ranges for various water classifications/types in California are listed in Table C4.1.

<table>
<thead>
<tr>
<th>Type</th>
<th>SpC, mS/cm</th>
<th>TDS, mg/L (or ppm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distilled water</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Rainwater</td>
<td>0.05 - 0.20</td>
<td>35 - 135</td>
</tr>
<tr>
<td>Freshwater streams (upper San Diego Co watersheds)</td>
<td>0.20 – 0.75</td>
<td>135 - 500</td>
</tr>
<tr>
<td>Freshwater streams (below impoundments)</td>
<td>0.75 - 2.2</td>
<td>500 – 1,500</td>
</tr>
<tr>
<td>Coastal streams of So. California</td>
<td>2.2 – 7.5</td>
<td>1,500 – 5,000</td>
</tr>
<tr>
<td>Estuaries and brackish groundwater</td>
<td>10.0 – 45.0</td>
<td>7,000 – 30,000</td>
</tr>
<tr>
<td>Seawater</td>
<td>&gt;45.0</td>
<td>&gt;30,000</td>
</tr>
</tbody>
</table>
Charts C4.1, C4.2 & C4.3

SpCond, mS/cm
TDS, mg/L

Chart C4.1 Average Monthly Specific Conductivity by SDR Reach

Chart C4.2 Average Monthly, Seasonal and Annual Specific Conductivity

Chart C4.3 Lower SDR Watershed 6-Yr SpC & TDS Profiles (WY05-WY10)
A summary of monthly SpC and TDS over the 6-yr monitoring period for the main river sections and an overall SDR average is provided in Chart C4.1. Salinity levels for all three sections slowly increased between 2005 and 2009, most noticeably in Mission Valley. Overall average annual TDS increased by about 400 mg/L from 1,500 mg/L (2.2 mS/cm SpC) in WY05 to 1,900 mg/L (2.8 mS/cm) in WY09.

River salinities began decreasing this past year (2010) as the watershed experienced slightly above normal rainfall and extended runoff. The overall 6-yr average salinity of the SDR is 1,560 mg/L (2.33 mS/cm SpC). Mean summer and winter salinities in Mission Valley range from 2,700 mg/L down to 1,300 mg/L over the 6 years. Santee Basin summer salinity levels are approximately 60 percent of those for Mission Valley whereas winter levels are approximately 70 percent of downstream values.

Average winter-to-summer period SpC values range from slightly above 3.0 mS/cm to a low of approximately 1.0 mS/cm. The annual average SpC value lies in the 2.0-2.2 mS/cm range. September presents the highest value month over the 6-yr period while February the lowest. There is a slight trend toward greater average annual values over the years driven by higher summer period values. The lowest SDR annual average of 2.2 mS/cm (10 % below average) occurred in WY06, the highest 2.5 mS/cm (10% above average) in WY09 as shown in Chart C4.3.

D. Dissolved Oxygen (DO) and Percent of Saturated DO (DO%Sat) – DO, the amount of gaseous oxygen (O2) dissolved in solution, is one of the most important parameters in aquatic systems. O2 is an absolute requirement for the metabolism of aerobic organisms and also influences inorganic chemical reactions. River systems both produce and consume oxygen. Water gains oxygen from the atmosphere and from plants as a result of photosynthesis. Running water, because of its churning action (aeration), rapidly dissolves more oxygen than still water. Respiration by aquatic animals, decomposition and various chemical reactions all consume oxygen. Aquatic animals are most vulnerable to lowered DO levels in early morning on hot summer days when flows are low, water temperatures are high, and aquatic plants have not been producing oxygen since sunset. DO can be expressed as an absolute concentration (in mg/L, ppm, etc) or as a percent of the total amount that is soluble at its saturation point that is dependent on temperature, atmospheric pressure, pH and conductivity. Both DO values are measured and recorded in the field.

Monitored monthly and seasonal dissolved oxygen (DO) and Percentage of DO Saturation (DO%Sat) patterns together with annual trends over the past 6 years are presented in Charts D4.1, D4.2 & D4.3. DO values vary considerably over time as well as from one site to another. The DO values provide the best overall single indication of general health of the river in terms of oxygen available for aquatic life (respiration). Highest DO values over the past 6 years have been consistently measured in the Mission Gorge section with winter highs averaging above 10 mg/L (>95%Sat); the lowest at Kaiser Ponds (Site 6) and River Gardens (Site 4) where summer values often decline to below 3 mg/L (<35%Sat). The 6-yr average (mean) DO value for the entire river is 6.56 mg/L (68%Sat), however, as stated, the variances over time and distance along the watercourse are notable.

Summer period DO values measured at most river sites lie in the 3.0 to 6.0 mg/L range (35 to 70%Sat), whereas winter season values are typically between 7.0 and 10 mg/L (70 to 95%Sat). Minimum DO levels of less than 1.0 mg/L (<10%Sat) have been measured at sites 3 (Fashion Valley), 5 (Kaiser Ponds) & 6 (Admiral Baker Field) in August and September. Maximum levels, in the 13 to 14 mg/L (>150%Sat) range, have been measured during winter periods (Dec-March) at sites 8 (Mission Trails), 10 (OMD) and 4 (FSDRIP). DO values are consistently higher where the river is moving swiftly and can re-aerate with higher gradients. DO levels drop significantly once waters reach the Upper Mission Valley reach at Admiral Baker Field where stream velocities decline. River DO levels recover somewhat past Qualcomm
Stadium and into the mid-valley (FSDRIP) portion, however, as velocity/current diminishes through the lower reach, DO levels again decline.

