An Overview of the Need for a Sewer System on Higgins Lake
by Dr. Mark Luttenton

A more comprehensive review of the empirical data by Dr. Mark Luttenton may be found in its entirety on the Higgins Lake Foundation website: www.higgins-lakefoundation.org

There is an ongoing debate regarding the need for a wastewater facility that has been proposed to serve the Higgins Lake community. However, there does seem to be general agreement that the addition of nutrients, particularly phosphorus, has resulted in dramatic changes in Higgins Lake and is a primary concern.

There is no doubt that Higgins Lake has changed substantially over the past 30 years. The addition of nutrients at an accelerated rate and the introduction of numerous aquatic invasive species (AIS) have pushed Higgins Lake to a condition that is unnatural for this type of Michigan inland lake. The fact that Higgins Lake has reached this state is no surprise; several previous studies outlined steps that needed to be taken to prevent this outcome.

Schultz and Fairchild (1984) clearly stated that increasing population density, aging septic systems, and decreasing nutrient binding capacity by the regional soils would result in impacts to Higgins Lake due to domestic sewage. Subsequent studies have confirmed that nutrient levels in nearshore groundwater have reached unnaturally high levels (Minnerick, 2001; Martin et al. 2014).

Controlling nutrient loading to Higgins Lake is absolutely essential and will require implementing several best management practices. Schultz and Fairchild (1984) provided several recommended actions to reduce nutrient loads.

Sources of Nutrients Affecting Water Quality

To develop their recommendations, Schultz and Fairchild (1984) evaluated the sources of nutrients entering the lake. For example, they evaluated the input from numerous road ends and confirmed that while some were high, many contributed relatively little to Higgins Lake. Many road ends have been modified since 1984, but reevaluation of some road ends is likely warranted. Schultz and Fairchild (1984) also note that the contribution of surface runoff varies with precipitation. Fortunately, because the soils in the Higgins Lake watershed allow precipitation to infiltrate very rapidly, nutrient loading by surface runoff from forested areas should not be considered an important source. Lastly, they recommended banning lawn fertilizers within 100 yards of the shoreline to protect shallow nearshore areas. Currently there is an ongoing campaign to reduce the use of lawn fertilizers which are considered to be a risk.

Shoreline erosion presents an additional source of nutrient loading to Higgins Lake. High water levels that result in shoreline erosion reduce the amount of shoreline vegetation that may have the capacity to take up nutrients before they enter the lake. Perhaps more important is that the condition leading to shoreline erosion (high water levels) will potentially raise groundwater levels. Higher groundwater levels will reduce the distance between septic tanks and groundwater thereby decreasing the capacity for soil-septic effluent interaction. Depending on the rise in the water table due to higher lake levels, nearshore septic systems may be inundated.

Septic Effluent a Primary Concern

If there is a true desire to improve and protect Higgins Lake, both historic and current data clearly indicate that reducing nutrient loading needs to be a priority. Although there are ongoing efforts to reduce the introduction of nutrients from several sources, the need to reduce nutrient loading to groundwater from septic effluent is paramount. Fortunately, because of the range of previous studies and ongoing annual lake assessments, we have a good grasp of the issues that Higgins Lake faces and the actions required to address them. Research indicates that a sewer system is essential in addressing these issues.

A Review of Higgins Lake Nutrient Loading Estimates

Planning for the sewer system has been based in part on several studies that have developed nutrient loading estimates for Higgins Lake. Many of these studies model the amount of phosphorus entering the lake from septic tank effluent. However, models estimating the same parameter (e.g., nutrient loading) for the same system often return different results. This fact is not surprising given that nutrient loading estimates are the result of various parameters used in the model and various assumptions made by the author(s).

When developing a model, the values used for model parameters and assumptions made are based on the information available at the time the study is conducted. Subsequently, new information becomes available which allows models to be refined and updated, often providing estimates (in this case nutrient loading) that are typically more representative of actual conditions. Because several modeling studies (and more recent empirical data) developed for Higgins Lake over the past 30+ years have estimated different loading rates, a critical evaluation of the available nutrient loading estimates in light of new information may offer some clarity and new insights.

