

## Bear Lake Nutrient Assessment Summary

### Annis Water Resources Institute

Bear Lake is a moderate to highly eutrophic lake that has elevated concentrations of total phosphorus (TP) and heavy summer blooms of cyanobacteria (formerly blue green algae). The sources of the excessive nutrient levels and algal blooms are the result of combination of external and internal loading sources to Bear Lake. The water quality in the tributaries is relatively good during base flow as TP concentrations range from 20 to 32 ug/l for Bear Creek and Little Bear Creek. Daily base flow loadings of TSS and TP to Bear Lake from Bear Creek averaged 400 lbs and 2 lbs, respectively. In contrast, the storm event data demonstrate elevated loadings of suspended sediment and nutrients. A 0.95 inch rain event delivered an average daily load of 3836 lbs of TSS and 12 lbs of TP. Bear Creek contributes approximately four times the loading of total suspended solids (TSS) and six times the loading of TP as Little Bear Creek. Stream flow hydrographs show that peak flows, during the early spring, result in stream discharges that exceed the amounts observed during the rain event monitoring. These data suggest that even higher loadings of TSS and TP enter the system during the spring. TP and TSS transport in the tributaries is enhanced by the channelized stream and the highly modified wetlands near the inlet to Bear Lake. While an investigation of the effects of nonpoint source (NPS) inputs from the immediate drainage area around Bear Lake was not conducted, the results of the Long-Term Hydrologic Impact Assessment Model (L-THIA) estimated that TSS and TP from rain events > 1 inch would exceed estimated loadings from Little Bear Creek.

While storm events can accelerate the loading of TP to Bear Lake, the presence of heavy cyanobacteria blooms, elevated chlorophyll-*a* concentrations, and low Secchi disk depth readings throughout the summer are indicative of an internal sediment loading source. The concentration of iron in the sediment appears to be sufficient to limit phosphorus release. In addition, the shallow bathymetry of Bear Lake (8 to 12 ft) prevents summer stratification and anaerobic conditions that enhance phosphorus release from the sediments. The moderate level of soluble reactive phosphorus (SRP) found in the sediments of Bear Lake is a function of the elevated iron concentrations and the lack of summer stratification. Because of the wind mixed water column, phosphorus can still be circulated up into the water column and become available to stimulate productivity. Since Bear Lake appears to be phosphorus limited, additional loading of this nutrient will stimulate primary productivity. The dominant phytoplankton organism, *Microcystis aeruginosa*, can take advantage of these conditions by adjusting its vertical position in the water column and accumulating phosphorus at the sediment/water interface. The shallow bathymetry of Bear Lake and the moderate level of phosphorus enrichment in the sediment are ideal conditions for *Microcystis aeruginosa* to form blooms.

To improve water quality in the watershed, a combination of NPS reduction strategies should be considered that involve the tributaries and the immediate drainage basin. With respect to the tributaries, the implementation of best management practices (BMPs) in the Bear Creek subwatershed is the first priority. The installation of effective buffer strips along the stream corridor plus creating more opportunities for runoff infiltration in developed areas will help reduce NPS pollution. In addition, returning some of the natural sinuosity to the stream channel and restoring the wetlands at the mouth of Bear Creek will help promote settling and slow the transport of sediment and nutrients to the creek. With respect to Bear Lake, riparian buffers along the lakefront will help reduce the input of nutrients. The use of phosphate-free fertilizer for lawn maintenance and adding more opportunities for infiltration instead of runoff also will lower the NPS contribution for the immediate drainage basin. Many of the homes along the shore of Bear Lake in Laketon Township are serviced by septic systems. Municipal sewer recently has been extended to this area and where possible, home owners are encouraged to connect to the system and decommission their septic tanks. Where connections are not possible, proper septic system maintenance and design are critical to limiting the leaching of nutrients into Bear Lake.