WATER QUALITY CHANGES RELATED TO WATER TRANSFERS BETWEEN RIVER BASINS IN VIRGINIA, USA.

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Increasingly in regions that are experiencing population and/or economic growth, increases in demand for potable water requires the development of new water sources to satisfy the demand. In developing new water sources, oftentimes the water from the newly developed water source is transferred via pipeline or aqueduct to a preexisting source of water, often a lake or reservoir. This transfer can occur over relatively short distances between adjacent watersheds that have similar geological and water quality characteristics or it can occur over larger distances (> 100 km) and from watersheds and waters of significantly different biological and chemical composition.

The transfer of water from one basin to another has the potential to change the characteristics and quality of the water source receiving the transferred water. Of particular concern are changes that may occur in a receiving water if the transferred water is of lower quality. In the case of water sources that are used as drinking water supplies, transfer of water of a poorer water quality into an existing water source can ultimately require greater levels of treatment at a water treatment plant. If greater levels of treatment are not provided then the result is increased risk to human health by the population utilizing this water. Decreases in the aesthetic qualities of a receiving water source may also accompany water transfer if the water being transferred is elevated in nutrients (e.g. nitrogen, phosphorus), particulate material, color, or if the water contains nuisance biological species (flora and fauna) not presently in the receiving water.

1 – STUDY SITE AND METHODOLOGY

As part of a source water management effort, intensive water quality monitoring of two reservoirs in southeastern Virginia, USA, has occurred since 1989 in part to determine the effect of water transfers between watersheds. The reservoirs, Lake Prince and Western Branch Reservoir, are run-of-river reservoirs that hold 49 million m^3 of water at capacity. The water withdrawn from these lakes exceeds the natural supply that comes from watershed drainage. To provide additional water to the cities that rely on this water source, water is regularly pumped from the Nottoway and Blackwater river basins through pipelines to these reservoirs

2 – INFLUENCE OF RIVER INPUTS ON LAKE WATER CHEMISTRY

The river inputs to Lake Prince and Western Branch Reservoir are highly variable and depend primarily on the amount of precipitation received in the reservoir watersheds. To highlight the variability of river pumping and the response of the reservoir system, data collected during 1994 are presented.

River pumping for the period February to October is shown to illustrate the pattern of river pumping in 1994 (Figure 1). Pumping from both rivers was extensive in January and February due to low reservoir storage but was discontinued for two months at the beginning of March after the reservoirs reached full capacity. Pumping of both rivers was reinstated in early May and the Nottoway river was pumped predominantly at maximum capacity through the end of the year. Pumping of the Blackwater River was discontinued for two extended periods during the rest of the year due predominantly to low flow conditions in the Blackwater River. The on and off cycling of Blackwater River pumping essentially had the effect of acting like an extended pulse input to the reservoir system and allowed an analysis of the influence of the Blackwater River on lake water composition.

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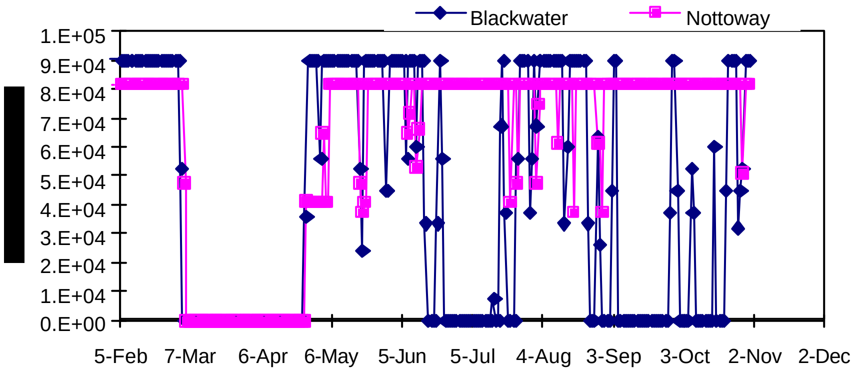

Figure 1 - River Pumping into the Reservoir

In Lake Prince, increases in dissolved organic carbon concentrations were observed to closely follow periods of pumping of the Blackwater River (Figure 2). The results from three monitoring stations that are located along the main stem of the lake are shown; LP3 is closest to the point of river inputs, site LP1 is farthest from the river inputs. The rise in DOC was dramatic after the first period of pumping with DOC increasing from approximately 6 mg C/L to 11 mg C/L at the two sites closer to the river inputs. After the second period of pumping, DOC concentrations again increased in a similar manner.

