Development of a mitigation method and ecological impacts offset for spring water withdrawals on downstream habitats for fish and invertebrates

Reconnaissance study on Wekepeke Brook

Executive Summary of Status Quo Determination

The Wekepeke Watershed lies primarily within the town of Sterling (including all of the study area), but is also within the towns of Leominster and Lancaster (**Figure 1**). The watershed drains 11.5 square miles and empties into the Nashua River in Lancaster. The brook's total length is approximately 5.1 miles, of which we will be focusing on about 2.1 river miles. The study area is dominated by forest, but is crossed by two secondary roads, some adjacent house lots and areas of agricultural land.

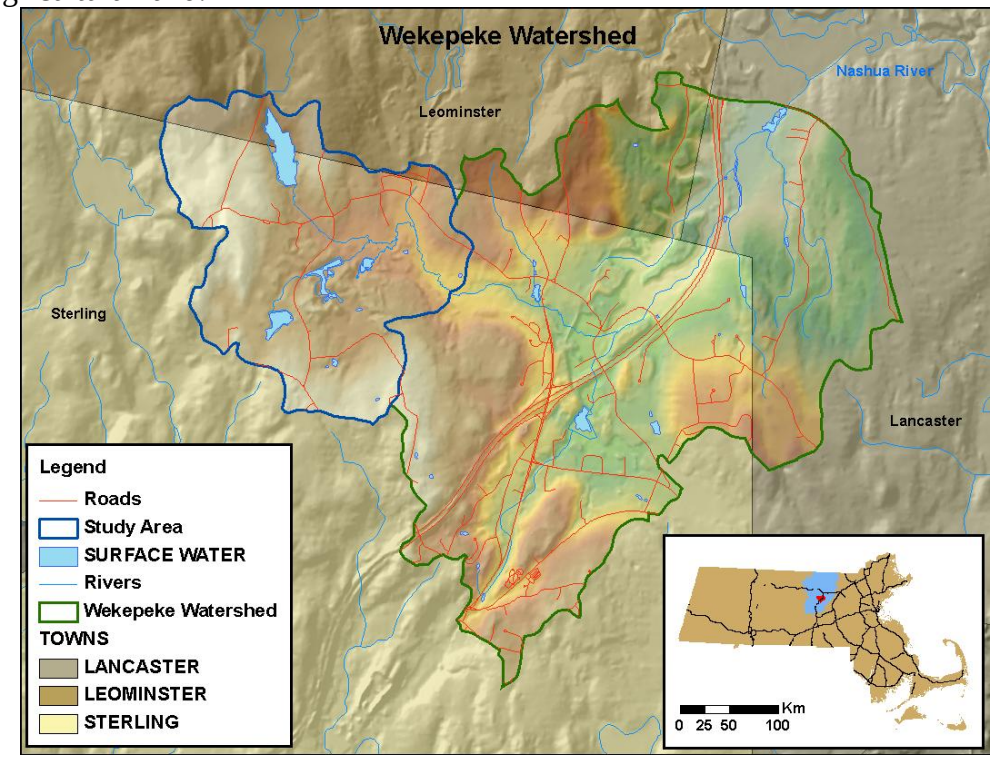

Figure 1: Wekepeke Watershed and Study Area.

There have been many changes to this area of the Wekepeke Brook Watershed since 1830. For the most part, the land has gone from forest, to agricultural and industrial use and now back to primarily forest. The creation of several mills and associated reservoir ponds lead to the establishment of the Clinton Water Works in 1876, which historically provided the Town of Clinton with over 1.2 million gallons of water daily (833 gpm or 1.856 cfs). The construction of the Wachusett Reservoir between 1897 and 1908, made Clinton's use of the Wekepeke's water obsolete, lowering the ecological pressure on the brook. Since the town holds right to the reservoirs as a potential supplemental water supply, full residential development of the watershed

has been prevented.

Recently Nestlé Waters proposed development of water withdrawal site upstream of Spring Basin with the maximum withdrawal potential of less than 250,000 gallons per day (0.4 cfs) and initiated this study. Determination of the ecological status-quo included analysis of hydrologic and thermal regime, water quality, the investigation of fish and invertebrate status and the development of a physical habitat model MesoHABSIM. Our research has shown that it is the first such comprehensive analysis of the Wekepeke Brook. It provides basic information about the system that should aid future management and decision making.

The study concluded that Wekepeke Brook is a typical headwater stream in central Massachusetts and as such is important, because the presence of any impairments may affect ecosystems far downstream. In general, the stream is characterized by high amounts of ground water contributions and cold-water temperatures. Compared to many other streams in the area, it appears not very strongly impacted by recent development. The fish and invertebrates species are abundant and riparian area is rich in wildlife.

