Appendix L
Nitrate Analysis

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DEQ reviewed the full suite of Zollner Creek nitrate data to build a better understanding of nitrate sources and nitrate transport into surface water. Combining the USGS and DEQ data sets provides data collected from 1989 - 2006.

A longitudinal comparison of nitrate concentrations (Figure L - 1) does not reveal statistically significant differences between the median nitrate-N concentrations in samples collected from various sites along Zollner Creek. Only one site, however, Zollner Creek at Monitor McKee Road (near Mt. Angel at river mile 0.3) has a large data set. The highest nitrate-N concentrations were measured at the Monitor McKee Road site.

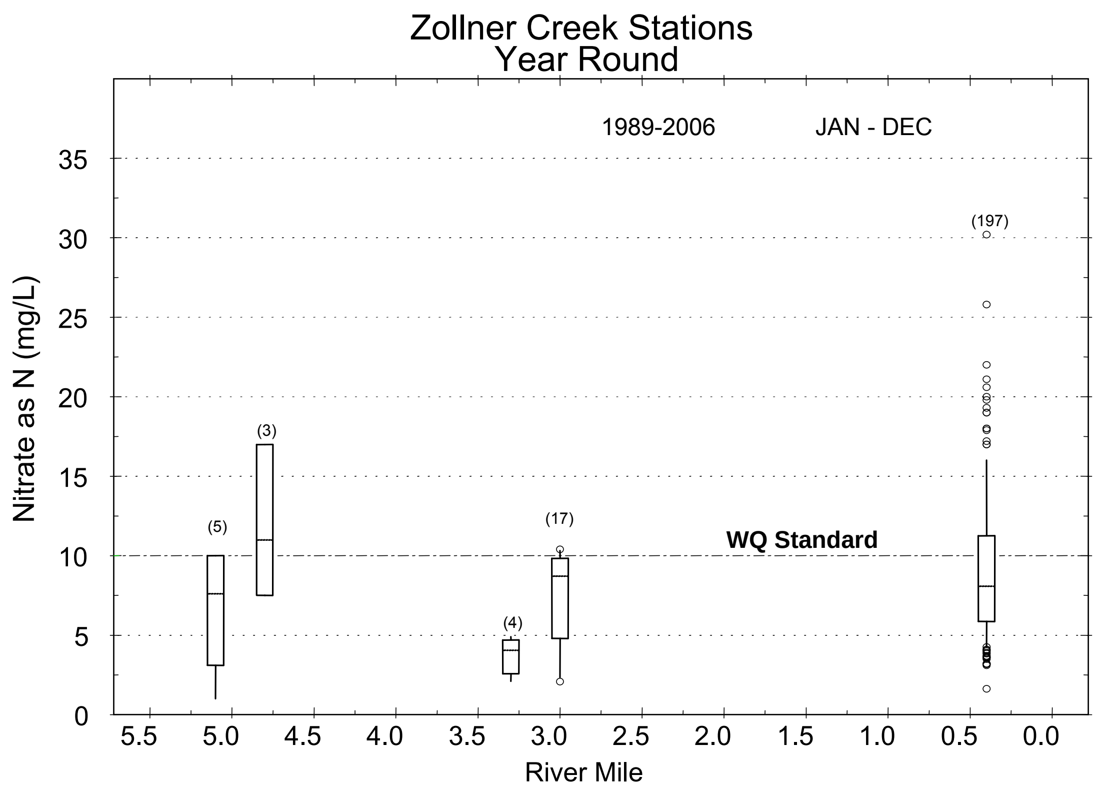

Figure L - 1: Zollner Creek longitudinal plot of nitrate-N concentration distribution.

Table L - 1 summarizes the nitrate data that DEQ and the USGS have collected from Zollner Creek at Monitor McKee Road (near Mt. Angel at river mile 0.3). Since DEQ found a statistically significant difference in nitrate concentrations measured during the third quarter (July – September), separate statistics for the third quarter and the remaining three quarters of the year are also presented in Table L - 1.