**Chart D4.1** presents monthly DO and %DO Sat levels for the main river reaches and segments as well as showing an overall SDR average and trends in each. Average annual SDR DO levels declined from nearly 7 mg/L (73% Sat) in WY06 to a low of 5 mg/L (55% Sat) in WY10. DO levels have begun to improve within all reaches and sections over the past several months as flows have increased.

The present SDR average DO value for the Lower watershed of 6 mg/L (70% Sat) is nearly the same as the 6-yr annual average. Oxygen levels can be expected to further improve with above normal river flows. However, another year of protracted dry weather would likely result in further declines.

As shown in **Chart D4.2**, SDR average and wintertime DO levels were highest in WY05 (nearly 40% above the annual norm) and lowest in WY10. This past year also presented the lowest summer period average DO levels of nearly 25% below the annual norm. DO levels indicate that overall river water quality is greatly dependent on flushing and regenerative actions during wet-weather season as well as maintenance of minimum base flows throughout the summer period. **Chart D4.3** presents a profile of average DO and %DOSat values for each site, reach and section extending over the 6-yr monitoring period.

**E. WQM Data Summary:**

A temporal (WY05 through WY10) summary of SDRPF RiverWatch water quality monitoring data for overall Mid-SDR (Lower SDR Watershed) annual, summer and winter values is provided in **Table 1.4**. The percent change in most recent (WY10) values from the previous year (WY09), from the initial year (WY05) and from the 6-year average is presented for each WQ parameter. Overall annual average physical-chemical water quality within the lower watershed, as expressed by the WQI, has declined by approximately 15 percent over the past 6 years. Winter season values (Dec-March) are down approximately 8 percent, while summer values (June-Sept) are down 21 percent over the 6-yr period. The annual index for WY10 is down 10 percent from the previous (WY09) year’s average.

A spatial (by distance and reach) summary of SDRPF RiverWatch water quality monitoring data for average annual, summer and winter values for each parameter is provided in **Table 1.5**. The Mission Gorge reach/section consistently presents the best water quality within the lower watershed, whereas the Upper Mission Valley reach (just downstream) presents the lowest. The lower/west section of the river (Mission Valley) consistently presents poorer water quality both on an average-annual and summer-season basis than evidenced in either upstream section. Overall (Mid-SDR) 6-yr average water quality within the lower SDR watershed ranges from low ‘Marginal’ (D-) in summer to ‘Good’ (B) in winter, or ‘Fair’ (C) expressed on a average annual basis.

Winter and average annual SDR water quality in WY11 is anticipated to generally improve should this year continue to be an above average rainfall, runoff, river discharge year. Summer water quality results could, however, continue to remain poor, should next summer’s dry-weather flows be significantly below seasonal norms. It is intended that dry weather flows and summer-time water quality relationships will be further explored and assessed by the RiverWatch Team in 2011.

Questions regarding this WQM database or interpretation of results can be directed to the attention of the report’s author, John C. Kennedy, through contacting SDPRPF at [info@SanDiegoRiver.org](mailto:info@SanDiegoRiver.org), or calling the WaterWatch Coordinator at 619-297-7380.

Charts D4.1, D4.2 & D4.3

---

**Table:**

<table>
<thead>
<tr>
<th>DO mg/L</th>
<th>DO%Sat %</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;8.5</td>
<td>&gt;90%</td>
</tr>
<tr>
<td>7.0-8.4</td>
<td>75 - 89</td>
</tr>
<tr>
<td>6.0-6.9</td>
<td>55 - 74</td>
</tr>
<tr>
<td>5.0-5.9</td>
<td>35 - 54</td>
</tr>
<tr>
<td>4.0-4.9</td>
<td>15 - 34</td>
</tr>
<tr>
<td>&lt; 4.0</td>
<td>&lt; 15%</td>
</tr>
</tbody>
</table>

**Legend:**
- **A**: Very Good
- **B**: Good
- **C**: Fair
- **D**: Marginal
- **E**: Poor
- **F**: Very Poor

**Charts:**

- **Chart D4.1 - SDR Average Monthly Dissolved Oxygen**
  - DO Average, mg/L
  - DO Percent Saturation, %
  - Mid-SDR Avg
  - LMV
  - UMV
  - Mission Gorge
  - Lower (W) Mission Valley
  - Upper (E) Mission Valley
  - Lower (W) Santee Basin
  - Upper (E) Santee Basin
  - Mid-SDR Avg DO%Sat Trendline (12mo Mov. Avg.)

