1.0 INTRODUCTION

The objective of this report is to document the water quality status of the Assabet River. A data collection program was designed and implemented to support water quality improvement for the Assabet River and is described in this report. From July 1999 to October 2000, 13 field surveys were conducted to collect hydrologic, water quality, sediment quality, and biological data to support a water quality improvement program. The data collection program quantified water quality conditions associated with summer-time eutrophication in the Assabet River and quantified time-varying nutrient loadings to the river system. The program to improve water quality in the Assabet River is mandated by the United States Environmental Protection Agency (US EPA) and is known as the Total Maximum Daily Load (TMDL) allocation process. This report summarizes the assessment phase of the TMDL development process focused on characterization of the water quality status of the Assabet River through collection and analysis of water quality measurements. The TMDL process is described in Section 1.2 below.

The Massachusetts Department of Environmental Protection (DEP), in conjunction with the US Army Corps of Engineers (Corps), is currently developing a TMDL allocation for nutrients in the Assabet River. Corps involvement with the TMDL process has been limited to the collection of data and study preparation. Authority for Corps participation is provided in its Section 22 “Planning Assistance to States” program (Water Resources Development Act of 1974, Public Law 93-251, as amended) which enables Corps cooperation with the states in preparation of plans for the development, utilization, and conservation of water and related land resources. A Cost Sharing Agreement was signed by the Corps and the DEP (the non-Federal sponsor) on March 25, 1999 (amended on May 3, 2000 and again on January 11, 2001), enabling the Corps and DEP to split the cost of this work on a 50/50 basis.

The Assabet River is designated in the Massachusetts Water Quality Standards as a Class B waterbody. The Assabet River has been placed on the 303d list for failure to comply with numerous standards and criteria including applicable numerical water quality standards for dissolved oxygen concentration and fecal coliform bacteria counts and for applicable narrative criteria for nuisance aquatic vegetation. The majority of water quality concerns associated with the Assabet River are directly related to a severe ecological condition known as eutrophication, described below.

1.1 Eutrophication

Eutrophication conditions occur in water bodies, such as lakes, ponds, and impoundments, when excess levels of nutrients result in very high growth rates of biota (Wetzel, 1983). The term eutrophication is derived from the Greek for “nutrient-rich”. Eutrophication is a process of nutrient accumulation and ecosystem change that occurs in aquatic ecosystems. This process can occur naturally as part of the long-term transition of lakes to marshes. Eutrophication can also occur

culturally whereby the process is dramatically accelerated by the activities of man (McNaughton and Wolf, 1973).

Eutrophication is problematic because high growth rates of biota can result in production of nuisance aquatic vegetation such as algal mats, floating macrophytes, rooted vegetation, and phytoplankton. These growths are aesthetically undesirable and, due to impacts on dissolved oxygen, they threaten the existence of fish and other aquatic organisms. High biological activity during eutrophic conditions produces large diurnal changes in dissolved oxygen (DO) concentrations as aquatic biota produce oxygen during daylight conditions and respire, reducing oxygen levels at night. Seasonal declines in DO concentrations are also likely as aquatic vegetation dies and decays. Dramatic DO concentration changes, particularly very low DO levels, can be lethal to fish and benthic organisms.

The following conditions are typically necessary to support eutrophication.

- Nutrient loadings – Excessive levels of phosphorus and/or nitrogen entering a waterbody.
- Physical Configuration – A water body, such as a gently-sloped river, lake, or impoundment with sufficiently long residence time and slow-moving water in which nutrients are retained and are available to support biological activity for an extended period.
- Summer-time Conditions - Factors effecting biological activity, such as water temperature, angle of solar incidence, duration of daylight, and solar irradiance, are most favorable to support aquatic plant growth through photosynthesis during the summer-time.

When the factors listed above are present, eutrophic conditions may occur resulting in abundant nuisance aquatic plant growth and dissolved oxygen concentrations that threaten fish and other aquatic organisms.