Table L - 1: Statistics from combined USGS and DEQ data sets from Zollner Creek at Monitor McKee Road (near Mt. Angel).

Time of sample collection	Sample Size (n)	NO_3 –N (mg/L) Median	NO_3 –N (mg/L) Minimum	NO_3 –N (mg/L) Maximum
Year round	227	7.7	1	30
Third quarter (July – September)	58	5.8	1.6	19
First, Second, Fourth quarters (October – June)	169	9	1	30

DEQ used a Seasonal Kendall test (WQ Hydro, Aroner, 1997) with an 80% confidence interval to review the data for trends. Trend analysis of the full data set does not reveal a statistically significant change in concentrations when year round data are graphed (Figure L - 2)[1]. Recent data (collected after 2000) are more variable and include higher maximum concentrations. This may be due, in part, to more frequent sampling, which increases the likelihood of detecting variability.

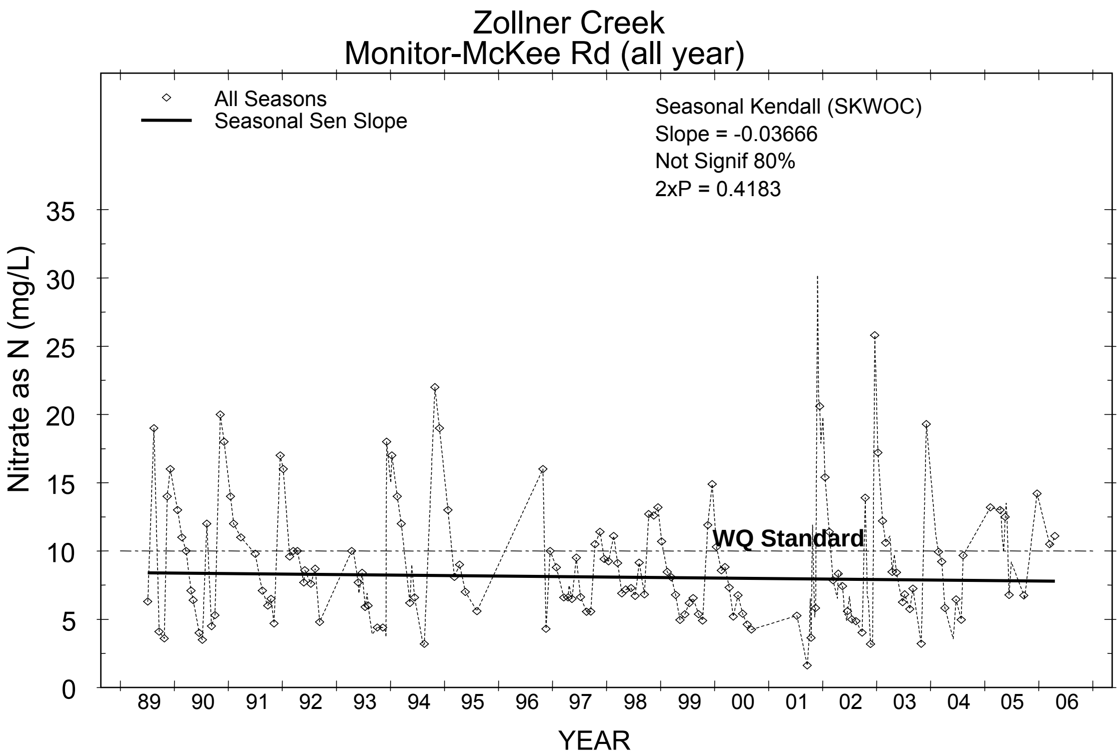

Figure L - 2: Zollner Creek nitrate-N concentrations 1989 and 2006.
Data do not show a statistically significant trend at the 80% confidence level.

Plots of the data separated by quarters (Figure L - 3 through Figure L - 6) do not indicate statistically significant trends in any season except the summer quarter (July – September). For the summer months, data collected indicates a downward trend at the 80% confidence level (2xP=0.1628)[2]. While the probability is not high that this downward trend actually exists, the difference between apparent summer and winter data trends does agree with other analyses that show seasonal differences in data.