Estimates of nutrient loading vary depending on the date of past studies and model parameters such as the width of the zone of study. The width of the study area has ranged from 300 feet from the lake to 1000 feet from the lake. Expanding the zone that contributes to nutrient loading from 300 feet from the lake to homes within 1,000 feet is based on two major factors that have emerged since the early 1990's: 1. The demographics of the Higgins Lake area has changed significantly since the early 1990s, and 2. the more recent study conducted by Martin et al. (2014).

Based on the study by Martin et al. (2014), expanding the zone of influence from 300 feet to 1000 feet is valid and reveals a much greater issue than previously recognized. Indeed, the previous estimates of nutrient loading into Higgins Lake are very likely significant underestimates of the true nutrient loading rates due to septic effluent.

Assuming that nutrients in septic effluent generated more than 300 feet from the lake will never reach the lake or are significantly reduced due to soil adsorption capacity could underestimate loading rates by as much as two-thirds.

Beyond the empirical data reported by Martin et al. (2014), there is additional information that supports expanding the zone that contributes to nutrient loading, specifically incorporating new soil information. Obviously, soil type plays a critical role because soils have the capacity to adsorb nutrients such as phosphorus, albeit at varying rates. The nutrient binding capacity of soil is based on a complex of chemical interactions: water infiltration rates, groundwater flow rates (e.g., Martin et al. 2014), distance between the nutrient source and the groundwater, and how long the soil has been subject to the addition of nutrients. Although early modeling studies suggested that the soils around the lake had a very high capacity to bind phosphorus, the new soil information indicates that those soils are not as common as thought. We now know that soils close to the shore are a combination of soil types, and the majority of soils beyond the 300-foot boundary have very low binding capacity.

Ultimately, even soils with relatively high nutrient binding rates will realize a significant drop in binding capacity. Even in areas with soils that have high phosphorus binding capacity, the amount of phosphorus that will be retained is not infinite. As phosphorus binds to particles in the soil, the total binding capacity is diminished over time. Consequently, less phosphorus is retained in the soil and more is transported to the groundwater and into the lake. In areas with numerous septic systems, the issue may be more severe. The soils between the lake and nearest septic system may have reduced binding capacity due to the system nearest the lake. This allows effluent from the septic systems farther from the lake to pass through with far less phosphorus (and other nutrients) being removed from the effluent.

Although the effect of nutrient loading in the lake is obvious, the need to reduce nutrient loading to groundwater from septic effluent was recently made clear by information on nitrate levels presented by the Central Michigan Health Department.

Their data show that concentrations in some residential wells now exceed the EPA drinking water standards for nitrate and a significant number of wells have levels that are of concern. High nitrate concentrations in drinking water can cause severe complications during fetal development and in young children, and recent information suggests a link to various abdominal diseases. As large as the concern is about the health of Higgins Lake, human health has now emerged as an additional, and in some cases an even greater, concern due to the high concentrations of nitrates.

Conclusion: Action Needed

Taken together, the data presented by Martin et al. (2014) and Minnerick (2001), a reevaluation of soils within the watershed, and the changes in regional demographics strongly suggest that nutrient loading to groundwater from septic effluent is a long-term and persistent issue. In addition, nutrient loading due to septic effluent has very likely been underestimated by earlier modeling studies. Even strict septic maintenance ordinances will likely do little to improve conditions.

High nitrate levels in private wells, high phosphorus levels in nearshore groundwater and surface water, and biological changes occurring in Higgins Lake all indicate that septic effluent is having a major impact within the Higgins Lake watershed. This unnatural increase in nutrient loading to Higgins Lake has resulted in substantial ecological changes to the lake. Unfortunately, the health of Higgins Lake will only continue to deteriorate if septic effluent continues to be released into the surrounding soils.

As the saying goes, “The best time to plant a tree was twenty years ago; the second best time is now.” The same holds true for a Higgins Lake sewer system.