- **Chart D4.2 - SDR Segment 6-Yr Avg DO (WY05-WY10)**
  - DO Average, mg/L
  - DO Percent Saturation, %
  - Mid-SDR Segment 6-Yr Avg DO Profile

- **Chart D4.3 - SDR 6-Yr DO Profile (WY05-WY10)**
  - Annual Avg. DO
  - Maximum
  - Winter Avg.
  - Median DO%Sat
  - Summer Avg.
  - Minimum

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**Explanation:**

- The charts display the dissolved oxygen (DO) levels in the Santee Diego River (SDR) from October 2004 to December 2010. The data is categorized by months and years, with averages and trends over the 6-year period (WY05-WY10).

- The charts highlight different segments of the river, such as Mission Gorge and the Santee Basin, with their respective DO levels and percent saturation.

- The DO levels are color-coded to indicate the quality of water, with ranges from very good (A) to very poor (F).

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**Summary:**

The SDRPF RiverWatch report provides a detailed analysis of the dissolved oxygen levels in the Santee Diego River, emphasizing the importance of sustained monitoring to maintain water quality standards.
Abbreviations:

AADF - Average Annual Daily Flow
ADF – Average Daily Flow
AF – acre-foot (1 AF = 43,560 cf = 325,900 gal)
amsl – above mean sea level (elevation)
Avg.– Average
cfs - cubic feet per second (flow/discharge)
Ck – Creek
CY - Calendar Year (Jan 1 - Dec 31)
DO – Dissolved Oxygen
DO%Sat – DO expressed as percentage of DO level at saturation point
d/s – downstream, u/s – upstream
E – East; W –West
SpC – Specific Conductivity (also Conductivity or Conductance)
Elev. - Elevation
FSDRIP – First San Diego River Improvement Project
ft. – feet;  mi. - mile
gal – gallon;  gpm – gallons per minute; mgd – million gallons per day
L/U – lower/upper (as in river reaches)
lbs - pounds
max/min – maximum/minimum
mg/L – milligrams per liter
mS/cm –milli-Semiens per centimeter (1 mS/cm = 1000 uS/cm)
MV – Mission Valley;  MG – Mission Gorge; SB – Santee Basin (river sections)
NO3 - Nitrate (a nutrient)
us/cm –micro-Semiens per centimeter (1 us/cm = 0.001 mS/cm)
PDMWD – Padre Dam Municipal Water District
PO4 - Phosphate (another key nutrient)
ph– measure of acidity or basicity (decimal logarithm of hydrogen ion activity)
ppb – parts per billion
ppm – parts per million
SB – Santee Basin
SD – Standard Deviation (also San Diego)
SDR – San Diego River
SDRPF – San Diego River Park Foundation
SpC - Specific Conductivity
sqft – square feet
TDS – Total Dissolved Solids
Temp – Temperature
TN/TP – Total Nitrogen/Total Phosphorus (nutrients)
tppd – thousand pounds per day
USGS – U.S. Geological Survey
WQI – Water Quality Index
WY – Water Year (Oct 1 – Sept 31)
% - percent
°C – degrees Celsius,
°F – degrees Fahrenheit

Formulas:

°C = (°F-32)x5/9
°F = (°C*9/5)+32
Flow (cfs) = Velocity (ft/sec)*Cross-sectional area (sq ft)

Constituent Load (lbs/day) = Flow (mgd)*Constituent Concentration (mg/L)*8.34;  or = Flow (cfs)*Concentration (mg/L)*5.39

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

For the lower SDR watershed - the DO/DO%Sat relationship is defined by the following polynomial equation: DO(mg/L)=DO%Sat(%)*[0.0041*T^2-0.0127*T+14.157]/100; or DO%Sat (%) = DO(mg/L)*100/[0.0041* T^2 -0.0127T+14.157], (where T-temperature is in °C). Other variables, incl. barometric pressure, elevation and conductivity, have negligible impact on the DO/DO%Sat relationship within the Lower SDR watershed.

SDR Water Quality Index (WQI) is computed through the following formulas:

WQI = DO%Sat/log(SpC)*2.5*Tfactor*Qfactor; where SpC is expressed in us/cm; the T factor = .002T^3-.0756T^2+.7264T-1.0687 and the Q-factor = 0.5537+0.1728LnQ-0.0015LnQ^2 (Mission Valley);
= 0.7074+0.1516LnQ-0.0041LnQ^2 (Mission Gorge);
= 0.7687+0.1467LnQ-0.0069LnQ^2 (Santee Basin);
=0.7777+0.222Ln0.7687+0.1467LnQ-0.0069LnQ^2-0.051LnQ^3 (Tributaries)

Water Equivalents:

1 cf = 7.48 gal = 62.4 lbs of water
1 AF = 43,560 cf = 325,900 gal
1 psi = 2.31 ft of water
1 mg/L = 1 ppm (in water)
1 lbs = 450 gpm = 0.64632 mgd =1.98 AF/day = 724 AFY
1 mgd = 694 gpm =1.547 cfs = 3.06 AF/day = 1,120 AFY
1000 gpm = 1.436 mgd = 2.23 cfs = 4.42 AF/day = 1,614 AFY
1 mS/cm = 1000 us/cm
1 inch = 25.4 mm
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