[1] The 2xP value shown on the trend plot is compared to a pre-determined error level which represents what is an acceptable chance of an incorrect conclusion (known as the significance level, α). For the 80% confidence level selected for this analysis, the significance level is 0.20. This indicates that the following is an acceptable chance of error: a 0.10 maximum probability of error in concluding that a significant increasing trend exists and a 0.10 maximum probability of error in concluding that a significant decreasing trend exists (for an overall error potential of 0.20). Since the since 2xP of 0.418 is not less than 0.20, it is concluded that there is no statistically significant trend. Even so, the 2xP result of 0.418 indicates that there is only a 41.8% probability that a trend does not exist in the population. Therefore, it is still quite possible that trend exists.

[2] Since the since 2xP of 0.1628 is less than 0.20, it is concluded that, at an 80% confidence level, there is a statistically significant trend. The 2xP result of 0.1628 indicates that there is a small (16.38%) probability that a trend does not exist.

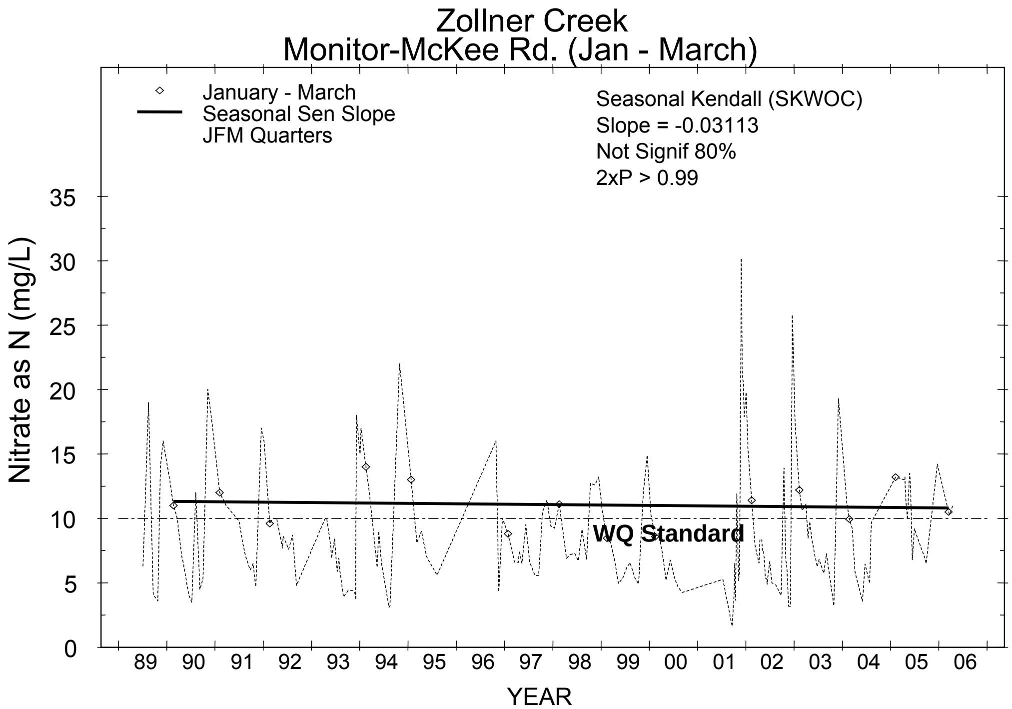

Figure L - 3: Zollner Creek nitrate concentrations, January through March 1989 - 2006.
The data do not indicate a statistically significant trend.