However, the remnant water works infrastructure and recent housing encroachment has resulted in the impression of a much more human impacted stream than was initially expected. A more detailed analysis confirmed this observation, corroborating that both sources cause impairment of the instream fauna.

The thermal recordings demonstrated that all three reservoirs (Heywood, Lynde and Spring basin) affect the water temperature downstream. Although the temperature is higher at the reservoir outlets in 2008, it did not reach levels that would be lethal for coldwater fish such as brook trout. Furthermore, the temperature decreases quickly downstream by substantial amounts of groundwater entering the stream. However, during drought conditions, water temperatures in the upper portion of the watershed could become a critical issue to the fauna health and distribution.

The studied portion of the Wekepeke Brook is a gaining stream throughout the majority of its reach. This conclusion is based on miniature piezometer readings, as well as stream gaging. The discharge per unit watershed area for Nashoba Brook can be use to calculate the stream flow and a flow duration curve for this reach of the Wekepeke Brook, based upon similar watershed characteristics and supported by a concurrent flow measurement.

In terms of water quality, we observed that the upper portion of the study area is impacted by nutrients creating conditions promoting stress-tolerant species. Often, N/P levels >20 are indicative of P limited productivity and of an environment typical to eutrophic reservoirs. The spillways of Heywood Reservoir and the Lynde Basin shared high N/P ratios, which promote algae growth and production.

Overall, the turbidity is in a range that could affect the abundance and diversity of macro invertebrates. The highest turbidity value was measured at the Spring Basin spillway. This goes in hand with increased conductivity, chlorophyll-*a* (chl-*a*) levels and lowest DO and pH at this site. The footprint of the Spring Basin outflow can also be observed at the Section 5 sample location.

The river contains high densities of invertebrate fauna, but deviates from the expected community. This is mostly due to the overabundance of Trichoptera (caddisflies), which may be indicative of a shift in community makeup due to increasing ecological stress. We found a high

density of freshwater mussels of one species, eastern pearlshell (*Margaritifera margaritifera*). Freshwater mussels are a critical component of the ecosystems due to their capacity of filtering substantial amounts water and their use as a food source to many riparian vertebrates. Eastern pearlshell is typically found in cold-water streams and rely on salmonid fish as a host necessary for reproduction. Mussel densities increase downstream with the increasing stream size and the quantity of suitable habitat. However, the low number of mussel juveniles found indicates low recruitment levels of this long living species. This may be due to the low observed densities of brook trout in upper portion of the study area.

The 2008 survey revealed high fish densities, but the community structure deviated from the expected community, which should be dominated by brook trout (*Salvelinus fontinalis)*. Instead, a large number of more tolerant blacknose dace (*Rhinichthys atratus*) and warm water species were documented. Further downstream, the community structure (and abundance of brook trout) is closer to what is expected.

The analysis suggests that the Wekepeke Brook may be affected by water quality conditions conducive to supporting warm-water, pollution tolerant species and limiting macrohabitat generalist species and cold-water species. Based on the overall dissimilarity of the existing fish community to the TFC, the biological integrity of the study area appears to be impaired.

The existing fish habitat corresponds well with the fish observations, indicating increase of brook trout habitat downstream and greater amounts of blacknose dace. . Adding structural improvements would offer conditions better supporting brook trout and additional habitat availability at extreme low flows. This is confirmed by the time series analysis, which identified the criteria for summers' base and subsistence flows (**Table 1**) and shows that the number of habitat stress days (when the criteria are violated) could be reduced with this measure (**Table 2**). In combination with flows, the current habitat configuration leads to the occurrence of catastrophic habitat limitations that are seven times more frequent than expected under unimpacted conditions.

Table 1: Selected subsistence and base flow thresholds for the Brook.

Bioperiod Approximate dates	**Rearing & Growth** July - Sept.
Base flow reference (cfsm)	0.71
Allowable duration under (days)	20
Catastrophic duration (days)	81
Subsistence flow reference (cfsm)	0.05
Allowable duration under (days)	12
Catastrophic duration (days)	28
Absolute minimum flow (cfsm)	0.001

Table 2: Increase in number of stress days compared to reference

Location	Wekepeke River	
Type	Persistent	Catastrophic
Rearing & Growth July 1 - Sept. 30		
Common events (% stress days)	132%	127%
Rare events (% stress days)	287%	698%

The effect on eastern pearlshell mussel habitat is similar. In each case the habitat modification increased habitat available at very low flows offering greater survival options during extended droughts. This part of the study concluded that the fish and invertebrate fauna is affected by human impacts and identified a number of possibilities for improvement of the health of the watershed.