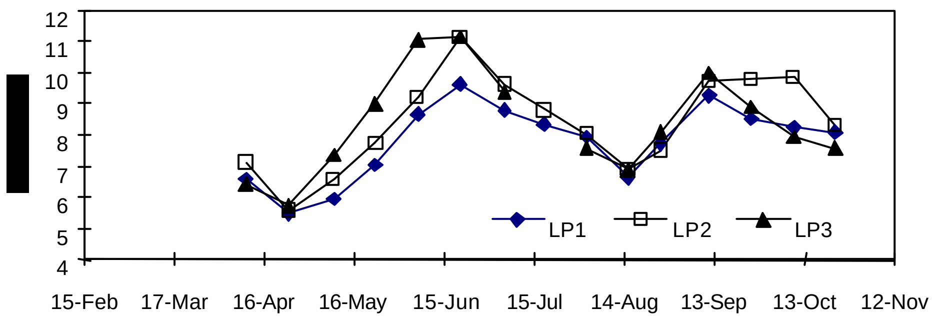

Figure 2 - Variation of DOC in Lake

Other parameters of interest with regard to water quality also were influenced in a similar manner. Both total trihalomethane formation potential (Figure 3) and iron concentrations (Figure 4) showed a similar response. The chemical composition of the Blackwater River is consistent with these trends and clearly influences how variable inputs influence the chemical composition in Lake Prince.

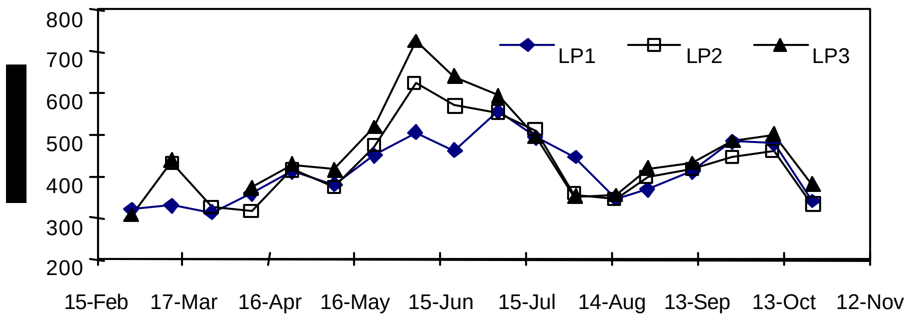

Figure 3 - Variation of THMFP in Lake

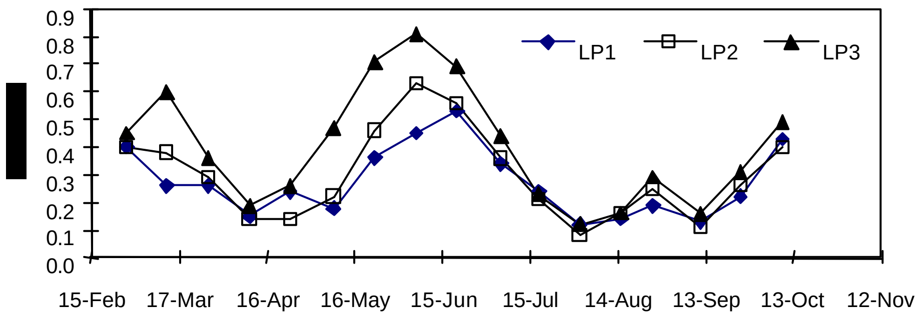

Figure 4 - Variation of Iron in Lake

The results presented here illustrate how the variable pumping of a given source water can exert considerable influence over the chemical composition of the receiving water. Similar results have been observed when groundwater from a deep aquifer in the region has been pumped into the reservoirs causing high phosphorus concentrations and subsequently elevated phytoplankton concentrations. These changes in composition have also been observed at the water treatment plants that use this water and can directly influence treatment.