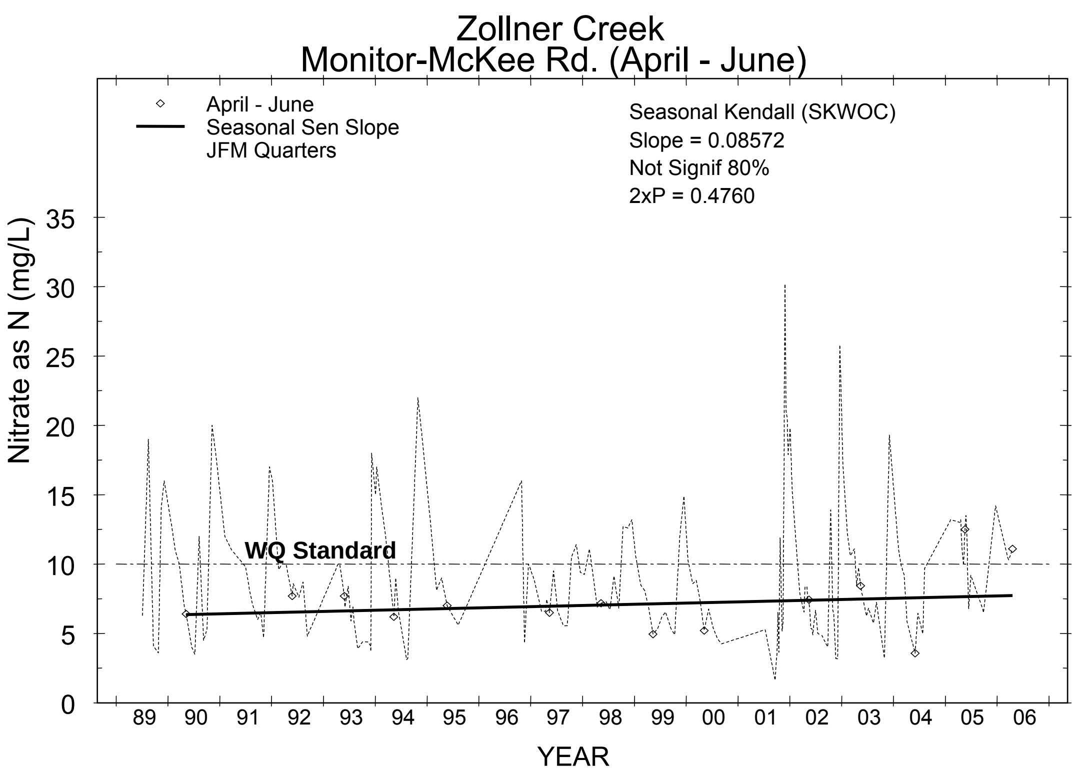

Figure L - 4: Zollner Creek nitrate-N concentrations, April through June, 1989 - 2006.
The data do not indicate a statistically significant trend.

