Ammonia-Nitrogen (NH3-N):

The water quality effluent limitations for Ammonia are based either on DO-based effluent limits or on toxicity-based standards, whichever are more stringent. The toxicity-based effluent limitations are based on Reg. 2.512 and are calculated using the procedure in an ADEQ Interoffice Memorandum from Mo Shafii to NPDES Permit Engineers dated 3/28/2005 as follows using the following mass balance equation:

\[(1) \quad (Cu \times Qu) + (Ce \times Qe) = (Cd \times Qd)\]

Rearranging to solve for Ce yields the following equation:

\[(1) \quad Ce = \frac{(Cd \times Qd) - (Cu \times Qu)}{Qe}\]

**May-October**

Qu = upstream critical flow of receiving stream (7Q10) = (819 cfs)(0.25) = 204.75 cfs
Qe = effluent design flow = 16 MGD = 24.72 cfs
Qd = Qu + Qe = 229.47 cfs
Cu = upstream concentration = 0 mg/L, based on geometric mean of 2011-2012 values recorded at ADEQ monitoring station ARK0029 at Murray Dam.
Ce = effluent concentration necessary to meet standards (determined with calculation)
Cd = downstream concentration = Chronic Ammonia toxicity criterion = 1.3 mg/L (30 day average) and 3.2 mg/L (7-day average) @ 32°C and pH = 7.6 (from Attachment 2 in memo referenced above)

Using equation (2), toxicity-based concentration limits (Ce) are computed as follows:

30 day average Ce = \[
\frac{(1.3 \times 229.47) - (0 \times 204.75)}{24.72} = 12.1 \text{ mg/L (May-Oct)}
\]
7-day average Ce = \[
\frac{(3.2 \times 229.47) - (0 \times 204.75)}{24.72} = 29.7 \text{ mg/L (May-Oct)}
\]

**November - March**

Qu = upstream critical flow of receiving stream (7Q10) = (1440 cfs)(0.25) = 360 cfs
Qe = effluent design flow = 16 MGD = 24.72 cfs
Qd = Qu + Qe = 384.72 cfs
Cu = upstream concentration = 0 mg/L, based on geometric mean of 2011-2012 values recorded at ADEQ monitoring station ARK0029 at Murray Dam.
Ce = effluent concentration necessary to meet standards (determined with calculation)
Cd = downstream concentration = Chronic Ammonia toxicity criterion = 4.1 mg/L (30 day average) and 10.3 mg/L (7-day average) @ 14°C and pH = 7.6 (from Attachment 2 in memo referenced above)

Using equation (2), toxicity-based concentration limits (Ce) are computed as follows:

30 day average Ce = \[
\frac{(4.1 \times 384.72) - (0 \times 360)}{24.72} = 63.8 \text{ mg/L (Nov-Mar)}
\]
7-day average Ce = \[
\frac{(10.3 \times 384.72) - (0 \times 360)}{24.72} = 160.3 \text{ mg/L (Nov-Mar)}
\]
April

Qu = upstream critical flow of receiving stream (7Q10) = (1440 cfs)(0.25) = 360 cfs
Qe = effluent design flow = 16 MGD = 24.72 cfs
Qd = Qu + Qe = 384.72 cfs
Cu = upstream concentration = 0 mg/L, based on geometric mean of 2011-2012 values recorded at ADEQ monitoring station ARK0029 at Murray Dam.
Ce = effluent concentration necessary to meet standards (determined with calculation)
Cd = downstream concentration = Chronic Ammonia toxicity criterion = 1.3 mg/L (30 day average) and 3.2 mg/L (7-day average) @ 32°C and pH = 7.6 (from Attachment 2 in memo referenced above)

Using equation (2), toxicity-based concentration limits (Ce) are computed as follows:

30 day average Ce = [(1.3 x 384.72) – (0 x 360)] / 24.72 = 20.2 mg/L (April)
7-day average Ce = [(3.2 x 384.72) – (0 x 360)] / 24.72 = 49.8 mg/L (April)

The above calculated ammonia toxicity limits for each season are compared with the oxygen-based ammonia limits from the MultiSMP Model dated 7/19/2013, and the more stringent limits of the two values are included in the permit for the monthly average and 7-day average. This comparison is tabulated as follows:

<table>
<thead>
<tr>
<th></th>
<th>Oxygen-based (mg/L)</th>
<th>Toxicity-based (mg/L)</th>
<th>Most Stringent (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Monthly Avg</td>
<td>7-Day Avg</td>
<td>Monthly Avg</td>
</tr>
<tr>
<td>May-Oct</td>
<td>15</td>
<td>22.5</td>
<td>12.1</td>
</tr>
<tr>
<td>Nov-Mar</td>
<td>15</td>
<td>22.5</td>
<td>63.8</td>
</tr>
<tr>
<td>April</td>
<td>15</td>
<td>22.5</td>
<td>20.2</td>
</tr>
</tbody>
</table>

*If the most stringent monthly average is determined to be 15 mg/l or greater, ammonia limits are not normally included in the permit. Alternatively, in these cases normally only a BOD5 limit is included in the permit which measures both the carbonaceous and nitrogenous portions of the oxygen-demanding organic level in the effluent. In this particular permit, an ammonia limit for May-October was deemed necessary to meet toxicity-based standards, but ammonia limit for November-April was deemed unnecessary since the most stringent value necessary to meet both toxicity-based and oxygen-based standards was 15 mg/L.