4.6 Ambient Nutrient Loading

Ambient loading was calculated from the basin-wide data set for wells located in undeveloped areas. The ambient nutrient loading is calculated to estimate the amount of nutrients that would discharge into Lake Tahoe regardless of anthropogenic sources. These conditions represent the nutrient concentrations as of today in undeveloped and undisturbed areas. The discharge rates which were determined to be the most reasonable estimates of groundwater discharge were used in calculating the ambient nutrient loading. Based on these estimates, the total dissolved nitrogen concentrations that may be entering the lake from natural processes is 1,300 kg/year (2,900 lbs/yr). The estimated ambient total dissolved phosphorus concentration entering the lake is 240 kg/year (530 lbs/yr). Review of the estimates shows that the estimated ambient nitrogen loading from Emerald Bay to Taylor Creek exceeds the total loading calculated. In addition, the estimated ambient phosphorus loading from Stateline exceeds the total phosphorus loading calculated in this subregion. In these cases, the ambient concentrations were set equal to the calculated loading estimate. The revised ambient loading estimates are 1,000 kg/year (2,200 lbs/yr) total dissolved nitrogen and 230 kg/yr (500 lbs/yr) total dissolved phosphorus. Table 4-18 summarizes the loading estimates using the corrected values.

Table 4-18. South Lake Tahoe/Stateline Ambient Nutrient Loading Estimate

Subregion	Groundwater Discharge (m^3/year)	Ambient Total Dissolved Nitrogen (mg/L)	Ambient Total Dissolved Phosphorus (mg/L)	Ambient Nitrogen Nutrient Loading[a] (kg/year)	Ambient Phosphorus Nutrient Loading[b] (kg/year)
Emerald Bay to Taylor Creek	1.6E+06			150	80
Subregion 1	4.7E+05			130	23
Subregion 2	1.2E+06	0.27	0.049	330	59
Subregion 3	4.9E+04			13	2
Subregion 4	7.2E+05			190	35
Stateline	8.6E+05			230	30
Total				1,000	230

Notes:

1. 1 m^3/year = 0.0008 acre-feet/year, 1 kg/yr = 2.2 lb/yr
2. Average nutrient concentrations derived from those included in Section 3.2.
3. All concentrations reported are dissolved.
4. a – When the nitrogen ambient concentration exceeded the total loading, the total loading value was used.
5. b - When the phosphorus ambient concentration exceeded the total loading, the total loading value was used.

4.7 Summary & Conclusions

The South Lake Tahoe/Stateline area has the largest monitoring network in the basin. This provides the best dataset available to calculate nutrient loading to Lake Tahoe. For this reason, a groundwater flow model was developed. The model encompassed all of this area except Taylor Creek to Emerald Bay and Stateline. The groundwater discharge estimates for the areas not modeled are computed in a similar manner as the rest of the basin.

The groundwater discharge estimates for the subregions ranged from 1.2×10^3 m^3/year to 2.8×10^6 m^3/year (1 acre-ft/year to 2,300 acre-ft/year). The broad range of values is due to municipal drinking water supply well pumping in subregion 3 and no pumping and a steeper gradient in the Emerald Bay to Taylor Creek area. A number of methods were used to provide a range of nutrient loading estimates for each subregion. The most reasonable estimate for each subregion is included in Table 4-19.

Table 4-19. South Lake Tahoe/Stateline Total Dissolved Nitrogen and Total Dissolved Phosphorus Loading Estimate Summary by Subregion

	Nutrient Loading Estimate (kg/year)						
Constituent	Emerald Bay to Taylor Creek	Subregion 1	Subregion 2	Subregion 3	Subregion 4	Stateline	Total
Total Nitrogen	150	370	780	20	450	650	2,420
Total Phosphorus	140	28	140	4	83	30	430

Notes
1. 1 kg/yr = 2.2 lb/yr
2. All concentrations reported are dissolved.

The modeling results compared to the results using the Darcy's Law approach showed that this is a reasonable method of estimation. All estimations were within one order of magnitude to the normal average year estimation developed using modeling. This shows that the Darcy's Law approach is an acceptable method to provide estimates of groundwater discharge to Lake Tahoe.