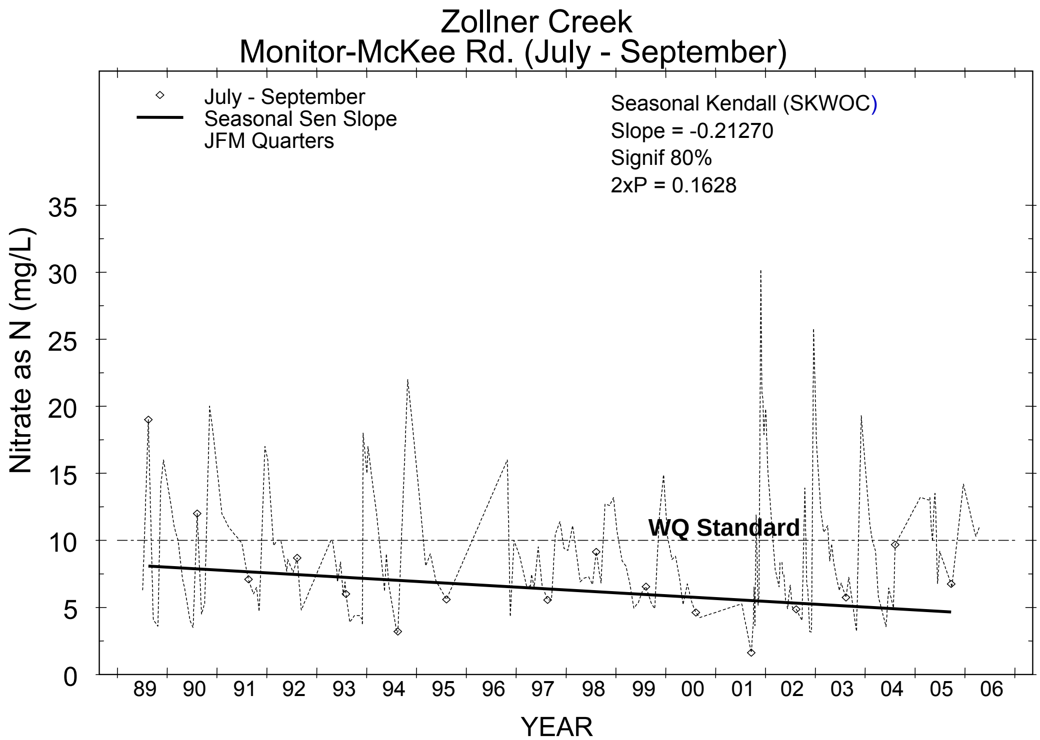

Figure L - 5: Zollner Creek nitrate-N concentrations, July through September, 1989 - 2006. The data indicate a statistically significant downward trend at the 80% confidence level.

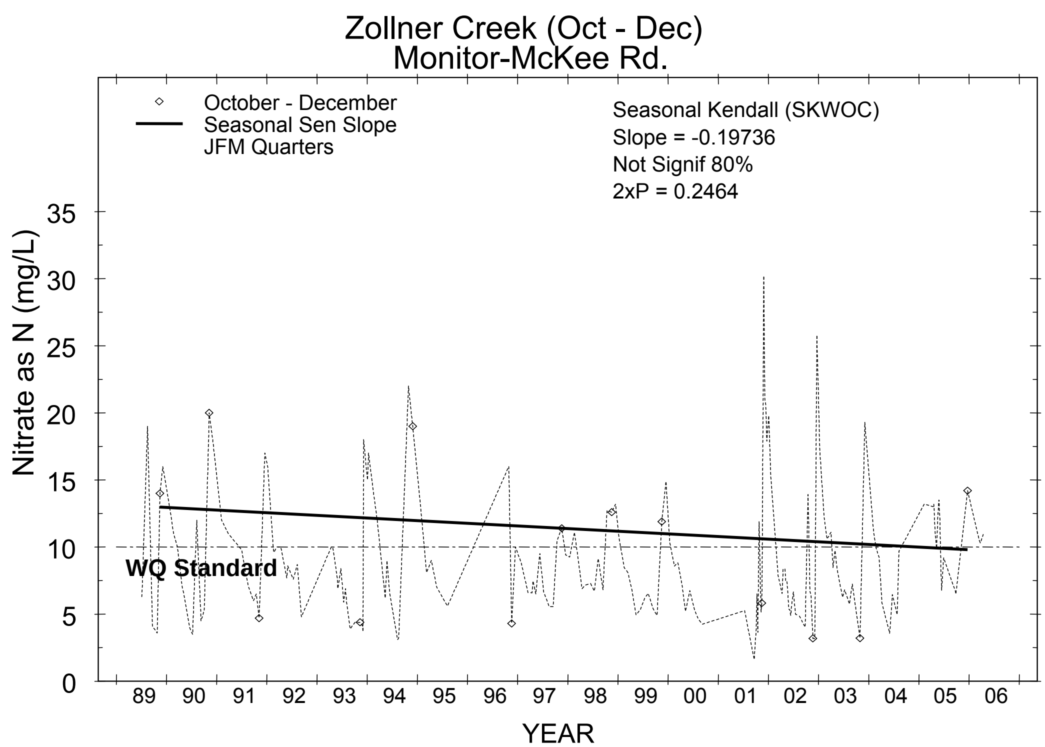

Figure L - 6: Zollner Creek nitrate-N concentrations, October through December 1989 - 2006. The data do not indicate a statistically significant trend at the 80% confidence level.

