BEAR LAKE IMPROVEMENT FEASIBILITY STUDY REPORT
A LAKE MANAGEMENT PLAN FOR BEAR LAKE, MANISTEE COUNTY, MICHIGAN

December, 2007

1.0 AQUATIC ECOLOGY BACKGROUND INFORMATION

1.1 Introductory Concepts

The following terms are provided for a more thorough understanding of the forthcoming lake management recommendations for Bear Lake. Limnology is a multi-disciplinary field which involves the study of the biological, chemical, and physical properties of freshwater ecosystems. A basic knowledge of these processes is necessary to understand the complexities involved and how management techniques are applicable to current lake issues.

1.1.1 Lake Hydrology

Aquatic ecosystems include rivers, streams, ponds, lakes, and the Laurentian Great Lakes. There are thousands of lakes in the state of Michigan and each possesses unique ecological functions and socio-economic contributions (O'Neil and Soulliere 2006). Some lakes (seepage lakes) contain closed basins and lack inlets and outlets, relying solely on precipitation or groundwater for a water source. Seepage lakes generally have small watersheds with long hydraulic retention times which make them sensitive to pollutants. Other lakes receive significant water quantities from tributaries and rivers (drainage lakes). Drainage lakes contain at least one inlet and an outlet and generally are confined within larger watersheds with short hydraulic retention times and are thus less susceptible to pollution. Spring-fed lakes rarely contain an inlet but always have an outlet with considerable flow. The majority of water in this lake type originates from groundwater and is associated with a short hydraulic retention time. Drained lakes are similar to seepage lakes, yet rarely contain an inlet and

have a low-flow outlet. The groundwater and seepage from surrounding wetlands supply the majority of water to this lake type and the hydraulic retention times are rather high, making these lakes relatively more vulnerable to pollutants. The water quality of a lake may thus be influenced by the quality of both groundwater and precipitation, along with other internal and external physical, chemical, and biological processes.

1.1.2 Biodiversity and Habitat Health

A healthy aquatic ecosystem will possess a variety and abundance of niches (environmental habitats) available for all of its inhabitants. The distribution and abundance of preferable habitat will depend on limited influence from man and development, and preservation of sensitive or rare habitats. As a result of this, undisturbed or protected areas generally contain a greater number of biological species and are thus more diverse. A highly diverse aquatic ecosystem is preferred over one with less diversity because it will allow a particular ecosystem to possess a greater number of functions and contribute to both the intrinsic and socio-economic values of the lake. A healthy lake will have a greater biodiversity of aquatic macroinvertebrates, aquatic macrophytes (plants), fishes, phytoplankton, and may possess a plentiful yet beneficial benthic microbial community (Wetzel, 2001).

1.1.3 Watersheds and Land Use

A watershed may be defined as an area of land that drains to a common point and is influenced by both surface water and groundwater resources that are often impacted from land use activities. In general, a large watershed of a particular lake possesses more opportunities for pollutants to enter the system and alter water quality and ecological communities. In addition, watersheds that contain abundant development and industrial sites are more vulnerable to water quality degradation since the fate of pollutant transport may be increased and negatively affect surface waters and groundwater. Since many inland lakes in Michigan are relatively small in size (i.e. less than 300 acres), they are

inherently vulnerable to nutrient and pollutant inputs due to a reduced water volume and small surface area. Due to this reduction in surface area and water volume, the living (biotic) components of the lake (i.e. fishery, aquatic plants, macroinvertebrates, benthic organisms, etc.) are highly sensitive to changes in water quality from watershed influences.

Land use activities have a dramatic impact on the quality of surface waters and groundwater. In addition, the topography of the land surrounding a lake may make it vulnerable to nutrient inputs and consequential loading over time. The topography of the land and the morphometry of the lake dictate the ultimate fate transport of pollutants and nutrients into the lake within a particular watershed. Steep slopes on the land surrounding a lake may cause surface runoff to enter the lake more readily than if the land surface was flat. In addition, lakes with a steep drop-off may act as a collection basin for the substances that are transported to the lake from the land. Many types of land use activities can influence the watershed of a particular lake. Such activities include residential land use, industrial land use, agricultural land use, water supply land use, wastewater treatment land use, and stormwater management. All land uses may contribute to the water quality of the lake through the influx of pollutants from non-point sources or from point sources. Non-point sources are often diffuse and arise when climatic events carry pollutants from the land into the lake. Point-source pollutants exit from pipes or input devices and empty directly into a lake or watercourse. Residential land use activities involve the use of lawn fertilizers on lakefront lawns, the utilization of septic tank systems for treatment of residential sewage, the construction of impervious (impermeable, hard-surfaced) surfaces on lands within the watershed, the burning of leaves near the lakeshore, the dumping of leaves or other pollutants into storm drains, and removal of vegetation from the land and near the water. In addition to residential land use activities, agricultural practices by vegetable crop and cattle farmers may contribute nutrient loads to lakes and streams. Industrial land use activities may include possible contamination of groundwater through discharges of chemical pollutants.