The model developed for this study (Appendix B) estimated the total groundwater discharge into Lake Tahoe from Taylor Creek to the California/Nevada state line is 2.4×10^6 m^3/year (1,900 acre-feet/year). This is similar to Woodling's (1987) estimation of 1.7×10^6 m^3/year (1,400 acre-feet/year) for the Trout Creek and Upper Truckee Watersheds. This comparison shows that independent studies have calculated similar groundwater discharge rates into Lake Tahoe. The similar estimates provide a greater level of confidence in the groundwater discharge rates calculated.

The South Lake Tahoe/Stateline Area has an extensive monitoring network, however the placement of many of the wells are not representative of the nutrient concentrations that may be entering the lake through groundwater. Subregion 2 and subregion 4 are prime candidates for a better placed monitoring network, as the wells currently are not placed to properly evaluate all the potential sources. While subregion 3 does not have an adequate monitoring network, the lack of groundwater discharge (Fenske 2003) to the lake in this area reduces the amount of loading originating from the subregion. The evaluation shows that subregion 2 and the Emerald Bay to Taylor Creek area contribute the most groundwater flow into Lake Tahoe. Considering the nutrient loading rates in Table 4-19, and the groundwater flow rates estimated for each subregion, the areas that should be top priorities for future investigations or mitigation in South Lake Tahoe/Stateline should be subregion 2, subregion 4, and the Stateline area due to nitrogen, and subregion 2 and Emerald Bay to Taylor Creek due to phosphorus.

Additional downgradient monitoring points would be beneficial in the Tahoe Keys area. The wells in this subregion are located approximately 2,800 meters (9,200 ft) from the lake. There are no wells that are sufficient to characterize groundwater near the lake. A cluster of wells installed to define the nutrient concentrations with depth would provide better information on the distribution of nutrients with depth.

The area between wells 024 and 013 in subregion 4, near the lake shore, would be a good addition to the monitoring network. Again, many of the wells are located too far from shore to provide a good estimation of nutrients near the lake.

Although well placement is acceptable in the Emerald Bay to Taylor Creek area, the groundwater level measurements and geology are not clearly defined. This subregion should be targeted for additional groundwater level measurements to better define the gradient for the subregion. The geology should be further investigated in this area, as well as the remainder of the region.

Bergsohn has conducted a study to determine depth to bedrock, but the intervening zones require additional investigation. An understanding of the stratigraphy of South Lake Tahoe is critical for evaluating contaminant and nutrient transport towards Lake Tahoe and their redistribution within the basin. Current models are based mainly on deep production wells drilled for STPUD and geophysically logged. Although this is a valuable dataset, each log represents a point measurement showing vertical changes in material types. Then, the data must be extrapolated between wells. To reduce potential for interpreter error, surface geophysical investigations should be run along key transects, both parallel and transverse to the shoreline. These data can be used to better define lateral continuity of major reflecting surfaces. Select, continuously cored test pilot holes should then be drilled to validate material types to ground truth the surface geophysics. Such geophysical surveys should include seismic reflection surveys to define general stratigraphic patterns and the basement geometry. Where shallow stratigraphic information is required, ground-penetrating radar surveys should be conducted to acquire high-resolution information for the upper 18 m to 40 m (60 to 100 ft).

Because of the multitude of land uses in the region, it is difficult to determine the contribution of nutrients from various sources. Specific land use types should be targeted for additional monitoring to better understand each as a contributor. Examples of land uses that require additional investigation are residential areas that are fertilized vs. those that prefer natural vegetation. Ball fields and urban parks should be targeted for additional information. South Lake Tahoe also contains numerous dry wells. The effects from these and other infiltration basins and trenches are unknown. Studies are underway or planned to monitor the effects from infiltration basins.

Additional data gaps for this area can be found in Appendix B.

Comparing the total groundwater nutrient loading (Table 4-19) to the ambient nutrient loading (Table 4-18), natural processes may make up to 41% of the nitrogen and 53% of the total dissolved phosphorus loading to the lake.