Seasonal Variation

The median of Zollner Creek nitrate concentrations measured in samples collected between July and September is less than medians of samples sets collected in other seasons. Figure L - 7 indicates that at the 99% confidence level, one of the quarterly medians differs significantly from at least one other quarterly median. Rinella and Janet (1998) surmised that one reason for a longitudinal decrease in Zollner Creek nitrate concentrations (from upstream to downstream), based on samples collected at low flow during the summer, was nutrient uptake by algal growth and other biological activity. This may be a reason for overall lower nitrate concentrations in the summer months in Zollner Creek.

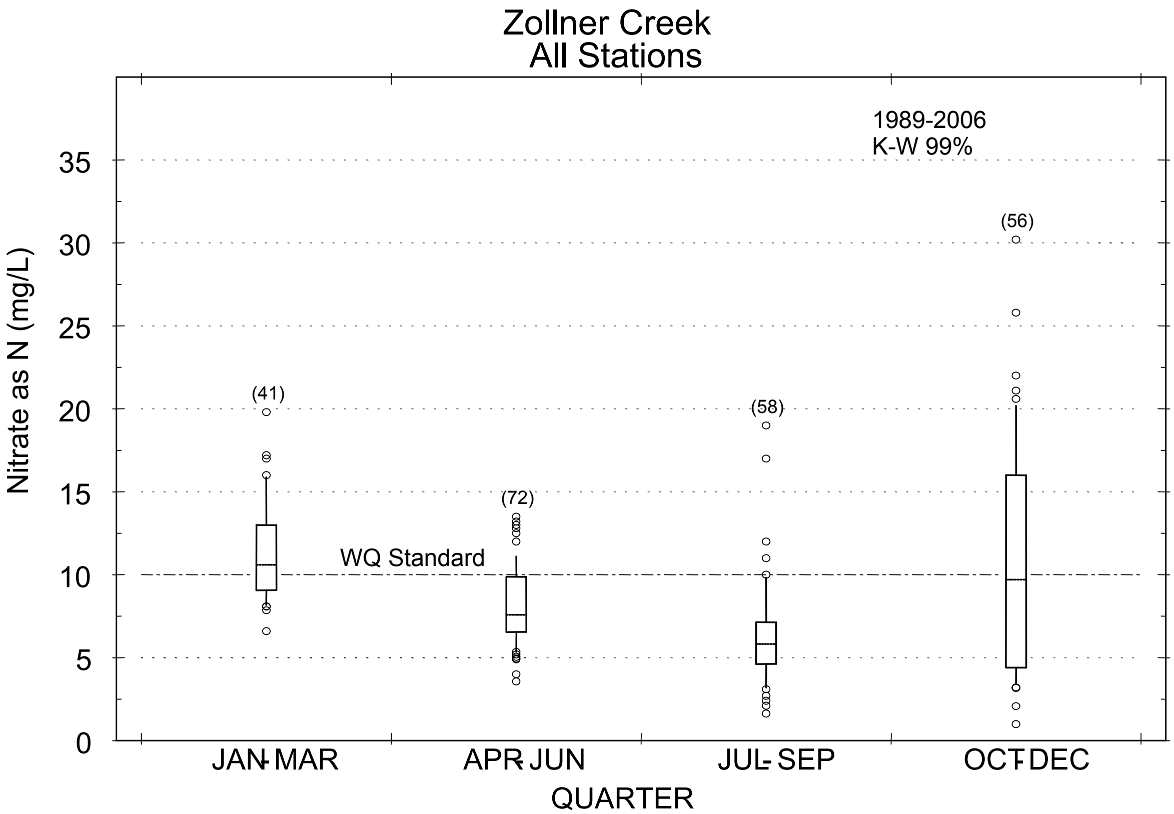

Figure L - 7: Zollner Creek nitrate-N concentration distributions plotted by quarter.

