# The Chesapeake Bay Water Quality Model and Nutrient Reductions

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An important consideration in the continual evaluation of water quality in the Chesapeake Bay is the effectiveness of reductions in nitrogen and phosphorus loading to the Bay. The dissolved oxygen (DO) of the bottom waters of the main trench of the Bay has been observed to be anoxic. The Chesapeake Bay Water Quality Model (CBWQM) provides a predictive framework for assessing Bay response to nutrient load reductions. The model is a three dimensional, time variable representation of the principal processes of eutrophication and includes hydrodynamic and sediment sub models. Input loads from basins draining to the Bay are generated by a separate Watershed Model. The models have been extensively calibrated by others to three years of data.

Following calibration, the CBWQM was used to evaluate water quality responses to a series of loading scenarios. The feasible range of reductions of point, nonpoint and atmospheric Total Nitrogen (TN) loading from the Base 1985 year is estimated to be from 18 to 29% and for Total Phosphorus (TP) from 31 to 56%, where the maximum reductions represent the Limit of Technology. Loading from the ocean is significant at about 30% of the TN load and about 60% of the TP load.

The temporal and spatial extent of anoxia is estimated to be reduced from 20 to 32% over the feasible range of load reductions. The decline in anoxia is approximately linear to the TN load reductions, but is largely insensitive to TP reductions even though the spring phytoplankton in the mid to upper Bay (the region of minimum bottom DO) is controlled by phosphorus and not nitrogen. One important reason for this result is that under a reduction in phosphorus load only, excess nitrogen is transported to the lower Bay where phytoplankton are controlled by nitrogen. Such transport stimulates production in the lower Bay resulting in increased loading of carbon to bottom waters and subsequent impact on bottom DO in the upper Bay. However, phosphorus load reduction completely controls spring phytoplankton biomass in the upper Bay with about a 20% improvement in light at the 2 m depth. Therefore, management of the water quality of the Bay requires both phosphorus and nitrogen load reductions; phosphorus control for upper Bay phytoplankton biomass reduction with subsequent improvement in light penetration and nitrogen control for improvement in bottom water DO.