This report documents the presence of excess nutrients within the system and the extent of nutrient loadings to the Assabet River. Excess nutrients, combined with the presence of river impoundments and summer-time conditions, result in eutrophic conditions throughout the Assabet River. Specifically, this report documents the presence of eutrophication in the Assabet River during the summers of 1999 and 2000 and reviews previous water quality studies performed over the past 30 years.

1.2 The TMDL Development Process

In 1996, the Assabet River was placed on a list of impaired waterbodies requiring water quality improvement, known as a Section 303(d) list, due to failure to comply with nutrient-related water quality standards (SuAsCo, 1996). According to the Clean Water Act, the states are required to develop a TMDL allocation for all priority waterbodies on the Section 303(d) list. Thus, the Massachusetts Department of Environmental Protection (DEP) is currently developing a Total Maximum Daily Loading

(TMDL) allocation for nutrients in the Assabet River. This TMDL is motivated by the presence of eutrophic conditions in the river during the summer season.

A TMDL allocation is an analysis that establishes the maximum loadings that a waterbody may receive and maintain its designated uses, including compliance with numeric and narrative water quality standards. The TMDL development process may be described in five steps, as follows:

1. Determination and documentation of whether or not a waterbody is presently meeting its designated uses;

2. Assessment of present water quality conditions in the waterbody, including estimation of present loadings of constituents of concerns from point and non-point sources;

3. Determination of the loading capacity of the waterbody. EPA regulations define the loading capacity as the greatest amount of loading that a waterbody may receive without violating water quality standards. If the waterbody is not presently meeting its designated uses, then the loading capacity will represent a reduction relative to present loadings;

4. Specification of load allocations, based on the loading capacity determination, for non-point sources (LAs) and point sources (WLAs), that will ensure that the waterbody will not violate water quality standards; and

5. Development of a plan to (1) implement load allocations developed based on the waterbody loading capacity determination and (2) monitor the waterbody to ensure compliance with water quality standards.

In summary, the TMDL development process begins with assessment of the present condition of a waterbody and concludes with specification and implementation of a set of modified loadings deemed necessary to bring the waterbody into compliance with water quality standards. The steps of the TMDL may be divided into Assessment (Steps 1 and 2); Analysis, often through modeling (Steps 3 and 4); and Planning (Step 5). This report represents a summary of the Assessment steps listed above through a review of previous water quality studies and documentation of 13 water quality surveys performed in 1999 and 2000.

A goal of the data collection task is to collect necessary and sufficient information to support development of a mathematical model of the Assabet River. A mathematical model of the Assabet River, if properly developed, will enable hydrologic, water quality, sediment, and biological processes throughout the Assabet River to be simulated. Water quality modeling will be necessary to determine the total loading capacity of the Assabet River and to allocate acceptable point and non-point source loadings (i.e., Steps 3 and 4 above). Determination of the loading capacity of the Assabet River is a complex task requiring sufficient supporting data and an appropriate assessment tool. The most

reliable and defensible assessment tool for establishing loading capacities is a mathematical water quality model. A water quality model provides a numerical representation of the physical, hydrological, chemical, and biological characteristics of a river.

A water quality model requires a sufficient set of data to achieve project objectives. Once established, water quality models are capable of simulating present conditions in the river. More importantly, water quality models are capable of predicting water quality and biological conditions associated with hypothetical scenarios. For example, a water quality model could be developed for the Assabet River that would be capable of predicting water quality and biological conditions in the river that would result from specific reductions in point and non-point source loadings. The modeling tool would then be used to quantify loading capacity and evaluate alternative approaches for achieving acceptable loading capacity. An Assabet River nutrient TMDL modeling project is presently underway to perform the mathematical modeling tasks necessary to complete the TMDL implementation process.

1.3 Report Sections

This report contains the following components:

- Section 2 – summary of existing data from previous studies including physical, hydrologic, water quality, and biological measurements;
- Section 3 – description of the data collection program including the rationale for the data collection program design, a summary of hydrologic, water quality, sediment quality, and biological data collection methods and tasks;
- Section 4 – hydrologic data collection summary;
- Section 5 – water quality data collection summary;
- Section 6 – sediment quality data collection summary;
- Section 7 – biological data collection summary; and
- Section 8 – summary and conclusions.