Plotting the nitrate data as loads on a load duration curve (Figure L - 8)[3] confirms the conclusions from other watershed studies of Zollner Creek (referenced in Chapter 5 of this TMDL), that the highest concentrations tend to occur at high stream flows. Figure L - 8 indicates few exceedances of the water quality standard at low flows (above 60% exceedance probability). Though there are few violations at low flows, nitrate concentrations overall are still greater by at least an order of magnitude than would be expected in surface water. The major source of Zollner Creek flow during low flow periods is probably groundwater (and possibly irrigation return flow). While the nitrate concentrations in groundwater may be high, the nitrate may be rapidly taken up by algae and other biological activity in Zollner Creek. During low flow periods, stream flow velocities are low and residence times high, providing an opportunity for nitrate to be consumed. During runoff events residence times and algal growth rates would be much lower, so little of the nitrate in runoff is consumed.

[3] An explanation of load duration curves and exceedance probability is contained in Appendix F of this TMDL.

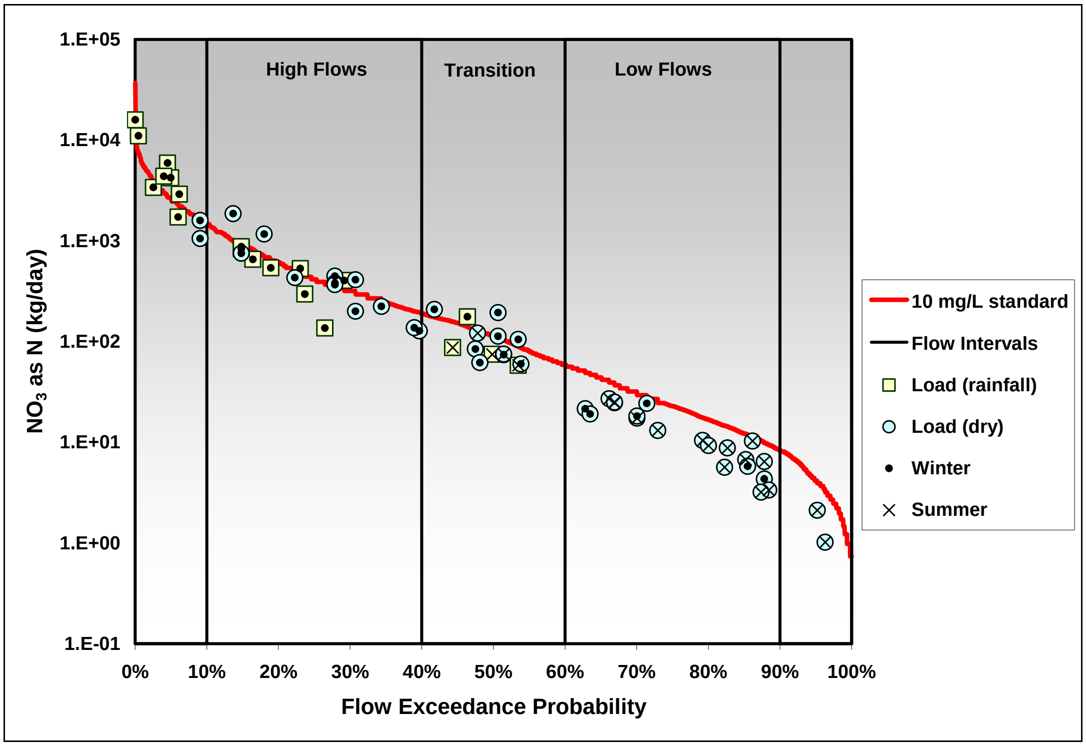

Figure L - 8: Most violations of the water quality standard occur and transition and high stream flows.

REFERENCES

Aroner, E.R., 1997. WQHydro – Water Quality/Hydrology Graphics/Analysis System – Environmental Data Analysis Technical Appendix. WQHydro Consulting, Portland, Oregon, 223 pp.