MANAGING THE SPACE-TIME-LOAD CONTINUUM IN TMDL PLANNING: A CASE STUDY FOR UNDERSTANDING GROUNDWATER LOADS THROUGH ADVANCED MAPPING TECHNIQUES

Phillip Harte, Marcel Belaval, Andrea Traviglia[1]

The lag time between groundwater recharge and discharge in a watershed and the potential groundwater load to streams is an important factor in forecasting responses to future land use practices. We call this concept managing the "space-time-load continuum." It's understood that in any given watershed, the response function (the load at any given time) will differ for surface runoff and groundwater discharge. The mean age of surface runoff may be days whereas for groundwater it could be many decades. Surface runoff reflects contemporaneous land use practices and relatively quick reactions whereas groundwater load reflects past land use practices and attenuation mechanisms in the aquifer and ephemeral zone around streams. The total load combines both response functions and understanding the makeup of the two responses can improve forecasting of future loads.

We used advanced mapping techniques to quantify potential groundwater loads of chloride to a small watershed in southern New Hampshire. The small watershed is adjacent to a major highway corridor and the use of salt as a road deicing agent has caused increases in chloride concentrations in nearby Policy Brook, the subject of a chloride TMDL. Specific conductance in Policy Brook showed high levels (1300 $\mu S\ cm^{-1}$), about five times background, during periods of baseflow indicating a groundwater pathway for road salt.

Electromagnetic (EM) terrain induction conductivity surveys were conducted along Policy Brook to map road-salt contaminated groundwater discharge. Three different EM tools were used that probed slightly different depths of investigation (ranging from 0 to 12 feet below the streambed). Electromagnetic surveys identified several reaches of high conductivity groundwater. Based on the delineation of reaches, seven streambed piezometers were installed to sample for shallow groundwater. Correlation of shallow groundwater conductivity with EM allowed for the calculation of a spatially continuous mass load of chloride. Given the depth of EM surveys, the shallow groundwater represents a near term (months to years) potential groundwater load. The potential groundwater load was found to be 50 percent greater than the instantaneous load calculated from increases in chloride along Policy Brook during a baseflow period. Over the next few years, we surmise that the seasonal variability in chloride in Policy Brook will increase in response to the inherent seasonal variability in groundwater discharge and the growing divergence of surface and groundwater loads; the divergence being fueled by current improved practices to reduce road salt as reflected in surface runoff, and past practices as reflected in groundwater loads.

[1]Phillip Harte, Research Hydrologist, US Geological Survey, New England Water Science Center, Pembroke, NH 03275
Marcel Belaval, Geologist, US Environmental Protection Agency, Boston, MA 02109
Andrea Traviglia, Environmental Engineer, US Environmental Protection Agency, Boston, MA 02109

Citation for proceedings: Stringer, Christina E.; Krauss, Ken W.; Latimer, James S., eds. 2016. Headwaters to estuaries: advances in watershed science and management—Proceedings of the Fifth Interagency Conference on Research in the Watersheds. March 2-5, 2015, North Charleston, South Carolina. e-Gen. Tech. Rep. SRS-211. Asheville, NC: U.S. Department of Agriculture Forest Service, Southern Research Station. 302 p.